CT-256
COMPUTER TERMINAL

THEORY of OPERATION

contents

MITS
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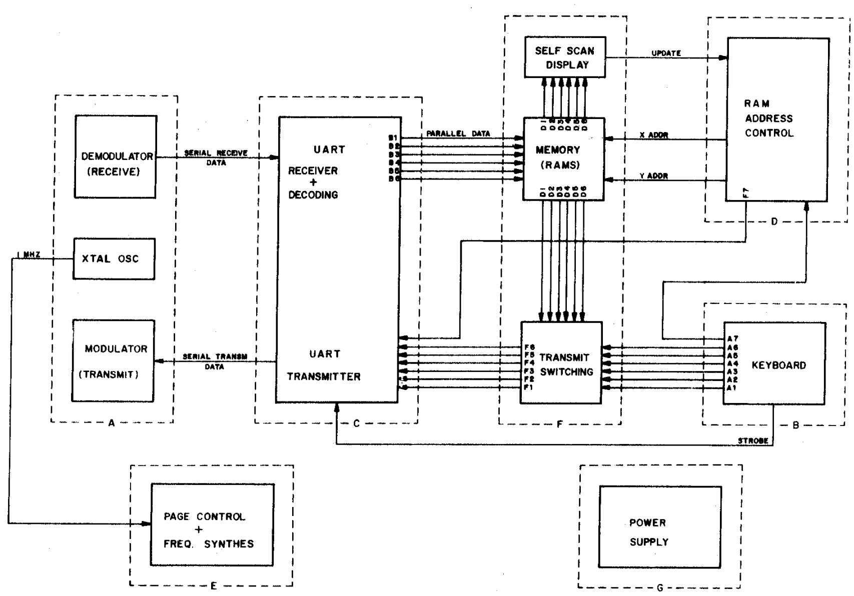

CT 256 BLOCK DIAGRAM (SIMPLIFIED)

SCHEMATIC REF

A	SHEET 1	MODEM CIRCUIT
B	SHEET 2	KEYBOARD
C	SHEET 3	RECEIVE CIRCUIT
D	SHEET 4	RAM ADD CONTROL CIRCUIT
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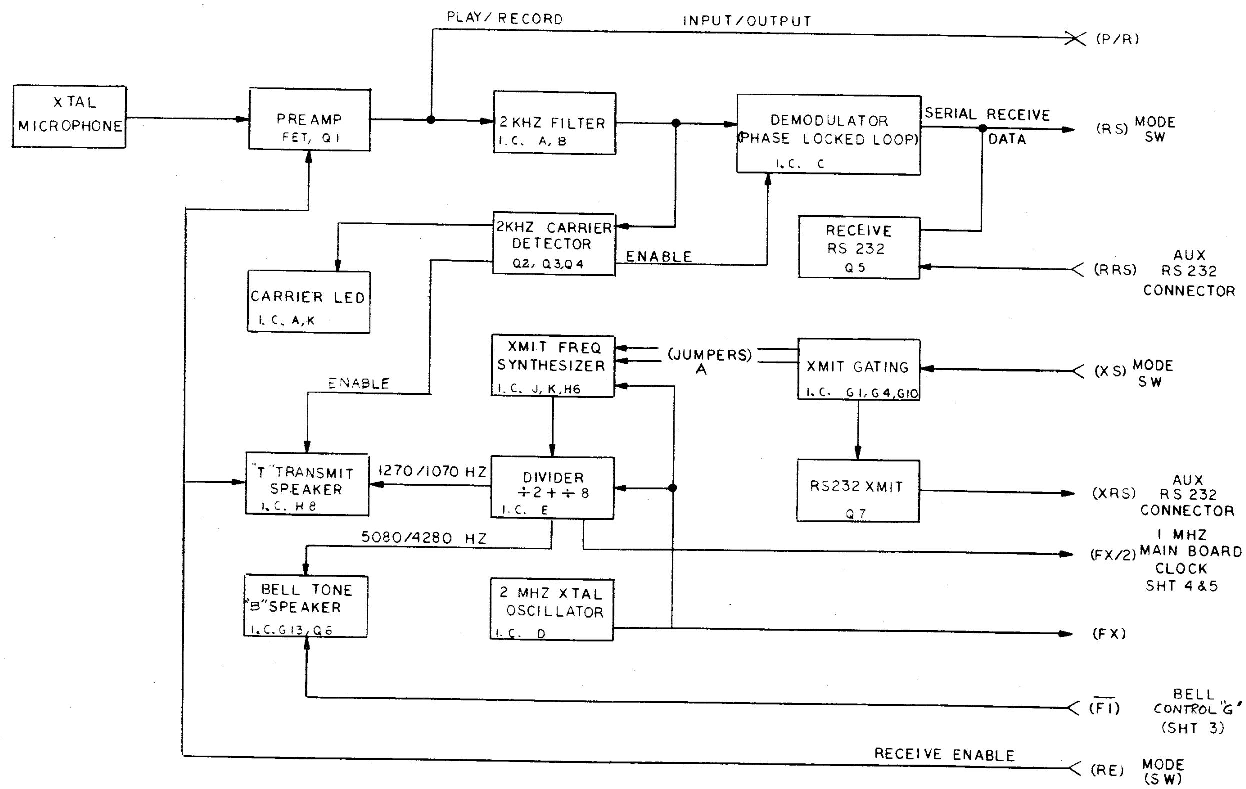
THEORY OF OPERATION MANUAL

