

**Radio Shack®**

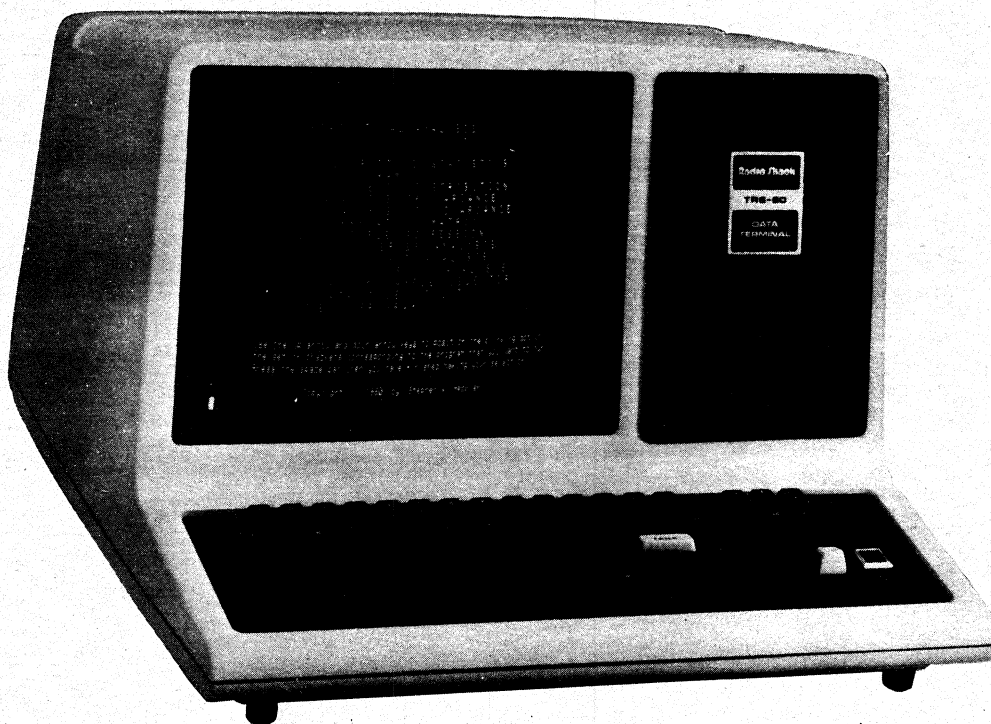
COMPUTER REPAIR  
0058

# Service Manual

26-6050

## TRS-80® DT-1

Catalog Number 26-6050



CUSTOM MANUFACTURED IN U.S.A. BY RADIO SHACK, A DIVISION OF TANDY CORPORATION

*TRS-80<sup>®</sup> DT-1  
Manual*

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**TRS-80®**

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**TRS-80 DT-1 Service Manual**

**26-6050**

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**Radio Shack®**

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## 1/ Specifications

## AC Power Supply

## Power Requirements

105-130 VAC, 60 Hz

## Power Consumption

20 Watts

## Temperature Range

55 to 110 F  
(13 to 43 C)Humidity Range  
non-condensing

10% to 80% relative

## Size

18.5" x 12" x 21"  
(17cm x 31 cm x 53cm)

## Weight

23.4 lbs (10.5kg)

## RS-232-C Input/Output

Signal	Function	Pin #
PG	Protective Ground	1
TD	Transmit Data	2
RD	Receive Data	3
RTS	Request to Send	4
CTS	Clear to Send	5
DSR	Data Set Ready	6
SG	Signal Ground	7
CD	Carrier Detect	8
DTR	Data Terminal Ready	20

Table 1.

## RS-232-C Serial Printer

Signal	Function	Pin #
PG	Protective Ground	1
TD	Transmit Data	3
CTS	Clear to Send	5
DSR	Data Set Ready	6
SG	Signal Ground	7
CD	Carrier Detect	8
DTR	Data Terminal Ready	20

Table 2.

## Parallel Printer Interface

Signal	Function	Pin #
Strobe	Clock the data from the processor to the printer	1
Data 0	Bit 0 LSB of output data byte	3
Data 1	Bit 1 of output data byte	5
Data 2	Bit 2 of output data byte	7
Data 3	Bit 3 of output data byte	9
Data 4	Bit 4 of output data byte	11
Data 5	Bit 5 of output data byte	13
Data 6	Bit 6 of output data byte	15
Data 7	Bit 7 of output data byte (MSB)	17
BUSY	Input to Terminal from Printer High indicates busy	21

Table 3.

## 2/Dissassembly Instructions

1. Turn the DT-1 upside down on your work area.
2. Remove the 6 screws from the bottom.
3. Rotate the DT-1 rightside up. You must hold the top and bottom section together during this operation. Leave room to the left for the top to rest.
4. Lift off the top section and lay it on its side to the left of the bottom section. The unit may be operated in this position for test purposes.

### Further Dissassembly

If desired the top section may be separated from the bottom section. To do this unplug the cable from the edge connector and the grounding lead from the spade lug ground connector on the Video Board. The top and bottom sections are now separate.

### Circuit Board Removal

Follow these steps to remove the circuit board from the bottom section of the DT-1:

1. Unplug the cables going to the video board, the power supply and the keyboard.
2. Remove the 6 nuts and washers holding the circuit board to the bottom section.
3. Unplug the power indicator cable going to the keyboard from the main circuit board.

### CRT Removal.

Be very careful removing the CRT. It is fragile, and could be dangerous if broken. Never hold it by the neck. Follow the steps below.

1. Remove the plug from the end of the neck. Gently pull straight back. Be careful not to bend the pins. Check to be sure you haven't shorted terminals or components mounted on the plug.
2. Remove the yoke from the neck by loosening the clamping screw, then pulling the yoke straight back. Be careful to avoid the pins at the end of the neck of the CRT.
3. To remove the anode lead, loosen the plastic insulating cover from the CRT, then remove the lead by pressing to one side on the connector while gently lifting up on the other.
4. Remove the 2 screws holding the video board to the top section and set the board to one side to allow access to the CRT mounting studs.
4. Remove the 4 nuts and washers from the mounting studs at each corner of the mask.
5. Supporting the CRT from the body (not the neck) lift it up and back off the studs. Lay it on a soft cloth face down.
6. Finally unhook the spring and the two loops of braid from the corners of the CRT.

