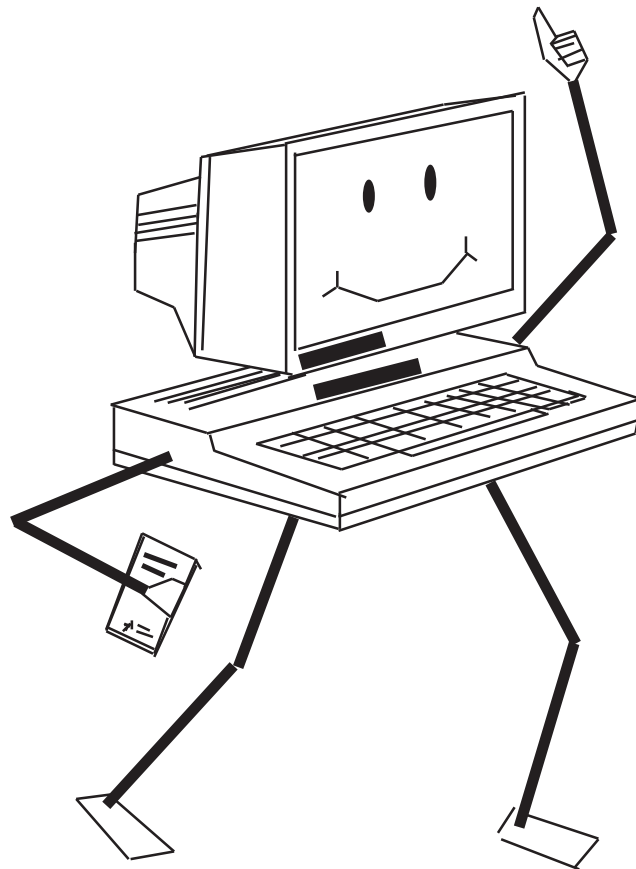


Tandy's Little Wonder The Color Computer 1979-1991

*A complete history and reference guide to the CoCo and all
related hardware, software, and support sources.*

by F.G. Swygert



SECOND EDITION - UPDATED FEB 2006

INSIDE FRONT COVER

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colored paper.

Tandy's Little Wonder

the Color Computer: 1980-1991

(and still going strong into the next century!)

Second Edition

written & edited by F.G. Swygert



The Original Tandy Color Computer

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Published by FARNA Systems
147 Tom Moore Road, Leesville, SC 29070
e-mail: farna@att.net

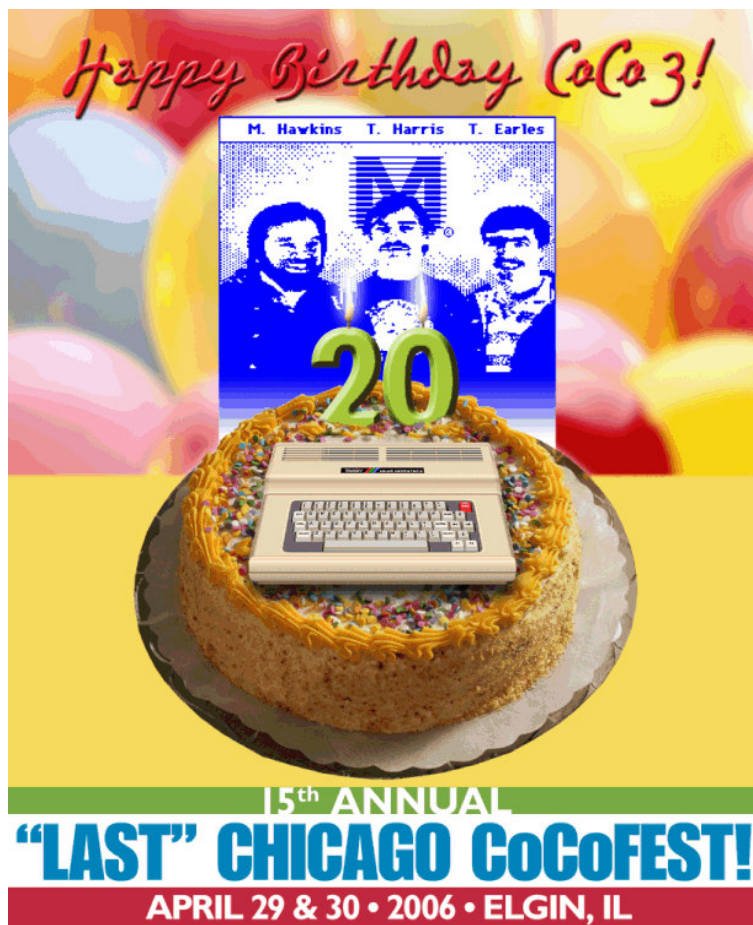
Tandy's Little Wonder

the Color Computer

SPECIAL ACKNOWLEDGEMENTS:

The following individuals have made contributions directly or indirectly to the content of this book :

Frances Calcraft
Lee Duell
Thomas Fann
Art Flexser
Marty Goodman
Frank Hogg
Alan Huffman
Don Hutchison
Carmen Izzi Jr.
M. David Johnson
Bob Kemper
Mark Marlette (Cloud-9)
Nicholas Marentes
Dave Myers
Bob Montowski
Alfredo Santos
Kelly Thompson
Jordan Tsvetkoff
Rick Ulland
Brian Wright
Glenside Color Computer Club
Mid-Iowa & Country CoCo Club



Banner for the 15th "Last" CoCoFest annually hosted by
Glenside Color Computer Club -- true stalwarts of the CoCo Community!

*This edition is dedicated to all those who continue
to collect, use, and enjoy the Tandy Color Computer.*

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All design and editing performed by F.G. Swygert.

First Edition Printed in U.S. by CopyMasters, Warner Robins, GA., 20 April 1993.

Second Edition Published via PDF by FARNA Systems, Leesville, SC, 29 April 2006.

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writing conventions *used in this book....*

In the course of writing, some standards were set so as not to confuse the reader.

***Hardware modifications, upgrades, and repairs** are referred to throughout this book. At times, the references given may not seem clear. They are written in such a way that a person with some understanding of electronics and the CoCo can easily figure out what to do. *If you do not understand the directions, you probably should not attempt the operation alone... get help!* **THE AUTHOR, PUBLISHER, NOR PRINTER ARE RESPONSIBLE IN ANY FASHION FOR THE RESULTS OF ANY PROJECTS OR REPAIRS MENTIONED IN THIS BOOK, TO INCLUDE BODILY HARM, LOSS OF EQUIPMENT, OR LOSS OF DATA!**

*** All references to hexadecimal addresses** are written as “&Hxxxx”. The “&H” is used to precede the actual hexadecimal value when poking into memory to let the computer know the value will be in hexadecimal. Some other texts use a dollar sign (\$) in front of a value to mark it as being hexadecimal, others use an asterics (*) or don't mark it at all, as eight bit hexadecimal values usually contain numbers and letters.

*** When Radio Shack lists an item** mentioned in their catalog (especially parts), the part number will be listed in parentheses. This is not to encourage patronage of Radio Shack, but there is a Radio Shack in or near almost every town across the U.S. One would be better served to find an electronics parts store with a better small parts stock than RS, or mail order parts from one of the following:

**All Electronics Corp.
P.O. Box 567
Van Nuys, CA 91408**

Order phone 1-800-826-5432, call for catalog. Minimum order is \$10 plus \$3.50 shipping and handling.

**Mouser Electronics
2401 Hwy 287 North
Mansfield, TX 76063**

Phone 817-483-4422, call or write for catalog.

**Digi-Key Corp.
P.O. Box 677**

Thief River Falls, MN 56701-0677

Order phone 1-800-344-4539. No minimum order, minimum shipping charge of \$5 (no shipping if order over \$25). No Motorola chips listed, but will supply non-listed items if available. Volume discounts for orders over \$100.

**Jameco Electronics
1355 Shoreway Road
Belmont, CA 94002**

Order phone 415-592-8097, call for catalog. \$20 minimum order plus 5% shipping and handling. Catalog usually has some IC pin-out information and RAM/EPROM cross reference... good reference source.

*** The following abbreviations are used:**

A/L - Assembly Language

ANSI - American National Standards Institute

ASCII - American Standard for Computer Information Interchange

BASIC - Beginners All-purpose Symbolic Instruction Code

BPS - Bits Per Second

CCx - Color Computer, x = 1, 2, or 3

CMOS - Complimentary Metal Oxide Silicon (chip construction)

CoCo - Color Computer

CPU - Central Processing Unit (actual processor chip)

DECB - Disk Extended Color BASIC

DOS - Disk Operating System

DRAM - Dynamic RAM

EDTASM or EDT/ASM - Editor/Assembler, usually the Tandy product

EMAIL or E-Mail - Electronic Mail

EPROM - Electronically Programmable Read Only Memory

GIME - Graphics, Interrupt, Memory Enhancement (chip, in CC3)

GUI - Graphic User Interface

IC - Integrated Circuit (a “chip”)

I/O - Input/Output

M/L - Machine Language

MPI - Multi-Pak Interface

MS - Milli-Seconds (millionths of a second)

MS-DOS - MicroSoft Disk Operating System

NMOS - Negative Metal Oxide Silicon (chip construction)

OS - Operating System

OS-9 - Operating System (for the 680)9

PIA - Peripheral Interface Adapter

PCB - Perforated Circuit Board

P/S or PS - Power Supply

RAM - Random Access Memory, usually meaning DRAM

ROM - Read Only Memory

RS - Rat Shack... er... Radio Shack (division of Tandy Corp.)

SAM - Synchronous Address Multiplexer

SECB - Super Extended Color BASIC

SIG - Special Interest Group

SP - Slot Pak (also used for Slot Pak II)

VDG - Video Display Generator

VOM - Volt and Ohm Meter (multimeter)

WYSIWYG - What You See Is What You Get

(and probably others not listed!)

Introduction...

Alfredo Santos, December 1990

While skimming through the pages of a popular Color Computer magazine recently, my thoughts traveled back through the 12 years of Color Computer history. Back to a time when there was NOTHING. I recalled the events leading up to my introduction to this wonderful machine. It seems like only yesterday...

Christmas morning 1980: Pam, my wife, must have known that I was very interested in getting a computer because, there, under the tree was the new Mattell Intellevision! Pam bought that machine due, in part, to the computer capabilities the unit would have with a keyboard console, scheduled for release in the spring. After several days of gunning down waves of aliens, we both suffered from blurred eye sight, blistered fingers, lack of sleep, and video game burn out. Spring seemed so far away.

A couple weeks after Christmas, I came across an ad in the New York Daily News for a new Radio Shack computer which, like the Intellevision, had game cartridge capabilities, an important feature because, if I didn't like computing, I could always go back to cleaning up the galaxy. For the refund price of the Intellevision (sorry Pam) plus another \$150, I had enough money to purchase the new TRS-80 Color Computer. I celebrated the arrival of an early "spring". It was January 9th, 1981. It seems like only yesterday.....

This project was, to say the least, a labor of love. Every attempt was made to ensure an accurate account of the Color Computer's evolution. Extensive use of various computer magazine articles and ads were used as the basis for "dating" events. This "dating" method was used because most of us probably heard about various developments through these sources. Keep in mind, however, that sometimes ads can precede product availability by as much as a month or more. Those of you who ordered the very first "Super Color Writer" program from Nelson Software know what I mean. Other information sources included printouts and files from old bulletin board sessions, telephone interviews, and correspondence with various users.

Before starting, let me just say that, while looking through the numerous back issues for Color Computer information, a strange thing started happening. Remember that frustrated feeling, of the early years, when YOU looked for Color Computer information and none could be found? It all started coming back to me.....

Francis G. Swygert, March 1993

Al graciously allowed me to use his existing text which was written for submission to The Rainbow Magazine. Rainbow decided not to print it, so Al released it to the public over Delphi (a major computer database). Als' format and style were used pretty much intact for the history portion of this book, though heavily edited and added to in places by myself. The original text only went up to June of 1986. All history text after that date and all additional information was written by myself (except where noted). Many thanks goes to Al and the other contributors! I can also echo Als' opening statement: this project was definitely borne out of a love for the little computer we affectionately call CoCo..

It is also important to remember just how this text is written. This was not intended to be a definitive history. Indeed, it is the authors' belief that the CoCo is far from being relegated to history as of yet. Instead, the history portion is more of an overview of what has happened in the life of the CoCo over the years, almost a "time line" type of chronology. The entire book itself is a complete CoCo reference book... the "CoCo bible", so to speak.

Francis G. Swygert, February 2006

This was not intended to be a definitive history, but it has pretty much become so. When the first edition came out, there was still a lot of life left in the CoCo. I used one myself until 1997 for all my on-line needs and a few other tasks, until the graphics intensive "World Wide Web" took over. The CoCo just doesn't have the graphics capability of newer computers. Nevertheless, it is still a favorite of experimenters and has a "retro computing" following as well. As powerful as modern computers are, they are also daunting for the average person to learn to program or to experiment with. Those are both areas the CoCo is well suited for. There may not be any more made, but there are still thousands out there.

I never intended to print a second edition, especially not this far after the first, but an active, though small, CoCo community has inspired me to do so. It is my sincere hope that this volume, this "CoCo survival guide", helps keep those computers alive in the hands of hobbyists for another decade... and beyond.

CoCo History

From Birth to the Present...

HOW THE COCO WAS BORN:

The initial Tandy/Motorola connection occurred sometime in the mid-70s when the two were invited by the U.S. National Weather Service to assist in developing a "weather radio" system. In 1977, a year after starting talks with Motorola about the possibility of designing a low-cost home computer that could be hooked up to a regular TV set, Tandy was invited to participate in an agricultural experiment. Project "Green Thumb", as it was called, would employ information retrieval to give farmers data, updated hourly by computer. Terminals used in this project were developed by and sold by Radio Shack in conjunction with Motorola. Terminals were distributed to 200 farms in Shelby and Todd counties, Kentucky. The "Green Thumb" network was sponsored by the National Weather Service, U.S. Department of Agriculture, and the University of Kentucky.

By late 1977, Motorolas' MC6847 Video Display Generator chip was developed. Although it was unclear if the VDG came about because of project "Green Thumb" or Tandy's search for the "low-cost" home computer, in 1978, when it was married to the MC6808 CPU, the Color Computer was born. This "prehistoric" Color Computer, however, contained too many chips to make it affordable for Tandy's anticipated target market. Motorola solved this problem late in the year by replacing the network of chips which made up the memory management circuits with its newly developed MC6883 Synchronous Address Multiplexer (SAM) chip.

In December of 1979, about a year after production began on the MC6809 microprocessor, reports circulated that it would be Microsoft, and not Motorola, that would write the Basic interpreter for the new "TRS-90". The name TRS-90 was eventually dropped in favor of a much more "colorful" name.

THE FIRST YEAR (Jul '80 - Jun '81)

On July 31st, 1980, two months after unveiling their TRS-80 Videotex terminal, Tandy publicly displayed its three new computers for 1981: the TRS-80 Model III, the TRS-80 Pocket Computer and the **TRS-80 Color Computer**. **In September, the Color Computer started appearing in Radio Shack stores. It sold for \$399.00** and came with 4K RAM, 8K Microsoft Color Basic 1.0, a 53 key calculator type keyboard, built-in video modulator to allow connecting to any television, RS-232 interface, a 1500 baud cassette interface, joystick connectors, and a slot where Program Paks could be inserted. In BYTE magazine's October issue, an article speculated that of the 3 new Radio Shack machines the TRS-80 Color Computer would probably create the most interest in consumer markets. **Steve Odneal** and **Wayne Day**, in the market for machines at this time, purchased Color Computers and yes, Virginia, some jumped

C-boards were sold. Tandy, meanwhile, was rumored to have a quality control hold on the Color Computer following several reported failures after only a few hours of operation.

'68 **Micro Journal** published the first data sheets for the new MC6883 (SAM) chip in November, but there were few Color Computer owners out there to read it. Radio Shack, at the same time, released the first Color Computer software. This **ROM-Pak** cartridge software included Chess, Checkers, Quasar Commander, Personal Finance, and a Diagnostic Pack. By the time December rolled around, there was a 16K upgrade available from Radio Shack, which would be required for the delayed Extended Color Basic ROM, which was only a month away from introduction.

If the Color Computer you got as a Christmas gift was your first ever computer, you were probably unaware that the "Getting Started with COLOR BASIC" manual accompanying the early machines contained only 13 of the scheduled 24 chapters. Radio Shack explained, in the December issue of its TRS-80 Microcomputer News, that when the machines were ready to ship, the manuals weren't! Rather than keep the Color Computer from customers, they sent what was available. It was probably more a case of not wanting to lose out on Christmas sales that prompted the decision to ship with incomplete documentation. With the only available information being found between the covers of the unfinished "Getting Started with COLOR BASIC" manual, the first year was like being in the Dark Ages for the small but hardy band of early Color Computer owners.

The place to look for information was either from your local Radio Shack store (probably the person who sold you the computer) or from Tandy's customer service. Salespeople, unless they were also "computer people", could offer little if any information. If you were lucky enough to find a salesperson with computer know-how, chances are it was Model I/Z-80 know-how. No help there. Customer service in Fort Worth, on the other hand, had plenty of information, and was only a toll-free call away. Unfortunately, Raymond, Martin, and Kathy wouldn't tell you much more than what was in your manual. Another dead end.

One of the first books detailing the internal workings of the 6809 was published in late 1980. Authored by Dr. Carl Warren, "**The MC6809 Cookbook**", contained all the information required for assembly language programming. Unfortunately it preceded the first Color Computer editor/assemblers by about 8 months and this book was pretty much overlooked.

Computer magazines, at this time, were filled with articles and reviews about every computer except the Color Computer. When anything did appear, it was usually comparing the Color Computer (unfavorably) to the Atari 800. Reviewers pointed to the "chicklet" keyboard, limited screen display (16 x 32), inverse lower case, and small RAM size as areas which make the Color Computer less desirable than even the Atari 400 or

the VIC-20. Perhaps I'm too sensitive but, I couldn't help feeling "they" were laughing at MY computer! Did anyone else get that feeling? If so, realize this: Every computer mentioned so far in this book was discontinued long before the Color Computer. Remaining virtually unchanged in its' first five years, our "toy", as it was often called, continued to flourish while the others died off one by one!

Three major events, instrumental in paving the way for the Color Computer information explosion, occurred in the opening months of 1981. **The Micro Works** and **Computerware** shared the distinction of being the first folks to offer software for the Color Computer. The "**CBUG**" monitor program and the "**80C**" disassembler, both from The Micro Works' **Andrew Phelps**, were released in January. Accompanied by documentation containing information about the Basic ROM, these fine programming tools would, in the right hands, reveal even more information about how the Color Computer worked.

With the arrival of Radio Shack's **Direct Connect Modem I** in February, a feeling of "community" began spreading among the isolated Color Computerists. Using Radio Shack's **Video-text**, the first communications package for the Color Computer, users started "meeting" on **CompuServe** or, more frequently, local area bulletin boards to share information and discoveries.

Of less significance, but certainly of interest, **Spectral Associates** introduced a 16K upgrade (\$75.00), an editor/assembler, plus several other utilities and **one of the first games: Space Invaders**. They were also in the process of developing **Magic Box**, which would enable Model I & III tapes to be loaded directly into the Color Computer. Magic Box enabled many to easily port (transfer then re-write) BASIC games and utilities from the popular Models I & III to the CoCo.

The **Connection-80 BBS** (Bulletin Board System) of Woodhaven, New York, which went on-line March 22nd, was like hundreds of other Model I boards providing information for the Model I & Model III... with one exception. The sysop (system operator), having just purchased a Color Computer, started putting things on the BBS about the Color Computer and at 300 baud, news spread quickly about **Bob Rosen's BBS**.

One of the main topics of BBS "conversation" at this time was an article in **BYTE Magazine's** March issue entitled: "**What's Inside Radio Shack's Color Computer?**". Authored by **Tim Ahrens, Jack Brown, and Hunter Scales**, the article contained the most comprehensive information ever assembled, including an in-depth look at the 6809E architecture, the job-description of all the major chips, the expansion port pin-out, the famous **POKE 65495,0** speed poke, plus "... a tricky way to get 32K bytes of memory"! Although occasional Color Computer "tid-bits" were printed in various computer publications, they were usually in the form of reviews with no more information than found in the "Getting Started With Color Basic" manual.

If, in those early days, you looked for information in **Wayne Green's 80 Microcomputing**, you missed out on lots of material appearing regularly in a publication called **68 Micro Journal**. **68 Micro** carried the first information on the MC6883 SAM chip (Nov '80), the first Color Computer software ads and a tip on disabling the ROM-Pak auto-start (Jan '81), **Mickey Ferguson's** letter mentioning plans for starting **Colorware** (Jan '81), talk of an expansion interface from **F&D Associates** (Mar '81), and a letter from **Tallgrass Technologies** about their proposed disk system (Apr '81). The April issue also premiered the first dedicated Color Computer column, **Bob Nay's "TRS80CC"**.

Only in retrospect can **Don William's 68 Micro Journal** be truly appreciated. With a reader base made up of Motorola 6800 users, they, were among the first to realize the true potential of the 6809E powered Color Computer. Names like **Star-Kits, The Micro Works, Computerware, Mark Data, Cer-Comp, Frank Hogg** and others were in the pages of **68 Micro** long before there was ever a Color Computer. With its support of the Motorola 68xx series **68 Micro** attracted some early seekers, most, however, gravitated toward **80 Microcomputing**, others to **80 U.S.**, with still others trying **BYTE**. As more and more interest grew, it was inevitable that somebody, somewhere would start a publication exclusively for the TRS-80 Color Computer.

Color Computer News (CCN) was the first dedicated Color Computer publication to hit news stands. Edited by **Bill Sias** and published by **REMarkable Software** of Muskegon, Illinois, CCN premiered with its May/Jun issue, a 48 page beauty, filled with program listings, reviews, letters from other users, and articles! **Don Inman, Ron Krebs, Wayne Day, Tom Mix, Ken Kalish, Jorge Mir, Gary & Susan Davis, Tony DiStefano, D.S. Lewandowski, and Andrew Phelps** were just some of the "new" users (weren't we all back then) whose names appeared within the first few issues.

Another feature of CCN was all those lovely ads! Did I say ads?? As much as we may sometimes say we hate commercials, during the opening months of 1981 many users poured through various computer magazines searching, not only for articles, but for that occasional ad which may have mentioned the Color Computer. Lets face it, ads ARE an information source, especially when new software releases were few and far between. Although there were only a handful of companies supporting the Color Computer in its first year, there was a surprisingly large amount of great software and hardware that was available and/or under development.

The Micro Works had its CBUG, 80C disassembler, and 16K or 32K upgrades. Editor/assemblers and "space invader" games were both available from Computerware and Spectral Associates. **Eigen Systems** was putting BASIC programs in ROM-Paks. The **WOLFBUG** monitor from **Mike Wolf** accessed 64K of RAM. **F&D Associates** released a **ROM/EPROM board** and a **Proto Board** while announcing plans for

an **Expansion Interface**. Both **Tallgrass** and **Atomtronics** were developing disk systems, and **Steve Odneal's Color Computer FLEX** conversion was reportedly just about completed. Microsoft's **Bill Gates** (the daddy of Color Basic and Extended Color Basic) was interviewed in the May/June issue of 80 U.S. and said there would be a book dealing with the overall structure of both ROMs in the future.

As the Color Computer's first year came to a close in June, third party support was starting to gather momentum but, if Fort Worth didn't step up support, the TRS-80 Color Computer may die from parental neglect.....

THE SECOND YEAR (Jul '80 - Jun '82)

Following its 1980 debut, the CoCo bumped along with virtually no Radio Shack support. The next 12 months, however, would witness the biggest outpouring of Color Computer support to date. This period produced a flood of upgrades, modifications, hardware, software, and most important of all, information.

In July of 1981, the Color Computer's first anniversary roared in like a lion. Many users celebrated by upgrading to Extended Basic, buying various new peripherals, and/or signing up with CompuServe. A word of sympathy here for anyone who ordered **Nelson's word processor** advertised this month. By January of 1982, the software was still nothing more than an ad on the pages of a few magazines. This is often referred to as "**vaporware**"- lots of "hot air" (ads and other publicity), but no actual product.

Another ad appearing that July was for the **Exatron disk system**. "32K PLUS DISKS \$298.00", read the ad. One could call the listed toll-free number and be placed on a list. After about a month and a half the systems were finally delivered. Soon after most were ready for a return trip back to Exatron's Sunnyvale plant. The amount of generated RFI (Radio Frequency Interference) made the screen unreadable. This was in the early computer days, before the FCC (Federal Communications Commission) stepped in to regulate the amount of interference a computer system could generate. Many small computers had little or no shielding! This was especially hard on apartment dwellers, as just turning a system on could interfere with a neighbor's TV and radio reception. Model I users would remember this well!

Steve Odneal, at about this same time, was having a little bit better luck. With a home-built disk system hooked up to his 32K machine and 8K of RAM on the disk controller board, **Steve completed the first ever conversion of the FLEX operating system** for the Color Computer.

While Mark Data was rushing to convert their Model I adventure games to run on the Color Computer, **IMB (Illustrated Memory Banks)** released its first offering. Although

written in Basic, **Meteor Storm** was the first software to take advantage of the CoCo's graphics capabilities. Thanks to **Fred Scerbo**, who authored Meteor Storm! July also witnessed the introduction of the first educational software from **Micro-Learningware**, and **Strawberry Software**, plus the first detailed instructions on performing the 32K "piggyback" upgrade.

By the time CCN's Jul/Aug issue arrived on your doorstep, two more Color Computer publications had sprung to life. The first ever cassette based Color Computer magazine was **Dave Lagerquist's Chromasette Magazine**. Instant software on a monthly basis for a mere \$3.50 an issue was quite a deal! The "magazine's" first issue contained 5 Basic programs and a very moving "cover". Very impressive!! In addition, all tapes were accompanied by a 5 or 6 page news letter explaining the programs. The news letter also featured tips, the latest rumors (Radio Shack disks soon?), and some of the editor's own "colorful" insights, which brings us to the second publication inaugurated in July.

Whoever wrote the words, "From small acorns, large oak trees do grow" was, undoubtedly, referring to **Lonnie Falk** and **The Rainbow**. The Rainbow's first issue was all of two pages in length (both sides, of course) and you could tell immediately by the typeset (LP VII), that no expense was spared in putting together this latest collection of Color Computer information. The debut issue was photocopied at the corner drug store and after the first 25 copies sold out (\$1.00 each), another trip to the drugstore was needed for an additional 10 copies. Containing the usual assortment of Color Computer articles, comments, tips, and program listings, the Rainbow became "legitimate" by the third issue with its first ads from The Micro Works and **Jarb Software**.

Although initially set up for the Model I & III, by July, Bob Rosen's BBS was crawling with Color Computer information left by **Wayne Day**, **Syd Kahn**, "**Barefoot**" **John Griffen**, **Cal Rasmusen**, **Kent Meyers**, **Lee Blitch**, and many other "gurus" including **Jorge Mir**. Radio Shack's cassette based Videotex, because it was the first (and only) terminal program for the Color Computer at this time, was used exclusively by anyone calling Bob's BBS with a Color Computer. Videotex, a very limited piece of software, stored incoming information in a "buffer" but, downloading (transferring files/programs from the BBS to the calling computer), saving to tape, or printing out the buffer was not supported. When off-line, the only thing you could do with the buffer was look at it and, to make matters even worse, the only way to exit Videotex and return to BASIC was to shut off the machine. Thanks to the efforts of **Jorge Mir**, information started showing up on the BBS about a Videotex modification allowing an exit to BASIC by pressing the reset button, thereby preserving the text buffer. Download capability was not too far away.

The **SDS80C** from **The Micro Works** was the Color Computer's first editor/assembler. Although marketed in August '82, it had been a reality since June. It should be mentioned that **Cer-Comp** of Las Vegas, in a letter dated June 1, 1982, stated the availability of their editor/assembler which may make it actually "the first". The Micro Works, however, did get theirs to market first. Other notable releases in August included **Mark Data's** first two adventure games **Calixto Island** and **Black Sanctum**, **Tallgrass Technologies'** disk system and **64K RAM** adapter board, and **THE FACTS**, a Color Computer technical manual from **Spectral Associates**.

Barry Thompson, Tandy's Product Line Manager, in his column for Radio Shack's TRS-80 Microcomputer News, replied to Mark Grangers "PCLEAR 0" inquiry with this explanation: "...THERE IS NO WAY TO RELEASE THAT LAST PAGE OF GRAPHIC MEMORY....". Had Mr. Thompson read The Rainbow's second issue, he not only would have found out about the PCLEAR 0 trick but, he would have heard from a "very high placed source" that a Radio Shack disk system would be out within 2 months along with a 32K upgrade. Hadn't we heard those stories before?

September is a time to return back to school. A time for learning, and learn we did. We learned from Radio Shack that the much rumored 32K upgrade was finally a reality. Although not mentioned, the upgrade included both the new E-board and 1.1 Basic ROM. One discovered that the first Color Computer word processor, **C.C. Writer**, was available from **Transformation Technologies**. We were taught by **C.J. Roslund** that the PCLEAR "bug" could be fixed with a simple "reverse reference", and our homework assignment was to read **Clay Abrams'** documentation for another Color Computer first, his **RTTY/CW** communications software!

The Sep/Oct issue of CCN debuted a column which quickly became one of the most popular: **Comment Corner**. Written by **Andrew Phelps**, author of The Micro Works' CBUG, 80C Disassembler, and SDS80C, each column took an in-depth look at one of the Color Basic ROM routines.

A first this month (September) from **Computerware** was the Color Computer's first alternate language: **PASCAL**. Computerware also started marketing **Magicube** (a Rubick's Cube game), and **Color Data Organizer**. **Steve Odneal's FLEX** had, by this time, been converted to operate on the newly released Exatron system and, it worked like a "champ"!. According to Steve, the **Exatron expansion board** was the key, as it allowed the ROMs to be turned off and RAM turned on. Steve, while converting FLEX for the Radio Shack disk system, doubted the system would be capable of switching ROM to RAM. Steve would surely have gotten an "F" for his speculation that the Exatron disk system would be the "standard" disk system for the Color Computer, possibly surpassing even Radio Shack's.

The month for trick or treating, October, saw the first details about the Radio Shack disk system, the debut of **Bob Nay's Color Computer Users Notes in 68 Micro**, plus the release of **Aardvark-80's** first 7 games. Another October treat was **Dennis Kitsz's** article detailing a modification that would deliver "true" lower-case instead of those unsightly inverse characters. This was the **first lower-case board** for the Color Computer, and was also available in kit form from **MSB Electronics**. Marketing began on **Soft Sector Marketing's Master Control**, the first single key entry utility. If you ordered immediately you were told "...some problems have cropped up and we'll be a few weeks late in delivering it...". Not again!!! **Jorge Mir** wrote an article describing how Videotex could be modified to return to Basic upon reset, thereby giving the Color Computer its first BBS download capability (the buffer content could be saved to tape).

Although there were a few bulletin boards which supported the Color Computer, **The Ark** appears to be the first that actually ran on a Color Computer. "**Barefoot**" **John Griffen**, the sysop, operated the BBS from his houseboat in Portland, Oregon. Callers included **Steve Den Beste**, **Shawn Jipp**, **Bob Rosen**, and **Ed March**.

Mike Wolf started marketing his Color Computer **disk controller** around this time (October). Unless one had either inquired or ordered his **WOLFBUG** monitor, chances are one didn't hear about it because the controller was marketed only through direct mail. With a price tag of around \$350.00, the unit included an 80 column card, real time clock, and parallel printer port. In a phone interview, Mike said that a Michigan Computer Club was responsible for the sale of about 10 pieces.

The name "TRS-80" stands for Tandy Radio Shack and the 80 was a result of the Z-80 cpu in Tandy's first computer, the Model I. Because the CoCo uses a 6809 cpu, maybe it should have been called either a TRS-68 or a TRS-09 Color Computer, but what's in a name? Some nicknamed it the TRS-80CC, other the TRS-80C, still others the 80C. It was **Dave Lagerquist** who first used the name **COCO** in October's **Chromasette Magazine**. This innocent enough action set off a "name calling" debate lasting for several months throughout the ever growing "CoCo" community.

Some things in the November winds included a tip to reduce internal heat produced by the 32K "piggyback" upgrades by painting the inside of the CoCo's top cover flat black, a rumor that Radio Shack was using half-good 64K chips in its 32K upgrade, and an interesting article about CoCos being used to control **Mr. Walt Bolden's** solar heated home in Washington state. The computers were set up by **Home Computer Systems, Inc.**, of Seattle. November also brought the first review of the Exatron disk system, the **Programmers Institute's** tape magazine, **TRC**, but still no Super "Color" Writer.

Nelson Software may have been dragging its feet, but not **Cognitec**. Within a couple of months of its November release,

Telewriter was the talk of the CoCo community. Telewriter was the first "world-class" CoCo word processor. To this day, Telewriter is probably **the most used** CoCo word processor—nearly every Color Computer owner has used Telewriter in one of its variations.

Although it was possible to do primitive Videotex downloading, **Colorcom/E** from **Eigen Systems** was light years ahead. It supported on-line/off-line scrolling, cassette file transfer, automatic or manual data capturing, off-line print-outs, and selectable RS-232 options. When **Mark Davidsaver's** Colorcom/E was ready for shipping, he mailed flyers to those who had responded to his "put your Basic program on a ROM" ad (June '81). Bob Rosen, upon receiving his flyer, immediately phoned Mark. Colorcom/E became the first major software sold by Bob's Connection-80 BBS. The rest, as they say, is history.... for both Bob and Colorcom/E.

December saw not only the release of **Computerware's Pac Attack** (the first of many PAC-MAN clones) but a review of the Tallgrass Technologies disk system. This was probably the only disk system ever which would run in 4K!

As 1981 drew to a close, reviews and comparisons were being made between the new Radio Shack disk system and the Exatron system. The consensus of opinion seemed to be that Exatron's single density format was its biggest drawback, as it stored less information on a single diskette than the Tandy double density format.

With third-party support growing dramatically, and even Radio Shack waking up, the CoCo's future seemed secure but, into each life, a little rain must fall...

THE COLOR COMPUTER IS DEAD!

Now, when most of us hear rumors, we usually consider the source. The more reliable the source, the more accurate the "information" is likely to be. Although it had been rumored for a while that Tandy was dropping the Color Computer, the rumor takes on special significance when, in January, it appears in **Wayne Green's 80 Micro** editorial. Since the beginning, critics had always pointed to the CoCo keyboard and snickered. A **Dennis Kitsz** article put a stop to all that by replacing the "chicklet" keyboard with a Model I keyboard (what would Dennis do next?).

Bob Rosen started his company, **Connection-80** (named after his BBS) in January and his first advertised CoCo product was Colorcom/E. Although Eigen ran his own separate ads, Bob's BBS probably accounted for a majority of initial sales. With every BBS sign-on being accompanied by a little "commercial", word spread very quickly, as the popularity of both Colorcom/E and the BBS grew rapidly. Truly a marriage made in computer heaven!

1982 marked the start of CCN being published monthly. It also witnessed the debut of **DSL's ML Rabbit**, **Sugar Software's Silly Syntax**, **Martin Consulting's Smart Term**, **Moses Engineering's Light Pen**, **Tom Mix's Moon Lander**, and **Frank Hogg's CCFORTH**.

In February, resumes were being accepted for the sysop of a **Color SIG** (Special Interest Group) which would soon be starting up on **CompuServe**, while in New England the CoCo was being used at the University of Vermont. Other events taking place at this time include the disk version of Telewriter undergoing final testing, **Steve Blyn** (soon to start **Computer Island**) marketing his first educational software, and violently negative reactions to Wayne Green's editorial started surfacing. Wayne sure didn't make too many friends that month!

CCN's February issue was probably the best issue of any Color Computer magazine ever published. The issue was special for several reasons. If you were looking for a method of transferring your tape files to disk there was **TPTDSK** from **Jack L. Aker**, **Tony DiStefano's** article on running machine language programs from disk, and **C.J. Roslund's** article on disabling the BREAK key. What really marked this issue worth its weight in gold, however, was the article appearing on page 23...**32K RAM FOR FREE!!!**, by **Frank Hogg** (see FHL story for more on this).

After Radio Shack's 32K upgrade became available, rumor had it that the "32K" chips used were, in fact, half-bad 64K chips. Frank Hogg's article detailed the steps required to enable your Radio Shack 32K CoCo (not "piggyback" 32K) to go into the "all RAM" mode, thereby giving the CoCo an effective 64K of RAM. Frank speculated (correctly) that, although very early 32K Radio Shack upgrades may have contained the half-bad 64K chips, most 32K upgraded CoCos contained prime 64K chips. Radio Shack's 32K upgrade also included the E-board and 1.1 Basic ROM. Although Frank Hogg didn't perform (or even make available) the first 64K upgrade, his article did bring to the CoCo community the information required to double the computer's effective memory and, in so doing, created a base for his FLEX operating system.

In March, **Kraft's new joystick** (available within 2 months), **Type-N-Talk** from **VOTRAX**, and **George Associates' Z-80** based **CP/M interface** were three new CoCo products previewed at the **West Coast Computer Fair** in San Francisco. **Data-Comp** debuted their **FLEX** operating system by marketing **Steve Odneal's** conversion which, at the time, utilized the Exatron disk system. In an attempt to pacify software reviewers who had been waiting for the long overdue Super Color Writer, **Nelson** shipped their **Super Color Terminal**. Magazine articles at this time include **Shawn McClenahan's** detailed instruction on various 64K upgrades, a non-Kitsz hardware project for those of us who were tired of constantly switching the modem and printer cables from the back of the CoCo, and Frank Hogg's article on moving ROM to RAM in your "new" 64K CoCo. Perhaps in light of February's

information flood, both CoCo publications seemed to have had a lack-luster March issue. If I hear about the double-speed poke one more time, I'm going to scream!!!!!!

With 2 FLEX operating systems available for the CoCo, **Microware** started looking into the possibility of porting its **OS-9** operating system. Meanwhile, **Dale Puckett's** article "FLEX Comes To The Color Computer" along with the first installation of Frank Hogg's column "64K Korner" appeared in the April issue of CCN, marking their increased FLEX coverage. **Clay Abrams'** article, "Amateur Radio and the TRS-80 Color Computer", dealt with the reception of SSTV pictures. Wonderful information for ham operators, but it seemed like all the useful utility listings that had come to be expected from CCN were starting to disappear.

The Rainbow, which by April had grown to **52 pages**, contained the first part of **Dennis Lewandowski's** column called "The Assembly Corner", plus **Rainbow On Tape**. Telewriter's disk version was being marketed by this time along with several other new CoCo products, such as **HUMBUG**, a machine language monitor program from **Star-Kits**, various software from **Prickly-Pear Software**, **Auto Run** from **Sugar Software**, **The Solution** (the first hi-res screen utility) from **Snake Mountain Software**, and **NANOS Systems** reference card.

Wayne Green must have freaked out when, in May, Tandy opened a 100,000 square foot plant in Fort Worth specifically to build Color Computers. Several New Jersey schools also started using the machine at this time. Seems like everywhere Wayne Green looks, there are CoCos (dying of neglect, no doubt)!

CCN celebrated its first year anniversary with apologies from Bill Sias about the "double" issue but, said it was needed to get back on schedule. While still a source of valuable information, the number of good articles and programs seemed to be declining.

Some CoCo firsts in May included an **EPROM burner** from **Computer Accessories**, **Disk Doctor** from **Superior Graphics**, **Spell 'N Fix** from **Star-Kits**, and the first **BASIC Compiler** from **Aardvark**. **Spectrum Projects** debuted as Bob Rosen dropped the name Connection-80. And finally, a review of **Super Color Writer** from **Nelson**.

The first national CoCo Users Group was inaugurated in June when **CompuServe** started it's **Color Computer SIG** with a membership of 52 and **Wayne Day** as sysop. **80 Micro** ran an interesting biography about **Bob Rosen** and his **Connection-80 BBS**. Thanks for the plug, Bob! Newly introduced CoCo support included **Micro Technical Products' LCA-47 lower-case kit** (the first kit featuring switch selectable inverse screen), and the **Rainbow Seal of Certification**. Started by The Rainbow magazine, certification insures that the product does, in fact, exist. **John Walco's** 3 part article on picking winning NFL teams with the CoCo began but, unfortunately, there would be no winners that year because the NFL went on strike.

Was it my imagination, or were both Color Computer magazines getting stale? Due, perhaps, to the sudden abundance of CoCo information in the second year, both appeared to be getting a bit thin.

THE THIRD YEAR (Jul '82 - Jun '83)

Despite rumors of its demise, the COCO celebrated its third birthday in fine health. With year 1 shrouded in mystery, and year 2 producing tons of information and software, what could we expect from year three?...**ARCADE GAMES and HARDWARE!**

First shown at the West Coast Computer Fair in February, **George Associates' CoCo CP/M expansion unit** hit the market in July. Although it looked impressive, who was going to drop \$1200.00 to upgrade a CoCo? Did anyone out there buy one of these??

In July, in "the best get better" department, **The Micro Works** unveiled its disk based editor/assembler, **MACRO-80C**. **Tony DiStefano's** first "Color Clinic" column in **68 Micro** explained why some CoCos would not accept the double-speed poke, and **Donald J. Sommer** of Seattle, Washington, detailed the steps required to upgrade a pre E-board CoCo to 64K. CCN continued putting more emphasis on FLEX, OS-9, and other CoCo operating systems but, features **Darrel Wright's** utility to convert Telewriter text files from binary to ASCII and vice-versa, and some pictures taken at a Cincinnati TRS-80 users meeting. Plans were disclosed to offer **CCN on Tape** and winners of the first CCN programming contest were announced. They were: J. Ventling for the George C. Scott portrait, Garry Howard for the William Tell Overture, and Regena's Cookie File program. **The Rainbow's first anniversary** issue was a beauty!! Featuring its first full-color cover and typeset copy throughout, it's hard to believe that it started out in a drugstore a year ago. Rumors circulate that the 4K CoCo will be discontinued and a 64K version will be introduced in the near future.

The first CoCo hardware to reach the market in August included **F&D Associates' EPROM board**, **Color Port** from **Maple Leaf Systems**, **Botek Instruments' serial to parallel printer interface**, & Shawn McClenahan's article describing the installation of a Model III keyboard (w/ numeric keypad) in the CoCo. **80 MICRO** ran its first annual Reader's Poll to find out the most popular software for Radio Shack machines.

With **Frank Hogg** writing the editorial in the August issue of CCN, things were really getting out of hand with all the FLEX material. There was the editorial, plus several full-page ads for his products, and of course his 64K Korner. It seemed like CCN had turned into the Frank Hogg magazine. Although a bit less technically oriented, The Rainbow continued growing and soon surpassed CCN in size.

With the addition of his second BBS, **Bob Rosen's Spectrum Projects** was growing too. His ads now took up three full pages, and in August, included **Eigen's** one key entry utility, **BASIC Aid**. Both **BASIC Aid** and another new single key entry utility, **Platinum Software's Platinum Worksaver**, offered much more than the first such utility, **SSM's Master Control**. **Med System** started marketing its software.

The "eyes" have it!! In September **Tony DiStefano's Color Clinic** column featured the eye-saving hardware mod which enabled the CoCo to display green characters on a black screen. Whenever I sat at my machine for hours on end (usually every night), I thanked "Tony D.". **Motorola** released a "souped-up" **MC6883 SAM** which supposedly allowed double-speed operation in the all RAM (64K) mode, but it was never marketed. New arrivals for the CoCo included **Star-Kits' STAR-DOS**, **The Toolkit** from **Arzin**, **joysticks** from **Endicott**, **Spectrum Projects' "gloom" stick**, **Game Writer** from **Washington Computer Services** (a \$129.00 program that helped write "super-action video games"), and software from a new company called **ANTICO**.

September's CCN issue (no date on the cover) featured a look at the CoCo's **INTERPRET** routine in **Andy Phelps' Comment Corner** column, **CCXREF** from **Mike Donahue**, a fine debugging utility used to locate variables in BASIC programs, and the first review of **Eigen's The Stripper**, a utility which removed spaces and comments, and "packs" program lines. **The Rainbow's 106 page** September issue made it the **BIGGEST** CoCo magazine in publication. Besides being their first official "theme" issue (education), and containing a readers survey, the **Rainbow's** cover mentions support for the **TDP 100** computer...

The TDP was Tandy's first venture at marketing outside Radio Shack stores. The TDP 100, which was really a CoCo in a white case, was marketed by RCA distributors and would later be found to contain the "F" (or "285") board, which would soon start showing up in the CoCo. Speculation was that the TDP venture would be successful (it wasn't!).

In October, **68 Micro** went on line with its BBS, and **Andy Phelps' last Comment Corner** appeared in CCN. **The Rainbow**, meanwhile, started **Charlie's Machine**, a column written by **Charles J. Roslund**, author of **War Kings**.

Dragon LTD., a British company, started making the **Dragon**, a CoCo clone. It used a similar BASIC and software but featured some major hardware differences- like full-travel keyboard, parallel printer port, and composite monitor output. An American version would be available sometime in 1983.

Messages on **CompuServe's Color SIG** rumored that a new CoCo magazine would debut in March of 1983. **MSB**, the folks who marketed the **Kitsz** lowerkit, folded. **Radio Shack** announced that they would market a **64K upgrade** and a **Multi-Pak Interface** in early 1983. **Basic Technology** marketed the first CoCo expansion interface with a real-time clock.

Just in time for Christmas, November releases included **Color LOGO** and a four color graphics printer from **Radio Shack**, **Frank Hogg's five slot expansion unit** called **The Solution**, and **Telewriter/64**. Other marketings were **Dunkey Munkey** from **Intellitronics**, and **Monkey Kong** by **Ken Kalish** of **Med Systems Software**. Although these are the first two "monkey" programs (actually "Donkey Kong" arcade game clones), the best is yet to come!

A premature ad for the **Sampo Color Computer** ran in November's **BYTE** magazine, but this CoCo clone never saw the light of day in the U.S. It was supposedly sold in Korea the next year. A reasonable assumption would be that the manufacturer couldn't get around U.S. copyright laws (the ROMs were probably near duplicates of the CoCo's), which were not legally protected in Korea and most other Asian countries.

With various disk systems available for the CoCo, the poor timing award went to **JPC Products Co.** for their high-speed cassette system. One can only wonder how many systems were sold at the \$129.95 price.

Lonnie Falk announced plans for a **big CoCo show** for the Spring of 1983 in Chicago. It will be called **RainbowFest!** **Lonnie** also hinted at an "electronic" **Rainbow** in conjunction with **Bob Rosen's BBS**. November also gave us the first look inside the new **TDP-100** computer, and the first review of **Eigen's disk ColorCom/E**.

When CCN first came out, it contained a lot of basic CoCo information, but with the magazine stalled at the 90-100 page size and **Bill Sias** devoting more ad and column space to **FLEX**, **OS-9**, **GIMIX**, and ham radio operations, much of the basic information was being squeezed out. The opening item in the December issue was a tour of the **GIMIX** plant!

Rainbow announced support for the **Dragon/32** in December, its first perfect bound issue (square back with glued in pages, just like a paperback book). **Tom Mix's** king of the **Donkey Kong** clones, **Donkey King**, was released just in time for Christmas. This is one of the best game ever done for the CoCo. Thanks Tom!!!!

DON'TBUGME!

1982 closed out with a tip of the hat to the very inventive folks in **Natick, Massachusetts** for coming up with a very imaginative idea..... **DEBUG**. The concept worked like this: You sent these folks a program you wrote that may have bugs. If the program is interesting enough, they send your program to "people who like to stomp on other people's bugs". The understanding was that the program is sold (by them) if debugged, and everybody shares in the profits! The ad asked for \$5.00 to accompany your "bugged" program, or \$9.00 for a cassette containing 20 or so "bugged" programs from other people, or \$12.00 for both. The idea of "buying" someone else's problems was (and still is!) a bit bizarre, however, and the ads soon disappeared.

In January Jake Commander (CCM) predicted the arrival of the British made Dragon computer early in 1983. CCN started the year with a new cosmetic look including a new cover ("The Color Computer Magazine for 6809 users") and newspaper quality pages.

Cosmetic changes also appeared in the Rainbow's January "Adventure" issue with the first **Fred Crawford** cover artwork! Fred brought a Norman Rockwell feel to the pages of The Rainbow, and many looked forward to Fred's covers. This issue probably had the first centerfold ever in a computer magazine.

Other January events included **Micronix Systems** marketing the first keyboard for the CoCo, **Dennis Lewandowski** writing the **Rainbow Check**, and dates confirmed for the first **RainbowFest**. It was held in Chicago, April 22-24th. **Peter Stark**, one of the pioneer CoCo supporters, started including little "tips" in his ads. Peter was a real innovator both in software and advertising.

In February, **68 Micro** eluded that they may be starting a CoCo publication to meet the explosion of "new" subscribers. Absent, for the first time since many issues of 68 Micro, are **The Micro Works** ads. Was something happening?

Most of the other February news included reports of CoCo products on display at last fall's **COMDEX** show in Las Vegas. The products included **AMDEK's** new **3 inch disk drives**, **WICO's joysticks and trackball**, and the long awaited **ZAXXON** from **Datasoft** (a licensed version of the arcade hit, not a clone!).

The February rumors were obviously true, because in March the third CoCo magazine hit the news stands. Edited by **Kerry Leichtman**, **The Color Computer Magazine (TCCM)** for short) premiered with articles from **Jake Commander**, **Bob Rosen**, **William Barden, Jr.**, and **Dennis Kitz**.

March's "nuclear" issue of Rainbow featured the first **Rainbow Scoreboard** and an ad for **Elite Software's ZAKSUND** (the first ZAXXON clone). The **Mark Data replacement keyboard** was also reviewed.

In **late April of 1983** users from across the United States and Canada (not to mention Great Britain, Germany, Hawaii, and the Yukon) descended upon Chicago to take part in the first ever CoCo convention, **RainbowFest!** Estimated attendance for this 3 day bash was around 10,000. On the sales floor, **J&M** unveiled its **JFD disk controller**, while seminars were held by **Don Inman**, **Fred Scerbo**, **Tom Nelson**, **Steve Bjork**, and **Charles Roslund**, to name a few.

TCCM's April showers included the cross reference index disassembly of 1.1 ROM, the first ad for **Computerware's 64K Screen Expander**, word that Bob Rosen was then operating 3 bulletin boards, Jake Commander's first installment of the

most ambitious commenting of the BASIC ROM ever, and the appearance of Datasoft's first ZAXXON ads. May brought flowers and a cross reference index disassembly of the 1.0 EXTENDED BASIC ROM to TCCM, plus a name change for **Med Systems** to **Screen Play**. What's in a name anyway?

The **Comment Corner** column returned to CCN in June, authored by **Andrew Hubbell**, and a list of differences for BASIC 1.2, EXTENDED BASIC 1.1, and DISK BASIC 1.1. CoCo's third year ended with two new releases. First: the long awaited and much rumored "new" Color Computer, the **Radio Shack MC-10**. Second: another Color Computer magazine, **HOT CoCo**, a **Wayne Green** publication, debuted without so much as a word of credit to Dave Lagerquist for coining the name "CoCo" for the Color Computer... oh well, we will remember!

THE FOURTH YEAR (Jul '83 - Jun '84)

CCN definitely seemed to be nearing its end. In July there was a full-cover photo of the **Dragon/32** but nothing on the inside about the computer. **Rainbow** magazine, now supporting the **MC-10** also, celebrated its **second anniversary with a 308 page issue** containing a two year index, a record with some BASIC programs, a look at the "new" MC-10, and a review of April's RainbowFest. Marketing began for **Un-Disk from Dr. Preble**, **Elite Calc** from **Elite Software**, and **PBJ's 80 Column Card**. If 64K wasn't enough for your CoCo, you could always try **Dennis Kitz's 128K bubble memory upgrade** which appeared in July's TCCM.

A new CoCo magazine, **68 Color Micro Journal**, was announced in August, which brought the number of dedicated magazines for the CoCo up to five. Just about all magazines carried articles on the **MC-10**. New product announcements in August included a **new CoCo keyboard from HJL**, the **Multi-Pak Interface** from **Radio Shack**, **Pirator** from **Sugar Software**, and **Chromasette** going to disk. **Soft Sector Marketing** stopped marketing CoCo software. Several hundred OS-9 users "got together" (mainly through BBS and E-mail systems) and formed the **OS-9 Users Group**. **Dale L. Puckett** (author of **Microware's Official Basic09 Tour Guide** and **KISSable OS-9** column for Rainbow) was elected president and **Peter Dibble** (wrote monthly OS-9 column for 68 Micro Journal) vice president. The stated purpose of the group was: "1) To stimulate and sustain interest in microcomputers in general and in OS-9 in particular. 2) To promote the cooperation and exchange of information between members. 3) To conduct programs and activities to promote fraternalism and to advance the general interest and knowledge of members."

Always on the leading edge, **Star-Kits** started its "**software amnesty**" program. Anyone with pirated Star-Kits software could send in a registration fee and receive a valid copy. Who but Peter Stark would be bold enough to give software pirates a chance to cleanse their souls? Star-Kits also marketed the

first MC-10 software, HUMBUG, a machine language monitor.

If you needed a new computer to take back to school with you in September, you might try **the newly released CoCo 2**. Don't bother subscribing to CCN because, unknown to its subscribers, the **September issue was the last**.

Reports circulated that **The Color Computer Magazine** would hold **COLOR EXPO '83** in Pasadena, CA. November 4-6. Not to be outdone, Rainbow would also hold more RainbowFests in the future.

New products released in September included **Color Micro Journals 32 page debut** issue, **Pooyan** from **Datasoft**, a **key-board** from **Keytronics**, **Pro-Color Forms** from **Derringer Software**, and the **Dragon/64** from **Tano Microcomputer Products Corp.** of New Orleans, Louisiana (the American distributor for the previously mentioned British CoCo clone). Nelson announced that Super Color Writer was the official word processor for the Dragon.

The highlight of **the second RainbowFest** (held in Fort Worth on October 14-16) was a walking tour of Tandy's new CoCo Plant. The same month **Radio Shack** released the **Walt Disney** and **Sesame Street** educational software, **Multi-Pak Interface**, the **Color Mouse**, the **Deluxe (Kraft) joystick**, and the **OS-9 operating system**. **Dennis Kitsz** said "I'm gonna teach you a lesson" when he released his **6809E Instructional Kit**, which came complete with text and audio and program cassettes.

In November, at **Color EXPO '83**, **Marty Goodman** debuted his state of the art graphics program **Graphicom**. Other new releases were **Elite Word** from **Elite Software**, **Super Screen** from **Mark Data**, **PASCAL** from **DEFT Software**, the **BASIC Unravalled** books from **Spectral Associates**, and **Computerware's** first **BASIC Compiler**. **Nelson Software** changed its management and name- to **Softlaw Corporation**. **Super Color Library** programs became "**VIP Library**" programs.

With Christmas only days away, **TANO** started including 8 FREE programs with its **Dragon/64** (home finance, word processing, and games). Things did not look good for the only CoCo clone. Reviews for the Dragon/32 and Dragon/64 appeared in a couple of publications along with the announcement of **Time Bandit** from the **Computer Shack**, **Magigraph** from **The Micro Works**, and **POKES, PEEKS & EXECs** books from **Microcom Software**.

In January, a **Barcode Reader** called **OSCAR** was advertised in several computer magazines for different machines, including the CoCo. Programs could be printed in magazines normal printing presses using barcodes... no need for expensive companion disk or tape subscriptions, just a one-time purchase of an Oscar by the user. And Oscar was independent-

with a software change he was ready to connect to virtually any computer with an RS-232 port. This \$178 ill-fated project ended up being liquidated for \$54.00 or less (some can still be found today!). **Wayne Technology** marketed its **CP/M for the CoCo** (actually an add-on Z-80 CPU board), and **Dynamic Electronics** marketed the first ever **128K upgrade**.

February marked the debut of **Graphicom** from **Marty Goodman**, and **Elite-File** from **Elite Software**, plus a name change for the **Computer Shack** to **Michtron**. A new newsletter, **Dynamic Color News**, was launched by **Bill Chapple**, owner of **Dynamic Electronics**. The first edition contained comments by the editor, a Q&A column, operating hints, and several programming tutorials. The newsletter was printed on heavy white paper in an 8 1/2"x 11" format. In addition to printing the newsletter, Dynamic Electronics also offered soft and hard ware for the Color Computer.

RainbowFest #3 was held in Long Beach, CA, February 17-19. Radio station KGON, it was reported, had its own bulletin board running on a CoCo.

The first **East Coast RainbowFest** was held March 30 - April 1 and featured the first **CoCo Hard Disk** from **Software Support**. In an attempt to clear its stock, **TANO** reduced the price of the **Dragon/64** to \$149.00. The last **Dragon/64** ad in Rainbow appeared this month, and rumors started circulating that the computer was about to breath its last flame. The **OS-9 Users Group** found a medium to communicate with members and potential new members- the **OS-9 Users Group President's Column** in the **Rainbow**. The debut article featured general information about the relatively new group. Membership would be \$25 per year and new users would receive one free disk from the library (additional disks were \$3 for members). A condensed library directory was also published. Disks would be sent on standard OS-9 5 1/4" or 8" floppies as well as CoCo 5 1/4" (single sided 35 track) format.

Bob Rosen moved **Spectrum Projects** to San Jose, California, in May. Word was out about the future release of the **C-Compiler** from **Radio Shack**, and **VIP CALC** from **Softlaw**. New product releases came from **Prickly-Pear Software** with their **Disk Trivia** and the **Tom Mix** milestone, **Worlds of Flight**- the **first real flight simulator** for the CoCo. This was the last issue of Rainbow that the OS-9 Users Group President's Column appeared in. A short note asking for assistance with group activities and new members appeared. Dale Puckett would print highlights from the user group in his **KISSable OS-9** column from then on.

By the time the **June 22-24 RainbowFest** touched down in Chicago, **Dragon/64** ads had vanished from all CoCo magazines as **Dragon Data Ltd.** (British parent company) went under receivership. It seemed that "...The Color Computer You've Been Waiting For" wasn't fairing as well as expected.

THE FIFTH YEAR (Jul '84 - Jun '85)

The CoCo turned 4 years old in July, at the same time **Radio Shack's TRS-80 Microcomputer News** published its last issue. **The Rainbow** celebrated its **third anniversary** with yet another innovative feature, **ascratch 'n sniff adventure** game. The issue also contained a complete index of articles and reviews which have appeared in the magazine since its beginning. Rumors appeared about **a new Radio Shack CoCo keyboard**, and the **folding of Chromasette**. A new product called **Tele-Form** was first marketed by **CIGNA**. The software enabled mail-merge with **Telewriter**.

In August, **TCCM** was the subject of "going out of business" rumors, Bob Rosen put BBS #5 "on the air" in San Jose, and rumors circulated in England that **Tandy** was interested in the floundering **Dragon Data Ltd.** company.

At the September **RainbowFest**, held in Princeton, NJ (28-30), **Dennis Lewandowski** debuted his **128K upgrade**. Other first timers include **NOMAD the robot** from **Frank Hogg**, **Graphicom II** from **Whitesmith**, and a **graphics program and digitizer** from **GRAFX**. The rumored takeover by a Spanish company (**EUROHARD**) gave British **Dragon** users something to roar about. Dragon production was moved to Spain when the takeover was finalized in October. Soon after, **TANO Micro-computer Products Corp.** sold their remaining stock to **California Digital**. Included in the deal was a number of joysticks and software. The number of computers was undisclosed, but CD was still selling them in March of 1993 for only \$39. At this time there were under 1000 left. Many had reportedly gone to South American companies and schools. The Dragon ended up having a long life after all!

TCCM's rumored demise proved correct as the **last issue** appeared in October. This was the third CoCo magazine to fold within the past year (including Chromasette's Disk Magazine). **Dennis Kitsz** also announced the start of **Under Color** (UCL for short), which hit newsstands in November.

An auto-answer modem too expensive? Check out the November issue of **Rainbow** and find out how to teach your Modem I to auto-answer. **Bill & Sara Nolan** sold **Prickly-Pear Software** to **Mike & Joanne Chinitis**. Rumors, rumors everywhere: Radio Shack has CoCos with **true lowercase** (using the new **Motorola 6847-TI VDG** chip) which won't be released until after the holidays.

Better late than never, a 26 page **Under Color** magazine **premiered in December** with information about two "new" **Korean** manufactured (for Tandy) CoCo 2s featuring a **1.3 BASIC ROM**. Other new December arrivals included **The Wizard** from **NEXUS** which modified **Telewriter's** character set, **Dennis Lewandowski's 128K upgrade**, the **Calindex** appointment scheduler from **Grantham Software**, a **video digitizer** from **The Micro Works**, and **NOVASOFT** (a **Tom Mix** company) started marketing its CoCo goodies. 7000

people attend **Britain's first 6809 Colour Show** for **Dragon** and **Tandy CoCo** users.

1985 started with a bang and a whimper! The bang came from the debut of another CoCo milestone, **CoCoMax** from **Colorware**. Like **Telewriter**, nearly every CoCo user has seen or used this graphics program, which was patterned after **MacPaint** (for the Apple Macintosh). The whimper was provided by rumors that **Color Micro Journal** was about to go "belly up".

The February **RainbowFest** in Irvine, California (15-17) attracted 8,000 visitors for a first-hand look at **CoCoMax** (250 sold). Product debuts included the **P-51 Mustang Attack Flight Simulator** from **Tom Mix**, the **68008 expansion card** from **RGS Micro Electronics**, and a **15 key numeric keypad** from **Moreton Bay**. Tandy sold 16K CoCos for a mere \$50, a drop in the proverbial bit bucket. Back to where it all started, CoCo information will start re-appearing in **68 Micro Journal** as rumors of **68 Color Micro Journal's** demise prove true. With this month's issue, **CMJ** joined **Color Computer News**, **Chromasette**, and **The Color Computer Magazine** as the fourth major CoCo publication to fold within the past 17 months.

March brought word that the "new" CoCo would be an exclusive OS-9 machine (no BASIC ROM) and would be in Radio Shack stores sometime **between September '85 and March '86**. Callers to any of **Bob Rosen's** 4 bulletin boards in Woodhaven, New York were greeted not by the usual high pitched carrier tone but by a "disconnected" message. **Bob signed off the east coast boards**. On March 30-31, London is the scene of the **second 6809 Colour Show** for **Dragon** and **CoCo** users. Looks like the Dragon lives on. **R.G.S. Micro Electronics** (Montreal, Canada), who had just debuted their **68008 expansion**, **folded**.

April saw the release of two library offerings, the long awaited **Complete Rainbow Guide to OS-9**, authored by **Dale Puckett** and **Peter Dibble** (president and vice president of the **OS-9 Users Group**, respectively), plus, from our Canadian friends at **Dragonfly Writing**, a cassette magazine called **DIGInews For CoCo**. **Spectral Associates** **withdrew their support for the CoCo** after four years of very good products and service.

In May, **voice recognition** for the CoCo becomes a reality when **Speech Systems** started marketing its **Electronic Audio Recognition System (EARS)** for short). **RainbowFest** celebrated the third anniversary of CoCo shows with three fun-filled days & nights (17-19) in Chicago. Causing quite a stir was **Steve Odneal's** fully **portable CoCo**, complete with disk drive and monitor built in. Although only a prototype, Steve used the show to judge user interest. It may have made production had a good low cost screen been available. Unfortunately, the three inch LCD TV was just too small to be practical.

In June, as the curtain descended on the CoCo's fourth year, so too does it fall on yet another Color Computer publication. This time it's **Dennis Kitz's "Under Color"** which **folded** after just seven months of publication.

THE SIXTH YEAR (Jul '85 - Jun '86)

Subscribers to **Under Color** magazine were informed in July that any unfulfilled subscriptions would be taken up by **Rainbow** magazine, celebrating its **fourth anniversary**. **Rainbow** was now the only widely circulated printed publication exclusively for the TRS-80 Color Computer, which itself turned five years old in July. Though somewhat overshadowed by **Rainbow**, **Dynamic Color News** had become a small magazine by this time and started printing product reviews this month. While **Rainbow** had a circulation in the tens of thousands, **Dynamic** only had just over 200.

In November, a little over four years after their debut on the CoCo scene, the absence of the **Nelson/Softlaw/VIP** (take your pick) ads were keenly felt. They were one of the first, but sadly not the last, large advertisers to start dropping CoCo support. This did not spell the end of availability of **Softlaw/VIP** products, however, as other vendors still advertised them.

It seemed that 1986 would be the year of the hard drive, with **Owl-Ware** advertising a **five megabyte hard drive system** for \$495 in November '85 and **J&M Systems** advertising a **five megabyte system** for \$495 in December. The Owl system used an **SCSI interface** made by **L.R. Tech** and required a MPI or Y cable. The J&M system was operated through the parallel port on their floppy disk controller, no external controller or MPI was needed.

THE SEVENTH YEAR (Jul '86 - Jun '87)

On **July 30th, 1986** (6 years and 1 day after the debut of the original TRS-80 Color Computer) **Tandy unveiled the long awaited and much rumored CoCo 3**. The basic unit (\$219.95) came with 128K (upgradable to 512K) and a "**Super Extended**" **BASIC**. Also announced were the **OS-9 Level II** operating system (which allowed use of the expanded memory) and a new **analog RGB monitor**.

Due to small attendance, August brings word of **RainbowFest West's** possible demise. Chicago & Princeton shows, however, will not be affected. **Dynamic Color News** started a column on "Ham Radio & Computers". **Dynamic Electronics** and their magazine quickly became THE SOURCE for Color Computer HAM software. The HAM column became a regular feature after this. Could have had something to do with **Bill Chapple** getting his HAM license (W4GQC as of January 1993)...

Rainbow's September issue carried the first in-depth look at the new **CoCo 3** (the cover states coverage for Color Computer 1, 2, and 3 for the first time). On power up, the 68B09E gets the 2 byte address at &HFFFE, puts it into the program counter and starts executing code. In the case of the CoCo III, the address found at &HFFFE is &H8C1B. The **GIME** chip (Graphics Interrupt Memory Enhancer, a custom job specifically for the CoCo 3) initializes to read the CoCo 3 ROM even if the system has the disk controller (Disk BASIC ROM) installed, so after entry at &H8C1B the CoCo 3 goes to its internal ROM at &HC000. **Computer Plus** sold the new **CoCo 3 for \$169** at the October (Princeton) **RainbowFest**, where they **sold out within minutes**.

The **first CoCo 3 only programs**, two graphics demonstration programs, were **published in the October Rainbow**. Also introduced this month was a new service- **Rainbow on disk**. The disk was a "floppy" with BASIC programs on one side and OS-9 on the other. It was predicted that **OS-9** would play a leading role in the future of the CoCo 3, especially since Tandy announced that all new software development would be under OS-9 (with the exception of ROM pack games). **Disto** finally followed the lead of **Owl-Ware** and **J&M** by advertising a hard disk adapter for their **Super Controller**- coming soon!

Yet another Color Computer magazine was advertised in the November issue of **Rainbow**! **Spectrogram** offered users columns on telecommunications, BASIC and Pascal programming, OS-9, and more. **Bill Bernico** was the most known contributor.

In the coming months, it is almost like the introduction of the original CoCo! Owners of the new CoCo 3 were pouring over the remaining CoCo magazines looking for new products and information that took advantage of the great new features. Except for a few offerings from Tandy (such as December's unveiling of **DeskMate 3**), the pickings were few and far between.

Spectrum Projects became the first third party vendor to advertise software for the CoCo 3. First came **C III Draw**, a graphics program, in December, then **Elite Word/80** in February- a word processor that used the 40 and 80 column screens and expanded memory. Like many programs to come, this one DID NOT work on previous CoCo models.

Cer-Comp started advertising versions of their software for the CoCo 3 in January. These special versions are only interim versions though! **Cer-Comp** had software that took full advantage of the power in the new CoCo still in the works...

In February, **Rainbow** reprinted an old article- the first (and only) time this was done. The article was a utility to transfer tape programs to disk. The reprint is due to the programs' popularity (it successfully transfers machine language as well as BASIC programs) and the popularity of **Rainbow on Disk**.

June marked the arrival of the first CoCo 3 only graphics program: **Computize's Color Max 3**. Picture converters to allow use of pictures in Atari ST (.ST, .NEO, and .TNY), Graphicom, and CoCo Max formats as well as several supporting utility programs are also offered. **Cer-Comp** started advertising their first CoCo 3 only products. A communications terminal, disk editor/assembler, and screen enhancing programs were described. A word processor, disassembler, and BASIC enhancer were promised, even by the time the ad was out! Speaking of BASIC enhancements, **Art Flexser (Spectro Systems)** introduced **ADOS-3** for \$34.95 this month. Although it was for the CoCo 3, it had a disable feature so that it could be burned into an EPROM and the disk controller could be used with a CoCo 1 or 2 also. Double speed disk I/O, command line editing, and support of 35,40, or 80 track as well as double sided drives were some of the new features.

A new "magazine" was introduced this month also. This newsletter was created by two seventh grade friends who had discovered the Color Computer just a few years before. The name of the newsletter/magazine was **TRS-80 Computing**, and the publishers were **Joseph Ahern** and **David McNally**. The first few would be delivered monthly, but the boys soon found that a bi-monthly schedule worked around their school work better. Good work guys, shows just what a couple imaginative teenagers and a computer can do!

Disto finally started delivering the long promised **hard drive interface** in February of 1987. Since it fits inside the Super Controller, there is no need for a MPI, and it makes for a neat installation. Good thing... **J&M** stopped advertising their neat hard drive system a few months back... maybe Disto came around just in time!

THE EIGHTH YEAR (Jul '87 - Jun '88)

The new CoCo year started with the introduction of a much needed book: **The Complete Rainbow Guide to OS-9 Level II - Vol. I: A Beginners Guide to Windows**. As the title suggests, the main subject of this volume was the new windowing system of OS-9 Level II. Very little was mentioned about the operating system in general, necessitating the need for the original **Rainbow Guide to OS-9** also. Still, this book provided much needed information to the beginner and experienced OS-9 user alike. The "Vol. I" in the title led readers to believe that other volumes were forthcoming. It is unknown whether more were planned, but there were no further volumes published or advertised. The book was advertised for August delivery.