INTRODUCTION

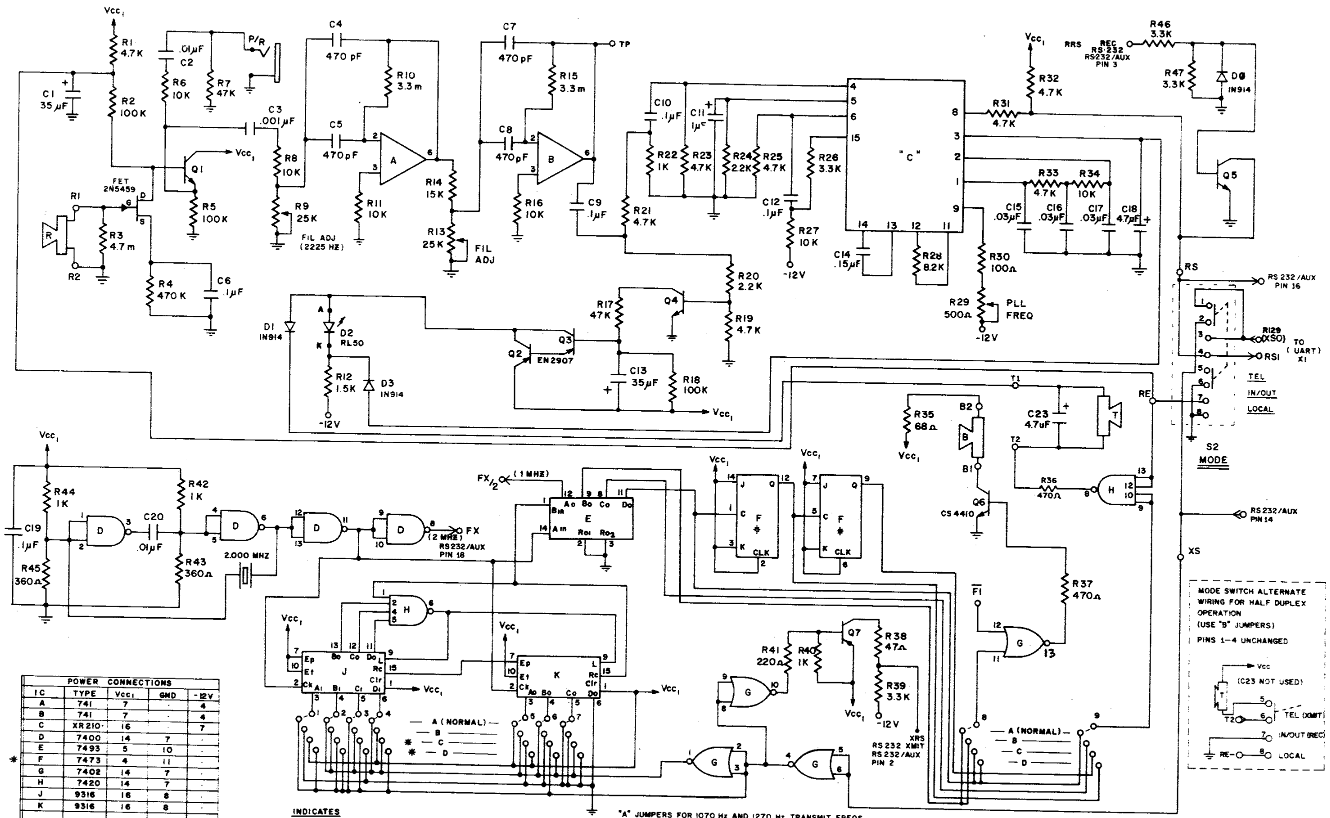
Referring to the simplified block diagram, the data path starts at the keyboard. When a character key is pressed, the character is encoded into a 7-bit code and is sent on lines A1--A7 to the transmit switching circuit and on to the UART on lines F1--F7. The UART (Universal Asynchronous Receiver-Transmitter) converts the parallel character data to a serially transmitted character upon receipt of a strobe signal from the keyboard. If the mode switch is in "TEL", the serial transmit data from the UART goes to the FSK modulator on the modem circuit board where it is converted into audio tones (logic 1 = 1270 Hz, logic Ø = 1070 Hz) and acoustically coupled to the telephone. If the mode switch is in local, the serial transmit data is connected to the serial receive data input line on the UART.

