DIGITAL GROUP SYSTEMS

Congratulations on obtaining a Digital Group microprocessor system. We hope you will be more than satisfied with your system. Please send us your negative and positive comments. While no one system will be exactly designed the way every individual would desire, we have tried to provide a system which would satisfy most people's requirements. The designs had to be simple, low cost, easy to build and maintain, updatable and simple to use effectively. These conflicting objectives are difficult to totally meet, but we hope that you will pleased with our resulting system.

System

A minimum Digital Group microprocessor system consists of three P. C. boards (CPU, I/O, and CRT Readout & Cassette) and a mother board to provide the necessary interconnections. Additional PC boards are, or will soon be, available to provide additional storage, storage display, I/O, and I/O related functions.

A power supply provides ±12V at 1 amp, -5V @ 1 amp and +5 volts at the needed current. A cabinet houses the system and connectors provide convenient interfaces to external devices.

TV monitors, ASCII keyboard, and a Cassette recorder provide the required minimum I/O. This general guide to system architecture should enable you or a helper to successfully complete a Digital Group System with a minimum of difficulty.

Construction of PC Boards

So you've got sacks of parts. Now what? First, analyze your own abilities. While we have tried to simplify construction as much as possible, and your responses will help future builders, a certain minimum level of expertise is obviously required. That's one reason why assembled and tested PC boards were advertised. If you find that a kit is just too much for you, arrange for a friend to help you, or contact the Digital Group to arrange an exchange for an assembled unit. We want you to succeed, one way or the other!

The various kits have different levels of expertise required for successful construction. We would recommend that you begin construction with the I/O board. You will find construction fairly open and easy. Wire the jumpers and IC's so that the board is set up for decoding Ports Ø, 1, 2, and 3.

The next board to construct is the CRT Readout/Cassette Interface board. The Cassette Interface section is rather open and easy to solder, but more involved to align. The CRT Readout requires a considerable amount of fine soldering work, so be careful. Be sure to carefully align the Cassette Interface section. Final alignment of the VCO section is accomplished under microprocessor control.

The 8K memory board should be built next if you have ordered one. (You get the idea that you're sneaking up on the CPU card, don't you!) Initially set up the jumpers on the memory board for ØK - 8K range but leave off the lowest order 16 2102's (IC00 - IC17). This will facilitate later memory testing.

Build the CPU card with great care. Initially assign the 2K RAM to the lower 2K of memory.

Cabinet Construction

The cabinet chosen for your Digital Group system is up to your personal desires. Some possible options:

a. A microprocessor only box.
b. A microprocessor and TV set cabinet.
c. A microprocessor and TV set with attached keyboard.
d. Microprocessor as a part of a much larger system.

A discussion of cabinet designs utilized for some Digital Group Standard Motherboard with 26K of memory systems may serve as a guide to those designing their own systems.

A Moduline MCP 7-17-12 @ $30.56 was used for the basic cabinet. This unit looks good, is sturdy, and is fairly reasonable. The measurements are 7" high, 17" wide, and 12" deep. Colors used were blue in one case, tan in another. Moduline cabinets are also available in grey or black. Other slightly larger cases are also available. An 8" x 17" x 14" model @ $35.60 gives more room, but seems a bit bulky. For a brochure and local availability, write to:

Insta Fab, Inc.
425 Queens Lane
San Jose, CA 95112
(408) 286-5596

The system pictured in the Digital Group's Flyer #5 showed the 26K Blue system. This system had the +5 @ 12 amp OEM supply mounted on the outside of the rear wall of the cabinet to eliminate a major source of heat from the inside of the cabinet. The ±12V and -5V low-current supplies were mounted inside the cabinet at the left of the system's boards. A flat fan was mounted on the right side near the front, and an exhaust hole was placed on the left. This provides a good flow of air past the memories and CPU card.

The Standard motherboard was mounted upon an 1/8" thick aluminum plate, with a portion cutout to clear the Standard motherboard's connectors and lines. The front memoryboard is spaced about 1" from the front panel. The 1/8" aluminum plate was attached to the sides of the cabinet using some 1/2" angle aluminum available from most hardware stores. The various Power and Reset/Start switches were then wired as well as the power supplies to the appropriate mother-

board terminal. Lines may be either soldered to the motherboard terminals, or lugs may be used, but be careful of shorts.