It seems everybody was out to capitalize on the outstanding graphics capability of the new CoCo. Even **Owl-Ware** got into the act with the introduction of **DaVinci 3** in August. A unique feature was that no hi-resolution adapter was needed, fine control of the input device (joystick, mouse, X-pad, or touch pad) was accomplished via software.

Diecom Products quickly followed **Computize** and **Owl-Ware** with a graphics program of its own in September- **the Rat**. This package came complete with a two-button digital mouse (not the Tandy analog mouse). Almost all functions were accessed through the mouse with pull-down menus. **Iron Forest**, a unique game which used a **SEGA light gun**, and several other CoCo 3 only games were also introduced.

Not to be outdone in the graphics field, **Colorware** introduced an updated version of its popular CoCo Max programs... **CoCo Max III** (naturally!) for the CoCo 3, which also debuted in the September issue of **Rainbow**. Rather than creating an entirely new hi-res adapter, Colorware supplied a modified Tandy hi-res adapter that did not require using the cassette port. Animation and color sequencing were special features of the new program. The November issue of **Rainbow** featured a Colorware ad comparing CoCo Max III to Color Max 3. Interestingly, the ad was back to back with a Computize Color Max 3 ad!

Cer-Comp released a terminal program, word processor, and BASIC compiler for the CoCo 3 only in September also. The word processor supported 512K by adding two RAM disks. Mail merge and even laser printers were supported! The ad was even edited and printed using **Textpro IV** and an Okidata laser printer.

With desktop publishing so popular, it is no wonder that CoCo users would be very interested in publishing programs. **Rainbow** started a very ambitious series which resulted in a **complete desktop publishing program** for the CoCo. Separate versions were available for the CoCo 1/2 and CoCo 3. The programs were written by **H. Allen Curtiss** and did, indeed, prove to be very popular. Several upgrades would come later.

Sundog Systems made their debut in the October issue of **Rainbow** with a half page ad. Their premier game was **Kung-Fu Dude**, the first full graphic martial arts game for the CoCo 1,2, and 3. Also advertised was **Champion** (previously from **Mark Data**) and **White Fire of Eternity** (previously from **Saguaro**).

The **14th RainbowFest** was held in **Princeton, New Jersey 9-11 October**. A new arrival to the CoCo market made their debut at this show with a **hard disk adapter** for the CoCo that allowed use of a standard PC type eight bit hard drive controller. **Burke&Burke** also had a version with a built-in real time clock. **Tandy gave away 500 64K upgrade kits** (the 16 RAM chip variety) and **4600 Plug n Power controllers**. **16K CoCo 2s** were sold for a mere **\$9.95** while **64K versions** sold for only **\$29.95**. **CoCo 3s** were on sale for **\$100 Friday night**, but back up to \$115 for Saturday and Sunday.

October 1987 was just a memorable month for the CoCo! Not only were the previously mentioned software packages first available, but **SD Enterprises** started advertising **Softlaw's VIP** products for the CoCo 3! The original versions would not all run on the new CoCo.

The first commercial desktop publishing package, **CoCoNewsroom**, appeared in the November **Spectrum Projects** ad. Over 140K of code, 22 fonts, and 50 pictures were boasted. With new products being introduced, it is hard to believe that faithful Spectrum projects would not be in the CoCo market much longer...

Howard Medical began selling hard drive systems using the **Burke&Burke** adapter shown at the last RainbowFest in December. They didn't say it directly in the ad, but the phrase "will also work with IBM & clones" sort of gave it away. Complete 20MB systems were sold for \$699... a much better deal than the \$999.95 5MB systems first sold in '84! The next month the first Burke&Burke ads appear, selling the hard disk adapter and software as individual components. This allowed individuals to get used PC hard drives and make their own systems at a substantial savings. Maybe the earlier systems just paved the way, and the Burke&Burke ad is correct... "1988 — The Year of the Hard Disk!". **FHL** also enticed us with an upcoming hard drive interface... claiming it to be the fastest. We'll see Frank, we'll see!

In February of 1988, **Microcom Software** introduced a very powerful word processor for the CoCo 3, **Word Power 3** (amazing how original the titles for CoCo 3 only software could be!). This original version supported only 80 column displays. In addition to the usual word processing features Word Power sported mail merge and a 72K-450K text buffer (for 128K or 512K CoCos). A punctuation checker was added in April of 1988 (Word Power 3.1). **FHL** advertised their new **hard drive interface**. It was similar in some respects to the Owl-Ware and Disto interfaces in that it was really just an adapter between the CoCo and a controller. The secret to the speed was in the controller used- a high speed WD 1002-05.

Cognitecs' Telewriter 64 had long been the most popular word processor for the CoCo, so the February introduction of **Telewriter 128** for the CoCo 3 was no real surprise (a "coming soon" blurb was in the January ad). The new version was kept as close to the original (command wise) as possible while taking full advantage of the CoCo 3s' new power. Like Word Power, only the 80 column screen was supported. Fortunately, Telewriter 64 ran on a CoCo 3 with no problem, and an upgrade option was available, so those not yet having an 80 column monitor weren't totally left out.

A real surprise this month was **SD Enterprises'** announcement of **VIP Writer III**. SD apparently had gained rights to the full source code of the VIP Library products! This was the first CoCo 3 word processor to support 32, 40, 64, and 80 column screen widths. Other features included a built-in spell checker (no longer an extra-cost item!) and print spooling. Unfortunately, only a 48K text buffer was allowed, though the 48K print spooler buffer did allow editing one document while printing another. This would be rectified in a future release...

February's **Spectrum Projects** ad was the last to grace the pages of a CoCo magazine. Orders were still filled for several months, and some advertising done by direct mail to repeat customers. Spectrum was sorely missed by many (the author included!). To end the month on an upbeat note, **Dynamic Color News** started a new series on OS-9 and Basic09. The 18th installment of the regular "HAM Radio & Computers" column was also printed. Good work, Bill!

Lonnie Falk's editorial column in the March Rainbow was written to quell rumors that Tandy was considering dropping the CoCo 3. Many of the rumors started due to large price reductions of CoCo products. Mr. Falk sought to put the rumors to rest by stating that the CoCo was outselling all other Tandy computers combined, and the lower pricing was due to lower costs incurred in production.

May 20-22 1988 brought forth the Chicago RainbowFest. Many vendors attended this annual gathering of CoCo enthusiasts. Host for the show was Chicago's very own **Glenside CoCo Club**, who had assisted with many RainbowFests.

Colorware, maker of **CoCoMax**, announced the arrival of **Max-10** with a two page ad in June's Rainbow. Max-10 was similar to the Apple MacIntosh's MacWrite word processor. It was all graphics based with mouse controlled pull-down menus. Since graphics and text could be mixed, it was billed as a **desktop publishing system** when combined with CoCo Max 3. Many different fonts and styles were available, and since all could be displayed on the graphics screen, Max-10 was the CoCos' first true **WYSIWYG** (what you see is what you get) word processor. The ad stated that Max-10 was not copy protected, but that wasn't entirely true. The disk itself had no copy protection, but a **hardware key** (the first and only one ever for a CoCo product) was included. This was a series of resistors and diodes which plugged into the cassette port. If the software didn't find it, it simply wouldn't run! Though the keys' components were cast into an opaque resin disk, hackers soon discovered how to mimic its signals and defeat the protection. Such an outcry was made over this new (to the CoCo world) protection scheme that Colorware soon dropped it in future versions. **SD Enterprises** released an updated **VIP Database** for the CoCo 3 in June. VIP Database owners could upgrade at a reduced price.

THE NINTH YEAR (Jul '88 - Jun '89)

In the beginning of the Rainbow's seventh year (CoCo's ninth), there are 79 advertisers. Many long time advertisers had started dropping support for the CoCo as their CoCo 1 and 2 products became dated. They just didn't see putting in the effort to update (in many cases entirely re-write) programs to take advantage of the many CoCo 3 features. Others, like **Computerware**, who ran their last CoCo ad this month, expanded into more profitable computer fields. **Paul Searby** (owner of Computerware) redirected his programming efforts

toward the popular IBM PC and compatibles. Computerware had been one of the largest CoCo suppliers. Fortunately, many small newcomers were joining the programming ranks (which accounts partially for the large number of ads). **Microcom** became the largest advertiser with five entire pages.

Several other interesting things happened in July of 1988. Windows came to Disk BASIC users through **Cer-Comp's Window Master** software. Up to 31 windows (even overlapping!) with pull down menus could be controlled via a mouse/joystick or the keyboard on a 512K CoCo 3. **Burke&Burke** introduced **R.S.B. (Radio Shack BASIC)** for OS-9, which allowed pure Disk BASIC programs to run in a window under Level II. Lastly, Rainbow reviewed another desktop publishing package for the CoCo 3- this one from Tandy and operating under OS-9 Level II. **Tandy's Home Publisher** was a bit slow, but did do the job. The main gripe with this program was that it only supported Tandy DMP and Epson RX-80 printers. While most printers would operate with the RX-80 drivers, the RX-80 was getting a bit dated and newer printers were much better and had features the RX-80 driver wouldn't access.

One of the first things that captured ones' attention in the August issue of Rainbow was a full page ad from **Adventure Novel Software**. In this unique ad, players of their new **Night of the Living Dead** interactive adventure game were offered \$500 if they were the first to "survive". **D.P. Johnson** introduced another **programming language for OS-9** users- **FORTH09**. This was a FORTH-83 standard implementation specially tailored for OS-9 (level I or II, even for other OS-9 computers!). Help for users of **Tandy's DCM Modem Pak** was offered. The Modem Pak's primitive communications software does not allow for downloads or uploads (transfer of files from or to the host computer/BBS). How to overcome this problem was the subject of an article by **Delphi CoCo SIG** database manager **Don Hutchison**.

Even though **Tandy** was pushing OS-9 for software developers, it dropped the **RS-232 Pak**, which was required for telecommunications under OS-9. It wasn't long before someone, in this case **Orion Technologies**, introduced a directly compatible clone (October '88). Unlike other products (such as the Disto RS-232 Pack), Orion's pack had the same hardware address as the Tandy. Just plug it in and go! A version with external power supply was made for the CoCo 2 and 3, or the standard version could be used with a CoCo 1 or Multi-Pack, which provided the necessary 12 volts.

Getting ready for Christmas, **Diecom** released several new games in November. **Xenion** ran on a CoCo 1,2, or 3 and was similar to the arcade game Xevious. **Medieval Madness** was another CoCo 3 only light phaser game. If one already had a Sega light phaser and interface from Iron Forest, the disk could be purchased alone. **Microcom** added a **spelling checker**, **pop-up calculator**, **split-screen editing**, and **two column printing** to **Word Power release 3.2**. **Colorware** started advertising their **Max** products (CoCo Max III and Max-10) as the ideal

desktop publishing package for the CoCo 3. Release 2.0 of **SD Enterprises' VIP Writer III** supports up to 495K of text space on a 512K CoCo 3 (106K on a 128K model), more than any other word processor to date.

It was hard not to notice that **Microcom** had become the biggest CoCo advertiser ever- their ads were up to 6 pages in the December '88 Rainbow! They offered a wide variety of CoCo products from many different companies as well as their own software. A new offering was **512K BASIC** for the CoCo 3. When Tandy updated the CoCo's BASIC, they didn't allow easy access to more than 32K for BASIC programs. This product patched BASIC to allow access to 64K on a 128K machine and 384K with 512K RAM. The only problem was that one must have 512K BASIC in order to run a program that took advantage of the extra memory!

What better time to advertise new products than the Christmas issue? Notable items were:

- * **Warrior King (Sundog Systems)** - a CoCo 3 fantasy game.
- * **CoCo Graphics Designer Plus (Zebra Systems)** - CoCo 1,2, & 3 were supported by this update of CoCo Graphics Designer. This was the closest thing to "Print Shop" available for the CoCo. Cards, signs, and banners could be printed.
- * **Start OS-9 (Kenneth-Leigh Enterprises)** - A book that stepped one through the process of setting up and getting started with OS-9 Level II. A disk with several extra utilities was also included. This was the easiest to use guide to OS-9 ever.
- * **Eliminator (Frank Hogg Labs)** - A multi I/O card for the CoCo 3 and OS-9. Featured two serial ports, 1 parallel port, real time clock, plus a high speed floppy and hard disk interface. No more multi-pak cluttering up the desk... if one were an OS-9 user only!

Colorware started advertising "**THE WORKS**" in the January 88 issue of Rainbow ("Your CoCo 3 will think it's a Mac."), in their words "The Ultimate in Desktop Publishing". **THE WORKS** included **Max-10+** (with a spell checker added), **CoCo Max III**, and additional font sets for both. **SD Enterprises** introduced **VIP Calc III** this same month. As in other VIP products, 32-80 columns were supported. VIP Calc also offered up to 16 windows, which allowed easy comparisons, and a spreadsheet size of 512 columns by 1024 rows. **Owl-Ware** purchased the rights to all CoCo products from **J&M Systems** and began advertising an improved disk controller based on the J&M design. The parallel port was missing, as was JDOS (OWLDOS or Disk BASIC are offered). Owl also introduced an **IBM keyboard adapter** for \$119- more than a CoCo 3 (Computer Plus had them on sale for only \$115 in the same issue), and without the keyboard! **Zebra Systems** had a cache of 500 64K CoCo 2s to sale for only \$49.95 (hurry while supplies last!).

If you hadn't upgraded your CoCo yet or were thinking of buying a hard drive, the March issue of Rainbow was an issue not to miss. **Marty Goodman** went through RAM and ROM upgrades for all CoCos ever made. He also went on in another

article to explain the ins and outs of adding a hard drive to a Color Computer system, not an easy task!

Simply Better, from **Simply Better Software**, was introduced in an ad and review in the April issue of *Rainbow*. This word processor for the CoCo made quite an impact, being preferred over other word processors by the likes of **Cray Augsburg** (a *Rainbow* Technical Editor, who also wrote the review for this product) after using it only a short time. At a price of only \$29.95, the review heading of "the most bang for your buck" was definitely true! The author even prepared this text using **Simply Better**, which was purchased largely due to the review and a comparison article in the same month's *Rainbow*.

The **Chicago RainbowFest** was held April 14-16 in 1989. **JWT Enterprises** introduced **Nine-Times**, a bi-monthly magazine on disk for OS-9. This would prove to be very popular for Level II users. Another new OS-9 item was **Owl-Ware's Window Writer word processor**. Unlike most other OS-9 word processing software, a separate editor and formatter were NOT used. Pull down menus were controlled either from the keyboard or with a mouse/joystick.

An important issue in April's *Rainbow* editorial column (Print #2) was the fact that the CoCo was being discontinued in Canada. **InterTAN** (an independent subsidiary of Tandy that handles overseas operations) had its own officers and stock, and also made its own decisions. One of those decisions was to **discontinue CoCo sales in Canada**. One reason for this decision was that many Canadians either drove across the border or ordered their CoCo supplies from American distributors, which lowered actual in Canada sales figures. The reason for doing this was the U.S./Canada monetary exchange rate... CoCos were cheaper if bought in the U.S. Lonnie Falk encourage alarmed Canadian users to write InterTAN and encourage the return of CoCo support. Many were afraid the CoCo was being discontinued by Tandy. That was still a few years off...

May was *Rainbow*'s printing issue, and desktop publishing was 1989's main feature. The three major desktop publishing packages for the CoCo (**Newspaper Plus - Second City Software**, **The Works - Colorware**, and **Home Publisher - Tandy**) were reviewed and compared. A major enhancement for *Rainbow*'s desktop publisher (written by **H. Allen Curtiss**, Oct. '87) was a high density printer driver written by the original author. Printouts were much improved over the original. This program was almost as good- if not AS good- as Tandy's Home Publisher. And speaking of bargains, Colorware put CoCo Max III and Max-10 on sale for only \$79.95 for BOTH if bought at the same time. Individual prices were \$49.95 and \$39.95 respectively. **The Micro Works**, makers of the **video digitizer (Digisector DS-69 & DS-69B) for the CoCo**, ran its last ad in the *Rainbow* this month. The digitizers were still available from Colorware.

Another product allowing the BASIC programmer access to more memory was introduced in June. **Danosoft** announced its **BIG BASIC**, which allowed access of up to 472K with a 512K

CoCo, 92K with a 128K machine. Only three new BASIC commands were required. One wonders why Tandy didn't do something like this! Like 512K BASIC from Microcom, a program written to take advantage of these new features meant that one had to also own a copy of BIG BASIC. That was the primary reason neither product was a real big seller.

THE TENTH YEAR (Jul '88 - Jun '90)

July marked the tenth anniversary of the Color Computer. This was a milestone in the small computer industry. Only the Apple II and Commodore 64 remained alive along with CoCo in what was once a teeming, competitive field. A new arrival this month was **CIII Pages** from **Microcom**. As the name may suggest, CIII Pages was a yet another **desktop publishing package for the CoCo 3**. A new advertiser was **Oblique Triad**. Their premier products were **The Seventh Link** (a three disk graphic adventure game) and **Studio Works** (a digital audio sampler).

What was probably the most welcomed new product, **Extended ADOS-3**, was announced by **Spectro Systems** in August. Not a new version of ADOS-3, EADOS-3 shared space with ADOS-3 in a 16K ROM. EADOS added RAMdisk, wild cards, clock support, and many other features to ADOS-3. EADOS couldn't be run from disk (had to be EPROMed) and required ADOS-3. Another new item introduction was the **RASCAN video digitizer** sold by **Microcom** (CoCo 3 only). This was similar to the **MicroWorks DS-69 Digisectors**, but plugged into the joystick ports instead of the expansion port, eliminating the need for a Multi-Pak or Y-cable. The RASCAN was developed and made in Australia.

Bill Chapple decided it was time to call and end to the publication of **Dynamic Color News** with the August issue. Circulation had dropped to just over 100 subscribers. The magazine, which peaked out with just over 200 subscribers at one time, had become too much of a draw on other business activities. It had never really made money, but hadn't been expected to do so anyway. The stated purpose of the magazine had been "...to provide instruction on BASIC & Machine Language programming, computer theory, operating techniques, computer expansion, plus provide answers to questions..." These goals were certainly carried out! Thanks for a wonderful five and a half years of service Bill! Though out of the magazine business, Dynamic Electronics would continue (to this day) to support the CoCo with hard and soft ware products, including a large and inexpensive public domain software collection.

By looking at the Advertisers Index of the September '89 *Rainbow* one would think that the CoCo market was growing. The reverse was true- the format of the index was switched to multiple ad entries instead of a single entry with multiple pages for each advertiser. This gave the first impression that there were more advertisers when there were actually only 52. Page count was down to 130, where it had been since August. The

August '89 advertiser count was the lowest to date: 40. The highest advertiser count was in December of 1985 at 142; highest page count was 288 pages in the same issue.

The **Somerset RainbowFest** was held **October 20-22**. This was the **LAST RAINBOWFEST held in New Jersey**. CoCo 3s were being sold by **Computer Plus** for just **\$99!** Tandy introduced several new ROM Pak games (**Robocop, Rampage, Predator, and Arkanoid**). **Tony DiStefano** of **CRC Computers** showed off a **1 megabyte upgrade** prototype for the CoCo 3! Now OS-9 (the only product that could take advantage of the extra memory) could REALLY be shown off... as soon as it becomes available! **Zebra Systems** introduced their **Label Designer**, a graphics based point-and-click program that made cassette, Rolodex, disk, file folder, and normal address labels, and a graphics program similar to CoCo Max (**Color Paint**). The new **Sundog Systems** ad in this month's Rainbow introduced three new games (**Sinistarr, Kyum-Gai to be Ninja, and Paladins' Legacy**) and a sound editing/sequencing program (**Soundtrax**).

In the November issue Rainbow decided to run a reader survey. All readers were encouraged to reply. The survey coincided with **the promotion of Cray Augsburg, a former Rainbow technical editor, to the position of Managing Editor**. Questions were asked about the reader him/her self and their system configuration. Readers were also asked to rank, in order of importance, certain topics and Rainbow columns. Congratulations Cray!

The Print#-2 column in Decembers' Rainbow was very interesting. Mr. Falk was visited by **Ed Juge, Tandy's Director of Market Planning**. Readers were reassured that Tandy would continue the CoCo as long as it sold well, and reminded that it ALWAYS sold well during the Christmas holidays. A note about the InterTAN decision to drop the CoCo from Canadian distribution was also included. It seems that enough CoCo users wrote InterTAN that they decided to reintroduce the CoCo. Unfortunately, the production run for the season had ended, and InterTAN's order was not large enough for another run. Readers were urged to write AGAIN, this time to encourage InterTAN to order as soon as the next run started.

Something different appeared in this month's Rainbow- **an article by Tandy itself!** Surprisingly, this article appeared due to a letter by a Rainbow reader. Back in May '89, a reader from Australia asked if there were an easy way to create new icons (graphics representing programs) for **OS-9's Multi-Vue**. Another reader replied in September, indicating that Tandy said "...Multi-Vue was originally intended for program developers..." and that a 10 page document addendum was available directly from Tandy. This prompted Tandy Computer Customer Relations to respond through a letter to the editor, stating that this impression about Multi-Vue was incorrect, the **STYLE** that Multi-Vues' documentation was written in was more suited to programmers. Tandy also offered "Multi-Vue and Pre-Existing Applications" (the 10 page addendum re-

ferred to above) for publication in Rainbow- it was published the very next month (December).

The number of advertisers for the 1989 December issue was 59. One of these, **Orion Technologies**, had an ad announcing a new hardware product for the CoCo- the **XPort**. This was a **direct replacement for the Multi-Pak but with only three slots**. These slots were on a short ribbon cable which came out of a box which contained the circuitry and plugged into the CoCo. A separate power supply provided 12 volts to the slots. Also debuting was **Howard Medical's MP-II**, later called **Slot-Pak II** (possibly due to concern that Tandy might object to "Multi-Pak II"). This was similar to the Xport, but built in a long disk controller case. Power for this multi-pak replacement was drawn directly from the CoCo, with an extra cost AC adapter for items that needed more power. The Slot-Pack II (or MP-II... whatever!) was designed by **Chris Hawkes**, a well known hardware designer for the CoCo (one reason Chris is so well known is his physical height... if one ever meets him at a 'fest, they will never forget!).

Microcom announced yet another improvement for its word processor- **Word Power 3.3**- in January. Now 40 and 80 column displays were supported, and graphics could also be inserted in documents (CoCo Max, PMODE 3/4, and HSCREEN formats). Three new games, **Overlord** (wargame similar RISK), **Defendroid** (similar to the arcade game Defender), and **Those Darn Marbles** (roll a marble through mazes... not quite that easy!) were released by **Oblique Triad**.

Lonnie Falk used the Print#-2 column to announce plans for the publication of a book (due out in late summer/early fall) entitled "**An Affectionate History Of The Tandy Color Computer**". The authors of this book were to be **Dale and Esther Puckett**. Unfortunately, the book would never be printed. An interesting side note is that the book you read now may not have been printed had Rainbow printed their history. Rainbow later announced they would be interested in finding a new author. This author responded after some thought. The problem was that the Rainbow book was to be simply a collection of interesting anecdotes and memoirs from various CoCo personalities and a brief history. After some thought, and before Rainbow was contacted, this author had already decided that more than a simply history was needed.

With the introduction of **Owl Ware's Window Writer 1.2** in February, **multi-lingual word processing** arrived on the CoCo. This slightly updated version also featured a **French edition**. Why French? There has always been a relatively strong French-Canadian CoCo market segment. Also from Canada was **Disto's new 1 megabyte upgrade!** This was a board with a small amount of circuitry and 512K in 41256 DRAM chips. The existing 512K board plugged into the 1MB board. A small satellite board also had to be soldered "piggy-back" style over the CPU, as several control lines had to be picked up. Alternately, the CPU could be socketed and a socket installed on the satellite board to carry the CPU. Either way, only the

competent "hacker" could install this memory upgrade. Disto also announced another "hardware" item- **Tony DiStefano's "A Full Turn of the Screw"** book, which reprinted all hardware articles published in Rainbow from January 1983 to July of 1989.

Hardware hackers would be well advised to get the March issue of Rainbow. **Marty Goodman** covered **floppy disk drives** for the CoCo, but the real hacker would be more interested in the **Computerized Instruments projects**. **William Barden Jr.** showed all how **to turn CoCo into a dual-trace storage oscilloscope** with a sampling rate of up to 6000 samples per second. **Dennis Weide** started his series on building a **digital logic analyzer** for testing and checking DIP type integrated circuits. An unusual ad promising a new computer in 1990, a CoCo users "dream computer", was run by **Kenneth-Leigh Enterprises** this month. Just what would this "dream machine" be? No details were given, just encouragement to write for details! Rainbowfest Report covered the Oct Rainbowfest in New Jersey, and a tentative date (Oct. 20-22) for the next New Jersey 'Fest was set. The Chicago Rainbow fest would be next month!

Chicago Rainbowfest was held (April 06-09). Two new computers, were shown. **Kenneth-Leigh Enterprises** was showing **their yet to be named 68020 based machine** while **Frank Hogg** had a **6809 based computer** on display. These were basically prototypes... more to come on them later. **Lee Veal** turned up with an old grey **original CoCo... serial number 000001** was engraved on the bottom!

Not to be completely overshadowed by Rainbowfest was a small quarter-page ad in this month's Rainbow by a new company called **CoCoPRO!**. They offered good prices on hardware, and also something new in the CoCo market... "gently used" software (with original documentation, of course... no pirating here)! Another item of interest was that **Danosoft** had acquired the **Simply Better** word processor. One last thing for this month- **Oblique Triad** upgraded their **Studio Works** program to create **Studio Works Professional**. New features include 35KHz 8 bit wide sampling, MIDI slave mode, and support for up to 1MB of memory. It seems that **Orion Technologies** had faded out of the CoCo market. Their last ad was run this month.

This is the first (May 1990) of the **100 page Rainbows**. There are only 46 advertisers. Sure is getting thin! Will the Rainbow fade away? In his editorial (Print #-2), Lonnie Falk is encouraging those who also have MS-DOS machines to try **PCM**. PCM was started two years after the Rainbow to support Tandy laptops and MS-DOS based computers. Is this a subtle hint? Maybe not... What's that on page 33? Another one of those odd **Kenneth-Leigh Enterprises** ads! This one promises "MS-DOS based applications multi-tasking alongside MIDI programs, in 256 colors and sound that surpasses CD quality." If you want to know the computers' name and price, you still have to write! Budding astronomers could take

advantage of their CoCos power to map the sky with **Gravity Studios' Planet Engine**. Maps could be made for any time/date... even with proper shadowing for phases!

If you want to know how Tandy managed to squeeze up to 1MB of data into a ROM Pak, then get the June issue of Rainbow. **Frank Hogg Laboratories** announced the **Tomcat TC9, a 6809 based computer** that was 25% faster than the CoCo, used a PC/AT 101 key keyboard, up to 1MB of RAM, high resolution joystick, parallel port, two REAL serial ports (ACIA controlled), K-bus and CoCo bus expandability, and fit into a PC type case! With the K-bus, one could later add a 68xxx processor and use the TC9 board as a multi-function graphics coprocessor! This machine **ran OS-9 Level II and Disk BASIC support was promised** for the future. Rainbow lost two pages this month! Now it seems to be losing them one by one!

THE ELEVENTH YEAR (Jul '90 - Jun '91)

The eleventh year of the CoCo started a new look for the **Rainbow**, which celebrated it's **ninth anniversary** of CoCo support. Saddle stitch (stapled) binding was introduced. In his "Wrapping the Rainbow" column, Cray Augsburg pointed out that there were advantages to this type binding- the flat spine binding ("perfect" binding is the proper term) made it hard to lay the magazine out flat for typing in listings and pages could come lose with repeated use. These were good reasons for switching, but the cover up didn't fool a lot of readers. Perfect binding didn't look good with a thin magazine (only 98 pages!), and saddle stitch cheaper. Like the author, most readers were just happy to get the Rainbow.

Several interesting ads appeared in the anniversary issue of Rainbow. A new one was from **P&M Products**. Their products were simple **keyboard templates** with the most used commands for BASIC (CoCo 1, 2 & 3) and Telewriter 64 and 128. They simply laid around the keyboard! So simple, why didn't someone think of it sooner? Hey, **Kenneth-Leigh** finally tells us the name of their new computer- the **MM/1** (multi media 1). The company promises to tell more each month. This month they tell us that it uses existing CoCo disk drives and analog RGB monitor- saving some of our investment when (if) we decide to "upgrade" to the 15MHz 68020 based system.

A new magazine hit the scene in July. Entitled "**The OSK'er**", the publication proclaimed to have "news and views in the world of OS9/68000 and 6809". The premiere issue contained 24 pages (including both sides of the cover) in an 8 1/2"x 11" two column format on a high quality white (not slick) paper, saddle stitched (stapled). There were some highly unusual formatting standards used. The table of contents looked like a disk directory, the title of each article like a file description, and the pages were numbered as "sectors". The entire magazine read like an on-line conference! The most interesting articles were a Q&A session about the TC9, TC70, and MM/1, and a rather lengthy **interview with Kevin Darling**, which described when Kevin first got interested in OS-9 (among

other things!). The magazine was published by **StG Computers, Inc.**, and edited by StG owner **Scott Griepentrogg**.

In the August Print#-2 column, Lonnie discussed the arrival of the new computers. He predicted that they would be natural extensions of the present CoCo, possibly an acceptable upgrade path for many users. He also alludes to the possibility of there being several regional CoCoFests sponsored by local groups, not Rainbow. This allusion is to the **Atlanta CoCoFest sponsored by CoCoPRO! and the Atlanta Computer Society (ACS)**, a CoCo club in Atlanta, Georgia, being planned for October 6 & 7. Stated right out is that there would be **NO NEW JERSEY COCOFEST** sponsored by Rainbow. There would be a single RainbowFest in Chicago during the spring. The Atlanta show (held at the Lakewood Holiday Inn) was advertised by CoCoPRO!, the primary sponsor, and also mentioned in the MM/1 ad.

Hey! What's this! Not only do we now have a picture of the MM/1, but prices as well! A single floppy (1.4MB, 3.5") system without monitor (use your CM-8 or compatible!), but with OSK, BASIC, C compiler, and several other programs and utilities cost \$779. They would even be **GIVING ONE AWAY** at Atlanta! A new company name appeared in the **MM/1 ad** for the first time also- **Interactive Media Systems (IMS)**. Not to be passed up, **Frank Hogg** bills his machine as "**the CoCo 4 that Tandy should have made...**" With the 6809 processor and genuine GIME chip, Frank is close to the truth in calling his machine a CoCo 4. The only thing missing is the promised Disk BASIC compatibility... Mr. Hogg also introduced a **reference book for OS-9** written by none other than **Kevin Darling**. **Inside OS-9 Level II** was not a replacement for the manual nor a tutorial, but a programming reference that really gets into OS-9 like no other. A disk full of patches and utilities was included. Kevin continues to support OS-9 and OSK (OS-9 for 68xxx processors) with his amazing programming prowess to this day. Keep up the good work Kevin... we need you!

The August OSK'er had a few improvements. The most noticeable was a somewhat better font and normal headings for each article, though the letters section entries still looked as if they came straight from an electronic mail file. Another "quirk" that appeared on the cover was the volume number. It was described as "VER01.02" (version 01.02 - meaning volume 1 number 2). Interesting articles included specifications of the MM/1 and TC70 OSK machines, an article on "OS-9 In Industry", "Playing Chess in C" (the program was being written as the article progressed through multiple installments), and an article explaining just what the term "multi-media" meant. Letters were all encouraging.

The CoCo and OS-9 SIGs (Special Interest Groups) on Delphi have always been great sources of up to the minute information, support, and software for CoCo users since their creation by Rainbow years ago. Price had been a major hurdle for many users of the low cost CoCo though. Until September of 1990, connect time cost was \$7.20 an hour. This barrier was shattered

when **Delphi announced the "20/20 Advantage Plan"**. For \$20 a month, a caller received 20 hours of on-line time. It isn't hard to see that this was a bargain! For what one would previously have paid for not quite three hours, 20 hours were available! If it could be considered a "catch", one had to pay \$20 monthly regardless of how little time was used. Time over 20 hours would only be billed an additional \$1.20 per hour. If one does not belong to Delphi, well... you don't know what you are missing!

IMS, in a bid to win over more users, **began offering a short lived lease to own option** in October. For as little as \$56 a month (with \$112 down and approved credit), one could get a new MM/1. **Owl-Ware** tried to get into the upgrade game by offering an unusual system- **a PC/AT clone!** This machine was **packaged not only with MS-DOS but also with a UNIX clone (similar to OS-9)** in an attempt to sway OS-9 users. **Gravity Studio** introduced something new for the CoCo... **PICO CAD**, a computer aided drafting (CAD) system. 3-D wire frame images could be assembled in full color with this system. The only drawback was that a pen-plotter that used the DM-PL plotting language was necessary for printing. **NMSA computer group** released a new hardware item- **CAT**. This was a **PC/AT case modified to contain a CoCo, disk drives, power supply, and a special seven slot bus interface** inside. Some CoCo users had already mounted their machines in modified or special built cases... this package would make such a chore much easier! A feature article in Rainbow was Spectra 3, a CoCo Max like graphics editor, just for the price of the magazine and a few hours of typing. One could always take the easy way out and purchase Rainbow on tape/disk or download from Delphi though.

Frank Hogg also had something new to sell this month, the **Tomcat TC70** computer. The TC70 was based on the **15MHz Signetics 68070 processor (Motorola 68020 clone)** and also came with BASIC, C compiler, OSK, and various software and utilities. A floppy based system (1.4MB 3.5" drive, 101 key keyboard, color monitor, 1.5MB RAM, 2 serial and 1 parallel port, SCSI hard drive port, and built in DMA cost \$1499.95. A similarly equipped MM/1 would cost \$1495. The TC70 board can be used to upgrade the Tomcat system to a 68xxx processor if the TC9 is already owned... or buy the TC9 and upgrade when the money comes along (\$999.95 for board and software only)! The TC9 board was upgraded to use two 512K SIMMs rather than DRAM chips and a CoCo type 512K board. The main board was also divided into two boards... a main processor board and a DAT board. The main board held all memory, but the DAT board was required to use the second 512K. This was done to decrease the cost of a basic system, which could also be used as a low cost terminal for more expensive multi-user computers.

Almost forgot... the **first ever Atlanta CoCoFest** was held in October! I was there! The show turned out to be a big success with many vendors and lookers alike. **CoCoPRO!** had a **LARGE** booth in the center of the main show floor with floods

of used and old stock Tandy software. They even had some rare scenery disks for Flight Sim II (Japan scenery), which was selling for only \$9.95 (the scenery disk was selling for more at \$24.95) and OS-9 Level 2 for only \$34.95! A new game, made especially for the fest, was available from CoCoPRO! also. In **Marty's Nightmare, starring Marty Goodman** (well, at least a good caricature of him!) had to search through a maze for a lost seminar! This neat software tribute to the good doctor was programmed by none other than **Steve Bjork**!

Highlights of the 'fest included seminars by **Steve Bjork** (history and development of the CoCo), **Cray Augsburg** (Rainbow managing editor, on happenings at Falsoft concerning the Rainbow), and a Q&A type meeting with **Kevin Darling** that lasted four hours! Good thing it was the last one! The manufacturers of the three "new" OSK machines were actually grouped together at a single seminar Sunday. After giving a brief introduction, questions flew concerning all three machines and their differences. Several notes of interest came from Crays' seminar- 1) Rainbow WOULD NOT be folded into PCM, 2) there would be a Chicago Fest sponsored by Rainbow next year, 3) the "new" computers WOULD be covered... as they became available to the general public, and 4) the planned CoCo history book project was being cancelled due to lack of time by the author. The Atlanta Computer Society took care of door prizes and assisted CoCoPRO! with running the operation. Good work guys, can't wait until next year!

October must end with a sad note. **Color Computing** magazine (changed in June from **TRS-80 Computing**) sent out what would be its last issue. Editors **Joseph Ahern** and **David McNally** were now freshmen in college and unable to spend much time putting a magazine together. The magazine had really grown, both in quality and size. From a few page, hand cobbled newsletter to a 34 page magazine, these two young men really put forth a memorable effort. Though circulation only reached a maximum of about 100 at any given time, they had put out a commendable effort for the past four years. The only break in publication had been between June 91 and this last issue. Good luck boys (no, men!), and thanks for the support!

The September issue of **OSK'er** was late. It actually arrived at most subscribers' homes in mid October! Aside from that forgivable incident, it was a very good issue. One reason for the lateness was the Atlanta CoCoFest (October 5-6). Scott went to the 'fest for a look-see and covered it nicely in the magazine.

Ah, nothing like Christmas with the CoCo! **Tandy** started their 1990 holiday season sale in November with **CoCos going for only \$99.95, CM-8 monitors for \$179.95, and drive 0 systems for \$199.95!** Heck, I remember when a 4K CoCo costs nearly as much as all that COMBINED. **Sundog Systems** introduced several new games this month: **The Quest for Thelda** (graphics adventure), **The Contrass** (military role playing game... an early announcement, wouldn't actually be ready until 1993!),

Crystal City (classic space shoot 'em up), and **Zenix** (similar to original space invaders, but much more action!). All of these games featured superior graphics, sound, and animation, especially when viewed on an RGB monitor. **Burke&Burke** had something new for **OS-9 users- a speech synthesizer called Cyber Voice** which used a SC-02 synthesizer chip.

The **December Rainbow** has **Lonnie** squelching rumors of the **Rainbow's demise**. He states that "**There is no intention, plan, idea, concept, or anything of the kind to cease publication of the Rainbow. I don't know how these rumors get started.**" Well, one way is the shrinking size and number of advertisers (still 98 pages, 47 advertisers). He reassured readers that there would be a Rainbow for some time, and that there would be a spring 'fest in Chicago. "Some time" was still two and a half years away... Many readers complained about no rack seller availability. This was due to cutting back the number of rack sellers. Why? Rainbow actually took a LOSS on many single-issue sales due to support of many locations that only sold a few copies monthly. Only those outlets with good sales would be supported from then on. Perfect time to save money and get a subscription! A new version of the Slot Pack, **Slot Pack III**, was introduced by **Howard Medical**. A hardware switch was added to allow use of most ROM packs in slot 1, a leg added to support the pack, faster buffer chips used, and an **external power supply** became necessary, as the draw from the CoCo was just to much.

If you have ever considered **recording CoCo screens on video tape** or using some of the CoCos abilities in your home movies, then do get a copy of the December 90 issue. An article by **Mark Haverstock** and **Bill Wills** shows how. An article by **Andrew T. Boudreaux, Jr.**, tells how **the New Orleans CoCo Users Group made a show on the CoCo through a local cable community access channel**. The group even used their CoCos for several required functions such as headers, title screens, and prompts. It's here- CoCo TV! A new **CoCo book** was reviewed this month. "**Connecting CoCo to the Real World**" was written by **William Barden, Jr.**, a Rainbow contributing editor. The focus was on connecting the CoCo, mainly through the joystick ports, to many items. Projects included a burglar alarm and weather station. If one can find the book it is very interesting and the projects pretty easy to build. Unfortunately, Mr. Barden left the CoCo community shortly after releasing the book. Worse, he seems to have left on a sour note... or at least left some CoCo users who ordered his book that way. The author was one of several who ordered the book and never received it, yet had their check cashed. Inquiries were left unanswered. Luckily, few CoCo vendors, who rely on mail order, leave us in this manner... most are VERY reliable! Who would have thought this of Bill? If there was extenuating circumstances unknown to us I apologize in advance for including this here, but we who ordered were at least due an explanation, and a refund. And sadly, yet another advertiser falls out as the last **Second City Software** ad appears. But take heart! They aren't leaving the CoCo market, just moving operations and changing name to **Kala Software**. Unfortu-

nately, Rainbow ads won't be in the "new" companies' future any time soon.

Hardly anyone noticed that the last **Computer Island** ad appeared in the October '90 issue of Rainbow. Nor that the last article written by **Steve Blyn** (a contributing editor since July 1982 with his **Education Notes** column) appeared in November. This was brought to their attention by Lonnie Falk in the January 1991 issue. Steve wrote a very good letter explaining that orders were slow and the operation was winding down. Lonnie publicly thanked Steve and his wife Cheryl for the many contributions to the CoCo community and wished them luck... from ALL of us! In this case, Lonnie definitely spoke for at least most longtime Rainbow readers. Well, at least there is some good news, as the first ad from **Rick's Computer Enterprises** appears. Several programs are offered, but the most interesting is **The Rainbow Indexes**, a database of all Rainbows since the original and promised to be updated annually. Now if one needed to refer to an old article, simply boot the program and search! No more thumbing through the anniversary/index issues! Thanks Rick, we needed something like this!

Not all was doom and gloom in January! **Zebra Systems** introduced **First Prize**, an award certificate making program for the CoCo 2 or 3. This useful program came on **SIX** diskettes, complete with storage box! Like other Zebra software, First Prize operated in an easy to use point and click graphics environment. CoCoPRO! came through the fest with some leftover Japan scenery disks, Flight Sim II, OS-9 Level 2, and Marty's Nightmare games. Those who didn't attend the fest were now able to purchase these bargains. The **IMS** ads featured an interesting twist: an **MM/1 could now be purchased as a kit** (add your own case, keyboard, monitor, and drives) for \$659, a savings of \$120. One reason for the kit was **delays in meeting FCC requirements** for full systems, which was causing serious delivery delays. Many people who had made down payments were wondering if they would ever get anything! Kits could be sold without FCC certification. **Delphi** users would notice **lower rates** in their ad (\$6/hour), and also discover that **Marty Goodman** is the CoCo SIG manager! And what is that on page 33? A **System IV** computer from **Delmar Company**! I remember! This was a **THIRD 68xxx based, OSK computer** system which first came to light at the Atlanta CoCoFest, which was only fitting, since **Peripheral Technologies of Atlanta** builds the boards! These machines used a **16MHz 68000** chip and a **PC/XT 8 bit expansion bus**. The PC/XT bus was used due to the availability of cheap expansion cards. A base model with four serial ports, a parallel port, 1.4MB 3.5" floppy drive, 40MB hard drive, case, keyboard, OSK operating system, and monochrome monitor sold for \$1399. **Delmar sold complete systems, kits were available directly from Peripheral Technologies**. This computer had been in existence for several years. It actually started as a build it yourself project in an electronics magazine several years before... sort of like the original hobbyists computer- the Altair (anyone reading this even remember one of those?).

The ads were interesting in February's Rainbow. The first thing one will notice was that longtime advertiser **Microcom** only had **two pages**. Didn't they ALWAYS have six before? Are they fading away also? **The last Howard Medical and last Dr. Preble's Programs** ads appeared this month. Thanks go to **Ross Litton** (Howard Medical) and **Dr. Preble** (he was actually a Dentist!) for the many years of good service. The **MM/1** had only two quarter page ads this time. Maybe the "new CoCo" isn't doing so well after all... (previous ads were one and two pagers). But here to save us from all this gloom is the **rising star of the CoCo community- CoCoPRO!** New this month was an **OS-9 version of Kyum-Gai, to be Ninja**. Though many critics thought OS-9 was not a good environment for action graphic games, they were proven wrong, as the two versions of Kyum-Gai were nearly indistinguishable. There were only 30 copies of Marty's Nightmare left now... better hurry! Last but not least, **Tandy** announced a **CoCo "blow-out" sale** on the back cover. **CoCo 3s could be purchased for \$99.95, CM-8 monitors and single disk drive systems for \$149.95.**

Marty Goodman told all about **monitors for the CoCo** in March. This was also **the thinnest Rainbow yet- only 82 pages!** CoCoPRO! ads grew to 1/2 page. They offered Tandy Orchestra-90 paks for only \$17.95 (was \$79.95) and "Where in the World is Carmen Sandiego" for only \$15.95 (was \$34.95). Sadly, another supplier is lost as **Danosoft runs their last ad**. **Rainbow stopped shipping the magazine in plastic bags this month**. Cray Augsburg said it didn't significantly reduce complaints about mangled magazines in the mail, but most subscribers realize it was mainly a cost cutting measure. **Better the bag than more pages!**

A **new serial pack** was introduced in the April CoCoPRO! ad. It was a **conversion of the Tandy 300 baud DC Modem Pak**, which contained most of the circuitry for a true serial port. The modification was **designed by Marty Goodman**. A completed pack or kit was offered. The company ad was up to a full page in May. Soft and hard ware from several companies was brought on line. There were only 23 other advertisers. A new piece of hardware came to light in May also the **Delta Pro** sound device by **Lucas Industries 2000**. The Delta Pro used the delta, or change, method of recording sound. Digitized sound was now possible with minimum memory usage. **H. Allen Curtiss' desktop publishing program was updated** beginning this month into **Ultralace**, which would run on the CoCo 3 only. The updates would occur over the next several months, as the program was almost totally re-written to take advantage of CoCo 3 features and for higher resolution printing.

April 26-28 was the time for the last Rainbowfest (held in Chicago). **Radio Shack** took up **almost a fifth of the floor space!** They were selling **CoCo 3s for \$80, OS-9 Level II for \$40, and lots of OS-9 based software for \$5 and \$10!** The final hours of the last day saw Tandy selling **CoCo 3s for only \$60...** guess they didn't want to load them back in the truck! Many

vendors were there showing their wares, including the three OSK machines. **Delmar** and **FHL** displayed actual **production models**, while **IMS** still had a **prototype**. **Developmental delays**, including FCC certification problems, had delayed production. Many people were upset, but they were continually reassured that the computer **WOULD** eventually come and the fact that the company was showing up at the 'fests at least let everyone know they still existed. **Lonnie Falk** moderated a **question and answer seminar** between **Ed Gresick** (Delmar), **Paul Ward** (IMS), and **Frank Hogg** (FHL) concerning the three OSK machines. Seems that interest in these "new" machines is pretty high. Wonder if I should consider making the switch? Guess I should try learning OS-9 on my CoCo first! Soon after this 'fest, **Tandy started selling most OS-9 software, including Level II, the Development System (assembler), and C compiler for \$5-\$10 nationwide** (they were let go at that price during the fest also). Interestingly, **Multi-View continued to carry a \$49 price tag**. These bargains were not advertised, but once they were found out, things went FAST! It was becoming hard to find CoCos and related hard/software in Radio Shack stores. **The end had finally come**. Many CoCo 3s were made before the Christmas season, and there were plenty... to many... left. **No more CoCos would ever be produced**.

Careful readers should have noticed by now that there has been **no mention of OSK'er for five months**. The reason is that they mysteriously disappeared! The **fourth issue** finally reached subscribers in **May**. Understandably, the editor decided to leave a date off the cover. In this case, the directory format of the table of contents comes in handy- the **editorial was last modified on April 23rd, 1991**. This lapse of coverage with no notice to subscribers was inexcusable and hurt the reputation of both the magazine and editor. The editor realized this, and wrote an apologetic editorial about missing deadlines. It seems that a big reason for the lapse in issues was that **the company (StG Computers) moved locations**. He also stated that **"OSK'er (was) back for good"**. To bad that **would not prove to be a true statement**. On the plus side, a good article on BASIC09 (Introduction to BASIC09) appeared in this issue.

It didn't take one long to notice that there was **no Microcom ad** in the June Rainbow! Last month it was **SD Enterprises**, distributor of the VIP series. Is one of the largest CoCo suppliers leaving? Lonnie lets us all know not to expect to find Rainbow on many newsstands. These sales were never high, but many were kept up because one could walk out of a nearby Radio Shack with a CoCo and pick up a magazine- this was now next to impossible. Only those stands with "historic" high demand would from now on be supported. **Frank Hogg**, who had a few troubles with the slow moving **TC9**, came out with the **Tiger 10MHz 68000 based processor board**. This was basically a **coprocessor for the TC9** that would speed execution of OS-9 Level II by a factor of two or three. OSK could be purchased and run later with the addition of other K-bus boards. A low price of \$129.95 made this an affordable alternative to the much more expensive TC70. **Burke&Burke**

introduced an **update** to the **Tandy Cyrus chess** cartridge. The update allowed transferring the cartridge to disk and running under OS-9! Mouse, disk, and windows support was also added. The Cyrus program is still considered the best ever chess for the CoCo.

An issue of **OSK'er** appeared... well it either appeared in June or July, or was it August? This time the table of contents didn't even reflect a date (that little item was probably overlooked in the last issue, not this one!). The **MM/1 was finally reviewed**, and promises of reviews for the Tom Cat computers were made for "next month" (no one was going to hold their breath for that!). The Rainbowfest was also covered in detail. The "Flame ON" column featured an article entitled **"Why the 'CoCo 4' Will Fail"**. The author, **Jim Hutchins**, pointed out various **shortcomings** of the new machines, their targeted market, and OSK support in general. An example was system cost. Any of the three OSK machines would run around \$1300, while a comparably equipped AT clone would only have cost \$1000. A **rebuttal by Paul K. Ward (IMS)** was also printed in the same column. A big point made about price was that the MM/1 would be better compared against at least a 386SX based machine, and that the MM/1 has a built-in network interface which would cost extra for an IBM clone. Operating system cost was also mentioned. One would really need a version of UNIX (or OS/9000) to equal the windowing and multi-tasking/ user capability of a 68xxx based machine. The operating system alone would add over \$300 to the 386SX price! No hint was given that OSK'er would expire, it just never appeared in a mailbox again. **The final issue was printed several months later**, much improved in appearance and even on "slick" paper. It was definitely the last. That makes six issues for the \$12 subscription price... fair enough, even though twelve were initially promised. Putting out a magazine is a lot of time consuming, costly work (as this author will soon find out)!

THE TWELFTH YEAR (Jul '91 - Jun '92)

Whew! **Microcom is back** with a one page ad! Well, at least they are back with us... that one missed issue was a scare! Lonnie recognized a special person (which hardly anyone will even know) in his column in this 11th anniversary (Rainbows, CoCo is 12!) issue- **Steve Ostrom**. Who is this? One who had **continually subscribed to the Rainbow for the entire eleven years**... can one be more loyal? Remember the CoCoPRO! **modem pak/RS-232 serial conversion? Marty Goodman showed how it was done** in this issue. **Advertisers are down to only 21**. We are slowly but surely losing support! Don't worry to much, a lot of the old ones are still out there ready to sell. The problem was that it **a quarter page ad in Rainbow cost around \$300**. Sales were falling to a level that could not support these rates for many suppliers. **And pages were down to only 66**.

A full page ad appeared in the August '91 Rainbow for the CoCoPRO! sponsored, Atlanta Computer Society hosted, **Second Annual Atlanta CoCoFest**. It would be held in October (5-6). Hmmm... must make plans to be there! A new **CoCoPRO!** product is **Newspaper 09**, a **desktop publishing package for OS-9 Level II**. It is based on Newspaper Plus. **Lonnie** used his **PRINT#-2** column to **review the Chicago fest of last April**, no pages taken up by a "real" Rainbowfest Report as before. He states that **coverage may be coming for the new 68xxx based machines**, and that **review machines were expected soon**. The **Delmar System IV** was even included in the "**Received and Certified**" section! The very **last Microcom ad** ran this month. They will be missed, but not for long... they go out by creating a small stir in the next few months...

Gracing the **front cover of Septembers' Rainbow** was none other than the **Delmar System IV** received last month! Because of high interest, this review item was given a high priority. Readers found that the **PT68K/4 motherboard** used **8 bit PC/XT compatible cards** (though drivers may not be available for some) and a **16MHz 68000** processor, all neatly packaged in a PC type case. A CoCo 3 was connected to one of the four serial ports as a terminal. It was remarked that this would be an excellent way to continue using existing software until OSK software could be purchased. The PT68K/4 **does not come with BASIC**, so the reviewing staff contacted **Microware** and received a copy for review, along with **an integrated package (word processor, spreadsheet, and database) called SMART**. Both had **high price tags- \$500 for BASIC and \$895 for SMART**. It was discovered that **terminals** running from the serial ports **required VT-100 emulation**. A prototype 8086 based card was shown. This would allow running MS-DOS software, but not simultaneously with OSK. A "new era" of computing was coming... at least for OS-9 enthusiasts. With the passing of Danosoft, CoCoPRO! picked up the rights of Simply Better. They advertised it on sale for \$29.95... "the BEST CC3 word processor ever" (I have to admit some bias here- SB was used to write this book!).

In October, Lonnie tells us that there was an example of all three "new CoCos" in the hands of the Rainbow technical staff. Coverage of the new machines was planned, but only "as we see evidence of 'upward' migration to these systems". The CoCo would still be covered, of course. **Marty Goodman** authored an article explaining exactly **why the Tandy Multi-Pak Interface (MPI) required updating for the CoCo 3**. Older models (grey case) had to be upgraded to use the disk controller because the GIME chip in the CoCo 3 used an address which would cause an unmodified MPI to switch away from slot 4 (which contains the disk controller). The newer models (large and small white cased) appeared to work just fine in most cases. Intermittent problems resulted from the 6809 trying to read data from certain GIME port addresses. The main problem was that the MPI was designed before the CoCo 3 and the data buffer is activated whenever a read was performed in that overlapping address range! The GIME and buffer would then try to give the 6809 data at the same time,

garbling the read data. This would happen even if nothing was in the MPI. Upgrading the large MPIs was easy- order a replacement PAL chip from Tandy. Upgrade instructions were given for the newest 26-3124 (small white) MPI, which required the addition of a single chip and a few jumper wires. Tips were also given for modifying the MPI for OS-9 use (not required, but some modifications enhance operations under OS-9). The IMS ad focussed on software companies with OSK software.

A phone number for **Kala Software**, formerly **Second City**, was given with the advice to call for a catalog. Yes, **owner Ed Hathaway** still supported the CoCo (though it wasn't mentioned in the ad). Many of the other vendors mentioned as "gone" were also still in the CoCo business, there just wasn't enough of it to pay for Rainbow ads (remember... around \$300 monthly for 1/4 page) and make a decent profit... in many cases, not enough to break even! To top the month off (actually to **START** it off!), the **Second Annual Atlanta CoCoFest was deemed a success** again. There were fewer people than the crowd the year before, but still enough to make an effort for next year. With the sluggishness of the economy in general, the smaller showing was no big surprise.

Gracing the cover in November was the **6809 based TC9 Tomcat** from **Frank Hogg Laboratories**. Until now, the TC9 design had been subject to several changes. The design reviewed was the production model then being shipped. The motherboard contained the 68B09 and a genuine GIME to maintain CoCo 3 compatibility. The CPU had to be run at just under 2MHz... the **GIME wouldn't run at a full 2MHz!** A pair of 256Kx8bit SIMMs (single in-line memory modules) took care of the 512K of memory. An additional pair could be added along with a DAT board (which handles address translation) for a full 1MB of RAM. The CoCo bus was a two-row 40 pin header connector. A short Y cable was connected to this. Unlike the CoCo, this bus was fully buffered so running with a Y cable would not strain the bus- nor the 200 watt power supply. Composite video and RGB was available, but no TV output. Two serial and one parallel port, the CoCo bus, and joystick ports were on an I/O board mounted above the motherboard.

The only real incompatibility with CoCo OS-9 hardware was that a **different address had to be used for the sound port**. Three bytes had to be changed in Kyum-Gai in order to here the sound effects. OS-9 Level II had to be purchased separately from Tandy or another source. New boot disks with the correct FHL TC9 drivers had to be made with a CoCo 3 or the original OS-9 disks sent to FHL so they could make a new boot for the TC9 purchaser. Disk BASIC was not yet supported, but FHL did release a utility within a year that allowed saving ones' CoCo 3 ROMs to disk and patched them for TC9 use, thus gaining Disk BASIC compatibility- but only if one had access to a CoCo 3 (note: it would be considered piracy if one did not own a CoCo 3).

Rainbow shrank yet again- down to 50 pages and 20 advertisers. Two letters were printed from readers who had **trouble with support from Microcom.** They were still shipping orders for **Word Power 3.3** but were **NOT returning letters asking for support** even after repeated queries. A sad way to end what was once a well respected company...

And finally- a review of the **IMS MM/1**, with an appearance on the cover of the December '91 Rainbow! This computer is "brained" with a **Phillips/Signetics 68070** (Motorola 68020 compatible... manufactured for Phillips, the licensee, by Signetics) and a **66470 Video System Controller (VSC)**. Due to delays in FCC certification, the MM/1 was being **delivered only as a "kit"**. The kit included a completed motherboard, case, power supply, keyboard, I/O board, and drives. Assembly took only 30 minutes. Anyone who had ever installed a second drive in their CoCo could accomplish this task easily! One serial, RGB analog video, keyboard (XT type), and sound ports were on the motherboard along with 1MB of RAM, two ROMs, and the CPU and VSC chips. The I/O board had a second serial, a parallel, stereo sound, and joystick ports along with an SCSI interface (primarily for hard drives) and sockets for two 1MB SIMMs for a total of 3MB RAM. The VSC chip supported an interlace mode which allowed crisp 16 or 256 color graphics with up to **720x480 resolution** (16 colors in 720x480 mode)- **even on a CM-8!** Real-time animation sequences were also possible. These last two items (high resolution graphics and animation) were both made possible by the capabilities of the VSC chip. Of all the new machines, **the MM/1 seemed to have left the greatest impression.** New this month from Sundog was **Photon** (a maze game), **War Monger** (war game, sort of a modernized version of Risk), and **Graf Express** (a graphics and music programming environment that allowed easy fast action and sound). Licensing options would be available for programs using Graf Express.

The February and March 1992 Rainbows were significant in one way: **February was the last magazine format Rainbow, and March the first tabloid, or newspaper, format.** The reason for the change was simple economics. With fewer advertisers there wasn't as much money flowing to stay with the comparatively expensive slick paper color cover magazine. Rather than raise subscription prices (\$31 for a 50 page magazine isn't cheap!), the new format was chosen. The "new" Rainbow featured **only 32 pages**, but space was actually **INCREASED** by roughly nine percent due to the **increase in size of the pages** themselves. A four color process was still used for the cover, but most of the cover space was used for content rather than just "window dressing". The ads were bigger and the ad prices were even rolled back to the previous years rates. Ad price was a big issue (sore spot!) for many advertisers, especially with the cheaper to produce tabloid format. The "magazine" was now the size of many small town newspapers (and we all know how much they cost). The Rainbow has many more expenses than a small newspaper, but many advertisers (including some with printing industry connections) felt the current subscription price alone should come close to sup-

porting the magazine- the ad rates were bordering on outrageous (still around \$300 for 1/4 page). Only the fact that the Rainbow was still the only vehicle for reaching the majority of CoCo users kept the few advertisers (only 18 this issue) in those pages. If you were looking for a **disk drive system**, you would be in for a search- **Computer Plus** listed them as **SOLD OUT** (though a Tandy disk controller was still available)! They had **last advertised the CoCo 3** in January '91 for **only \$89**.

Another supplier "bit the dust" in April '92- sort of. **CoCoPRO!** **acquired all inventory and rights to the entire Howard Medical line.** CoCoPRO! stated that all outstanding warranties would also be picked up in the transfer. The **last Howard Medical ad had run in January '91.** With no Rainbow support, **CoCoPRO!** again **picked up organization of the Chicago CoCoFest**, first advertised in this issue. This fest is being billed as the **"First Annual 'Last' CoCoFest"** (May 30-31). Not that it will be the last, but only time will tell unless users keep up support! Dave Meyers is starting to show a little strain from organizing these events. **Glenside** will again be supporting Dave as they have always supported Rainbow, and may pick up organizing the next Chicago event altogether, as ACS will be doing the next Atlanta event. The only thing missing from the non-Rainbow sponsored events was the Rainbow itself (with the exception of the October '90 Atlanta CoCoFest). One can understand their inability to organize these affairs out of their home state, but it is hard to understand that the magazine won't at least support the fests by having a booth or at least covering them in the magazine. These events are of great interest to the CoCo community, as many new and old supporters often showed up to display their wares. And anything good for the CoCo community would also have been good for the Rainbow.

Lonnie started quite a controversy in May. He stated that **Rainbow WOULD NOT be supporting the new 68xxx based computers** based mostly on the fact that software was either unavailable, hard to come by, or too expensive for most home users (remember \$500 BASIC?). What REALLY vexed many people was that he **recommended buying an INTEL based PC if one really needed a new computer.** While this would be a logical choice for most users, **the OS-9 community really got upset!** NOTHING on an MS-DOS based PC came very close to the power of OS-9 on one of the new machines (except maybe **Microware's OS-9000, OS-9 for a PC type 386 or higher** processor, but it was too expensive for real consideration), especially when the amount of investment is considered. That a **special offer for PCM (Falsoft's PC magazine)** followed the above statements made it seem as though he were steering one toward MS-DOS because he also published an MS-DOS magazine similar to the old Rainbow (this was not, however, the case).

A feature article by **Bill Palmer** told **how to use a Hewlett-Packard DeskJet printer** with a CoCo. These high resolution ink jet printers produce laser quality print and graphics without sophisticated software features at half the price (or less)

of an expensive laser. **H. Allen Curtiss** was at his **Ultralace desktop publishingsystem** again, correcting some problems and adding some new features. His desktop publisher appeared to be one of the most popular Rainbow programs yet! A new **Zebra Systems** ad (they had been absent for two months- was starting to be concerned!) indicated that they had gained rights to the **POKES, PEEKS 'N EXECS** books previously from Microcom. An ad for a new magazine, "**The 68XXX Machines**", couldn't have been better timed, considering Lonnie's editorial! At only \$14.75 for a one year subscription, it was worth looking into if one was considering a 68000 based computer.

A new ad from **FARNA Systems** appeared that not only advertised software, but also **advertised space**! Since Rainbow ads were so costly, why not **sublet advertising space** at a more reasonable rate? The idea was to purchase a large block of space at a better rate than a small ad, then spread the cost over many small advertisers. The idea was sound in principal, but not enough advertisers were interested to continue for long. **CoCoPRO!** had a full page ad for the "**Second Annual Last Chicago CoCoFest**" held this month (May 30-31) that included directions for getting to the Inland Meeting Center, where the fest was held.

Burke&Burke introduced their **PowerBoost** in June. This software/hardware combo included a **Hitachi 63B09E** processor chip and **drivers for OS-9 Level II**. The Hitachi processor was a 68B09E clone in CMOS architecture, but with some advanced features. These advanced features were taken advantage of by the new OS-9 modules and patches, providing an **average 40% increase in speed** while maintaining direct compatibility. A 6809 could be directly replaced with a 6309 without the user knowing any difference. The new software, and the enhanced mode of the 6309, was the secret! A book describing the newly found "secrets" of this CPU was also available from B&B.

What's this? **A NEW MAGAZINE!** The first issue of "**The OS-9 Underground, Magazine Dedicated to OS-9/OSK Users Everywhere**" was sent out in June. The cover featured a 6309 chip on wheels being driven by a CoCo driver! The **40 page** magazine featured **advertisements from eight companies**, most notable being Delmar (System IV computer). It was printed in a **5 1/2" x 8 1/2" format**, saddle stitched (stapled). Although the print was a little small, it was exceptionally well laid out and professional looking with multiple fonts. No wonder! **The editor (Alan Sheltra)** was a graphics artist by trade! Articles included "Test Driving the 6309", and "BASIC Training". A classified section was also carried. The cover was a bright yellow, which certainly added to the magazines' visual impact. **Subscription price (US) was only \$18 for a year, cover price \$2 per issue.**

The new **OS-9 Users Group** was officially formed in June '92. The new group picked up where the old left off, keeping many of the same goals and even the same name for the newsletter

(MOTD... "Message of the Day"... what users first see when signing on a multi-user OS-9 system). Elected **president** of the new group was **Boisy Pitre**, **vice president Carl Kreider**.

THE THIRTEENTH YEAR (Jul '92 - Jun '93)

Lonnie Falk made an understatement in July's Print#-2 column- "... it seems I have stirred up something of a hornets nest..." This statement was made over the mail received after the May column. He clarified his stance- **he WAS NOT advocating that anyone with a CoCo change to an MS-DOS system, nor that MS-DOS was a substitute for OS-9.** The point was that **the new machines were not the ticket for anyone who wanted more out of their Color Computer.** If one is looking for another computer, though, an MS-DOS machine- with its vast software base- might be a better choice than one of the new machines with little software support. The new machines were basically where the CoCo was when it first appeared on the market. The big difference was that most other affordable home computers were not in much better shape than the CoCo, and those that had much software weren't far ahead. Lonnie also stated that this may be **the last Print#-2 column.** He invited readers to give their opinions- **use this space for a continued editorial, or more information?** Sorry Lonnie... I will miss you (some), but I'd rather see more for my CoCo!

The **OS-9 Underground** had a few changes (for the better!) in just the second issue! The magazine was noticeably thicker, this time sporting **50 pages** wrapped in a fluorescent green cover. The colored covers did add a bit to the magazines overall appearance. On the title page of this second issue appears a little box exclaiming "**Now incorporates 68xxx Machines**". Rather than fold, "**The 68xxx Machines**" editor/publisher **Jim DeStafeno** decided that there was no need to fragment the OSK market with two magazines. A **merger agreement** was reached between 68xxx Machines and OS-9 Underground whereby Underground would absorb the subscription base and writers of the former. Several columns were carried over also. A **complementary disk** with program listings was first offered this month. The disk would be "published" on a quarterly basis, the first being available in mid-August, for \$35 yearly or \$10 per issue. There were **fourteen advertisers** in this issue, notably Delmar, Peripheral Technologies (makers of System IV kits and boards), and Frank Hogg Labs (TC70). The only OSK system missing is the MM/1 (IMS). The subscription rates stayed the same, but cover price increased to \$3 due to the increase in size. **Gale Force** picked up on the extra 6309 power by introducing **NitrOS9**. This was a set of patches for OS-9 Level II that **allowed native mode operation of the Hitachi 6309**, similar to the B&B PowerBoost.

The **August OS-9 Underground** issue featured a communications theme. An insert featuring many OS-9 supporting Bulletin Board Systems (BBS) was a nice touch. The cover color

this month was fluorescent orange. A short **Chicago CoCoFest report** (to be continued next month) and a rather detailed **review of several OS-9 BBS software packages** was featured. **Sixteen advertisers and 53 pages...** not bad for only the third issue! Keep up the good work, Allen! A very interesting feature article instructed one on how to **connect multiple terminals to a CoCo**, creating a small LAN (local area network) with no extra software, just some cabling and serial port cards.

The **Hitachi 6309** and **Burke & Burke's Powerboost** made the headlines in the **September Rainbow**. **Marty Goodman** described the **history of the 6309** and also **reviewed the PowerBoost**. We are told that the "new" **6309** (it had actually been around since 1987!) **may also increase speed under Disk BASIC by as much as 15%**, but the BASIC ROMs would have to be modified (or patched in RAM of a CoCo 3). **Bill Vergona** of **Cer-Comp** reported that he was **95% complete on an assembler (m/l) that would take advantage of the 6309 under Disk BASIC**. One would have to install a 6309 in order to utilize the assembler or any software written for it. Bill was **also considering modifying some of his software for 6309 operation**. **JWT Enterprises** had an interesting ad. **"If you are interested in the latest, new products for the CoCo and the 'newer breed' of machines, write to us..."** Just what do they have in mind here? Will have to send a post card and find out. The smaller size of OS-9 Underground meant less lead time (and overhead), and they were able to "get the jump" on Rainbow with the 6309 story. An issue of **OS-9 Underground** was **missing this month**, but the magazine was well represented at the October Atlanta CoCoFest. What gives Alan?

JWT let on to what they were up to last month. October's Rainbow sported a full page ad for **UpTime**, an **advertising newsletter covering all CoCo and 68xxx machines**. Not a magazine, the newsletters' function was to provide low cost advertising and product info for the supported products. One year subscriptions were available for \$15 in two installments of \$7.50 each. **Nine-Times OS-9 disk magazine** was also continued. **Burke & Burke** introduced another new product- **Thexder: OS-9**. This OS-9 program **took the code from the Tandy Thexder ROM pak and patched it for operation under OS-9**, similar to the **World Class Chess** program introduced earlier. **Gale Force** advertised their **NitrOS9** software this month. It was now available as a **kit with a 63B09E and installation instructions**. Missing this month was **PRINT#-2**. Seems a lot of readers, while appreciating the fact that Lonnie was keeping the Rainbow in publication, would rather have more info than 1/2 page of editorial. **Alan Sheltra** answered subscriber inquiries about the **missing September OS-9 Underground** with the news that **a double issue would come out this month**. The double issue was **finally delivered in November!** At the time this book went through final editing (March '93), the next issue was nowhere to be seen, and inquiries weren't being answered. It seems we have lost yet another support source.

Although Lonnie Falk said he would not be covering the 68xxx machines just a few months ago, it seems a truce had been called between the Rainbow and hard core OS-9 users. **John Donaldson** authored the first of a series of **articles on his experiences with his new MM/1** in November. Mail from worried CoCo users had a lot to do with Lonnie's first decision, mail from angered OS-9 users and even advertisers (the three producers of the 68xxx machines had pumped a LOT of money into Rainbow advertising!) prompted this repositioning. **Cray Augsburg** stated that although **Rainbow** wasn't going to put a lot into support of the new machines just yet, they **would consider articles on them for publication**.

A **"C" programming language compiler** had been available for the Disk BASIC CoCo user in the early days, but had not been available for some time (last advertised in Dec. '84 Rainbow). This prevented many users from learning that language as they had no interest in learning the intricacies of OS-9. Well, **Infinitum Technology** changed all that in December '92. They **introduced a complete C compiler, assembler, library/linker, command coordinator, and text editor package for the CoCo 2 and CoCo 3** Called simply **COCO-C**, this was a complete C development package **based on the original Kernighan and Ritchie C standards (as was OS-9 C)**.