The computer at the other end of the telephone line demodulates and uses the data. When the computer "echos" back the transmitted data or transmits its own, it does so at 2225 Hz (logic 1) and 2025 Hz (logic Ø). These tones are picked up by the demodulator and are converted to serial receive data. The receive portion of the UART changes the serial data to parallel form (B1--B6) and presents it to the memory. As soon as the data is written into memory (during the 32nd character display time) it is displayed on the self-scan one position from the right.

The "RAM Address Control" circuitry runs all display and memory functions, and is the heart of the Comter.



BLOCK DIAGRAM
MODEM
SHEET 1



POWER CONNECTIONS				
IC	TYPE	Vcc_1	GND	-12V
A	741	7	·	4
B	741	7	·	4
C	XR210	16	·	7
D	7400	14	7	·
E	7493	5	10	·
* F	7473	4	11	·
G	7402	14	7	·
H	7420	14	7	·
J	9316	16	8	·
K	9316	16	8	·

MODEM CIRCUIT
SHEET 1 OF 7

NOTE: All I.C. references on block diagrams refer to I.C. letter and output pin number.

MODEM (SHEET 1)

1. 2MHz Oscillator - FX

The crystal oscillator operates by biasing the two gates of I.C. D to act as amplifiers. The crystal is the feedback element for the oscillator. The 2MHz signal is divided by 2 by I.C. E for the 1MHz main board clock (FX/2).

2. Modulator

The modulator consists of I.C. G, used as a buffer and inverter, I.C.s J & K as presettable counters for the frequency synthesizer and I.C. E to divide the frequencies further. Depending on line "XS" being logic 1 or logic Ø, J & K divide the 2MHz clock by different counts. The resultant audio frequency is fed through I.C. H8 to the transmit speaker. For an audio tone to be transmitted, the speaker must be enabled by mode switch in "TEL" ("RE" high), and a carrier being received (supplying Vcc to the speaker).