A connector block from an old surplus 2nd generation computer was used with the blue system to provide a ready means of disconnecting and changing external I/O. A 17 or more parallel pin connector block for each port is advisable to provide an 8 bit in, 8 bit out, plus common ground connection per port capability. The tan system used the Molex connectors shown in the Digital Group Flyer #5, and the flat cable lead to external devices was brought directly out through a 1" grommetted hole at the rear.

A BNC connector and two miniature phone jacks are mounted on the rear wall to provide a convenient means of connecting the TV monitor and cassette record/playback.

The power cord is a 3-wire grounded type with the metal chassis grounded.

TV Monitor

The TV monitor used with the Digital Group systems may be either a TV specially designed for use as a monitor, or it may be a converted TV set.

The commercial monitor will generally give the highest quality picture. Some monitors may be overloaded by the Digital Group's CRT Readout. The ≈3V of video output can be easily reduced by placing a 10 ohm resistor across the video output cable near the TV.

Byte magazine, October, 1975 p. 20 gives a good description of converting an old B&W TV set to a monitor. 6MHz or greater bandwidth is highly desirable. Avoid non-transformer operated sets! Small screen transistor sets frequently have very poor quality, especially in corner focus. Older transformer operated tube portables, although bulky, seem to give the best pictures.

Cassette

The cassette recorder can range from a $20 El Cheapo to a $300 Hi Fi wonder. However, we would recommend a well-constructed portable in the $100 range as being the best choice. Our preferred recorder is a Superscope C104 @ $120 list, but generally available for $100. Several desirable features to look for are:

a. Steady tone! (low "wow" and Flutter.)
b. Low noise - freedom from buzzes, crackling & harmonics of tones.)
c. Index counter.
d. Battery or AC operation.

e. Built-in speaker & Amp. (audible monitor of data start & stop).
f. Variable playback speed. (useful for matching data tapes from friends using out of speed tolerance tapes.)

The C104 has all of the above characteristics, and has been a good, troublefree unit. A 3KHz tone was recorded on an expensive "Hi Fi" cassette with very good speed characteristics. The cassette was then played on several recorders at the department store and the best recorder purchased. I got a few strange looks initially, but after explaining my intentions, further questioning by the curious was prudently surpressed.

The recorder's earphone jack should be modified so that insertion of a miniature phone plug cable will not disconnect the speaker (see pictoral).

What cassette tapes to use is another rather general area. Don't waste your money on "cheap" tapes. Rather extensive testing at data rates several times faster than the 1100 baud of the Digital Group Group Systems has resulted in the following recommendations:

Good: Memorex MRX2
Maxell UD

Fair: Sony Low-Noise
Realistic Low-Noise High-Frequency

Poor: Realistic Supertape
Radio Shack Concertape
TDK (low-cost types)

Other experimentation has shown that the better grades of TDK are equivalent in tape quality to the Sony low-noise, but with superior mechanics for an improved speed stability. The tape most frequently has its errors at the beginning of the tape. About 1 in 100 Sony tapes from several batches would exhibit errors caused by a fold on the tape caused by improper factory handling. Letting about 1/2 minute of tape at the beginning of a cassette go unused generally made poor tapes function fine. Some tapes had poor quality control on the pressure pad plate. Since even a 32K program would occupy only about 5 minutes of tape, 30 minute tapes are the best value. I typically have a cassette dedicated to a single program, and can go from program to program with a minimum of searching.

Be sure to rewind the tape before removing the cassette from the recorder. This will prevent damaging the data area of the tape by handling. Always "backup" your programs on a master tape in case of accidental damage to the working cassette. Several months of programming effort can be stored sequentially on one 30 - 60 minute tape.

Keyboard

An ASCII keyboard attached to Input Port Ø is used as the normal input medium to the Digital Group Microprocessor Systems. Surplus ASCII keyboards can provide a low-cost means of data entry, but can be a very risky alternative due to quality problems. The keyboard chosen should have the standard ASCII coded output, preferably with both Upper and Lower case capability, positive logic output, with a delayed keypressed strobe pulse. Some keyboards have extremely bad bounce problems and no strobed pulse. The early SWTP kit keyboard was of this calibre, and you would waste your time on this product. The latest SWTP kit may be better.