A sad note for the CoCo community appeared in the **February '93 issue of UpTime**. In their usual three page ad, **CoCoPRO!** **printed a letter stating that they would soon cease operations as a CoCo vendor**. An unusual offer was made: **buy at least \$30 of software from a discounted list of products that CoCoPRO! owned outright, and a license to use ALL 14 of the listed products would be granted**. The "catch" to the offer was that **at least 33% of the mailing list had to take up on the offer**. The programs could be obtained via a special password to a database on "Jim's CoCo Corner" BBS (313-292-4713), E-mail on Delphi, or by sending \$1 per disk to and \$3 shipping per order to the CoCoPRO! address. If 33% didn't respond, the programs wouldn't be released but one would still have the software one paid for. Not a bad deal! The letter was also sent to many CoCo users via direct mail, bringing **the total sent to 1966 plus the just under 300 UpTime subscribers** (who weren't counted in the total). 84 were returned as undeliverable, leaving 1882 for the group. This meant **752 would have to place orders** for the offer to succeed. As of **19 February**, Dave reported that **the original goal was unlikely to be met**, so the response rate was **lowered to 22% and the deadline to 10 March**. At that time, any who participated would be able to get copies of all the software for \$1 per disk plus shipping, provided the lowered goal was met. **CoCoPRO!** granted licenses to the software to other vendors to guarantee continued availability. **Even if the goal wasn't met, Dave promised "something extra" for those who supported him in the last days**. Sorry to see you go Dave, but glad you made an effort to pass everything on rather than just leaving as so many others have! The offer ended up netting only 18% total response.

Why did CoCoPRO! fail? The CoCo community is small, and naturally getting smaller. Dave Myers attempted to run CoCoPRO! as a **full time business**, while most other vendors run their businesses as part time or sideline endeavors. There simply is **not enough business to keep a full time operation going and growing!** Most vendors make a small amount from their efforts, but a lot of the energy is pure enjoyment and support of the CoCo. There isn't enough money in the CoCo community any more to support a thriving, full time operation. This shouldn't discourage users from marketing their software, just don't expect to make a fortune in a shrinking, tight market. CoCoPRO! did well their first couple years, and **Dave must be applauded for his efforts and support of the CoCo community.**

Talk of a possible **new magazine** hit the FIDO network and Delphi in February. This new magazine would be supporting primarily Disk BASIC, but also CoCo OS-9 and limited OSK coverage. In May, the announcement came through that the magazine, **"the world of 68' micros"** (all in "micro" letters!), was a go! The first issue would be delivered in August... get those subscriptions in!

Really sad news started trickling down in March. Falsoft started calling advertisers and letting them know that **the May issue would be the last of "The Rainbow"**. The decision at Falsoft couldn't have been easy. "The Rainbow" made Falsoft into what it is today. From a business standpoint, however, "The Rainbow" couldn't continue. Subscriptions were down to a point that the publishing capacity could be put to better use printing almost anything else. That "The Rainbow" survived as long as it did was due to the good will of Lonnie Falk. Thanks Lonnie... you kept us all informed and helped us to learn one heck of a lot about Tandy's little wonder... much more than Tandy ever did! On a personal note, without "The Rainbow", this book would have been next to impossible to write...

What does the future hold for the CoCo? Who could have imagined that the CoCo, almost "ignored to death" by Tandy in the beginning, would be around today to enjoy its thirteenth birthday? **With continued support from YOU, the current users, the Color Computer will be around for at least another decade.** It was with this in mind that this book was written... to keep your CoCo alive and well for many more years to come...

RADIO SHACK'S AFFORDABLE TRS-80 COLOR COMPUTER ATTACHES TO ANY TV FOR FAMILY FUN AND EDUCATION

NOW GET 128K MEMORY—BUILT IN—FOR 100 LESS THAN LAST YEAR'S EQUIVALENT!

399.95

- 128K 160,000 Character Extended BASIC
- 128K 160,000 Character Extended BASIC
- 128K 160,000 Character Extended BASIC

499.95

Radio Shack
The biggest name in electronics
& computers for home & business

RIGHT: Radio Shack catalog page for the CoCo 2, 1984.

SUPER-POWERFUL COLOR COMPUTER 2

64K Extended BASIC

259.95

AS LOW AS \$299.95

- 128,000 Characters of Memory
- Absolute White Case With Typewriter-Quality Keyboard
- Easy-to-Use One-Line Commands
- Simplified Detailed Color Graphics
- 128 x 192 Resolution (16,128 Pixels)

The Heart of a Sophisticated Disk-Based Color Graphics System. Double your programming power with our new, low-cost 64K Extended BASIC Color Computer 2. You'll enjoy creating spectacular color graphics with this truly professional system.

Dynamic Enhancements. The 64K Color Computer gives you a compact, white case with a new electric typewriter-quality keyboard. Add our new Color Computer 2 Disk Kit and 256K expansion system (see page 54) to utilize the full 128,000-character memory. Or access 64K of memory using the powerful, built-in Extended BASIC language.

Features-Packed. Get the features required by the various popular games. Two separate, spring-riding keys up to 255 characters, giving a range up to 255 characters, full-featured editing, saving, loading, point-to-point accuracy, trigonometric functions, user-definable keys, specific error messages, and PEEL, POOL, and LOG commands.

Color Computer Specifications

Memory: 64K extended BASIC, 128K RAM, 128K ROM, 128K disk, 128K tape, 128K cassette, 128K floppy, 128K hard disk, 128K optical disk, 128K laser disk, 128K CD-ROM, 128K DVD-ROM, 128K Blu-ray, 128K HD-DVD, 128K UDF, 128K ISO, 128K JIS, 128K X-Box, 128K PS3, 128K PS4, 128K PS5, 128K Xbox One, 128K Xbox Series X, 128K Xbox Series S, 128K PS VR, 128K PS Move, 128K PS Eye, 128K PS Camera, 128K PS Micro USB, 128K PS Type-C, 128K PS DualShock 4, 128K PS DualSense, 128K PS VR2, 128K PS Move2, 128K PS Eye2, 128K PS Camera2, 128K PS Micro USB2, 128K PS Type-C2, 128K PS DualShock 5, 128K PS DualSense2, 128K PS VR3, 128K PS Move3, 128K PS Eye3, 128K PS Camera3, 128K PS Micro USB3, 128K PS Type-C3, 128K PS DualShock 6, 128K PS DualSense2, 128K PS VR4, 128K PS Move4, 128K PS Eye4, 128K PS Camera4, 128K PS Micro USB4, 128K PS Type-C4, 128K PS DualShock 7, 128K PS DualSense2, 128K PS VR5, 128K PS Move5, 128K PS Eye5, 128K PS Camera5, 128K PS Micro USB5, 128K PS Type-C5, 128K PS DualShock 8, 128K PS DualSense2, 128K PS VR6, 128K PS Move6, 128K PS Eye6, 128K PS Camera6, 128K PS Micro USB6, 128K PS Type-C6, 128K PS DualShock 9, 128K PS DualSense2, 128K PS VR7, 128K PS Move7, 128K PS Eye7, 128K PS Camera7, 128K PS Micro USB7, 128K PS Type-C7, 128K PS DualShock 10, 128K PS DualSense2, 128K PS VR8, 128K PS Move8, 128K PS Eye8, 128K PS Camera8, 128K PS Micro USB8, 128K PS Type-C8, 128K PS DualShock 11, 128K PS DualSense2, 128K PS VR9, 128K PS Move9, 128K PS Eye9, 128K PS Camera9, 128K PS Micro USB9, 128K PS Type-C9, 128K PS DualShock 12, 128K PS DualSense2, 128K PS VR10, 128K PS Move10, 128K PS Eye10, 128K PS Camera10, 128K PS Micro USB10, 128K PS Type-C10, 128K PS DualShock 13, 128K PS DualSense2, 128K PS VR11, 128K PS Move11, 128K PS Eye11, 128K PS Camera11, 128K PS Micro USB11, 128K PS Type-C11, 128K PS DualShock 14, 128K PS DualSense2, 128K PS VR12, 128K PS Move12, 128K PS Eye12, 128K PS Camera12, 128K PS Micro USB12, 128K PS Type-C12, 128K PS DualShock 15, 128K PS DualSense2, 128K 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128K PS DualSense2, 128K PS VR27, 128K PS Move27, 128K PS Eye27, 128K PS Camera27, 128K PS Micro USB27, 128K PS Type-C27, 128K PS DualShock 30, 128K PS DualSense2, 128K PS VR28, 128K PS Move28, 128K PS Eye28, 128K PS Camera28, 128K PS Micro USB28, 128K PS Type-C28, 128K PS DualShock 31, 128K PS DualSense2, 128K PS VR29, 128K PS Move29, 128K PS Eye29, 128K PS Camera29, 128K PS Micro USB29, 128K PS Type-C29, 128K PS DualShock 32, 128K PS DualSense2, 128K PS VR30, 128K PS Move30, 128K PS Eye30, 128K PS Camera30, 128K PS Micro USB30, 128K PS Type-C30, 128K PS DualShock 33, 128K PS DualSense2, 128K PS VR31, 128K PS Move31, 128K PS Eye31, 128K PS Camera31, 128K PS Micro USB31, 128K PS Type-C31, 128K PS DualShock 34, 128K PS DualSense2, 128K PS VR32, 128K PS Move32, 128K PS Eye32, 128K PS Camera32, 128K PS Micro USB32, 128K PS Type-C32, 128K PS DualShock 35, 128K PS DualSense2, 128K PS VR33, 128K PS Move33, 128K PS Eye33, 128K PS Camera33, 128K PS Micro USB33, 128K PS Type-C33, 128K PS 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Eye89, 128K PS Camera89, 128K PS Micro USB89, 128K PS Type-C89, 128K PS DualShock 92, 128K PS DualSense2, 128K PS VR90, 128K PS Move90, 128K PS Eye90, 128K PS Camera90, 128K PS Micro USB90, 128K PS Type-C90, 128K PS DualShock 93, 128K PS DualSense2, 128K PS VR91, 128K PS Move91, 128K PS Eye91, 128K PS Camera91, 128K PS Micro USB91, 128K PS Type-C91, 128K PS DualShock 94, 128K PS DualSense2, 128K PS VR92, 128K PS Move92, 128K PS Eye92, 128K PS Camera92, 128K PS Micro USB92, 128K PS Type-C92, 128K PS DualShock 95, 128K PS DualSense2, 128K PS VR93, 128K PS Move93, 128K PS Eye93, 128K PS Camera93, 128K PS Micro USB93, 128K PS Type-C93, 128K PS DualShock 96, 128K PS DualSense2, 128K PS VR94, 128K PS Move94, 128K PS Eye94, 128K PS Camera94, 128K PS Micro USB94, 128K PS Type-C94, 128K PS DualShock 97, 128K PS DualSense2, 128K PS VR95, 128K PS Move95, 128K PS Eye95, 128K PS Camera95, 128K PS Micro USB95, 128K PS Type-C95, 128K PS DualShock 98, 128K PS DualSense2, 128K PS VR96, 128K PS Move96, 128K PS Eye96, 128K PS Camera96, 128K PS Micro USB96, 128K PS Type-C96, 128K PS DualShock 99, 128K PS DualSense2, 128K PS VR97, 128K PS Move97, 128K PS Eye97, 128K PS Camera97, 128K PS Micro USB97, 128K PS Type-C97, 128K PS DualShock 100, 128K PS DualSense2, 128K PS VR98, 128K PS Move98, 128K PS Eye98, 128K PS Camera98, 128K PS Micro USB98, 128K PS Type-C98, 128K PS DualShock 101, 128K PS DualSense2, 128K PS VR99, 128K PS Move99, 128K PS Eye99, 128K PS Camera99, 128K PS Micro USB99, 128K PS Type-C99, 128K PS DualShock 102, 128K PS DualSense2, 128K PS VR100, 128K PS Move100, 128K PS Eye100, 128K PS Camera100, 128K PS Micro USB100, 128K PS Type-C100, 128K PS DualShock 103, 128K PS DualSense2, 128K PS VR101, 128K PS Move101, 128K PS Eye101, 128K PS Camera101, 128K PS Micro USB101, 128K PS Type-C101, 128K PS DualShock 104, 128K PS DualSense2, 128K PS VR102, 128K PS Move102, 128K PS Eye102, 128K PS Camera102, 128K PS Micro USB102, 128K PS Type-C102, 128K PS DualShock 105, 128K PS DualSense2, 128K PS VR103, 128K PS Move103, 128K PS Eye103, 128K PS Camera103, 128K PS Micro USB103, 128K PS Type-C103, 128K PS DualShock 106, 128K PS DualSense2, 128K PS VR104, 128K PS Move104, 128K PS Eye104, 128K PS Camera104, 128K PS Micro USB104, 128K PS Type-C104, 128K PS DualShock 107, 128K PS DualSense2, 128K PS VR105, 128K PS Move105, 128K PS Eye105, 128K PS Camera105, 128K PS Micro USB105, 128K PS Type-C105, 128K PS DualShock 108, 128K PS DualSense2, 128K PS VR106, 128K PS Move106, 128K PS Eye106, 128K PS Camera106, 128K PS Micro USB106, 128K PS Type-C106, 128K PS DualShock 109, 128K PS DualSense2, 128K PS VR107, 128K PS Move107, 128K PS Eye107, 128K PS Camera107, 128K PS Micro USB107, 128K PS Type-C107, 128K PS DualShock 110, 128K PS DualSense2, 128K PS VR108, 128K PS Move108, 128K PS Eye108, 128K PS Camera108, 128K PS Micro USB108, 128K PS Type-C108, 128K PS DualShock 111, 128K PS DualSense2, 128K PS VR109, 128K PS Move109, 128K PS Eye109, 128K PS Camera109, 128K PS Micro USB109, 128K PS Type-C109, 128K PS DualShock 112, 128K PS DualSense2, 128K PS VR110, 128K PS Move110, 128K PS Eye110, 128K PS Camera110, 128K PS Micro USB110, 128K PS Type-C110, 128K PS DualShock 113, 128K PS DualSense2, 128K PS VR111, 128K PS Move111, 128K PS Eye111, 128K PS Camera111, 128K PS Micro USB111, 128K PS Type-C111, 128K PS DualShock 114, 128K PS DualSense2, 128K PS VR112, 128K PS Move112, 128K PS Eye112, 128K PS Camera112, 128K PS Micro USB112, 128K PS Type-C112, 128K PS DualShock 115, 128K PS DualSense2, 128K PS VR113, 128K PS Move113, 128K PS Eye113, 128K PS Camera113, 128K PS Micro USB113, 128K PS Type-C113, 128K PS DualShock 116, 128K PS DualSense2, 128K PS VR114, 128K PS Move114, 128K PS Eye114, 128K PS Camera114, 128K PS Micro USB114, 128K PS Type-C114, 128K PS DualShock 117, 128K PS DualSense2, 128K PS VR115, 128K PS Move115, 128K PS Eye115, 128K PS Camera115, 128K PS Micro USB115, 128K PS Type-C115, 128K PS DualShock 118, 128K PS DualSense2, 128K PS VR116, 128K PS Move116, 128K PS Eye116, 128K PS Camera116, 128K PS Micro USB116, 128K PS Type-C116, 128K PS DualShock 119, 128K PS DualSense2, 128K PS VR117, 128K PS Move117, 128K PS Eye117, 128K PS Camera117, 128K PS Micro USB117, 128K PS Type-C117, 128K PS DualShock 120, 128K PS DualSense2, 128K PS VR118, 128K PS Move118, 128K PS Eye118, 128K PS Camera118, 128K PS Micro USB118, 128K PS Type-C118, 128K PS DualShock 121, 128K PS DualSense2, 128K PS VR119, 128K PS Move119, 128K PS Eye119, 128K PS Camera119, 128K PS Micro USB119, 128K PS Type-C119, 128K PS DualShock 122, 128K PS DualSense2, 128K PS VR120, 128K PS Move120, 128K PS Eye120, 128K PS Camera120, 128K PS Micro USB120, 128K PS Type-C120, 128K PS DualShock 123, 128K PS DualSense2, 128K PS VR121, 128K PS Move121, 128K PS Eye121, 128K PS Camera121, 128K PS Micro USB121, 128K PS Type-C121, 128K PS DualShock 124, 128K PS DualSense2, 128K PS VR122, 128K PS Move122, 128K PS Eye122, 128K PS Camera122, 128K PS Micro USB122, 128K PS Type-C122, 128K PS DualShock 125, 128K PS DualSense2, 128K PS VR123, 128K PS Move123, 128K PS Eye123, 128K PS Camera123, 128K PS Micro USB123, 128K PS Type-C123, 128K PS DualShock 126, 128K PS DualSense2, 128K PS VR124, 128K PS Move124, 128K PS Eye124, 128K PS Camera124, 128K PS Micro USB124, 128K PS Type-C124, 128K PS DualShock

CoCo Hardware Prices...

The following prices were obtained from Radio Shack advertisements and catalogs. This list is far from all inclusive (my personal RS catalog collection dates back to 1987), but does give an idea as to what early CoCo enthusiasts gave for their equipment. If an item is not priced for a given year, that usually means that earlier prices were carried over (no change). Note that CoCo specific items use 3xxx catalog numbers. These will be shown first, with remaining numbers in numerical order. Listed printers have the 4 pin CoCo style serial connector and all have 9 1/2" wide carriages and 9 pin print heads unless otherwise noted.

1980- Introduction

26-3001 - \$399.00 - 4K CoCo 1
26-3002 - \$599.00 - 16K CoCo 1, Extended BASIC
26-3008 - \$24.95 - Joysticks (pair)
26-3010 - \$399.00 - TRS-80 Color Video Receiver
(13" digitally tuned TV)
26-3015 - \$119.00 - 16K RAM Upgrade
26-3018 - \$99.00 - Extended Color BASIC Upgrade
26-1206 - \$59.95 - CCR-80A Cassette Recorder

1981

26-3003 - n/a - 32K CoCo 1
26-3004 - \$399.95 - 16K CoCo 1
26-3017 - \$199.00 - 32K RAM Upgrade
26-3020 - \$4.95 - CoCo printer cable
26-1167 - \$399.00 - Line Printer VII
26-1168 - \$799.00 - Line Printer VIII
26-1172 - \$149.00 - TRS-80 Modem I (300 baud)
26-1182 - \$39.95 - Plug 'n Power Controller
(original- uses cassette port)
26-1191 - \$1995.00 - Multi-Pen Plotter (use w/ digitizer)
26-1193 - \$199.95 - CGP-115 (12 cps, 4.5", color)
26-1195 - \$449.00 - Screen Digitizer

1982

26-1196 - \$349.95 - Color X-Pad
26-1211 - \$499.00 - Network 2 Controller
(software/cables included)
26-1212 - \$599.00 - Network 3 Controller
(software/cables extra)
26-1253 - \$399.00 - DMP-100 (50 cps)
26-1254 - \$799.00 - DMP-200 (120 cps)
26-2775 - \$149.00 - Network 3 Software (floppy drive)

1983

26-3005 - \$199.00 - 64K CoCo (9/83)
26-3011 - \$119.95 - MC-10 Micro Color Computer
26-3012 - \$39.95 - Deluxe Joystick
26-3022 - \$499.00 - Disk Drive 0 Kit
26-3024 - \$179.95 - Multi-Pak Interface
26-3025 - \$49.95 - Color Mouse
26-3026 - \$239.95 - 16K CoCo 2
26-3027 - \$319.95 - 16K CoCo 2, Extended BASIC
26-1208 - \$59.95 - CCR-81 Cassette Recorder
26-1261 - \$99.95 - TP-10 Thermal Printer (30 cps, 4")
26-1268 - \$699.00 - CGP-220 Ink Jet Printer (color)

1984

26-3024 - \$179.95 - Multi-Pak Interface
26-3026 - \$159.95 - 16K CoCo 2
26-3027 - \$199.95 - 16K CoCo 2, Extended BASIC
26-3128 - n/a - 16K CoCo 2 w/mono composite video
adapter (factory installed, schools only)
26-3134 - \$119.95 - 16K CoCo 2
\$99.95 - 12/84
26-3136 - \$159.95 - 16K CoCo 2, Extended BASIC
\$139.95 - 12/84
26-3127 - \$259.95 - 64K CoCo 2, Extended BASIC
\$199.95 - 12/84
26-3129 - \$399.95 - FD-500 Disk Drive 0 Kit
\$349.95 - 8/84 on
26-2226 - \$79.95 - Deluxe RS-232 Pak
26-1209 - \$49.95 - CCR-82 Cassette Recorder
SPECIAL - \$299.95 - 16K CoCo 2, CGP-115, CCR-82,
Joysticks, Vocabulary Tutor Cassette (11/84-12/84)

1985

26-3008 - \$19.95 - Joysticks
26-3012 - \$29.95 - Deluxe Joystick
26-3015 - \$29.95 - 16K Upgrade (from 4K)
26-3016 - \$24.95 - CoCo 2 Keyboard (w/ CoCo 1 adapter)
26-3017 - \$59.95 - 64K Upgrade (from 16K)
26-3018 - \$39.95 - Extended BASIC Upgrade
26-3134 - \$119.95 - 16K CoCo 2
\$88.00 - 12/85
26-3127 - \$219.95 - 64K CoCo 2, Extended BASIC
\$159.95 - 12/85
26-3129 - \$349.95 - FD-500 Disk Drive 0 Kit
\$199.95 - 12/85
26-3143 - \$99.95 - Orchestra 90 Stereo Music Pak
\$79.95 - 12/85
26-3144 - \$99.95 - Sound/Speech Pak
\$79.95 - 12/85
26-1178 - \$59.95 - DCM-3 Modem (300 baud)
26-1185 - \$59.95 - Graphics Touch Pad
26-1261 - \$99.95 - TP-10 Thermal Printer (30 cps, 4")
\$79.95 - 12/85
26-1268 - \$599.00 - CGP-220 Ink Jet Printer (color)

1985 (continued)

26-1275 - \$299.00 - TRP-100 Thermal Ribbon Printer
(battery or AC powered)
26-1276 - \$199.95 - DMP-105 (80 cps)
26-1277 - \$899.00 - DMP-430 (180 cps, 15", 18 pin)
26-1278 - \$599.00 - DWP-220 (20 cps, 15")
26-1280 - \$349.95 - DMP-130 (100 cps)
26-2226 - \$79.95 - Deluxe RS-232 Pak
\$59.95 - 12/85
26-2228 - \$89.95 - DCM Modem Pak (300 baud)

1986

26-3124 - \$99.95 - Multi-Pak Interface
26-3127 - \$199.95 - 64K CoCo 2, Extended BASIC
\$159.95 - 08/86 on
\$99.95 - 12/86
26-3131 - \$299.95 - FD-501 Disk Drive 0 Kit
\$199.95 - 12/86
26-3132 - \$179.95 - FD-501 Drive 1 Kit
26-3141 - \$24.95 - Electronic Book
26-3145 - \$129.95 - Hard Disk Interface
(works only with OS-9, Tandy 10/15/35 MB drives)
26-3215 - \$299.95 - CM-8 RGB Monitor
26-3334 - \$219.95 - 128K CoCo 3
26-3335 - \$149.95 - 512K Upgrade
25-1025 - \$699.00 - 10MB External Hard Disk
26-1277 - \$699.00 - DMP-430 (180 cps, 15", 18 pin)
26-1393 - \$59.95 - DCM-6 Modem (300 baud)
26-4172 - \$2695.00 - 35MB External Hard Disk

1987

26-3028 - \$9.95 - Hi-Res Joystick Interface
26-3030 - \$69.95 - OS-9 Level I
26-3031 - \$79.95 - OS-9 Level II
26-3032 - \$99.95 - OS-9 Level II Development System
26-3125 - \$49.95 - Two button Mouse
26-3133 - \$299.95 - FD-502 Disk Drive 0 Kit
\$219.95 - 12/87
26-3135 - \$179.95 - FD-502 Drive 1 Kit
26-3142 - \$99.95 - Appliance/Light Controller (serial)
26-3143 - \$79.95 - Orchestra 90 Stereo Music Pak
26-3144 - \$79.95 - Sound/Speech Pak
26-3334 - \$219.95 - 128K CoCo 3
\$199.95 - 09/87-11/87; \$129.95 - 12/87
26-1386 - \$99.95 - Modemphone 100 (300 baud)
26-1394 - \$99.95 - DCM-7 Modem (300 baud)
26-2812 - \$399.95 - DWP-230 (20 cps)

1988

26-3018 - \$14.95 - Extended BASIC Upgrade
26-3133 - \$299.95 - FD-502 Disk Drive 0 Kit
\$199.95 - 12/88
26-3334 - \$199.95 - 128K CoCo 3
\$129.95 - 12/88
26-1385 - \$199.95 - DCM-212 Modem (300/1200 baud)
26-1814 - \$379.95 - DMP-132 (120 cps)
26-2802 - \$219.95 - DMP-106 (80 cps)

1989

26-3123 - \$29.95 - Pistol Grip Joystick
26-3335 - \$39.95 - 512K Upgrade board (bare)
25-1079 - \$149.95 - 256K RAM Kit (2 required for 512K)
(NOTE: This was during the first RAM shortage)
26-2815 - \$379.95 - DMP-133 (160 cps)
26-2821 - \$279.95 - DMP 107 (100 cps)
900-2009 - \$129.95 - Disto Super Controller 2 (no-halt)

1990

26-3008 - \$19.95 - Joysticks
\$9.95 - 06/90
26-3123 - \$29.95 - Pistol Grip Joystick
\$21.95 - 12/90
26-3125 - \$49.95 - Two Button Mouse
\$24.95 - 06/90
26-3133 - \$299.95 - FD-502 Disk Drive 0 Kit
\$179.95 - 06/90
\$199.95 - 12/90
26-3215 - \$299.95 - CM-8 RGB Monitor
\$199.95 - 06/90
\$179.95 - 12/90
26-3334 - \$199.95 - 128K CoCo 3
\$129.95 - 06/90
\$99.95 - 12/90
26-1384 - \$59.95 - CCR-83 Cassette Recorder
26-2228 - \$89.95 - DC Modem Pak (300 baud)
\$9.95 - 06/90

1991 - The Beginning of the End

36-3028 - \$9.95 - Hi-Res Joystick Interface
\$4.95 - 02/91
26-3112 - \$22.95 - Deluxe Joystick
\$11.95 - 02/91
26-3133 - \$299.95 - FD-502 Disk Drive 0 Kit
\$149.95 - 02/91
26-3215 - \$299.95 - CM-8 RGB Monitor
\$149.95 - 02/91
26-3334 - \$199.95 - 128K CoCo 3
\$99.95 - 02/91
26-2228 - \$89.95 - DC Modem Pak (300 baud)
\$9.95 - 02/91

The last appearance of the CoCo in a Tandy catalog was in RSC-22 (1991). The last Tandy CoCo ad ran in the May 1991 Rainbow. During late 1991 and all of 1992, many software packages were discounted nationwide. Users eagerly sought the OS-9 software, especially Level II, the Level II Development System, and the "C" Compiler. Other software was deeply discounted, eventually being cleared out for as little as \$1! Even today, a few game cartridges and, more rarely, disk software can be found in the back corner of Radio Shack stores. Some of the software will not show up on the stores' computer, meaning that the manager can just about name any price. Most cartridges will be found for \$3.99 or less. The author recently picked up a copy of "DynaCalc" (OS-9) for just \$1, so do look!

CoCo Clones... *an attempt to ride Tandy's wake...*

There were only three CoCo clones ever made. The most known in the U.S. is the **Dragon Systems Ltd.** (a British company) "**Dragon**", imported to the U.S. by **Tano**. A second clone was advertised in Byte Magazine, the **Sampo Color Computer** (made in Korea), but never made it to the sales floor. It is quite possible that the ROMs used were near duplicates (if not blatantly so!) of the Tandy code, and that Tandy therefore prevented importation. Until four to five years ago, U.S. copyrights weren't protected in most Asian countries, including Japan and Korea. One could walk into a Korean computer store and find hundreds of copies of commercial software for share-ware prices... averaging \$5 per disk, plus \$5-\$10 for a manual.

The third "clone" was not really a clone at all, but an attempt to make an improved but downwardly compatible computer. The **FHL TC9** used a 68B09 and GIME just like the CoCo 3, but had some improved hardware design. It was intended to primarily be an OS-9 platform.

The Dragon Data/Tano Dragon

The following article was originally written for the October issue of **Color Computer News** by Alfredo Santos but never appeared due to the magazines discontinuance.

Enter The Dragon/64

Alfredo Santos September 30, 1983

The **Dragon/64** computer, which is enjoying great success in England, is now available in America. What makes the Dragon worthy of mention in this magazine is the fact that it uses a **6809E microprocessor** and **Microsoft BASIC** just like our friend the TRS-80 Color Computer.

When I first heard about the **Dragon/64** (and little brother **Dragon/32**) my first question was: "Will Color Computer programs run on the Dragon?". The answer is YES... and NO! The incompatibility of **BASIC word tokens** between the 2 machines prevent CoCo programs from working on the Dragon, directly. If you save a CoCo program using the ASCII format (CSAVE "filename",A) it will CLOAD and RUN on the Dragon with little or no problem. Problems may occur if any memory locations in low RAM are PEEKed or POKEd and problems will occur for sure if any CoCo ROM routines are called.

Here's why: Dragons' Color BASIC and Extended Color BASIC are identical to CoCos' in many ways with some major exceptions. Both are burned into a single HN4827128G-30 28 pin EPROM. While the Dragons' BASIC chip (IC 18) occupies memory locations &H8000-&HBFFF like the CoCo, ROM entry points are different. CoCo's POLL CAT routine, for instance, is at &HA1C1 while on the Dragon it's at &HBBE5. This fact prevents Color Computer machine language programs from running on the Dragon unmodified.

Dragon ROM entry points and CoCo BASIC equivalents:

CoCo Address	Dragon Address	Comment
(A000) A1C1	(A000) 8006	POLL KEY
(A002) A282	(A002) B54A	CHAR OUT (cass)
(A004) A77C	(A004) 8021	CASS READ
(A006) A70B	(A006) B93E	BLOCK IN
(A008) A7F4	(A008) B999	BLOCK OUT
(A00A) A9DE	(A00A) 8012	READ IN JOYSTK VAL
(A00C) A7D8	(A00C) 801B	HEADER OUT
Both the CoCo and Dragon have indirect addresses at &HA000-&HA00C- the Dragon's bid at CoCo compatibility.		
894C	9D3	
95CF	A95D	
A00E	B39B	SECONDARY RESET
A027	B3B4	MAIN RESET
A02A	B3B7	
A06E		HARD START
A0E8	B44F	SOFT START
A176	B50A	CHAR IN
A186	B51A	
A1B1	B538	
A1C1	BBE5	CHECK KEYBRD
A282	B54A	CHAR OUT (cass)
A290	B560	
A2A8	B578	
A2BF	BD1A	
A30A	BCAB	CHAR OUT (screen)
A34B	BCE2	SCROLL UP ONE LINE
A390	B5C6	INPUT FROM KEYBRD
A393	B5C9	
A398	B5CE	
A42D	B663	
A444	B67A	
A46C	B6A8	
A491	B6CD	
A502	A095	
A59A	B7CC	Data mover routine
A5EE	B820	
A619	B84B	
A629	B85B	
A635	B867	
A65C	B88E	
A65F	B891	
A663	B895	
A701	B933	
A70B	B93E	BLOCK IN
A77C	BDE7	Cass. READ out
A7E9	BD52	
A7D1	B480	
A7D3	B482	
A7D8	BE68	
A7F4	B999	BLOCK OUT
A928	BA77	Clear Screen
A951	BAA0	
A956	BAA5	
A974	BAC3	
A976	BAC5	sound routine
A9DE	BD52	
AD19	8417	Clear mem (NEW+3)
B277	89B4	get operand
B99C	90E5	PRINT text string

Another area of major incompatibility is the keyboard (HI-TEK 107044 H). Although the Dragon has a full stroke keyboard, its

matrix is not wired the same way as the CoCo keyboard. For example, a CoCo machine language program (which you've modified, of course) will produce unexpected keyboard input. Typing the following: "DRAGONCOLOR COMPUTER" will put this on the screen: "4B17/. 3/./B 3/- @ED5B". Indications supporting the keyboard matrix incompatibility is the fact that if the Dragon keyboard is installed in the CoCo, or vice versa, the weird output continues. This condition does not affect any CoCo BASIC programs running on the Dragon (unless you are PEEKing the keyboard rollover table to check keys pressed).

A couple more items on keyboard related matters: Dragon BASICs' routine to poll for entry from the keyboard is somewhat less efficient than CoCo's. I'm not a speed typist but, in the two years I've been computing, I've gotten pretty proficient at typing the word "LIST". The word is typed so fast that before the "L" key is released, the "I" key is being pressed then "S" and "T". The Dragon turns my lightning "LIST" into "LST". This occurs because the Dragons' keyboard polling routine will not recognize the "I" key stroke until the "L" key is released because they are apparently on the same row of the keyboard matrix. This also effects the method used to pause scrolling during a LIST with a "SHIFT @". The inability to accept a double keystroke happens only while Dragon is in the 32K mode (on power-up). While in the 64K mode, not only is the problem eliminated but, if a key is held down for more than a few tenths of a second, it starts repeating.

By the way, you'll know at a glance whether you're in the 32K or 64K mode simply by the cursor color. In the 32K mode, the cursor will be a blinking solid black graphics character while a blinking solid blue cursor indicates 64K mode.

Dragons' 64K mode is entered by typing "EXEC" and pressing ENTER. Easy hey?? When the machine is turned on, part of its initialization process includes moving data into low RAM (&H0000-&H03FF) for the BASIC interpreters to use. For instance, the system uses location &H009D to hold the EXEC address of the last machine language which was loaded into the computer. This eliminates having to specify an EXECution address after you CLOADM a program. Power-up initialization puts the value &HBF49 at &H009D Dragons' 64K mode ROM entry point is &HBF49. If you wish to enter the 64K mode AFTER having loaded in a machine language program, &H009D will then contain then EXEC address of that program so typing EXEC &HBF49 will be required to access the 64K. Another nice thing about the Dragons' use of its 64K is that it frees user RAM from &H0600-&HBFFF's by moving the ROMs up to &HC000-&HFFF0. The CoCo doesn't move its ROMs, so you end up with 2 blocks of RAM (&H0600-&H7FFF and &HC000-&HFFF0, with memory locations &HA000-&HBFFF; &H8000-&HBFFF for Extended BASIC CoCos) off limits because CoCo's ROMs are there.

With 64K of RAM (Dragon/64), full stroke keyboard, parallel printer, port and color composite monitor output, this computer should be a very serious consideration for anyone in the

market for an inexpensive yet powerful machine with high resolution graphics capabilities. In addition to the above mentioned ports, the Dragon has the standard CoCo type connections for 2 joysticks, a cassette recorder, 40 pin ROM cartridge/expansion slot, and TV hook up. The power transformer is externally mounted, making the computer run a good bit cooler than a CoCo... no fan needed!

The Dragon has all the power and versatility of the very popular TRS-80 Color Computer plus features which make the Dragon a more professional machine with greater capabilities. If you've held off buying the TRS-80 Color Computer because of some above mentioned limitation then now is the time to stop "Dragon" your feet and check out this very "great Briton" (You liked the Beatles, didn't you?).

Even today, there is continued support for the Dragon in the United Kingdom (England). There is an active user group that continues to provide limited support for the machines through the Internet (<http://www.dragon-archive.co.uk>). The M.E.S.S. emulator also supports the Dragon.

EUROHARD, a Spanish company, bought Dragon Data and all rights to the computer in 1984 and attempted to revive it as an educational computer. The attempt was not successful and the factory closed in 1987.

New-in-the-box Tano Dragon 64s are still available from California Digital (17700 Figueroa Street, Gardena, CA 90248; phone 800-421-5041 (orders) or 310-217-1945 (tech support/information)). **As of February 2006, California Digital still had a small supply of new in the box Tano Dragons. Their web site address is: <http://www.cadigital.com/computer.htm>.** Tano (Technical Associates of New Orleans) was the U.S. company licensed to sell and manufacture Dragon Data computers in North American and the Caribbean Basin. As far as could be determined, only Dragon 64s were made by Tano. Tano worked closely with Dragon Data on a new Dragon 128 that featured dual 6809 processors and 128K, but it never got beyond the prototype stage. It was designed from the start to run OS-9 and featured four serial ports for terminals. It's truly to bad that machine didn't get off the ground!



TANO Dragon 64

Tomcat TC9... *Frank Hogg Laboratories bid to build a better CoCo...*

FHL introduced the Tomcat TC9 in June of 1990. Unlike other OS-9/OSK computers, the TC9 was designed to use existing CoCo hard and software, reducing the initial investment required. To maintain this compatibility, it used a 68B09E and original Tandy GIME chip. A CoCo type 40 pin expansion bus was also included via a 40 pin header connector. A one or two 40 pin card edge connector ribbon cable attached to the header. Even the MPI could be attached! Since the bus was fully buffered (unlike the CoCo's), the cable presented no problems, and a cable with a couple more connectors would probably work just as well as long as it was kept to a minimal length. A 68xxx type "K-bus" was also used on the TC9. This allowed adding numerous FHL K-bus cards and even a 68xxx processor card. The processor card could be used as a coprocessor for 6809 OS-9 or vice-versa. A special 10MHz 68000 based card, the Tiger, was designed specifically for that purpose, though one of the faster, more expensive 68xxx based cards (such as the 15MHz 68070 based TC70) could also be used.

Features of the TC9 included:

- * CoCo 3 soft/hard ware compatible (OS-9)
- * 25% faster than the CoCo 3
- * IBM/PC compatible 101 key keyboard, case, and power supply
- * Two hardware serial ports- no need for RS-232 Paks
- * Support for a PC type serial mouse
- * Parallel printer port
- * Improved joystick ports, higher resolution
- * Better sound capabilities
- * CoCo 3 and K-bus expansion capabilities
- * Up to 1MB of DRAM on the motherboard (the original design used a CoCo 512K upgrade and Disto 1MB board, the final used four 256K SIMMs and a plug in control, or DAT, board)

The TC9 was designed with running Tandy/Microsoft/Microware SuperExtendedDisk BASIC (CoCo 3 BASIC) in mind. There were some problems, however. The first was that Tandy held the copyright, so an agreement would have to be reached with or ROMs purchased directly from them. Second was the improved hardware. OS-9 could easily cope with the added hardware by supplying the correct software drivers. Disk BASIC was another story- the code itself required modification.

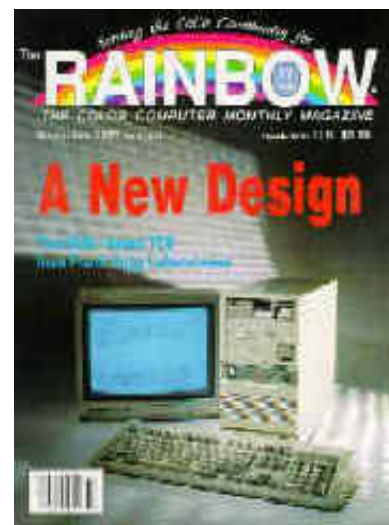
FHL eventually got around most of this, though it took about a year of tinkering. The first step was hardware. An emulator circuit was devised that would intercept CoCo output and send it to the correct TC9 port. Since the TC9 was a bit faster than the CoCo 3, the hardware didn't slow operation when compared to the original. Rather than deal directly with the ROM situation, software was supplied that would allow a CoCo 3 owner to copy his ROMs to disk then patch them for

TC9 operation. This was used since relatively few TC9 customers insisted on Disk BASIC support- most wanted to run OS-9 only. This method sort of stepped around copyright infringement, since one was expected to own a CoCo 3.

Unfortunately, the improvements just weren't enough for most OS-9 users who had outgrown their CoCo 3s, and the price was a bit high for those just seeking a CoCo 2 or 3 replacement. Prices started at \$499.95 for a starter system which included a low profile case, and 512K (1990 price. The second type sold for \$549.95, but used a mini tower case, a \$20 option for the 1990 unit). One still needed their CoCo disk drive controller and drive, CM-8 (or similar RGBA) or composite monitor (no TV output), and a PC/AT style keyboard (PC/XT keyboard not supported). 512K CoCo 3s could still be purchased new for under \$350 in 1990. Note that if one purchased the 512K upgrade and RAM from Tandy, the total price would have been \$539.80. Tandy was still stuck with lots of 256K DRAM chips they were forced to purchase during the 1989 DRAM shortage, and were STILL trying to pass the high cost to the end user. Most purchased the bare board (\$39.95) and got their DRAM elsewhere, or purchased third party upgrades for \$150 or less. In 1991, a complete TC9 system with one 360K floppy, keyboard, 20MB hard drive, 1MB upgrade, and Magnavox 1CM135 monitor was priced at \$1649.95. Boards could be purchased by those wishing to assemble their own TC9 (main board set- \$349.95, 1MB upgrade board- \$59.95... memory not included).

The TC9 faded into oblivion after only two years of production. Frank Hogg stated: "The TC9 took far longer to finish than any previous computer I've done because of the complexity of marrying an eight bit CoCo to a 16 bit 68000. We went through four design stages. This work was done by Bob Puppo with the help of just about everybody in the CoCo community offering advice." To bad all that work didn't bear more fruit, as the TC9 was truly the closest thing ever to the "CoCo 4" Tandy should have built!

The FHL
TC-9 on the
cover of
Rainbow,
Nov. 1991



Color BASIC

The authors first thought was to make separate sections dealing with these two subjects. This wouldn't really be appropriate for the CoCo though. It's main operating environment, Color BASIC, is also a programming language!

Like many of the first generation of "home" computers, the CoCo is ready to go as soon as it is turned on. All of these computers (Timex/Sinclair ZX & TS series, Commodore VIC-20, 16, & 64, Atari 400 & 800, Colleco Adam, TI 99/4A, etc.... even the IBM PCjr) have a BASIC programming language stored in a ROM chip. The ROM is active after power is turned on, meaning that nothing has to be loaded before beginning to operate the computer (unless working with a pre-recorded program). This was done to make the computers seem less intimidating. Cartridge slots were also a part of most early home computers. A cartridge containing a different ROM chip (Tandy ROM-Pak) could be inserted before turning the system on, and when powered up whatever was in the cartridge ROM would be ready to go. What could be simpler?

There are four types of BASIC for the CoCo in three versions: **Color BASIC**, **Extended Color BASIC**, **Disk BASIC** and **Super Extended Color BASIC**. **Color BASIC** is the simplest form of BASIC for the CoCo. It came in an 8K ROM and was the first BASIC available. There were no definition commands (DEFUSR, DEF FN, etc.), only one trigonometric function (SINE), no error trapping, and few graphics commands (only POINT, SET, and RESET). If a line was typed in wrong, it would have to be retyped- there was no editing capability. This BASIC was very similar to TRS-80 Model I Level I BASIC. CoCos with only this BASIC installed would display "COLOR BASIC VERSION 1.0" on screen when turned on.

It didn't take Tandy long to realize that programmers wanted more. **Extended Color BASIC (ECB)**, similar to TRS-80 Model I Level II) was announced when the CoCo was introduced in September 1980, with an expected introduction of "late November". It actually arrived in mid January, 1981. Extended BASIC contained many new commands in another 8K ROM that plugged into a socket next to the existing Color BASIC ROM, for a combined total of 16K. New commands included those "missing" from Color BASIC, including a wide range of graphics commands, algebraic and trigonometric functions, the play command, and many new programming statements- the most notable being a statement to save machine language programs on tape. The Extended ROM could be added to any CoCo for \$99.00 plus installation. Many of the graphics commands required 16K to use (the first CoCo was only 4K), the upgrade would add an additional \$119.00 (plus installation) to the price. The best deal was to purchase a 16K Extended CoCo new- it was only \$100 more than a 4K non-Extended model (\$599 vs. \$499).

There were some minor problems in **Color BASIC 1.0**. One was the printer driver. Tandy used a seven bit code to drive a printer in the CoCo. Less than a year after the CoCo's introduction, printers (including Tandy models) standardized on an eight bit code. Tandy first rectified this by supplying a new printer eight bit printer driver on tape for free (note that some early Tandy printers were seven bit input, others were switchable between seven and eight bits). This was brought on by the introduction of the Line Printer VII, the first with a built-in CoCo serial connector (four pin) and the first capable of dot addressable graphics. The seven bit printer driver would print characters but no graphics.

In November 1981, the new 32K CoCo was introduced. With it came a new revision of **Color BASIC- version 1.1**. The main reason BASIC was changed was the 32K RAM upgrade itself. The old 1.0 ROM would only address up to 16K, so it had to be changed. While the engineers were making changes anyway, they decided to add some items to the original ROM code and to fix a couple minor problems, though the official stance was that nothing was wrong with the 1.0 ROM. The additions included 32K support, the eight bit printer driver, and displaying an "S" while searching a cassette for a file and an "F" when a file was found.

When disk drives became available from Radio Shack in October of 1981, a new BASIC extension came with them. Rather than create a disk based operating system, Tandy decided to add commands to BASIC that would allow access to the disk drives. **Disk Extended Color BASIC (DECB)** resided in an 8K ROM contained in the disk controller. With the controller plugged in the disk commands loaded into the Program-Pak area of Color BASIC. This method allowed the CoCo to retain simplicity of use with the speed and convenience of a disk drive. An advantage to BASIC programmers is immediate access to disk information. A true disk loaded disk operating system (DOS) not only has to have BASIC loaded from disk, but BASIC has to call the DOS to access most disk information. DECB has commands that allow extensive disk data manipulation, including directly reading and writing to specifiable portions of the disk.

A new type of CoCo 2, the Korean made "A" and "B" models (and "A" or "B" follows the catalog number) required the last revision of Color BASIC- version 1.3. These computers used a different type RAM chip, the 4464, and required different timing rates than previous DRAMs. A new SAM (74LS285) also had to be used. The new SAM supported the 256 cycle RAM refresh rate required by the 4464 chips as well as the 128 cycle refresh of the old style chips, so it could be used in any CoCo but the original SAM could not. All the 1.3 ROM does is tell the SAM to use the 256 cycle refresh rate if jumpers are set for the 4464 chips and change the revision number. Color

BASIC and ECB are both burned into a single 28 pin, 128K ROM on these CoCo 2 models. Standard Color BASIC ROMs will fit, but won't work with 44xx series RAM chips. The 1.3 ROM will also work in earlier CoCos.

The final type, **Super Extended Color BASIC**, was introduced in 1986 with the CoCo 3. Like Disk BASIC, this was an extension of the existing Extended Color BASIC. Due to the copyright agreement with Microsoft, Tandy couldn't alter the ECB code, and didn't want to pay high royalties for MicroSoft to make the necessary changes... MicroSoft was much bigger now than they had been when Color and Extended Color BASICs were written!

In order to add commands to the CoCo 3, a new ROM was made for Tandy by Microware, publishers of OS-9. What happens is that the CoCo 3 powers up in an "all RAM" mode (ROM contents copied to RAM) and the new ROM patches the ECB code in RAM, much as one would alter the code with POKE statements, avoiding copyright problems with Microsoft. Twenty six new commands were added to take advantage of the CoCo 3s enhanced graphics, text, and memory capabilities as well as error handling.

The three people who designed the code also did something else with some extra space in the single 32K ROM (Color and Extended BASIC are in the lower 16K with minor changes, CoCo 3 BASIC in the upper)- they put a portrait of themselves! To see them, hold down the CTRL and ALT keys while pressing the RESET button on the back of the computer. This does a "cold start" also, the RAM is reset and in most cases the computer behaves as if it has been turned off then back on, which is the only way to "cold start" a CoCo 1 or 2 (pause at least 15 seconds before turning back on!). There are times when this may have to be done with a CoCo 3 also, such as after running some machine language programs. To return the CoCo 3 screen to normal and complete the "cold start", press RESET once more (holding no keys down this time).

Note what the screen says when a CoCo 3 is powered up. It should read "Extended Color BASIC 2.1" or "Disk Extended Color BASIC 2.1" (or 2.0, depending on version in disk controller). No, there isn't really a third and fourth version of BASIC, nor a new version of Disk BASIC. The ECB code was changed to replace the "1" with a "2" to indicate a CoCo 3. No new commands were added to Disk BASIC. It would have been nice had Tandy taken the opportunity to support at least 40 track drives, possibly even double sided. The most likely reason this support was not added was to maintain optimum compatibility with existing systems.

BASIC is normally an "interpreted" language. This means that the computer reads the BASIC code directly through a BASIC interpreter, as the CPU can't directly read the code. The interpreter converts the BASIC code into machine language- the native language of the CPU. The interpretation process is

Easy DECB Enhancements...

There is an easy way to add a few extra to Color BASIC and DECB. Changes can be made to the system by poking different values into specific memory locations. This can be done easiest on a CoCo 3 as the ROM code is copied into RAM automatically. The CoCo 1 and 2 require being put into an all RAM operating mode (ROMs copied to RAM) by running the following program:

```
10 REM PROGRAM TO COPY BASIC ROMS INTO RAM
20 REM COURTESY FRANK HOGGLABS
30 CLEAR 999
40 DATA 26,80,190,128,0,183,255,222,166,128
50 DATA 183,255,223,167,31,140,224,0,37,241,57
60 FOR I=1 TO 21: READ A:A$=A$+CHR$(A):NEXT I
70 P=VARPTR(A$)+1
80 POKE P,126
90 EXEC P
100 PRINT "BASIC NOW IN RAM!"
```

Note that unless the changes are made permanent by burning into an EPROM, they will be lost upon reset or power off .

The first thing one may want from the CoCo is more speed. There is a relatively simple way to accomplish this... through a POKE! Type POKE 65495,0 to put a CoCo 1 or 2 into "double speed" mode. What this does is address the ROM at twice the normal clock speed (1.79MHz instead of .89MHz) of the CPU. POKE 65494,0 returns the processor to normal speed. Another address (POKE 65497,0) addresses the ROM and RAM at double speed, but terminates RAM refresh (could cause loss of memory) and also makes the screen unreadable as it affects the video clock rate also (which won't operate at double clock speed). If one has lots of math functions to process, this may come in handy, but the slow down POKE (65496,0) will have to be entered to view the results. The computer could also lock up if the RAM drops any bits. This seems to work in practice, as the author has turned the TV off and let CoCo plot away at Mandelbrot graphics all night (the particular program required approximately six hours to plot a single graph at double speed), but it is not recommended programming practice and would be unacceptable in a commercial program.

Some CoCo 1 models required the following minor changes to allow proper double speed (65495,0) operation:

D & E board - clip capacitors C30, C73, & C75 (also C85 when using a disk controller)

F or NC board - clip capacitors C36, C37, and C86

The board letter is in the serial number printed on the board. No harm will come from removing these 56pf capacitors, they are for filtering and distort the clock signal in double speed mode (there may be a slight increase in RFI, but it shouldn't be noticeable).

The CoCo 3 DOES NOT support the first "double speed" POKE. Tandy actual did something better... they decided to support the double speed POKE fully! The address at 65497,0 supports true double speed operation of ROM, RAM (RAM is refreshed properly), and video. POKE 65496,0 still returns to standard speed. Many CoCo 3 programs take advantage of the double speed mode, but disk operation is still hindered because the Disk BASIC extension was not modified. OS-9 Level II runs in double speed all the time- there is no way to slow the processor down!

The following program makes several changes to Disk BASIC. These changes can be burned into an Intel 2764 ROM to make them permanent. The 2764 is a 28 pin chip, meaning an adapter (available from Spectro Systems) is required for all Tandy controllers except the short one. Simply run the program and then save a copy of the Disk BASIC ROM code to disk (or tape). The listing is commented with explanations between program lines (don't type in the explanations, **program lines are in bold**). Eliminate the lines with unwanted features. Programmers may use portions of this listing in commercial products as long as the statement "Portions by F.G. Swygert & L.Todd Knudsen" is included in the new BASIC code.

10 REM Program for setting printer baud, drive step rate, and double speed disk access, CoCo 3.

Program was written for a CoCo 3. Will run on a CoCo 1/2 after changing all LOCATE statements to PRINT@ and running the ROM into RAM program.

30 REM by F.G. Swygert, January, 1993 - 1110-1140 by L.Todd Knudsen, 1992

60 POKE 65497,0

CoCo 3 double speed; 65495,0 for CoCo 1/2

65 POKE 150,18

Change printer baud rate to 1200. Will be 2400 (double the value) with the speed-up POKE.

70 IF PEEK(&HA282)=23 THEN 120

Check for ADOS & EADOS3. ADOS should already be set up with faster drive access rates. If present go to line 120.

80 IF PEEK(&HC004)=215 THEN 100

Check if DECB 1.0/1.1. If PEEK value is 215, then DECB 1.1 is present. Value would be 214 for 1.0. If 1.1, go to line 100. If not (therefore 1.0), continue.

90 POKE &HD6CD,0 : POKE &HD723,20 : GOTO 140

Set drive to 6ms access time, DECB 1.0/2.0

100 POKE &HD7C0,0 : POKE &HD816,20 : GOTO 140

Set drive to 6ms access time, DECB 1.1/2.1

120 CLS : SOUND 150,4 : LOCATE 14,16 : PRINT "Currently set up for 2400 baud printer." : LOCATE 14,17 : INPUT "Do you wish to change this? (Y/N)"; A\$

Clear the screen : Make a sound with tone 150 for a duration of 4 : move cursor to column 14, line 16 : PRINT statement in quotes : move cursor to column 14, line 17 : accept INPUT after printing statement in quotes, the INPUT will be stored as A string

130 IF A\$="y" OR A\$="Y" THEN 320 : IF A\$="n" OR A\$="N" THEN 420 : GOTO 120

If A string is "y" or "Y" (yes) go to line 320, if it is "n" or "N" (no) go to line 420. If A string is neither, the computer will go this far and start over by returning to line 120.

140 CLS : SOUND 150,4 : LOCATE 14,16 : PRINT "Currently set up for 2400 baud printer and 6ms drive"

See comments for line 120.

150 LOCATE 14,17 : INPUT "step rate. Do you wish to change this? (Y/N)"; A\$

See comments for line 120.

160 IF A\$="y" OR A\$="Y" THEN 190 : IF A\$="n" OR A\$="N" THEN 440 : GOTO 150

See comments for line 130

190 CLS : LOCATE 6,4 : PRINT "Select Drive Step Rate: " : PRINT

See comments for line 120. The PRINT at the end causes a blank line to be put on the screen.

200 PRINT TAB(8) "1 = 6ms 2 = 12ms 3 = 20ms 4 = 30ms"
PRINT the following beginning 8 spaces over.

210 PRINT : LOCATE 6,8 : INPUT "Selected Value"; D\$

See comments for line 120.

220 IF PEEK(&HC004)=215 THEN 230 ELSE 270

Check for DECB 1.1. If present go to line 230, otherwise go to line 270.

230 IF D\$="1" THEN POKE &HD7C0,0 : POKE &HD816,20 : GOTO 320

240 IF D\$="2" THEN POKE &HD7C0,0 : POKE &HD816,21 : GOTO 320

250 IF D\$="3" THEN POKE &HD7C0,0 : POKE &HD816,22 : GOTO 320

260 IF D\$="4" THEN POKE &HD7C0,0 : POKE &HD816,23 : GOTO 320

265 POKE &HD762,2

POKE the values for the specified step rate, DECB 1.1 then go to line 320 (see line 200 for rates). Line 265 sets the number of times the computer will try to read a disk before issuing an "I/O ERROR" (in this case, 2 tries- normally 5)

270 IF D\$="1" THEN POKE &HD6CD,0 : POKE &HD723,20 : GOTO 320

280 IF D\$="2" THEN POKE &HD6CD,0 : POKE &HD723,21 : GOTO 320

290 IF D\$="3" THEN POKE &HD6CD,0 : POKE &HD723,22 : GOTO 320

300 IF D\$="4" THEN POKE &HD6CD,0 : POKE &HD723,23 : GOTO 320

305 POKE &HD66F,2

Same as 230-265, except for DECB 1.0.

310 GOTO 190

If none of the above, go back to line 190.

320 LOCATE 6,10 : PRINT "Select Printer Baud Rate:" : PRINT

See comments for line 190.

330 PRINT TAB(8) "1 = 600 2 = 1200 3 = 2400 4 = 4800 5 = 9600"

See comments for line 200

340 LOCATE 8,14 : A=PEEK(65314) : B=INT(A/2) : C=A/2 : IF C-B=0 THEN PRINT " PRINTER IS ON " ELSE PRINT " PRINTER IS OFF "

Move cursor to column 8 line 14 : the next four statements check the printer port for activity : PRINT whether the printer is on or not.

350 PRINT : LOCATE 6,18 : INPUT "Selected Value"; R\$

See comments for line 120.

```

360 IF R$="1" THEN POKE 150,180 : GOTO 420
370 IF R$="2" THEN POKE 150,87 : GOTO 420
380 IF R$="3" THEN POKE 150,41 : GOTO 420
390 IF R$="4" THEN POKE 150,18 : GOTO 420
400 IF R$="5" THEN POKE 150,4 : GOTO 420
410 GOTO 320

```

POKE the values for the specified baud rate then go to line 420. Note that the value is actually HALF the specified rate because the double speed POKE is used.

```

420 LOCATE 20,23 : PRINT "PRESS ANY KEY TO ACCEPT,
BREAK TO STOP"; : EXEC 44539

```

This line allows a chance to stop if a mistake was made. EXEC 44539 makes the computer wait for a key to be pressed before continuing the program.

```

430 IF PEEK(&HA282)=23 THEN 1000

```

Check for ADOS/EADOS. If present, go to line 1000

```

440 IF PEEK(&HC004)=214 THEN A$="C0EED52AD6
D1D6F1D727D75E" ELSE A$="C101D617D7C4D7E4D
81AD851"

```

Check for DECB 1.0, use first string for data if it is present, else use the second string for DECB 1.1

```

450 FOR V=1 TO 24 STEP 4

```

```

460 A=VAL("&H"+MID$(A$,V,4))

```

```

470 POKE A,189 : POKE A+1,240 : POKE A+2,157 : POKE
A+3,18

```

```

480 NEXT

```

```

490 POKE &HF09D,52 : POKE &HF09E,127

```

```

500 POKE &HF09F,53 : POKE &HF0A0,255

```

Lines 450-500 use the data strings in line 440 to POKE values into Disk BASIC to change timing so that double speed can be used reliably.

```

510 IF PEEK(&HC004)=214 THEN 520 ELSE 600

```

Check for DECB 1.0, go to 600 if not present.

```

520 POKE 50952,78

```

```

530 POKE 50986,84 : POKE 51083,78

```

```

540 POKE 51104,78 : POKE 51135,78 : POKE 52300,78

```

```

550 POKE 52697,78

```

```

560 POKE 53680,40

```

```

570 POKE 54111,78

```

```

580 POKE 54342,39

```

```

590 POKE 54642,40 : POKE 54677,40

```

Lines 520-590 patch the following in DECB 1.0 for 40 track operation (line by line): KILL, FAT (File Allocation Table), GAT (Granule Allocation Table), FREE, BACKUP, COPY, DSKI\$/DSKO\$, and DSKINI. Values 40 and 39 are tracks, 78 is the maximum number of files (68 for 35 tracks).

```

600 POKE 50997,78

```

```

610 POKE 51034,84 : POKE 51131,78

```

```

620 POKE 51183,78 : POKE 51152,78 : POKE 52518,78

```

```

630 POKE 52917,78

```

```

640 POKE 53917,40

```

```

650 POKE 54349,78

```

```

660 POKE 54580,39

```

```

670 POKE 54879,40

```

See comments for lines 520-590, these for DECB 1.1.

```

1000 CLS : PRINT : PRINT : PRINT "FINISHED!!!"

```

Clear screen, print three blank lines then FINISHED!

Miscellaneous Useful PEEKs, POKEs & EXECs:

1. **POKE 111,254 : DIR** - Prints disk directory on printer.

2. **POKE 308,0 : POKE 313,0** - Disables ALL disk commands.

3. **POKE 308,19 : POKE 313,6** - Restores all disk commands (DECB 1.0; change 19 to 20 for DECB 1.1).

4. **POKE 113,0 : EXEC 40999** - does a "cold start". Can use POKE then press RESET (good for program protection- prevents listing after RESET). Mostly used for CoCo 1/2, CoCo 3 has CTRL-ALT-RESET (use EXEC 35867 with POKE 113,0 for CC3).

5. **POKE 234,0 : EXEC 55135** - "parks" disk drive heads.

6. **PRINT PEEK(188)** - Prints 14 with a disk system, 6 with cassette.

7. **POKE 282,0** - Sets lowercase display.

8. **POKE 282,255** - Sets uppercase display.

9. **POKE 293,0** - Disables all BASIC functions, 293,20 restores.

10. **POKE 306,178 : POKE 307,119** - Disables Extended and Disk BASIC only, 306,129 : 307,104 restores.

11. **PRINT PEEK(33021)** - Prints 50 if CoCo 3.

12. **POKE 65281,0** - Locks out keyboard, RESET to restore. POKE 65281,4 restores keyboard in a program.

14. **POKE 383,158** - Prevents listing of a BASIC program. POKE 383,126 restores.

15. **POKE \$H167,&H39 : POKE &HFF22,21** - Enables CoCo 2B lowercase display mode, prevents ASCII saves. Try without first POKE... may not prevent ASCII saves then.

16. **PRINT PEEK(341)** - ALT key (prints 191 pressed); PEEK(342)-CTRL key; PEEK(343)-F1; PEEK(344)-F2 (these will work on keyboards with four function keys also)

17. **POKE 65502,0** - Disables all CoCo 3 commands, reads only ECB portion of ROM directly from ROM, just as a CoCo 1/2 would. Some programs that won't run on a CoCo 3 might after this. POKE 65503,0 restores normal CoCo 3 functions.

More POKE enhancements can be found in the books "500 POKES, PEEKS, 'NEXECS", "Supplement to POKES, PEEKS, 'NEXECS", and "300 POKES, PEEKS, 'NEXECS for the CoCo III" series of books from Zebra Systems. These have many programming hints for all CoCos and are highly recommended to all programmers.



ADOS... *Arts' Disk Operating System...* by Art Flexser

A crucial step in the development of ADOS occurred in 1983 when I decided to buy a Lowerkit for my CoCo 1 from Dennis Kitz's Green Mountain Micro. I did this mainly to have lowercase available for telecommunicating, which I was doing quite a lot of on CompuServe's CoCo SIG. My preferred terminal program at the time was Colorcom/E. It was able to use a software-generated upper/lowercase display on the PMODE graphics screen, but output to that was a bit sluggish for my tastes. In order to have lowercase on the regular 32 column hardware display, I needed one of Kitz's gizmos, so off went my check in the mail.

But soon, it began to bother me that whenever I would type a BASIC command in lowercase, all I got for my trouble was the familiar ?SNERROR. I wrote a little ML patch for BASIC to make it understand lowercase commands. This exercise was intellectually satisfying to some degree, but was not of much practical value to me; LOADMing it was more bother than just switching to uppercase.

Meanwhile, on CompuServe, I had run across a bunch of small utilities by various people to remedy assorted shortcomings of the CoCo's stock BASIC. There were patches for automatic line-numbering, 40 tracks, fast step rates, and a few others, including a particularly nice one for editing the last direct-mode command, contributed by Bill Dickhaus, who later gave permission for me to use it in ADOS. After the 64K upgrade became available, several people on the CompuServe SIG put a number of these patches into a 64K program called DOS64.CC. I contributed my lowercase patch and a RUNM command. But even having a number of extra features collected into one utility struck me as limited in usefulness; it was a bother having to boot up the utility and there was quite a bit of software that DOS64.CC was incompatible with. It seemed to me that a collection of BASIC enhancements would be a great deal more useful if they were burned into an EPROM; this would not only avoid the hassle of having to boot it up from disk, but would also enable a much greater degree of software compatibility. I was also aware that Tandy had left 2K of free space in the 8K chip that Disk BASIC resided in; this free space would be ideal for a collection of enhancements to BASIC.

I do not want to claim that the idea of putting enhancements into the Disk BASIC chip originated with me. There was a recently-developed product known as JDOS on the market from J&M Systems that had many of the same features I was thinking about putting into an EPROM. But JDOS had the important drawback of being incompatible with quite a lot of software. This was not really the fault of the authors, who were hampered by copyright restrictions in a way that I (debatably) was not. The folks at J&M had developed JDOS as an adjunct to the disk controllers they were selling. For them to have put a patched version of Tandy's ROM in their controllers would have been a copyright infringement, so they were forced to do

a complete rewrite of Tandy's ROM. This changed the addresses of all the entry points into various ROM routines, resulting in a lot of incompatibility. Had Tandy included a full set of documented entry points in Disk BASIC, rather than just DSKCON, JDOS would have been much more highly compatible, and it is conceivable that I never would have bothered to develop ADOS.

Unlike the JDOS folks, I had no intention of selling disk controllers; my market was people who had already bought a disk controller from Tandy and who had bought use of a Tandy ROM. Thus there was a strong argument that there was no copyright infringement involved in my selling such people a means of improving the ROM they had bought from Tandy. I realized that this argument was not entirely airtight, so I was always just a tiny bit worried that Tandy might some day come after me. But I gauged that (a) I was too small for them to bother with, and (b) if they did notice me they would probably just tell me to knock it off, rather than sue. Still, it was the copyright worries that caused me later to farm out the EPROM-burning to others, rather than handle that myself.

In addition to the compatibility advantage of being built around the Tandy ROM, there was also another important way in which I felt ADOS would be a significant advance over JDOS: configurability. I saw it as an enormous advantage that users of ADOS (yes, it stands for "Arts' DOS") would be able to configure the default printer baud rate, the drive step rates, and keystroke macros prior to having an EPROM burned.

Throughout the development of ADOS, software compatibility was always uppermost in my mind. I saw the biggest hazard to compatibility as arising from 64K software that used the area immediately above Disk BASIC where I intended to put my enhancements. The DISABLE command in ADOS was my attempt to solve this problem. In shutting off most of the ADOS enhanced features, DISABLE also freed up the memory above Disk BASIC for other uses, allowing "problem" programs to be made compatible. In the early days of ADOS, I made quite a few minor changes to achieve compatibility with one program or another, with the result that there soon remained practically nothing that wouldn't run under ADOS at all, and very few that required DISABLE.

The compatibility issue also guided my choice of features to include in ADOS. Notably absent from ADOS are commands like DPOKE (double-byte poke). While such a command is convenient in some situations, the use of it within a program renders that program unusable by CoCo owners with standard Disk BASIC. My aim was to create a more powerful but also compatible computing ENVIRONMENT. Hence, the extra commands of ADOS are those that would mainly be used from direct mode, rather than from within programs.

As I began to develop ADOS, I was faced with the problem of what features to include. I knew I had a limit of 2K of space to work in. Two K does not sound like very much—a modest-sized BASIC program takes up more space than this—but I rapidly discovered that many BASIC enhancements could be accomplished using surprisingly few bytes. My addition of RUNM to the command set required only 18 bytes; allowing COPY <filename> to <drive number> took 37 bytes. This economy was made possible by the fact that many pre-existing ROM routines could be called to accomplish parts of the task, and I made maximum use of such routines to squeeze as much as possible into my 2K.

During the early phases of development, I did not feel squeezed for space at all; after putting in various enhancements to BASIC that had occurred to me early on, I still had quite a bit of space left, and began to wonder if I would be able to fill it. I began casting around for suggestions on CompuServe and in a Miami CoCo users' group I was then attending. Pretty soon, I had more than enough to fill 2K. I found myself poring over already-written routines, modifying the code to save a few bytes here and there in order to squeeze in this or that additional feature. The original Microsoft ROM code provided me with an excellent model to imitate; it is extremely economically written with regard to accomplishing tasks using a minimal number of bytes. The code for the CoCo 3's Super Extended BASIC, written much later at Microware, is much less efficient.

In April, 1984, when I had a preliminary version of ADOS ready, I sent a copy to Dennis Kitz, hoping that the tie-in between his Lowerkit and ADOS' support of lowercase commands might lead to some sort of commercial collaboration. I heard nothing for months and then got a call from him. This was something of a thrill for me, since I had in my very early CoCo days been an eager reader of his CoCo articles in 80 Micro. We wound up sharing a booth at a number of RainbowFests, beginning with the September, 1984 Princeton one at which ADOS officially debuted.

When the CoCo 3 appeared, I wanted to have a version of ADOS that supported its features, and so began work on ADOS-3. There was very little room to add any features beyond those present in ADOS, since the ADOS enhancements entirely filled my available 2K. But I managed to make a little room by taking advantage of the fact that BASIC runs out of RAM on the CoCo 3, which allowed certain routines to be rewritten. Also, ADOS' ON ERROR GOTO and RAM commands were no longer needed, so that gave me some extra bytes to work with. I was particularly interested that BASIC should support the CoCo 3's double-speed mode, and modified disk and printer routines while adding FAST and SLOW commands. I also allowed ADOS-3 to be configured to boot up in 80-column mode. ADOS-3 was introduced in January, 1987 at the Color Expo in Anaheim, California.

One thing that disappointed me about the CoCo 3 was that its internal ROM was soldered in. Had it been socketed, I would have strongly considered having ADOS-3 reside there, since the internal ROM contains plenty of free space (6K of which is taken up by the infamous "Three Stooges" graphic). To remove that ROM and install a socket would require some delicate soldering, which struck me as a highly undesirable requirement for a commercial product. Still, after releasing ADOS-3, I was itching to include quite a number of additional enhancements—I had a backlog of ideas and suggestions by this time—and so began to consider a second possibility for where to place the required code.

From the outset of ADOS, I had been aware that a disk controller could accommodate an EPROM with 16K of space rather than 8K. The problem was that this could only be done with controllers having a 28-pin ROM socket due to the fact that the only suitable EPROM was the 27128, which had 28 pins. All Tandy controllers had 24-pin sockets. A solution was to offer a 24-to-28-pin adapter for the Tandy controllers, and I had a source of these, a fellow by the name of Jim Smith that I had met at a meeting of the Miami CoCo users' group, who made them by hand. These were originally offered to ADOS users simply as a convenience, since 28-pin EPROMs were cheaper and easier to obtain than 24-pin ones, and since some CoCo EPROM burners were incapable of handling the 24-pin type. Since requiring an adapter made the product less attractive, I had decided to confine ADOS and ADOS-3 to an 8K EPROM, even though that limited me to 2K worth of enhancements. With the passage of time, though, two developments occurred that rendered an adapter unnecessary for many CoCo users to use a 28-pin EPROM. First, third-party controllers became considerably more popular, especially with the more experienced CoCo users that ADOS primarily appeals to. These third-party controllers all had 28-pin ROM sockets. Second, Tandy came out with the FD-502 controller, which contains a 28-pin ROM socket, although a minor modification is required to use a 27128 EPROM. Therefore, I began to develop Extended ADOS-3 to fit together with ADOS-3 in a 16K EPROM.