3. Amplifier and Demodulator

The audio 2KHz signals from the computer are picked up from the telephone by the crystal microphone and preamplified by the FET and Q1. The 10mv signal is available at P/R for recording and is also fed into the 2KHz op amp filters for removing the 1KHz signals introduced by the modulator signals. The filtered signal is used for the carrier detector circuitry (which enables the demodulator) and is the input for the demodulator.

The demodulator is a phase locked loop which detects whether the received signal is 2225HZ (logic 1) or 2025Hz (logic Ø). It operates by comparing the received frequency with its own VCO frequency, set at 2125Hz. As the VCO frequency is forced to track the incoming signal by a phase detector, the internal control signal (pin 2 of I.C. E) is fed into a voltage comparitor whose output is the serial receive data referenced to -12v.

4. RS232 I/O

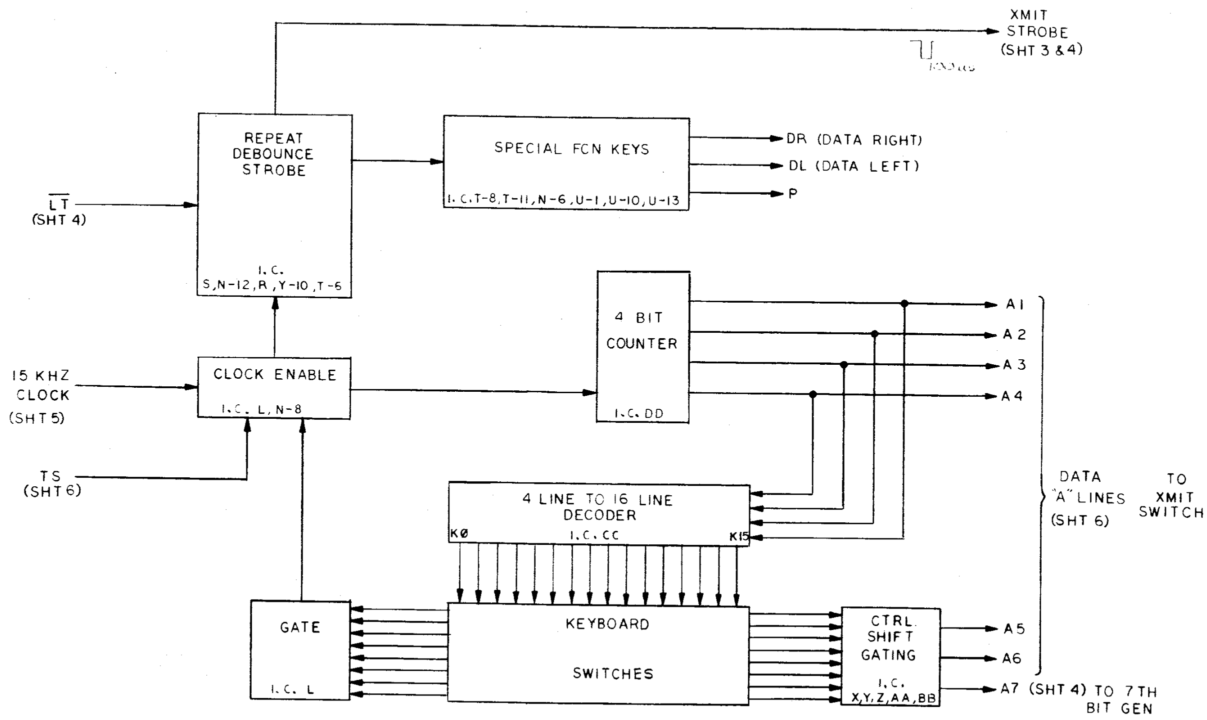
RS232 is an interface standard set up by EIA specifying signal levels and circuit identification for data communications.

Simply defined, it specifies a logic 1 is a voltage signal between -5 volts and -25 volts and a logic Ø is a signal between +5 volts and +25 volts and a termination impedance from 3K to 7K. The voltages for the transmit side of the Comter (logic 1 = -12v and logic Ø = +5v) are developed by Q7 and I.C. G.