Assembling the System

Tools: Soldering iron, diagonal cutters, pliers, screwdrivers, drill, metal sabresaw, hole punches.

Test Equipment: Volt/Ohmeter, Oscilloscope, Frequency Counter

Estimated Construction Time: 2 days

1. Insert the two 22-pin duals, 36 pin dual, and the 50-pin dual connectors into the motherboard from the topside. (The top is indicated by the side where the Digital Group label is printed near the TV 22-pin dual connector). Be sure that the tops of the connectors are at an even height. Some brands of connectors have spacers at the connector bottom, others do not. Use temporary spacers until soldered.

2. After insuring equal height and no warp or twist, invert the board and solder the pins.

3. Mount the motherboard onto the bedplate, avoiding any shorts.

4. Temporarily mount the bedplate to the sides of the cabinet. Allow about 1" of clearence between the bottom of the mother-board and any metal cabinet bottom. This will permit using the Molex connectors if desired. Be sure that the cabinet cover will still clear the tops of the boards. Be sure to space the mother-board on the panel so that there is about 1" of space between the front memory board and the front panel. Mark the level where the top of the bedplate contacts the sides, front, and back of the cabinet. Remove the bedplate.

5. Drill the cabinet holes required for fans, ventilation, switches, jacks, power supply, cable leads, and connector block if used.

6. Mount the low-current supplies of ±12V @1A and -5V @1A on the bedplate. Be sure to leave clearence room for the power and reset switches, PC boards, and I/O cables and connector block.

7. Bolt the bedplate to the cabinet.

8. Mount the 5V power supply, fan, switches, jacks, power cord, and I/O connector block.

9. Connect the switches, etc. to the motherboard using the supplied pictoral.

10. Connect the power cord to the power switch, fan, fuse, and power supply.

11. Measure the power supply outputs and power cord to insure that no shorts exist. Turn on the power supply (no boards in yet, of course) and check for the following voltages at the CPU connector:

```
Pin 1  = +5     (between +5.5 and 5.0)
Pin 2  = Ground
Pin 4  = -5     (between -4.75 and -5.25)
Pin 49 = +12    (between +12.5 and +11.5)
Pin 50 = -12    (between -12.5 and -11.5)
```

Turn off power after verifying proper power supply voltages.

12. Insert the TV Readout board. Temporarily short pin 1 to ground. Connect a TV Monitor to the BNC connector. Turning on the the power should now result in a stable display of 512 characters on the TV screen. Connect the cassette read jack on the cabinet to the earphone output of your recorder via a shielded cable. Playing data from the Operating System cassette supplied should result in an ≈5V peak to peak data signal on the cathode or bar end of G1 on the cassette interface section of the CRT/ Cassette Interface board. Attaching an oscilloscope to the output **of the cassette interface card** should see an ≈1V p-p signal. Putting this output into the cassette mike jack or AUX input should give a capability of recording the tone on a fresh cassette.

13. Plug in the I/O board and the CPU board. Be sure that the I/O board is jumpered to decode Ports 0-3. The CPU must be jumpered to assign its RAM as the bottom 2K of memory.

14. Turn on the system. The screen should now display the Initialize message. In case of trouble, refer to the CPU documentation.

15. Place the **operating system** cassette in the recorder. When the tone begins, press reset, and the system should begin loading data, finally resulting in the Option List. At this point, your system's software descriptions will enable you to use your Digital Group system.

