*This article was written some months back, and since then the Digital Group has come up with a nice collection of cabinets to house the various subassemblies which make up their system. With a couple of additions, the comments and observations I made regarding their system still hold true (90% favorable, I might add). The first additional comment concerns the Digital Group monitor program and the fact it resides in page zero. This seems to cause problems when it comes to loading other software in almost every instance. One owner, I know even went so far as to put a switch in which allowed him to select between the monitor's PROM or RAM memory in page zero. Naturally, he still isn't able to use the PROM for loading programs into page zero . . . the answer seems to lie in relocating the monitor elsewhere in memory. The second additional comment concerns the fact the Digital Group didn't go with the Altair bus. Granted their bus layout may even be better than the Altair, there are still a lot of occasions when a Digital Group owner would like to have one of those peripherals, or options, which plugs into the Altair. On the other hand, there are probably a lot of Altair system owners that would like to be able to use the Suding Phi-deck controller or video driver or whatever. If someone has developed a Digital-Group-to-Altair interface (or is thinking about it),* Kilobaud Magazine *would be tickled pink to pay you well for the plans (i.e., a construction article). — John.*
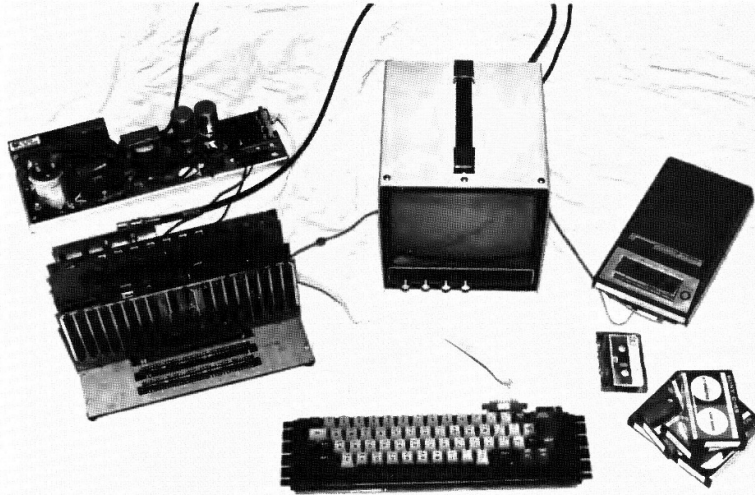
The Digital Group System (posing for a photo). Starting at top-center and going clockwise: the Sanyo Monitor; substitute El Cheapo (but good) Roberts cassette recorder (normally a Superscope C-104); some of the gobs of software available on cassettes; the keyboard; the motherboard, with the four boards of a basic system plugged in (8K of RAM, CPU board w/2K of RAM, video and cassette interface board, and the I/O board with four input and four output ports) with room for memory and I/O expansion; and last, a more than adequate power supply.

What's that Digital Group Really Doing?

*John Craig
Editor*

If you can design and build a microcomputer system that will play the Star-Spangled Banner through an AM radio and at the same time generate an American flag on a TV screen, it doesn't really *have* to do anything else! The average layman will be so fascinated by this demonstration that the last thing in the world he'll ever ask is, "But what are you going to use it for?" (You've heard that one before, right?)

Dr. Robert Suding WØLMD is the man behind the design of the Digital Group System, and you can rest assured that the system is capable of doing much more than playing the Star-Spangled Banner. One of the main objectives behind the design of the system was to make it a truly "turn-key" system (i.e., build it, connect the various components, apply power, and begin operating). I'm here to tell you he/they did it!

There are several things about the system which are impressive just from first glances. Quality prevails in almost every instance (and, I'll be sure and clue you in on the one or two places I feel it doesn't ... keep count, I think it's only ONE). Upon walking up to one of these systems, your eyes first fall upon the 9 inch Sanyo monitor (not a regular TV) and the sharp, clear characters being displayed. The character set includes both upper and lower case, as well as the Greek alphabet (just what you always wanted, right?). The quality of the PC boards is equal to, if not better than, boards I've seen put out by some of the biggies. The cassette recorder sold with the system is a Superscope C-104 with variable speed and other neat features. It's a rather expensive unit ($119.50), but then it's really the heart of the system and they figured it shouldn't be compromised. I might add, however, that the system I

worked with didn't have this recorder with it, so I proceeded to connect my $24.95 Roberts recorder (pictured in the upper right-hand corner of the photo) and didn't have any problems with reading prerecorded programs.