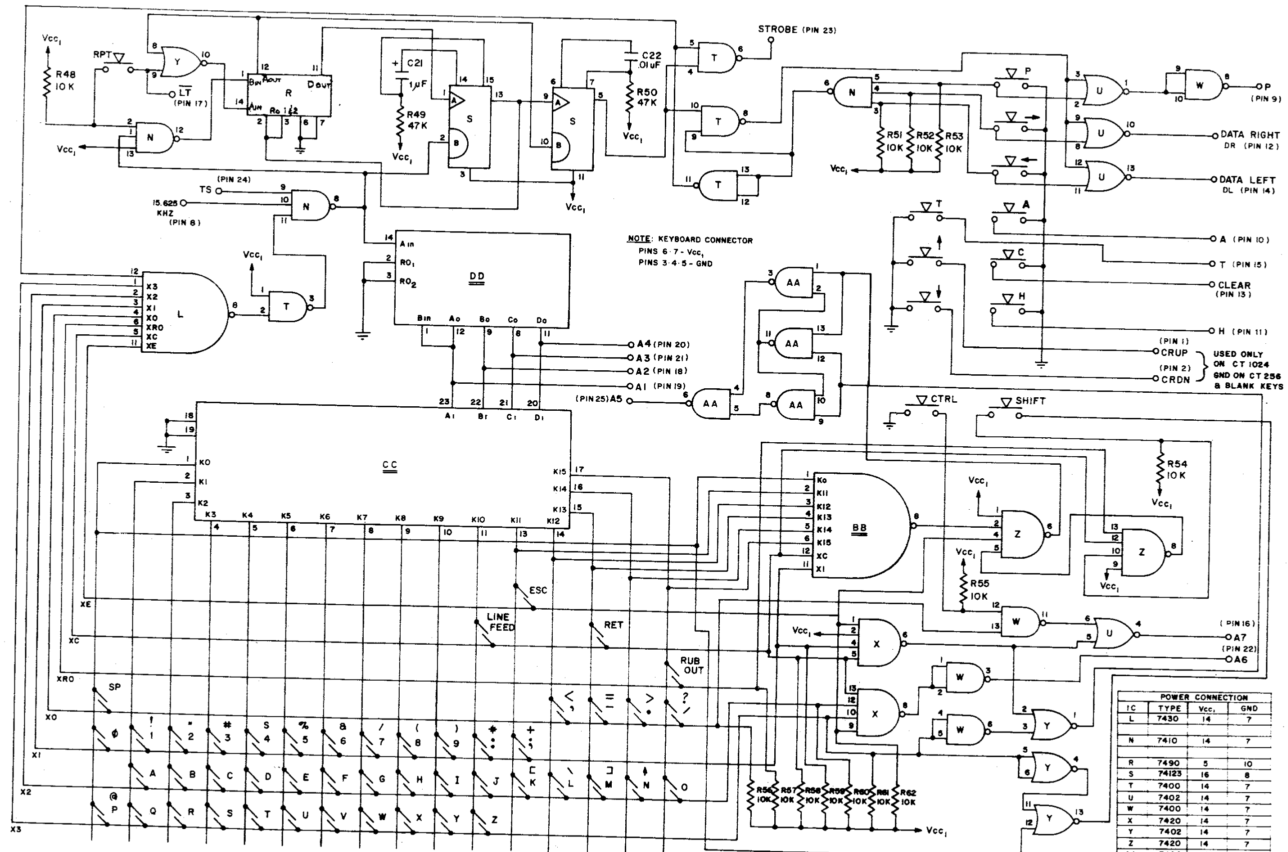
The receive side of the RS232 circuit is simply an NPN transistor. With a logic 1 on the line (negative voltage) Q5 is off, with a logic Ø on the line (positive voltage) Q5 is on.

5. Bell Tone

When a control "G" is received, $\overline{FT}$ line goes low for enabling I.C. G-13 to pass a 4KHz tone to the "B" speaker.