DIGITAL GROUP SYSTEMS PARTS LIST

CPU board
I/O board (assigned to Ports 0-3) others optional
CRT/Cassette Interface board
Optional- 8K memory boards
Motherboard-Minimother, Standard mother
Cabinet
Power supplies: (all should be current limiting and over-voltage prot.)
+5 volt supply (6 Amp min for 10K or less system.)
(12 Amp min for 32K or less system.)
(18 Amp min for 64K.)
+12 volt supply (.1 amp to 1 amp depending on I/O accessories)
-12 volt supply (")
-5 volt supply (" - may not be needed at all with 6501 or 6800 based systems)
TV Monitor - 6Mhz or better bandwidth desireable
Cassette Recorder - Better quality portable with low noise; stable.
ASCII Keyboard - Positive logic, delayed keypressed strobe.
Misc supplies:
1/8" thick aluminum sheet for motherboard's bedplate.
3 wire grounded power cord.
Fuse & fuse holder (rating depends on systems size.)
Power switch & power on indicator.
Video connector (BNC type UG290U)
2 Miniature phone jacks
I/O port rear mount connectors (optional)
Fan - flat pancake style (optional)
3' strip of 1/2" angle aluminum
Misc. mounting hardware
Misc. wire - Heavy guage for +5, lighter for other supplies, shielded cable for video and cassette leads, and ribbon cable for I/O ports.
2 6' shielded cables with miniature phone plugs on each end.
TV cable - BNC type connectors on coaxial cable
Supply of 1/2" rubber grommets
Reset switch (normally open push switch)

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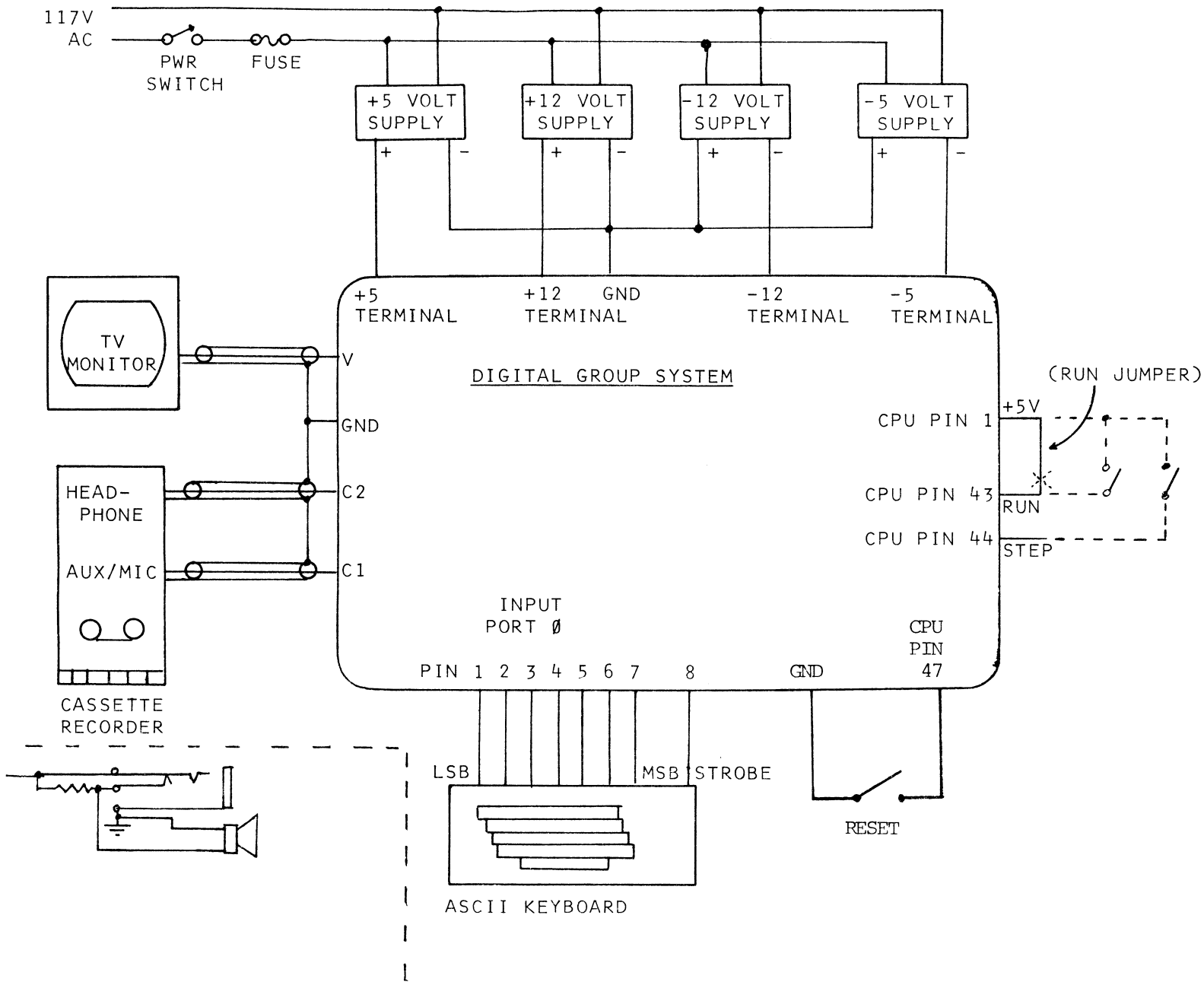
117V
AC
PWR
SWITCH
FUSE
+5 VOLT
SUPPLY
+12 VOLT
SUPPLY
-12 VOLT
SUPPLY
-5 VOLT
SUPPLY
+
-
+5
TERMINAL
+12
TERMINAL
GND
-12
TERMINAL
-5
TERMINAL
TV
MONITOR
V
GND
DIGITAL GROUP SYSTEM
(RUN JUMPER)
+5V
CPU PIN 1
CPU PIN 43
RUN
CPU PIN 44
STEP
HEAD-
PHONE
AUX/MIC
C2
C1
INPUT
PORT Ø
CPU
PIN
PIN 1 2 3 4 5 6 7 8
GND
47
CASSETTE
RECORDER
LSB
MSB
STROBE
RESET
ASCII KEYBOARD