After having had to squeeze everything into 2K, watching every last byte, having another 8K to work in seemed like the lap of luxury, sort of like moving from a closet to a mansion. When I began, I never felt I would come anywhere near to using the whole extra 8K, even though I had quite a few things I wanted to add. These included a RAMdisk, which Marty Goodman had been begging me to put in for some time; a menu-driven utility for selecting files to execute, kill, load, copy, etc.; fast BACKUP and DSKINI; wild-card copy; file-dating that supported real-time clocks; block move and copy of BASIC program lines; and various other miscellaneous goodies. As things turned out, I came a lot closer than I expected; less than 1K was left unused, and I had included pretty much everything on my "wish list". Extended ADOS-3 debuted at the Chicago RainbowFest in April, 1989.

Compiled BASIC...

A BASIC compiler takes the BASIC code, converts it to M/L, then saves the M/L code in a form that the computer can run directly, bypassing the built in interpreter. This speeds the program up from 10-20 times over interpreted BASIC. The interpretation from BASIC to native 6809 machine language is part of what makes BASIC slow compared to other languages. A good analogy is speaking to someone through an interpreter... how much longer does it take to get your message through, since you have to speak to the interpreter, then he/she to the other person?

There are two BASIC compilers available for the CoCo now, **WasatchWare's MLBASIC** and **Cer-Comp's CBASIC**. It is important to note that compilers don't normally accept as-is BASIC code, they have certain formats the code must be written in before compiling. These differences are minor if one is already familiar with BASIC though. The Cer-Comp compiler requires much fewer changes (reportedly up to 99% compatible with BASIC) than WasatchWare's, but is more expensive.

Converting Between BASICs... *not an easy task...*

One would think that converting a program between the CoCo 1/2 and the CoCo 3 would be quite simple. This is only true if the enhanced capabilities of the CoCo 3 are not to be used. The main problem is converting between PRINT@ and LOCATE statements. In cases where only the appearance of the screen needs changing, simple replotting of the text locations on screen is in order and relatively simple. If a program scans across the screen for input (such as a spreadsheet program), the programs just aren't easily converted. The PRINT@ function works very different from LOCATE (and vice-versa) when a formula is incorporated into a program to scan or plot locations on the screen. One can simply add and subtract from the PRINT@ value since all screen locations have their own, specific value. LOCATE must move up and down as well as back and forth, making the required formula more difficult to program- and entirely different from that required by PRINT@.

The PRINT@ and LOCATE differences are just some of those encountered between CoCo 1/2 and CoCo 3 BASIC. The others can be easily documented by going through the manuals for both computers and comparing. Note that the CoCo 3 doesn't support the undocumented "semi graphics" modes of the CoCo 1/2. This is a function of the 6847 VDG that was not officially supported by Tandy. Only one commercial program is known to have used this mode, the **Plug 'N Power ROM Pak**.

"Converting" is probably NOT the correct term when IBM BASIC (BASIC-A or GW-BASIC) is concerned. The author has done this before, and it isn't quite that easy. There are many differences between the two, too many to even begin to list here. Manuals for both BASICs can be gone through and the differences compared, possibly during a program "conver-

sion" exercise. One can also visit the local library and see if **BASIC Program Conversions** (HP Books, 1984, ISBN 0-89586-297-2) is available. This book lists all the commands and equivalents of IBM/compatibles, Commodore 64, Apple IIe/II+, TRS-80 Model III/IV, and CoCo 1/2 BASICs. There is room for notes to be made on the CoCo 3 commands, but they aren't included in the book. These other computers could theoretically be converted to/from, but only the TRS-80 models would be practical, as the Commodore and Apple BASICs have many unique commands.

PEEK, POKE, and EXEC locations are different for all the previously listed computers! One must find out exactly what the original program expected to find at the specified memory location and write a routine (or find a similar operation on the target machine) to emulate the PEEK, POKE or EXEC operation. It can be extremely difficult, sometimes virtually impossible, to rewrite a program that contains a lot of these statements.

When converting from the IBM to CoCo, it is much easier to convert to the CoCo 3 because the LOCATE commands are similar. The format for the CoCo 3 is "LOCATE x,y" (column, row) while the IBM is the opposite ("LOCATE y,x"; row, column). The CoCo 3 numbers rows and columns beginning with 0 (0-79, 0-24) and the IBM numbers beginning with 1 (1-80, 1-25). If going from the IBM to CoCo, many routines will have to be totally rewritten. Going from the CoCo to IBM is easier, as CoCo BASIC is simpler than the IBM version. Converting to/from the CoCo 1/2 has the same major problem as converting to the CoCo 3- the PRINT@ and LOCATE command disparities.

Other DECB Programming Languages...

Other programming languages were written to operate in conjunction with DECB over the years. These include "**C**", **FORTH**, **PASCAL**, and **LOGO**. Only the first two are currently available.

A new company (**Infinitum Technologies**) recently released a new "**C**" compiler for the CoCo, called simply "**CoCo-C**", which is very similar to the OS-9 "**C**" compiler- the same reference material is usable with minor differences. The best book to get for reference is "The C Programming Language" by Kernighan and Ritchie. The current edition is based on ANSI "**C**", but the differences between the original "**C**" language and ANSI are minimal. The main advantage of the "**C**" language is that it can be transported between different computers and operating systems (usually) with minimal changes.

The basic "**C**" commands are the same for all compilers. The compiler is different for each computer/operating system. "Source code" (the actual list of commands, similar to a BASIC program listing) is written with an editor or word processor then saved in ASCII format and compiled on the desired computer. The differences come in because some computers have added commands that take advantage of differences in the hardware and operating systems. One example is the graphics resolution on a CoCo and on an IBM compatible with VGA monitor. Any high resolution graphics on the IBM would have to be changed to the lower resolution of the CoCo before the program could be compiled with a CoCo "**C**" compiler. Some operation systems have more math capabilities than the CoCo also. These differences can be overcome, but only with more programming. Text based programs usually compile with a minimum of changes. Many OS-9 commands have been ported over from UNIX computers through "**C**". "**C**" wasn't as popular with CoCo BASIC (it was available for the CoCo early on, but only as a subset of the full "**C**" language) as it has been for the OS-9 crowd, but renewed popularity of "**C**" across all computers should change that. It will also mean converting a program from one computer to another won't require as much work as it has in the past, as a program written on a CoCo in "**C**" should easily transport to a more powerful machine.

The package from Infinitum is more than just a compiler, it contains all one needs to start programming in "**C**" except a text book! Included in the software package is a **text editor** for creating/editing source code (any word processor may also be used), the **compiler**, an **assembler** for creating assembly language files, **library/linker** to create stand-alone binary files, and a **command coordinator** to integrate the above into a **user friendly environment**.

CF83 FORTH is available from **BDS Software**. The following description was written by **M. David Johnson**.

BASIC has 157 commands in a CoCo 2 and 185 commands in a CoCo 3. This is quite a lot and when you combine commands to make a program, the number of things you can accomplish with your CoCo becomes very large indeed. But there ARE limits. Because there are only so many commands, there are some things that you just can't do in BASIC. And because BASIC has to interpret every command as it is encountered, BASIC tends to be rather slow. Commands can't be easily changed or new commands easily added, unless you are intimately knowledgeable concerning every internal idiosyncrasy of the CoCo, and an adept assembly language and machine language programmer to boot. It takes hours of development and debugging time also.

So, you can choose slow, easy BASIC, or fast, difficult Assembly Language. But, what if you want fast and easy both? CF83 FORTH is not a perfect solution, but it comes close. CF83 FORTH is almost as fast as Assembly Language and almost as easy to use as BASIC (once you get past the initial learning phase which is admittedly not trivial).

The first FORTH was written by Charles Moore in 1971 to be a data acquisition system for the National Radio Astronomy Observatory at Kitt Peak in Arizona. FORTH has since grown into a major control language for the entire astronomical community.

But FORTH is no longer limited to astronomy. FORTH is also currently used in image processing, robotics, servomotion controls, electrophoretic separation of biological materials on the space shuttle, and many small-scale imbedded systems. These systems all require very compact code in small packages, and that is just what FORTH was designed for. But FORTH also does well in truly huge systems. A FORTH system currently controls almost all the operations of the main airport in Saudi Arabia. The game, "STARFLIGHT", for the PC is written entirely in FORTH.

Another FORTH system is Amtelco's massive EVE (Electronic Video Exchange) which has become the predominant, largest, and most sophisticated messaging system for the telephone answering service (TAS) industry. EVE has captured 70 percent of the TAS market and consists of about 100,000 lines of source code. Despite its "large" size, EVE comfortably runs on a single 10 MHz 68000 Motorola microprocessor. Olaf Meding of Amtelco says, "FORTH is much more than a computer language. FORTH is a complete programming environment, and even more it is a philosophy. The concept of simplicity is what makes FORTH so effective and powerful."

When you LOAD and RUN a BASIC program, the BASIC interpreter analyzes each program line, translates it into machine code, and then executes that code. BASIC programming is interactive: you can make changes in your program and test those changes immediately. This makes program development and debugging comparatively easy. But, because BASIC must analyze and translate each program line every time the program is run, BASIC programs are also comparatively slow.

If you use an assembler (such as EDTASM) or a compiled language (such as C, PASCAL, or a BASIC compiler), you write your program in an ASCII source code file and then assemble or compile and link it to a machine language object code file. When you want to run the program, you simply LOADM and EXEC the machine language object code file. The machine language executes directly: it doesn't have to be analyzed and translated each time the program is run. Therefore, machine language is comparatively fast. But assemblers and compilers are not interactive: if you make any changes in the program, you have to re-assemble or re-compile and re-link it before you can test the changes. This makes program development and debugging difficult.

A threaded interpreter builds fully analyzed and translated machine language code by compiling new words as you write them into the program. A FORTH program consists of a list of word definitions, where each word definition is simply a list of previously defined words. Once it has been defined, a FORTH word is like a BASIC subroutine - it can be called over and over, and it can be called from other subroutines which themselves can be called over and over, etc., etc.!!

Aha! The best of both worlds! So... Where's the catch? First of all, you have to learn a whole new way of thinking. Forget everything you've ever learned about computer programming! Start from scratch...

CF83 FORTH does not use floating point numbers; it only uses integers. 5 is a legal number in CF83 FORTH, but 5.0 is not. This is both an advantage and a disadvantage. Integer arithmetic is MUCH faster than floating point arithmetic, so anything that can use integer arithmetic (e.g. screen graphics) will make BASIC really look like a turtle. And if your application really needs floating point results, you can write new floating point routines to provide them.

CF83 FORTH is an Extensible, Stack Oriented, Reverse Polish, Threaded Interpreter. FORTH is Stack Oriented. BASIC and other languages are Variable Oriented. In BASIC, you store numbers in variables and then use the variable name whenever you want to access the number or pass it to a subroutine. FORTH also uses variables when it has to, but most of the time it stores numbers on a stack and passes numbers to other words via the stack.

A stack is a simple Last-In, First-Out (LIFO) storage device. Suppose you have a handful of pennies and you stack them one on top of the other on your desk. Now, if you want a penny, you take it off the top of the stack. You don't try to take it from the bottom or the middle of the stack because the entire stack would fall down. So, the last penny you put on the stack is the first penny you take off the stack, i.e. LIFO. The stack orientation saves memory - less memory is devoted to variable storage. You might think that the variable memory you save would be offset by the memory needed for the stack. But BASIC and other languages also use stacks. Programmers just aren't aware of those stacks because programmers aren't allowed to use them directly - the stacks are reserved for internal use by the language itself.

Stack operations are more efficient if you use Reverse Polish Notation (RPN). RPN should be familiar if you own one of the more expensive Hewlett-Packard Scientific Calculators. Some less expensive HP calculators and most others use Algebraic Notation (AN). AN is familiar and easy to understand. If we want to add 3 and 5 with an AN calculator, we simply press: 3 + 5 = and the answer 8 appears in the display. With an RPN calculator, we press: 3 ENTER 5 + and the answer 8 appears in the display. The answer is the same, but the procedure isn't as clear or natural. Similarly, under BASIC, we would enter: PRINT 3 + 5, but in CF83 FORTH we would enter: 3 5 + . Algebraic Notation makes things easier for us. But RPN makes things easier (spell that F A S T E R) for the computer. FORTH programmers will readily testify that the additional speed is well worth the added effort.

FORTH is Extensible. In BASIC and other languages you have a set of reserved operators and keywords like +, -, *, /, PRINT, INPUT, RETURN, STRING\$, etc. These are the only words you can use in writing programs. If you want to PRINT "This Phrase" at three different points in the program, you either have to repeat the program line three times:

```
110 PRINT "This Phrase"
260 PRINT "This Phrase"
430 PRINT "This Phrase"
```

or set up a subroutine and call it three times:

```
110 GOSUB 1000
260 GOSUB 1000
430 GOSUB 1000
1000 PRINT "This Phrase"
1010 RETURN
```

But in CF83 FORTH, when you define a new word, you can use it just like any other word. If you define the word ptf:

```
: ptf ." This Phrase " cr ;
```

which does the same thing as the BASIC program line PRINT "This Phrase", then you can use ptf anywhere and it will print the phrase at that point, i.e.:

```
ptf ... ptf ... ptf
```

You have just added a completely new keyword - you have EXTENDED the CF83 FORTH language. This is one of the

most important features of FORTH: you can extend and customize it to meet your own particular needs. And, you can do so almost without limit! (Except, of course, that you can't use the word until after you have defined it).

CF83 FORTH is modular. Unlike other languages where you have to buy the entire package whether you need it or not, CF83 FORTH is organized onto individual disks that you can buy one or more at a time. You only buy what you need, and only when you need it. As an additional savings, each module's instruction manual is stored on the module's disk (printed manuals are available though). Prices are significantly lower without the printed manuals. You can view the stored manual on the screen and, if you need one, you can print a hardcopy on your own printer.

CF83 FORTH is a 1983 Standard FORTH for the 64K CoCo 2, 128K CoCo 3, and 512K CoCo 3, with at least one standard single sided 35 track floppy disk drive. As of January 1993, the CF83 FORTH system included the following modules:

CF83: FORTH-83 Standard Required Words. This module is the foundation - you must have this one for any of the others to work).

CF83-1: Technical Reference Manual

CF83-2: FORTH Tutorial

CF83-3: Block Editor. You need a FORTH editor to write your programs in CF83 FORTH. Unless you can write your own editor, you'd better get this one!

CF83-4: Double Number Set. CF83 only handles 16-bit integers by itself. This set lets you handle 32-bit integers.

CF83-5: Assembler Set. Integrate machine code routines that have to be real fast with this full-featured assembler.

CF83-6: System Extension Set. Helps you define new control words more effectively.

CF83-7: Controlled Reference Set. Words that perform many different functions. Includes recursion, block control, and system maintenance routines.

CF83-8: Uncontrolled Reference Set. Includes case structure, string operations, printer control, and more.

CF83-9: PMODE Graphics Set. Use PMODE graphics in programs.

CF83-12: Turns your CF83 FORTH programs into binary files that will EXEC directly from BASIC. Includes system saving and general disk file handling & creation.

The entire set could be purchased for as little as \$120, not bad for such a high-level language. Most general users would only need three or four modules though, bringing the cost down to under \$50. Just recently, however, the main FORTH module (CF83) was placed into the Public Domain, making this language even more attractive! Contact **BDS Software** for more info on PD modules.

Modules that were under development at the time this was written include:

CF83-10: HMODE Graphics Set. Use high-resolution CoCo 3 graphics.

CF83-11: Sound, Joysticks, Timer, & Random Numbers

CF83-13: Floating Point Numbers Set

CF83-14: Trigonometry Set

CF83-15: Complex Numbers Set

REFERENCE:

(1) Medding, Olaf; "FORTH-Based Message Service"; FORTH DIMENSIONS, Volume XIV, Number 5, January-February 1993; FORTH Interest Group, P.O. Box 2154, Oakland, CA. 94621

FORTH09 is a CF83 FORTH implementation for the OS-9 operating system. It is also available from BDS Software.

Actual **machine language (M/L) and assembly language (A/L)** programming is beyond the scope of this book. Machine Language refers to the actual code that the MPU reads directly. One CAN write directly in this code, but most programmers use an Assembler to put the code together, thus the term Assembly Language (M/L and A/L are usually used interchangeably).

Writing directly in M/L requires poking the certain values in the correct memory locations. This is exactly what is being done when a BASIC program has a routine like the one shown in the double speed program (PEEK, POKE, EXEC Enhancements, lines 440-480). A data set (in this case A\$) contains a list of values that is then poked into memory by a short BASIC program.

An assembler makes life easier for the programmer. The program is written in mnemonic instruction code with an editor (usually bundled with the assembler... Tandy's EDTASM+ name comes from EDiTor/ASseMbler). The instruction code is a set of instructions that are programed into the CPU itself. These instructions operate on and access data in different ways through addressing modes. The 6809 has 59 instructions and ten addressing modes for a total of 1464 different operations. Variations of these modes bring the total number of modes up to 19. This code must then be assembled into a list of binary data (m/l code) that the CPU can use directly.

Mnemonic instructions are abbreviations of what the command actually does. The instruction itself (ADDB, for example) is called the "opcode" (operation code). This is followed by a value for the instruction to act on or with, called the "operand" or argument. Together, the opcode and operand define exactly what the instruction does. The mnemonic "ADDB #1" means "add the contents of register B in the CPU to the number 1 and put the result back in the B register". The

"#" sign defines a decimal value in EDTASM+. Other assemblers may use a different designation.

The above description is a bit simplistic, as any A/L programmer will readily testify. A full discussion on M/L and A/L programming is beyond the scope of this book. Check the "Library" section for recommended texts.

As for assemblers, several were available for Color BASIC. Tandy's own EDTASM, EDTASM+, and Disk EDTASM were naturally popular. So was MicroWare's MACRO80C, which for a time was even more popular than the Tandy product! Used copies of these are likely to show up with used CoCo systems. If the manuals are intact, they are still good products to have. There are many enhancements available for the Tandy product available from Delphi or **FARNA Systems**. FARNA also sells an enhancement that **adds support for the Hitachi 6309 CPU**. Versions for all CoCo models are shipped on the same patch disk.

The only currently supported Color BASIC editor/assembler is **Cer-Comp's EDT/ASM III**. It is designed to take advantage of the added features of the CoCo 3, but versions are available for the CoCo 1/2 as well. **Cer-Comp** also sells a "**disassembler**", which breaks machine language programs down into opcode and operands. A skilled A/L programmer could use a disassembler to break down an existing program, make modifications to the code, and then reassemble a modified version. This takes quite a bit of practice and patience! Although A/L programs are much faster than BASIC, debugging is harder and more time consuming.

The only **OS-9 assembler** came with **OS-9 Level I** and the **OS-9 Level II Developers Pack**. The assembler was shipped with Level I instead of Basic09, which was sold separately. Tandy wised up when Level II came out and included Basic09 instead of the assembler, which was relegated to the Development Pack. The Level I assembler works fine with Level II- in fact, the Level I and Level II assemblers are virtually the same.

Binary and Hexadecimal Conversions - Wes Ratcliff

Regardless of programming language used, there will come times when **hexadecimal and binary numbers** will be needed. The following method works well and is rather simple. Most other methods require tables of numbers. These work, but require looking up each "nibble" (4-bit half of an 8-bit byte) separately. Wes' method is a bit easier, especially if one needs to do conversions without tables.

As an old assembly language programmer, hexadecimal (hex) is second nature. But anyone can calculate hex in their head without resorting to tables. Just break a number into nibbles. That is, each hex character represents a value from 0 to 16. If

you have the number &HF2, for instance, think of it as "F" and "2". Each character in hex is represented by 4 digits in binary. "F" in binary is 1111, and "2" represented in binary is 0010. So that &HF2 (hex) is the same as 11110010 binary. A little practice and it will come naturally. All you have to remember is the values from 0 to 15. 16 bit values are interpreted the same way, as four nibbles.

DECIMAL	HEX	BINARY
0	0	0000
1	1	0001
2	2	0010
3	3	0011
4	4	0100
5	5	0101
6	6	0110
7	7	0111
8	8	1000
9	9	1001
10	A	1010
11	B	1011
12	C	1100
13	D	1101
14	E	1110
15	F	1111

If you want to convert a decimal number, you can start at the left. If you're working with an 8-bit number, bit 7 represents 128 decimal (bits numbered 0-7, right to left). So if your number is greater than 128, write a 1. If not, write a 0. If you wrote a 1, subtract 128 from your decimal number. Move to bit 6. Here a bit represents 64. Repeat the above exercise, writing a 1 if the number is greater than 64, then subtract 64 from the number and go on to the next bit, which represents 32. Each lesser bit represents half the bit before it. Continue until you're at bit 0. The opposite is also true. In the binary representation above, we have a 128, 64, 32, 16, no 8, no 4, a 2, and no 1. Add 'em up and you've got your decimal number.

To convert a decimal number to hexadecimal, convert it to binary first then break it down into nibbles. Write the values of the nibbles down in binary from the sixteen values above. For an eight bit number add the values together. For a 16 bit number, add the first two and the last two nibbles (two eight bit bytes) and write those values down. Multiply the first byte (on the left) by 256, then add to the value of the second.

Microware's OS-9... *a heavy-dutyDOS for CoCo...*

An Introduction to OS-9 *Rick Ulland*

Do you need OS-9? Maybe not! Many users view their computer as an appliance. Any good appliance should perform its job as easily as possible, without much muss or fuss. For this type of use, DECB cannot be equalled. You cram is a disk, type run, and away it goes. The only problem with computer as appliance is, they just aren't that good yet!

Making it simple usually means leaving things out. Individual programmers can write any capability into any program, and sometimes do, but this approach to upgrading has proven less than impressive, resulting in giant, expensive programs that each do things their own way. OS-9 attempts to put many of the most wanted features of modern computers where they belong- in the operating system. Of course you only have to learn everything once, but sometimes it seems you have to learn everything first! The natural tendency is to ask somebody what the heck is going on. Those fortunate few who know a fellow OS-9 user who lives nearby enjoy a pretty painless introduction. The rest of the world has to settle for hurried conversations carried out over telephone or modem, and even though the other person is really trying to help, there is just too much information to pass on in a few minutes. In an attempt to cover as much ground as possible, the helper may lapse into that dreaded variant of technobabble known as the buzz-word.

A Very Buzzy Bee

OS-9 promises (and delivers) quite a lot of capability in a very small package- watching Level II run on a 6809 is an awesome sight to folks familiar with the chips' limitations in memory space and speed. You may well ask, why worry about memory? After all, there are 2 megabyte RAM upgrades available. Well, the rub is the 6809 can only address 64K at a time. DECB users are quite familiar with this limitation. Even a 512K CoCo only shows 24K free (the rest of its 64K ate up by the basic ROMs and some data space). BASIC does gain some use of the extra ram by moving the graphics screens out of the base 64K area, but all of the program code still has to fit there. OS-9 Level II doesn't remove this barrier, but does work around it nicely, by splitting the whole into separate groups.

A **process** is up to 64K of code and data. The difference is under OS-9 you can have as many processes as you have memory for, while under DECB you have one. This is the reason some OS-9 programs are split into two parts, for example word processors will be divided into a separate editor and print formatter. This way the whole package can use 128K (2 processes) instead of 64K (one process). Processes can be connected together from the command line as well.

When someone speaks of **pipes**, they are talking about connecting one process' output directly to another ones' input. On the command line, a pipe looks like an exclamation point-**proc1**

! proc2. There are two reasons to do this- either to get around the memory problem, or to make a single utility more useful. We'll get into this more later.

There is still a problem with the total RAM available. The practical problem is fitting the operating system into the machine. There are 3 ways to do this. The DOS can be kept small and simple, or simply demand the machine grow larger and larger, so the whole thing will fit. (the disk drives also have to get faster and faster, so the thing can be loaded the same day, and larger so the thing will fit on a decent number of disks... in other words, it can be like MS-DOS). Microware took the third tack. OS-9 (and OS-9 programs) are split into modules, which can be loaded as needed, or unlinked to free up memory. You'll see this in action when running **config** or **os9gen**- out of all the things that could go into OS-9, the user picks the ones he needs. OS9gen packs them into a small, quickly loaded boot file.

There are a few additional space saving tricks. First all of these modules are reentrant. One copy in memory can be ran many times simultaneously. Each separate iteration gets its own block of data space, but uses the same copy of the code. The other trick involves how a module is run. For example, the OS-9 prompt you see on screen doesn't come from OS-9 itself, but a special program called **shell**. When you type a command, shell reads it, then runs that module. It doesn't go away, but waits in the background for the new process to finish. This is called **forking** a process. The old process (known as the parent) is still around, just hidden in the other fork of the road waiting for the new process (the child) to finish. Now, if you really need every byte of RAM, you can **chain** the new process, using the **ex** command. The parent shell is killed, freeing up the memory it used, but if the child process ends, the window seems to lock up! It hasn't really crashed, but there is nothing for it to run.

To keep track of all these modules, OS-9 has a special directory. **Mdir** (module directory) lists all the modules in memory, and keeps track how many times each one is being used. The **link count** starts at one if a module is loaded, or 0 if it's just called, and goes up one each time it is executed, then down by one when it's finished. If it hits 0, that module is dropped and you get the RAM back. So a module that was run from the command line, and not loaded first, disappears when it's finished. There are two special commands to deal with this- **link** bumps the number up one so a module will never be dropped, while **unlink** reduces it one. Enough unlinks and it disappears!

With all these modules and processes lurking around, things could get a little skitzoid! The input and output can't be left to each process, else running your OS-9 system would resemble a bad adventure game. The **unified I/O system** helps keep the

data organized. There is a path leading to and from each process, the standard path being keyboard to process to screen. But it's negotiable. Redirection can be used to connect a process to any hardware device, using the greater/less than arrows. So **'list file'** goes to the screen, but **'list file >/p'** goes to the printer, and **'list file >/t2'** sends it out the RS-232 port. The **slash letter** part of these commands is called a **pathlist**, and can get quite long sometimes-**/d0/cmds/icons/myicon** is a pathlist meaning **'look in drive 0, find the cmds directory, look in cmds, find the icons directory, look in icons, find the file myicon.'**

Lets take an example that uses both redirection and pipes. **DSave** looks at a disk, and outputs all the copy commands it would take to copy the disk one file at a time. **'Dsave/d0/d1'** would just print this list of copy commands to the screen (standard path). Not terribly useful. **'Dsave/d0/d1 >/d0/file'** would send these to a disk file on drive 0, which you could run later. A little better.....**'Dsave/d0/d1 ! shell'** pipes this list of commands directly to a shell. Since shell's job is to run commands, and dsave outputs commands, the disk gets copied immediately. So far, we have been talking about space- the pile of actual things (modules) that make up an OS-9 system. Now we have to address time.

The **primary design goal** of OS-9 is that is be a **real time, multi-tasking operating system**. This causes some unique problems. Since computers can only do one thing at a time, all multi-tasking systems have to switch the CPU between each process that's waiting in line for CPU time, a system known as time-slicing. There are two options. The first is cooperative multi-tasking, where the individual programs decide when, or if, they are going to give up the CPU. This idea has some problems- you have to buy special programs written to cooperate, and any program can hog the machine. Definitely not real time. OS-9 uses pre-emptive multi-tasking. The individual programs all think they own the machine, only the operating system knows for sure. Every process has a priority, which tells OS-9 how much time to give it. This priority is up to you, and it's a handy power to have. Bumping a process priority way down reduces the load on the machine to the point where the user can't tell it's running. It will get done eventually, and in the meantime you can do other things. This helps, but there is still a problem....

Unlike with DECB, a program can't just sit on the hardware. For instance, a terminal program might be switched out when a new character comes in. Since the terminal program doesn't know it's being switched in and out, it would miss that character. This is where interrupts come in. **Hardware interrupts** inform OS-9 it's time to go take care of the hardware, regardless of what else is going on. Another concern is wasting time. If a process is waiting on keyboard input, for instance, there is no need to give it CPU time until something is typed. So, a process can sleep, giving up it's CPU time, until a signal (the software version of an interrupt) comes along.

With all this multi-tasking ability laying about, there has to be some way to use it. The first way is by using the CoCo Windowing system. This system establishes virtual consoles, switching the screen and keyboard between separate processes. It doesn't matter which window is visible on the screen, they all run full speed (depending on priority). OS-9 considers each window to be a separate hardware device, with it's own keyboard and screen.

The second possibility is using background tasks. DECB users are no doubt familiar with using colons to put more than one command on a line. The same thing can be done in OS-9 using semicolons- **'list file>/p; dir /d0'** first lists 'file' to the printer, then does a directory of drive 0. But there is another command line separator- the ampersand. **'list file>/p& dir /d0'** lists the file to the printer, and at the same time puts the directory on screen. Just want your prompt back? **'List file>/p&'** immediately returns an OS-9 prompt. Free printer buffer!

There is a third way. Although Tandy didn't include them with Level II, owners of the Level II Development System will find the utilities **tsmon** and **login** included. These allow other people to log in to your CoCo. This can be another computer on the same desk or somebody halfway 'round the world using a modem. The remote user gets his own shell, and can run any programs you let him (this is why OS-9 files have both 'public' and 'owner' attributes). So not only is your CoCo a multi-tasking computer, it is **multi-user** capable as well! All you need is the above commands and a couple serial ports, cables, and terminals (or other computers... a good use for an MS-DOS machine!)

What OS-9 Does for You

The preceding discussion has delved pretty deeply into what OS-9 is, but hasn't really said anything about what you, the user, gains. Here are a few of my favorite things:

One thing that can't be emphasized enough... **any** capability of the operating system is usable by any program. Some DECB programs support multiple windows or 80 track disk drives, but under OS-9 **all** programs do.

The big feature is windows. I often find myself doing more than one thing at a time- perhaps I'm writing a letter and need some information from a disk file, or from a spreadsheet. Just a clear key away, there is a separate screen waiting! I also use windows to answer my on-line E-mail. One window displays the mail captured, while the other has a text editor running in it for the replies. Even simple things, like not having a formatted disk ready, are easy to fix with that separate window (or two or three... as many as needed provided there is memory for them!) always ready and waiting.

Since all of OS-9's commands and utilities are really separate modules, the user isn't stuck with any of them. In fact, new utilities and system patches probably represent half of the software written for OS-9. Don't like the way the copy com-

mand works? Use a different one! Need to read and write MS-DOS disks? There is a patch to fix the disk driver so it can do that. Most of these patches are available free from BBS services, or on disk form from several sources.

If you enjoy programming, OS-9 is the key to a whole new world. Microware BASIC (aka Basic09) can be used to write everything from old fashioned line number oriented programs to structured, modular code your computer science professor would be proud of (try to get a copy of "The Official Basic09 Tour Guide" from Microware... it even has some general OS-9 hints)! There are plenty of languages to work with- besides Basic09, there are C and Pascal compilers, FORTH09, and two assemblers were produced. And, you don't just have two or three 'documented ROM calls', but literally hundreds of system calls to make things easy. The unfortunate thing is that unless a new or used copy of the Tandy version of these languages is found, they are pretty much unavailable. The exception is FORTH09 from BDS Software (see the article on FORTH under "Other DECB Programming Languages")

Shell scripts can automate a complex set up process. Lets assume a program runs best with a RAMdisk, but you don't usually have one running. Make a text file containing the commands to start and format a RAMdisk, and run the program. Typing the name of the text file as a command will run each line just as if it had been typed at the OS-9 prompt.

Then there is **Multi-Vue**... Guru types don't like to use Multi-Vue, since it's a little slow. Not many commercial programs come with the **icon** and **aif** file included, either. But if you have the patience to set it up and get the icons and aifs from an on-line service, (or make your own) it does make a pretty neat GUI. And you don't have to worry about turning your kids loose on the CoCo!



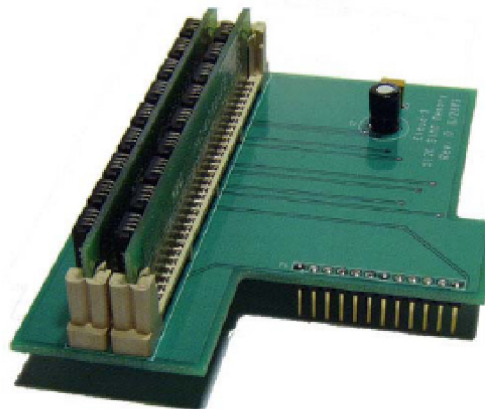
Cloud-9 Super IDE hard drive controller works with OS-9 and DECB. Also has a flash memory card socket. Boot from flash super quick!

And last, a powerful operating system greatly reduces the number of programs the user has to own. For example, OS-9 comes with an editor. It's not a great text editor, but it can do the job (of course, there are better ones available free from on-line services). It also has a list command, which can list any file to any hardware device. So, it's possible to write a short letter and print it without using a 'program' at all, just the operating system!

OS-9 isn't without it's share of problems though. Anything with the power and versatility of OS-9 is usually more complicated also, so there is more to learn. The syntax for the commands is entirely different from DECB, so that has to be learned also (one reason many DECB users find it easier to cross over to MS-DOS machines is that the command syntax is so familiar). Last but not least, the system is just adequate as shipped by Tandy. There are lots of additional commands that can be added and patches to improve the original commands. Sorting through those can be difficult at best, which is why I made a disk of extra commands and patches with an automatic patching program (Patch OS-9, which was marketed by FARNA and CoNect).

The OS-9 manuals from Tandy are not the best, to put it mildly. "The Complete Rainbow Guide to OS-9" (printed by Falsoft) will be very helpful, as well as a copy of "Start OS-9"... if it can be found or borrowed. "The Complete Rainbow Guide to OS-9 Level II Vol. I: A Beginners Guide to Windows" (Falsoft) will help Level II users with windows, but assumes a basic understanding of OS-9.

All this makes it hard for the long time DECB user to make the jump to OS-9. Be patient and get help from an on-line service, local BBS, user group, or local OS-9 user. OS-9 will seem difficult at first, but like anything else, you will gain confidence and skill with practice. You may even find, in time, that you actually *like* OS-9!



Cloud-9 also makes this 512K upgrade that uses two 256K SIMMS.

NitrOS-9... *the newest OS for the CoCo, written by CoCo users!*

UPDATED FEB 2006

NOTE: *This article is unashamedly plagiarized from the official NitrOS-9 web site (<http://www.nitros9.org/>).*

NitrOS-9 is arguably the biggest, most intensive software project ever undertaken for the Color Computer. It been in existence since 1994, having been created by a number of dedicated individuals within the Color Computer OS-9 community. Much of the code was written by the original NitrOS-9 team: Wes Gale, Bill Noble and Curtis Boyle. Later, Alan DeKok made even further improvements. NitrOS-9 is an operating system created by the Color Computer Community, for the Color Computer Community. NitrOS-9 (and the original OS-9, for that matter) is very much like Linux on a PC. Since both were derived from UNIX, just for different platforms, the similarity is natural.

Just what is NitrOS-9? With the discovery of the additional features of the Hitachi 6309 replacement for the Motorola 6809 processor, several members of the CoCo OS-9 community decided that it would be a big boost to incorporate those features into OS-9. To take maximum advantage of the features would require the eventual rewrite of the entire operating system, but since OS-9 is modular, it could easily be done one command at a time. It took several years before the complete system was rewritten, but it was eventually accomplished. Not only was the 6309 fully supported, which led to a 10-20% increase in speed, but every module was carefully gone over and tweaked as much as possible, resulting in additional code efficiencies which added another 2-5% in speedups, and a unique operating system. By this time Microware had long dropped support for eight bit OS-9 (with the exception of support for a few remaining industrial users at the time), and didn't have much concern about the rewrite. By the time everything was finished, very few remnants of the original Microware code remained anyway. The name "NitrOS-9" was used to highlight the "explosive" increase in speed and to pay homage to the system it was based on.

NitrOS-9 maintains compatibility with OS-9 Level One and OS-9 Level Two by using identical system calls and I/O handling. It is today's and tomorrow's operating system for all Color Computers. It is constantly being improved and enhanced, is freely available, and is also faster and more optimized than Tandy's OS-9 operating systems. There are two issues with using OS-9 Level One or OS-9 Level Two today: first, there is no upgrade path for the products; second, neither operating system has been sold in Radio Shack stores for years, denying new users the ability to purchase valid licenses. As long as there is community interest in NitrOS-9, it will remain available. Support is limited only by those who use it and their willingness to share their work with the community.

Around the turn of the century (2000), NitrOS-9 users decided

that OS-9 had been dead long enough, and the new OS was different enough from the original OS-9, that they should support the original 6809 and CoCos as well as the 6309. While the speed improvements wouldn't be as dramatic without a 6309, NitrOS-9 would still run 10-15% faster than OS-9. This led to the current support scheme of three levels and two processors, yielding seven possible distributions:

- * NitrOS-9/6809 Level 1 for the CoCo 1 and 2
- * NitrOS-9/6309 Level 1 for the CoCo 1 and 2
- * NitrOS-9/6809 Level 1 for the Dragon 64
- * NitrOS-9/6809 Level 2 for the CoCo 3
- * NitrOS-9/6309 Level 2 for the CoCo 3
- * NitrOS-9/6809 Level 3 for the CoCo 3
- * NitrOS-9/6309 Level 3 for the CoCo 3

Level 1 will run on a CoCo 1 or 2 with 64K of memory. It will also run on a CoCo 3, but won't access more than 64K. Level 2 and Level 3 are exclusively for the CoCo 3. Level 2 is compatible with OS-9 Level 2, which utilizes up to 2MB of memory. Level 3 is still under development. It will contain additional features to manage system memory more efficiently.

At the time of this printing (Feb 2006), only four distributions were available:

- * NitrOS-9/6809 Level 1 for the CoCo 1 and 2
- * NitrOS-9/6809 Level 1 for the Dragon 64
- * NitrOS-9/6809 Level 2 for the CoCo 3
- * NitrOS-9/6309 Level 2 for the CoCo 3

Few CoCo 1 and 2 users utilize a 6309, so those distributions may not appear. All levels should be compatible with lower levels, but programs written using higher level features naturally won't run on lower level systems.

For more information and to download the available distributions in ".DSK" format, point your browser to <http://www.nitros9.org/>. DSK files are images of CoCo compatible disks. There are instructions on the site for transferring DSK format files to an actual CoCo OS-9 disk. NitrOS-9 is distributed as two 40 track double sided disk files and one 80 track double sided file. Another source of a simplified DSK file is <http://nitros9.stg.net/>.

Support... *where to go from here...*

UPDATED FEB 2006

Where does one go for support? The local Radio Shack won't be much of much help, they ran out of Color Computer items a long time ago, and many had little knowledge of the CoCo anyway. There is not likely to be anyone in your area with a CoCo or any more knowledge of the beast than you have. It's almost as it was when Radio Shack first introduced the Color Computer, only at least then they had a little software and a few peripherals available!

But all is not lost! The Color Computer has always been a robust machine. It's hard to blow up, and not difficult to make most repairs if you're not scared of a soldering iron. In fact, most of the info to repair the machine is contained in this book! Even if you don't know how to solder, there are several enthusiasts still working with the CoCo that can help you out.

Glenside Color Computer Club

At one time there were Tandy Color Computer user groups or clubs in nearly every large city. I don't have to tell you that those times are gone! There was only one well known groups still active as of February 2006 -- the **Glenside Color Computer Club** near Chicago, Illinois.

Glenside has been in existence almost as long as the CoCo itself (1981). They have members from across the US and Canada, and from around the world. Regular meetings are still held at the Schaumburg Township District Library. A newsletter (CoCo 123) is printed quarterly publication.

Glenside hosts the **Annual "Last" Chicago CoCoFest** yearly (usually in May), as it had done when Rainbow magazine promoted the 'fest. This year the 15th Annual Last CoCo Fest is being held April 29th and 30th at the Holiday Inn Hotel & Suites, Elgin, IL (about an hour west of Chicago). Will it be the real last CoCo Fest? As long as there's a Glenside to put on the show, and enough people to come so that the associated bills get paid, there will be a 'fest. So says Glenside!

Contact information as of FEB 2006:

Glenside Color Computer Club
c/o Bob Swoger
613 Parkside Circle
Streamwood, IL 60107-1647

Internet: <http://members.aol.com/clubbbs/index.html>
e-mail: rswoger@aol.com (Bob Swoger)

Cloud Nine

About the only real vendor left for the CoCo is Cloud Nine, run by Mark Marlette and Boisy Pitre, two long time CoCo enthusiasts. It's a hobby business for them, nothing full time, but there hasn't been a full time CoCo vendor in at least 20 years! The partnership works perfectly: Mark is mostly a hardware guy, and Boisy is mainly a software type. Of course both have a good knowledge of both hardware and software when it comes to the CoCo.

Most of their work is OS-9 related, or more specifically NitrOS-9. They do, however, carry hard drive controllers and the software necessary to operate a hard drive with the CoCo's Disc BASIC, and many of the hardware items work with DECB and OS-9 equally well. Some does require OS-9 due to the way the DECB works. OS-9 will work with any hardware, DECB is hard coded to expect specific hardware to work with.

The DECB hard drive software is an updated version of RGB-DOS, the most compatible with the CoCo ever made, now called HDB-DOS. It partitions the hard drive as 255 single sided floppy drives and patches DECB to recognize the additional drive numbers. While there are a few pieces of software that won't work on a hard drive, most that runs from a single disk will. You can have nearly your entire collection of CoCo software in one place ready to run, and small IDE hard drives are pretty cheap! The controller for a CoCo is still around \$100, but that's still a bargain!

A list of hardware offered by Cloud Nine as of Feb 2006:

- * Refurbished CoCo 3s
- * 512K Upgrade boards and memory
- * PC keyboard adapter
- * DOS Adapter (use 28 pin EPROM in 24 pin socket)
- * Pro-Tector+ (buffers 6809 lines, protects against blow-outs)
- * Multi-Pak PAL upgrade for CoCo3 use
- * Hitachi 63x09E Processors -- 6809 replacement with enhanced features
- * TC^3 SCSI controller -- can use with HD and CD-ROM!
- * Super IDE Interface -- controls IDE hard drives and has a Compact Flash memory card interface as well. CF card can be used to hold any ROM image or program, can be used in place of the DECB ROM!
- * Refurbished floppy disk drives, hard drives, and CD-ROM drives.
- * Cables and misc. items supporting the CoCo and Cloud Nine products.
- * Drive Wire software for transferring data between a CoCo and a PC through the serial ports. Works with DECB and OS-9/NitrOS-9.
- * OS-9/NitrOS-9 software.

Cloud Nine also offers repair and modification services for all CoCos. This can be anything from socketing the 6809 (required for some upgrades and replacing the 6809 itself) to burning a custom ROM chip for DECB.

Cloud-9
3749 County Road 30
Delano, MN 55328
Internet: <http://www.cloud9tech.com/>
e-mail: info@cloud9tech.com

Internet Resources

The Internet is a nationwide computer network originally established, or perhaps a better term is "cultivated", by the National Science Foundation (NSF). It is actually a collection of many regional networks all interconnected using a common communication protocol called the Internet Protocol or "IP". The original intent was to enhance research and education projects through open communication and exchange of data. Development of the telecommunications backbone was subsidized by the U.S. government. Up until about fifteen years ago (as of 2006) use of the Internet was restricted to people or organizations involved in research and education. The guidelines governing acceptable use were changed in the late 80s to allow commercial companies and online services like Delphi to use Internet mail for many purposes. Internet use exploded with the introduction of "web" pages in the early 90s.

Now it's almost possible to find anything on the Internet. As long as there's an interest, someone will have a page up about it. The only problem is those pages may not have all the facts! One can only put what they know on a page, and there are a lot of pages with opinions given as facts. You can't always assume something is fact because it's repeated on many pages either -- sometimes one page picked something up from another and it just gets perpetuated. So the Internet isn't all it's cracked up to be! It takes some digging and a little research to separate fact from fiction and opinion sometimes.

The Internet is so ubiquitous now that there is no need to explain it! Listed below are the addresses to a few of the most active CoCo sites. These will, naturally, have links to others. Happy surfing!

TRS-80 Color Computer Web Ring

Links to many Color Computer sites.
<http://m.webring.com/hub?ring=coco>

Capt's CoCo Hut Many articles, but the one that got it on here is the regularly updated price guide! The owner watches Ebay and other sites and reports on average prices for hard and software.
<http://coco.clubltdstudios.com/index.html>

The CoCo Lounge Lots of history, monthly articles, and a nice selection of used hardware and software for sale.
<http://www.coco.8bit-micro.com/>

CoCo3.com This is probably the best of all the sites! Lots of support and links to just about everything to do with the CoCo. The site is very well designed, but a bit busy. There's a 24 hour chat room and lots of software downloads. This is the best site to get one of the free CoCo emulators from. If you don't want to download, you can order a CD-ROM with all the emulators on the single CD.
<http://www.coco3.com/index.php>

CoCo Friends Disk Magazine Web Archives CoCo Friends Disk Magazine (CFDM) was published on a floppy disk from February 1992 through December of 2000. It was one of the first electronic publishing ventures. It is now available free on the Internet at this site. Articles, programs, etc. Download it while you can and burn on a CD-ROM! An emulator is required to transfer the downloaded file to a CoCo compatible disk or file. Only DECB was supported, no OS-9.
<http://142.179.110.134/~jeffv/cocodisk/index.html>

Alan DeKok, one of the primary supporters of OS-9 on the CoCo, maintains a site with a lot of NitrOS-9 and OS-9 information and links.
http://www.sandelman.ottawa.on.ca/People/Alan_DeKok/interests/

SockMaster's Tandy Color Computer 3 Page One of the more interesting pages out there. It's full of programming info and some hardware info as well. The "SockMaster" is John Kowalski, best known for his amazing graphics demos for the CoCo3. He probably knows more about graphics programming on the CoCo3 than anyone else ever has!
<http://www.axess.com/twilight/sock/index.html>

CoCo Wiki Alan Huffman, a long time CoCo addict and former Microware employee, also maintains a great site. This site, like this book, is mainly an historical archive of the CoCo and people that made it come (and stay) alive.
http://www.coco25.com/wiki/index.php/Main_Page

The original 1981 Tandy Technical Reference Manual is online at http://homepage.ntlworld.com/kryten_droid/coco/coco_tm.htm. I suggest copying this to a CD-ROM before it goes away!

The Color Computer Library

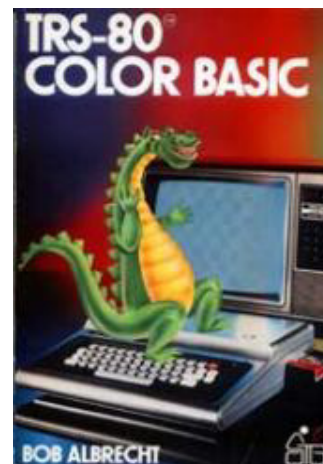
The first section contains a list of books which will help you acquire a better understanding of the TRS-80 Color Computer, programming it, and its various systems. The word "COCO" (all capitol letters) is used to replace the words "Color Computer" in some titles. If the title uses "CoCo", it will appear in that form. Watch yard sales, flea markets, used book stores, classified ads on Internat sites, and E-bay for them.

The past magazine section lists all defunct magazines and the approximate dates of publication. Many useful programs and much information can still be found in these publications. Again, about the only place these will be found is through yard sales, classifieds, etc.

Books

- 1978**MC6809 Macro-Assembler Ref. Manual** Motorola
- 1979**MC6809 Preliminary Programming Manual**
Motorola
- 1980**The MC6809 Cookbook** Carl D. Warren
- 1981**MC6809-MC6809E Microprocessor Programming Manual** Motorola
- 1980**The MC6809 Cookbook** Dr. Carl Warren
- 1981**101 COCO Programming Tips & Tricks** Ron Clark
- 1981**55 COCO Programs For Home & School & Office**
Ron Clark
- 1981**55 MORE COCO Programs For Home School & Office** Ron Clark
- 1981**6809 Assembly Language Programming**
Lance Leventhal
- 1981**6809 Microcomputer Prog & Interfacing**
Andrew Staugaard Jr.
- 1981**The Facts** Spectral Associates
- 1982**COCO Graphics (RS)** William Barden, Jr
- 1982**TRS-80 COCO Programs (RS)**
Tom Rugg & Phil Feldman
- 1982**TRS-80 COCO Quick Reference Guide** Radio Shack
- 1982**The Color Computer Songbook** Ron Clark
- 1982**Color Computer Graphics** Ron Clark
- 1982**TRS-80 COCO Graphics** Don Inman with Dymax
- 1982**Programming The 6809**
Rodnay Zaks & William Labiak
Motorola (see "The Motorola Connection")
- 1982**COCO Secrets Revealed** Disk 'N Data
- 1983**TRS-80 COCO Interfacing With Experiments**
Andrew Staugaard Jr.
- 1983**TRS-80 Color Basic** Bob Albrecht & John Wiley
- 1983**Troubleshooting & Repairing Personal Computers** Art Margolis (2nd edition, 1993, also)
- 1983**TRS-80 Mod I, III & COCO Interface Projects**
William Barden Jr.
- 1983**TRS-80 Extended Color Basic** Richard Haskell
- 1983**Top-Down Basic For The COCO** Ken Skier
- 1983**Assembly Language Graphics For The COCO**
Don Inman
- 1983**How To Do It On The TRS-80** William Barden Jr.

- 1984**500 POKEs, PEEKs 'N EXECs** Kishore M. Santwani, Zebra Systems
- 1984**Color Basic Unraveled** Spectral Associates
- 1984**Extended Basic Unraveled** Spectral Associates
- 1984**Disk Basic Unraveled** Spectral Associates
* All three available free as PDF files at:
http://www.coco3.com/ind_unravelled.php
- 1984**Things To Do With Your COCO**
Willis, Miller, & Johnson
- 1984**COCO Assembly Language Programming (RS)**
William Barden Jr.
- 1984**COCOINDEX** Dean Norris
- 1984**Your Color Computer** Doug Mosher
- 1985**Complete Rainbow Guide To OS-9**
Dale Puckett & Peter Dibble
- 1985**Utility Routines for the Tandy & COCO, Vol. I**
Kishore M. Santwani
- 1986**THE BOOK: Assembly Language Programming for the TRS-80 COCO** Tepco
- 1986**Utility Routines For the Tandy & COCO, Vol. II**
Kishore M. Santwani
- 1986**Supplement To 500 POKEs, PEEKs & EXECs**
Kishore M. Santwani; Zebra Systems (see 1984)
- 1987**THE ADDENDUM** (CoCo 3 supplement to **THE BOOK**) Tepco
- 1987**Super Extended Basic Unravelled**
Kishore M. Santwani
* Available free as PDF files at:
http://www.coco3.com/ind_unravelled.php
- 1987**300 POKES, PEEKS 'N EXECs for the CoCo III**
Kishore M. Santwani; Zebra Systems
- 1987**The Complete Rainbow Guide to OS-9 Level II, Vol. I: A Beginners Guide to Windows**
Dale Puckett & Peter Dibble; Rainbow Bookshelf (see 1985)
- 1988**Start OS-9** (step by step tutorial) Paul K. Ward
- 1989**A Full Turn of the Screw** ('83-'89 Articles from Rainbow) Tony DiStefano ;Rainbow Bookshelf (see 1985)
- 1990**Connecting CoCo to the Real World**
William Barden Jr.
- 1992**The OS-9 Catalog** (description of all OS-9/68000 modules, useful for OS-9/6809 also)



Past Magazines

The Color Computer definitely had its' share of publications over the years! The large ones were **Hot CoCo**, **The Color Computer Magazine**, and **The Rainbow**. These were all three published simultaneously during the CoCos' heyday. It wasn't long before all succumbed except for "The Rainbow". According to Lonnie Falk, founder of "The Rainbow" and Falsoft, the others just didn't offer as much as "The Rainbow". That may very well be true, as it is doubtful that "Hot CoCo" and "The Color Computer Magazine" combined had as many subscribers during the CoCos' "golden years" as did "The Rainbow". Even so, back issues of all are still valuable information sources... they were for this book!

The Rainbow

July '81-May '93 Falsoft, Inc.

TRS-80 Microcomputer News (all Tandy computers)

September '80-July '84 Tandy

80 Microcomputing (80 Micro, all TRS-80 computer)

October '80-May '83 March '86-.... CW Communications,

68 Micro Journal

November '80-July '83, March '85-1990 ... Don Williams

BYTE Magazine (various articles, not in every issue)

October '80-'83

The Color Computer News

June '81-September '83 REMarkable Software

Chromasette (cassette mag through July '83, disk after)

July '81-July '84 Chromasette

The Programmer's Institute TRC (cassette/disk mag)

November '81-March '84 (?) Future House

The Color Computer Magazine

March '83-October '84 Ziff-Davis Publishing,

HOT CoCo!

June '83-February '86 CW Communications,

Dragon User (specifically for Tano Dragon)

August '83-September '86 ... Business Press International,

68 Color Micro Journal

September '83-February '85 Don Williams

Dynamic Color News

February '84-January '89 (?) Dynamic Electronics,

Undercolor

December '84- June '85 Green Mountain Micro

DIGInews (cassette magazine)

April '85-April '86 (?) Dragonfly Writing

CoCo Time (disk magazine)

October '85-July '86 Microcom Software

Spectrogram

November '86-June '87 Spectrogram Magazine

TRS-80 Computing/Color Computing (bi-monthly)

June '87-October '91 Color Computing,

the world of 68' micros

October '93-March '98 FARNA Systems

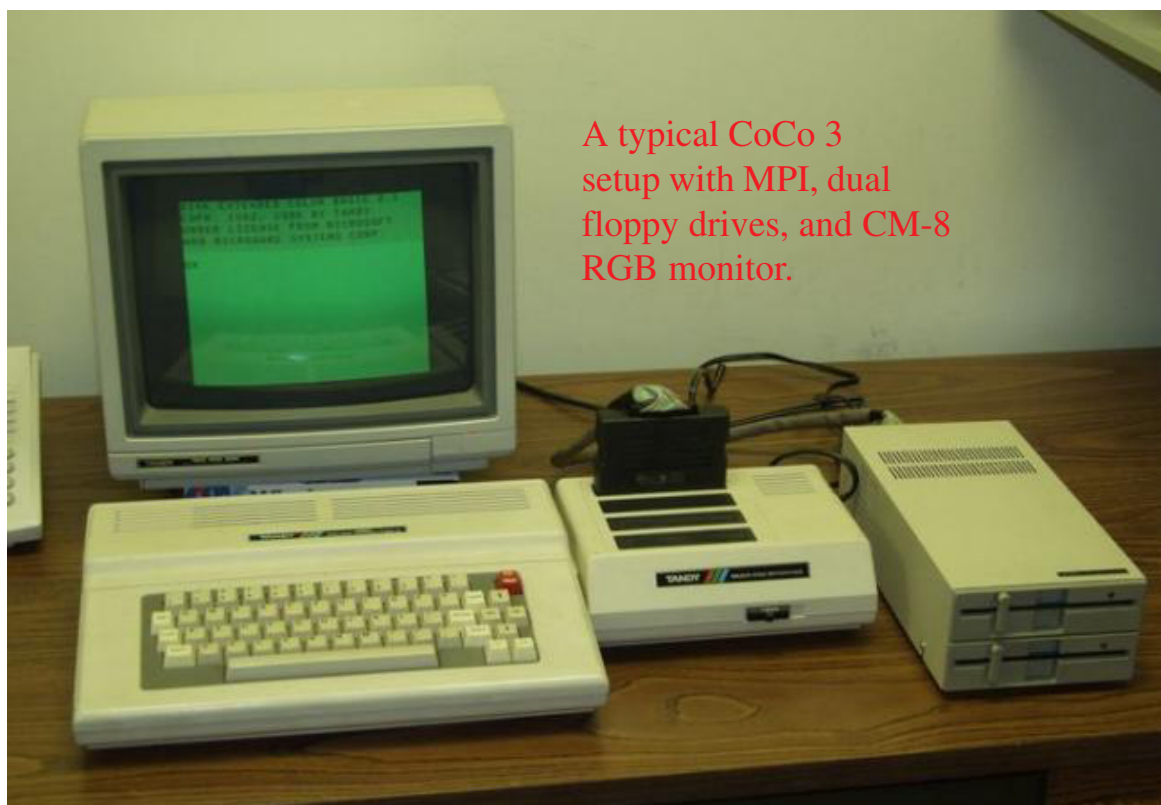
CoCo Friends Disk Magazine

February '92-January '00 Rick's Computer Enterprises

The Upgrade

Disk Newsletter from Mid Iowa and Country CoCo Club.

1984 - 2001 (?) Terry Simons, Editor



A Tribute to "The Rainbow", 1981-1993

It is possible that **The Rainbow** is responsible for the CoCo being as much a success as it was. When Tandy wouldn't tell us what we wanted to know, Rainbow did. At one time, the Rainbow published over 200 pages per issue! It was far from that when it finally ceased publication, down to 16 pages in a tabloid format. Yet, it was still packed with good CoCo information. It will be sorely missed by all CoCo users.

The Rainbow started life on a CoCo and Tandy Line Printer VII (dot matrix, without lowercase descenders, even!), typed in with a little three line editor written by Lonnie Falk just for that purpose. The premier issue consisted of four pages copied at the corner drug store... the four pages included the cover! Who would have thought that little newsletter would have grown into Falsoft, which is now a publishing firm of some size? (note: the premier issue is still available!)

Unfortunately, the size of Falsoft (along with the dwindling number of CoCo users) is why The Rainbow ceased publication with the May, 1993, issue. Subscriptions had fallen to under 4,000 by that time. For a company of Falsoft's size, it was difficult to justify allocating resources and personnel to continue publication... resources that could be put to more profitable use. It was not an easy decision for Lonnie Falk to let the Rainbow go. It must have been like losing a dear friend. We all feel that way Lonnie, but at least some of us understand the economics of the situation, and I hope others do after reading this.

A limited number of back issues are still available from Falsoft! Prices range from \$5-\$50. Check the list out on the Internet at : <http://www.the-e-mall.net/netcat.htm>.



Left to right:
First issue of "The Rainbow"
September 86 issue
Last issue

Technical Reference Section

...covers all the hardware aspects of the CoCo!

Peripherals

A peripheral is any hardware item attached to the computer. These include Video Display Devices, Mass Storage Systems, Printers, Expansion Devices, and many more specialized attachments. The primary CoCo peripherals will be discussed individually, with other, less common items grouped together.

1. Video Display Devices

One of the most important peripherals for any computer is a video display device. In the early days of personal computing, when a 4K, non-extended basic CoCo 1 sold for \$399, most personal computers (even the original IBM PC) relied on a standard television set for a display. No wonder -- even the relatively low resolution TRS-80 Model 1 monitor sold for \$199, and it was only capable of adequately displaying 16 lines of 64 characters in black and white. Note that this and other monitors of the day were really nothing more than TVs modified for direct video input and increased bandwidth. This was comparable to most other monochrome monitors which were inferior in many ways (B&W resolves graphics with more shades than monochrome.. how many shades of green or amber are easily separated by sight?). Composite color monitors were selling for as much as \$349, and were no more capable than lower cost B&W models (all prices circa 1982). The CoCo was designed as a low cost color capable computer, and most people already had color TVs, so the TV was the only officially supported display device until the 1986 release of the CoCo 3, which supported TV, composite video, and RGB Analog video. Support for these devices was long overdue, as prices had come down to under \$100 for monochrome composite monitors and to around \$300 for RGB monitors.

The following paragraphs explain in detail the various aspects of each of the main types of video displays available to CoCo owners. There are certain advantages and disadvantages for each. Choose carefully and use whatever fits your needs and budget.

The first video device most people consider for the Color Computer is a **standard television set**. This is usually adequate for games, the low resolution text screens (32 and 40 columns), and the CoCo 3 medium resolution screen (64 columns). Some CoCo 1/2 software generates a 51 and/or a 64 column screen, which also resolve adequately on a TV.

When choosing a TV set, stick with a 10 to 16 inch screen. A color TV only has a maximum usable resolution of 256x256, which means 256 dots left to right, 256 lines from top to bottom. This means that there are a total of 65,536 dots on the entire screen. The smaller the screen, the closer those dots are and the better the picture will appear to be.

A **black and white TV** will give a superior text display. There is less signal data to decode in a B&W signal. Color will look better with games, the difference between color and B&W will basically be the same as watching color versus B&W TV shows. Text displayed on a color set will have a "fuzzy" colored edge around the letters, caused by the color burst signal. This can be reduced by turning the color all the way out on sets with a color adjustment or by turning the color burst signal off via software on a CoCo 3. Turning off the color burst requires machine language programming for the CoCo 1/2. CoCo 1/2 programs using high density text screens usually have this feature built in. Changing colors also helps. A problem is that most programs will override your changes. Some text based software automatically turns the color burst off. A 10-12 inch B&W TV will render readable, though small, 80 column text in most cases with no hardware modifications.

TURN OFF COLORBURST SIGNAL. For CoCo 3 only, 40/80 column text on TV or Composite monitors:

10 WIDTH 80: REM or 40

20 POKE & HE033, 16: POKE & HE03C, 19: POKE & HE045, 19: REM turn off color burst

30 PALETTE 8, 255: REM change background color

40 PALETTE 0, 0: REM change foreground (character) color

Try experimenting with the PALETTE values. 8, 63 and 0, 0 or 0, 63 and 8, 0 may be more to one's liking.

The TV signal coming out of the CoCo is not the best. Though the cable supplied by Tandy is shielded, it is small and interference will be noticed- especially with disk drives. The best way to remedy this would be to get a composite or RGB monitor and avoid use of a TV altogether. Fortunately, there is an easier solution! What is needed is better shielding on the cable between the TV and computer. Simply get a suitable length of 75 ohm cable (the type used with cable TV, VCRs, and antennas) with "F" connectors on each end (RS #15-1536 is a 6' cable). Plug one end into a cable ready TV or cable TV adapter, and plug the other end into the CoCo. An "F" connector to phono plug adapter will be required to connect the 75 ohm cable to the phono plug on the back of the CoCo (old RS #278-252). All this will result in about a 100% improvement in video quality at a cost of under \$10... well worth the investment!

The next video type to consider is **composite video**. This is basically a TV without a tuner, but is much clearer. Composite monitors are readily available as combination color TV/monitors, usually for use with high quality VCRs. Harder to find nowadays are **monochrome** (single color, usually green or amber) **composite monitors**, which are really needed for 80

column text display, for the same reason that B&W TV is superior to color. As good as monochrome are B&W composite monitors. These are usually available at security dealers as they are frequently used for surveillance systems. Check with surplus electronics dealers for composite monitors of all types (Timeline Inc., 1490 W. Artesia Blvd, Gardena, CA 90247, (213) 217-8912, <http://www.timeline-inc.com/>; and California Digital, 17700 Figueroa Street, Gardena Calif. 90248, (310) 217-0500, <http://www.cadigital.com/cadigitl.htm>, for example).

If TV and composite are virtually the same, then how is composite better? Composite video monitors reduce the sources of possible interference and allow an increase in bandwidth. TV tuners and RF modulators (the metal box inside the CoCo that converts the video signal to a TV signal) are great sources of interference. The modulator is actually a low power TV transmitter that broadcasts via direct wiring over the channels selected by the switch on the back of the computer (3 or 4 on U.S. model CoCos). These modulators must comply with strict regulations set by the communications authority in the country of use (FCC in the U.S.), and bandwidth (signal width) is limited to a maximum of 3.5MHz for B&W sets, 3.0MHz for color. A composite monitor overcomes all this by eliminating the interference sources (modulator and tuner) and extending the bandwidth (though only to 3.5MHz for composite color models). Due to a wider bandwidth, monochrome and B&W monitors are capable of a maximum resolution of 648x264 (dots x lines).

To use a composite monitor, simply plug a video patch cable between the video and audio jacks on a CoCo 3 to those on a monitor or TV/monitor. A CoCo 1/2 will require a video amplifier to add direct video output. At one time these were readily available, but are not in much demand anymore (Dynamic Electronics may still have some). Anyone somewhat handy with a soldering iron can build the simple circuit shown. This will allow plugging into a color or mono composite monitor. If the monitor in question doesn't have sound, a stereo or simple audio amplifier can be used (RS #32-2031 or #277-1008). Get sound output by soldering the center lead of a female RCA phono jack to pin 3 (marked on mother board) of the RF converter (the silver box the TV plugs into) and the outer lead to ground. Almost any audio amp IC can be used to build a simple circuit to drive a small speaker, which could be mounted inside the CoCo case.

Tandy produced a number of CoCo 1/2 models with composite video but no RF or audio circuitry. These were for use in classroom network systems originally sold only to schools. Some of these have become available as schools upgrade their classroom computer systems. Note that the turning off the colorburst signal and changing colors on a CoCo 3 will produce better text, just as with a TV set.

A TV without composite input can have the input added. ***THIS SHOULD NOT BE PURSUED UNLESS ONE HAS EXPERIENCE WITH ELECTRONICS.*** There are **dangerously**

high levels of current in a TV, **ESPECIALLY COLOR SETS!** **DO NOT** attempt this on old tube type sets or sets known to have a "hot chassis". These sets have one side of the AC power cord connected directly to the metal frame inside the TV (the chassis), and present a **SEVERE SHOCK HAZARD. THIS IS ESPECIALLY TRUE IN EVEN MODERN COLOR SETS!** Therefore, this modification is only recommended for B&W sets (other reasons are explained in the following text). Always use a solid state or transistor TV that has a power transformer. Most B&W TVs made over the last 10 years or so should be safe, but do look before continuing. Any AC/DC portable set will work well (color or B&W). ***IF YOU DON'T UNDERSTAND THE SCHEMATICS SEEK HELP FROM SOMEONE WHO DOES OR DO NOT ATTEMPT THIS PROJECT!*** Those warnings given, I'll continue...

Adding the video input directly is incredibly simple. All that is required is five components, a small piece of PC board, and a bit of wire. Use a female RCA type phono jack for the input, either mounted to the TV cabinet or a short piece of cable (#274-346 or #274-338). The shield (negative) side is grounded to the chassis (hence the shock hazard for "hot chassis" sets!). The positive (center) lead is connected to the chassis through a 470 ohm resistor, and to the base of the video driver, right before the bias circuit, through two 1N914 or 1N4148 diodes and a single 0.1 uF capacitor. The hard part is finding the video driver transistor in the TV. There is usually a schematic inside the case of most TVs. Use this to locate the video driver transistor. If no schematic, one must be located or the project referred to a qualified TV technician. TV technicians should be able to get a schematic for a reasonable fee. A speaker circuit will have to be used, as the sound from the TV signal is no longer available. If the TV is to be used solely as a computer monitor, wire the circuit in directly. Otherwise, add a switch between the video input circuit and video driver.

With a color set, this is the limit to the modifications that will improve the display as there is an essential 3.58MHz colorburst signal. It is therefore best to use a B&W TV, as the signal can be further improved... enough to adequately display 80 column text. The easiest additional modification for a B&W TV is elimination of the 4.5MHz sound trap. This is done either by cutting the circuit board trace connecting a series wired trap or adding a jumper around a parallel wired trap. A switch will have to be used to cut the trap out or bypass it if the set is to be used for normal TV reception. Eliminating the sound trap widens the bandwidth to 4.5MHz, enabling 80 column displays to be viewed without undue eye strain.

The above are the extent of practical TV modifications for the average hobbyist to accomplish. For further information, consult **TV Typewriter Cookbook** by Don Lancaster, chapter 8 (last known printing 1981, Howard W. Sams & Co., 4300 West 62nd Street, Indianapolis, IN 46268), available in many public libraries, the publisher, or directly from the author (Synergetics, Box 809, Thatcher, AZ 85552, phone 602-428-4073).

Typical Black and White (B&W) TV Circuit

The diagram illustrates the internal circuitry of a B&W television. The signal path starts from the input (via a box labeled "CONNECT DIRECT VIDEO HERE") through a series of components including a 470 ohm 1/4W Resistor, a 1N914 Diode, and a 0.1uf Capacitor. It then passes through a Last Video IF Transformer and a Video Driver (transistor) which is biased by a +12V supply. The Video Driver's output goes to a Video Output (transistor) which is biased by a +2.4V supply. The Video Output stage includes a 4.5 MHz Sound Trap and a 4.5MHz Sound Pick-Off. The final output is connected to the CRT (Cathode Ray Tube) which is biased by a +150V supply. The circuit also includes various adjustment points for Sync, Sound, Brightness, and Contrast, and is powered by +12V, +80V, and +150V supplies.

LEGEND:

- Coil
- Resistor
- Capacitor

Female RCA Ceramic Phono Jack Capacitor

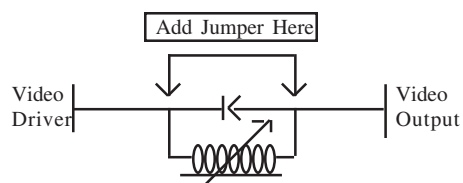
1N914 Diodes

470 ohm 1/4W Resistor

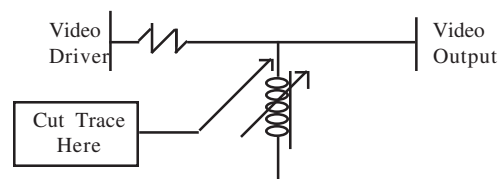
GND

GND

Combined trap/pick-off circuits handled the same as similar traps.



Parallel Resonant Trap



Series Resonant Trap

By far the best video source is an **RGB color monitor**. "RGB" means that the signals for three colors- Red, Green, and Blue - are sent from the computer to the monitor separately, where they are then combined in varying degrees to form colors. Only the CoCo 3 is made to deliver RGB output. There is no simple way to add RGB output to a CoCo 1 or 2. Since an RGB monitor receives the video signal directly, and no mixing/separating circuitry is required, there are no bandwidth limitations other than those imposed by the monitor design itself. This allows an increase in resolution, again limited only by the monitor design and signal delivered to the monitor. The CoCo 3 will deliver a maximum resolution of 640x192, and 640x225 is possible with special machine language programming. The monitors used with the CoCo 3 will support a maximum resolution of 640x200, the limiting factor being the bandwidth (15.75KHz... compare THAT to a TV's 3-3.5KHz signal!) and dot pitch (width). In general, the smaller the dot pitch, the sharper the image (a CM-8 had a dot pitch of .52mm, the popular Magnavox 8CM515 and 1CM135 is only .42mm). It is not advisable to get a monitor with a dot pitch of more than .52mm for viewing 80 column text. An RGB monitor will support all screen modes from 32 to 80 columns.