BLOCK DIAGRAM
KEYBOARD CIRCUIT
SHEET 2



POWER CONNECTION			
IC	TYPE	Vcc_1	GND
L	7430	14	7
N	7410	14	7
R	7490	5	10
S	74123	16	8
T	7400	14	7
U	7402	14	7
W	7400	14	7
X	7420	14	7
Y	7402	14	7
Z	7420	14	7
AA	7400	14	7
BB	7430	14	7
CC	74154	24	12
DD	7493	5	10

KEYBOARD CIRCUIT
SH 2 OF 7

KEYBOARD (SHEET 2)

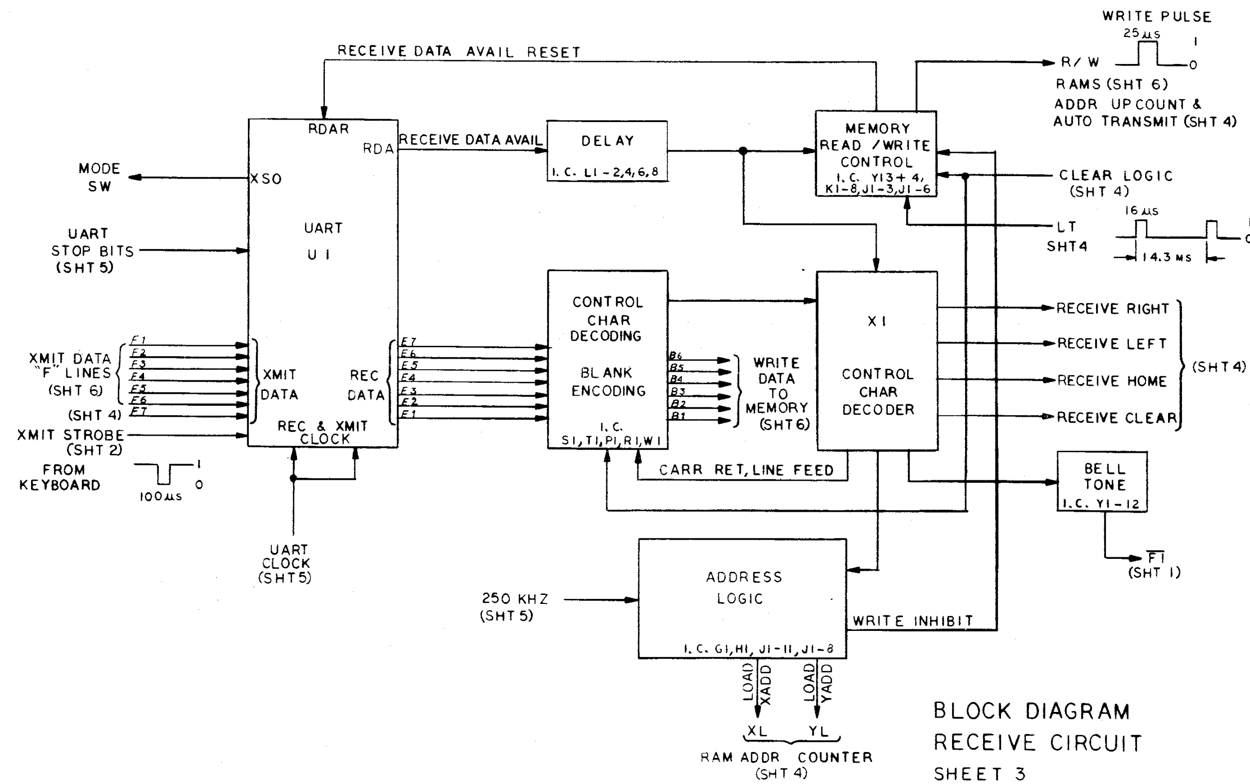
The keyboard encodes the character by feeding a 15KHz signal to a 4-bit counter (I.C. "DD") that is connected to a 4 to 16 decoder (I.C. "CC"). The character key switches are connected to the 16 lines according to the first 4 bits determined by the ASCII code. When a key-switch is closed and the line it is connected to is strobed, the 4-bit counter is halted. The 4-bit count where the counter is stopped is the first 4 bits of the 7-bit ASCII code and the other 3 bits are encoded by the control and shift gating. After a debounce period, a transmit strobe signal is sent to the UART, where the selected character is sent out serially.