CPU CARD

CPU Ref Number	Pin No.	Description	CPU Ref Number	Pin No.	Description
1	1	+5V	51	A	+5V
2	2	Ground	52	B	Ground
3	3	Spare Voltage	53	C	Spare Voltage
4	4	-5V	54	D	-5V
5	5	MSB	55	E	MSB
6	6	MSB-1	56	F	MSB-1
7	7	MSB-2	57	H	MSB-2
8	8	MSB-3 Data from	58	J	MSB-3 Data from
9	9	LSB+3 Memory	59	K	LSB+3 I/O
10	10	LSB+2	60	L	LSB+2
11	11	LSB+1	61	M	LSB+1
12	12	LSB	62	N	LSB
13	13	MSB	63	P	MSB
14	14	MSB-1	64	R	MSB-1
15	15	MSB-2	65	S	MSB-2
16	16	MSB-3 Data to	66	T	MSB-3 Data to
17	17	LSB+3 Memory	67	U	LSB+3 I/O
18	18	LSB+2	68	V	LSB+2
19	19	LSB+1	69	W	LSB+1
20	20	LSB	70	X	LSB
21	21	Mem Read Data Strb	71	Y	I/O Input Strobe
22	22	LSB	72	Z	LSB
23	23	LSB+1	73	AA	LSB+1
24	24	LSB+2	74	AB	LSB+2
25	25	LSB+3	75	AC	LSB+3
26	26	LSB+4	76	AD	LSB+4
27	27	LSB+5	77	AE	LSB+5
28	28	LSB+6	78	AF	LSB+6
29	29	LSB+7 Memory	79	AH	LSB+7 Port
30	30	MSB-7 Address	80	AJ	MSB-7 Address
31	31	MSB-6 Lines	81	AK	MSB-6 Lines
32	32	MSB-5	82	AL	MSB-5
33	33	MSB-4	83	AM	MSB-4
34	34	MSB-3	84	AN	MSB-3
35	35	MSB-2	85	AP	MSB-2
36	36	MSB-1	86	AR	MSB-1
37	37	MSB	87	AS	MSB
38	38	Mem Write Data Strb	88	AT	I/O Output Strobe
39	39	Cycle Steal	89	AU	IRQ
40	40	DMA Request	90	AV	Data to Cass. Int.
41	41	DMA Grant	91	AW	I/O Output Port 1 Bit Ø
42	42	Interrupt Request	92	AX	Data from Cass. Int.
43	43	Run	93	AY	I/O Input Port 1 Bit Ø
44	44	Step	94	AZ	NMI
45	45	Wait Request	95	BA	CPU-I/O undefined
46	46	CPU-Mem undefined	96	BB	CPU-I/O undefined
47	47	Reset	97	BC	Spare
48	48	ROM	98	BD	VMA
49	49	+12V	99	BE	+12V
50	50	-12V	100	BF	-12V