Note that RGB monitors do not support "artifacting"- a programming technique used by some CoCo 1 and 2 programs to generate additional colors on screen. Programs using artifacted colors will display as black and white on an RGB monitor. There is no easy way to fix this problem. When the CoCo 3 first appeared, a few vendors sold patch programs to display artifacted programs in color on an RGB monitor. Unfortunately, most of these programs are no longer available. There are a few patches available from the Delphi CoCo SIG for specific programs. Perhaps the best solution is to purchase a monitor that displays both RGB and composite video (such as the 1CM135 and 1084, and almost all TV/monitor combinations).

There are two basic types of RGB monitor that will work with the CoCo 3. The first is an **ANALOG** type. An analog signal varies almost infinitely from 0-.9V, allowing a large range of colors (limited to 64 colors by the CoCo 3). This is the type the computer is really designed to use, ala the Tandy CM-8. The most widely available monitors that accept this type signal are the Commodore 1084 (for the Amiga) and Magnavox 1CM135 (note that the Commodore 1084 is made by Magnavox for Commodore... it is almost identical to a 1CM135). The Commodore 1084S also works- it is just a 1084 with two speakers for stereo sound (hence the "S"). All three sold for just under \$300 new at the time of publication. An analog monitor was used because of the high number of colors for minimal hardware cost.

Some other monitors that will work are listed below (note that these are no longer being manufactured). Monitors followed by an asterics (*) have both RGB and composite inputs. Both may be connected to the CoCo 3 at the same time, which allows switching between RGB and composite for games that use

artifacted colors (a color TV may also be connected in conjunction with an RGB monitor... indeed, the CoCo 3 will drive all three video devices at once!). The dot pitch is listed in parentheses when known:

Commodore 1902
Commodore 1084 and 1084S (.42mm)*
Magnavox 8CM505 (.65mm)
Magnavox 8CM515 and 1CM135 (.42mm)*
Magnavox 8CM643 (.39mm)
NEC MultiSync (.31mm)
Teknika MJ305 (.41mm)

Other RGB Analog monitors are also usable. The CoCo 3 uses **separate** (horizontal and vertical) "**up-going**" (positive) **sync signals**. The below listed monitors differ from these standards but are usable with a little added circuitry.

MONITORS WITH COMBINED DOWN-GOING SYNC:

Feed both the H and V sync signals from the CoCo 3 into the inputs of a NOR gate (74LS02) and feed the output to the monitor's combined input. The NOR gate can be piggybacked on top of IC 15 (74LS04) in the CoCo 3 where the H and V signals and +5V and ground for the chip are readily available. Monitors followed by an asterics (*) have both RGB and composite inputs. The dot pitch is listed in parentheses when known:

Commodore 1080*
SONY KX-1211HG (.39mm)
SONY CDP-1201 (.25mm)
SONY CDP-1302 (.25mm)
SONY CDP-1310 (.37mm)*
SONY KV-1311CRTV/monitor (.37mm)
SONY CDP-9000 (.25mm)*
SONY KV-20XBR (.37mm)*
SONY KV-2011CR (.37mm)*
SONY KV25XBR (.55mm)*
SONY KV-2511CR (.55mm)

NOTE: The Sony "K" series are TV/monitor combinations. The first two numbers indicate picture size except for the 9" CDP-9000.

Atari ST RGB color monitors are also usable. They require **separate negative sync signals**. One would have to run the CoCo 3s' positive sync signals through inverter gates (74LS04) before connecting to the Atari monitor.

The second type RGB monitor is the **DIGITAL** type. This is the type **used by IBM** for their first color monitor for use with their color graphics adapter, hence the common designation "**CGA**". The sync signals are correct for the CoCo 3, so just connect all the lines from the CoCo 3 connector to their counterparts on the CGA monitor connector. Digital signals are either on (+5V) or off (0V). Each of the three signals (RGB) can only be combined in such a way as to display six colors, and two of those colors are black and white (RGB all off or all on). Another pin on the CGA type monitor doesn't have a counterpart on the CoCo 3. This is the "intensity" pin (which leads to the designation of RGBI for a digital monitor). By using

this signal even an IBM type computer can display only 16 colors. The limited resolution (640x200) and color set led to the development of higher resolution analog monitors for IBM type computers. While these higher resolution monitors are not normally usable with the CoCo 3, it does mean that used CGA monitors are readily available at electronic and amateur radio (HAM) swap meets at reasonable prices... around \$100 or less (around \$200 new). While some game screens may be hard to read due to the limited color selections, 80 column text will be easily readable.

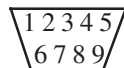
NEVER CONNECT ANEGA OR VGA MONITOR TO A COCO 3! These monitors sync at faster rates than the CoCo 3 and damage to the monitor and/or computer WILL result. Only monitors known to be compatible with CGA or that are known to sync at 15.75KHz should be connected to a CoCo 3. Note that many expensive Multi Sync monitors support 15.75KHz, but not all. Check with the owners manual or manufacturer to find out. Even today, multi sync monitors are somewhat expensive. The only reason they are mentioned here is that they can be used with higher resolution IBM type machines as well as a CoCo 3, so if one has both machines one monitor may suffice, though both computers obviously can't be used at the same time.

RGBI(IBM CGA TYPE) PINOUT:

PIN FUNCTION

- | | |
|-----|-----------------------------|
| 1&2 | Ground |
| 3 | Red |
| 4 | Green |
| 5 | Blue |
| 6 | not used |
| 7 | Sound (pin usually missing) |
| 8 | Horizontal Sync |
| 9 | Vertical Sync |

LOOKING AT MALE PLUG:



It is possible that some monitors will shift the display one or two characters to the left. This is a hardware problem within the CoCo 3, not the monitor. Try cleaning the GIME and socket by carefully prying out the chip (remember how it is oriented in the socket!) and cleaning the chip with a pencil eraser, the socket with rubbing alcohol. If this doesn't cure the problem, replace capacitor C-64 (150 picofarads... the only "C-64" a CoCo user should ever be concerned with!) with a 220 picofarad capacitor of the same type. The problem rests in timing, which is affected by capacitance.

Note that most of the above monitors are no longer being made! Some "multi-sync" monitors will sync down 15.75 KHz, but very few will. If you're not sure, DON'T HOOK IT UP! No damage to the monitor and/or CoCo is likely as long as it's connected for only a few seconds.

2. Mass Storage Systems

Mass storage is considered anything that (more or less) permanently holds a program or data. Four major types of storage are available for the CoCo- ROM Pak, Tape Drives, Floppy Disk Drives, and Hard Disk Drives. Luckily, the CoCo was never subjected to punched tape!

ROMs (Read Only Memories) are definitely mass storage, but only one way. A ROM can be read and a program executed from it, but it can't store new information. Therefore, **ROM Paks** have to be used in conjunction with tape (or in some rare exceptions disk) if any information is to be stored.

A program stored in a ROM for the CoCo is normally a machine language program. BASIC programs *can* be stored in a ROM, but must include a m/l loader to move them into an area where BASIC can run them. The computer detects the presence of a ROM Pak through the CTS (cartridge select) signal on the expansion port or MPI. The CART (cartridge detect interrupt) line senses the presence of a ROM Pak also, and auto executes it. Auto execution can therefore be deterred in all but a very few ROM Paks by **taping over pin eight** on the cartridge itself. The ROM can then be executed by typing **EXEC 49152** (CoCo 1/2 ONLY) or **EXEC 57360** (CoCo 3 ONLY), or the information can be saved to tape with: CSAVEM (name), 49152, 65279, 49152 This will save a standard 16K ROM Pak (all CoCo 1/2 Paks are only 16K) to tape. A special program or patch has to be used to save and run the larger ROM Paks from RAM. Patches for some are available from Delphi or FARNA Systems.

The first mass storage system time CoCo users were introduced to was the **cassette recorder**. Tandy made several recorders with computers in mind (CTR and CCR series.. Computer Tape Recorder and Computer Cassette Recorder), but any portable cassette recorder with a remote, microphone, and earphone jack will work (on the CTR/CCR series, the AUX jack is used instead of the earphone jack). The first problem with cassettes is that they are **SLOW**. It takes a few seconds to load or save even a short program. The second major drawback is that files cannot be randomly accessed- the entire file must be read into memory before use (in most cases), limiting the amount of data that can be worked with.

When using tape, one must be careful to start loading only at the beginning of a file. An I/O error will occur if a load is attempted in the middle of a file. An easy way to locate a file is to type **MOTOR ON : AUDIO ON**. This turns the monitor speaker and tape motor on, allowing one to listen for the beginning of a file. Another method is to pull the remote and earphone jacks and listen through the recorder speaker. The Tandy recorders come in handy for either method, as they have a "cue" and "review" feature which allows rewind and fast-forward operations while still listening to the tape (the buttons must be held half depressed).

Tape I/O for the CoCo normally occurs at 1500 bps. **Tape operations can be sped up** (to approximately 2700 bps) by using the double speed POKE (POKE 65495,0 for CoCo 1/2, POKE 65497,0 for CoCo 3) to save. Load by typing POKE 143,14 : POKE 144,24 : POKE 145,6 CLOAD "name" (or CLOADM) while in double speed mode; POKE 143,8 : POKE 144,24 : POKE 145,4 at normal speed. POKE 143,18 : POKE 144,24 : POKE 145,10 restores to the normal rate (1500 bps). **Only high quality tapes should be used**, especially when using high speed mode. In general, the higher quality the tape, the fewer I/O errors one is likely to experience whether using double speed or not.

Note that Radio Shack no longer lists computer cassettes (#26-302 10 minute, #26-308 20 minute). They do have leaderless five and ten minute answering machine cassettes (two and a half and five minutes per side, #43-437 and #43-4399) that are practically the same as the older computer cassettes. **These shorter tapes are easier to work with**. It is good practice to store only one file per tape with three or more copies of that file on the same side, one after another. If the program is used often, put multiple copies on both sides. This prevents having to rewind a lot- just make sure there is a bit of blank tape between copies.

Floppy disk systems were rather expensive in the early days of home computers (the first Tandy system was \$499). A cheaper alternative was therefore a modification of the basic tape drive- the **Exatron Stringy Floppy** (ESF) system. This system used an endless-loop tape cartridge called a "wafer". A typical wafer would store around 70K of data and up to 99 files. The good points about the ESF was that random access files were possible, it plugged into the standard cassette cable, it was faster than cassette (7200 bps compared to 1200 bps for cassette... a 16K program loaded in less than 20 seconds... wait a couple MINUTES for cassette to load), and the cost was about 2/3 of a disk set-up (under \$300 in 1982). The major drawback was that only Exatron made the thing, limiting availability of software (though Exatron DID line up some popular products). Another drawback was that the operating system had to be loaded from tape before use, and some m/l programs would write over the operating system, making the system useless (note that the operating system resided in memory normally reserved from use, but clever m/l programmers often re-mapped CoCo's memory to get a few more bytes of program space). The Exatron was pretty popular in the early days, enough that it was made for a number of computers and recognized by most knowledgeable computer hobbyist. It faded from the market around 1983 as competition and demand drove disk drive system prices close to the cost of an ESF system.

With all the deficiencies of tape it is no wonder that the more expensive **floppy drives** eventually won out. **Exatron** was responsible for the first floppy disk systems for the CoCo. The Exatron system was advertised in July of 1981 for only \$298 and included **a controller with 16K RAM, a single density, single sided, 35 track drive (80K capacity), drive case, and power**

supply. One reason Exatron dropped the disk drive in favor of the ESF was the amount of RFI (Radio Frequency Interference) generated by their disk system. Properly shielding circuit boards and cables drove up the cost of a good disk system... RFI problems were virtually non-existent with tape drives. The early Exatron disk system generated so much RFI that the TV screen was unreadable during disk access. Within months after delivering these systems, Exatron was taking them back! The FCC finally had to step in and lay ground rules for the amount of RFI a home computer could generate. Exatron finally got the RFI problems straightened out late in 1982.

Tandy released it's own **disk system** for the CoCo in **October of 1982**. The retail price for this system was \$499, but the drives were **single sided, 35 track, double density** units capable of storing **176K**. An Exatron system required two drives at about the same total cost to come close to this storage capacity. The Tandy drive quickly drove the Exatron system out of the market simply because software developers naturally chose the Tandy for compatibility. Had the Exatron used double density drives, there may have been a way to make the systems compatible. The first Tandy controller (drive 0 kit 26-3022) required 12V to operate. Later models were 5V only. The 12V controller can be used with a CoCo 2 or 3 only through an MPI, which supplies the necessary voltage. It is not reliable at double speed disk operation even if DECB has been modified for double speed (OS-9 Level II operates at double speed only).

There were several other early disk systems made, but all failed to gain support as they were not fully compatible with the Tandy system. The operating system was usually the major problem. **Tandy didn't develop a disk operating system (DOS) per se. What was developed was an extension to the existing BASIC language that allowed direct disk operations**. If one has ever programmed in GW-BASIC or BASIC-A on an IBM compatible, then the fact that many disk activities can't be done in BASIC is known. The DOS (PC-DOS or MS-DOS) must be called to perform all but the most rudimentary disk operations (such as a directory). Tandy's **Disk Extended Color BASIC** (DECB) can write and read directly from disk, and is much more convenient to program disk operations with. **The term "RS-DOS"** is often used to refer to DECB, but the term **is technically incorrect**. Only two versions (1.0 and 1.1) of DECB were ever published by Tandy. The CoCo 3 changes the first one to a two (2.0/2.1) but does not alter the disk commands themselves. DECB must be patched for reliable double speed disk operation.

CoCo drives are numbered from 0 to 3, meaning four single sided drives can be accessed. Tandy chose an odd method of selecting which drive was which- by removing the contacts from the connector of the three that the drive wasn't! This method had one merit- it was foolproof. All the drive select jumpers could be selected on a drive from the factory. Anyone could then plug in a drive and it would work properly... no configuration necessary! Another oddity was that position 32

on the cable was used for drive select 3 instead of position 6, which was used by all other manufacturers. The problem with this was that position 32 is the side select line! Position 6 is unused on Tandy cables. To use four single sided drives position 32 must be jumpered back over to position 6. There is good reason NOT to do this- use of double sided drives (explained later).

The first fully compatible aftermarket disk controller was manufactured by **J&M Systems**, introduced in April of 1983. This controller was quite popular due to its compatibility with the Tandy system. The controller was shipped with **JDOS**, a J&M version of DECB, but a standard Tandy DECB ROM could be used as well. Later models had two external switch controlled ROM sockets and a parallel printer port (accessed through JDOS or modified DECB ROM). One of the ROM sockets supported a 24 pin ROM (such as the DECB ROM) and the other a 28 pin (such as popular, low cost Intel EPROMs required). A smaller controller was released in 1987 that contained no parallel port. J&M sold production rights of the small controller to Owl-Ware (who still produces it) late in 1988. A full drive 0 kit from J&M was priced just \$50 less than Tandy's, but used higher quality TEAC drives.

Another controller worthy of mention was the **Hard Drive Specialist** floppy disk controller. This controller had two ROM sockets (one 24 and one 28 pin) also, but no external switch for selecting which one was active (this was done by a set of internal jumpers). The HDS controller could support two 24 pin ROMs by setting jumpers inside the controller. The second 24 pin ROM was then placed in the 28 pin socket. The DECB ROM supplied by HDS was usually enhanced for faster disk access times, as only the oldest Tandy drives required the DECB default of 30ms. HDS sold CoCo disk controllers from 1985-1989.

About the most well known aftermarket supplier of CoCo hardware is **Disto**. They introduced a disk controller, the "**Super Controller**" as their first product in 1985. This controller had four 28 pin ROM sockets and came with C-DOS, which was DECB compatible. The ROMs could be selected via a software switch. If one wanted DECB it had to be copied into a 2764 EPROM. The Super Controller had a unique "Mini Expansion Buss" (MEB) where several add-ons could be attached without the need for a MPI. This is probably the feature that sold more Super Controllers than any other aftermarket controller. A full range of add-ons including a real-time clock, EPROM programmer, 80 column card for CoCo 1/2, a parallel port, an RS-232 port, and a hard drive adapter were eventually made- with most still available today. A **Super Controller II** (described later in this section) and a **Mini Controller** (introduced in 1989) were also made by Disto. The later contained only two ROM sockets (with provisions for a 24 pin ROM) and no MEB. It was shorter than the SC or SCII, like the Tandy FD-502.

There was yet another odd disk system marketed for the CoCo, the **Amdek Amdisk-III**. This was the first small floppy disk system- the disks were only three inches in diameter. The disks were also more protected as they were in a hard plastic case. The Amdek disk resembled the newer 3.5 inch disks available today, but there was no metal "shutter" over the case slot... a jacket was still required. The only problem with the Amdisk was the disk size. Amdek wisely used the standard Radio Shack disk controller, but one still needed a standard 5.25 inch drive. The Amdisks' biggest feature was price- it came with two drives, two blank disks, and a controller for only \$599 (introduced in 1983). A key feature of the system was that both sides of the two drives were accessible, giving 624K of storage capacity. These weren't very popular with CoCo owners due to the non-availability of software on the small disks. The Amdisk was only advertised in Rainbow in 1983- it didn't take them long to realize CoCo owners weren't biting! A side note is that Amdek DID find a niche market for their three inch disks- many typewriters and dedicated word processors used the Amdek instead 3.5 inch drives.

When OS-9 came out a flaw was quickly discovered in the Tandy disk controller (and all others made at that time). Although OS-9 was a multi-user, multi-tasking true DOS, the CoCo disk controller was not! The controller used a simple design that interrupted the 6809 during disk access. This was the cheapest and easiest way to build the controllers, but it prevented OS-9 from doing anything until disk access was completed. To alleviate this problem, **Sardis Technologies** introduced a "no-halt" controller late in 1987. This "smart" controller used a RAM cache to speed up disk operation and limit halting of the 6809 while retaining full compatibility with the Tandy controller. Under DECB halt mode was used while under OS-9 no-halt operation was allowed. This controller sold for about \$50 more than comparable disk controllers. Why so late before one of these became available? OS-9 wasn't very usable for multi-tasking/user operations with just 64K in the CoCo 1 & 2. With the 512K CoCo 3, faster operation became desirable to increase productivity. Sardis had dropped out of the CoCo market by the next year.

Disto also introduced a no-halt controller, the **Super Controller II**, just a month or two behind Sardis. The SCII was priced about the same as the Sardis controller, but had the features of the original Super Controller as well (four ROMs- one could now be a 24 pin- and mini expansion buss), which made it more attractive than the Sardis model... not to mention the respect which Disto products had earned.

There is something strange about the disk controller's I/O address in the CoCo's memory map. The disk controller is addressed from &HFF40 to &HFF4F. This means that the SCS line activates the controller, as the SCS line area is &HFF40 to &HFF5F. Note that the entire area isn't used by the disk controller, just half of it. When Tandy designed the CoCo it intended only one item to be in the expansion port at a time. Therefore, they allowed whatever was written in this I/O area

to completely fill it. What happens is that a copy of whatever is in one half "ghosts" to the second half also. This causes problems when a second hardware device (such as a hard drive controller) attempts to use the I/O area from &HFF50 to &HFF5F, as the signal "ghosts" up into the area used by the floppy controller. The MPI was designed to allow more than one device at a time. It fully decodes the SCS I/O area so that ghosting is prevented. So does the X-Port and Slot Pak (see Expansion Devices). Y cables have no circuitry to do this, so will not work with certain devices.

Naturally, CoCo users have found a cure for this situation! The address area can easily be fully decoded by adding a 74LS32 (quad OR gate... only one gate is used) to intercept the SCS signal and OR it with the A4 address line. Connect as follows: 1) Bend all EXCEPT pins 7 & 14 of the 74LS32 straight out from the sides of the chip. 2) Place this chip on the back of any other 14 pin 74xxxx chip in the controller and solder pins 7 & 14 to the same pins of this chip. Make sure the notches in the ends of both chips are lined up! 3) Solder a jumper between pins 4, 5, 9, 10, 12, 13, & 14. This sends power to the unused inputs, forcing them high and preventing possible problems later (pins 6, 8 & 11 can remain unconnected). 4) Locate land 36 (SCS line) on the edge of the controller that plugs into the CoCo. Cut the trace from this pin with a razor knife just after the wide land stops. Solder a short piece of wire to the land, being careful to leave enough room for the controller to push in the CoCos' connector. The other end of this wire should be soldered to pin 1 of the 74LS32. 5) Find out where the trace that was cut from land 36 goes on the controller (it will be slightly different depending on the controller part number). Solder another piece of wire from this point to pin 3 of the 74LS32. 6) Locate land 23 (A4 address line) on the same end of the controller. Solder a short piece of wire to that land also (DO NOT cut the trace!). The other end of this wire goes to pin 2 of the 74LS32. The controller should now work properly with a Y cable.

All other CoCo floppy controllers will require this operation also. Even the Disto Super Controllers need this modification to work with a Y cable. On the Super Controller (and possibly the J&M controllers with built in parallel port) this modification renders the mini-buss expansions unusable, as they are decoded in the &HFF50 to &HFF5F area. To use the mini-buss, a Slot Pak, X-Port, or MPI MUST be used, as they re-supply the necessary decoding.

Now a word about floppy disk drives themselves. Early Tandy drives are most often made by **TEC** (Tokyo Electric Company).. These are full height units notorious for not staying in alignment (as are many early floppy disk drives). Most after-market suppliers stuck with higher quality **Tandon**, **Shugart**, or **TEAC** models (Tandy later switched to Shugart drives, and other manufacturers). Most full height units provided by Tandy were capable of reading only 36 tracks with a seek access time no faster than 12ms (access time is the amount of time, measured in millionths of a second - ms- it takes the read/write head to move from one track to another). The old TEC

units may not work faster than 20ms. The only full height drive supplied by Tandy that will read 40 tracks is the white cased unit. Nearly all single sided half height drives, whether supplied by Tandy or another vendor, are capable of accessing 40 tracks and most will work at 6ms. The FD-502 drives are all double sided 40 track.

The best thing about CoCo disk systems is that the drive is a standard model available almost anywhere computers are sold. **Any 360K 40 track double sided drive will work**, and should be used for replacing older full height and single sided drives. These drives are available used for as little as \$20-\$25 in most areas. Many IBM people have upgraded to higher capacity drives and no longer want or need these drives. Check with local computer shops if searching for a drive. The old full height drives were quite power hungry when compared to newer models, so two half height drives will work nicely in one of the old full height cases.

Was 360K mentioned in the previous paragraph as the drive capacity? DECB only supports 35 track single sided operation (156K), but the drive mechanicals are otherwise identical to the double sided 360K units. There are several DECB enhancements that allow accessing the full 40 tracks and the "back" sides of these drives. All configure the "front" (normal single side) as drives 0 and 1 and the "back" as drives 2 and 3. If only one double sided drive is used, it can be configured as drive 0 and 1. The back sides can also be accessed by using some memory location POKes (see "Color BASIC"). The connectors on the drive cable will have to be replaced with new ones (#276-1564) if there are teeth missing, as the contact for position 32 (missing from "pulled teeth" cables) is necessary to switch to the back side. Only three physical double sided drives can be connected to a CoCo controller because all follow the Tandy convention of using position 32 as drive select 3 (necessary to maintain software compatibility). Drive number selection is made with a "shunt" on the oldest drives (one is NOT likely to find a drive with a shunt in use today!), by the more common jumper block on newer ones. Once the connectors have all their teeth, the drives must be configured for position. This is done by placing a jumper over the pins marked "DSx", where "x" is the position desired (note that some drives are marked 0-3, others A-D). Shunts had metal jumpers that were initially all connected; the drive desired would be broken. Changing configuration meant replacing the shunt.

There are two simple hardware modifications that allow accessing the back of a double sided drive; one to the controller, another to the drive (only one or the other is necessary). The modifications are fully reversible. **This is not recommended unless it is known that OS-9 will not be used**, as OS-9 can use the drives as single 360K units. If one owns a set of full height drives by all means keep using them provided they are reliable and meet ones needs. If any problems, replace them with double sided 40 track drives.

MODIFYING CONTROLLER FOR DOUBLE SIDED DRIVES: This is perhaps the easiest of the two modifications to accomplish. All that is needed is a SPDT toggle switch!

1. Cut the trace on the disk controller circuit board between land 32 of the drive cable connector end and the rest of the circuit board (use a sharp razor knife to cut the trace).
2. Solder a wire to the land (32) and another to the other side of the land. Solder another wire to ground (all of the bottom drive cable connector lands are grounded).
3. The wire on land 32 should be connected to the center pole of the switch, the other two to either side.
4. The switch can be mounted in a hole drilled in the top shell half. Make sure enough wire is used so that the shell can be easily separated and the circuit board removed.
5. Reinstall disk controller. When the switch is in one position, the normal side of three double sided drives is active. In the other position (grounded) the "back" sides are accessed. The confusing part is that both the front and back of the same drive will be accessed by the same drive number!

MODIFYING DRIVE FOR DOUBLE SIDED OPERATION:

This method is a little harder, but more rewarding since it operates with no user interaction other than selecting a drive number. All that is needed is a 74LS08 (quad two input AND gate) and a 16 pin socket (all wiring is done to the socket, not the chip... socket can be eliminated). It is recommended that the number corresponding to the side of the drive be marked on the drive itself for easy recognition.

1. On the socket, attach a 4-6 inch piece of wire to pin 1, 2, 3, 14, and 15.
2. Tie pins 8,9,11, and 12 to pin 14; pin 14 to +5V (position 1 on the drive power connector).
3. Tie pins 4 & 5 to pin 2.
4. Solder the wire from pin 1 to land 32 on the cable connector. DO NOT cut the trace on the drive!
5. Connect the wire from pin 6 to the drive select line for the normal side of the drive on jumper pin closest to drive cable connector. Connect the wire from pin 2 to the drive select for the "back" side (DS0 and DS1 makes the normal side drive 0, back drive 1). The usual method is to use DS 0 & 1 with a single drive, 0 & 2 and 1 & 3 with two double sided drives.
6. Connect the wire from pin 3 to any drive select on the jumper side across from the drive cable connector.
7. Connect pin 7 to ground (anywhere on the drive frame)
8. Once all connections are made to the socket, firmly press the 74LS08 into it. Mount the chip upside down to the drive frame with double backed foam tape (picture hanging tape), being sure to place it where it won't touch the case sides or interfere with other drives.
9. Install drive in case and plug into disk controller. It should now operate as if it were two single sided drives. If not, go back and check your work!

Although the standard CoCo drive is the 156K or 360K 5.25", 35-40 track unit, **the disk controller will also support 5.25" or 3.5" 720K, 80 track drives.** Simply plug the drive into the cable along with the other drives! Unless a modified DECB

(such as ADOS) is used, only the first 35 tracks and one side will be available (the previous modifications will work on these also). OS-9 comes with drivers that allow full use of these drives. The 5.25" units were made obsolete when IBM skipped over them in favor of the 3.5" 720K drives. The ill-fated Tandy 2000 several other non-IBM type systems adopted the 5.25" drives before IBM started using an 80 track drive. The best thing about these drives is they can be "double stepped" (the head moved two tracks instead of one) to read (but NOT write!) standard 5.25" disks. OS-9 and ADOS provide for double stepping. OS-9 users will benefit most from these drives, especially if a hard drive is not a viable option due to cost or other reasons. **1.2MB and 1.44MB floppies can't be used.**

Hard drives were first made available to CoCo users by **Software Support** in early 1984. These were five megabyte units and sold for \$999.95 for a complete system! Sure is a good thing that prices have come down dramatically, but that is the major reason that hard drives have really been an elite peripheral for most CoCo users. Even now, complete CoCo hard drive systems cost around \$350 for a 20MB system.

Cost is not the only problem with hard drives for some users. Hard drives work very well with OS-9. Tandy even realized that OS-9 needed a hard drive when it introduced it's own hard drive adapter in 1985. Disk BASIC is another story. DECB was designed to be a simple floppy disk system, period. It was never intended to handle the file structure necessary for proper hard drive operation. The systems that do work with it partition the drive into as many as 255 virtual 156K floppy drives and patch DECB to recognize as many drive numbers. It is up to the user to keep up with what is on each virtual drive! This isn't as bad as it sounds... it can be viewed as having up to 255 directories, each directory limited to 156K. Most DECB hard drive programs have some type of menu system that allows at least a one line entry for each virtual floppy.

Something must be said about the **Tandy Hard Disk Interface (26-3145)-under no circumstances try to use it!** This has got to be the worst thing Tandy EVER produced for the CoCo! No aftermarket hardware or software is usable with the thing. Tandy provided drivers for OS-9, but never for DECB. The worst problem is that the interface and software will only support old style Tandy hard drives which are no longer available, were slow, and if found used are not likely to last long. Only 10MB, 15MB, and 35MB hard drives were available for use with this interface. These drives had custom built in controller boards and were originally made for the Model I-IV computers.

The most known hard drive system still available is one built around a **Burke&Burke CoCoXT** adapter. This adapter fits between a Multi-Pak Interface, Slot Pak, or Y cable (modified to supply external power... the CoCo can't power a hard drive controller!) and a standard half card PC/XT eight bit hard drive controller. This system is one of the fastest available for the CoCo.

With new eight bit PC/XT controllers falling in price to the \$40-\$50 range and smaller 20MB-60MB hard drives falling rapidly in price, many CoCo users are now looking at hard drives. Used controllers and drives are readily available for \$200 or less simply because PC owners no longer need or want them. It is getting increasingly difficult, if not impossible, to find new 20MB-40MB hard drives! The Burke&Burke interface comes with OS-9 drivers. A software package for DECB users (Hyper I/O) is sold separately for \$30. A typical Burke&Burke system would price as:

CoCoXT Interface	\$75
New 8 bit controller	\$50
Refurbished 20MB hard drive	\$130
Case and power supply (surplus)	\$75
Hard Drive Cable Set	\$5
TOTAL	\$335

All new equipment would add another \$50+ to this price. Two reasons are apparent that make a CoCo hard drive system so costly- the need for an interface converter (in this case the CoCoXT) and the external case and power supply. Together these add up to nearly half the cost of the entire system (\$150). Today's hard drives don't require a lot of power. An old full size floppy drive case will happily power a small half height hard drive (especially if it is a 3.5" unit) AND a half height floppy without overheating.

The second best known hard drive set-up uses a **Disto hard drive adapter**- either in a Super Controller or MPI adapter. The Disto adapter is designed for use with an **SASI** (Shugart Associates System Interface... pronounced "sassy") or an **SCSI** (Small Computer System Interface... pronounced "scuzzy") type controller. These controllers are getting hard to find now. The following controllers can be used:

SASI	SCSI
Western Digital WD1002SHD	Adaptec 4000A
Xebec 1410A	Adaptec 4070 DTC 520 series

All but the 4070 use standard "MFM" type hard drives, the 4070 uses an "RLL" type drive.

Most currently available SCSI drives have built in (embedded) controller boards, meaning they do not require an external controller between the Disto interface and hard drive. The only problem with this arrangement is that most newer SCSI drives only support the PC standard of 512 byte sectors. The driver software that comes with CoCo adapters requires 256 byte sectors. Only Seagate "N" (numbered as "ST157N") and Rodime 650 series drives are known to support 256 byte sectors (all have embedded controllers). **Cloud-9** offers an OS-9 driver that supports 512 byte sectors, meaning almost any SCSI drive can be used, and software for DECB.

Other hard drive systems include:

* **Owl-Ware** - This system supports almost any SASI and SCSI controller or embedded drive (with 256 byte sectors). The Omti 5200 controller, which also supports high speed, no-halt floppy drives under OS-9, is fully supported. Hard drive works under DECB with drivers from Owl (Hard Drive BASIC 3) and Burke&Burke (Hyper I/O for Owl). The floppy system works ONLY under OS-9. A Tandy type floppy disk controller is still required for DECB support with the Omti 5200 floppy system.

* **Ken-Ton** - The Ken-Ton interface is the best true SCSI interface available for the CoCo. It also supports SASI controllers. RGB-DOS is available for DECB users, as well as drivers for OS-9.

Prices vary depending on the size drive and type of controller, but should be similar to new equipment Burke&Burke prices. A good source for small, inexpensive hard drives is **AAA Disc Drive Repair** 1464 Madera Road Simi Valley, CA 93065 (phone 805-523-9495) At the time of this writing they had ST125N SCSI drives (20MB, refurbished, 15 month warranty) for \$125 and floppy drives for as little as \$25 (same warranty). Call or write for current pricing.

As of February 2006 the only source to consider for a hard drive controller is Cloud-9. See their contact info under "Support". Cloud-9 makes an IDE and SCSI hard drive interface. The IDE is probably the best bet as small used IDE drives are cheap and plentiful. Small SCSI drives are still relatively easy to find though, and it can be used with a CD-ROM drive as well. Unfortunately, there is no new floppy controller.

3. Printers

The CoCo comes equipped to operate a serial printer, not the more common parallel type. Serial devices transmit data one bit at a time, over as few as three wires for a printer. Parallel devices transmit data over a minimum of ten lines one byte (eight bits) at a time. Though the speed of parallel transfer is fixed, it is usually faster than serial transfers. Parallel rates depend upon the speed of the computer and printer.

Serial transfer speed varies from as little as 120 bps (bits per second) to as fast as 19,200 bps on the CoCo. With no alterations, serial data is transferred at 600 bps. Note that bps and the term "baud" are usually used interchangeably. The serial transfer rate can be changed by poking a different value in memory location 150 (see appendix).

Many Tandy/Radio Shack printers were made with connecting to the CoCo in mind. These have a four pin serial port as well as a parallel port (in most cases). Most are switchable between 600 and 2400 bps and serial/parallel operation, making them usable on all Tandy/Radio Shack systems (including IBM compatibles). In the Tandy/Radio Shack numbering system, an "LP" model is a Line Printer (early dot matrix), "DMP" a Dot Matrix Printer, "DWP" a Daisy Wheel Printer,

"CGP" a Color Graphics Plotter (or ink jet in the case of the CGP-220), and "TP" a thermal printer, which also uses dot matrix technology but with special heat sensitive paper instead of a ribbon.

Dot matrix types are the most prevalent, as they can print graphics as well as text. All but the LP series, CGP-115, TP-10, and DMP-105 through 120 models are capable of correspondence quality text printing, which is slower but neater than standard (draft) output. The most common printer today is the nine pin dot matrix, though 24 pin models are quickly becoming the standard. Generally, the more wires the better the print, though the nine pin printer is adequate for most uses. A daisy wheel printer is slow, but produces typewriter quality output—they use the same daisy wheels as typewriters, and are essentially typewriters with no keyboard. Indeed, many high-end typewriters have serial ports built in or available as options.

The following list of Tandy/Radio Shack printers have the four pin connector built in. All are nine pin and support the IBM graphics character set unless otherwise noted. A couple of the printers were made to use with the CoCo only. The ribbons for some of these may be next to impossible to find in stock (note that the DMP-107 was the last advertised to work directly with the CoCo, in 1991). Radio Shack will order ribbons for you, no extra charge or minimum order, for many of their printers. Catalog numbers for ribbons were listed in the 1993 catalog (thermal paper for TP-10):

Cat.#	Printer	Notes	Ribbon
26-3020	(all)	6' CoCo/MC-10 Printer Cable (4 pin) n/a	
26-1167	LPVII	9", 30 cps, 7 pin, Tandy graphics	26-1424
26-1168	LPVIII	9", 80 cps	26-1418
26-1261	TP-10	4" thermal paper, 8 pin, CoCo only	26-1332
26-1275	TRP-100	9" thermal ribbon, battery/110V	26-1297
26-1193	CGP-115	4.5", 12 cps, ink jet (3 black)	26-1480
		(color set: 1 ea. red, green, blue)	26-1481
26-1268	CGP-220	9", 37 cps, ink jet (black)	26-1281
		(color set: 1 ea. red, green, blue)	26-1281
26-1253	DMP-100	9", 50 cps, 7 pin, Tandy graphics only.	26-1424
26-1276	DMP-105	9", 80 cps, 7 pin, Tandy graphics only.	26-1288
26-2802	DMP-106	9", 80 cps	26-1288
26-2821	DMP-107	9", 100 cps	26-1236
		(3 pack)	26-1238
		(color set: 1 ea. red, green, blue)	26-1235
26-	DMP-110	9", 50 cps, 8 pin	26-1283
26-1255	DMP-120	9", 120 cps, Tandy graphics only.	26-1483
26-1280	DMP-130	9", 100 cps, Tandy graphics only.	
		(DMP-130A, msmae specs)	26-1235, 1236, 1238
26-2814	DMP-132	9", 100 cps	" " "
26-2815	DMP-133	9", 160 cps	" " "
26-1254	DMP-200	9", 120 cps, Tandy graphics only.	26-1483

26-2812	DWP-230	15", 20 cps	26-1458
		(3 pack)	26-1445
26-1251	DMP-400	15", 140 cps, Tandy graphics only.	26-1418
26-1277	DMP-430	15", 180 cps, 18 pin	26-1296, 26-2808
DMP-440	15", 300 cps		26-2809

Other printers have add-on serial interface boards. Virtually any printer (or typewriter) with a serial interface may be connected to any CoCo. A special cable will be needed, as the standard for serial devices is a DB-25 25 pin connector. Just connect the lines as follows. The functions are listed just in case the printer in question does not use a DB-25, such as the PC jr. serial printer (a once popular surplus item, this was a thermal printer that required special paper, which is still available at large office supply stores, or fax roll paper may be used).

COCOSERIALPRINTERCABLE:

CoCo		DB-25	
Pin #	Function	Pin #	Function
2	Receive Data	20	External Ready
3	Ground	1 (or 7)	Ground
4	Transmit Data	3	Receive Data

Serial printers are difficult to find, and few are made today. The following printers have serial interfaces built in. Prices were average mail-order selling as of January 1993. They can occasionally be found used very cheap now, but make sure you can obtain ribbons before buying.

Alps Allegro 500,	216 cps, 24 pin, 9", \$350 *
Alps ASP1600,	192 cps, 9 pin, 9", \$235 *
Brother M-1809,	360 cps, 18 pin, 9", \$340
Brother M-1909,	360 cps, 18 pin, 15", \$450
C.Itoh ProWriter C-510,	240 cps, 24 pin, 9", \$270
C.Itoh ProWriter C-240,	240 cps, 9 pin, 9", \$300
C.Itoh ProWriter C-245,	240 cps, 9 pin, 15", \$390
Citizen 200-GX,	240 cps, 9 pin, 9", \$225 *
Citizen 200-GX15,	240 cps, 9 pin, 15", \$275 *
Citizen GSX-130,	180 cps, 24 pin, 9", \$310 *
Citizen GSX-140,	192 cps, 24 pin, 9", \$325 *
Citizen GSX-145,	192 cps, 24 pin, 15", \$450 *
Epson LX-810,	200 cps, 9 pin, 9", \$250 *
Epson FX-850,	220 cps, 9 pin, 9", \$265 *
Seikosha SP-2000S,	192 cps, 9 pin, 9", \$210
Seikosha SL-230AI,	277 cps, 24 pin, 15", \$460
Seikosha SP-2415,	300 cps, 9 pin, 15", \$300

* Includes the cost of an optional serial interface board, but not installation. Make sure the serial interface is there!

Somelaser and ink-jet printers also had serial interfaces built in. If one already has a laser or other serial capable printer, by all means connect it! Most CoCo software supports the Epson/IBM graphics standards, so any printer emulating an IBM or Epson model should work nicely. Cer-Comp's word

processor is the only CoCo program known to have a laser driver. Other programs will only work if the laser has Epson/IBM emulation built in. Few were made that way, and none made today have it. The same goes for most modern inkjet printers. USB interfaces won't work, of course.

Apple printers are usable as is (a special cable may have to be made, and some features may not be accessible by software), but Commodore 64 printers ARE NOT! The Commodore uses a unique serial interface not compatible with other computers.

There is a better, usually cheaper, and much more versatile way to connect a printer to your CoCo- through a **serial/parallel converter**. These devices convert the serial data signals to parallel compatible signals, as well as converting the connectors as well (parallel printers normally use a "centronics" 36 pin connector rather than a DB-25). Radio Shack used to sell a serial/parallel converter (26-2889, \$99.95) that has a DB-25 on one side, a centronics connector on the other.

A cheaper solution was a converter specially made for the CoCo. Several manufacturers made them, and they can still be found occasionally. Some printers provide +5V on pin 15 of the centronics connector, others don't. Those that don't will have to be modified to provide this voltage (solder a wire from any +5V source inside the printer to pin 15... make SURE this pin IS NOT GROUNDED FIRST!... if it is grounded, disconnect from the circuit board by cutting before adding +5V) or an external power supply will have to be purchased. "Wall wart" power supplies are relatively cheap and readily available at Radio Shack.

By using a converter, the printer can be used with almost any computer, and the converter can be kept if a newer, more capable printer comes along later. The CoCo serial/parallel converters can also be used with other computers by making a special cable, as the CoCo type converters use the CoCo four pin serial input instead of a DB-25.

Some manufacturers made parallel port cards for the CoCo. All suffered from the fact that BASIC had to be patched in order to use them. Both J&M and Disto disk controllers supported parallel ports with their modified DECB ROMs. Disto also supplied drivers usable under OS-9. The Disto parallel ports require either a Disto Super Controller or a MPI and adapter.

One thing to remember -- most modern printers are "dumb" devices. The printer itself has little software inside. What used to require a chip in the printer is now done in the printer driver of most printers designed for Windows 95 and later, and even Linux. This makes it difficult to know if a printer can be made to work with a CoCo even if it has a parallel interface. The few dot matrix printers still made will, but lasers and inkjets made over the last 10 years most likely won't. Many businesses continue using dot matrix printers, but new ones are back up to 1980s prices.

4. Expansion Devices

When Tandy first came out with the CoCo, they envisioned it as a beginner/game machine. If one got serious about computing, they should buy a more serious (Tandy) computer. Only one expansion port, the game cartridge connector, was included. Needless to say, Tandy underestimated the market and the CoCo, and users soon wanted to install a disk drive, RS-232 Pak, and still be able to plug in the latest game cartridge- without tearing the system apart first!

Tandy introduced the four slot **Multi-Pak Interface (MPI)** in 1983 to cure the limited expansion offered with only one port. Just before the MPI was released, in October of 1982, Basic Technology introduced its own answer to the expansion problem, a five slot expansion buss on a cable. At one time, there were three to five expansion bus devices available for the CoCo. It is not advisable to use any of these with a CoCo 3, as addressing may conflict with memory areas used by the GIME. All were discontinued by 1986.

Any MPI slot could contain a ROM Pak game. To choose between them, one merely turned the MPI off and then moved the numbered switch on the front of the MPI to the desired pak. The disk drive controller is normally used in slot 2 or 4, and the RS-232 Pak in slot 1 or 3. A hard drive controller would reside in slot 2 or 4 also, whichever the disk controller was not occupying (location depends on particular setup). Only the CTS (cartridge select), SCS (spare cartridge select), and CART (cartridge select interrupt) are switched between the pairs of slots- all other lines are always connected to all four (CART and CTS are switched together). The reason for this is that the CTS and SCS lines are used to activate devices with a ROM in them. Only two such devices can be used in the MPI at any one time. The other pair of slots must contain a device (such as the RS-232 Pak) that doesn't use the SCS or CTS lines for port decoding. The Speech-Sound Pak, Modem Pak, and RS-232 Pak (and a few others) contain internal circuitry that tells the computer where to find them, while the disk controller (and others that rely on SCS/CTS slot switching) doesn't.

Slots can be selected by software also. This is done by POKEing a value in location &HFF7F. Once memory location &HFF7F has been written to, the hardware switch is deactivated until the MPI is reset or turned on after being turned off. It is best to leave the hardware switch on the slot the disk controller (normally slot 4) is in when the computer is first turned on. The hardware switch must be used to select a ROM Pak in a slot when a disk controller is left in the MPI.

The following values are used to determine which slots the CTS/CART and SCS lines are switched to:

SLOT	CTS/CART	SCS
1	&H0	&H0
2	&H10	&H01
3	&H20	&H02
4	&H30	&H03

To change all three signals to a slot, add the two values together. For all three in slot one: POKE &HFF7F, &H00; for all three in slot two: POKE &HFF7F, &H11, etc. To place CTS and CART in slot two, SCS in slot four: POKE &HFF7F, &H13 (value &H10 + &H03). Note that there are enough bits in the control byte to allow up to 16 slots. The most ever used in one device was six (by PBJ Slot Pak and J-NOR Industries User 80C).

IMPORTANT MPI RELATED SIGNALS:

CoCo to MPI:

SCS- secondary chip select signal (FF40-5F)

CTS- cartridge enable (8000/C000-FEFF: 32K/16K ROM pak... used for device selection under OS-9).

MPI to CoCo:

CART- cartridge interrupt, connected to FIRQ via PIA, or FIRQ/IRQ via GIME. Enabled from slot which also has CTS selected.

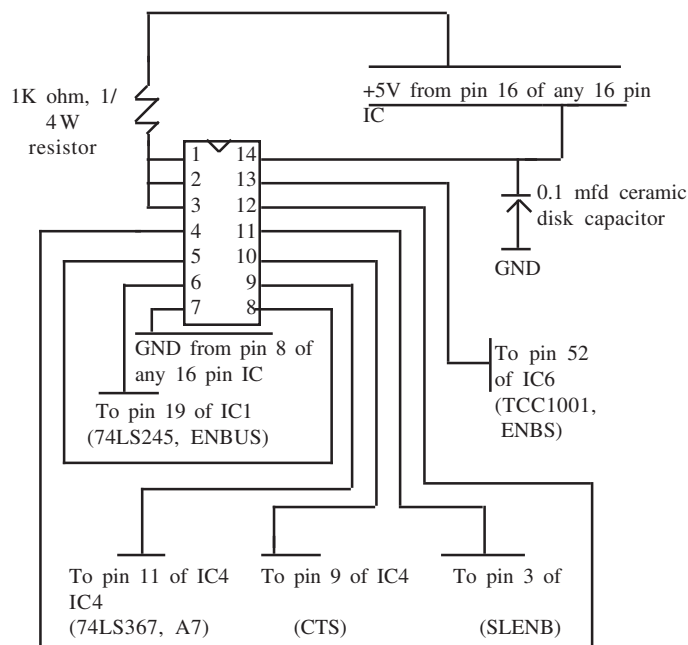
There were two different versions of the MPI made. The large MPI (10.25"x8.5"... 26-3024) was the first. It was initially marketed in a "Mercedes Grey" case to match the CoCo 1. With the introduction of the CoCo 2 later in 1983, a matching white cased unit was made available. The second version, a smaller unit (approximately 8.5"x7.5"... 26-3124) due to a reduction in circuit board size, was introduced late in 1985. A custom 64 pin chip in the small unit took the place of nine separate chips in the large.

The coming of the CoCo 3 late in 1986 caused a few problems for the MPI. The oldest (grey) MPI stored a copy of the slot select address (&HFF7F) at another address (&HFF9F- the address older MPI manuals recommend POKEing to for slot selection). This was not a problem on older CoCos because they did not use &HFF9F for anything- the CoCo 3 uses it as part of its video horizontal-offset register. Any time this address was written to by the CoCo 3, the older MPI switches away from slot 4, where the disk controller normally resides. Subsequent writes to this address would further confuse the MPI's slot select circuitry, thus preventing normal operation with a CoCo 3. The solution is to buy and install an upgraded PAL chip (U8), which is fortunately socketed (the ONLY socketed chip!) and currently available from FARNA Systems and possibly from Tandy National Parts.

Some of the newer large white MPI and all the small MPI units appear to work fine with the CoCo 3, but there is still a minor problem. The reason these MPIs seem to work acceptably is that the address at &HFF7F is not copied to &HFF9F, so the slot select circuitry is not inadvertently changed. Problems arise when attempts to read data from ports of the GIME chip between location &HFF80 and &HFFBF are made. The MPI was designed before the GIME was conceived, and thinks these memory addresses are available for general input/output operations. The data buffers in the MPI are therefore opened when an attempt to read these GIME data ports. This means that both the GIME and MPI are trying to access the data bus at the same time, which can garble the data being read

from the GIME ports. Using an un-upgraded MPI with a CoCo 3 WILL NOT damage either device, but software may not work correctly at times, causing quite a few headaches and uncontrollable results.

Again, the solution for the large MPIs is to replace U8 with an upgraded PAL. The newer, small MPI requires a different approach due to the custom chip, which is soldered in place and unalterable. The data buffer enable circuit must be modified to prevent the MPI from opening its data buffers when the GIME addresses are in use. The fix involves mounting a 74LS10 NAND gate chip on a small piece of circuit board (a 14 pin socket may also be used). Wire as shown below. Make sure the circuit board is mounted so that it cannot move about inside the MPI, possibly causing a short circuit (if using a socket, place a piece of double backed foam tape on the chip, then stick upside down on top of another chip or the circuit board).



OS-9 poses a few additional constraints on MPI use. Placement of devices in particular slots is mandated by OS-9 device driver software, device decoding, and if the device needs to send a CART interrupt back to the CoCo.

The RS-232 or Modem paks need to get an interrupt line back to the 6809 inside the CoCo. Therefore, they must be in a slot selected for the CTS/CART lines before the interrupt can get through. Since only one slot can do so at a time, you have two different drivers, ACIAPAK and MODPAK. ACIAPAK sets up for an interrupt from slot one, and MODPAK instead uses

the VIRQ timer to check regularly (called polling) for an interrupt register flag in a fully decoded device in slots two, three, or four.

So, if a device fully decodes itself (like the Speech-Sound Pak), it can go in any slot. If it uses the SCS to enable it (like the disk controller), or needs to use the CART (like the RS-232 pak, which is fully decoded), it must go in the slot that the SOFTWARE decides. Note also, that you cannot use more than one device that fully decodes itself at the same address, since such a device is slot-independent in that respect and ALL of them will turn on at the same time - a mess! So you can't use two RS-232 paks, for instance, unless they are internally re-wired for different addresses. Some aftermarket RS-232 paks have jumpers so that an alternate address can be selected.

The RS-232 Pak is easy to modify (by design) to a different address. It comes decoded for FF68-6B. It is easily changed to be decoded for FF6C-6F though. /T2 and ACIAPAK can then be used for the original in slot one and /M2 and MODPAK for the readdressed one in slot two or three. Rewiring is this easy:

- 1) Cut the trace running from pin 8 of the 74LS04 (U6) to pin 2 of the 6551 (U1).
- 2) Solder a wire from pin 9 of U6 to pin 2 of U1.

That's it! The use of the A2 address line had to be low before, now it has to be high. The disk controller address can also be changed, see "Mass Storage" for details.

Why aren't all devices fully decoded? Cost is why. It's cheaper to make a disk controller that uses the already decoded SCS line from the CoCo, than to include the one or two extra chips needed to decide it's own address. Theoretically, it also meant you could have a disk controller in each slot and pick between them, but that isn't really practical.

Many OS-9 Level II users (CoCo 3 ONLY) have found it necessary to "strap" the CART line between all four slots. This is done by soldering a jumper wire under the MPI circuit board between the CART pins (pin 8) of all four slots. This keeps the RS-232 pak from locking up or loosing characters during operation, and allows more than one device to send an interrupt to the CPU without switching slots.

The RS-232 will sometimes loose characters or lock up in a CoCo 3 due to the way the GIME chip detects the CART signal. The GIME detects a CART on transition from high to low of the interrupt line. If one interrupt occurs directly after another, the GIME never sees the second one. This situation can easily occur when using an RS-232 Pak under OS-9, as an interrupt is generated each time a character comes into the RS-232. At the same time, the GIME is generating 60 interrupts per second. Sooner or later one interrupt follows another to close and a character is lost or the RS-232 Pak locks up.

A Schottky barrier diode (#276-1165) must also be added inside the CoCo 3 to complete the fix. The anode of the diode (lead opposite the stripe) should be connected with a length of wire (24 or 26 gauge) to resistor R2 (4.7K ohms... the part reference numbers are printed on the circuit board). This resistor is located near the reset button. Solder the wire on the end of the resistor farthest away from the reset button. The other end of the diode, the cathode (end nearest the stripe), should be connected with a length of wire to resistor R7, which is located near the PIA (40 pin chip near the opposite corner of the board as the reset button... "kitty corner" from reset). Solder the wire to the end of R7 nearest the PIA. Insulate the diode and all bare areas of the wire well to prevent shorts on the circuit board. This modification bypasses the GIME interrupt and connects the CART line directly to the IRQ (interrupt request) pin of the 6809. The diode prevents interrupt signals from feeding back to the CART line. If a Schottky barrier diode is not available, a more common 1N34 germanium diode can be used. Silicon diodes CANNOT be used, they could cause logic problems. The only DECB program known to use interrupts when using an RS-232 Pak is Ultimaterm (a popular share-ware terminal program). Otherwise, only OS-9 users need to consider this modification.

The only problem with strapping the CART line is that auto-execute ROM cartridges and expansion devices would cause a crash of the system. The solution is to either cut the trace to or tape over ("scotch" tape will work fine) the auto-exec land (land 8.. usually the first one from the left-bottom of the card edge) of the cartridge, thus preventing automatic execution. One then types EXEC &HE010 to execute the cartridge. Note that devices other than game ROM Paks, the Tandy RS-232 Pak, and Tandy DC Modem Pak that auto-execute are extremely rare.

In OS-9 Level I Version 2.0 (which will run on a CoCo 3), you are expected to power up using the slot in which you have your disk controller. CCDisk does NOT set the MPI SCS latch. However, ACIAPAK assumes the RS-232 pak is in slot one and the disk controller is in slot 4, as it stores a \$03 at FF7F. CCHDisk, when it needs to access the Tandy Hard Disk interface (which uses the SCS line), changes the MPI select to \$02 (CART from slot one, SCS to slot three). So the HDI must be in slot three. In both cases, the RS-232 or Modem Pak that you wish to be interrupt-driven by ACIAPAK must be in slot one. CCHDisk clears D.DMAFlg when it's not using slot three, so CCDisk "knows" the SCS is going to slot four when it wants to shut off the motors after a time-out. That is, the disk controller had BETTER be in slot four! If CCHDisk is using the MPI latch, it sets D.DMAFlg so CCDisk will reset it's time-out counter and try again later. Drivers that change slots should use this flag byte. Some third-party drivers, most notably the ones by Brian Lantz for Disto and J&M, don't use this flag. In the case of the Disto paks, since they are slot-dependent - these drivers shut off interrupts while accessing the hard disk or RAMdisk, while the SCS slot is changed. This is probably in the mistaken belief that drivers can be time-sliced (a common

misconception) and some other might change slots. There's no reason to do this, unless there is an IRQ-driven device that will change slots on you. None are known to do that. Most third party hard drive interfaces (except the Disto, as noted above), also need to reside in slot three when using OS-9. The mentioned slot assignments are usually used by convention even on Level II systems.

CCHDisk and ACIAPAK can be easily patched to use a specific slot for the RS-232 pak. The bytes to change are at offsets \$80 in ACIAPAK, and offsets \$4D7 and \$4E9 in CCHDisk (if you use it). Currently, these bytes are set to \$03, \$02, \$03. Change the zero (\$0x) to whichever slot code you desire for the RS-232 pak, re-verify the modules, and you're done. For the RS-232 pak (using ACIAPAK driver) in slot three, change them to \$23, \$22, \$23, for example.

Tandy discontinued the MPI in 1989. This left the market open for vendors to come up with a way to allow more than one cartridge to be plugged in at one time. Howard Medical introduced the Slot Pak II in December of 1989. This device is packaged in the equivalent of an old long disk controller shell (about six inches long), leaving enough room outside the CoCo case to mount three cartridge connectors. A support is glued under the shell for stability. The original SPII was powered by the CoCo itself or an external wall transformer, which was necessary for devices which required +/-12V. The SPIII has an integrated power supply, as the CoCo 3 does not have sufficient capacity to power more than one external device without over heating. It also has a switch which allows use of a ROM Pak game cartridge in the center slot without unplugging all cartridges. Some ROM Paks do not seem to work properly though- it would be best to unplug all devices except the disk controller and ROM Pak then transfer the ROM to disk if possible, or unplug the SP for ROM Pak use. Due to the possibility of dislodging the SP from the CoCo (and subsequently blowing the 6809), it is best used with a keyboard extension cable of some sort.

Slots one and two of the SP function similarly to the MPI slots. Slot one uses the bits for MPI slots one AND three, slot two for MPI slots two and four. Only one of the bits is necessary to set the slot value though. This was done so that if software was hard coded to use slot four, the three slot SP would still function correctly. The CART line IS NOT switched by the SP at all, it is "strapped" between all three slots- similar to the modification described earlier (the diode still needs to be installed inside the CoCo 3 though). The third slot DOES NOT have the CTS or SCS connected at all. This means that only devices NOT decoded in the range of &HFF40-&HFF5F and WITHOUT on board ROMs can be used there. This slot was intended for an RS-232 Pak, though others meeting the previous criteria work also (Tandy Speech & Sound Pak, most MIDI adapters, etc.).

In the same issue of Rainbow (December '89), Orion Technologies introduced their "XPort", also a three slot MPI replacement. This device worked identically as the Slot Pak, with two

switchable slots and one fixed. The main difference was that the XPort had a fifteen inch ribbon cable between it and the CoCo. This allowed moving the XPort away from the CoCo.. the keyboard could easily be pulled closer to the user, greatly reducing the possibility of blowing the 6809 and the need for an extended keyboard. The XPort also had its own power supply built in from the start. Unfortunately, Orion is no longer in business.

In 1992, a new company appeared to support the CoCo with hardware... CoNect. They provided two expansion devices- the "XPander" and a "Y Box". The XPander plugs into the cartridge connector and provides two SCS driven ports as well as a third port for fully decoded cards. The third port can also be used for ROM cartridges with the flip of a switch. The XPander was designed to fit in a modified CoCo case or used for repackaging in a PC type case. Another feature of the XPander is a built in RS-232 port which is compatible with the Tandy RS-232 Pak. The Y Box was a fully buffered Y cable (more reliable and longer than a Y cable alone). A powered version that supplied +/-12V was available (required by Burke&Burke hard drive systems).

One other expansion device bears mentioning.... the simple Y cable. This is nothing more than a short piece of ribbon cable with two 40 pin connectors on it. Anyone capable of soldering can easily make a Y cable. Get a 44 pin card (#276-154) and cut four of the lands off one edge. Trim it down to a comfortable length (about one inch). Get a 40 conductor ribbon cable no more than six inches long. Now get two 40 pin crimp-on card edge connectors (44 pin types can be used, just tape over the last two positions). First separate the wires (about one inch) on one end. Strip enough of each to solder onto the positions on the shortened card. Now take a good look at the shortened card lands. Notice that they alternate between the top and bottom lands on the board. Take a good look at the crimp-on connectors. One side is offset so that the contacts actually alternate from one side to the other. The ribbon cable should alternate also so that the lands top of the card match the top contacts of the connectors and vice-versa. Once the positions have been lined up, solder the cable to the card. Plug this into the CoCo. Cut the ribbon cable so that it will just touch the surface of the work surface. Crimp one connector on the end and the other up just enough so that a second device will rest on top of the first. The cable should be only three to four inches in length.. the shorter the better! Y cables usually work well with a disk controller and RS-232 Pak. Using two devices that contain a ROM or use the SCS and CTS lines requires changing the address location of one of the devices (see "Mass Storage" for modifying the disk controller address, "Expansion Devices" for modifying the RS-232 Pak). A good way to disable a ROM is to cut the leg from the chip across from pin number one (cut the power pin). Note also that some devices require 12V power, which would have to be supplied from an external source for CoCo 2 and 3 models (make sure the 12V DOES NOT go into the CoCo cartridge connector!).

5. Miscellaneous Devices

Many more items have been made over the years that allow the CoCo to do many specialized jobs. The most prevalent are listed below. Two items not listed are modems and RS-232 paks. These are discussed in detail under "Telecommunications" elsewhere in this book. Only one modem, the 300bps DC Modem Pak (#26-2228), was made specifically for the CoCo.

* **Joysticks** - Three different joystick designs were made for the CoCo by Tandy. The first was a very simple one button stick (#26-3008). They were housed in a black case and sold in pairs for \$19.95. All that can be said is that they are better than nothing! The second design was much better- the Deluxe Joystick (#26-3012). This stick was switchable between self-centering and free-floating action (the first are free only). Two "fire" buttons are used, though only one works on the CoCo 1/2, both on the CoCo 3. These sticks were made by Kraft, and also connect to the 1000 series of IBM compatibles (note that the similar appearing IBM sticks are wired different- they WILL NOT work with the CoCo or 1000 series). They may still be available in some stores, but are not listed in the 1993 catalogs. Only the last stick design, the #26-3123 Pistol Grip model, was listed in 1993. This stick features two buttons on the base plus a trigger and thumb button on the stick. The stick buttons work the same as the two base buttons (only two active inputs). Like the Deluxe stick, these also work with the 1000 series. A Hi-Res Joystick Interface (#26-3028) was also available for the CoCo 3. This gadget plugged into the cassette and one joystick port and increased the resolution of the joystick, making for smoother action. Unfortunately, special software was required and little of this was made. The last versions of CoCo Max3 (a popular paint program) and Max-10 (a graphic, Mac/MSWindows type word processor) require the Hi-Res Interface.

* **Mouse** - Tandy came out with a CoCo mouse not long after the CoCo 2 was introduced. The original mouse (#26-3025) featured only one button since the CoCo 2 supported no more on the joystick port. A two button mouse, the Deluxe Color Mouse (#26-3125), was introduced along with the CoCo 3. These mice plug into the joystick port and act just as the joystick does. An OS-9 driver for a serial mouse is available on Delphi (see "Telecommunications") or FARNA Systems (requires an RS-232 pak- the CoCoPRO!/DC Modem Pak conversion won't work).

* **Video Digitizer** - Two companies made popular video digitizers for the CoCo. The Micro Works DS-69 "Digisector" was the most popular. A later model, the DS-69B, is similar to the original (sometimes referred to as the "A" model) but faster. Neither are currently available. An Australian company still produces the "Rascan" Digitizer (updated and renamed "DigiSector", available from FARNA Systems), which is the faster of the listed models. These are not "frame grabbers"- they don't pick a moving picture from a video tape or TV set. They require a still subject, as they take 15 to 30 seconds to fully digitize a picture. They don't digitize text either, just

pictures. These devices are similar to the ones found in malls and amusement parks making "computer portraits".

* **Plug 'N Power Appliance/Light Controller** - Two models of this X-10 compatible home controller were made. The first plugged into the cassette port (#26-1182) of a CoCo or Model I/III. This came with a cassette program, and may be usable on the CoCo 3, but they are extremely rare devices now! The second model (#26-3142) came out with the CoCo 2. It can still be picked up new, but attaches to the serial port and CANNOT be used with a CoCo 3. The reason is that it comes with ROM-Pak software that won't load on the CoCo 3 because a "semi-graphics" mode of the CoCo 2 is used. This mode is not supported on the CoCo 3 due to limited use- the Plug 'N Power is nearly the ONLY thing to use that mode! It might be possible to use the IBM compatible Plug 'N Power or X-10 controller (serial version), but software would have to be written for it.

* **Orchestra 90 CC** - This was a six octave, five voice stereo music composing cartridge with built in ROM software (#26-3143). It could be connected to a stereo for output. Some music files can be downloaded from Delphi (see "Telecommunications"). Created music can be stored on tape or disk (with a MPI).

* **Sound/Speech Cartridge** - This thing would actually make your CoCo talk (#26-3144)! A few games supported this cartridge... very few! It came with instructions for easily programming speech.

* **A-Bus** - This is a general purpose control system for the CoCo and a number of other computers as well. Each computer had a special adapter that connected to a special five slot A-BUS board. Up to five of these could be interconnected, making 25 slots available. A full range of devices for process control, robotics, data acquisition, monitoring and sensing, and motion control were available. Software was not supplied- this was an experimenter's system! This item is still available from the manufacturer (Alpha Products, 242-W West Avenue, Darien, CT 06820... phone 203-656-0756). If the special CoCo adapter is no longer available, their RS-232 adapter can be used for serial port connection to the CoCo.

* **MIDI Synthesizer Interface** - Several units were once available, but only two are currently produced. The first, and probably most known, is the MusicWare CoCo MIDI 3 and CoCo MIDI Pro systems. Both consist of software that functions like a studio recorder, and a MIDI interface adapter that plugs into an MPI or Y cable (required). Multiple tracks can be recorded and played in real time. CoCo MIDI 3 runs on any CoCo with at least 64K. A four minute, nine voice recording will consume about 95% of memory and require approximately 45K of disk space. Disk files can be linked to play in sequence. CoCo MIDI Pro requires a 512K CoCo 3 and has additional memory capacity as well as other added features. MIDI 3 records 10 tracks, MIDI Pro 16. This is an update of the popular Lyra system.

The second MIDI system is the Kala Software UltiMusE III and UltiMusE/K systems. The first runs under OS-9 Level II, the second under OSK. Both are virtually the same except for the platforms they run from. Actually, the only hardware involved is a special cable that connects to the serial port (schematics included to build cable, or purchase from Kala ready made). Records up to 16 tracks. May be a little harder for a non-OS-9 user to set up (OS-9 version uses VDG screen), but has the advantage of not requiring an MPI.

Many more items have been available at one time or another for the CoCo. The best source for information on unusual finds would be Rainbow and other CoCo magazine back issues, especially 1984 to 1986 issues. A few will not be compatible with the CoCo 3, but all should work (to some degree) with the CoCo 1 and 2, unless they require 12V which is not provided by the CoCo 2 (unless an MPI is used).

Hardware Upgrades and Modifications

The following upgrades and modifications are the most common. Note that disk drive, Multi-Pack, and monitor upgrades and modifications are covered under "Peripherals".

ROM Upgrades

ROM upgrades aren't really necessary in most cases. Replacement ROMs are still available from some dealers, though they may be hard to find. There were **three versions of Color BASIC- 1.0, 1.1, and 1.2**. The only one that really needs changing is 1.0. 1.0 used a seven bit printer driver instead of the more common eight bit (Tandy only had a seven bit printer at the time). This ROM won't print graphics without a special, no longer available, printer driver program. Version 1.1 allowed

use of a full 64K, and version 1.2 cleared a few minor bugs in 1.1 and the BASIC interpreter was re-written to run slightly faster. All NC board CoCo 1 and TDP-100 models will have 1.1 or 1.2 ROMs, all CoCo 2s 1.2 or 1.3. If a new ROM is desired, try to get the 1.3 version (#8040364C... 1.2 is #8040364B, 1.1 #8040364A, 1.0 #8040364). If there is an empty socket on a CoCo 1 or 2 next to the Color BASIC ROM, then Extended BASIC is not present. The catalog number for the required 24 pin ECB ROM kit is 26-3018 (includes ROM and new manual... part #AXX7072 for the ROM only).

The "A" and "B" model CoCo 2s require a single 28 pin ROM that has both Color and Extended BASIC in it. A set of five jumpers near the ROM socket are marked 64K and 128K (the size of the ROM). If the computer came with Color BASIC only, the jumper wires will have to be cut and moved to the 128K positions. The easiest method is to trim the wires as close to the 64K pads as possible then bend them back to the 128K pads and solder there. These CoCo 2s also have a version 1.3 Color BASIC ROM, but the only changes are for the SAM setup routine (required for these models... the 24 pin Color BASIC 1.3 ROM will also work in older CoCos) and the copyright notice. The part number for the 128K ROM upgrade is MX-6436. These upgrade ROM kits are likely no longer available, but it will only cost 29 cents to write Tandy National Parts and find out. Make sure you know the catalog number of the CoCo that will be using the ROM. Tandy sorts parts lists by catalog numbers.

The version number of the highest level BASIC ROM is displayed on screen when a CoCo is turned on. Type the following to discover each version of BASIC:

```
PRINT PEEK(41302)-48 - Color BASIC version
PRINT PEEK(33023)-48 - Extended Color BASIC version
```



The back of a CoCo 3. The RGB connector (right) was underneath and required a special cable. Only the CoCo 3 had the RESET button and Audio/Video out connectors. Other CoCos looked the same across the back except for those three things.



RAMUpgrades

Each of the various CoCo models were upgraded in a different fashion. All original model (gray case) CoCos can be upgraded to 64K, though the earliest models only supported upgrades to 16K officially. It just took some enterprising CoCo enthusiasts to figure out how to access additional memory once it was learned that the 6809 could actually address 64K. Each model is discussed separately, along with its' identification characteristics.

Revision numbers are found on the right front side of the circuit board on the CoCo 1 models. All CoCo 2 boards are easily identifiable by the DRAM configurations. Each revision of these boards is only slightly different from the others. All CoCos are most easily identified by their catalog numbers, though it is possible that a later board was installed in an older case when upgrading or repairing by a Tandy/Radio Shack service center. In such a case, there should be a sticker on the bottom of the case stating which board was installed and what upgrade was done.

Generic numbers have become common for DRAM. In the number "4116-12", the "4" indicates Dynamic RAM, the first "1" a one bit chip, and "16" the capacity in "K" bytes (1K is actually 1024 bytes, though this figure is usually rounded to 1000). The "12" indicates the speed of the chip in hundreds of nanoseconds (ns, one billionth of a second, in this case 120ns). Therefore, a "164-10" is a 64Kx1bit, 100ns DRAM. If the second digit is a "4", the chip is a four bit chip. Remember that it takes eight bits to make up one byte, so two 4464-10 chips make up a complete 64K, whereas it takes eight 4164-10 chips. 120-150ns DRAM should be used in all RAM upgrades. Less than 120ns (faster) DRAM chips will be slightly higher priced, but will also work just fine. Slower chips will overheat and eventually fail, causing intermittent problems as the computer heats up. Do note that the early CoCo 1s did use 200ns DRAM. These were never intended to run at double speed, however, so the slower access time wouldn't normally cause a problem. At any rate, it is difficult to find chips rated at less than 150ns anymore, and the smaller chips (4K & 16K) are difficult to find at all.