A. For debounce and strobing, a detailed sequence of events is as follows:

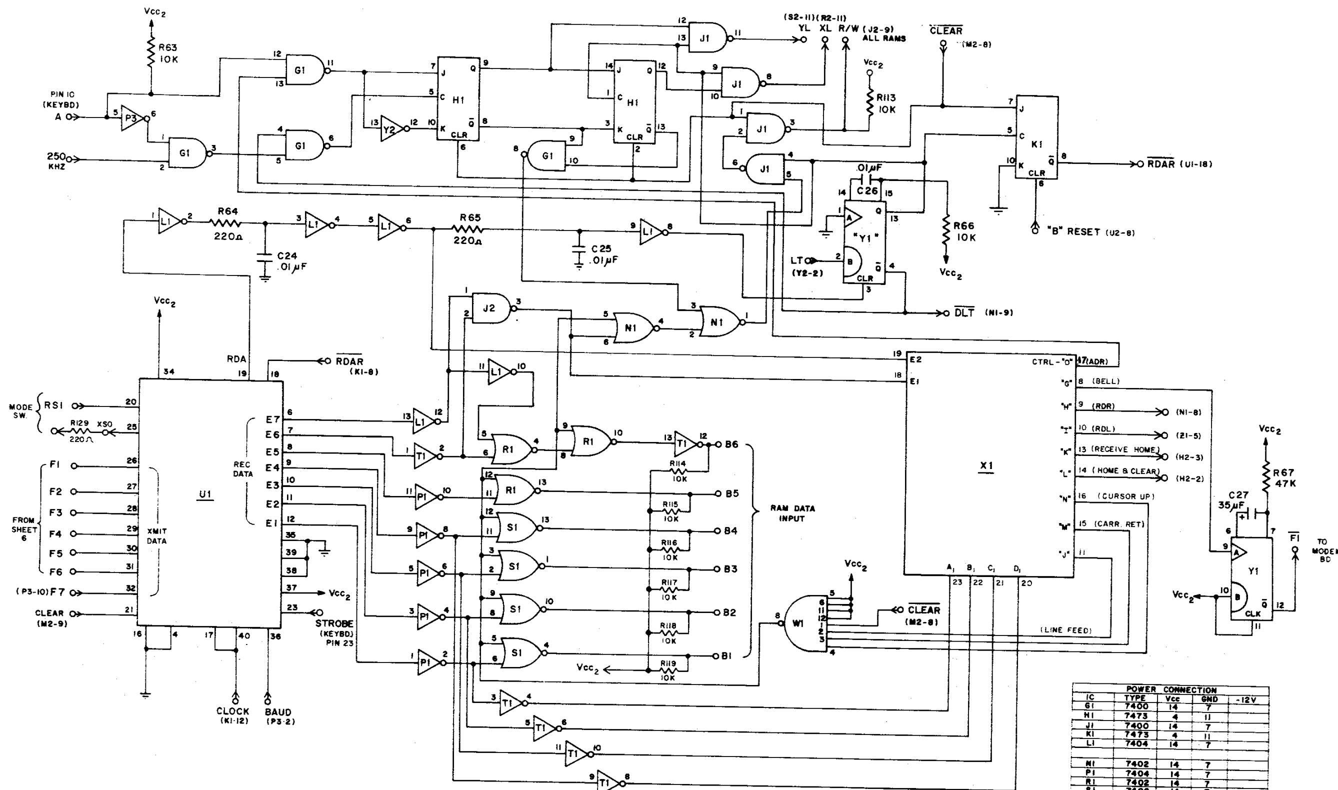
1. Keyswitch depressed
2. Line from decoder goes low
3. L-8 goes high, T-3 goes low
4. 15KHz clock inhibited, DD stops counting
5. Retriggerable one shot S-13 previously in continual triggered state, resets 15msec after clock stopped.
6. S-13 goes low, enabling I.C. R pins 2 & 3
7. $\overline{LT}$ into Y-9 inverted and fed into R-14 (input to "A" flip flop)
8. R-12 goes high, and latches (disabling input of Y-8)
9. R-12 triggers S-10 for 100 usec strobe pulse