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MEMORY BUS

CPU Ref Number	Pin No.	Description	CPU Ref Number	Pin No.	Description
1	1	+5V	3	A	Spare Voltage
2	2	Ground	4	B	-5V
5	3	MSB	13	C	MSB
6	4	MSB-1	14	D	MSB-1
7	5	MSB-2	15	E	MSB-2
8	6	MSB-3 Data to	16	F	MSB-3 Data from
9	7	LSB+3 CPU	17	H	LSB+3 CPU
10	8	LSB+2	18	J	LSB+2
11	9	LSB+1	19	K	LSB+1
12	10	LSB	20	L	LSB
21	11	Mem Read Data Strb		M	Spare
30	12	MSB-7	22	N	LSB
31	13	MSB-6	23	P	LSB+1
32	14	MSB-5 Memory Addr	24	R	LSB+2 Memory Addr
33	15	MSB-4 Lines	25	S	LSB+3 Lines
34	16	MSB-3	26	T	LSB+4
35	17	MSB-2	27	U	LSB+5
36	18	MSB-1	28	V	LSB+6
37	19	MSB	29	W	LSB+7
	20	Spare	38	X	Mem. Write Data Strobe
39	21	Cycle Steal		Y	Spare
40	22	DMA Request	41	Z	DMA Grant
42	23	Interrupt Request		A	Spare
43	24	Run	44	B	Step
	25	Spare		C	Spare
	26	Spare		D	Spare
45	27	Wait Request	46	E	CPU-Mem Undefined
47	28	Reset	89	F	IRQ
48	29	ROM	94	H	NMI
98	30	VMA		J	Spare
	31	Spare		K	Spare
	32	Spare		L	Spare
	33	Spare		M	Spare
	34	Spare		N	Spare
	35	Spare	48	P	Spare
49	36	+12V	50	R	-12V

INPUT/OUTPUT BUS

Top of Card - Component side			Bottom of Card - Pin side		
CPU Ref Number	Pin No.	Description	CPU Ref Number	Pin No.	Description
51	1	+5V	53	A	+5V
52	2	Ground	54	B	-5V
55	3	MSB	63	C	MSB
56	4	MSB-1	64	D	MSB-1
57	5	MSB-2	65	E	MSB-2
58	6	MSB-3 Data to	66	F	MSB-3 Data from
59	7	LSB+3 CPU	67	H	LSB+3 CPU
60	8	LSB+2	68	J	LSB+2
61	9	LSB+1	69	K	LSB+1
62	10	LSB	70	L	LSB
71	11	Input Strobe		M	Spare
80	12	MSB-7	72	N	LSB
81	13	MSB-6	73	P	LSB+1
82	14	MSB-5 Port	74	R	LSB+2 Port
83	15	MSB-4 Address	75	S	LSB+3 Address
84	16	MSB-3 Lines	76	T	LSB+4 Lines
85	17	MSB-2	77	U	LSB+5
86	18	MSB-1	78	V	LSB+6
87	19	MSB	79	W	LSB+7
94	20	NMI	88	X	Output Strobe
95	21	CPU-I/O undefined	96	Y	CPU-I/O undefined
99	22	+12V	100	Z	-12V

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INPUT/OUTPUT PORT CONNECTIONS