### Keyboard Removal

To remove the keyboard,

1. Take out the 6 screws that hold the mask to the bottom section.
2. Lift off the mask and the keyboard.
3. Unplug the ribbon cable going to the main circuit board and the grounding spade lug from the left end of the keyboard. See Figure 1.

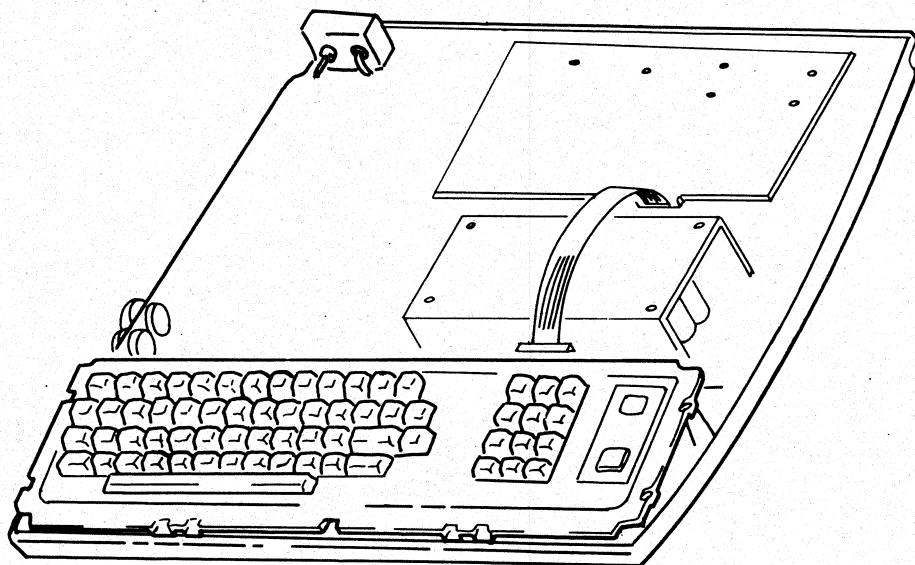


Figure 1. Keyboard Removal

#### Removing the Power Supply Module

To remove the power supply module, take out the screws holding the bracket to the bottom section. Do NOT remove the nuts from the top of the power supply.

Turn the Module over and unplug the AC power cable.

### 3/Troubleshooting

Troubleshooting a terminal involves two steps.

- . Isolating the problem to the terminal.
- . Creating a life-like environment for the terminal to operate in.

#### Preliminary Considerations

Before attempting the steps above, check system protocol.

- . Are the Baud rate, parity, character length and number of stop bits correct?
- . Are the handshaking signals (DTR, DCD and DSR) compatible?
- . Are you connected properly to the Host?
- . Is the printer turned on?

If you have satisfied yourself that the problem is with the DT-1, and not the Host, connections, or protocol, proceed with step 2 as follows:

If a Modem II is available, use it in Local Test Mode to echo characters from the DT-1. Set the Baud Rate at 300 baud for testing with a modem.

If a Modem is not available disconnect the DT-1 from the Host and connect pins 2 and 3 together at the connector on the RS-232 cable, or at the connector to the printed circuit board (of the DT-1).

Either method routes output from the DT-1 back to input. Keys typed on the DT-1 should be displayed on the screen.

If not, check for handshaking signals that are holding the DT-1 in a non-transmitting state. From Set-Up Mode, turn off DTR, DCD and DSR by setting their switches to 0. The terminal will then ignore those signals.

## Specific Symptoms and Suggestions

### Extra Characters Displayed

If pressing one key results in a substitute character or characters on the screen suspect the Baud Rate. Proceed as follows:

Set the DT-1 for Half Duplex from Set-Up Mode. Then press a key.

If the key you pressed is displayed along with one or more stray characters, then the Baud rate is probably wrong.

### Wrong Cursor Moves, Bad Commands, etc.

Some Host systems will send End-Of-File terminating codes that are not compatible with the emulation mode you are using. For example, suppose you are using the Terminal to read data stored in some Host system. The cursor jumps suddenly to the top of the screen and begins overwriting data already present on the screen. The DT-1 has received a code that homed the cursor.

There are two approaches to this problem.

1. Reconfigure the Host to match the emulation mode you are using. CompuServe and most other communications services have a setup program that will modify the Host for your terminal. Some systems can be instructed to operate in DUMB mode. In this mode the Host will not transmit any cursor positioning sequences at all. In CompuServe, this is done by appending ",TTY" to the user ID.

2. Change emulation modes through the Set-Up Mode to match the Host system's requirements.

### Buzzer ON Continually

This could result from one of the following:

- . The MPU (U-12) is not working.

- . The oscillator is not working. Check for 7.328 MHz at pin 18 of U-12.
- . The Reset Capacitor (C-13) is installed backwards or is shorted.
- . R-22 Missing or open. Some units may have 8751 microprocessors instead of 8051's. 8751's need the pull-down resistor (R-22) to operate.

#### Keyboard Will Not Operate

- . Eliminate the Host, connections, protocol, etc.
- . Check keyboard Cable.
- . Make sure keyboard is being scanned by U-5. You must press a key to see activity at this IC's output, OR add pull up to +5 volts. This is an OPEN COLLECTOR circuit.
- . Check for two or more keys shorted or jammed closed.
- . Check for defective U-5 or U-6.
- . FSTRW\* to pin 1,19 on U-6 not present.

#### EEPROM Will Not Retain Data or Data Stored in the EEPROM Changes.

- . Power Fail Detect Circuitry not operating.
- . CR-1 or Q-1 shorted; Q-2 open.
- . Defective U-25. This part has a 10,000 store cycle life.

#### Parallel Printer Port Will Not Operate Printer.

- . PSTRB\* will not drive a heavy STROBE current from printer. Add shunt resistance to ground on this pin. The resistor added should match the resistance of the pull up resistor in the printer.