The keyboard was the one item which I didn't get too excited about. In the documentation supplied with the system they make quite a point of the fact that if you're dissatisfied with any item they welcome its return. Therefore, if a body felt as I did about this keyboard, it could certainly be returned for a refund or an exchange, and I understand they will be offering a different model (or models) in the future.

CPU-Independent Architecture and Upgradability

A very unique, and certainly worthwhile feature of the system is the fact that the architecture isn't dedicated to any one particular microprocessor. The 8080 CPU board is the most popular, but DG also offers a CPU board which has your choice of a Motorola 6800 or a MOS Technology 6502 (with only two or three jumpers necessary to go from one to the other). There's going to be a lot of software developed within the hobbyist community for all three of these processors, and there aren't too many systems around offering this capability.

And, talk about upgradability!! How's about upgrading to the ZILOG Z-80?? The Z-80 has got to be one of the hottest items to come out of the Silicon Valley in quite some time ... and DG has put together a CPU board using the little beast. Here are just a few of its worthy features: 1) Refresh for dynamic memory is generated internally within the chip, and the refresh address register can be accessed for *random number generation*! 2) Two sets of six general-purpose registers, which can be combined in pairs to form 16-bit registers. 3) Instructions for moving any size

block of memory and also for searching a block of memory for a particular value. 4) Bit manipulation instructions. 5) And more ...

Construction

The unit I worked with was already built and running, but a friend of mine, Robert White, recently constructed a DG system and had some worthwhile comments. Perhaps the most significant was the fact he felt the construction documentation was adequate for the job. He brought up the system by plugging each board into someone else's unit (which is one of the advantages of finding another unit in your area ... during the firing up of *any* system). He also mentioned that a scope was necessary for checking the timing and performing the cassette board alignment. On a scale of 1 to 10, he gave the unit a resounding 10.

The Digital Group System doesn't have a front panel. If you've ever had occasion to troubleshoot a computer
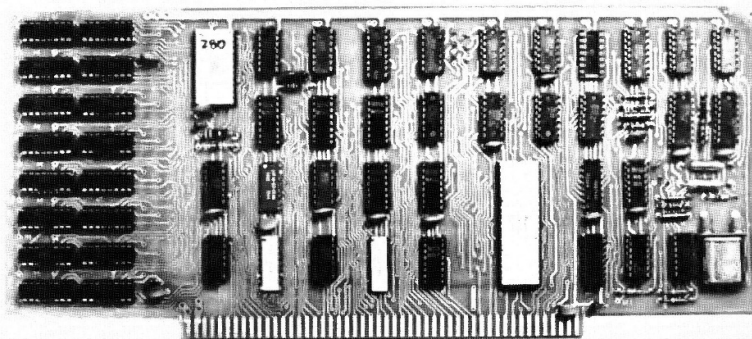
The new Z-80 CPU board (for only $50 more than the 8080 board!).

Features (displayed on the screen after reading in the TBX-TVCOS cassette):

1. READ BASIC Program (from cassette)
2. WRITE BASIC Program (to cassette)
3. Display Commands (displays an unannotated list of TBX commands on TV screen)
4. Display Error Codes (annotated list of TBX error codes listed on TV)
5. Continue Programming (useful for exiting and re-entering BASIC program during debugging)
6. TINY BASIC (causes entry into TBX for writing BASIC programs)

TBX Commands:

LST — List Program
RUN — Execute (run) resident program
NEW — Start new program (& "scratch" old)
SZE — Display resident program size
PR — PRINT output data
IN — Enter (INPUT) a value from keyboard
LET — Assign a value to a variable
IF — Conditional test statement
FOR — Beginning of a loop
NXT — End of loop
GOTO — Alter program execution sequence (Jump)
GOSUB — Jump to subroutine
RET — Return from subroutine
DTA — Assign value(s) to simple or single dimensioned array variable (equivalent to LET)
DIM — Assign array dimension(s)
END — End of program

Table 1. Tiny BASIC Extended TV-Casette Operating System, Features and Commands.

without a front panel, perhaps you can appreciate the value of one. (Very handy for single-stepping through a program or entering short troubleshooting routines ... so you know exactly what the machine is doing, rather than trying to also figure out what's going on with the Monitor program.) The Digital Group folks apparently didn't go the front panel route because of the reliability of their unit. But for those desiring one, they have very thoughtfully provided construction plans for building one.