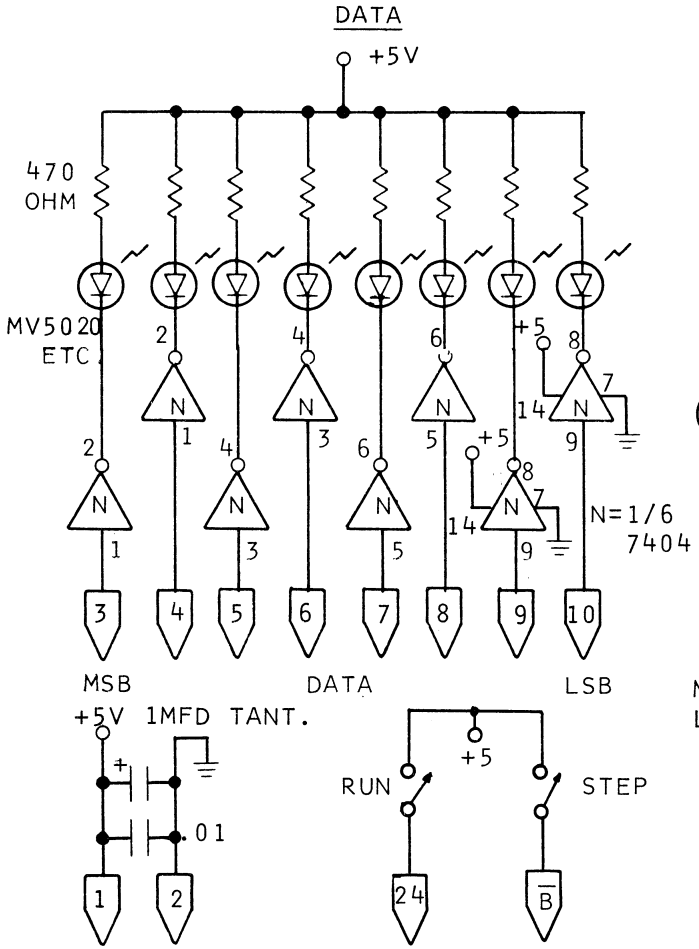
Top of Card - Component side				Bottom of Card - Circuit side			
Pin No.	Description	bit		Pin No.	Description	bit	
1	LSB	Ø		A	LSB	Ø	
2	LSB+1	1		B	LSB+1	1	
3	LSB+2	2		C	LSB+2	2	
4	LSB+3	3	Input	D	LSB+3	3	Output
5	MSB-3	4	Port Ø,4,8,...	E	MSB-3	4	Port Ø,4,8,...
6	MSB-2	5		F	MSB-2	5	
7	MSB-1	6		H	MSB-1	6	
8	MSB	7		J	MSB	7	
9	n/c			K	n/c		
10	LSB	Ø		L	LSB	Ø	
11	LSB+1	1		M	LSB+1	1	
12	LSB+2	2		N	LSB+2	2	
13	LSB+3	3	Input	P	LSB+3	3	Output
14	MSB-3	4	Port 1,5,9,...	R	MSB-3	4	Port 1,5,9,...
15	MSB-2	5		S	MSB-2	5	
16	MSB-1	6		T	MSB-1	6	
17	MSB	7		U	MSB	7	
18	n/c			V	n/c		
19	LSB	Ø		W	LSB	Ø	
20	LSB+1	1		X	LSB+1	1	
21	LSB+2	2		Y	LSB+2	2	
22	LSB+3	3	Input	Z	LSB+3	3	Output
23	MSB-3	4	Port 2,6,10,...	A	MSB-3	4	Port 2,6,10,...
24	MSB-2	5		B	MSB-2	5	
25	MSB-1	6		C	MSB-1	6	
26	MSB	7		D	MSB	7	
27	n/c			E	n/c		
28	LSB	Ø		F	LSB	Ø	
29	LSB+1	1		H	LSB+1	1	
30	LSB+2	2		J	LSB+2	2	
31	LSB+3	3	Input	K	LSB+3	3	Output
32	MSB-3	4	Port 3,7,11,..	L	MSB-3	4	Port 3,7,11,...
33	MSB-2	5		M	MSB-2	5	
34	MSB-1	6		N	MSB-1	6	
35	MSB	7		P	MSB	7	
36	n/c			R	n/c		