**Display Will Not Operate**

- . +12 Volt power supply fault.
- . U-7 Defective.
- . Display Oscillator (U-4) not functioning.
- . U-15 Defective.

**RS-232 output Not Functional**

- . DTR, DCD, or DSR not set correctly.
- . U-20 Defective.
- . Cable not connected, or open wire in cable.

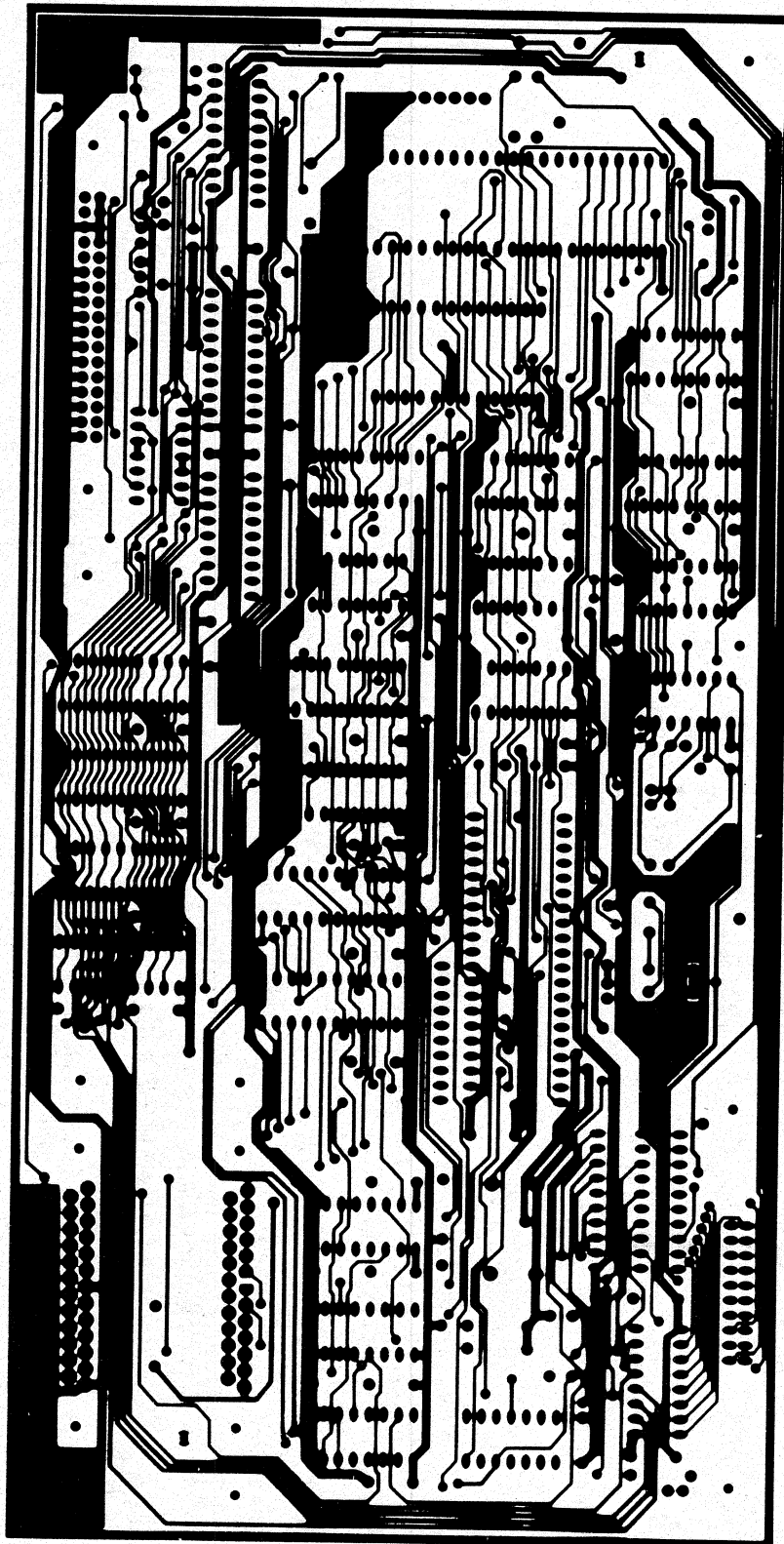
**Serial Printer Port will not operate.**

- . DSR, DTR, or DCD Not set correctly.
- . R-18 open.
- . Cable open or missing.

**Problem with Video Board, CRT, etc.**

See Technical Reference Manuals for similar Model III Modules.

## Main Logic Board Solder Side



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## 5/Parts List

## Electrical Parts

## Capacitors

Component Description		Part Number
C1	0.1 mfd Mono 50V	837-4104
C2	0.1 mfd Mono 50V	837-4104
C3	0.1 mfd Mono 50V	837-4104
C4	0.1 mfd Mono 50V	837-4104
C5	1000 pf Mon 50V	830-2105
C6	15 pf disk 50V	8300153
C7	15 pf disk 50V	8300153
C8	0.1 mfd Mono 50V	837-4104
C9	0.1 mfd Mono 50V	837-4104
C12	10 pf disk 50V	830-0104
C13	33 mfd Electrolytic 16V	832-6331
C14		
to		
C35	0.1 mfd Mono 50V	837-4104

## Integrated Circuits

U1	74LS175 Flip Flop	802-0175
U2	74LS175 Flip Flop	802-0175
U3	SN74LS86N	802-0086
U4	74LS04 Hex Inverter	802-0004
U5	74LS145 Decoder	802-0145
U6	74LS240 Inv Octal Buffer	802-0240
U7	8276 Video Generator	804-0276
U8	2716 Character Generator	804-5716
U9	SN74LS08N	802-0008
U10	74LS00 Nand Gate	802-0000
U11	7406 Hex Inv Buffer	800-0006
U12	8051 Microprocessor	804-0051
U13	MC1489 Quad Level Converter	805-0189
U14	74LS166 Shift Register	802-0166
U15	SN74LS161N 4-bit counter	802-0161
U16	74LS138 Decoder MUX	802-0138
U17	74LS74 Dual J-K Flip Flop	802-0074
U18	SN74LS373N Octal D-Type	802-0373
U19	74LS245 Octal Bus Transceiver	802-0245
U20	MC1488 Quad Level Converter	805-0188