The Original CoCo (CoCo 1)

IDENTIFICATION : Gray Case w/vents on the sides, "Chicklet" keyboard.

CATALOG NUMBERS: 26-3001, 26-3002

BOARD REVISIONS: C, D, & E

It IS NOT practical to upgrade these boards to 64K, though it is possible. A description of each board and reason for not upgrading follows. Many early CoCoists DID upgrade these boards, but with CoCo 2 computers selling for under \$25 in most areas, it is not advisable nor cost effective to make such upgrades. If one must upgrade one of these machines, order a back issue of the May 1984 Rainbow from Falsoft ("RAM/ROM Upgrade Roundup", pp. 49-51). Practical RAM upgrades are mentioned.

Very few "**C**" boards were actually sold, so few that no attempt to upgrade them should be made- these are definite collector items! The C version was almost a prototype, with many wires and a small satellite board inside.

The "**D**" board is quite similar to the C, but does not have the satellite board. Most 4K and 16K CoCo 1s have the D board. This board would only work with 4K and 16K DRAM (generic number 4104 and 4116). Simply replace the 4K chips with 16K units. Next find the two jumpers marked 4K and 16K (one next to the 6883 SAM, the other between the two 6821 PIA chips) and move them to the correct position. The C board may not even be upgradable to 16K!

"**E**" boards were the first to be upgradable to 32K. These require simply installing 64K chips in place of the existing 16K units and moving the jumpers (one between U8 and U9, three next to the keyboard connector, and one just below C44) to the 32K position. Hmm... 64K chips but only 32K RAM? That's correct! 32K was selected as the maximum supported RAM because Color BASIC couldn't use more than 32K anyway, and no other operating system was available at the time. There never were any 32K DRAM chips made. 32K chips were made up by piggy backing 16K DRAMs, even commercially! Tandy got discount prices on half good 64K chips (half bad?). There is a jumper located near U29 marked HIGH and LOW. This selected either the upper 32K or lower 32K halves of the 64K chips (all the chips had to have the same half bad, Tandy just sorted them before installing). If new chips were purchased, it won't matter which half is selected. Later versions have all good 64K DRAM as the supply of half-good chips dwindled.

Why were there half-good chips to begin with? Manufacturing a chip on a silicon wafer is tricky business. Even now 10%-20% of chips made are defective and must be thrown away because there is no way to repair them. The larger scale the chip integration (more components on a single chip), the higher the rejection rate. The supply of half-good chips dried up as manufacturing techniques improved.

64K CoCo 1; TDP-100

IDENTIFICATION : Beige Case, Low-profile keyboard, vents on sides (some early models came with CoCo 1 style cases and keyboards)

CATALOG NUMBERS: 26-3002A, 26-3003A, 26-3004A, 26-3005

BOARD REVISIONS: "NC" (also called "F" or "285").

This board either had "NC" or no revision marking at all. Many people refer to it as the "F" board because it came after the D revision (why not the "E" then?... who knows!), or the "285" due to those numbers being the first in the number silk screened on the board. It is unclear what NC actually meant. The keyboard on these machines had full size square keys, but they were only about 1/4 inch tall, leading to the "low profile" designation.

All that is needed to upgrade these boards are eight 4164 DRAM chips, moving three jumpers from 16K to 64K positions, and adding another jumper (the pegs can be soldered together). The jumpers are located near U21 (2), U28 (1), and U17 (the one that needs a jumper added). If the computer originally came with 16K, clip capacitors C58, C60, C62, C64, C66, C68, C70, and C72. These can just have one leg cut rather than entirely removed. It is not necessary to reinstall the capacitors even if 16K DRAM is put back in.

American Made CoCo 2

IDENTIFICATION : White case, vents on top.

CATALOG NUMBERS: 26-3026, 26-3027

BOARD REVISIONS: A(?) & B

There may be only one board revision that was produced. The only one the author has seen has "REV B" printed on the board. It is possible that an "A" version was produced, or maybe the "A" was just a prototype (like the CoCo 1 "A" and "B" revisions). The RAM upgrade is the same regardless. Remove the eight 4116 chips and replace them with 4164 DRAM. Locate the two adjacent solder pads labeled "W1" between U6 and U7 (near the center of the board). Solder a tiny piece of wire between the two pads and the 64K will be activated. Many people bend a short piece of wire in a "U" shape as it is easier to hold with a pair of tweezers or needle nose pliers while soldering.

Korean Made CoCo 2

IDENTIFICATION : Identified by DRAM type and ROM socket, and catalog numbers.

CATALOG NUMBERS: 26-3134(A,B), 26-3136(A,B)

BOARD REVISIONS: A and B revisions noted by RAM locations and catalog numbers.

There were three different CoCo 2 boards manufactured in Korea. Tandy gave each a separate catalog number. The first were 26-3127, 26-3134, and 26-3136. 26-3127 came with ECB and 64K installed. 26-3134 and 26-3136 came with Color BASIC and ECB, respectively. These were upgraded by replacing the 4116 chips with 4164s. In the front left hand corner of the board are two solder pads labeled "J1" and "64K" (between R7 and R27, near IC7). Solder a jumper between these pads just as with the American made CoCo 2.

The second Korean version added an "A" to the catalog numbers (26-3134A, etc.). This model uses only two 4416 RAM chips. Upgrade by replacing with 4464 RAMS and soldering a jumper between the solder pads labeled "J6", "RAMSIZE", and "64K" (near IC4, front left corner of board). Notice the two white connectors on either side of the RAM chips? These were to support a plug in RAM board with eight 4164 chips if necessary. The availability and cost of 4464 chips was questionable when Tandy first designed the motherboard. To the best of the authors knowledge no upgrades were ever made using that method.

The final Korean CoCo 2, the "B" version, could be upgraded in three ways: two 4464 chips, eight 4164s, or via the previously mentioned plug in board with eight 4164s. The best, and only known to exist method, is by using two 4464s. To use eight 4164s on the motherboard, sockets would have to be added to the blank spaces marked off for them on the motherboard (or the chips could be soldered in directly). **NOTE:** The 4464 chips removed from a CoCo 3 when upgrading to 512K can be used in an A or B model CoCo 2.

CoCo 3

IDENTIFICATION : Has different arrow key location; F1, F2, CTRL, and ALT keys

CATALOG NUMBERS: 26-3334

BOARD REVISIONS: Only one board made.

The CoCo 3 comes with 128K installed. This is made up by four 4464 DRAM chips. There are two white connectors near the four RAM chips. These are for a 512K upgrade board. Before installing the board, pull the four 4464 chips out and clip capacitor C65. Several 512K upgrades were made, all using 41256 (256Kx1bit) DRAMs. Cloud-9 currently offers 512K upgrades that use 256K SIMMs.

Disto made a 1MB upgrade that plugged into the 512K upgrade sockets, required a bit of soldering to the CPU, had 16 41256 chips on board, and had sockets for an existing 512K board. This took up quite a bit of room inside the computer, made it run hotter, and wasn't exactly easy to install. Many OS-9 users loved the extra memory regardless of the difficult installation.

In 1993 Disto announced a 2MB upgrade. This board uses two 1MBx8bit SIMMs (Single In-line Memory Modules... the "three chip" variety) and plugs right in. The only soldering required is replacing the CPU with a socket (which the 2MB board plugs into; there is a socket for the CPU on the 2MB board). This is a much neater installation! One should note that these boards were designed with the OS-9 user in mind. Programs for DECB can be written to take advantage of the added memory, but only ADOS is known to use any memory over the standard 512K, and then only for RAM disk use. The 1MB and 2MB boards will also function as if they were 512K upgrades under DECB.

The MMU (Memory Management Unit) inside the GIME chip is capable of addressing up to 2MB, but is two control bits short to access that much RAM. Tony DiStefano (the designer of the boards) added one bit on the 1MB board and two on the 2MB board with external circuitry. The problem with DECB use of the additional RAM is that the GIME doesn't track the contents of these added bits and therefore can't read them. Any DECB applications must store the contents of these two bits so that the GIME can move around the extra RAM without crashing the computer. OS-9 handles memory differently and does not require the GIME to track the two added bits.

There are no other commercially available upgrades, but for the avid electronics hobbyist, up to 8MB can be added. Take a look at the "CoCoZilla" website (<http://home.wwdb.org/irgroup/frontpage.html>) for details. Cloud-9 is currently (as of FEB 2006) working on completing their "SuperBoard" upgrade for the CoCo3 that is similar to the "NoCan" projects on the CoCoZilla site. The SuperBoard will feature 2MB (via two 1MB SIMMs), a parallel port, two serial ports, and options for hard drive controllers, a PS/2 keyboard adapter, and even a LAN port! It will be the biggest, most complete upgrade for the CoCo 3 ever devised or made available.

Beyond 64K in the CoCo 1 & 2

There were several 128K CoCo 1 & 2 upgrades introduced in 1984. All suffered the same fate- not enough support or utility to really be used. The main problem with these upgrades was that they had to move large chunks of memory (either 32K or 64K) to maintain compatibility with existing software (this was also due to the memory map of the CoCo). All of these upgrades actually "banked" or "paged" through the large memory chunks. Some had the 32K ROM area stationary and the 32K RAM area was switched, others (the more useful with existing software, actually) switched the entire 64K memory block in and out, ROM and all.

A machine language program was usually required so that a POKE switched between memory banks. The one exception was the **Dynamic Electronics** upgrade, which had a toggle switch to page between two banks of 64K. This proved to be a bit more useful, as two m/l programs that changed the ROM code could be loaded and switched between. This setup was designed so that two documents could be edited at once using Telewriter 64 by switching the two banks. There was no way to copy text between the two banks, however. The POKE method worked well with BASIC programs, but m/l programs couldn't be switched without crashing.

The main problem with these upgrades was that they never caught on. Drivers were never written for OS-9 to take advantage of the extra memory, indeed, it may not have even been possible! Due to the programming restrictions of these upgrades (another reason they weren't very popular), they are not recommended. If one is interested, articles on how to build them were printed in the following magazines:

Rainbow, DEC 1984, "128K The Easy Way", pp. 162-168
HOT CoCo, SEP 1985, "The Fat CoCo" (256K), pp. 28-31, program listing pp. 46-49

The Rainbow issue is still available from Falsoft as a back issue order, the Hot CoCo article may still be available from the publisher. See "Library" for addresses.

The only practical way to use memory over 64K in these machines is by using a RAM disk. This uses RAM memory to emulate a disk drive. A RAM disk is very fast, but one must remember to copy or backup anything in the RAM disk to a

physical floppy before turning off or resetting the computer. Most RAM disk software can set the RAM drive as any number, making it useful for games that load different parts as needed. Several were made at one time, though none, accept possibly a Disto unit, are available today. A project to build a RAM disk appeared in the SEP, OCT, and DEC 1989 issues of Rainbow (in three parts- all three needed), which are available as back issues from the publisher.

Upgrading the Keyboard

The original CoCo had a "chicklet" keyboard with small square keys. It was functional, but didn't look or feel like a "real" keyboard. "Professional" keyboards made their appearance on the CoCo market in 1983 to replace the chicklet model. These plugged right into the CoCo in place of the normal keyboard. The first was a re-wired Model 1 keyboard provided by Spectrum Projects in 1983. This was closely followed the same year by KeyTronic, Micronix, Mark Data, and HJL, the later being the most known. Looking at the CoCo keyboard schematic, it is easy to see that there is room for four additional keys. All of the replacement keyboards had these keys on them. The keys could be programmed for special uses, but no programs for the CoCo 1 or 2 were written to take full advantage of them.

The next CoCo keyboard appeared from Tandy late in 1983. Did Fort Worth take notice of all the replacement keyboards? Maybe not, but the CoCo 2 and 64K CoCo 1 were introduced with a new full travel, low profile, typewriter like keyboard. The keys were only about 1/4 inch tall (thus "low profile"), but typing was much easier and faster. This keyboard was later supplanted (1985) by a "deluxe" keyboard with 1/2" tall keys slightly angled to make typing even easier and faster yet.

The CoCo 3 was introduced with a keyboard similar to the CoCo 2 deluxe model, but with four additional keys (CTRL, ALT, F1, F2) added. The arrow keys were also moved to the right in a diamond pattern, and the BREAK key was coded to provide an ESCape (control C) signal when shifted. The additional keys were functionally equivalent to the added keys of the aftermarket keyboards mentioned earlier, so those boards work well with the CoCo 3. The keys will be laid out different though. An interesting side note is that the original CoCo 3 keyboard was laid out just like most of the aftermarket boards- with two extra keys on each side of the space bar (with a gap between SPACE and the added keys). In fact, a good number of those keyboards were made for Tandy, enough that they were sold through Radio Shack as surplus for \$5 each in early 1985, when the final design was decided on.

All early CoCo keyboards used a ribbon cable and in-line pin connector to attach to the motherboard. All "285" (or "F") board CoCo 1, TDP-100, CoCo 2, and CoCo 3 keyboards have a mylar film connector. The early CoCo required an adapter (no longer available) for use of a mylar strip keyboard, and vice-versa. The keyboard connector on a CoCo 2 or 3 can be replaced with an in-line pin connector for use of an early type keyboard. The female mylar strip connector may still be

available from Tandy (part #AJ-7567). This connector was made by Amphenol (AMP, #193910680A or #193911090A) and might be found at large supply houses. This connector can be installed in a CoCo 1 or used to make an extended keyboard. Don't bet on finding one today!

Tandy made the CoCo and its' keyboard all in one case to save money. The CoCo can't always be put in the most comfortable position for typing though, especially with an MPI attached (and there is the possibility of moving the MPI enough to blow the 6809!). The simple solution to this problem is to extend the keyboard away from the CoCo. This can be easily done with up to six feet of 16 conductor ribbon cable and a suitable connector on each end. 16 conductors will probably have to be removed from a 25 or more conductor cable (#278-772 is a five foot, 25 conductor cable).

A single row, PCB mount, male in-line pin connector can be inserted into the mylar strip connector. A matching connector can be purchased for earlier model CoCos. The connector for the mylar strip is a little more difficult. One could de-solder the keyboard connector from the CoCo motherboard and replace with a single row, PCB mount, male in-line pin connector, using a matching female connector on the ribbon cable. An easier approach is to use a 34 position card edge connector (a disk drive cable connector, #276-1564). This works well but requires a heavy piece of cardboard behind the mylar strip. Also note that the mylar strip only makes contact on one side. If using a crimp on type connector, remember that every other pin goes to the opposite side of the connector. Simply place the strip in the connector with the two unused pins on one end.

Most people use a DB-25 connector mounted on the CoCo case and cable to connect to the CoCo rather than plugging straight into the motherboard. This leaves several extra wires that can be used to mount a remote reset button, LED indicators, etc., on the keyboard case. If using the original keyboard, cut a piece of thin plywood or hardboard, sheet metal, or heavy cardboard to cover the hole left by the removed keyboard. This makes an ideal mounting location for the DB-25 connector.

What to use to house the keyboard? Many CoCo hackers use the original CoCo case, either as is or cut down in size, preferring to mount the motherboard in a separate case with the drives and MPI or other expansion device (see "Putting It All In One Case"). A nice looking case can be made from two pieces of plywood. Cut a keyboard size hole in the top piece and use a spacer material of suitable thickness around the edges, making sure there is enough space for the connector and support for the edges of the keyboard. The flat ribbon cable can be laid between the top and spacer sections, firmly holding it in place. It is suggested that the top be screwed down to facilitate removal if necessary. If making a wood case, leave two and a half to three inches of blank space below the space bar for wrist support. Your hands will thank you! Room can also be left to either side for a numeric keypad.

Adding an extended keyboard cable is the perfect time to consider a numeric keypad, since the CoCo is open anyway! HJL used to make a keypad, but one can be made by examining the keyboard layout on the schematic. Single pole momentary on or keyboard switches (mechanical switches... most clone keyboards use "Hall effect" switches that WILL NOT work) can easily be wired to the same points that the keyboard number switches are wired to (row pin 6, then pins 9-16 for 0-7, row pin 7, pin 9 & 10 for 8 & 9 on keyboard connector). Why not add some additional keys also? A shift lock key is easily made by wiring a push on, push off switch between the two SHIFT keys (pin 8 and 16 of the keyboard connector). What about those often used shifted keys (+, =, *)? They can be made single stroke keys on the number jack (or alone) simply by using a double pole momentary on switch wired to press both keys at once. This type switch may be difficult to find in the shape of a key. An old keyboard cap may have to be removed, modified, and glued to the top of the switch. Tony DiStefano described using a transistor along with a single pole momentary switch to simultaneously "press" two keys at once in the April 1985 Rainbow (still available as a back issue at time of printing).

The ultimate upgrade is to use a PC type keyboard. I know, I just wrote that the key switches are different and won't work. The PC keyboard has a processor in it that sends a signal to the PC itself. The only way to use such a keyboard is to purchase an adapter from Cloud-9 (see contact info under "Support"). This is an upgraded version of the "Puppo Keyboard Adapter". Schematics for the Puppo are still floating around, but a ROM is required for use with the CoCo.

The Hitachi 6309 CPU

There is another processor that will work in place of the 6809—the Hitachi HD6309 ("HD" designates Hitachi as the manufacturer). This chip has been around for some time, and is pin compatible with the MC6809. At first, the only reason to use it was that the computer ran cooler than with the original 6809. The reason is that the 6309 uses CMOS (complimentary metal oxide silicon) construction, which consumes less power than standard NMOS (negative metal oxide silicon) chips such as the 6809. (Don't forget the CoCo uses the 6809E, not a standard 6809, and needs the corresponding 6309E).

When Motorola decided they had a need for a CMOS version of the 6809, they contracted with Hitachi to provide it, thus the compatibility between the HD6309 and the MC6809. Hitachi went one step further, however, and added six registers and a number of new commands to the 6309. Memory moves could be made four times faster than with the 6809, and a 16 bit multiplication to a 32 bit product was also included, plus more! When a 6309 is installed in place of a 6809, no difference in processing speed will be noted and there is no access to the added registers or instructions.

The 6309 runs in a 6809 "emulation mode" when first powered up. "Native" 6309 mode is accessed through a special command. Some software written for the 6809 times itself by the IRQ (interrupt request) and NMI (non-maskable interrupt) instructions. In native mode, the 6309 reduces the number of clock cycles required by IRQ and NMI, causing these programs to crash. Changing stack pointers directly also causes a system crash. Anything indexed from the stack pointer goes to a different location, due to the added registers of the 6309. In DECB, disk drive functions, the PLAY and SOUND commands, and the TIMER function all use the interrupts for timing. Any use of the drives or these commands causes Disk BASIC to crash.

There was a slight problem, however: Motorola did not authorize any improvements! Motorola wanted a work-alike in CMOS packaging, and that was all it authorized Hitachi to make. This led to no documentation for the advanced native mode of the 6309 being officially available. When a group of CoCo users started discussing possible faster processors to replace the 6809 on Internet (see **Networks**), a Japanese student volunteered the 6309 due to the added functions. When asked for additional information, he transcribed a detailed article from a Japanese trade journal describing the added registers and instructions. Details of the native mode were apparently leaked or discovered in Japan.

With this new information in hand, **Burke&Burke** and **Gale Force Enterprises** developed packages for OS-9 Level II that took advantage of the new registers and commands to provide 10%-30% speed increases in program operation. The only modification required to the CoCo itself is the addition of a socket for the processor. Two editor/assembler packages were available to allow using 6309 functions with DECB; a patch from CoCoPRO! to Tandy's EDTASM and a new editor/assembler by **Cer-Comp**. NitrOS-9 was written specifically to take advantage of the 6309.

There is hope for Disk BASIC users also. The following program, written by Rick Ulland (of **CoNect**) with the assistance of Art Flexser (**Spectro Systems**), puts the 6309 in native mode and patches Disk BASIC 1.1/2.1 and the PLAY, SOUND, and TIMER commands for proper operation.

```
5 REM 6309 Patch by Rick Ulland and Art Flexser
10POKE&H0300,&H11
20POKE&H0301,&H3D
30POKE&H0302,&H01
40POKE&H0303,&H39
50POKE&HD8AA,&H6C
60POKE&H9C55,&H69
70EXEC&H0300
```

Change line 50 to "&HD7B7,&H6C" for Disk BASIC 1.0/2.0 or ADOS. There will only be a slight speedup, maybe 10%, in BASIC programs. Machine language programs could be sped up 30% or more using the extended 6309 instructions.

There are still a few problems for BASIC users. One is that the baud rate is thrown off. This can be adjusted by using different values for setting the printer baud rate (POKE 150, xx)- values other than those listed for BASIC. Experimentation will determine the proper values.

A manual describing the 6309 extended machine language commands is available for download at http://www.sandelman.ottawa.on.ca/People/Alan_DeKok/interests/6309.techref. The biggest problem with using the additional 6309 instructions is that code written to do so will require the presence of a 6309 and will not run on a 6809.

Putting It All In One Case -The Ultimate CoCo Upgrade!

Many CoCo users don't like having their system spread all over a desk. It doesn't look neat, there is a tangle of cables, and the possibility of moving the MPI and shorting out the CPU. Some bolt the bottom halves of the CoCo case and MPI to a piece of plywood and add an extended keyboard cable, while others repackage the CoCo, MPI or Y cable (if used) and disk drives all in one case, usually a surplus PC case, but homemade cases are used as well. These can be anything from a custom made sheet metal case to a wood case lined with aluminum foil (glued to the inside and ground to the motherboard to reduce RFI). Almost any old, obsolete computer case found at a salvage sale can be used. Since the CoCo 3 will drive a CGA monitor, even an old "luggable" PC case equipped with said monitor will work quite well (or a small TV screen can be substituted), or the **BarSoft** TTL monitor adapter can be used with a monochrome screen. Some older CP/M computers, such as the Tandy Model IV and IVP (IV is monitor, computer, keyboard, and drives in one case, IVP is a luggable); and Kaypro II, 4, and 10 models used composite monitors which may be adaptable for use with the CoCo.

Before attempting to repackage your CoCo, please remember to be careful! It is next to impossible to replace a damaged motherboard. It will take some careful planning and basic electronics and soldering knowledge, but it can be successfully accomplished. It may be a good idea to read the **Peripherals, Upgrades and Repairs** sections of this book for some hints and tips before continuing.

The following is an account by one person who repackaged his CoCo successfully. Use it as a guide, be careful, and good luck!

ATCoCo - Putting it all in one Box By Mike Haaland

Written: December 14, 1988 Updated: January 15, 1989 Edited/added to by: F.G. Swygert, February 17, 1993

This article is the procedure I have used to get the clutter of computer components off my desk and into a single PC/AT clone case. It has been put together and distributed to aid those CoCo owners who are tired of the mess to do the same.

I (nor the author of this book) cannot take responsibility for any damage you may do to your system while attempting this project. The need for such a transplant depends totally on your own tastes.

The nicest thing about the ATCoCo (CoCo in a full size IBM AT type case) is you have so much room for drives, expansion packs, etc.; and that your system will be nice and neat without the need of having cables running all over the place. In an AT size case you have room for:

Three half-height disk drives
A full or half-height Hard Drive
The CoCo motherboard (main circuit board)
An MPI (small... large may fit)
Four Paks (fit in four slots of the MPI)

This is what I have installed in my ATCoCo. If I can figure out how to get the modem in there, I'll put it in too! My system has been running this way since Dec. 1988 with no problems at all.

NEEDED PARTS

Before you can get started you will need:

1) Suitable Case and Power Supply. This article assumes a full size (at least six inches tall inside) PC/AT clone case and power supply. Other cases, such as the more common PC/XT size, can be used but the actual installation will differ, as there is not sufficient room in a PC/XT case to put an MPI or Slot Pak on it's edge as described. The CoNect Xpander, however, doesn't require as much height and will easily fit inside an XT size case, or any case as little as four inches tall inside. Tower cases usually have enough room to mount the MPI on the bottom and the motherboard running up one side, 90 degrees to each other. Check the size of your MPI before purchasing a tower case, as some mini tower cases may not have enough room for the MPI. In many cases, a Slot Pak or Y cable can be used where an MPI can't. Power supply connectors may differ. If in doubt, use a VOM to check voltages before connecting to a CoCo. A floppy only CoCo system needs about 40 watts, a hard drive adds another 15W-20W, so 65W-100W would be sufficient.

2) A set of all the connectors on the back of the CoCo, both male and female, including the RGB connector if you are using an RGB monitor. Cable to extend the ports and male cable type connectors will also be needed. For the cleanest installation get the female chassis mount connectors that can be mounted to a plate on the back of the case. Alternately, get female cable type connectors and run the cables out the back of the computer. They will have to be labeled in either case.

4) A short (4 to 6 inch) 40 pin extender cable that will go from the CoCo motherboard to the MPI/SlotPak. You can make your own by removing the 40 plug on the motherboard and wiring a ribbon cable in its place, or get another 40 pin (a 44 pin with four positions taped over on one end works nicely) and solder the ribbon cable to the back of the original.

5) A keyboard extender cable. See **Upgrades** for instructions on making one, or contact Cloud-9 for a PC keyboard adapter.

6) A VOM meter.

7) The ability to use a soldering iron.

8) GUTS To take the plunge!

PREPARATION:

1) Make up the extender cables for the ports and check that they work properly. Each cable will need to be long enough to reach through the back of your case.

2) Make the extender cable for the RGB plug.

3) Make the necessary arrangements for connecting the PC power supply (see **Power Supply Repairs**) to the CoCo and MPI.

INSTALLATION:

1) Remove the CoCo motherboard and MPI from their cases.

2) Lay your CoCo motherboard in the AT case with the ROMPak slot facing away from the drives and the plugs facing the front of the AT case, as far back in the case as possible.

3) Mark where the four mounting holes on the coco are on the case. Drill out the holes in the case. You can either mount the coco with the plastic legs supplied with the case or build your own mounts using small blocks of wood or plastic under each hole. Keep the CoCo OFF the bottom of the case (about 1/8 to 1/4 inch). This will give you enough room to run the port extension cables under the board, prevent shorts, and allow the power supply fan to cool the motherboard. It would be a good idea to place a piece of cardboard between the case bottom and CoCo as further protection from shorts.

4) Put the MPI in the left hand front corner of the case with the slots pointing in and the card edge that connects to the CoCo towards the back. Put electrical tape over the components that may be easily shorted to ground on the bottom edge of the MPI such as D1. Again, a piece of cardboard between the MPI/SlotPak and case would be prudent.

If you have a short extender ribbon connector for the 40 pin ROM Pak slot on the coco, you can see how easily you can connect the MPI to the CoCo. If you want to make up your own, you will have to de-solder the slot connector and remove it. Solder a ribbon cable where the connector was and the other end to the removed connector. Be sure pin 1 goes to pin 1, etc. Make the cable no longer than necessary, a long cable will cause problems. This is where the **CoNect Xpander** or **Y-Box** will help, and installation will be easier.

5) I cut a piece of sheet metal to mount all those extended connectors on. Cut out some of the PC card slot dividers for

additional room and make a plate to mount the connectors on that covers the slot area. If using long cables only, just leave one of the slot covers out and run all cables through that slot. 6) Plug everything together, connect to the power supply, and double check all the wiring.

7) Mount the drives in their slots and hook them up to the power supply.

8) Plug your various packs into the MPI.

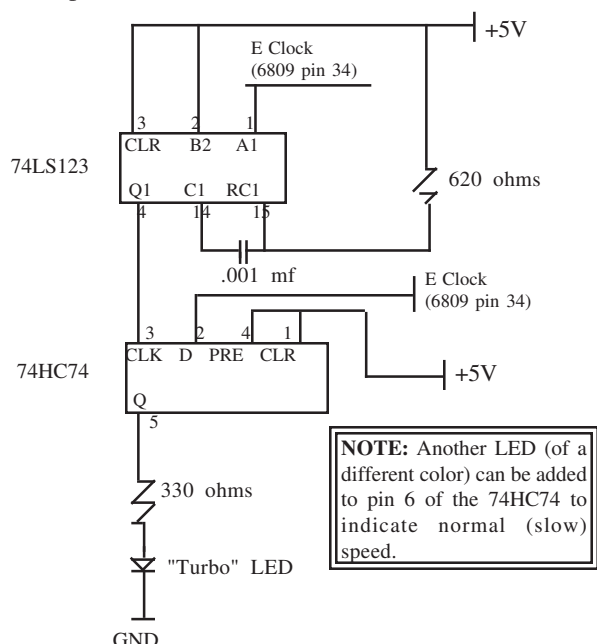
9) Go back and **double check ALL connections**. Make sure EVERYTHING is connected properly. Turn on the power supply and test the various peripherals. If everything checks out okay, you're done. If not, you know what to do if you got this far!

AFEWEXTRAGOODIES:

There are usually three lights, a momentary reset button, a two pole (on/off) "Turbo" button, and a two pole key switch on most all PC type cases. If you have a hard drive you can easily use one of the lights to indicate drive access by simply finding where the drive access light pins are on your HD and connecting them to the appropriate light. This is a big help if you have used a slot behind the front cover to put your HD in.

You can wire the power on light by hooking +5VDC from the power supply through a 100 ohm, 1/4W resistor and the other side to ground. The "Turbo" light can be wired to indicate double clock speed by using a 74LS123 and 74HC74 with the following schematic:

The "Reset" switch can easily be wired to the CoCo reset button. Remember, you can't get to the original one now! Simply connect the wires from the case reset button to the two pins on top of the CoCo reset button.



Now if you can, remove the plaque from you old CoCo 3 top cover, the one that says "TANDY 128K COLOR COMPUTER 3" and mount that on the front of the new case (for the completed look!!).

CAUTIONANDDISCLAIMER:

This text file reveals how several CoCo users (including myself and the author of this book) have repackaged their CoCos. No responsibility whatsoever is assumed for anyone following the procedure described above. If you mess up your CoCo, it's your own fault, not mine, the book author's, nor the publisher's. Just be careful, it has been done many times before, and good luck!

Repairs

Most CoCo repairs can be made with only a basic knowledge of electronics and soldering. The hardest repair to make will require removing a chip from a circuit board, but even that isn't very difficult for the "greenest" novice to attempt. The CoCo is a relatively robust computer and will take lots of abuse that would damage most others. Remember the following basics and repairs should be simple and even fun!

It **IS NOT** the purpose of this section to cover detailed operation of the CoCo circuitry. Simple explanations are given when possible, some may seem (intentionally) vague. **If you can't figure it out, DON'T TRY IT!** For more detailed information, consult a CoCo Service Manual (may still be available from Radio Shack, ask a salesperson or call Tandy National Parts to order a service manual for the catalog number of the desired CoCo) or the Motorola MC6883 or 74LS785 (earlier version was 74LS783) data sheet, as well as those for the other major components. Schematics are reprinted in the back of this book also.

1) Before attempting a repair, observe the symptoms carefully. It is extremely important to describe what is happening as completely as possible, especially when asking for help. Try substituting components if possible. Also remember to disconnect ALL peripherals before assuming there is a problem with the computer. A bad printer, joystick, disk controller, etc., could be causing the problem. Unplug EVERYTHING, then if the computer works right, plug items back in ONE AT A TIME and see which causes the failure. If asking for additional help, outline ALL the steps you have already taken. Help is readily available on Delphi. Leave a forum message to "ALL" or to "MARTYGOODMAN". If you don't leave details as described above, that is the first thing you will be asked to do!!

2) Before touching any chips on a circuit board, make sure you ground yourself by touching something metal or the ground on the board first. Some chips are static sensitive, meaning that a good static electric jolt could damage them. Touch the case of the RF converter on the CoCo motherboard (the metal box), the bottom edge connector pins on peripherals that plug into the cartridge port. There is usually a wide band that runs around the edge of most circuit boards. This is the ground plane, and is a good area to touch first also.

3) The right tools and supplies are needed to do the job! A CoCo repair kit should include the following tools, subject to the repairs being attempted:

Necessary Items:

Multimeter (VOM), three range (minimum #22-212)
Precision Screwdrivers (#64-1948)
Phillips and Plain Screwdrivers
Needle Nose Pliers
Soldering Iron, 15-30 watt (#64-2070, 25W)
De-soldering Tool (#64-2120 or #64-2098)
Pointed Cutters (#64-1833)
Silver Solder (#64-013 or #64-015)
Paste Flux (64-021)
Diagnostic Utilities

Optional Items:

Logic Probe with Hi/Low LEDs (#22-303)*
IC Inserter/Extractor Set (#276-1581)
IC Pin Straightener (#276-1594)
Soldering Heat Sink (#276-1567)
1/4" Nut Driver (a multi-tip screwdriver uses 1/4" hex bits, doubles as a nut driver)
TV Tuner Cleaner (#64-3315) or Cleaner/Degreaser (#64-3322)

* A multimeter can be used for some logic probe applications. Find a good circuit board ground, then test for a voltage for a high signal (usually +5V), 0V for low. Some tests REQUIRE a logic probe!

One might want to consider Radio Shack's compact 14 piece PC tool kit (64-1972), which contains screwdrivers, chip extractor/inserter, nut driver, tweezers, and carry case in lieu of some of the listed items.

The "necessary" items could be purchased at the time of writing for under \$40, with the optional items an additional amount under \$20, plus another \$20 for the logic probe. Almost any repair the average hobbyist is capable of making can be done with the "necessary" tool list, the "optional" list makes the job a bit easier, especially when working with ICs (chips).

Solder wick is NOT recommended for the novice. The vacuum type solder removers are more efficient and easier to use. If one is practiced and comfortable with wick, by all means go ahead and use it, otherwise get a vacuum remover- the purchase won't be regretted.

Diagnostic utilities on disk are available. The only problem with disk based diagnostics is the disk drives could be the problem! It might be a good idea to transfer some of the diagnostic programs to tape (I can hear long time users, who have used tape storage before, groaning already!). Of course, the tape circuitry could be affected also. In that case, the only alternative is to find a Tandy Diagnostic ROM-Pak. Good luck finding one! They only tested up to 16K of RAM, but checked all other circuitry. All but the RAM test is usable on the CoCo 3 also.

4) The "**destructive removal**" method of IC removal should be used by all but accomplished hobbyists. Use pointed cutters to cut the legs off of a chip close to the chip body, removing the body after all legs are cut. Now grasp each leg individually with needle nose pliers and heat the solder joint, pulling out the leg. Go back and clean each hole. Hold the de-soldering tool ready, then heat the solder, quickly placing the de-soldering tool and triggering it as soon as the solder becomes liquid. This method destroys the chip being removed, but greatly reduces the chance of damaging an irreplaceable circuit board. The de-soldering tools listed can be used to remove a chip without cutting in much the same way, just be CERTAIN that all solder is removed before pulling the chip out. It is best to practice on an old circuit board before trying this on anything else. Chips are cheap, and usually suspected bad before removal. The exception might be when replacing the 6809 with a 6309. The 6309 (or another 6809) is replaceable, the CoCo motherboard is not!

5) The only way to learn to solder is by practice! Get an old circuit board and practice soldering wires and chips to it. Remove some ICs also, destructively first, then try removing without damaging the chip or circuit board. You'll be a decent solderer in no time!

6) **Always, ALWAYS, replace a bad chip with a socket!** Sockets only cost a few cents (only \$1 for a 40 pin), and if the repair has to be repeated it will be much easier. Using sockets also reduces the possibility of heat damage to the replacement IC.

General Troubleshooting

Let's start with checks at the major chips. These checks will indicate a lot of potential problems. Problems aren't necessarily the same in all cases, so check the suspected chip as well as any others in the same circuit. It is possible that conditions other than those shown could cause the same results listed. A short description of the major components and common problems follows troubleshooting tips.

The following charts list logic probe readings (computer turned on) of the major ICs. A VOM will read highs as +5V, lows

as 0V. A pulse should read as a bouncing or wavering reading between 0V and +5V. Low/pulse will read 0V, high/pulse +5V. A VOM is not very accurate when reading anything other than a steady high or low signal.

6809E:			SAM:		GIME:	
NO.	DESC.	READING	NO.	DESC.	NO.	READING
2	NMI	high	2-4	A10-A8	47-49	h/p
3	IRQ	h/p	7	VCK	n/a	pulse
4	FIRQ	high	8	DA0	n/a	h/p/l
7	Vcc	high	9	HS	n/a	h/p
8-11	A0-A3	pulse	10	WE(0)	10	h/p
12	A4	h/p	11	CAS	5	pulse
13	A5	pulse	12	RAS	4	pulse
14-18	A6-A10	h/p	13	Q	7	pulse
19-20	A11-A12	pulse	14	E	6	pulse
21	A13	h/p	15	R/W	8	h/p
22	A14	pulse	16-19	A0-A3	25-28	pulse
23	A15	h/p	20	GND	n/a	low
24-31	D0-D7	pulse	21	A4	43	h/p
32	R/W	high	22	A5	44	pulse
34	E	blinking	23-24	A6-A7	45-46	h/p
35	Q	blinking	25	S2	29	low
37	RESET	high	26	S1	30	high
40	HALT	pulse	27	S0	31	low
			28-31	MA0-MA3	n/a	pulse
			32-33	MA4-MA5	n/a	l/p
			34-35	MA6-MA7	n/a	pulse
			36	A15	54	h/p
			37	A14	53	pulse
			38	A13	52	h/p
			39	A12	51	pulse
			40	Vcc	n/a	high
			n/a	Vss/Vdd	1/35	high
			n/a	WE1	11	h/p
			n/a	RESET	9	high

NOTE: 6809 address signals will read +2.4-4.0V and clock signals +2.4V on a VOM. HALT will also read +5V.

PIAs (6821, 6822)				VDG (6847)		
NO.	DESC.	READING		NO.	DESC.	READING
		I/O	KB	1	GND	low
1	GND	low		2	DD6	pulse
2	PA0	high		3-8	DD0-DD5	l/p
3	PA1	high		11	OA	low
10	DD7	l/p		12	MS	h/l/p
4-9	PA2-PA7	low	high	13	OB	low
10	PB0	low	h/p	17	Vcc	high
11	PB1	n/c	h/p	22	DA0	h/l/p
12-17	PB2-PB7	high	h/p	27	GM2	low
18	CB1	high	h/l	28	Y	(low comp. video)
19	CB2	low		29-30	GM1-GM0	low
20	Vcc	high		31	INT/EXT	low
21	R/W	h/p		32	INV	pulse
22	CS0	high		34	A/S	l/p
23	CS2	high	h/p	35	A/G	low
24	CS1	high		37	FS	h/l/p
25	ENABLE	pulse		38	HS	l/p
26-33	D7-D0	pulse		39	CSS	low
34	RESET	high				
35-36	RS1-RS2	pulse				
37-38	IRQB-IRQA	high	h/p			
39	CA2	low				
40	CA1	high	h/p			

h/p = high or pulse, l/p = low or pulse, h/l = high or low

h/p/l = high, pulse, or low

NOTE: Pin 28 (Y) of the VDG is a source for a weak (about 1V peak to peak) monochrome composite video signal. The color composite signal is available at pin 1 of the RF modulator or pin 12 (unamplified) of the video mixer (MC1372).

If testing of the listed signal gives results other than those shown, the tested chip or part of the circuit attached at that point is faulty. Check all leads before replacing a chip.

Other chips, even those in peripherals, can be easily tested also. Take a good working computer, disconnect all peripherals (except a TV... don't use a monitor, interference won't show the same!), and test each chip with a logic probe or VOM. Note any interference on the TV display. While not the most accurate testing method, TV interference (or lack thereof) will indicate potential problems. Make a testing chart for each chip. Another working computer of the same model should give the same results.

Many of the 6809 signals can also be checked at the cartridge port, so check there also, especially if the problem appears to be a peripheral that connects to the port. Just because a signal is present at the CPU doesn't mean it is reaching the port, or any peripheral plugged in there. If a MPI is being used, check each port for the same signals. The following tips should be checked with power ON unless otherwise indicated.

1. If computer is running but experiencing intermittent problems or problems in just one area, run a diagnostic program and test the area believed to be at fault. If all checks good, run complete test cycle.

2. Unplug **ALL** devices (except TV or monitor) and see if computer works correctly first. If it does, plug each peripheral back in one at a time, checking operation after each. Repair/replace faulty peripheral.

3. No or higher/lower than +5V on Vcc - check power supply. Also check bypass capacitor between Vcc and ground.

4. No clock signal - check for signal at SAM (pins 13 & 14) or GIME (pins 6 & 7) outputs. If nothing, check at crystal inputs (SAM pins 5 & 6, GIME 2 & 3). Touching a logic probe to either of these pins will produce a good bit of TV interference (TV only, not monitor), indicating the crystal is working. If still no signal, check capacitor and resistor in clock circuit. If they are good, replace crystal. If the crystal & circuit are good, replace SAM or GIME. If a signal is at the SAM/GIME outputs, check traces between there and CPU.

5. With power OFF, check address and data lines for continuity first (VOM + on one end, - on the other end of the trace or a section of). Then check for resistance between trace and ground. All should be very near the same. If not, look the circuit over and see if there is a reason for the difference. If none found, there could be a possible short between that trace and ground. Check resistance from one trace to another. There

should be a high resistance. If not, suspect a short between traces with low resistance (check each line with all the others). Run diagnostics for further checks.

6. If ground is high, replace chip (internal short). If no low logic probe on ground, chip should be replaced.

7. The address lines of the SAM/GIME (A0-A15) should indicate an address in the BASIC ROM. Check each with a logic probe. A pulse only or pulse/low indicate a low (0), pulse/high a high (1). The combination should indicate a binary number (10100111110100000 in early CoCo I [A7D0]) which is a location in the BASIC ROM. Convert to hex or decimal and check the memory map for location. If it isn't in BASIC ROM, there is a problem between the CPU and SAM/GIME.

8. If the pattern on SAM pins 25-27 (GIME 29-31) are other than indicated, replace the SAM/GIME. The pattern shown selects the BASIC ROM.

9. If SAM pins 28-35 and pins 11 & 12 are other than shown, replace the SAM. These are used by the multiplexer.

10. SAM pins 9 & 10 are frequency driven. Check by presence of a logic pulse and interference on a TV screen. SAM pin 7 must also show a pulse. If these tests fail, replace the SAM. Test only pin 10 of the GIME.

11. If any but the data pins on a PIA read differently than noted, suspect a bad PIA. The PIA may not be initialized properly though, which indicates a problem in the CPU or ROM circuits, SAM, 74LS138 3/8 decoder, or GIME. Check these before replacing the PIA.

12. If there is a signal other than a pulse on the data lines of a PIA, the trouble is somewhere along the data bus, not in the PIA.

13. Any of the signals coming into the VDG could be bad, producing bad output. Check the inputs first. If they are all correct, check outputs. Bad outputs require replacement of the VDG. If inputs are bad, check circuitry going into them.

The previously listed tips are just that- **tips**, not complete trouble shooting procedures. They should be enough to get a repair started on the right track. Unless the repairer has a lot of patience and trouble shooting experience, repairs are usually limited to replacing one of the major chips. These chips provide so many functions of the CoCo that one of them usually is the problem (more often than not the CPU).

MC6809E CPU

(also HD6309E in emulation mode)

The CPU usually needs replacing when garbage is displayed on the screen, especially vertical columns and ampersands ("@" signs). Other, random garbage could be caused by other components, though the CPU is still suspect. Most totally "dead" CoCos are due to a blown 6809. There are no buffers between the 6809 and the cartridge port. Pin 9 on all CoCos has +5V (300mA) on it. The original CoCo also has +12V (300mA) on pin 2 and -12V (100mA) on pin 1. Anything removed or inserted from the cartridge port at a slight angle while the computer is on can blow the processor by crossing one of these powered pin with an adjacent pin. This would apply power to the Q clock (pin 7), data bit 1 (pin 11), HALT (pin 3), or NMI (pin 4) pin of the 6809. Later ROM Paks and cartridge peripherals have a shorter land on pin 9, reducing the likelihood of a short, but not eliminating it.

Before replacing the 6809, make sure no peripherals are plugged in and test the computer again. A bad disk controller or joystick can cause the computer to lock up or appear dead. Clean the GIME in a CoCo 3 and check the SAM in a CoCo 1/2 before replacing the CPU. Check all other possibilities also.

MC6821/MC6822 PIA (all models) Keyboard, Cassette, Serial Port, Joystick, Sound, & Video

All Color Computers use two PIAs (Peripheral Interface Adapters), one for the keyboard and one for cassette, serial, and joystick I/O as well as sound and video outputs. The CoCo 3 uses a customized PIA (LSC81001) for keyboard input. It is unclear just what was changed in this chip, as a standard 6821 or 6822 will work just fine. The 6822 is a more robust version of the 6821- the 6822 will handle higher voltages without damage. It is suggested that a 6822 be used in place of a blown 6821 for durability. No letter in the number indicates 1MHz operation, an "A" 1.5MHz (68A22), and "B" 2MHz. A 1MHz rated part will generally work at 2MHz, it just isn't guaranteed by the manufacturer.

A keyboard problem could indicate a bad address line on the keyboard PIA (closest to power supply). It could also indicate a bad trace on the mylar ribbon "cable". Pull the mylar strip out of its socket with a firm tug. It isn't as delicate as it looks- pull it out! Now would be a good time to spray a bit of cleaner in the socket. Check continuity of the traces with a VOM. Bend the mylar strip as it is being checked- the break may be small and only show when the strip is flexed. If one is found to be bad, look carefully for the break. A break can be fixed with a rear window defogger grid repair kit (such as Loctite #15067), usually available in auto parts stores.

The other PIA, a 6821, is used for cassette, joystick, and video I/O (video in CoCo 1/2 only). Check it if experiencing problems in these areas, especially if an input device has been used in the joystick port other than a joystick (video digitizer, temperature sensor, home built project, etc.).

MC6883 and 74LS783/785 SAM Chip (CoCo1/2)

SAM stands for "Synchronous Address Multiplexer". This chip replaces a good deal of circuitry normally required for output from the CPU.

The main job of the SAM (MC6883 or 74LS783 in early models, 74LS785 in later CoCo 2s) is to produce the various clock frequencies required by the CPU and video. A few capacitors, resistors, and a 14.31818MHz crystal make up the master clock frequency. The SAM divides this value by four to generate the RF color video frequency of 3.579554MHz. The CPU "E" and "Q" frequencies, which must be 90 degrees out of phase with each other (a job also handled by the SAM), are created by dividing the master clock by 16. Any change in the master clock affects both signals. Anything other than the above video frequency renders the video output useless, which is why the crystal can't be changed to speed the computer up. The CPU frequency is altered by the speed up poke, which reduces the divide value to eight. $14.31818 \text{ divided by } 16 = 0.8948862 \text{MHz}$, by 8 = 1.7897725MHz ...just under 1 or 2MHz. This was necessary to produce the required video signal, which must be exact (the CPU signal can vary a good deal from the rated speed).

The second job of the SAM is device selection. The portion of computer circuitry looked at by the CPU is controlled through the address lines of the CPU. Internal registers of the SAM can be addressed or up to eight external devices can be addressed. For external device selection, the SAM has three chip select lines which are connected to a three to eight decoder chip. Devices are selected by a combination of "on" and "off" settings of the three select lines (there are only eight possible combinations).

The final job of the SAM is address multiplexing. In summary, this means that the address and video signals are used in different combinations to form a larger number of addresses than otherwise possible. These addresses activate different portions of RAM.

There are only two versions of the SAM. The MC6883 and 74LS783 are the same except for designation. A slightly improved version, the 74LS785, was introduced in late Korean made "A" model CoCo 2s and is in all Korean "B" models. The '785 will replace the MC6883 and '783, but a '783/MC6883 WILL NOT function in place of a '785.

The SAM runs quite a bit hotter than most of the other chips. Over heating can cause failure and intermittent problems. Many users stuck heat sinks (a pair of TO-220 types, #276-1363, or similar longer type) on top of the SAM with heat sink grease (#276-1372). This will definitely increase the life of the SAM, especially if the computer is on for long hours or in a particularly warm environment.

It is hard to pin point particular problems that could be caused by the SAM because this chip is the "lungs" of the system (if the CPU is considered the heart). The SAM affects total operation of the computer. Commence with eliminating all other possible problems then proceed to the checks outlined under "General Troubleshooting". If the problems start only after the computer has been on a while, add a heat sink as described in the previous paragraph before replacing the SAM.

MC6847 and MC6847T1 or XC80652P VDG

The 6847T1 (or XC80652P) is an enhanced version of the original 6847. In order to make it perfectly software compatible with the older 6847, the enhancements aren't readily accessible. This chip is used in all CoCo 2s with a "B" in the catalog number. It cannot be used as a direct replacement for the older 6847 as the pin assignments are slightly different. To use the T1 in an older CoCo, one chip has to be removed and some re-wiring done. This was described in the October 1986 issue of Rainbow ("More on the Video Display Generator", pp. 88-92).

The most important change was true lower case on the 32 column screen, something Tandy chose not to support for backwards compatibility purposes. This mode can be temporarily invoked by typing POKE &HFF22, (PEEK(&HF22) or 16). To enable lower case mode all the time, bend VDG pin 30 up and solder a wire from it to pin VDG pin 1. An SPDT switch may be used to make the change temporary. Bend pin 30 up and wire to the center pole of the switch. Solder a wire from pin 1 to one of the other switch poles, from the other pole to the socket hole (or cut leg) of pin 30.

The second change involves the screen border. Normal text mode is black letters on a green screen with a black border. The border can be changed to green by typing POKE &HFF22, (PEEK(&HFF22 or 64). Change to lowercase AND green border with POKE &HFF22, (PEEK(&HFF22 or 80). The green border can be made permanent by bending pin 27 up and soldering a wire to pin 17 or wiring a switch exactly as for lowercase only, substituting pin 27 for pin 30.

The third change provided inverse video (a black screen with green characters). POKE &HFF22, (PEEK(&HFF22 or 32) invokes this mode, with POKE &HFF22, (PEEK(&HFF22 or 48) invoking inverse and lowercase. This can also be made permanent by wiring pin 29 the same as pin 27 and 30.

WARNING: Hardwiring these modes (jumper to pin 17) will result in the loss of some graphics modes! A "no switch" modification using a 74LS157 to automatically switch between text and graphics modes was described in the December 1986 Rainbow ("The No Switch VDG", pp. 98-101).

After 30 minutes or more of operation, intermittent video problems (random characters in the second and ninth columns) would start occurring on early models of the CoCo 1. A short time after the video problems started, the computer

would lock up. Because the SAM gets hot, it was initially thought to be the problem. Tandy issued two fixes. The first fix didn't do the job, so a "Final Fix" (that's what Tandy called it!) was issued. This consisted of a small, 1" x 1.5" circuit board with a logic gate and binary counter on it (plus a couple resistors and a capacitor). These components formed a pulse generator that cleaned up the horizontal synchronization (HS) pulse coming from the VDG. The pulse would become unstable as the VDG warmed up. The Tandy fix restricted the HS pulse to four clock cycles, synchronized to the falling edge of the E clock. The original pulse was 4.5 cycles long.

The Tandy "Final Fix" kit has long since been discontinued. If a CoCo 1 is found without this kit installed, it can still be used reliably. The culprit is indeed heat, but in the VDG. Mounting a heat sink (pair of #276-1363s) with heat sink grease (#276-1372) to the top of the VDG will probably cure the problem. If not, further work to remove heat from the case is necessary. See "Power Supply Repairs" for some suggestions. Cooling the SAM can also help (same as cooling the VDG).

The GIME (CoCo 3)

The GIME (Graphics Interrupt Memory Enhancement) replaces the SAM and VDG (see) in the CoCo 1/2 and also handles the enhanced graphics and memory capabilities as well as interrupts of the CoCo 3. The GIME is suspect of causing problems in several instances including:

Screen flicker or "sparklies"
Intermittent "trash" on the screen
Intermittent memory loss
"Missing" characters (screen shifted 1-2 characters to the left)
No horizontal synchronization signal at power up

Most of these problems can be cleared by cleaning the GIME and socket. Use a pair of small screwdrivers to carefully pry the GIME out of its socket from the corners. Note how the GIME is oriented in the socket! It can be easily rotated and may be damaged if inserted wrong (lettering is usually right side up with lettering on the 6821 PIAs and the 68B09). Once out, clean the contacts on the chip with a pencil eraser or alcohol. The socket should be cleaned with alcohol also. It is best to use a foam swab, not cotton. Tuner or electronic contact cleaner in a spray can may also be used.

If cleaning the socket doesn't solve the video problems, replace C64 (a 150pf capacitor) with a 220pf, 50V (or greater), 5% tolerance ceramic disc capacitor. This capacitor is in the clock circuit and may cause the clock to power up into an abnormal state. These problems are most likely to occur when the computer is cold and may be less noticeable after warm-up. There was a problem with the original (1986) GIME chip. Subtle timing differences between the CoCo 1/2 and CoCo 3 created "sparklies" on some monitor screens, caused intermittent problems with hardware that plugged into the cartridge port,

and created a "bootlist order bug" (BLOB) problem with OS-9. This can be corrected by either replacing the GIME with a newer one (1987 manufacture) or changing the timing signal on the motherboard. The timing problem affects the ROM selection circuitry and the CTS and SCS lines of the cartridge connector.

The motherboard modification requires adding an extra gate so that the ROMs are only read during the "E" clock portion of the read cycle. This does require basic electronics skill, but isn't overly hard to do.

1) Mount a 74LS02 Quad NOR gate somewhere near IC9 (74LS138) and supply power to pin 14, ground pin 7.

HINT: Mount the 74LS02 "piggy back" on another nearby 14 pinchip. Bend all legs straight out except pins 7 and 14. Solder the two unbent pins to pins 7 and 14 of the board mounted chip, supplying power and ground to the 74LS02.

2) Solder a jumper wire between pins 14, 13, 12, 10, 9, 2, and 3; disabling three of the four NOR gates (inputs tied high).

3) Solder a wire between pin 3 of IC9 to pin 5 or 6 of the 74LS02 (GIME line S2). Solder a wire from the other pin (5 or 6) to the intersection of R9 and C10 ("E" clock signal from the GIME).

4) Cut pin 4 or 5 (not both!) of IC9 as near the circuit board as possible. Bend the remaining portion out and solder a short wire to it. Solder the other end to pin 4 of the 74LS02.

Unless intermittent hardware problems or "sparklies" on the screen appear regularly, this modification is unnecessary. It should not be required with 1987 and later GIME chips as the problem was addressed inside the GIME.

Disk Controller and Drive Repairs

The first step in repairing a disk controller is to make sure the controller is the problem:

1. Unplug the controller and make sure the computer operates normally.

2. A faulty disk drive or cable could also cause problems. Test the suspected controller, cable, and drives on another system if possible. Check the cable for continuity.

3. If another, known good disk system is available, see if it works correctly on the problem computer.

4. A software problem could be the culprit. Make sure a cold start is effected if a problem occurs after running a m/l program.

Turn the computer off for a few seconds, then back on. CTRL-ALT-RESET may not clear everything up on a CoCo 3.

5. Check all the cartridge port lines using the logic probe readings for the 6809 previously listed. The CPU could be at fault.

Note that the 12V controller requires an MPI (for +12V power) if used with a CoCo 2 or 3. +12V may have been run to the controller from the disk drive power supply by an enterprising user; such was common when the CoCo 2 first came out. This type setup may be used on a CoCo 3 also. Problems will occur when running a 12V controller with OS-9 Level II, and possibly under DECB if running the CPU at double speed (OS-9 Level II runs at double speed all the time). This is due to the design of the 12V controller and cannot be fixed.

If the disk controller is still suspect, clean the contacts on each end of the controller. The case will have to be snapped apart to properly clean the contacts. On long (approx. 6") controllers, a single phillips head screw is located under the label on top. On short controllers (approx. 4"), the screw is located under a seal that reads "WARRANTY VOID IF LABEL REMOVED" (or something similar). Remove the screw and snap the case halves apart. Clean the contacts with a pencil eraser until they are bright and shiny. Re-assemble and test the system. This cures most unexpected errors. Incidentally, any peripheral plugging into the cartridge port or MPI can be affected by slightly corroded (dirty) contacts. Clean in the manner noted. The sockets themselves can be cleaned by spraying with TV tuner cleaner or degreaser/cleaner (see tool list).

If the normal Disk Extended BASIC copyright notice appears on screen but reading and writing to the disk fails (the drive light comes on and heads move... a "buzzing" sound can be heard from the drives), one of three chips need to be replaced. The most likely culprit is the 7416 (or 7406) on the NMI and HALT lines, especially if the controller is used in a CoCo 1 or MPI. These pins are the second from the left (looking "in" at the cartridge slot end of the controller board) on the top and bottom. Use the schematics to locate the correct chip, or replace both. Cut the offending chip out and replace with a socket. It is suggested that a 7416 be replaced with a 7406, which will withstand higher voltages than the 7416. Note that there are two 7416s. The second likely culprit is the 74LS221, which is the second most likely to blow chip. On the 12V controllers, the 74LS02 and 74LS04 have a nasty habit of blowing. If the 7416 in the NMI and HALT lines is blown, the 6809 and SAM should also be checked, as they usually go down with a +12V short in a CoCo 1 or MPI also.

If replacing these three (two 7416/7406, one 74LS221) doesn't do the trick, suspect the main disk controller chip (only 40 pin chip, a WD1795, MB8877, WD1793, WD1773), or auxiliary disk controller chip (WD9216, not used on WD1773 models). On 12V controllers (those with the WD1795) also suspect the WD1691 and WD2143. Unfortunately, these disk controller chips are ALL hard to come by, as they are no longer manufactured. They may still be found in large parts warehouses,

however. The ROM could be at fault, but rarely gives any problems.

If the problem is determined to be a disk drive unit, replace it with another drive. Floppy drives, especially the 360K, 5.25", double sided units used with the CoCo are not economical to repair. A simple alignment would cost more than a used replacement drive. Remember that standard 360K IBM type drives work with the CoCo and will read/write 35 track single sided disks. This is the perfect time to upgrade those single sided drives... see the "Upgrades" section.

A less common problem is a worn cartridge port connector on the motherboard. This can be identified as the problem when VERY mild wiggling or tilting of the controller causes the system to crash or give intermittent results. If this occurs, clean the controller and connector first. If this doesn't solve the problem, the connector must be replaced. First remove the mother board then the ground plane (foil covered cardboard backing, held in place with push-in clips). Then clip each leg on the connector close to the connector housing. Remove each wire individually by heating with a soldering iron and pulling out with needle nose pliers. Carefully clean all holes with a solder sucker. Put a new connector in position and solder it in. Connectors can be purchased from Tandy National Parts.

RS-232 Pak Repairs

There are a few common repairs for the Tandy RS-232 Pak. Note that most other RS-232 adapters are similar in design, meaning these tips may be used for them also.

A dead RS-232 Pak usually has one or two blown chips- the RS-232 level converters. These are the 1488 and 1489 chips. Check each line while sending data over the RS-232 port with a terminal program or diagnostic utility. Replace the chip that supports the lines not receiving signals. These are really cheap chips (each chip and socket under \$1.00) so don't hesitate to cut them out and replace with sockets if they are suspect. Tests can be conducted at the inputs and outputs of the chip also, making sure they follow each other.

Next check the AZTEC voltage converter. This chip converts +5V to the RS-232 standard +12V (1) and -12V (0). Check for +12V on pin 5 and -12V on pin 3 of the converter, +12V on pin 14 of the 1488 and pin 10 of the 1489 (on other side of resistor R2), and -12V on pin 1 of the 1488. Don't forget to check the traces and all components between the converter and 1488/1489 chips (the 33mf capacitors near the converter and 10K ohm R2).

A bad 6551 ACIA is possible, but rare, as the level converters receive voltage spikes or surges coming in from the source first. If replacing the converters fails to cure the problem, the 6551 may be suspect. It is easiest to check by replacing with

a known good unit. Many Tandy and aftermarket paks have a socketed 6551, but some later Tandy units don't. There have been some reports of intermittent failure of the RS-232 Pak under OS-9 Level II. If this occurs, test the suspect pak under a DECB program. If it works fine then, replace the 6551 with a 2MHz rated 6551A. Note that most 6551 chips work fine at 2MHz with no problems. The majority of non-Tandy RS-232 paks use the 6551A.

In rare cases, the crystal may be damaged. If the pak initializes (DTR and RTS line change status when a terminal program is run) but no data is sent or received suspect the crystal. First check for continuity of the traces between the 6551 and 1488/1489 and between them and the DB-25 connector. If all is well, replace the 1.8432MHz crystal.

Multi-Pak Interface (MPI) Repairs

If intermittent program problems are occurring with an MPI connected to a CoCo 3, check to see if the MPI has been upgraded. The 26-3024 MPI (large, gray or white case) requires a new PAL. The upgraded Tandy PAL will have NOT have a Tandy number on it. The four digit date code should be after 1986. The original MPI PAL DOES have "Tandy" and a part number (8075144 for the later model). The small (26-3124) MPI requires a satellite board. The board and necessary wiring should be visible through one of the slots or cooling vents. See **Upgrades** for details.

If some slots work and others do not, the problem is most likely in the SCS, CTS, and/or CART select circuitry. In the 26-3124 MPI (newest, small one), the big custom IC handles slot selection. In the large MPIs, slot selection is handled by the LS139 (SCS & CTS), LS153 (CART), LS368 (CTS & SCS), and LS374 (CTS, SCS, & CART) chips.

Check to see if the slot selection problem is limited to the CTS and CART lines or only the SCS line, or if both groups of switchable lines are affected. This may help narrow down the problem to a particular chip.

The big custom IC in the new MPI is unavailable, and replacing it with small scale logic chips would mean making up a five chip circuit, or designing a complex PAL chip. There is a fuse map posted on Delphi in the CoCo SIG (also available from FARNA Systems) for burning 14L4 and 16V8 PALs and GALs for replacement of that custom IC for anyone with access to a PAL programmer. On the old MPI, all the chips are widely available small scale logic chips, except for the factory upgrade PAL chip. Information on programming this PAL is also on Delphi.

It is easy to check the switching of the SCS line with a logic probe. Just put the probe on the line in a given slot, select that slot, and then try to WRITE a value to the appropriate address range in the SCS line, and see if the probe flashes. Check the CTS line by plugging a ROM Pak into the slot to be checked. If the Pak comes up on screen, then the CTS line is good.

Intermittent problems after the MPI has been on for a while usually occur because of a bad buffer IC. There are four 74LS367 (control functions and address bus) and one 74LS245 (data bus) buffers. To find out which is the culprit, remove the upper case of the MPI, then plug back into the computer and commence operations. When the computer locks up, determine which chip is warmest. One method is to turn the computer and MPI off, then unplug the MPI and physically touch each chip. One should be warmer to the touch than the others, maybe even hot. A better method is to spray each chip (being careful not to get much overspray on nearby chips) with "component cooler" (#64-3321). The computer should reset itself and/or resume operation as soon as the offending buffer is cooled down. Replace the defective chip.

If an individual slot is causing problems the connector or cold solder joints could be the problem. Inspect the connector first, making sure all contacts are visible and protruding enough to connect with a circuit board. Next try cleaning the socket with tuner cleaner or cleaner/degreaser. Clean the device being inserted into the suspect slot also. Check the solder joints on the underside of the board. If some of the joints appear dull, re-melt the solder with an iron. Test the unit to see if the problem persists after each check if a problem is found. If the connector needs to be replaced, order a new one from Tandy National Parts. This connector cannot be destructively removed- proceed with removal with extreme caution if not experienced with a de-soldering tool! DO NOT attempt removal with solder wick. Irreparable damage to the circuit board will result. Go through the checks for slot selection circuitry before determining if a connector is bad. Also, try different devices in the suspect connector, there could be a device problem.

Finally, if the entire MPI is dead, suspect the power supply. See the next section for repair details.

Power Supply Repairs

The power supply in all CoCo models, MPIs, and disk drives are pretty simple and easy to repair. Remember that live 110V AC current is at the transformer, so be extremely careful when attempting repairs, especially if the computer is still plugged in for testing.

On older D board CoCo 1s, loss of +5V power is usually caused by the 6.2V zener diode. This diode will fuse if overloading occurs, sacrificing itself (and grounding +5V power out) to save the rest of the power supply. Check the zener diode with power off. Current should only pass through any diode in one direction only. If it passes from both ends, the diode is fused and will need to be replaced. On the D and E board CoCo, the zener is a 1N4735 (CR17). Another popular reason for loss of +5V is a burned out .33 ohm, 2 watt power resistor (R66).

The CoCo 2 uses a custom Tandy IC for much of the regulator circuitry. This chip, the Supply And Level Translator (SALT), handles +5V power regulation, RS-232 level translation, and cassette input. This chip is (was?) only available from Tandy. Early CoCo 2s used a SALT that required 3.9V zener diodes on the incoming RS-232 lines for protection. Later model CoCo 2s used a newer SALT that was internally protected. The later SALT can be substituted for the early and vice-versa. Just either eliminate or add the protective 3.9V zeners. The zeners are located near the power supply (CR5 and CR6).

A problem common to all CoCo and MPI power supplies is cold solder joints. The joints expand and contract with heating and cooling. When they expand, intermittent loss of power can result due to cracks in the joint. This usually occurs after the computer has been on a while, progressively getting worse. A cold joint won't be as shiny as a good one, so may be visible. The cure is to re-melt the solder at the joint.

Heat can also cause problems. Most of the heat generated in a CoCo 1 or 2 is from the large TO-3 cased power transistor. It is hard to miss- large, round, and in a heat sink. There are many cures for this, ranging from replacing the power supply as described in the next paragraph to installing a fan. Some users merely added vents directly over the power transistor by drilling holes in the case. Others just used a small desktop fan blowing over the computer. Larger heat sinks were also used. I have even seen the transformer removed from the case via longer wires to the motherboard! The CoCo 3 power supply is less likely to cause heat related problems.

The old style +5V power supply is somewhat complicated and runs a bit hot. With a basic knowledge of power supply circuitry and a schematic of the board, the old power supply can be replaced with a TO-3 case 7805 1.5A monolithic regulator, which can be mounted in the socket and heat sink of the TO-3 case power transistor. Study a schematic to locate where traces must be cut or jumpered. Add 2.2mfd tantalum capacitors on the input and output lines of the 7805 to prevent oscillation. MPIs have a similar power supply.

Another method of power supply replacement is to use a PC style or other surplus external power supply. Mounting the power supply can be as elaborate as re-packaging the CoCo in a PC style (or other) case or simply making cables long enough to mount the supply outside the CoCo case (on the floor under a desk, beside the CoCo, etc.). Any good +5V power supply will work for a CoCo 2 or 3. The CoCo 1 requires -5V, +12V, and -12V (some of the older chips require the negative voltages to operate). If using a MPI, remove that power supply also and run both the CoCo and MPI off of the same external power source. If a heavy enough supply is used (such as a PC type) disk drives can be powered from the same also. Use some type of connector between the CoCo, MPI, and power supply to facilitate easy removal. An external power supply gets rid of a lot of heat in the CoCo case by removing the transformer, regulators, and power transistor.

There are several ways to connect an external power supply, depending on which CoCo is being connected:

CoCo 1: Cut the traces on the circuit board on the CoCo power supply side of test points (TP) 9, 10, 11, and 12 (D & E board, possibly the same number for others) between the last capacitor and the power supply. If this is a tantalum capacitor, replace with a 50-100mfd ceramic disc type for filtering. DO NOT leave a tantalum capacitor in the circuit! These points were provided for testing the power output of the three regulators. The 78M12 (U17, TP9) provides +12V, 79M12 (U18, TP10) -12V, 79L05 (U19, TP11), and the 723C +5V (U13, TP12). The NC board eliminates the 79L05 and provides unregulated -5V at C82. Apply the corresponding voltages from the external power source.

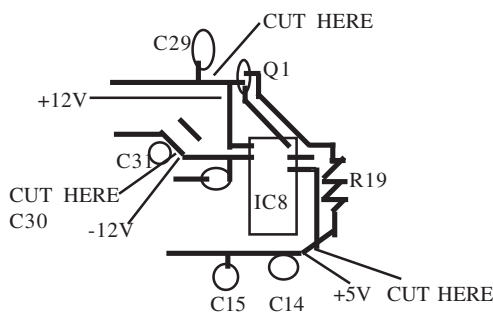
CoCo 2: Feed pins 15 and 16 of the SALT (SC77527 in all... IC1 in original CoCo 2, IC7 in Korean [A & B] models) with -12V and +12V, respectively. WARNING: Connecting in reverse order could damage the SALT chip and other components. Cut traces and feed +5V as follows:

26-313x - Cut trace between C5 and C11 and C6 and C11. Supply +5V on positive side of C11.

26-313xA or B - Cut trace between C34 and C35. Add +5V on positive side of C34.

Replace C11 and C34, respectively, with 50-100mfd ceramic disc capacitors to provide some filtering on the +5V input. DO NOT leave the original tantalum capacitors (C11 & C34) in the circuit!

CoCo 3: Feed +12V and -12V to the SALT (IC8) as for the CoCo 2. Cut the trace between C14 and R19, applying +5V to the positive side of C14. Cut the trace between C30 and C31, applying -12V to the positive side of C30. Next cut the trace between Q1 and C29 (cut the main trace between the leg that goes to C29 and that goes to SALT pin 16). Apply +12V to the trace that goes between pin 16 of the SALT and the input of Q1.



PAL (European) CoCos: The PAL version of the CoCo follows the same procedures as outlined for the American/Korean made units and CoCo 3. The only difference is that the PAL encoder (a satellite board near the modulator) requires +12V on one of the connectors (seven pin CN9 on the CoCo 3). The +12V input point is clearly marked on the encoder circuit board. Cut the trace on the motherboard going to the +12V pin and then supply the pin with +12V from the power supply.

Note the voltages fed into certain points. These voltages are supplied by the normal CoCo power supply, and may be used for testing.