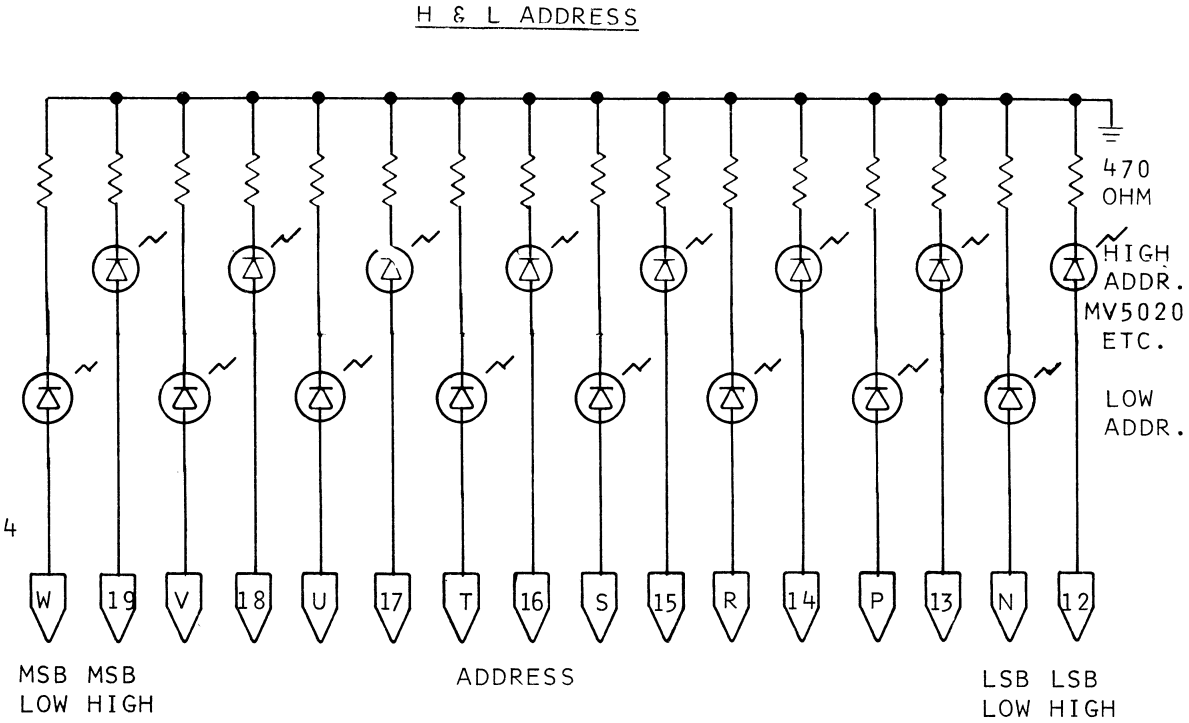
Note: MSB = Most Significant Bit
LSB = Least Significant Bit
n/c = no connection

TV READOUT & CASSETTE

Top of Card - Component side

CPU Ref Number	Pin No.	Description
	1	MSB
	2	MSB-1
	3	MSB-2
	4	MSB-3 Data (connected to
	5	LSB+3 In Output Port Ø)
	6	LSB+2
	7	LSB+1
	8	LSB
	9	Cassette Recorder Output
	10	Cassette Recorder Input
	11	n/c
	12	n/c
	13	n/c
	14	n/c
	15	n/c
	16	Video Out
92	17	Data to CPU
90	18	Data from CPU
	19	+5V
	20	Ground
	21	+12V
	22	-12V





NOTE: ARRANGE ABOVE LED'S IN TWO ROWS OR GROUPS - ONE FOR HIGH ADDRESS (CONNECTED TO NUMBERED PINS), ONE FOR LOW ADDRESS (CONNECTED TO LETTERED PINS).

DIGITAL GROUP CPU TEST BOARD

READS BINARY OF DATA & ADDRESSES
USED FOR TROUBLESHOOTING CPU CARDS

12/7/75 DR. ROBERT SUDING

1. PLUGS INTO ANY MEMORY SLOT OR MAY BE PERMANENT
2. MAY BE BUILT ON A 22-PIN DUAL READOUT CARD IF CAREFULLY INSERTED SO THAT CARD IS AT FAR LEFT AS VIEWED FROM FRONT. (RADIO SHACK BOARD #276-152 @ $2.49 IS ADEQUATE.)
3. TEST 8080, 6501, & 6502 SYSTEMS BY HALTING CPU, THEN SINGLE STEPPING AFTER PRESSING RESET. 6800 WILL NOT SINGLE STEP WITH THIS READOUT. 6800 GOES TRI-STATE WHEN READY LINE IS LOW.
4. THE "STEP" AND "RUN" FUNCTION OF THE CPU MAY BE INCLUDED ON THE CARD IF A 24-36 PIN DUAL CARD IS USED. CONNECT A "RUN" NORMALLY OPEN "PUSH SWITCH" BETWEEN +5 AND PIN 24. CONNECT A "STEP" NORMALLY OPEN "PUSH SWITCH" BETWEEN +5 AND PIN B. DISCONNECT ANY "RUN" TIEUP WIRES IF USED.

DGS-14-R0

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