U21	MC1489 Quad Level Converter	805-0189
U22	74LS00 Nand Gate	802-0000
U23	74LS240 Inv Octal Buffer	802-0240
U24	SN74LS373N Octal D-Type	802-0373
U25	X2210-30 64 x 4-bit RAM	804-0210
U26-29	2114A-6 RAM	804-1114

## Semiconductors

CR-1	1N748ARL Zener Diode	815-0748
Q1	MPS3904 NPN Transistor	811-0904
Q2	MPS3904 NPN Transistor	811-0904

## Resistors

R1	330 Ohm 1/4W 5%	820-7133
R2	4.7K x 8NTWRK 1/8W 5%	829-2247
R3	330 Ohm 1/4W 5%	820-7133
R4	470 Ohm 1/4W 5%	820-7147
R5	1K 1/4W 5%	820-7210
R6	6.8K 1/4W 5%	820-7628
R7	1K 1/4W 5%	820-7210
R8	10K 1/4W 5%	820-7310
R9	10K 1/4W 5%	820-7310
R10	4.7K x 8NTWRK 1/8W 5%	829-2247
R11	4.7K 1/4W 5%	820-7247
R12	4.7K 1/4W 5%	820-7247
R13	10K 1/4W 5%	820-7310
R14	4.7K 1/4W 5%	820-7247
R15	4.7K 1/4W 5%	820-7247
R16	4.7K 1/4W 5%	820-7247
R17	10K 1/4W 5%	820-7310
R18	10K 1/4W 5%	820-7310
R19	4.7K 1/4W 5%	820-7247
R20	4.7K 1/4W 5%	820-7247
R21	2K 1/4W 5%	820-7220
R23	330 Ohm 1/4W 5%	820-7133
R24	10K 1/4W 5%	820-7310
R25	30 Ohm 1/4W 5%	820-7030
R26	100 Ohm 1/4W 5%	820-7110
R27	1K 1/4W 5%	820-7210

## Miscellaneous Electrical

Audio Transducer

849-0001

Y1	Crystal 12.48 MHz	84Ø-9ØØ4
Y2	Crystal 7.3728 MHz	84Ø-9Ø22

## Mechanical Parts

### Sockets

Component Description		Part Number
U7	4Ø-pin DIP	85Ø-9ØØ2
U8	24-pin DIP	85Ø-9ØØ1
U12	4Ø-pin DIP	85Ø-9ØØ2
U25-29	18-pin DIP	85Ø-9ØØ6

### Connectors

P4	DB-25 RS-232 Connector	851-9136
P5	DB-25 RS-232 Connector	851-9136
J1	4-pin Right Angle SIP	851-9Ø79
J2	2Ø-pin Right Angle (Dual 1Ø)	851-91Ø7
J3	6-pin Right Angle SIP	851-91Ø3
J6	34 POS Connector	851-9138

### Cables

Shielded CRT Cable	87Ø-9272
Power Cord	87Ø-9138
A/C Harness	87Ø-9289
Power Supply Harness Assembly	87Ø-9178
LED harness	87Ø-9291
Keyboard Cable Assembly	87Ø-9271
Main Ground Harness	87Ø-929Ø