Voltage/Amperage Requirements:

	+5V	+12V	-5V	-12V
CoCo 1	1.35A	400mA	100mA	100mA
CoCo 2	2.00A		100mA	
CoCo 3	2.00A		100mA	
MPI	1.35A	400mA	100mA	
Disk Drive	300mA	600mA		
Hard Drive	300mA	1.2A/600mA		

Floppy drive rating is for a typical 5.25" half height drive. The +12V current is with spindle motor and stepper running at the same time. In a two drive system, both spindles will be on at once, but only one stepper. +12V at 1.0A would therefore be sufficient. Old full height drives require as much as 50% more power than listed. Full height drive cases have adequate power capacity to drive two half height drives or a half height floppy and hard drive. It should adequately power even two 3.5" hard drives. The hard drive power requirements are for average 5.25" half height models. Older full height models will use more power, and newer 3.5" models much less. For the +12V line, 1.2A is drawn only on start-up, after which 600mA is drawn to maintain speed. Most power supplies are rated at a steady load and will put out over their rating for short periods (hard drive start-up). Find the total wattage by multiplying each voltage by the required amperage, then adding all together. A CoCo 3 with two floppy drives would require a minimum of 30 watts ($+5V \times 2.6A = 13W$; $+12V \times 1.2A = 14.4W$; $13W + 14.4W = 27.4W$, rounded up to 30). Always allow at least 10% over the required capacity for items (such as the disk drive controller and RS-232 Pak) that aren't included in the calculations, since they draw very small amounts of power.

Alternate Power Connection Method *Rick Ulland*

The trace-cut methods previously described are the neatest way to add an external power supply and are recommended by Marty Goodman. There is an equally effective method for those unwilling or unable to cut traces. This method is described for a CoCo 3 and has been working reliably for a number of years. Review the schematics of other models to apply to them. All the components that require removal can simply be cut out on a CoCo 3.

The CoCo Motherboard:

- 1) Remove Q1 (5V regulator on heat sink).
 - 2) Connect +12V to the unbanded end of D2 and D14.
 - 3) Connect -12V to the unbanded end of D4.
 - 4) Connect +5V to the end of R19 closest to Q1.
 - 5) Connect ground to the motherboard (one of the keyboard ground clip lands is a good spot).
- NOTE: "unbanded" end of diodes Dx is the cathode.

Multi-Pak:

- 1) Remove IC9 (front left side of board).
- 2) Remove R7 (front right near slot switch).
- 3) Connect +5V to circle labeled TP1 (near slot 1).
- 4) Connect +12V to circle labeled TP2 (near slot 2).
- 5) Connect -12V to circle labeled TP3 (near slot 1).
- 6) Connect ground to any ground point.
- 7) Leave the power switch OFF position, or remove.
- 8) Put slot selector to slot four.



Tid-Bits... *miscellaneous items of interest to CoCo users...*

The "Colour" Computer Down Under - *Seigfred Remin*

The history of the Colour Computer in Australia has been and continues to be a checkered one. The CoCo community here has seen the highs and lows reminiscent of a volatile stock on the worlds stock markets.

Although Tandy introduced the Colour Computer to Australia, it could be argued that it was given its real start in this country by **Greg Wilson**. Greg was instrumental in producing the first magazine dedicated to the CoCo in Australia; **The CoCo Magazine**. Although it was heavily dependent on material from **The Rainbow Magazine** in its infant days, it quickly became an almost totally Australian content magazine. Greg also brought into Australia the first non-Tandy software from the USA, a move that Tandy was reluctant to make in the early years.

The early to mid eighties could be recorded as the hey day of the CoCo in Australia. During this time a plethora of companies sprang into existence supporting what at the time was considered the ultimate home computer and a rival to the Commodore as a games machine. Also during this time a great number of user groups and CoCo clubs came into existence all over the country, some of these are still in existence today, years later. These user groups and CoCo clubs seemed to be made up of a different sort of computer enthusiast. Unlike those using other machines, the CoCoists seemed to genuinely want to help each other and were more interested in learning about the computer than pirating the latest software. That is not to say that an amount of pirating did not go on, to say other wise would be a travesty, but, compared to those clubs dedicated to the other machines, it was insignificant.

Support for the colour computer in the eighties was phenomenal. There were the user groups and CoCo clubs, **The CoCo Magazine**, **Softgold** magazine, **The Australian Rainbow**, **The (American) Rainbow**, Tandy, and hundreds of businesses ranging from chemists (drug stores in the USA) to dedicated computer stores Australia wide.

During this time a strong bond was forged between CoCoists not only in Australia but around the world. Letters and articles in the various publications ensured that contact was maintained between CoCoists in Australia, America, Europe and numerous other countries. It was not unusual to see a letter to the editor in an issue of **Softgold** asking for help with a particular problem from someone in New Zealand or even Holland.

The advent of the CoCo 3 further advanced the CoCo community in Australia. At last there was a comparable memory on board without more expensive add ons, and the introduction of OS-9 Level II put the CoCo ahead of the other, more expensive machines. OS-9 also saw a great number of program-

ming gurus come forward and share their abilities with the community at large. The **National OS-9 User Group** in Brisbane, Queensland was formed, and is still going today.

The mainstay of the CoCo community in Australia was **The CoCo Magazine** started by **Greg Wilson** and then taken over by **Graham Morphet** on Greg's untimely death. In the pages of this magazine was the contact needed by CoCoists from the vast outback of the country with those closer to the cities and the software and hardware vendors world wide. The magazine gave hope and a sense of belonging to those who were without telephones and received mail only once a month. Content included helpful hints, reviews of the latest soft and hard ware, and allowed users from the very young to the most experienced to share their programming abilities.

Two things happened in the late eighties which almost saw the death of the CoCo in Australia. One was the loss of **The CoCo Magazine** produced by **Graham Morphet** and the second was the discontinuing of the CoCo by Tandy. These two events caused a large section of the CoCo community to move to other machines or to place their CoCos in the cupboard and forget about them for a while. It was also at this time that the majority of the businesses which had been supporting the CoCo decided to go to other machines or leave the computer business.

Non-existent support resulting from these events left the remaining CoCo community in a very precarious position. They still used their CoCos and found more uses for them, but were slowly being forced to lean towards other machines as parts, software, hardware, and contact became scarce.

It was at this time that **Robbie Dalzell**, a member of a CoCo club in South Australia, decided to do something about this state of affairs and began to produce a magazine called **CoCo-Link**. **CoCo-Link** again gave some support to the remaining CoCo community. It maintained contact, gave assistance to those still learning, and shared new found knowledge amongst those who subscribed. Robbie's magazine again kept the CoCo community together for a further period of four years. Notwithstanding the contact and support provided by the **CoCo-Link** magazine, software and hardware still became increasingly harder to obtain. Those few who still carried products in Australia charged inflated prices which the community could not afford and those who were producing their own software had no way of marketing the products. When it seemed that the CoCo was again about to die a natural death, **Fred Remin**, a CoCo user, decided to approach a number of companies in the USA with a view of obtaining software and hardware for the ailing CoCo community in Australia. Success was slow but it was forthcoming with **FARNA Systems**, **Rick's Enterprises**, **Sundog**, **Cer-Comp**, and **JWT Enterprises** being some of the first to recognize an

untapped market and responding to Freds' request. With software and hardware again being available a large number of ex CoCoists retrieved their CoCos from the cupboards and dusted them off to relearn and once more enjoy the pleasures that come from using the CoCo.

By the end of 1992 **Robbie Dalzell** had been producing the **CoCo-Link** magazine for four years and had decided that it was time for him to have a rest. **CoCo-Link**, however, has not ceased, it is now being produced by **Fred Remin** and is continuing to maintain contact between the CoCo users throughout Australia.

In conclusion, the Colour Computer has in Australia had a checkered life span similar to its' evolution in other countries. It has, however, maintained pace with its more expensive counterparts and continues to grow and surprise not only those who use it but also those who were under the impression that it was dead and gone or just a kids games machine. The advent of the Hitachi 63B09E coupled with the advances in both OS-9 and Disk BASIC will undoubtedly ensure that the CoCo will survive for many years to come. Australian CoCoists, like their American counterparts, have recognized the potential of the Colour Computer. While contact can be maintained and software and hardware is available, these users will ensure that this amazing computer system will outlive its strongest rivals.

The "68xxx" Story - by Jim DeStafeno, former editor

The idea to start a monthly publication centered around the revitalized OSK community that was brought on by the newly released OSK/KMA computers. The idea became more than a dream at the 1990 CoCoFest held in Atlanta Georgia sponsored by Dave Myers of CoCoPRO! As I was told later, **Fredrick Brown**, manufacturer of the PT-68K2/4 computer boards; **Ed Gresick**, owner of Delmar Corp. and soon to become vendor of the System IV; **Dan Farnsworth**, author of REX-DOS and many application programs for it and SK*DOS; **Jack Crenshaw** and **Ron Anderson**, both nationally known writers of computer related books and magazine articles; and **Gil Shattuck** of Granite Computer Systems pulled two tables together at the hotel restaurant.

After dinner the conversation turned to their perceived need for a magazine to unite the anticipated growth of the OSK community. After the 'fest I was contacted; told of the desire, and that **Peter Stark**, the author of SK*DOS, might be willing to lend a hand by giving me his magazine and a mailing list. It took a week to talk with people in the industry, line up a printer and get **Randy Keippner** to agree to do the layout. **The 68xxx Machines** was now in business.

The aim was to satisfy the higher level user/programmer - quality not quantity. Despite our lack of experience the first issue was mailed Feb '91, all of sixteen pages long. The format was small, 5 1/2" X 8 1/2" pages with small print. The result was

full size information within a package that reduced production and mailing costs.

By the end of the first year the subscriber base had grown many times over, and the number of advertisers had more than doubled. The number of pages was held at 24 to keep costs and quality under control. All bills had been paid on time since day one, including advertising in **The Rainbow**.

It soon became apparent, however, that the traditional user base for OSK was not going to number into the thousands, not even one thousand. Trying to increase the number of potential subscribers, several out of the main stream operating systems had been featured. These articles didn't increase the subscriber numbers very much. Requests to include OS-9 kept coming in. I had reasoned that since **Rainbow** hadn't done much with it, it wouldn't do a lot for **68xxx**. But to leave no stone un-turned, I began to include one OS-9 article a month.

Though we had made many changes by the June '92 issue, we were in a practiced groove and all was going well - we were continuing to get new subscribers and advertisers. Then, while working on the July issue, I received a copy of a new magazine called **OS-9 Underground** (OS9U). It was dedicated to OS-9 with a hint to lean toward OSK. In my opinion, it appeared to have a more professional flavor than **68xxx**.

I phoned the editor/publisher, **Alan Sheltra**. Among other things, he said such activities as authoring and publishing small periodicals was his profession. I told him that I thought there was not enough user/advertiser dollars to support two OSK/OS-9 magazines. With that point in mind we discussed combining the two publications. Previous to this discussion I had been trying to get the rights to publish the new **OS-9 Users Group** magazine. When I received the news that Alan was going to do it I thought he might just as well do the whole thing. He and I went ahead with the merger/buy-out idea.

Our agreement was very simple. I would contribute my stock of OSK articles to OS9U at no cost for a few months until Alan developed his own contacts in that world. The OS9U action would be to take over the printing and mailing of the combined content magazine, under the mast head of OS9U, to all current **68xxx** subscribers. In exchange for this service, **68xxx** would pay OS9U for the print space its articles and ads used, as well as any extra mailing cost. To sweeten the deal, OS9U would keep all proceeds from subscription renewals, new subscribers, and new advertisements. In exchange for the **68xxx** no-cost mailing list, OS9U would pay the postage cost of the OS-9 part of the magazines sent to **68xxx** subscribers. We both deemed it to be a fair exchange and the deal went through.

EDITORS NOTE: Although **The 68xxx Machines** was dedicated to **68xxx** based computers, this story is included here because many CoCo OS-9 users benefitted from the OS-9 articles. **The OS-9 Underground** was short lived, quietly disappearing after less than one years' existence.

Two Boys and a CoCo... Joseph Ahern and David McNally *by Joseph Ahern, former editor, TRS-80 Computing*

It all began in the fifth grade when we were introduced to the Radio Shack Color Computer. Once a week our class was allowed to go to the computer room and use **Color Logo**. We soon learned how to master all those impossible shapes they had us draw. We had such a good time using these computers that both of us talked out parents into getting one.

It was hard learning **BASIC** because up to now we had only used Color Logo. Both of us tried **learning to program** by spending hours reading through and typing the sample programs **from the Color BASIC manuals**. After sharing each others' knowledge, we could do some simple programming. Within a years' time, Joe had saved enough money to buy a **DMP-105** printer. This, along with a computer cassette recorder and a blank tape, was just enough equipment to make an attempt to start a small CoCo magazine. Shortly after, Joe came to school one day in June 1987 with the first issue of **TRS-80 Computing**. He said he had been working on it for a few weeks and asked me if I would like to continue with the venture. I loved the idea, so we teamed up and started working on improvements.

That first issue looked like some natives had put it together! At the time we had no word processor and still a minimal knowledge of BASIC. Everything had to be printed using that nasty old PRINT#-2 statement. We even cut lettering from newspapers for the logo on the cover!

Our **first few customers** were teachers at the junior high school we were attending. We had about four or five customers for the longest time and printed monthly. After six consecutive months, it started to become time consuming and was interfering to much with our school work. Besides, it wasn't really worth the effort for just a few people. As a result, we stopped printing for a few months and figured that if we were to continue it would be published annually. However, with the purchase of many new development programs such as word processors and art programs, we figured that with some time, effort, and a lot of planning, we could re-start the magazine with a new format, bi-monthly frequency, and a raise in price.

At this time we started promoting the magazine by using flyers. Our best customers were still our teachers and some relatives. We still didn't give up though, and eventually, by sending out several letters to CoCoists across the U.S. and Canada, we got our first contributing editors. There were also some who were willing to occasionally submit programs and articles, which helped out a lot and allowed us more time to work on giving the magazine a better look. We got away from using markers and relied heavily on the word processors while still trying to build our knowledge of BASIC. You can actually tell by looking at our first issues that we didn't know BASIC all that well; a keen eye would be able to spot our improvements as the years progressed.

In an attempt to improve business by covering a broader market, we **started to include Commodore and Apple material** (we didn't yet have enough money to advertise much further than the local area). This did help some, but we eventually gave that up and **went back to an all CoCo publication**. During this time we were able to place a small classified ad in the November 1989 issue of **Computer Shopper**. In about two weeks, the ad paid off with the addition of about 25 more subscribers. A few months later we placed another ad and got another 20 subscribers. Many more people had heard about us and as far as we were concerned **business was booming!**

Our next ad went into the March/April 1990 (last) issue of **CoCo Clipboard**. At the end of 1990 we sent out 1000 flyers direct mail in conjunction with **CoCoPro!**. The direct mail advertising method was the most effective as it brought in many more subscribers and contributors. In June of 1991 we decided to change the name of the magazine to **Color Computing** because **TRS-80** was a registered trademark of Tandy Corporation. By this time we were able to get access to a Macintosh and a laser printer to give some of our pages a more professional look.

After five long years of supporting the CoCo, we were in our senior year of high school and both realized that it would be impossible to continue the magazine once we graduated. We were both planning on going to college and there was just no way we could go on. **Publication ended in October 1991.**

Around the same time as the demise of the magazine, we were informed by one of our former teachers that a couple of elementary schools still had the **CoCoLab**. When the actual lab was dismantled, the TVs were given to the teachers and the CoCos stuffed into a closet. The teacher decided she wanted to use them in her class. She went around and collected all the TVs and got the keyboards out of the closet. Having no idea what to do with them, she asked around for assistance. She ended up contacting one of the junior high teachers who had subscribed to our magazine. He told her how to get in touch with us. It so happens that the teacher wanting to use the CoCos was **our former first grade teacher!**

She contacted us and we agreed to go down to the school and show her how to use the CoCos. After a few hours work, we asked if she would like us to come in and show some of the kids how to use the computers. She thought that was a wonderful idea. Joe and I couldn't believe it! We were about to teach Color Logo on the same Color Computers we started with ourselves! We went in that week and **taught the kids Logo**. They were amazed at what they could make the machines do and we agreed to come back once a week. We even got permission from our high school principal to leave school early on Mondays so we could teach at the elementary school.

Now that we are out of high school and in college, we still find time to go teach Logo and Scripsit to the third grade class on the good old CoCos. We even support an **after school computer club** that meets once a week. The children are

allowed to come in and use the CoCos to play games or create/print graphics using CoCoMax or the CoCo Graphics Designer during the club "meets".

The CoCos are all connected to a **Network 2** controller. This controller allows up to 15 CoCos to be connected to the host CoCo via the cassette port (the host must have a disk drive). To send a BASIC program to the students, one must first load the program into the host. Then all the students do a CLOAD. The person at the host will do a CSAVE and the program will be sent to all student stations. A disk to tape utility is required to send m/l programs.

If a student needs to save or print their work, the dial on the network controller must be set to the station number that will be saving/printing. Then the student CSAVES to the host which is set to CLOAD. When the file is received, the person at the host can then save or print it. All this is a little time consuming, especially as the students end the day, but the system is simple and reliable... and was cheaper than purchasing disk drives or cassettes for each station. Would you like to deal with 15 tape systems, I/O errors and all? There are ROMPaks for each station, but most of these are so old and worn that not all of them work. It is actually easier to send the programs via the network from disk. By using the dial, different programs can be sent to each station also.

Joe and David both went on to college with the goal of pursuing computer related careers. Their experiences with the CoCo led them that way, as it did for many people. They also showed an interest in teaching. The author was unable to get in touch with either at the time of printing for an update.

Frank Hogg and Frank Hogg Laboratories (FHL)

EDITORS NOTE: This article was transcribed by myself from a tape sent by Mr. Hogg. I apologize for any misspelled names and possible misinterpretations.

The first computer I bought was a 6502 based "Kim I" in 1977 with 1K RAM. **Tom Spear** (a friend) had a SWTPC (South West Technical Products Company) 6800 based SS-50 bus computer. Well, I got a SWTPC in late 77-78. **Dale Puckett**, who was taking a post-graduate course at Syracuse University, was also in Syracuse NY area. We were the only ones in the area with 6800 based home computers. We exchanged software and developed the systems, and communicated with others around the country with similar systems. This lasted until about 1980.

I run a dental laboratory and bought computers then just for the business. We had heard rumors of a Tandy 6809 computer coming in late 79. I felt that there would be a major market for a Tandy 6809 computer with a lot of users. This was discussed with Dale, Tom, **Al Jost** (who wrote **DynaStar**), and some others. It was decided that I would expand into selling software the others wrote. This would provide all with added income

and tax deductions for new equipment, helping to justify hobby expenses. My first ad was a full page in the July 1980 issue of **68 Micro Journal** selling Dale Puckett's **Spell Test (DynaSpell)** and Tom Spears' "Remote" terminal program.

The Tandy 6809 machine, the original CoCo, was a disappointment -- only 4K of RAM and no real expansion, just a cartridge port. We all had more powerful and expandable SS-50 bus 6809 machines running FLEX and OS-9. Well, I went out and bought one anyway. **Richard Hogg**, a nephew, had graduated college and was working for Bell Labs. He took the CoCo and found that a 32K model could easily be converted to 64K by adding a few wires. Richard wrote an article describing the conversion, but didn't want to publish it under his name to prevent any possible conflict of interest with Bell Labs. I published the article under my name, entitled **64K for Free** in **Color Computer News**, **68 Micro Journal**, and **The Rainbow**.

Frank Hogg Labs had licensed **FLEX** from **Technical Systems Consultants (TSC)** in NC. The 64K upgrade made it easier and better to run FLEX and OS-9. Business picked up overnight! We started selling FLEX by the thousands, though we had only expected to sell a few. Other companies tried to get into the FLEX market, Spectro Systems and 68 Micro tried selling versions of FLEX, but weren't very successful due to lack of supporting software.

The CoCo 2 was finally introduced with full 64K capability. Tandy came out with a version of OS-9 for the CoCo 2, something I almost had before hand. **Ken Kaplan** contacted me long before Tandy came out with OS-9. We made a "gentleman's agreement" that **FHL would port OS-9** and receive a license to sell without paying up-front license fees for the work. My crew started work on the port and we ran ads in 80 Micro (I think...). Suddenly I couldn't contact Ken. After a couple months, Ken finally called and reported that **a deal had been reached with Tandy** and MicroWare wouldn't be able to keep the original agreement. I could have raised a law suit, or made a lot of noise about the deal, but decided against it since nothing would really be gained. Instead, we used our advance knowledge of OS-9 and the CoCos' limitations to develop some software. The first we developed was the **O-Pack** utilities for Level I.

The CoCo running Level I was pretty useless.... only 40K left after loading OS-9. Most people writing about OS-9 and all it's glories were actually using **Level II** machines (usually a GIMIX). They were really writing about Level II! You just couldn't do much with OS-9 in 64K. **FLEX only used 8K**, so was a better fit to the CoCo hardware. One could do more... software was more capable and had more memory to work with.

I was sort of misunderstood in the Rainbow columns I wrote pitting FLEX against OS-9... maybe that was my fault for not being clear enough! Those articles were really not against OS-9, as I was running a Level II GIMIX system with nine terminals in the dental lab business, but simply that OS-9 Level I left much to be desired on a 64K CoCo with 32 column screen. One

had to go out and purchase O-Pack or an 80 column board to get more than 32 columns, and most software required 40-80 columns. Multi-tasking/user capabilities were extremely limited in the 40K left on a 64K CoCo! FLEX left more resources for programs. We weren't running FLEX on the GIMIX because it wouldn't do the job as well as OS-9. We weren't running OS-9 on the CoCo due to the same reasoning. I took a lot of heat about that stance! People **STILL** remember those articles and assume they are anti-OS-9. If FHL wasn't so heavy in OS-9 later, they probably wouldn't though! With 128/512K, the CoCo 3 was much better suited for OS-9 and support for CoCo FLEX dropped.

I first got involved in 68000 computers in 1984. Mike Spit at Hazelwood Computer had designed a 68008 single board computer with 128K RAM (upgradable to 512K) that ran OS-9. This board sold for just under \$1000. That was a good price for the time. The only other 68000 based computers were from Hazelwood on a SS-64 bus (extended SS-50) and sold for \$4,000-5,000. The new board was called **Uni-Quad**. Since FHL was selling hardware for the CoCo and OSK software, Mike thought we might be interested in selling the 68008 computers. He sent one, and we called it the **QT** (Quad Terminal ... for four serial ports).

I was advertising in **16-17 magazines .. full page ads**. The cover of the QT brochure was used for a single page Rainbow ad. We sold 3-4 QTs the **FIRST DAY** the Rainbow ad came out! The QT sold for \$3,000-\$3,500 with a hard drive, and I was surprised at how many sold. We followed with the QT+, which had a 68000 processor instead of a 68008 (68008 has 8 bit bus, 68000 16 bit) and up to 1MB. Then came the QT20 from GIMIX. The QT20 didn't sell well due to the high price, like all GIMIX systems. GIMIX had intended to take some of Hazelwoods business with the QT20. The QT20X was the first 68000 board designed to fit in a PC case (before the PT68K sold by Delmar). This form factor allowed the use of low cost, readily available enclosures, not custom made ones. This was followed by our K bus systems.

At the 1989 Rainbowfest in New Jersey, **Kevin Darling** and some others asked me to stay for a few minutes after the show for a conference Sunday afternoon. I was told that Tandy had definitely discontinued the CoCo 3. Kevin and a group of OS-9 programmers had been working on an upgrade to OS-9 Level II, which was sort of in limbo without Tandy support (the upgrade was being done for Tandy). I suggested that a CoCo 3 upgrade **COMPUTER** be developed, something to get the CoCo OS-9 users into the 68K world. There wasn't enough OSK software around and what was out was too expensive for most CoCo users. You just couldn't do much with a 68K machine at the time due to lack of software.

I talked with **Kevin Pease** and **Kevin Darling** about making a 6809 based computer. I wanted to use the K-bus because it was an existing bus and FHL already had products for it. Kevin Pease bowed out because he didn't think the K-bus was the

way to go. **Paul Ward** called and wanted to form a committee to develop a 68K based OS-9 platform. FHL had been involved in developing many computers, and I knew that the committee method wouldn't work well, as no one usually agreed on anything, and by the time everyone had compromised, you had a hobbled system. I didn't want to work with Paul for that reason.

IMS was formed shortly after by **Kevin Pease** and **Paul Ward**, who then started promoting the **MM/1**, which at the time was non-existent. The reality is that IMS may have done some damage to the market, as they were promising complete compatibility with all OSK systems and the CoCo but never delivered. The MM/1 actually shipped much later, and many users waited months before they had complete systems. FHL got many calls from shoppers asking if the FHL system would do all the MM/1 was advertised to do. The answer was no, and **neither would the MM/1**. Many people waited to see what would happen instead of buying systems, and there was a long wait from IMS. Part of the problem was lack of business experience within IMS.

The **TC9** was originally designed to be a **direct CoCo compatible machine** with the ability to upgrade to a 68K processor at a later date. The idea was to get a lot of people into the upgradable TC9 and then into OSK. The result would have been a few thousand more OS-9 users out there. Instead, FHL had to compete with (undelivered) promises of CoCo compatibility from a non-existent machine. This caused us to change our marketing.

Mike Smith and I talked (in July 90) about using the same chip set of the MM/1 (68070 and VSC) in the form factor of the original QT. This would allow upgrading the QT and provide a low cost board to sell CoCo users directly. Design started well after the MM/1 design, but came to market well ahead of it. This was the **TC70**. The TC70 was a 16 bit machine, while FHL had been working on 32 bit models -- essentially a step backwards. The design was priced to be competitive with the MM/1. I was going to go with **Kevin Darling's K-Windows**, but **Steve Adams' J-Windows** was a more mature product so I went with it instead.

In July 1992, we started with the concept of a new computer. Mike had **268030 32 bit machines** on the market, the **PC-30 (QT-30)** and **PC-30-16 (QT-30-16)**. These were somewhat successful, the QT-30 was made for Washington University and had a **PC/XT 8 bit bus**, similar to the PT68K sold by Delmar. This taught us that interfacing to all those PC type cards wasn't very easy! Documentation was difficult, sometimes impossible, to get -- making it hard to write proper drivers that would work with the low cost cards on the market. We ended up (like Delmar) with support for only a few cards... software support was horrendous! OSK is a bit more fussy about what is connected to it, the drivers have to know **EXACTLY** what is there. Each card had to be reverse engineered individually to create proper drivers.

The new machine was originally going to use the **PC/AT 16 bit bus**. We started working on the design with that in mind. At this time, the "local bus" was being talked about in the PC market, which was a 32 bit bus. Mike did a study on supporting the AT bus. Supporting it would take a LOT of board space. Not supporting the AT bus would bring the cost of the motherboard down enough to provide serial, SCSI, floppy, parallel, etc. ports.

The AT bus was only 16 bits and only operates at 8MHz (editor: Some AT class 386/486 machines did use faster bus speeds, but the ISA standard is 8MHz to maintain backwards compatibility with original AT cards.). The ports built into the motherboard wouldn't be limited to 8MHz operation. We therefore decided to scrap the PC/AT bus support idea.

The **video cards** from FHL were **32 bit**, ran up to **33MHz**, had mouse port (serial), keyboard port, high quality sound and video for around \$300, similar to the price of high performance 32 bit PC cards. Since these cards were stand alone meant that **more than one could be installed**. Each card could support a separate user with full 32 bit video and multiple windows.

The computer design finalized in August -- the **Kix-30**. The design fell into place very easily. The board fit into a PC case easily using standard cables and connectors. The first boards came in at 10:00a.m. on a Friday early in October and a computer was running that same day (this was a prototype board!). The prototype board actually only needed six jumper wires to correct minor errors. From conception to finished product only took four months. No committee could have agreed on anything by that time! The fewer people involved in designs like this the better. Keeps cost down compromises to a minimum.

After the **Kix**, the **TC70** lost interest. TC70 was slower than the Kix30, and cost more to expand. Since our supply of boards was low, as well as interest, the TC70 was dropped. There was actually very little difference in cost between the TC70 and Kix30 (Kix is a couple hundred more for a complete system, but is 52.5 times faster than a TC70). The Kix was so good that the other QT products were dropped also. The Kix could be configured for any system, so there was no need for any other boards.

CoCo sales had degraded so much by January 1993 that support was more trouble than it was worth. Sales averaged only 1-2 per month. The remaining CoCo people seem to be in two categories: 1) happy with what they have and love the CoCo, and appreciate anything that you do to help them, and 2) those just looking for a bargain, who don't want to pay fair prices for expensive hardware. **Current plans are to put the FHL 6809 material out as unsupported shareware**. This is sort of on the "back burner" .. will be done eventually.

There is still **TC70 support**, as some industrial users still have requirements for the cards, but this is dwindling. Many industrial customers are converting to the more powerful

Kix30. FHL is "market driven" .. we build and sell what customers want. Some of the larger companies (Apple, IBM, etc.) will do surveys then build what they think the customers want. If they make a mistake, they dump the products at a lowered price and start over. We can't afford those tactics!

What should CoCo users go to? Well, many bought the CoCo because of low cost. The OSK machines, the better ones, are rather expensive (\$1500-\$2000). A PC may be a better choice for those people when/if they want to upgrade to a faster machine. **For the OS-9 user, the OSK machines are definitely the way to go**. Anything else with the power of the OSK machines would cost much more. It really depends on what a person wants to do with their computer.

The OSK market is now back to the "pre-CoCo days" where there is more camaraderie, with people in the OSK world more appreciative and less demanding. Now there is a very powerful 68030 machine rather than the CoCo. This is a better market to deal with, going into unknown territory.

Computers are more of a hobby than a business for me. I am very happy with the Kix30... don't know what I would do different if designing it over again. The next computer will be a 68040, but not anytime soon, as the Kix does all we need it to do and the 68040 processor chip alone is currently \$800. I don't think there would be much market for the price we'd have to charge.

Frank Hogg Labs went on to develop an SVGA card and a 68040 processor for the Kix line of computers. I couldn't trace down exactly when, but by 2000 Frank Hogg Labs was out of the computer business. Mr. Hogg continues to run a dental lab in Syracuse, New York.

FARNA Systems by F. G. Swygert

It seems that some story about the publisher of this book is in order. My father had been working on our family genealogy and asked me if there was a program for the CoCo. We tried using one published in Rainbow, but it wasn't powerful enough. I then searched the PC SIG database on Delphi for a BASIC genealogy program for the IBM PC. I found one by the name of "Genealogy ON DISPLAY!". Equipped with a general knowledge of BASIC on both the CoCo and IBM PC (GW-BASIC or BASIC-A), and "BASIC Program Conversions" (HP Books), I proceeded to "convert" the program to the CoCo.

There is a good reason "convert" is in quotes... it isn't the correct word! GW-BASIC has several keywords unavailable to the CoCo, variable names can be up to eight characters long, and the memory limit is around 60K, not the CoCo's 32K. Genealogy ON DISPLAY! was made up of twelve individual modules. Each one had to be totally re-written to work on the CoCo 3. It wasn't an easy job... I finally completed the work after

a year of on and off laboring. My father would start using each module as it was finished, so the programs were thoroughly debugged. Few bugs found their way into the commercial version, which was ready for the public in early 1991.

I had thought of uploading the program to Delphi, but wasn't about to give away that much work! I started selling the genealogy program early in 1992. I ran my first ad in The Rainbow that May. Up until then, I had been involved with installing point of sell and other programs for small businesses. There wasn't much work for a small, part time operation in this field, so I turned my attention to my real love, the CoCo.

I got my first CoCo thanks to my first hobby and a Timex Sinclair 1500. My first hobby is old cars, specifically sixties AMC/Ramblers, my personal driver being a 1963 Rambler Classic. I wrote and published a book on the history of the AMC Rambler using a typewriter. This lead me to realize a computer would be much easier for that type work! Due to limited funds, an IBM PC was out of the question (PCs were still priced over \$1000 with dual floppy drives and a monochrome monitor in 1985!).

I first purchased a Timex Sinclair T/S 1500 from a pawn shop for \$50. I also purchased a couple books on the little beast. I wasn't much of a typist, so the small calculator type keys wouldn't present much of a problem. The entire unit was only 8 1/2" wide, 5 1/2" deep, and 1 1/2" thick, with all of 16K RAM. I soon found one fatal flaw in the 1500. It used a bit by bit printer port that was designed for the little 40 column T/S printer ONLY. No full size printer could use that port, and a serial printer interface would cost \$100.

Well, I determined I could get another small computer for that price, as the bottom had fallen out of the "home computer" market. TI99/4A computers were being sold in department stores for \$49.95 (around 1985)! I did some research this time around, and decided that of all the small computers, the Tandy Color Computer 2 was the best. Not only did it have a serial port that many printers would connect to, but the disk drives were standard units except for the controller. I soon located a used CoCo2 for \$100... about half the cost of a new one.

I started out with a cassette recorder and Scripsit cartridge. The problem with the cartridge was the lack of an ASCII save feature. I purchased a copy of Telewriter 64 on tape and was in heaven! I then ordered a surplus IBM PC jr. thermal printer and made a special cable to adapt it to my CoCo. I only paid \$49 for that printer. It required thermal paper, but was full size.

I eagerly sought all the information I could on my new computer. In many ways, it was just like my Rambler... simple, durable, and efficient, doing its' required job with few problems. I got a subscription to Rainbow, and bought a couple boxes of older magazines from a friend who was switching to an IBM compatible. I saw no reason... my CoCo (by now a CoCo 3 and RGB monitor) did all I needed.

I completed my second book, a complete history of all AMC products, on the CoCo 3 in 1992. ASCII files were transferred from the CoCo (written with Simply Better) to a Macintosh at a local copy shop. The book was then assembled using PageMaker and printed on a laser printer. The text quality was exceptional, especially when compared to that first work. It was this book which kept the ads in Rainbow going, as the ads were expensive and software sales weren't up to justify the cost, though the software was moderately successful.

Falsoft had announced a history of the CoCo, but then told us they wouldn't be printing due to unexpected problems the authors were having (health problems), but they would reconsider if another author was found. About six months after this, about a year ago now, I had finished my AMC book. Since I'd have the time to write about the CoCo now, I gave Falsoft a call. I was asked to send in my ideas and a sample of my writing. The idea at Falsoft was to make a compendium of recollections from long time CoCo users, the pioneers of the CoCo as it were. In my opinion, what the CoCo community really needed was an all encompassing reference, not just a simple history. Support was floundering all around us... we needed a collection of all those valuable tid-bits of information that would be helpful to all users! Falsoft turned my ideas down by merely saying they were no longer interested in publishing the history. At that point, I determined to go ahead and write this book. it should be noted that had Falsoft stated that they were interested in printing a history, but not my ideas for a complete reference, I would have been willing to go ahead with whatever they wanted. In a way, I'm glad it didn't turn out like that.

When The Rainbow hit an all time low of 16 pages, I was greatly concerned about future CoCo support. I wrote Mr. Falk a letter expressing an interest in possibly buying out Rainbow. About a week later, I got a call from him. We talked a while, and it was apparent I couldn't come up with the funds needed for The Rainbow. About two weeks passed and I received another call from Mr. Falk. They were getting ready to cease publication of the Rainbow (this was in February of 1993), and would consider a sum much lower than he had originally mentioned. This lower amount was somewhat attainable, so I discussed the idea with several potential investors. The outcome of these discussions was that they didn't think it was a reasonable risk, \$90-100,000 would be invested in all, but they would be interested in helping to support a new magazine.

I gave the idea of starting a magazine from scratch some thought. With the support of several influential CoCo people, I decided it could be done. I contacted several people who had published small CoCo publications in the past. All had ceased publication, but were willing to give much helpful information.

With my research in pricing and publishing in mind, I formulated plans to start a new magazine. In order to survive, the magazine would have to leave the door open for OS-9 and OSK support, but for the present and near future, CoCo Disk BASIC support would be the priority. The title was finalized as "the world of

68' micros" (all lower case.. "micro"... letters), with a sub-heading spelling out "Tandy Color Computer, OS-9, OSK". This would prevent the necessity of a future name change.

As stated, the primary goal of "68' micros" would be support of the Color Computer. To begin with, the target would be a CoCo BASIC content of around 70% with the remaining 30% coverage for OS-9 and OSK combined. In all fairness, articles that pertained equally to all operating systems would be included in the CoCos' 70% (such as Bill Sgambatis' "C Programming" series, which is based on the "CoCo-C" compiler, but can be used with ANY compiler.). Also, the percentages would have to change with the subscriber base. As long as a high percentage were CoCo BASIC users, the content for those would remain high. As people moved away from the CoCo, something that was inevitable, then a higher percentage would be devoted to OS-9 and OSK. I expected the CoCo BASIC users to keep at least 50% of the magazine for the next five years... I myself was primarily a DECB user!

I had intended to base percentages on reader surveys, which would be done yearly and when one sent in a subscription form. Unfortunately, there just weren't enough responses to base anything on. The problem is the old chicken and egg routine. You have to have a chicken to get an egg, but you have to have an egg to get a chicken. I had DECB users, so I had to support them. In order to attract OS-9/OSK users, I had to show some support, but I needed articles from some of those users to print! And I didn't want to alienate the DECB users either. So instead of growing in to a new market, I just ended up supporting the old until it just got to be more trouble than it was worth to me.

I spent 40+ hours on each magazine, and earned about \$2.00 an hour. I'd grown in my own computer needs that the CoCo could no longer fill them, and there was no affordable OS-9/OSK machine that had the software base to do the things I wanted to do. Like most CoCo users, I migrated to a PC clone computer instead of a more expensive and ultimately less capable (due to lack of software) OSK machine. Not only that, but I was getting more involved in my first love, AMC cars, and I had a new wife and family that I needed to spend time with. I just didn't have time and money for two big hobbies, and my Rambler won out. But don't think the CoCo was slighted any -- I even told my new wife (celebrated our 10th anniversary in December 2005!) that the Rambler had seniority even over her!

The day came that I finally decided I no longer had time to print 268'm . The last fest I went to had cost me a couple hundred dollars, and I had other interests as well. I didn't bail because I was no longer making money -- except for the fest trip I was still making a bit. In the end I was working for about \$2.00 an hour putting 268'm out. My original goal was to do it with no out-of-pocket costs, so as long as it was a break even proposition I'd have continued. Time for my family and other interests, and a lessening of my interests in the CoCo in general, are the reasons I decided to cease publishing.

When I stopped printing "268'm" in 1998 I still had a loyal subscriber base that had an interest in the CoCo. I tried to find someone to take the publication over at no cost by announcing that fact in the magazine, and letting subscribers know that I wouldn't just stop printing without warning. After about six months I found a taker! We made an arrangement where I paid for the printing and mailing of the next two issues, and forwarded all renewal funds from the take-over date on. I usually received enough renewals to cover printing and mailing costs between issues even at that late stage of the game, so that plan should have given a little extra to start off. We did discuss all business aspects, and that the magazine alone would be little more than a break-even proposition -- I didn't want anyone having a false hope of making much money off the deal.

Unfortunately that person ran into problems and only printed another issue or two after the printing money ran out, and around 100 subscribers lost a little money -- some the entire \$20 subscription price, but most half that or less. I never could get in touch with the person again, and forgot who it was a long time ago. It's possible that after the announcement that I was personally getting out of publishing that a lot of people simply didn't renew. The two issues printed after I left off were as nicely done as I had printed, in my opinion (the deal included a copy of PageMaker software and templates to ensure reasonable quality and little change in appearance at first -- and no start-up costs). Not getting enough renewals to cover printing and postage expenses would have been disheartening to say the least, but I think the guy had personal problems (like a divorce?) that caused the sudden drop.

Instead of packing my CoCos up and keeping them, I made the tough decision to sell them. I figured that someone willing to pay a reasonable amount for them would have to have a keen interest in the CoCo, and would continue to put them to good use for a while. I sometimes wish I still had one of them, but I don't regret that they continued in service at least while longer. Being an old car nut, I've always hated seeing a car sitting and rusting away because someone was going to "fix it up one day" -- but you just knew it would never happen. I didn't want that happening to my CoCos -- I'd rather know someone got a bit more enjoyment from them before they were retired.

If anyone wants copies of "268'm", "Tandy's Little Wonder", or any of the FARNA publications, contact Glenside Color Computer Club (see support). A couple years after 268'm died I donated all the hard copies to them, and made everything public domain.

FARNA Systems is still in the small publishing business. Currently I'm printing an AMC/Rambler quarterly magazine and working on a couple more AMC/Rambler publications. I also provide services to others who wish to get their small publishing projects off the ground. See the FARNA Systems web site at <http://farna.home.att.net>.

Appendix... *even more useful information!*

Color Computer Users Guide By Lee Deuell

EDITORS NOTE: The following guide is a "quick and dirty" run-down of using a Color Computer. Lee wrote this for the person who will inherit his CoCo 3 system (when that time comes!). It was edited to include CoCo 1/2 information also. Feel free to photocopy this article and keep it or send it with a CoCo that finds a new home!

The CoCo 3 has 57 keys. Uppercase and lowercase are toggled by holding down the SHIFT and 0 keys. The F1, F2, and ALT keys are not used by most programs. The BREAK key is used to halt operation of some programs (most programs automatically end.). The CoCo 1 and 2 do not have F1, F2, ALT or CTRL keys (53 keys). Most programs for these use the CLEAR key for a control key when necessary. CLEAR will clear the screen under BASIC for all CoCos. See the manuals for more information.

On the rear of the computer are 10 connections and buttons (8 on CoCo 1 & 2). From left to right (as viewed from the rear) are the following: Reset, Audio (CC3 only), Video (CC3 only), Channel selector, RF out (for TV), cassette, Serial I/O (input/output), Right joystick, Left joystick, and Power. Always use care when plugging/unplugging cables!

The Reset button is used to end some programs. Also, after some machine language (ML) programs (ones that have a ".BIN" after their names on the disk or tape) cause strange things to happen to CoCo when you exit them. Pressing reset should remove the program completely from memory. If not, power down the computer for a few seconds. For a CoCo 3, hold ALT and CTRL down, then press reset. Let go of all the keys. A screen with three people on it will appear. These men helped design the CoCo 3. Finally, press reset again, and you will get the start-up message and RAM will be cleared.

The CoCo 3 Audio and Video ports are used to connect the CoCo to a composite monitor. An RGB monitor port is located underneath the computer. Be careful when moving the CoCo 3 if the RGB cable is still connected! It's fragile, so don't plug/unplug it often.

The Channel Selector switch is used to select either Channel 3 or Channel 4 when using a TV with the computer.

The RF Out port is used to connect the CoCo to a television set. Some games written for a CoCo 1 or 2 use colors not displayable on an RGB monitor due to the way the colors are derived by the programmer (he actually "cheated" with some fancy programming to get more colors).

The Cassette port allows one to connect a cassette drive (tape recorder) to the CoCo. Disk drives are much faster for storage and retrieval, plus files (programs) are easier to find on disks. A regular audio tape recorder with facilities for an external microphone and remote control will work nicely. The volume setting may have to be played with a bit to get it exactly right. The cassette port is also used to connect the hi-res interface to a CoCo 3.

The Serial port is used to plug in a printer or modem cable. Only one of these can be attached at a time. A two-position switch or cable which allows connection of both peripherals at the same time can be used. Only one of the peripherals may be actually used at once though. A "parallel" printer must use a serial-to-parallel interface (another interface!) to be connected to the CoCo. These interfaces can run at a variety of baud rates. The CoCo must, of course, be set at the same rate as the convertor or serial printer. This is accomplished with a POKE 150,x either entered from the keyboard, or put in a program, where "x" is 180 for 300, 87 for 600 (the rate normally used on power-up), 41 for 1200, 18 for 2400, 4 for 4800, or 1 for 9600 baud. Consult your serial printer manual for the correct baud rate (most run at 2400). Parallel interfaces can usually be run at the highest speed, though not much difference will be noticed over 2400 baud. Commands to print to the printer are issued like this: PRINT #2,"THIS WILL PRINT ON SCREEN".

Some games and other programs use the joysticks (or a mouse). They plug into the left and right joystick ports. Some CoCo 3 specific programs require the hi-res joystick interface. This plugs into the right joystick port and the cassette port, with the joystick then plugging into the hi-res interface. The hi-res interface cannot be used unless specified by the program as special programming is required.

Use the Power button to turn the CoCo on and off. Always turn the computer on after all other peripherals, and off before them. If all peripherals and the computer are connected to a multi-outlet surge protector or power strip, all may be left on all the time, turning all on and off with the surge protector or power strip switch (a surge protector is highly recommended!).

The expansion port on the right side of the computer is used for program packs, the disk controller, a multi-pak, or one of several available peripherals. Always make sure the system is off before inserting or removing anything from this port! The computer could be seriously damaged if the item in this port is moved much during operation! The Multi-Pack Interface (or MPI, for short) allows connecting more than one program pack or peripheral to the expansion port at once.

When using the MPI the disk drive controller must be in Slot 4. Most other items can reside in any slot. Slots can be selected by either setting the switch and pressing reset, or by typing POKE 65407,x (where x is 0 for Slot 1, 17 for Slot 2, 34 for Slot 3, or 51 for Slot 4).

The controller for the disk drives is inserted into the Color Computers' cartridge slot. It contains the Disk BASIC ROM or a ROM for another DOS (Disk Operating Systems). Disk BASIC is often referred to as "RS-DOS" (Radio Shack Disk Operating System), but this is a misnomer! The Disk BASIC ROM contains additional BASIC commands that simply allow BASIC itself to access information on the disk drive. OS-9 is an example of a true DOS, as is MS-DOS (Micro Soft DOS) for IBM compatibles. Even A-DOS, a popular Disk BASIC enhancement, is not a true DOS. Disk BASIC is available immediately upon starting the computer, whereas most DOSes have to be loaded from disk.

The CoCo is capable of using up to four single sided disk drives, though most people only use two. Up to three double sided disk

drives may be used (Tandy used the side select line for the fourth single sided drive), though only OS-9 is really capable of fully utilizing double sided drives. Several programs and disk BASIC enhancers (notably A-DOS) will allow accessing the back sides of double sided drives as if they were additional single sided drives (therefore, two double sided drives could be treated as four single sided drives). The Tandy disk controller is capable of handling drives with a capacity of up to 720K, both 5.25" and 3.5" types. Disk BASIC enhancers or OS-9 must be used to access the larger drives. Under disk BASIC, drives are numbered from 0 to 3 instead of 1 to 4 or A to D. Always make sure there are no disks in the drives when the computer is turned on or off. A stray signal over the cable sometimes erases or changes the data directly under the drive head(s)!

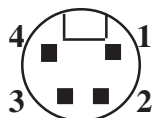
To run programs under BASIC, type RUN "filename (:disk#)" to load and automatically run, or type LOAD "filename (:disk#)".R. Use LOADM "filename (:disk#)" followed by EXEC (after load is finished) to execute (run) machine language programs. If no disk number is specified, drive number 0 is assumed by Disk BASIC. Cassette systems are similar, except with a "C" appended to the front of the command (CLOAD, CLOADM) and no device number is needed (there is only one cassette recorder!).

Most programs include a way for them to automatically end. One way to stop a program that is running is to press the BREAK key. As a last resort you can press the reset button on the back. Be careful when using reset, however, as it can erase a program that is in memory or on a disk in the drive. If a program asks you on the screen if you wish to quit or end the program, you may need to press SHIFT and "y" (yes) or "n" (no), as some programs only recognize capital letters.

I think this is enough information to get you started using the Color Computer. I don't want to tell you everything! If you have any problems or questions, get in touch with one of the computer clubs listed elsewhere in this book. Also, don't forget to read any manuals or books you may have with your system. The Library listing and past magazines should help also. Good luck, and happy Color Computing!

Serial Interface Specifications

Looking at the connector from the back of the CoCo:



PIN#	RS-232C SIGNAL	CODE
1	Carrier Detect (status input)	CD
2	Receive Data (to computer)	RD
3	Ground (0 voltage reference)	GND
4	Transmit Data (from computer)	TD

Baud rate is changed by typing "POKE 150,x" where "x" is:

BAUD Rate	Decimal	Hexadecimal
120	202	CA
300	180	BE
600	87	57
1200	41	29
2400	18	12
4800	4	n/a
9600	1	n/a

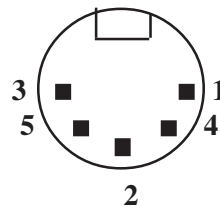
Cassette Interface

Suggested input playback level- 1-5V peak-to-peak with a minimum impedance of 220 Ohms.

Typical output level to recorder- 800mV peak-to-peak at 1K Ohms.

Remote switching (relay) capacity- 0.5A at 6V (max.)

Looking at connector from back of the CoCo:

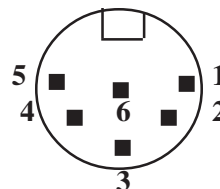


PIN#	SIGNAL
1	Remote Control
2	Signal Ground
3	Remote Control
4	Input (from recorders' EARphone jack)
5	Output (to recorders' MIC or AUX jack)*

* Radio Shack CTR and CCR recorders use the AUX jack, "generic" recorders use the MIC (microphone) jack.

Joystick Interface

Looking at connector from back of CoCo:



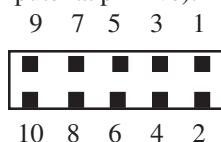
PIN#	SIGNAL
1	Right/Left comparator input
2	Up/Down comparator input
3	Ground
4	Fire button 1; high/open, low/closed
5	+5V DC, 0.5A
6	Fire button 2; high/open, low/closed



A: One button Mouse plugged in place of a joystick, useful for some applications. A white two button mouse was made for the CoCo 3. B: Original joystick, no self centering, one button. C: The "deluxe" joystick had slide adjusters and self centering that could be turned on and off for the X and Y axis individually.

RGB Interface

Looking at the connector under the CoCo (cable exits from under the computer at pin five):



PIN#	SIGNAL
1	Ground
2	Ground
3	Red
4	Green
5	Blue
6	Polarity (no pin)
7	Sound
8	Horizontal Synchronization
9	Vertical Synchronization
10	NOTCONNECTED

Cartridge Port (Expansion) Connector

Looking "in" at the connector on the CoCo, odd numbered pins are on top from right to left, even numbered pins on bottom from right to left (39&40 on left, 1&2 on right):

PIN# DESCRIPTION

1	-12V, 100mA (CoCo 1 only)
2	+12V, 300mA (CoCo 1 only)
3	HALT input to CPU (normally low)
4	NMI (non-maskable interrupt, normally low)
5	RESET to CPU (normally low)
6	E clock signal (main)
7	Q clock signal (leads E)
8	CART (cartridge detect interrupt, normally low)
9	+5v, 300mA (all models)
10-17	D0-D17 (consecutively numbered, data bits)
18	R/W (read/write signal to/from port, high on write)
19-31	A0-A12 (consecutively numbered, address bits)
32	CTS (cartridge select, normally low)
33-34	Signal ground
35	Sound output
36	SCS (spare cartridge select, normally low)
37-39	A13-A15 (consecutively numbered, address bits)
40	SLENB (disables internal device selection, normally low); allows decoded but unused sections of RAM to be used by external devices.

ASCII Character Codes

Display characters by typing "PRINT CHR\$(xx)", where "xx" is the decimal code. 32 column screen (CoCo 1/2) only displays codes through 122.

Character	Decimal Code
BREAK	3
CLEAR	12
ENTER	13
SPACE	32
!	33
"	34
#	35
\$	36
%	37
&	38
'	39
(40
)	41
*	42
+	43
,	44
-	45
.	46
/	47
0	48
1	49
2	50
3	51
4	52
5	53
6	54
7	55
8	56
9	57
:	58
;	59
<	60
=	61
>	62
?	63
@	64
A-Z	65-90
Up Arrow	94
(+SHIFT)	95
DownArrow	10
(+SHIFT)	91 (I)
LeftArrow	8
(+SHIFT)	21
RightArrow	9
(+SHIFT)	93 (J)
^	96
a-z	97-122
{	123
	124
}	125
~	126
_	127

Codes 128-159 are mostly European accent marked characters. They are not printable with a CoCo 1 or 2.

BASIC/Extended/Disk Error Codes

Code	#	Description
SN	1	Syntax Error
RG	2	RETURN without GOSUB
OD	3	Out of Data
FC	4	Illegal Function Call
OV	5	Overflow
OM	6	Out of Memory
UL	7	Undefined Line
BS	8	Bad Subscript
DD	9	Redimensioned Array
/0	10	Divide by 0
ID	11	Illegal Direct
TM	12	Type Mismatch
OS	13	Out of String Space
LS	14	String too Long
ST	15	String Formula too Complex
CN	16	Can't Continue
FD	17	Bad File Data
AO	18	File Already Open
DN	19	Device Number
I/O	20	Input/Output Error
FM	21	Bad File Mode
NO	22	File Not Open
IE	23	Input Past End of File
DS	24	Direct Statement in the File
UF	25	Undefined Function Call
NE	26	File not found
BR	27	Bad Record
DF	28	Disk full
OB	29	Out of buffer space
WP	30	Write protect
FN	31	Bad file name
FS	32	Bad file structure
AE	33	File already exists
FO	34	Field overflow
SE	35	Set to non-fielded string
VF	36	Verification error
ER	37	Write or input past end of record

Super Extended BASIC Error Codes (CoCo 3 ONLY):

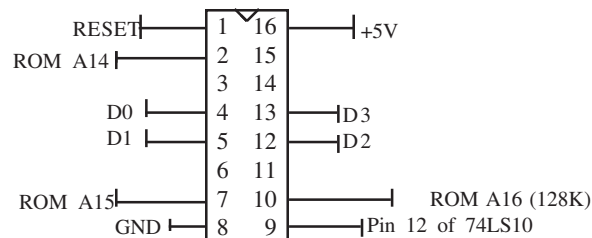
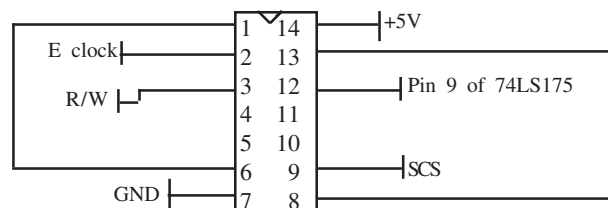
Code	#	Description
HR	38	Hi-Res Graphic Error
HP	39	Hi-Res Screen Print Error

Bank Switched ROM Pak (Activision)

Some of the CoCo 3 ROM Paks contain more than 32K of data, which the CoCo 3 can select directly from the cartridge port (the CoCo 1/2 could only use 16K Paks). This is accomplished by switching banks of 16K in and out of the memory map. This switching is accomplished totally within the ROM Pak by two ICs- a 74LS10 triple input NAND gate and a 74LS175 edge triggered quad flip flop. Up to 16 banks could be selected by this hardware, allowing ROM Paks to contain up to 256K of data.

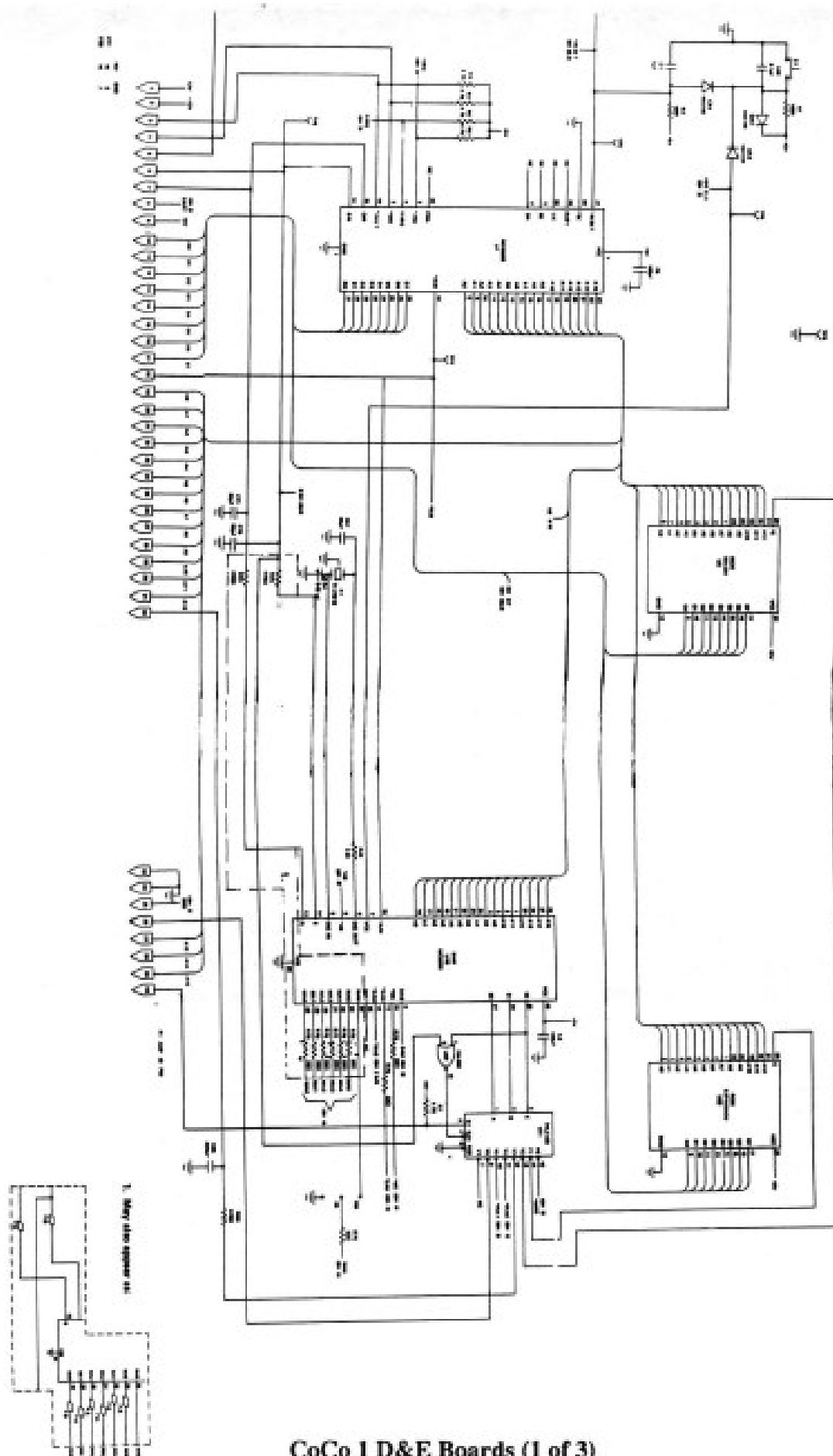
Switching is accomplished by writing to the first four bits of location &HFF40. This sets the outputs of the 74LS175. These outputs control the high order address lines of the ROM. At power up or reset, the outputs are all set to zero so that the first bank is always selected first. This is done by tying the ROM master reset to the CoCos' reset. Writes to any address in the &HFF40 through &HFF5F range will set the bank select latch, as no further decoding was done. Note that since bank selection is done in 16K increments, this same technique could be used with a CoCo2.

74LS10



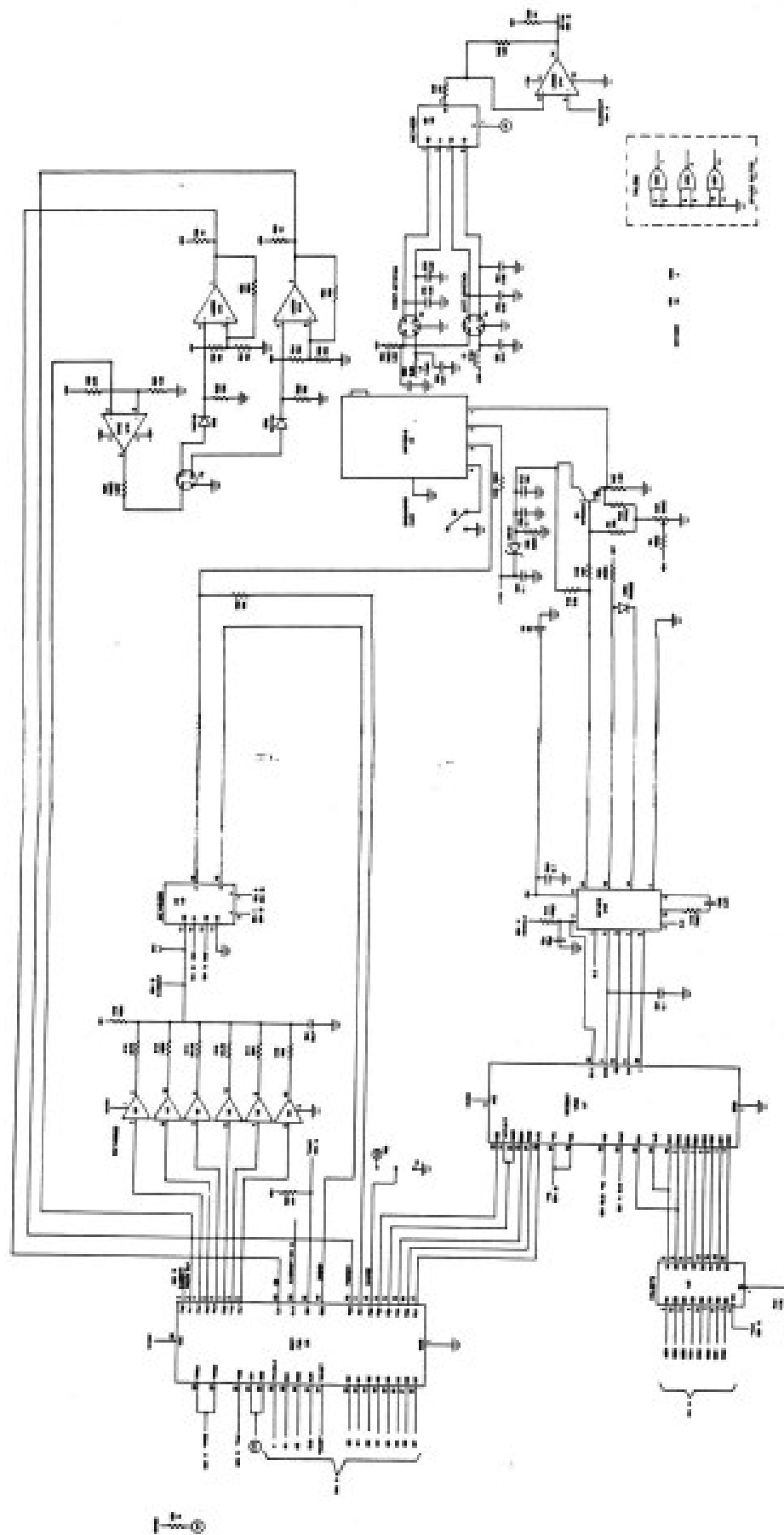
74LS175

The remaining ROM lines are wired as a normal 16K ROM Pak. D0-D7 of the CoCo is wired to the same on the ROM, and likewise with A0-A12. A13 would be connected to 74LS175 pin 15, but is not used on the Activision ROM Paks. It would only be used with larger ROMs.