The Software!

Digital Group Software Systems, Inc. (DGSS) is a company formed by DG for software distribution. The operation is run by Charles and Dianne Howerton in Arvada, Colorado. They try to ship all orders within a 24 to 48 hour time frame ... and if they can't, notify the customer. All shipments are guaranteed, and they've replaced several cassettes that

have developed "glitches" after being shipped. They pointed out that it is very unwise to place cassettes on top of, or beside, TV monitors ... especially those with metal cabinets.

When power is initially applied to a Digital Group System, the message "READ 8080 INITIALIZE CASSETTE" appears on the monitor screen. One simply starts the cassette recorder at the beginning of the program to be loaded, and when a steady tone begins, the reset button is pushed and released. At the end of the tone leader, the program is read into main memory. The TV displays the least significant digit of the octal page currently being loaded, byte by byte (so you can "see" the program as it's coming in). Memory is also checked byte by byte and missing or defective memory addresses are indicated by a period (".") rather than the octal digit of the page. This cassette loader program in ROM is further

evidence of the "turn-key" characteristic of the system.

Following is a list and brief description of some of the neat software available from Digital Group Software Systems:

TINY BASIC EXTENDED TV-CASSETTE OPERATING SYSTEM — Developed by Dick Whipple and John Arnold of Tyler, Texas. Tiny BASIC Extended (TBX) was their baby, and Dr. Suding interfaced it with TV and cassette drivers to come up with the Operating System (TBX-TVCOS). A very neat package, and easy to use. Table 1 lists the features and commands available with TBX-TVCOS.

8080 OPERATING SYSTEM (standard with the system) — Provides the user with cassette read and write routines, memory dump, and machine language programming capability from the keyboard. Also has a "calling" feature so that the user can call up a particular program or routine in main memory and run it. This cassette also includes five demonstration and diagnostic programs:

1. *Computerized Amateur Radio* ... with a "CW Keyboard" routine (speed selectable) and a "RTTY Receive" routine for converting frequency shifted 60 wpm Baudot to ASCII and displaying the characters. (Very simple to implement.)
2. *Synthesized Music* ... described earlier ... that's the program that plays the Star-Spangled Banner while drawing an American flag on the monitor. (Interesting insofar as a regular AM radio is used to pick up the music ... resulting from frequency modulating the data paths with different timing loops.)

3. *15 Hz to 10 kHz Frequency Counter* ... developed by implementing a very small amount of external circuitry (an FET, a transistor, etc.) and sampling an incoming audio frequency using the CPU's crystal-controlled clock.
4. *CPU Interrupt Handler Diagnostic*
5. *Memory Diagnostic* ... right down to the bad chip.

THE GAMES ... AND MORE GAMES — Computers are for kids (young *and* old), and DGSS has certainly put together an impressive collection of games written in Tiny BASIC. They have (at the time this was written, anyway) four cassettes of Tiny BASIC games ... each cassette with five or more games. The number of programs prevents them from all being listed here, but some of the more popular ones are: CHOMP, CHECKERS, TIC-TAC-TOE, BIORHYTHM, TRAP, BLACK-JACK, 23 MATCHES, plus some good educational and simulation game programs. Also, available on a separate cassette are the game of KINGDOM and two versions of LIFE.

EDUCATOR-8080 — This is a very interesting program which demonstrates the effect executing certain instructions has on the status, Accumulator, and B and C registers of an 8080. All of them are displayed on the screen; you enter an instruction and then see the change. Quite a program for a teaching environment. (The only limitation was the fact that memory reference instructions couldn't be executed.)

The cassettes are reasonably priced at $5 to $10 ... are recorded on high-quality tape ... and are checked before shipment. Listings are not provided in an effort to keep the cost down ... but