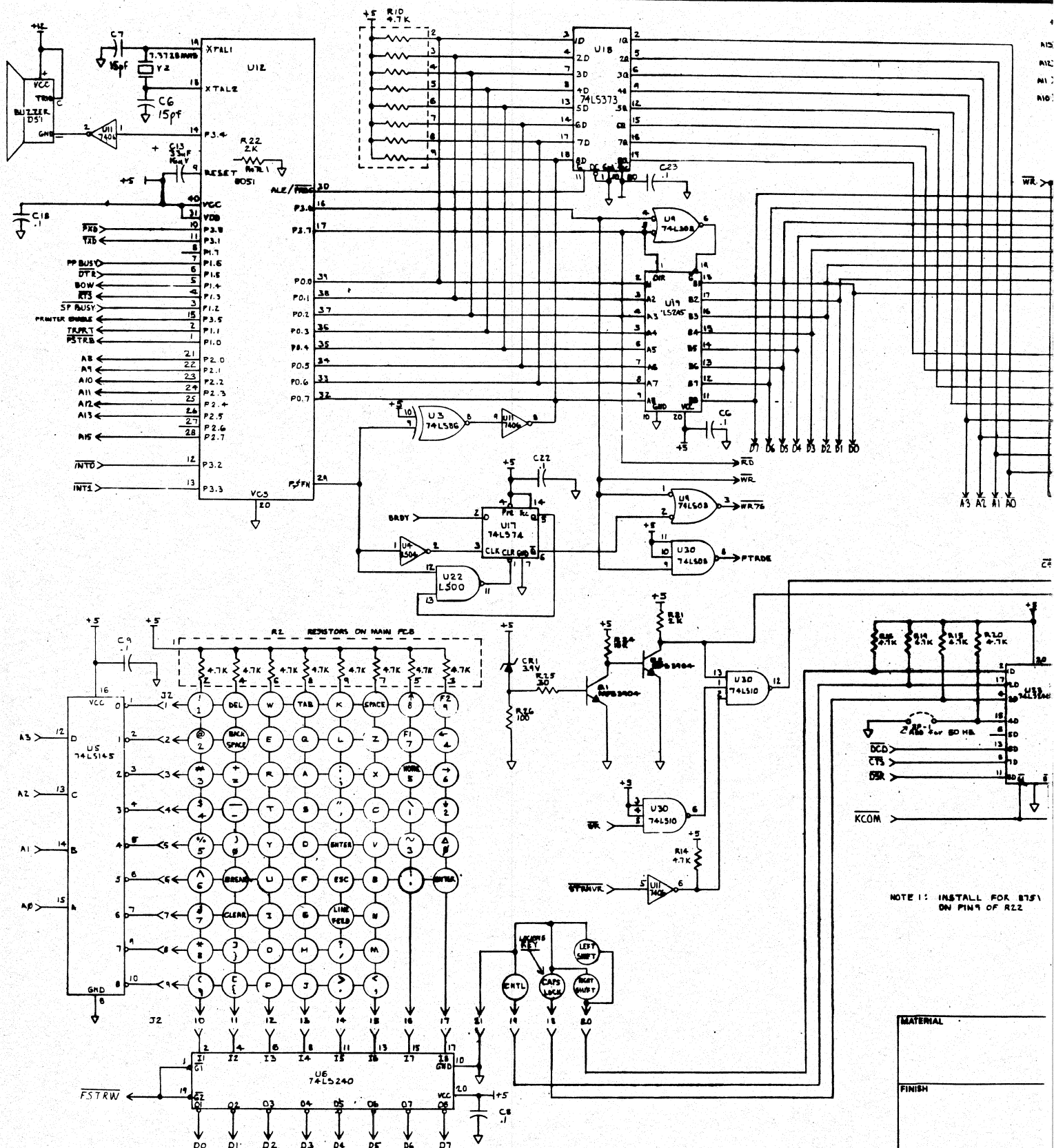
### Sub-Assemblies

Keyboard	879-Ø515
Video Control Sub Assembly	885-8Ø2Ø
KTR 131B Video Display	849-2ØØ2
Logic Board Assembly	885-8Ø22
Power Supply, Switching	879-ØØ21