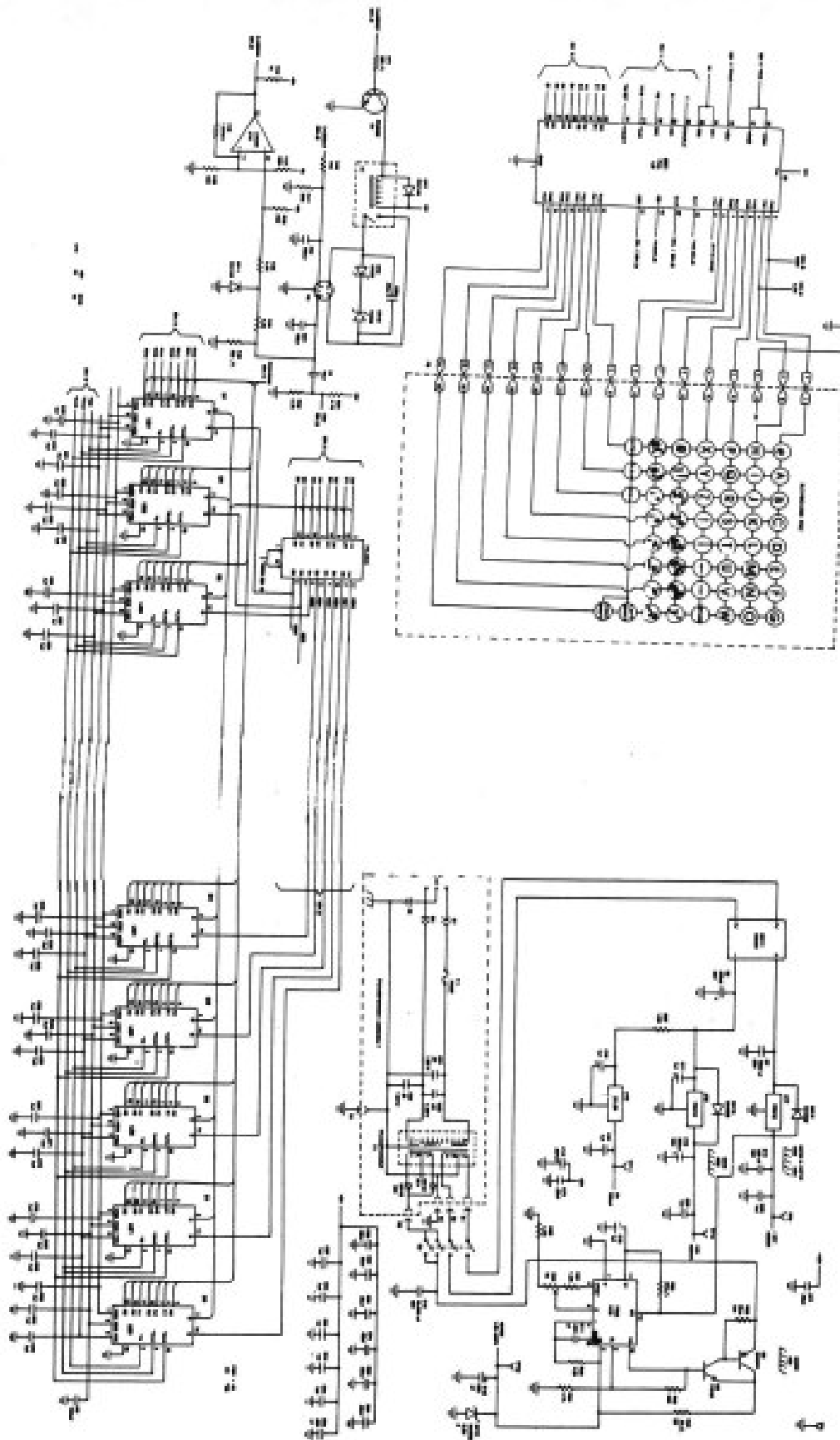


CoCo 1 D&E Boards (1 of 3)

Tandy's Little Wonder

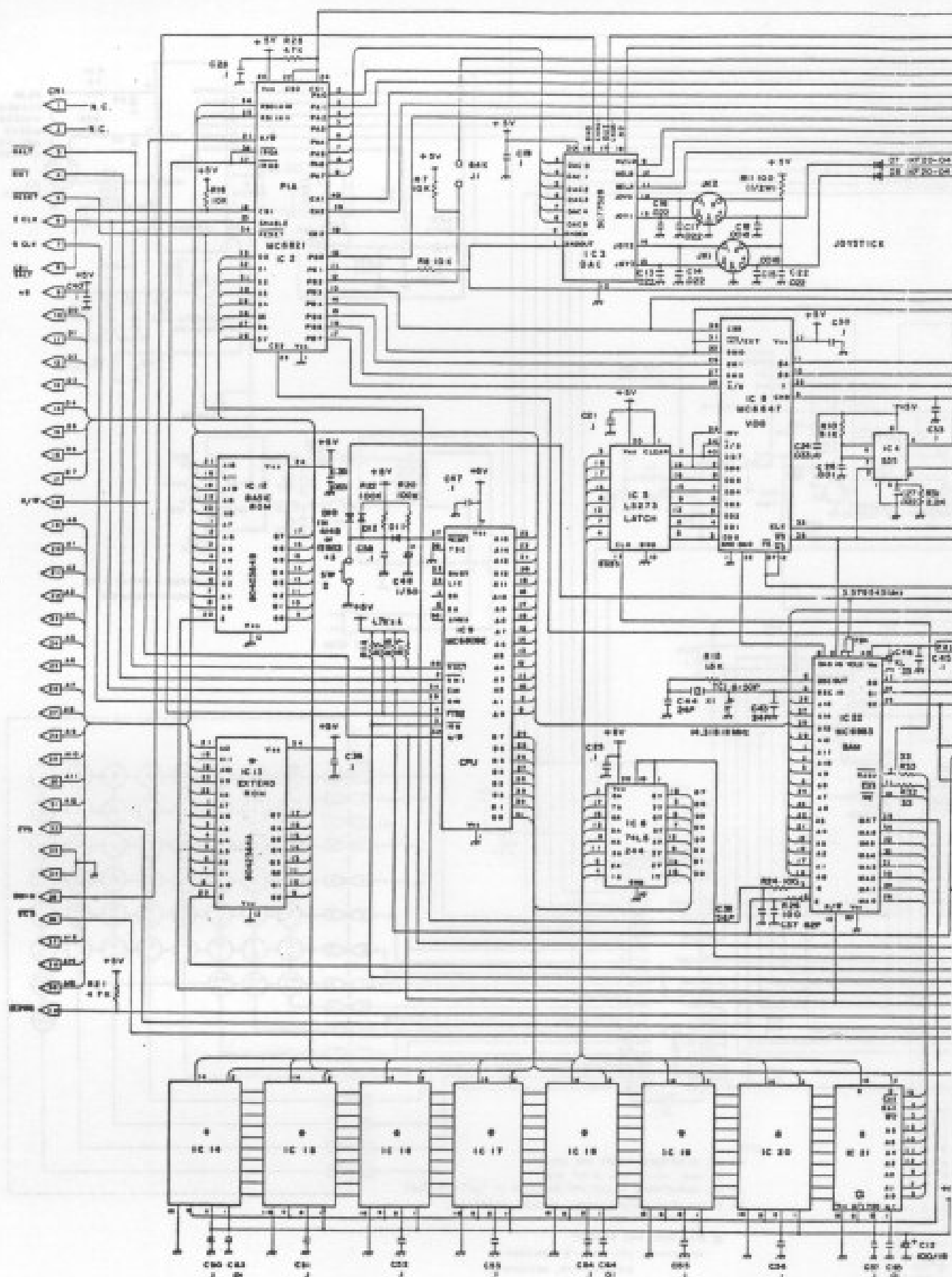


CoCo 1 D&E Boards (2 of 3)

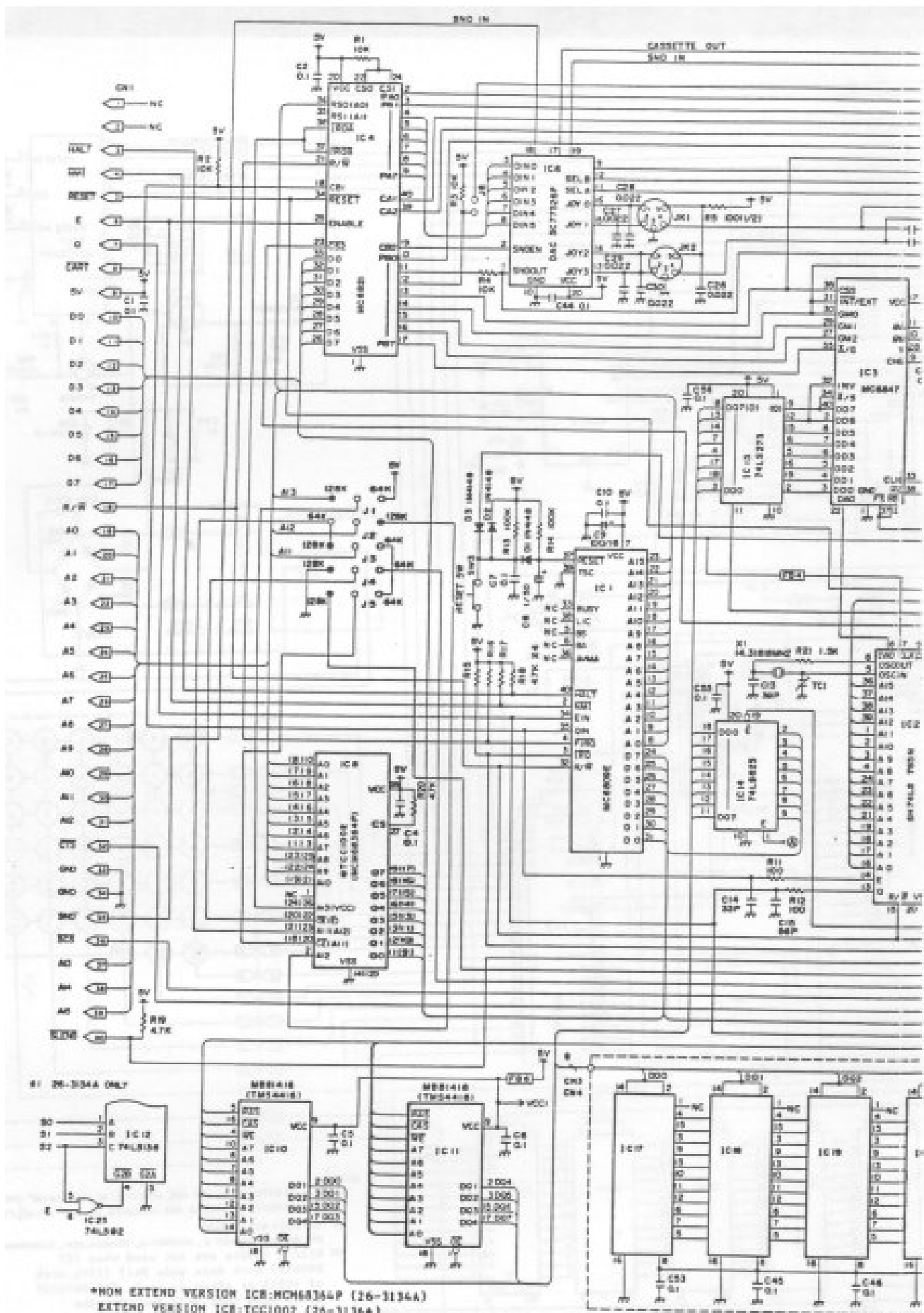


CoCo 1 D&E Boards (3 of 3)

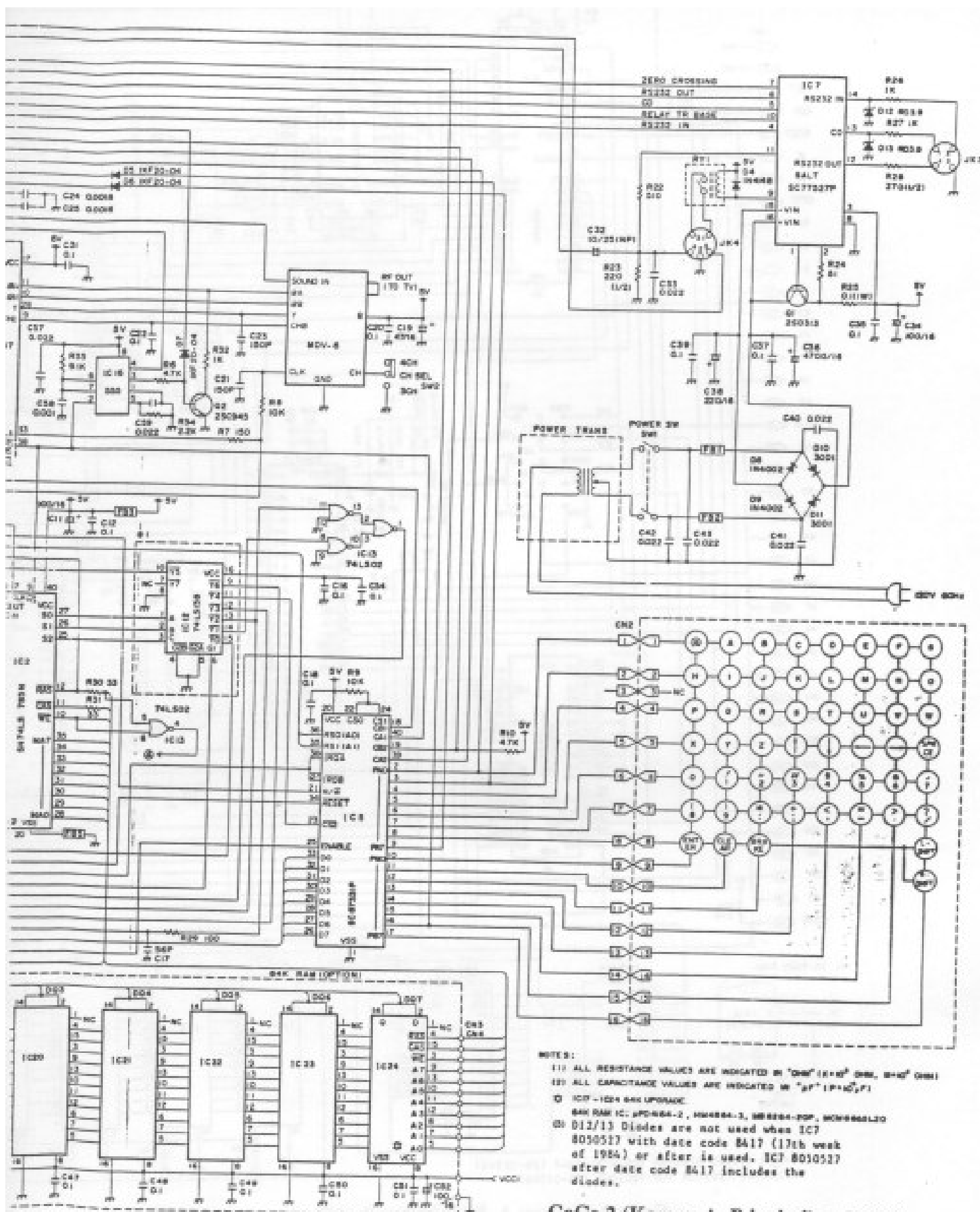
Tandy's Little Wonder



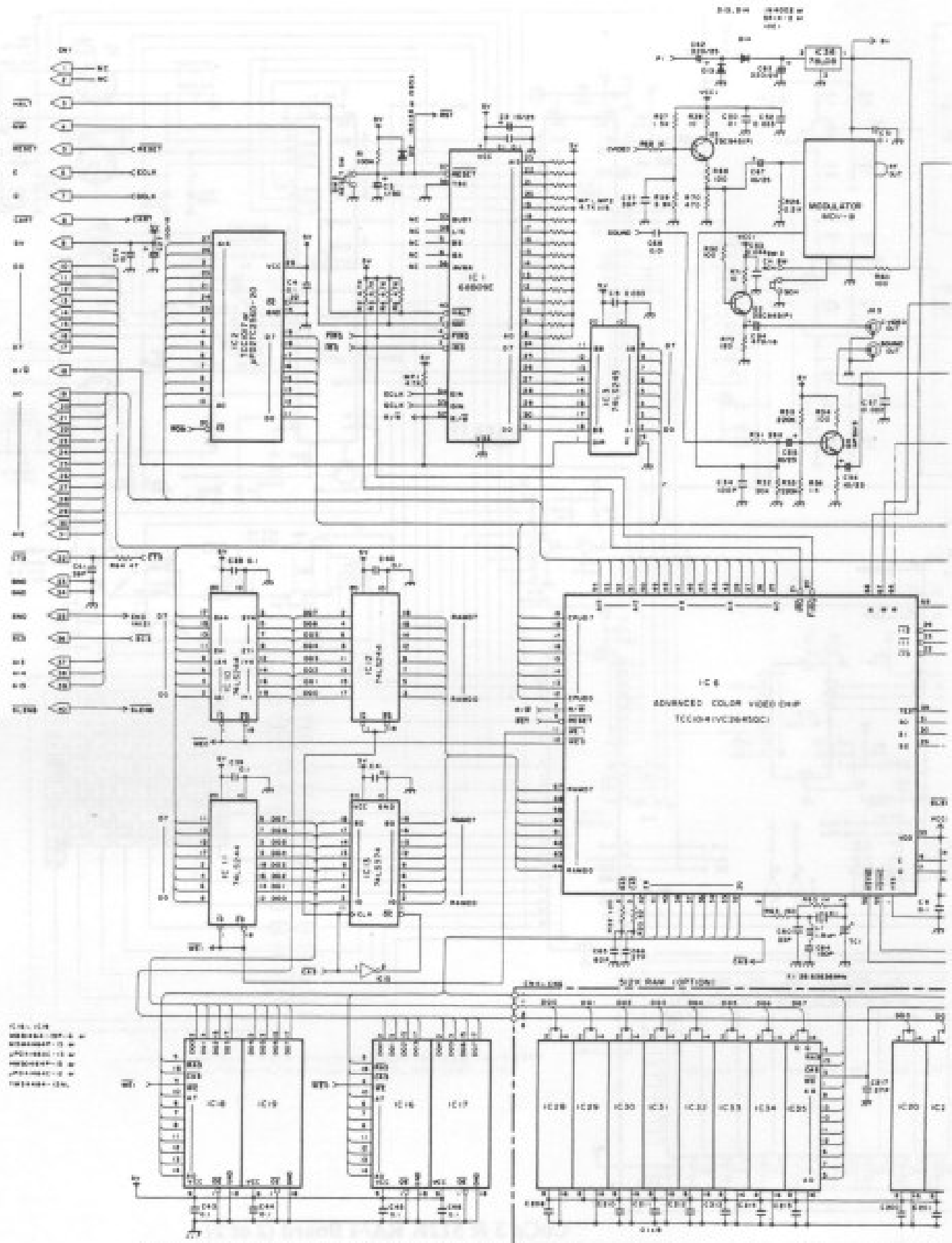
CoCo 2 (American, 1 of 2)



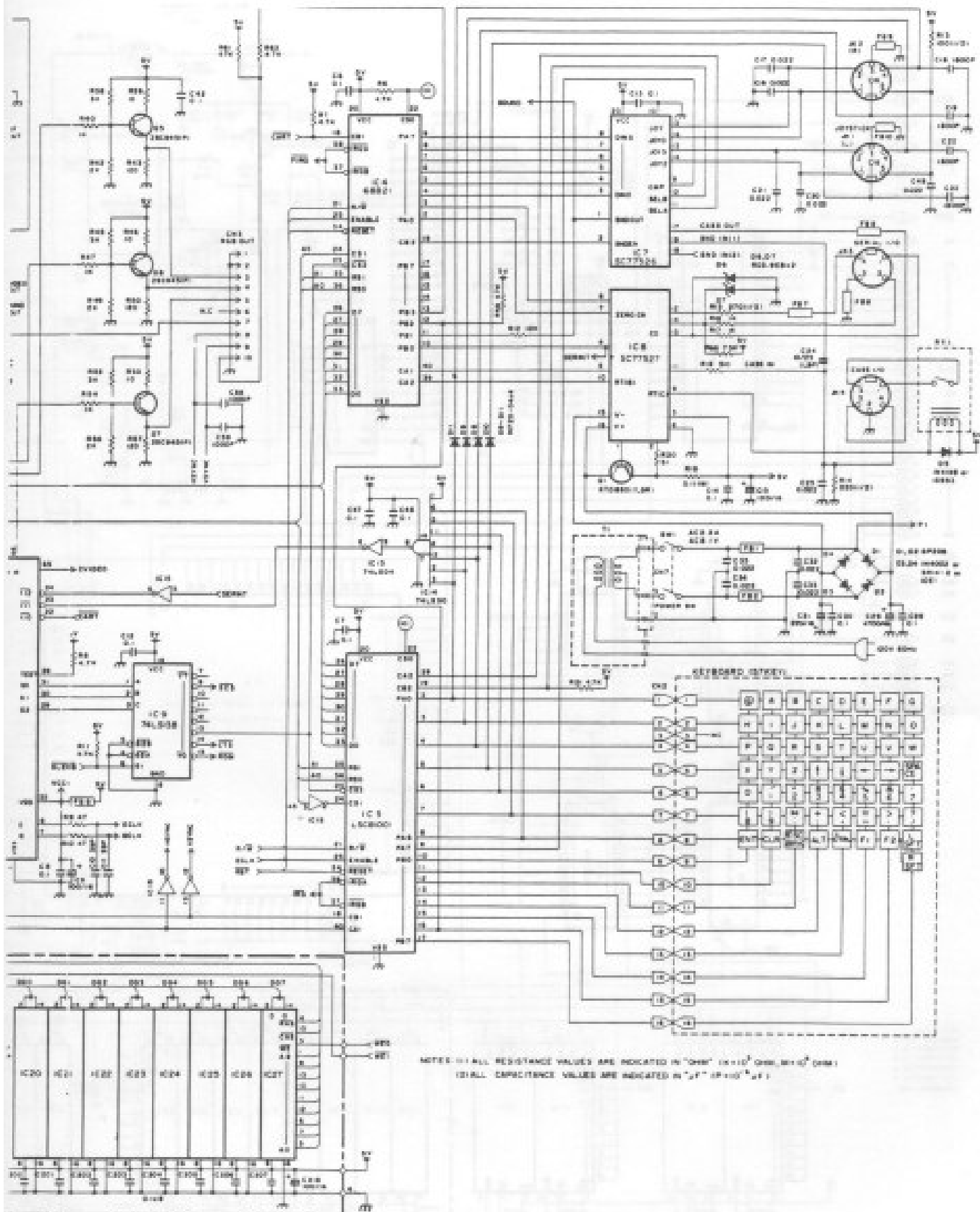
CoCo 2 (Korean A, B is similar, 1 of 2)



CoCo 2 (Korean A, B is similar, 2 of 2)

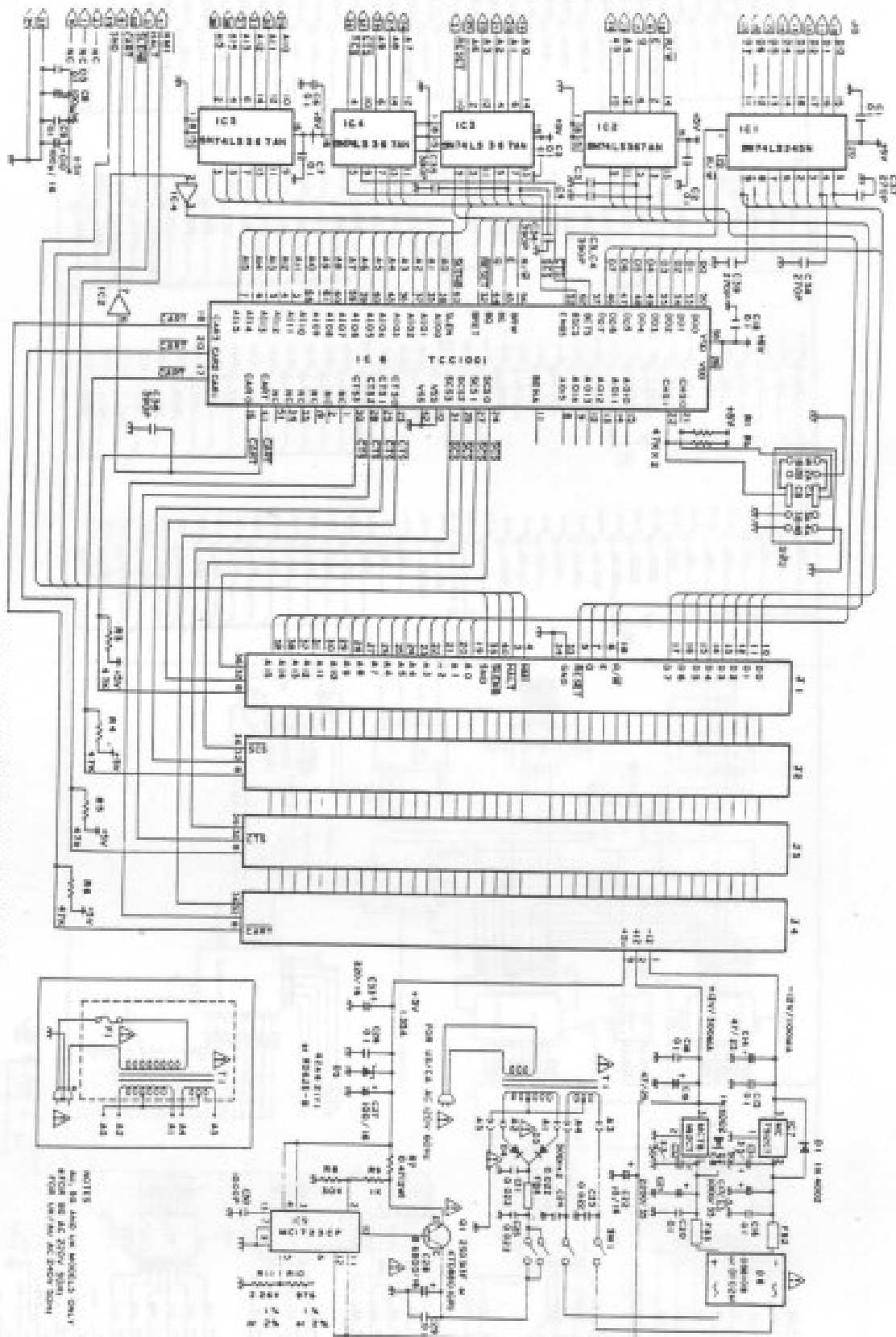


CoCo 3 & 512K RAM Board (1 of 2)

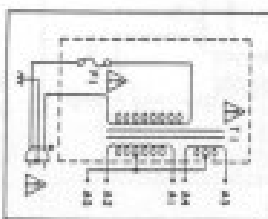


CoCo 3 & 512K RAM Board (2 of 2)

NOTE: IN ALL RESISTANCE VALUES ARE INDICATED IN "OHMS" (R=10⁰ OHM),
IN ALL CAPACITANCE VALUES ARE INDICATED IN "PF" (P=10⁻⁶ PF).

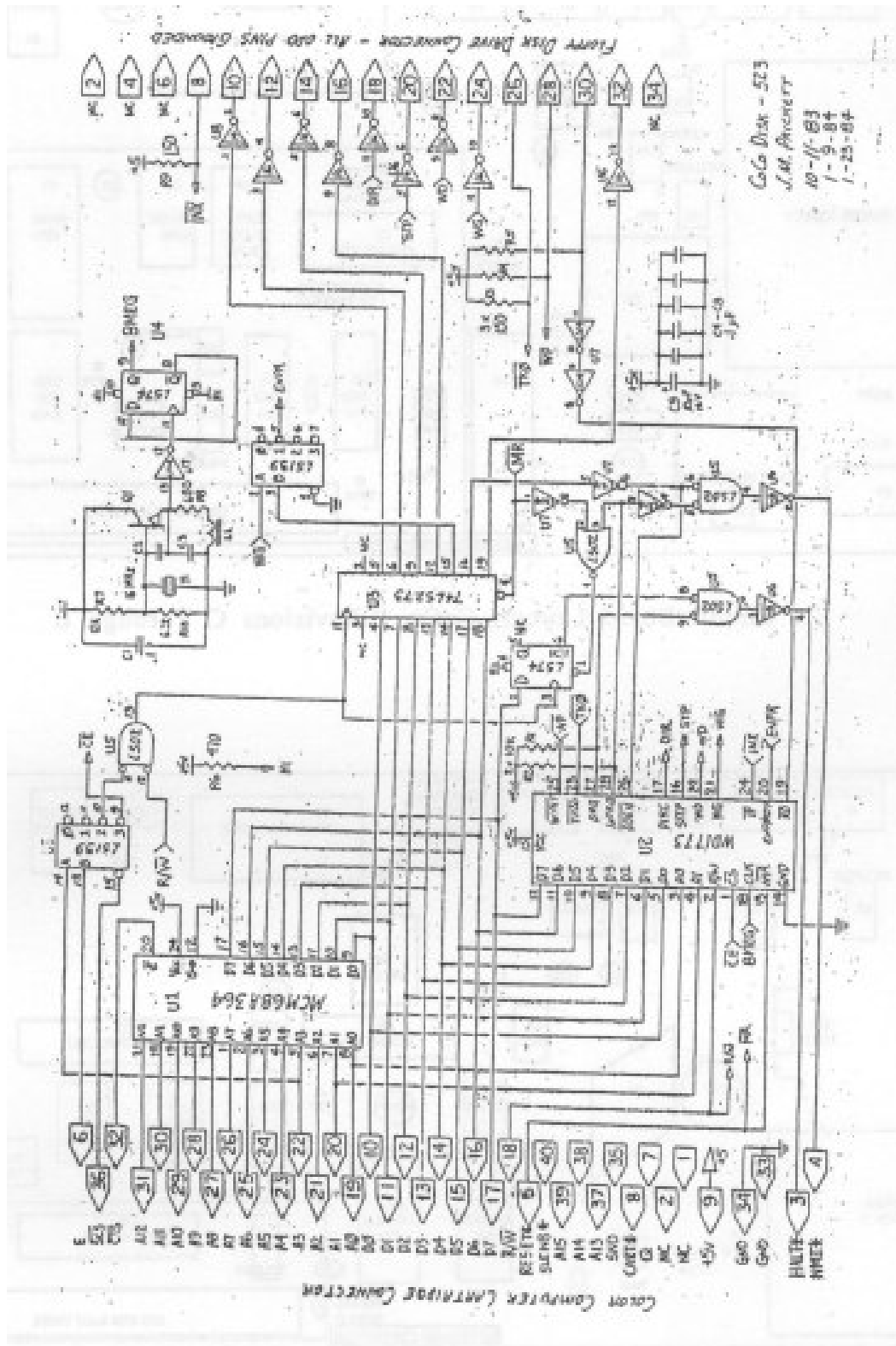


CAPTION: SINCE THE COMPONENTS PLACED AT 4400, CRITICAL FOR SAFETY,
USE COMPONENTS DESIGNATED IN PARTS LIST ONLY.
Before entering the air in the outdoors, make appropriate testing system or use.
These instructions to determine that required parts are properly installed from
the safety circuit.



NOTES:
1. DO NOT USE MODELS ONLY
2. DO NOT USE 255V 50Hz
3. DO NOT USE 255V 50Hz
4. DO NOT USE 255V 50Hz

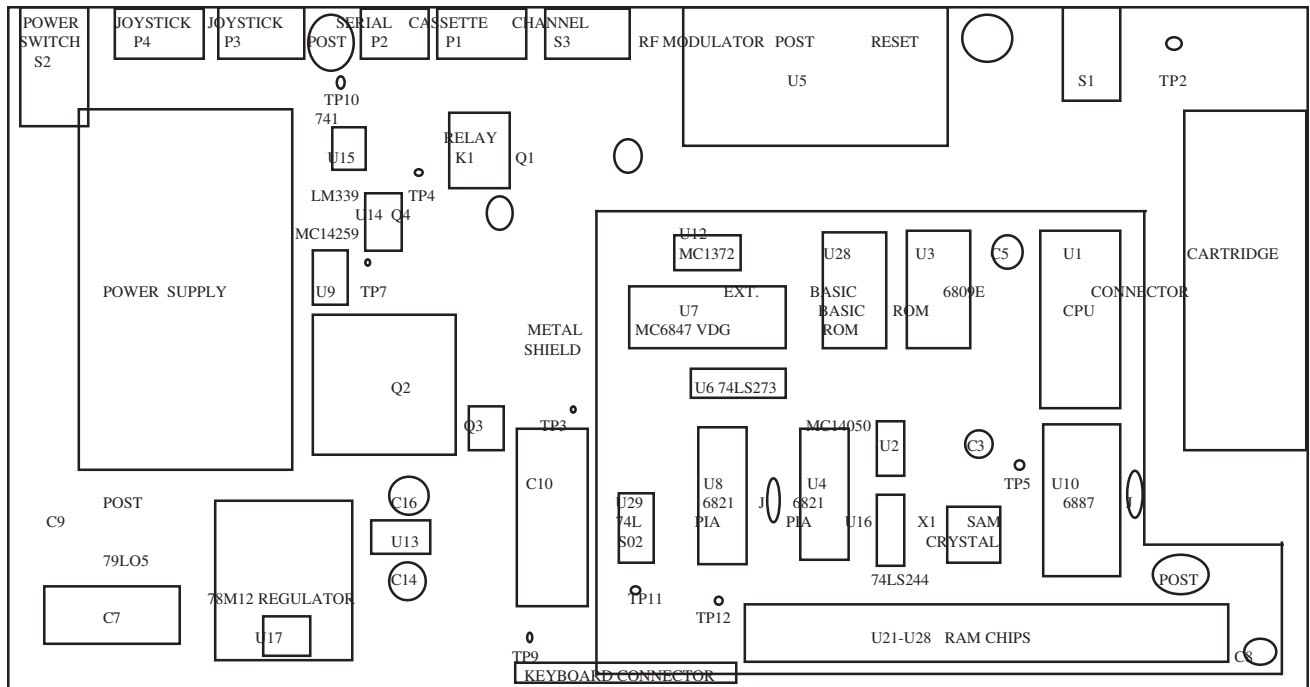
Multi-Pak Interface (small)



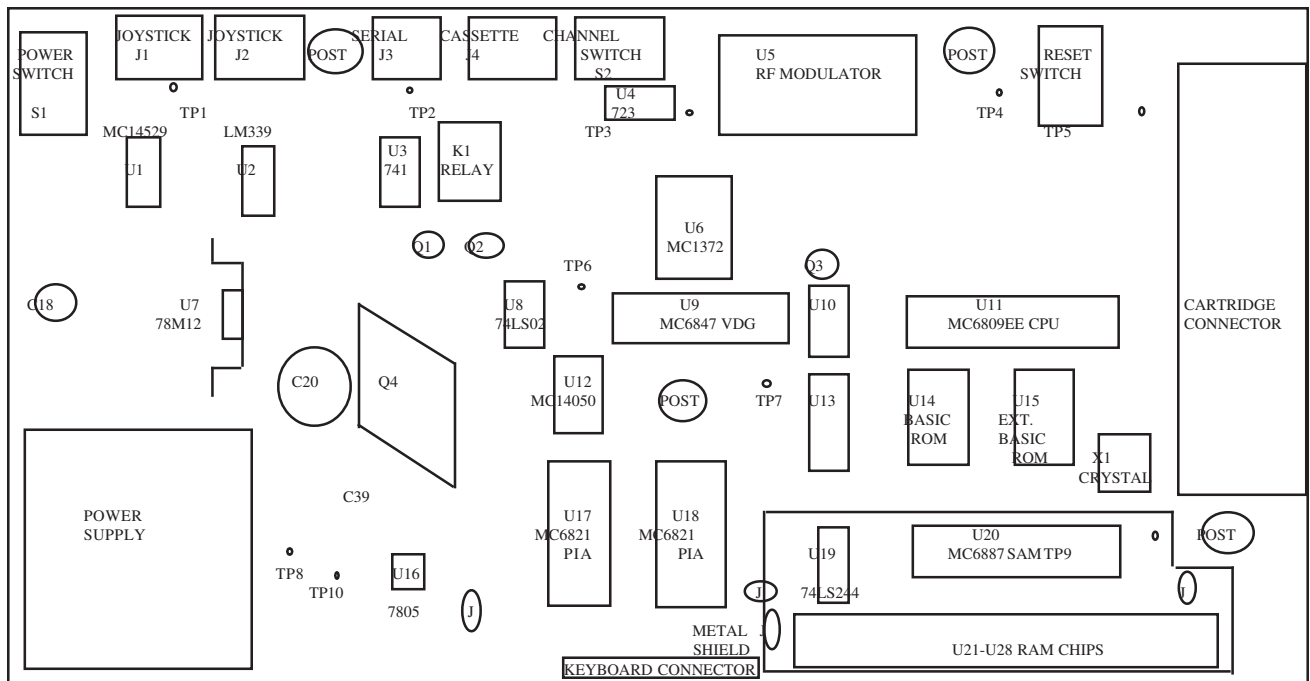
FD-501 Disk Controller (FD-502 similar)

NOTE: (1) ALL RESISTANCE VALUES ARE INDICATED IN "OHM" & $\times 10^3$ OHM
(2) ALL CAPACITANCE VALUES ARE INDICATED IN "pF" & $\times 10^{-6}$ F, $\mu = 10^{-6}$ F

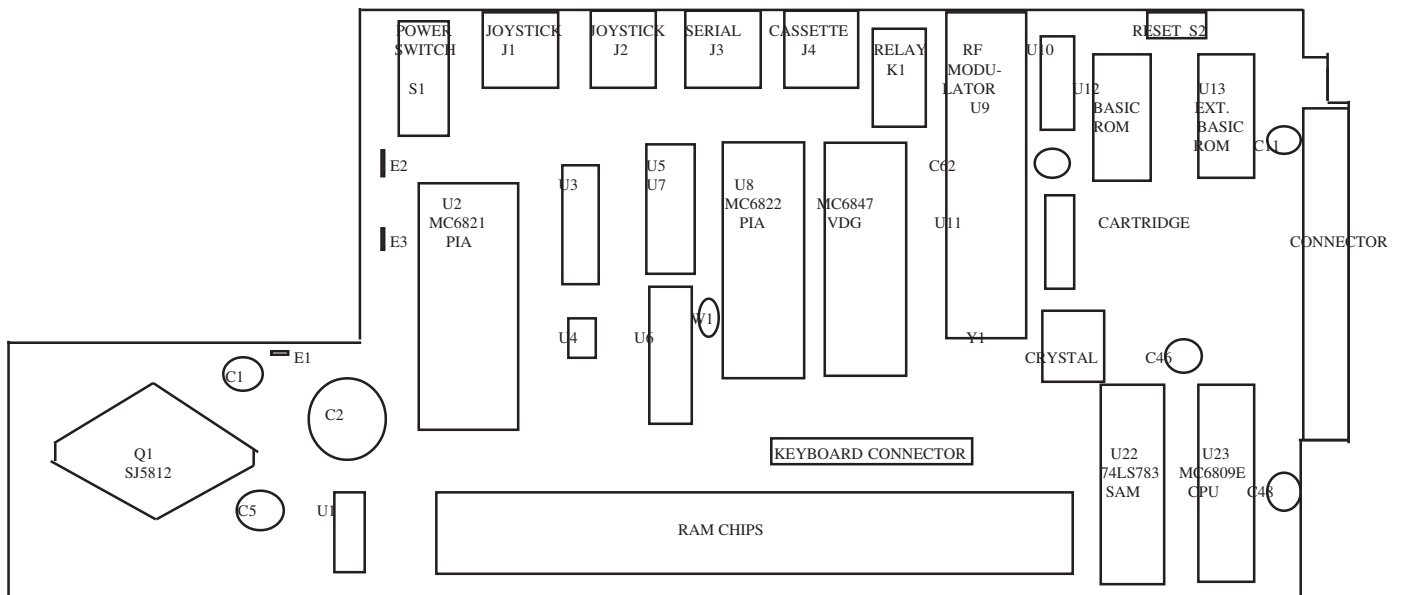
14



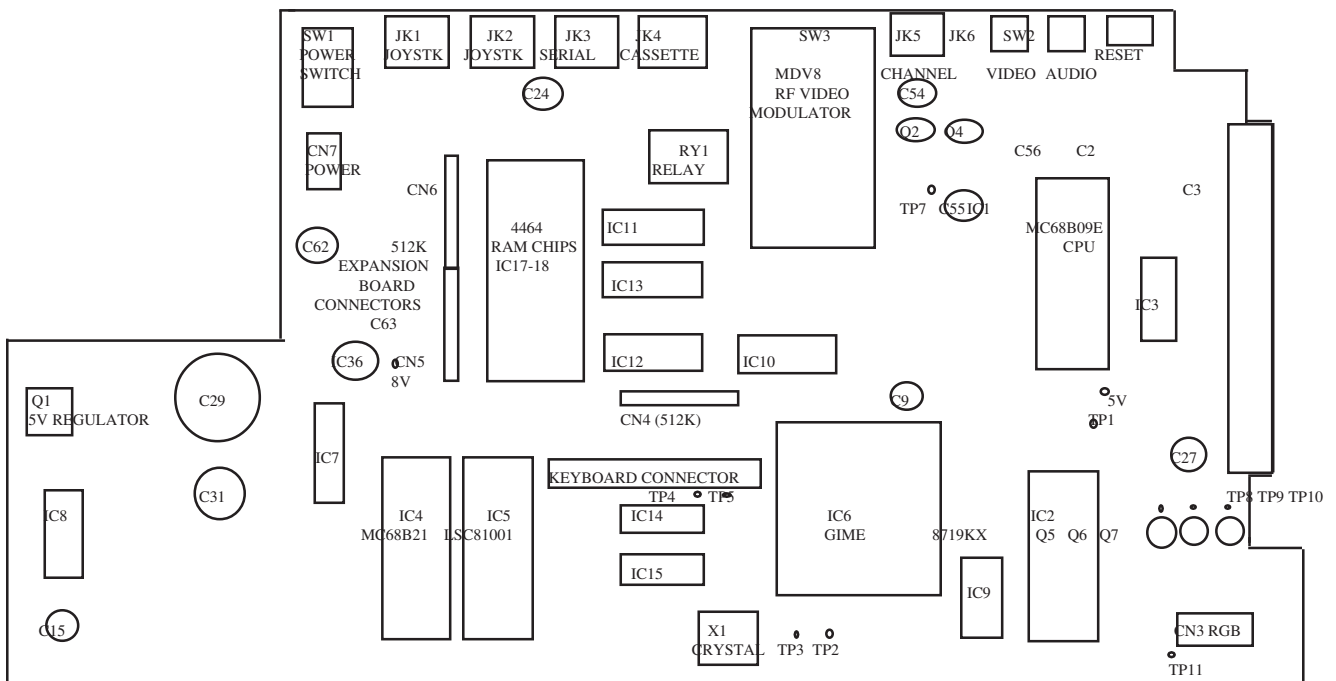
Circuit Board Layout, CoCo 1 Revisions C Through E



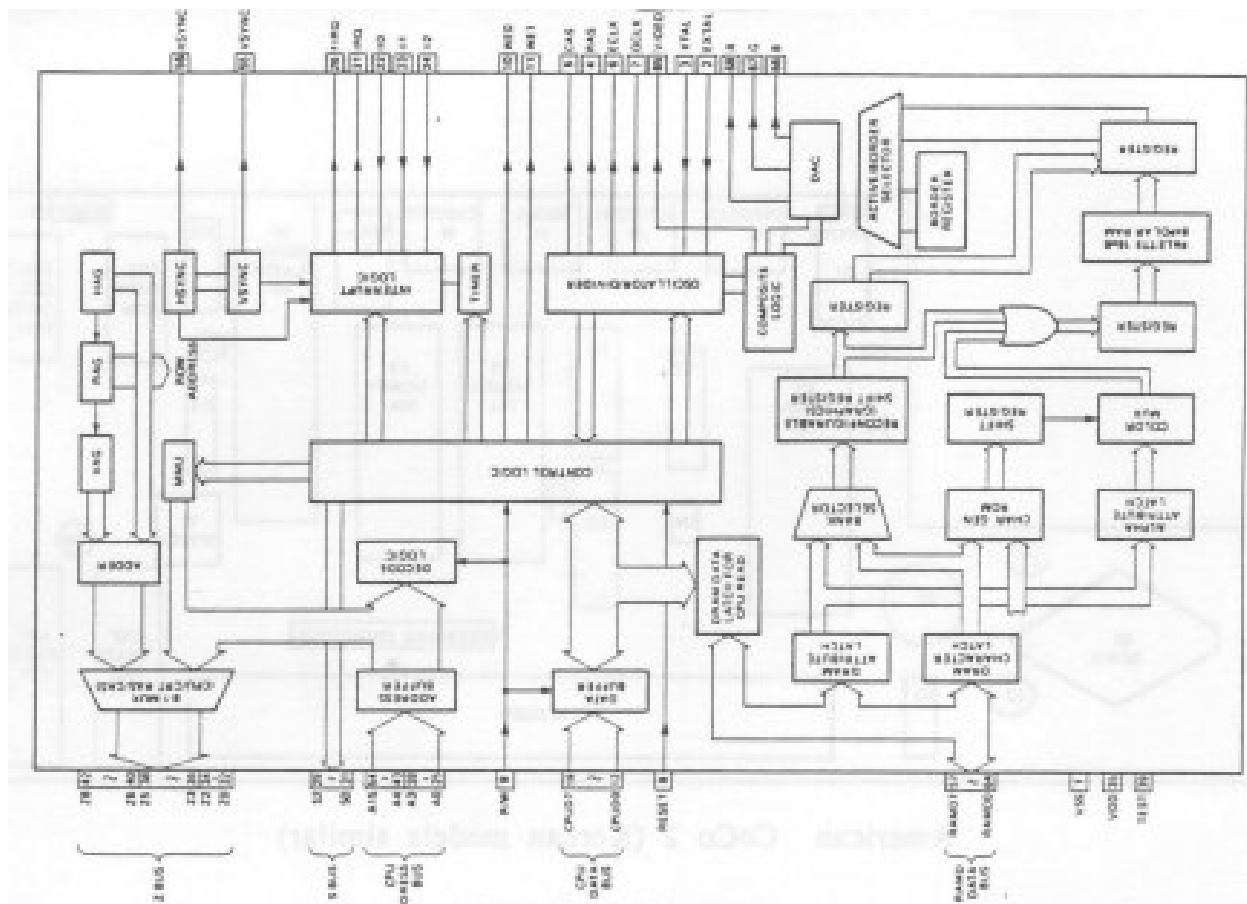
CoCo 1/TDP-100 Circuit Board Layout, Revision NC (also called "F" or "285")



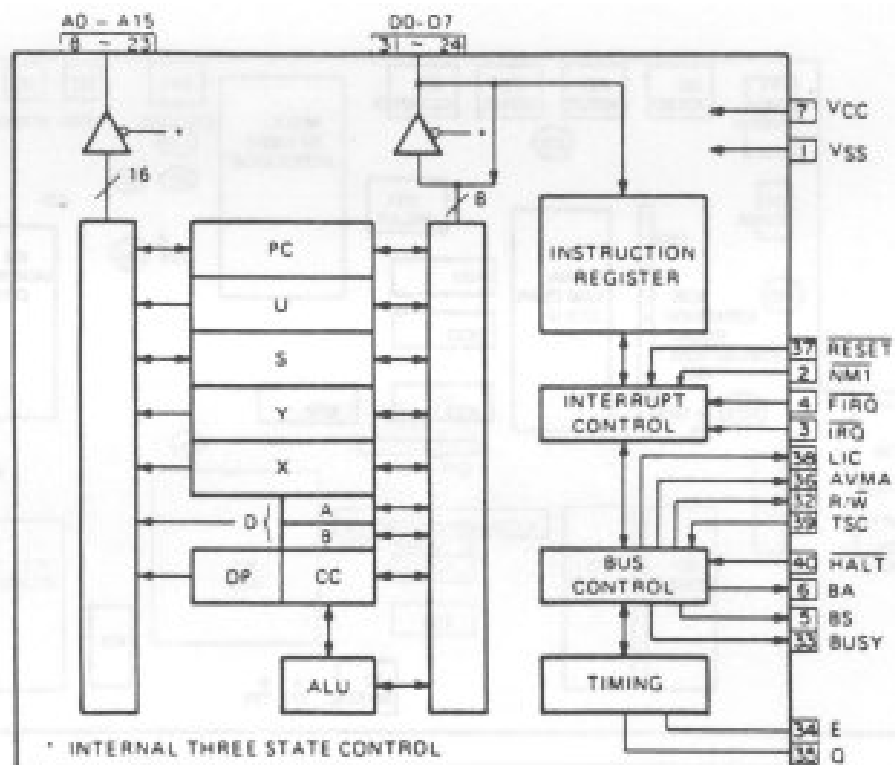
American CoCo 2 (Korean models similar)



CoCo 3 Circuit Board



GIME Block Diagram



MC6809E Block Diagram

The Tandy Color Computer 3

More colors, superb graphics, greater power at a low price

With Radio Shack's Color Computer 3 (26-3334, \$219.95), you can start computing right away—even if you've never used a computer before! Simply attach it to your TV, and you're ready to start.

Not only does the 128K Color Computer 3 offer twice the memory, twice the speed, and even better graphics than our popular Color Computer 2, it's also compatible with the Tandy hardware accessories and software designed for the popular Color Computer 2—you may never outgrow it!

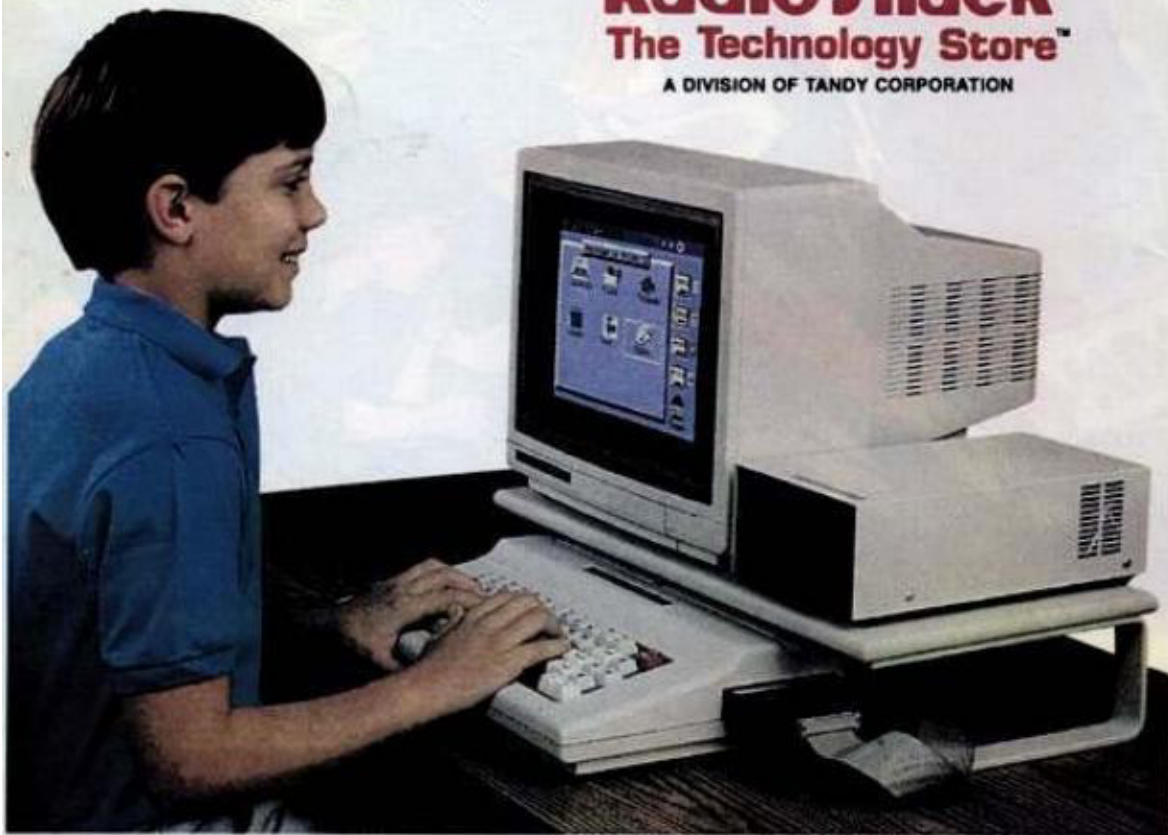
You can choose from a wide selection of educational software, including programs designed to improve your math skills, history, spelling, vocabulary and

typing skills. The Color Computer 3 can even be used for writing your own sophisticated programs—simply plug in an instant-loading Program Pak™ for fun and games. You can even add an optional modem to access educational databases over the phone. Enjoy services such as an electronic encyclopedia—great for homework, and fun to use for the whole family.

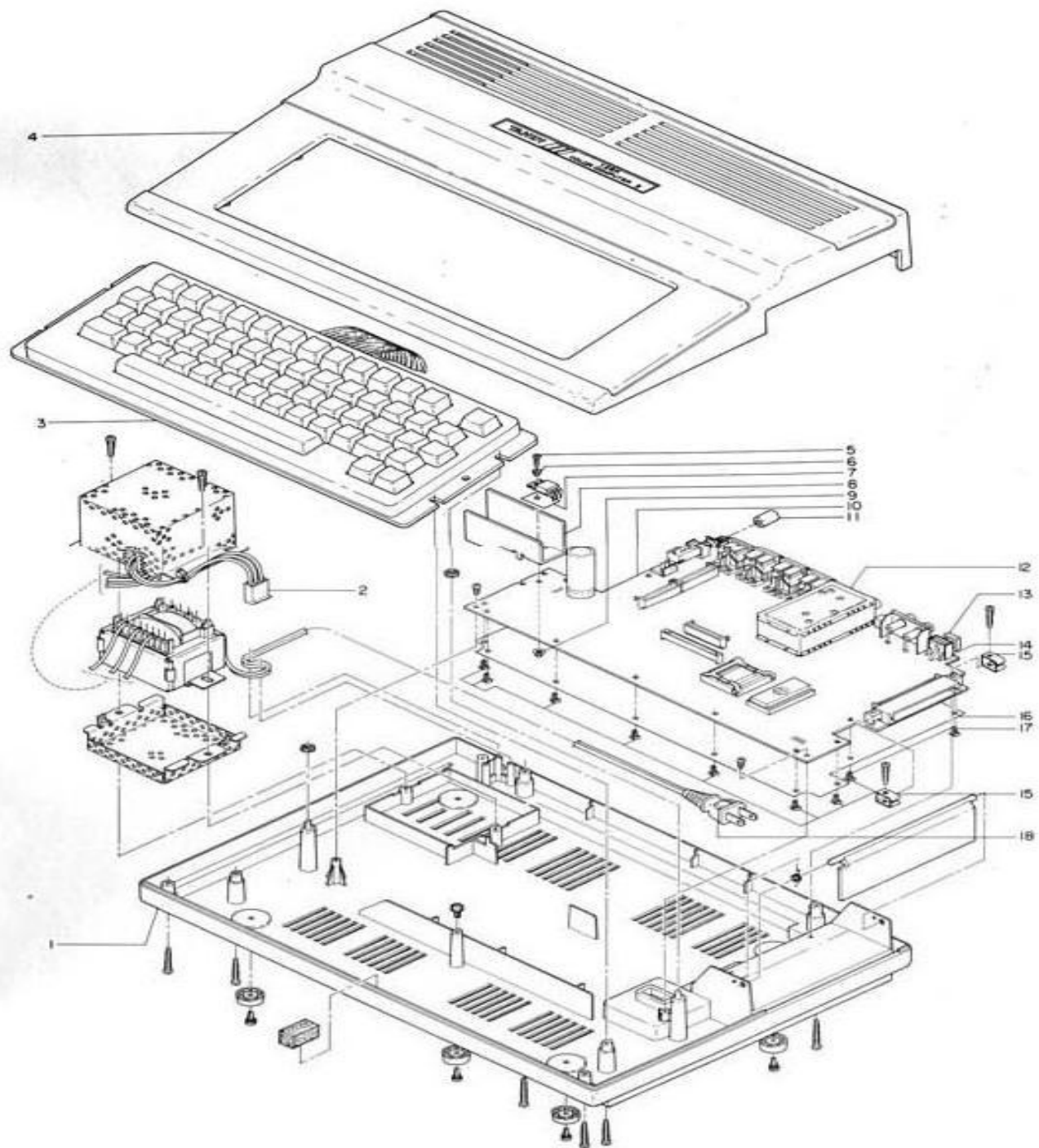
The Color Computer 3 is available at more than 7,000 Radio Shack stores, Computer Centers and participating dealers nationwide. See it today!

Price applies at Radio Shack Computer Centers and participating stores and dealers. Monitor, disk drives, software and monitor platform sold separately.

Radio Shack®
The Technology Store™
A DIVISION OF TANDY CORPORATION



CoCo 3 magazine ad, circa 1987



Exploded view of a 128K CoCo 3. Other CoCo models are similar.

Photo Gallery... *an added bonus!*

ADDED FEB 2006

Since this is a PDF publication, there is no added publication costs for a lot of pictures! Well, not until the user prints it out anyway. I thought the pics would be both useful and enjoyable though. I hope you think the same. The following pics are printed courtesy of Dave Dunfield, <http://www.parse.com/~ddunfield/museum/coco/index.htm>.



Left: Original 4K silver TRS-80 Color Computer.
Right: Last edition of the CoCo1, the white 64K Color Computer.



Left: TRS-80 labeled Color Computer 2
Right: Tandy labeled Color Computer 2

The CoCo3 used the same size case as the CoCo2, but changed the keyboard layout. The arrow keys were arranged together on the left and four new keys added: a CTRL (control) and ALT (alternate) key in place of the CC2 up and down arrows and an F1 and F2 (function 1 and 2) on the lower right. The BREAK and CLEAR keys were also repositioned.



ABOVE: Rear views show how motherboard arrangements changed. Labeled left to right: Top, CoCo1: Reset button, RF out, RF Channel selector, Cassette port, Serial Port, Joystick ports (2), Power switch. Center, CoCo2: RESET button, Cassette port, Serial port, Joystick ports (2), RF channel selector, RF out, Power switch. Bottom, CoCo3: RESET button, Audio/Video jacks, RF channel selector, RF out, Cassette port, Serial port, Joystick ports (2), Power switch.

RIGHT: Side views. Cartridge ports remained the same, but motherboards got much smaller with the CoCo 2 and 3.





A complete CoCo 1 system. The original keyboard (on dust cover in front) has been replaced with a later model CoCo 2 keyboard or an aftermarket version. Many people didn't like the original "chicklet" keyboard.

The original box would have included the CoCo1, user manual, and antenna lead switch box located beside the cassette recorder. Of course the recorder was needed to save anything, and every CoCo enthusiast had a collection of game cartridges and at least one joystick. Cartridges should only be removed or inserted with the power off! That's something CoCo owners learned quickly -- many the hard way! Later cartridges had the power land shortened to prevent shorting to ground and blowing the 6809.



A complete CoCo 2 system. The manual isn't shown. The disk drive system was almost a necessity with the CoCo2, though a cassette recorder could be used with cartridge or tape based programs. Anyone who messed with tapes for long really wanted a disk system and would get one as soon as they could afford the ROM and RAM (at least 32K required, I think) upgrades and the disk system. The good thing about the CoCo is that it could use standard IBM type drives. These could be purchased used to reduce costs. The disk controller was strictly a Radio Shack item for several years, then a few aftermarket companies such as Disto started making them.

The controller was still the most expensive component.



Now this is quite the CoCo 3 setup! The white box and instruction sheet in the lower right is for the whopping 512K upgrade. The box in the center left is an appliance and light controller -- use the CoCo to run your house! The CoCo 3 shipped with three books: The Extended BASIC Manual, Introduction, and Quick Reference. The books in the center right are French versions. Note the spelling on the box -- the box is for the Canadian version of the CoCo3.



To the left is the original FD-500 floppy disk controller with a late model dual drive case. To the right is an Owl Ware aftermarket controller and dual drive setup. Early Tandy drives also used the vertical installation case. The first drives used were very similar to the TRS-80 Model I and Model III/IV drive shown below except that the transformer was inside the case instead of hung on the back.

The author's (F. Swygert) first drive system consisted of a used TRS-80 Model I drive and a Radio Shack FD-500 controller. The single full height drive was later removed and a pair of surplus half height drives installed.





The Dragon 32 was a CoCo Clone made in England by Mettoy (later Dragon Data) and in the US by TANO under license from Dragon Data. The ROMS had to be changed slightly to prevent copyright infringement problems with Tandy. Only slight changes need to be made for most BASIC programs to run. Machine Language programs require recompiling. Most of the connectors are on the left side, including a standard parallel printer port.





There was a law in Brazil in the 1980s preventing foreign computer makers from importing products. This was to help the Brazilian electronics industry. Prologica teamed up with Sinclair at first to make a ZX-81 clone, the CP-200. It then teamed with Tandy to produce the CP-300 and CP-500 TRS-80 Model I/III/IV clones, the 500 being aimed at the business market, the 300 for the home market. This led to a CoCo2 clone, the CP-400. Cartridges fit in the front under the hinged lid on the right and the transformer was outside the case. This is a true clone licensed from Tandy but with a Brazilian designed case. The ROMS were edited to display "Prologica" instead of Tandy. CoCo cartridges won't fit the CP-400 case, but programs are compatible. (NOTE: These photos are from an e-bay auction, not from Dave Dunfield's page.)





It is unknown whether or not the Sampo Color Computer ever actually hit the marketplace anywhere, though it was advertised briefly in the November 1982 issue of "BYTE" magazine, in a special advertising section entitled "Computers in Taiwan". According to the ad, the Sampo Color Computer uses the 6809E CPU, and Extended BASIC -- the same general features found on the Radio Shack Color Computer, though the ad mentions true lower case (lacking in the first Radio Shack Color Computer), and a full-travel keyboard. The ports are shown on the right side of the computer. It could have been a clone of the Dragon instead of directly a clone of the CoCo.

RADIO SHACK'S AFFORDABLE TRS-80 COLOR COMPUTER ATTACHES TO ANY TV FOR FAMILY FUN AND EDUCATION

NOW GET 16K MEMORY—BUILT IN—FOR
*139 LESS THAN LAST YEAR'S EQUIVALENT!

549⁰⁰
Less TV

- EIGHT VIVID COLORS—EXCITING SOUND EFFECTS
- USES INSTANT-LOADING PROGRAM PAKS
- LEARN TO WRITE PROGRAMS IN COLOR BASIC

TRS-80 STANDARD COLOR COMPUTER. Our most popular family computer now comes with four times the memory—and costs only \$549.00! Plug in a handy Program Pak* and you can balance the family budget, practice math, analyze your investment portfolio, or update household files. You can play exciting action games, too! Teach yourself programming with our entertaining 300-page manual. Expand with a printer, telephone communications, disk drives. 26-3004 **549.00**

EXTENDED BASIC ROM KIT. Upgrades 16K Color Computer for simple access to high-resolution graphics. 26-3014 **149.00***

NEW LOW PRICE! 16K RAM UPGRADE KIT. Converts 4K Color Computer to 16K. Was \$139.00 in 1982 Catalog. 26-3015 **69.00***

*Upgrade kit prices do not include required installation.

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EXTENDED BASIC COLOR COMPUTERS!**

DOUBLE THE PROGRAMMING POWER
LETS YOU CREATE HIGH-RESOLUTION
GRAPHICS WITH COLOR AND SOUND

Low As
699⁰⁰
Less TV

TRS-80 COLOR COMPUTER WITH EXTENDED BASIC. Now advanced programming is more affordable than ever! With Extended BASIC, it's easy to draw highly-detailed shapes using simple, one-line commands. Produce impressive designs, charts, even animation! And it's loaded with the dynamic features a serious programmer needs. Includes tutorial manuals on both Standard and Extended Color BASIC.

16K EXTENDED BASIC COLOR COMPUTER. Was \$799.00 in 1982 Catalog. 26-3002 **699.00**

32K EXTENDED BASIC COLOR COMPUTER. Was \$949.00 in 1982 Catalog. 26-3003 **899.00**

32K RAM UPGRADE KIT. Converts 4K or 16K Color Computer to 32K. 26-3017 **199.00***

Radio Shack

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1983 magazine advertisement

TRS-80® COLOR COMPUTERS—BETTER THAN EVER

Our Color Computers Are Ideal for Entertainment, Education and Home Use

16K Standard
Color Computer 2

349⁰⁰
Less TV

NEW
FOR '84

16K Extended
Color Computer 2

459⁰⁰
Less TV



- Each Model Uses Instant-Loading Program Paks
- Eight Vivid Colors • Exciting Sound Effects

TRS-80 Standard Color Computer 2. We improved our most popular family computer with a compact white case, low-profile, electric typewriter-quality keyboard and a price that's \$100 less than last year's model! Easily attaches to any TV—then Program Paks let you set up a budget or monitor your investments, and help the kids develop math and reading skills. You can also learn how to program, battle starships, run a maze, play baseball—and lots more. Expand with a cassette recorder, disk drives, a printer or telephone communications. With entertaining 308-page beginner's manual. **26-3026 349.00**

TRS-80 16K Extended Color Computer 2. All the features of the Standard Color Computer 2, plus advanced programming capabilities to make spectacular, high-resolution color graphics with music and sound effects using simple one-line commands. Powerful programming features include PEEK, POKE and USR commands, multi-character variable names (two significant), string arrays up to 255 characters, full-featured editing, tracing and 9-digit accuracy. Includes tutorial manuals on both Standard and Extended BASIC. **26-3027 459.00**

Specifications

Microprocessor: 6809E 8-bit processor. **Clock Speed:** 0.894 MHz. **Keyboard:** 53 keys, including up, down, right and left arrows, BREAK and CLEAR. **Video Display:** 16 lines of 32 upper case characters. Color graphics capabilities range from 32 x 64 (8 colors) to 192 x 256 (1 color and background color) with 3 intermediate formats. Higher resolutions in the same range are available through machine language, Extended BASIC or Program Paks. Output connects to any standard TV set (300 ohms) and includes video and sound. **Memory:** 16K internal dynamic RAM. Expandable to 64K. Color BASIC is in 8K ROM, 16K ROM with Extended BASIC. **Input/Output:** 1500-baud cassette (recorder optional). Connectors for two 2-dimensional joysticks (optional). RS-232C serial I/O port. **Interrupt Timer:** Accessible from Extended BASIC or machine language only. **Dimensions:** 3 x 10 3/4 x 14 3/4". **Power:** 120VAC, 60 Hz, 50W.

Color Computer Upgrade Kits Add More Memory and Better Graphics

16K RAM Upgrade Kit. Converts a 4K Color Computer to 16K. **26-3015 69.00***

64K RAM Upgrade Kit. Converts a 4K, 16K or 32K Color Computer to 64K. **26-3017 199.00***

New Low Price! Extended Color BASIC ROM Upgrade Kit. Upgrades a Color Computer for advanced graphics capabilities. Requires a minimum of 16K. Was \$149.00 in 1983 Catalogue. **26-3018 110.00***

New Keyboard Upgrade Kit. **26-3016****

*Upgrade kit prices do not include required installation.

**Under development. Price and availability to be announced.

178

Items Shown Are Available Through Selected Radio Shack Stores, Computer Centers and Participating Dealers

Color Computer Accessories Add Even More Fun to Games

A Color Computer Joysticks. For faster, more realistic action. 360° movement. Single-shot button.

26-3008 Pair/29.95

B NEW! Color Mouse. For the ultimate cursor control! Adds speed and ease to game-playing and to creating color graphics. Use alone or with a joystick.

26-3025 69.95



NEW LOW PRICE

29⁹⁵
Pair

Was \$37.95/pair
in 1983 Catalogue

NEW
FOR '84

69⁹⁵

Time-Saving Color Computer Multi-Pak Interface

269⁹⁵

NEW
FOR '84

NEW! Multi-Pak Interface. Connect up to four Program Paks to your computer at once! Play repeatedly without changing setup or cartridges!

26-3024 269.95

NEW! Deluxe RS-232 Program Pak®. Communicate with information services! **26-2226 119.95**



From 1984 Tandy Catalog

POWERFUL COLOR COMPUTER 3



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NEW FOR 87

219⁹⁵

Less Monitor \$20 Per Month*

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- Produce Sharp, Crisp Graphs and Illustrations
- Display 32 x 16, 40 x 24 or 80 x 24 Text
- 160 x 192, 320 x 192 or 640 x 192 Resolution
- Use With a High-Resolution Monitor or Your Own TV
- Expands Easily As Skills and Needs Grow

128K Extended BASIC Color Computer 3. Introducing Radio Shack's newest version of our famous Color Computer. The Color Computer 3 can be used in a variety of applications such as graphics, programming, budgets, word processing, database management, spreadsheet analysis and many others. The Color Computer 3 comes with 128K memory (expandable to 512K), and gives you the advantage of greater programming and data processing power, as well as higher resolution graphics. Simply connect the Color Computer 3 to a high-resolution monitor—like the new CM-8 monitor (sold separately, at

right)—and you can create incredibly detailed charts, graphs and engineering drawings in vivid colors. The special higher graphics mode lets you paint 160 x 192- or 320 x 192-resolution graphics using 16 out of the 64 total colors. Or produce razor-sharp 640 x 192-resolution in 4 colors. The 21 new commands featured in the Color Computer 3's Extended BASIC language allow you to switch between screens, colors and backgrounds at a higher resolution and in a greater variety of colors than any previous Color Computer. When connected to a TV, the Color Computer 3 will display text in a 32-character by 16-line format. Get a 40-character by 24-line or 80-character by 24-line display with a monitor. Best of all, the new Color Computer 3 is compatible with software and accessories designed for the Color Computer 2 (in the Color Computer 2 mode). Expands easily with disk drives, printer, telephone modem and more. UL listed AC. 26-3334 219.95

Color Computer 3 512K Upgrade Kit. Installation required (not included). 26-3335 149.95

New! High-Resolution Color Monitor

CM-8 RGB Analog Color Monitor. Designed for use with the Color Computer 3. Displays up to 80 x 24 text and 640 x 192 graphics. It is the perfect complement to the superb graphics capabilities of the Color Computer 3. The CM-8 features a 13" diagonal screen and a built-in speaker with volume control. Includes cable. UL listed AC. 26-3215 299.95

SPECIFICATIONS FOR COLOR COMPUTER 3. Microprocessor: 68B09E 8-bit. Clock Speed: 0.894 MHz or 1.788 MHz. Keyboard: 57 keys, including Control, Alternate, F1 and F2. Video Display: 16 lines of 32 characters (uppercase only) to 24 lines of 80 characters (uppercase/lowercase). Color graphics capabilities range from 64 x 32 (8 colors) to 640 x 192 (4 colors and background color) with 8 intermediate display formats. High-resolution graphics in the same range available through machine language, Extended BASIC or Program Paks. Memory: 128K RAM—internally expandable to 512K. Twenty-one commands in enhanced Extended BASIC. Input/Output: 1500-baud cassette (recorder optional). Two joystick ports. RS-232C serial port (4-pin only). Standard TV (300 ohms), composite monitor and RGB Analog Monitor outputs. Dimensions: 3 x 10 1/2 x 14 1/4". Power: 120VAC, 60 Hz.

SPECIFICATIONS FOR COLOR COMPUTER 2. Microprocessor: 6809E, 8-bit. Clock Speed: 0.894 MegaHertz. Keyboard: 53 keys. Video Display: 16 lines of 32 characters (upper case only). Color graphics capabilities range from 64 x 32 (8 colors) to 256 x 192 (1 color and background color) with three intermediate formats. Memory: 16K ROM and 64K RAM. Input/Output: 1500-baud cassette (recorder optional). Two joystick ports. RS-232C serial port (4-pin only). Standard TV (300 ohms) output. Dimensions: 3 x 10 1/2 x 14 1/4". Power: 120VAC, 60 Hz.

From 1987 Tandy Catalog

*REVOLVING CREDIT AVAILABLE—See Page 2

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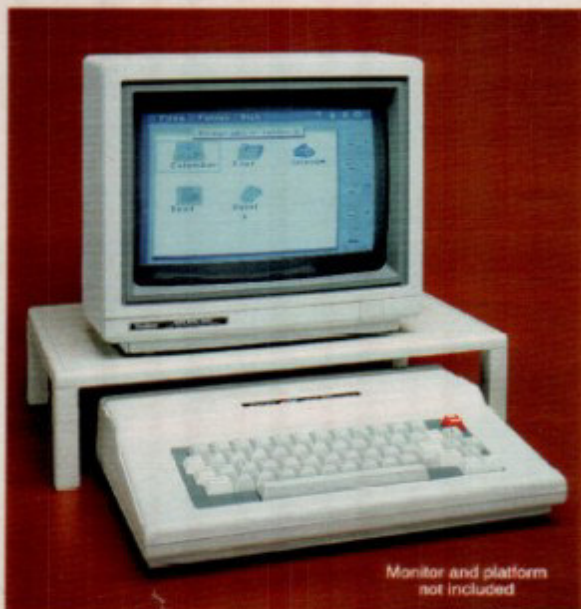
VERSATILE COLOR COMPUTER 3™

Ideal for the Whole Family

199⁹⁵

Low As \$15 Per Month*

- Produces Sharp, Crisp Graphs and Illustrations
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Monitor and platform not included

SPECIFICATIONS. Microprocessor: 68000E 5/16-bit. Clock Speed: 0.004 MHz or 1.788 MHz. Input/Output: 1500-baud cassette (recorder optional). Two joystick ports. RS-232C serial port (4-pin only). Standard TV (300 ohms). Composite Monitor, and RGB Analog Monitor. Dimensions: 3 x 10 1/8 x 14 1/4". Power: 120VAC, 60 Hz. Certification: FCC Class B.

128K Extended BASIC Color Computer 3. Ideal for graphics, programming, budgets, word processing, database management, spreadsheet analysis and many other applications. The Color Computer 3 comes with 128K memory (expandable to 512K), and gives you the advantage of greater programming and data-processing power, as well as higher-resolution graphics. Simply connect the Color Computer 3 to a high-resolution monitor—like the CM-8 (sold separately, below)—and you can create incredibly detailed charts, graphs and engineering drawings in vivid colors. Compatible with most software and accessories designed for the Color Computer 2. UL listed AC. 26-3334 199.95

Monitor Platform. 26-1329 19.95



CM-8 RGB Analog Color Monitor. 1 80 x 24 text, 640 x 192 graphics. 13" diagonal screen. Built-in speaker with volume control. Includes cable. UL listed AC. 26-3215 299.95



FD-502 Color Thinline Disk #0. Turn any Color Computer with Extended BASIC into a disk system. Write your own disk applications or add ready-to-run software. Plugs into the Program Pak port or Multi-Pak Interface. UL listed AC. 26-3133 299.95

Color Computer Upgrade Kits and Enhancement Options

DC Modem Program Pak



89⁹⁵

RS-232 Interface and 300-bps Modem

Transfer/receive ASCII files or access information services by phone.

26-2228 89.95

Deluxe Joystick



29⁹⁵

Get accurate cursor control and quicker response. Select "spring-centering" or "free-floating". 26-3012 29.95

Joysticks



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Our lowest priced joysticks. Now two players can experience the fun. Fast 360° movement! Single-shot button.

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9⁹⁵

Lets you address higher-resolution graphics modes (up to 640 x 640).

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49⁹⁵

Simply "roll" across tabletop to position the cursor. Two buttons for Tandy 1000-compatible software. 26-3125 49.95

Hard Disk Interface



Utilize Primary Drives

129⁹⁵

Requires 64K, Multi-Pak Interface, floppy disk with controller and OS-9 (2.0 or later). 26-3145 129.95

Kits and Upgrades

16K RAM Upgrade Kit. 2 26-3015 29.95*

Low-Profile Keyboard Kit. 2 26-3016 24.95*

64K RAM Upgrade Kit. 2 Converts a 4K, 16K or 32K Color Computer. 26-3017 59.95*

Second Drive for FD-502. Requires installation (not included). 26-3135 179.95

512 RAM Kit. 1 26-3335 149.95

Operating Systems

OS-9 Disk Operating System. 26-3030 69.95

OS-9 Level Two. 1 Supports 512K RAM and dual speed. 26-3031 79.95

OS-9 Development System. 1 Complete editor and assembler with full-screen editing. Requires OS-9 Level Two. 26-3032 99.95

Multi-Vue. 1 User-friendly graphics interface for Level Two programs. 26-3035 49.95

Save \$40 on an FD-502 Disk Drive and a Level One or Two OS-9 Operating System

FD-502 and OS-9 Level One. Reg. Separate Items \$369.90.

26-3133/26-3030 329.90

FD-502 and OS-9 Level Two. Reg. Separate Items \$379.90

26-3133/26-3031 339.90

44

Items Shown Are For Use With the Color Computer 2 or 3, except as indicated: 1 Color Computer 3 only. 2 Color Computer 2 only. *Installation Required (Not Included). Some Installations May Require Additional-Cost Hardware. OS-9™ Microware and Motorola.

1989 Tandy catalog CoCo3 page.

Tandy catalogs from 1977-1991 can be downloaded from Ira Goldklang's site:
<http://www.trs-80.com/trs80-cr.htm>. This file came from his 1989 archived catalog.

REAR COVER

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The Last CoCo --1/4 page spot in 1991 Tandy catalog

Tandy's Little Wonder

the Color Computer: 1980-1991

Second Edition

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Published by FARNA Systems
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