Controls

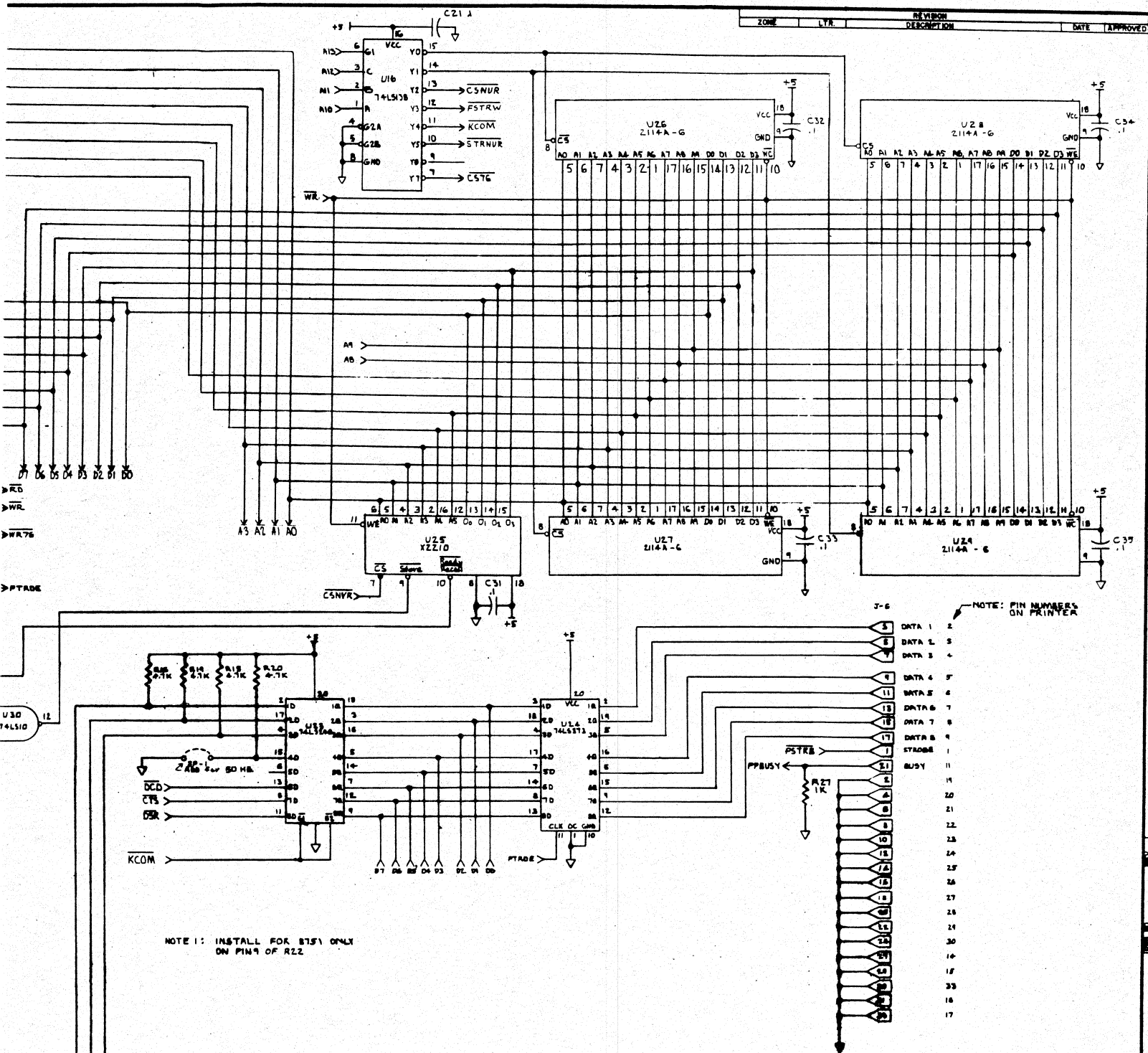
Power Switch

848-9030



NOTE 1: INSTALL FOR B751  
ON PIN 9 OF R22

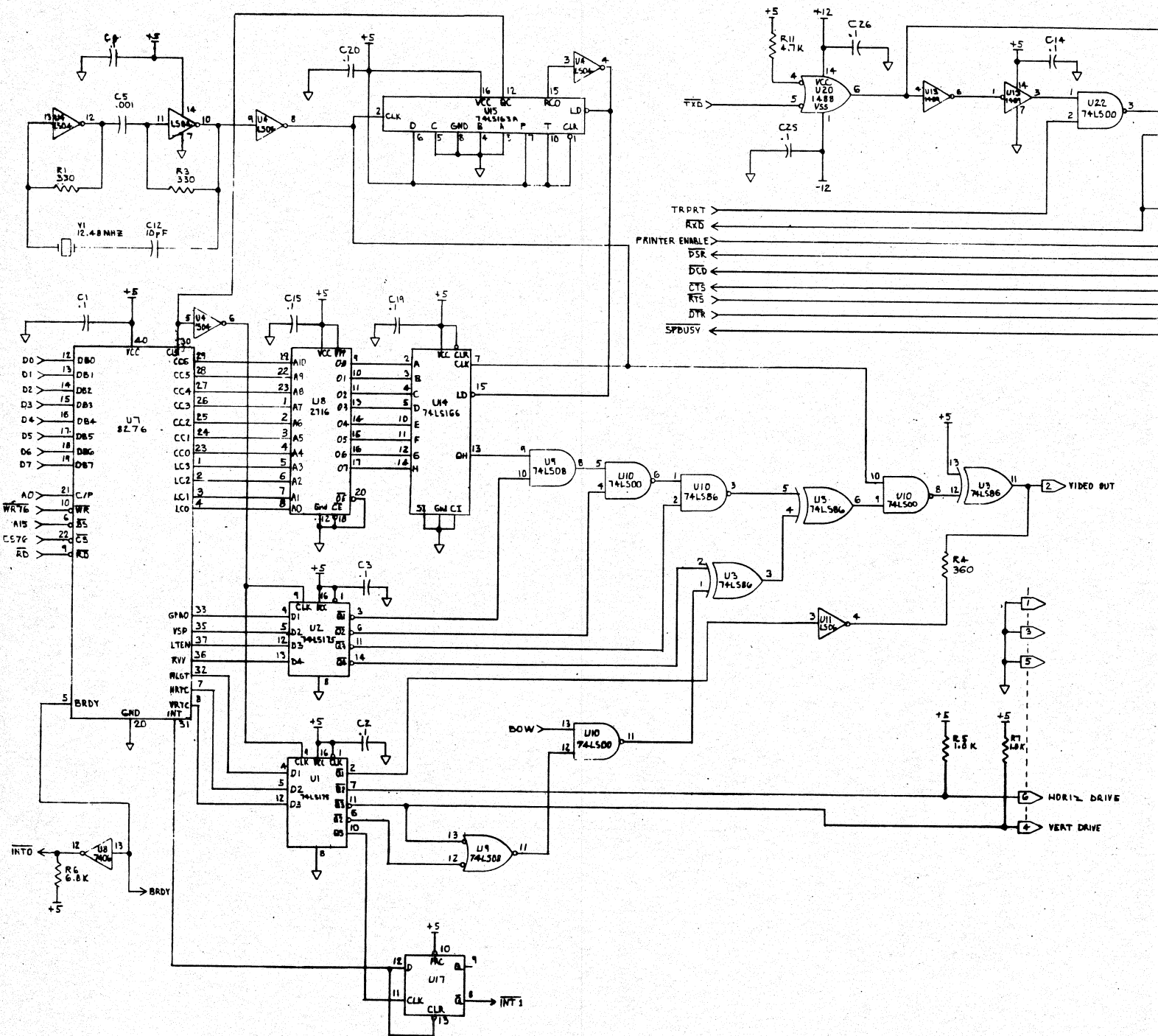
**MATERIAL****FINISH**

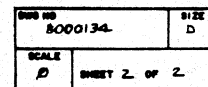


MATERIAL	UNLESS OTHERWISE SPECIFIED			DRAFT	DATE	TITLE  DATA TERMINAL
	TOLERANCES			T. C.	12-1-80	
	.XX = ±.010 .XXX = ±.005			CHECK	DATE	
	ANGLES = ±P			DESIGN	DATE	
	HOLE DIA TOLERANCES			APPRO	12-1-82	
				APPO	DATE	
FINISH	.014 - .250 = +.005 - .001					
	.251 - .750 = +.008 - .001					
	.751 - UP = +.015 - .001					
	DIMENSIONS ARE IN INCHES AND APPLY AFTER PLATING					
	DO NOT SCALE THIS DRAWING	NEXT ASSY.	USED ON	DWG NO. 8000134- SCALE 1 OF 2		
				SIZE D		

**tandy**

OWE NO. 3000134-  
SCALE 1 OF 2  
BEE D





## 7/Theory of Operation

### System Overview

The DT-1 Data Terminal consists of a state of the art single chip microcomputer, video RAM, keyboard interface, CRT controller, and two printer ports.

The microcomputer has 4K bytes of ROM, and 255 bytes of RAM. Video RAM is made up of four 1024 byte by four bit memories, structured into 2048 eight bit words. The display is formatted to have 24 lines and each line holds up to 80 characters.

The Data Terminal can emulate four of the "standard" terminals on the market today, and has certain common features that apply to all emulations. The two printer ports, one serial, and one parallel, allow the Data Terminal to be used with just about any printer available on the market.

The DT-1 is an RS-232 serial communications device, operating at Baud rates from 75 to 19,200. The serial printer must operate at the same baud rate as the terminal, while any speed parallel printer may be used. XOFF and XON protocol is used to control printer feed rates.

While most terminals use Dip Switches to set user features and functions, the Data Terminal utilizes a state of the art non-volital memory, that is programmable from the keyboard. This memory retains settings even when power is off.

### Detailed Theory of Operation

#### Microprocessor

The 8051 microprocessor, U-12, contains over 4K bytes of on chip ROM that has been coded to operate as a terminal. It contains a full duplex serial interface that allows this microcomputer to be easily used as a terminal controller.

U-12 controls all sections of the Data Terminal. Operating at 7.3728 MHZ using crystal oscillator Y-2, the microprocessor receives data from the Host system and routes this data to the video RAM. It also scans a nine by eight

keyboard matrix and generates the proper output codes for the Host.

The built in UART allows 10 baud rates ranging from 75 to 19,200 baud.

### Addressing

The Data Terminal is a memory mapped system. That is, all subsections are assigned an address, and the microprocessor reads and writes to these addresses just as if it were memory. The data bus is generated at port 0 and supported by Data Transceiver U-19. Depending on the mode of operation, the microprocessor directs U-19 to output or input data from the rest of the system.

The lower 8 address lines (A-0 through A-7) are generated using port 0 and an eight bit data latch. U-18 supplies the rest of the system with a lower order address when the data is output by the microprocessor on the unbuffered side of the data bus. High order addresses (A-8 through A-15) are generated on port 2. A memory map decoder, U-16, is used to select between the various subsections.

### Power On Sequence

When power is first applied to the DT-1, reset capacitor C-13 passes a positive going spike to reset pin 9. The program stored within the microprocessor is then executed in an orderly manner, and terminal operation is initiated.

### Electronic Buzzer

An electronic buzzer is included to sound when the Data Terminal receives a CONTROL G. This buzzer will also sound when the terminal goes through a cold start (power off and on) or a warm restart via software.

The bell, DS-1, is controlled by inverter U-11, an open collector device. The microprocessor supplies a logical HIGH to the inverter to enable it. When the collector (the output at pin 2) goes LOW, a ground will be supplied to DS-1, and the bell will sound.

## Memory Map Decoding

External subsections of the Data Terminal are memory mapped. Each subsection is mapped to a range of addresses that is directly addressable by the microprocessor. Enabling of each subsection is preformed by map decoder U-16. This chip has four of the higher order address bits connected to it. Depending of the state of the inputs, one of the outputs of U-16 will go LOW, selecting a subsection.

The subsections are listed below, along with the bit patterns necessary to select them. Notice bit A-13 must be HIGH before any of the subsections are enabled. In general, the decoder segments the subsections into 1 K byte "pages."

=====				
A-13	A-12	A-11	A-10	Contents
-----				
1	0	0	0	Low video memory select
1	0	0	1	High video memory select
1	0	1	0	Non-volital array select
1	0	1	1	Keyboard read select
1	1	0	0	Keyboard/RS-232 input read
1	1	0	1	Non-volital RAM write select
1	1	1	0	Decoded position not used
1	1	1	1	CRT controller enable.
-----				

Table 4

## Video RAM

The Video RAM holds the character data for the display. The CRTC does not read this RAM to format video and generate the sync signals. The microprocessor will read and write data to the video RAM, and will pass character data to the CRTC upon request. The Video RAM is just a holding area the microprocessor uses to store characters for the CRTC.

The RAM consist of four 1024 by 4 bit static memories, structured and mapped in the address decoder map as 2048 bytes of eight bit words. Only the microprocessor has access to this memory.

## Non-Volital RAM

A Non-volital RAM gives the DT-1 the ability to retain Set Up parameters. This non-volital RAM is wired into the display RAM circuitry just as if it were system RAM. The

unique feature of this memory is its method of transferring volatile data to a non-volatile EEPROM storage area.

When power is applied to the system, the EEPROM portion of U-25 transfers its contents into another section of the chip. This section is configured just like "normal" memory, so that the system can do reads and writes from and into it. These functions are controlled by U-25 pin 11, LOW to write, and HIGH to read.

When the terminal user wants to transfer data from the RAM section to the non-volatile EEPROM section, U-11 pin 5 and U-30 pin 5 are strobed. After a short time delay, the task is complete and the EEPROM has been programmed.

During power on (or power off) conditions, U-25 needs to be protected from spurious logic "glitches" that can fool this memory into starting a EEPROM store cycle. Data could be changed in the EEPROM that is not what the user wanted changed. To prevent spurious logic levels from occurring, a power fault circuit is included. Q-1 and Q-2 are the active components of this circuit.

When power is on, and the terminal is operational, CR-1 is conducting. Q-1 is biased into saturation which turns off Q-2. With Q-2 off, U-30 pin 13 and U-25 pin 10 are supplied with a logical HIGH. With these two pins HIGH, the system may write to the EEPROM.

If the power supply voltage starts to fall below about 4.6 volts, CR-1 turns off, and bias is removed from the base resistor of Q-1. Q-1 turns off, turning on Q-2. A low is now applied to U-30 and U-25. When these pins are LOW, the EEPROM can not be written to, and its data is not modified by spurious signal levels caused by the microprocessor and gates when power fails on these parts.

## Keyboard

The keyboard is matrixed into a nine by eight, normally open, key matrix. This matrix is row scanned by decoder U-5. Column data from the matrix is supplied to inverting tri-state U-6. The microprocessor reads the tri-state and determines if a key is pressed.

The lower four address bits of the microprocessor is applied to U-5, which is a one-of-nine decoder. One of the open collector outputs of this IC will go LOW, depending on the input code. If a key is pressed on this row, current is

supplied by a pullup resistor on the row and column of the key. This LOW is passed on to U-6, and the microprocessor will read a HIGH at the inverting output pin assigned to that key. Since the microprocessor knows which row was enabled, and it also knows which column the HIGH was detected, it can look up the proper ASCII key code.

When no key is pressed in the matrix, U-6's input will be presented with all HIGHS. Its output to the microprocessor will always be LOWs. In this state, the scan process by U-5 (on the rows) will NOT be visible to a 'scope probe. Since the outputs of U-5 are open collector, there are no voltages at these pins to allow the activity to be seen. You will only see activity at these outputs if a key is pressed on the row that is being monitored.

Four of the 70 keys on the keyboard are not in the row/column matrix. Both shift keys, the control and caps lock keys are separated from the matrix and applied to another tri-state. U-23 receives the states from these keys, which are read by the microprocessor to determine the actual key code.

### CRT Controller

The CRT controller supplies the display with character and sync information in a timed sequence that will present to the user 24 lines of 80 characters each. The process is just about as automatic as possible, and the microprocessor is not burdened with the task of generating the complex signals required.

A 12.48 MHz crystal is used for timing reference. Part of U-4 is used as the active element for the crystal oscillator. The high frequency is buffered by U-4 pins 9 and 8, and the output is applied to the character counter U-15, to the dot shift register U-14, and to the video dot processing gates.

The character counter divides the DOT clock by eight, generating the character clock for the CRTC, U-7 and the load pulse to the shift register. The CRTC, in turn, applies character code information to a 2 K byte ROM character generator, which supplies dot information to the shift register.

The CRTC contains internal RAM that will hold two lines of character data. The microprocessor must load character information into this buffer. It does so by writing a

second line of characters to the CRTC while the CRTC is processing the first line. The CRTC signals the microprocessor that it is processing a line of data, and it is ready to receive another line of characters by toggling the BRDY pin (pin 5). This pin interrupts the microprocessor and starts a DMA of sorts.

In its basic form, this "false" DMA is generated by the interrupt routine stored in firmware. The microprocessor is fooled into believing that there is external firmware, and it will try to execute this firmware at a machine cycle rate. The address line will start counting as if the microprocessor were reading external ROM. But this read action is turned around by U-17, U-22, and U-9, and forces a CRTC write sequence by toggling U-7 pin 10.

The microprocessor is fooled into believing it is executing some minor two byte instruction, over and over again. But actually, display RAM data is being addressed by the microprocessor and this data is being written into the CRTC buffer. The microprocessor does not touch the CRTC's data at all! (The pull up package on port 0 of the microprocessor and the two gates (U-11 and U-3) on this same port are generating the "fake instruction".)

## Video Processing

As mentioned before, the CRTC is supplying the character generator ROM with display line and character addressing. The character generator will provide the dot shift register with the proper line of dots that is to be scanned by the CRT's electron beam. The dot shift register takes the parallel dots from the character generator and serially clocks it as video dot information.

Dot video from the dot shift register is then applied to attribute gate U-9, pin 9. The output of this gate is applied to blanking/blinking attribute gate U-10, pin 5. The output at U-10 pin 6 is sent to the underline/cursor gate at U-10 pin 1 for processing. After receiving the underline and cursor information, the signal is routed to the video dot chopper U-10, at pin 9 and then on to the video buffer U-3 pin 12. The video dot chopper directs the electron beam to create equally sized dots on the phosphor. Hence, the video will be of a consistent brightness, even though some dots are side by side.

Half intensity video is generated by loading down the video at the buffer output. A resistor, R-4, is switched to load pin 11 of U-3 during half intensity video time. During this time, the video level (the white level) is decreased in voltage and gray dots are formed.

U-9, pins 12 and 13 provide raster blanking when using full screen black on white (BOW). BOW is forced by U-10 pin 13, which ultimately causes U-3 to invert the logic of the video dots and the blanking information.

The horizontal and vertical sync signals are generated by the CRTC, and are sourced by U-1.

### **RS-232 Serial I/O and the Serial Printer Interface**

The DT-1 does not use a UART to generate or receive RS-232 data. Instead, special hardware within the microprocessor creates serial data from keyboard inputs, or reassembles serial input into parallel words.

Gate U-20 translates TTL level serial information from the microprocessor into RS-232 levels. The input from the microprocessor is at pin 5 while its output is at pin 6. The output of this gate feeds another gate, and is routed to the RS-232 connector (P4) at pin 2.

Input RS-232 from P4, pin 3, is routed to another type of translator, U-21, pin 10, which converts the RS-232 levels to TTL levels at pin 8. The rest of the gating between output and input translators support RS-232 handshaking and the serial printer port.

The serial printer port is supported by level shifter U-13, pins 4, 6, 1 and 3. The buffered signal is applied to half duplex gate U-22 at pin 1. Pin 2 of this gate allows the microprocessor to send transmitted data to the serial printer port. The half duplex printer data is then passed to receive data mixer gate U-22 pin 4, and mixed with the received data present at pin 5.

The mixed data is then sent to the serial enable gate U-22 pin 9. Pin 10 of this gate is controlled by the microprocessor which controls the sending of data to the serial printer port. The printer data is then level translated back to RS-232 levels by U-20, pins 11, 12 and 13.

Notice that the serial printer is not truly supported by the microprocessor. That is, the microprocessor does not process serial printer data, but the microprocessor only "steers" or gates the data path for printer information.

There are three input handshaking gates which are used by the RS-232 port. DSR, (Data Set Ready) DCD, (Data Carrier Detect) and CTS (Clear to Send) are supplied to the terminal from a Host system. The pull up resistors on these gates default them to the asserted, or true, states if they are not used in the connection between the Host and the terminal.

There is only one output handshaking signal the terminal generates for the Host to use. This one, called DTR (Data Terminal Ready) is available to the Host system at pin 4 of P4, and is supplied by U-20 pin 3.

The serial printer port also has a handshaking signal associated with it. Pin 20 of P5 is the Printer Busy status line for the printer. This pin is connected to translator U-13, and to the microprocessor. A pull up resistor on this gate's input will also default the printer to the asserted state if the serial printer port is enabled by the microprocessor, but a printer is not actually connected at P5.

If a printer is connected the pin will go to -12 volts if the printer is signaling the microprocessor that it is busy. The microprocessor will then issue a XOFF (CONTROL S) code, and the Host must stop data transmission, or printer data will be lost.

### Parallel Printer Interface

Unlike the serial printer port, the parallel printer port is fed by the microprocessor. When the printer port is enabled, the microprocessor supplies parallel data on the data bus and strobes the clock pin of U-24, used as the parallel printer latch.

Data is retained in this latch and held while the microprocessor "strokes" the printer by toggling pin 1 of J-6. After the strobe cycle is complete, the parallel printer latch will retain the data of the last character sent to the printer until the next print character is sent, OR the next time a write occurs in system memory.

Parallel printer status is obtained by the microprocessor from pin 21 of J-6. When this pin is LOW, the printer is NOT busy. But when it goes HIGH the printer is BUSY and cannot accept further strobe cycles. A XOFF will be generated by the terminal to stop the Host from sending further characters. If the Host does not stop sending characters printer data WILL be lost.

If a parallel printer is not connected, and the printer port(s) are enabled, pull down resistor R-27 will hold the parallel printer port status line in a NOT BUSY state.

The firmware within the microprocessor will enable BOTH serial and parallel printer ports, even though only one is actually being used. Also, the printer busy status lines are firmware processed as if they were tied in parallel. That is if one printer port goes busy, the terminal assumes both printers are busy.

The terminal will only control the actual sending of characters to the parallel port since it has no real control over the data going to the serial printer.

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