B. For repeat, same sequence with added steps as follows:

10. Repeat key pressed, $\overline{LT}$ fed into N-2 (N-1 high), N-12 goes to R-1 (input of divide by 5 counter)
11. Output of R-11 triggers S-1 every 70 milliseconds which in turn (through S-13) triggers S-9 for a strobe pulse every 70 milli-seconds
12. Keys released, 15KHz clock enabled, fed into N-1, clocking R-1 until R-11 goes low (if not low at time of key release) allowing S-2 to retrigger, causing S-13 to go high, clearing I.C. "R"



BLOCK DIAGRAM
RECEIVE CIRCUIT
SHEET 3



POWER CONNECTION				
IC	TYPE	Vcc	GND	-12V
G1	7400	14	7	
H1	7473	4	11	
J1	7400	14	7	
K1	7473	4	11	
L1	7404	14	7	
N1	7402	14	7	
P1	7404	14	7	
R1	7402	14	7	
S1	7402	14	7	
T1	7404	14	7	
✱ U1	2502	1	3	2
W1	7430	14	7	
X1	74154	24	12	
Y1	74123	16	8	

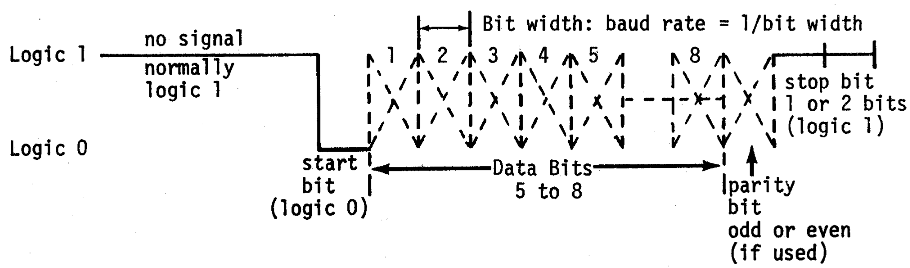
✱ - DENOTES IC TYPE 1883 ARE EQUAL

RECEIVE CIRCUIT
(SHEET 3 OF 7)

RECEIVE CIRCUIT (SHEET 3)

A. <u>UART Description</u> (I.C. "U1")

The UART transmits and receives serial data at a rate determined by the clock input (clock frequency = 16 X baud rate). The format for serial data transmission and reception is as follows:



The Comter is wired to transmit 7 data bits, odd parity, 2 stop bits at 110 baud and 1 stop bit at 300 baud. The UART format is selected by:

No parity bit (pin 35): high = no parity, low = parity as selected

# of stop bits (pin 36): high = 2 stop bits, low = 1 stop bit

# of data bits 2 (pin 37) -	low	low	high	high
# of data bits 1 (pin 38) -	low	high	low	high
# of data bits -	5	6	7	8

Parity (odd or even) (pin 39): low = odd, high = even

With the clear input low (pin 21), the chip select input high (pin 35), and the correct clock signal present, the UART will transmit data on a negative going strobe pulse (in the Comter it is 100 usec). The data on pins 26-33 will be transmitted at that time.

B. Receiving a Character

The receive circuit is more involved and the sequence is as follows:

1. Valid character received, RDA - pin 19 (Receive Data Available) U1 - goes high.

2. RDA delayed by L1 and R/C circuits, enables clear input on Y1-3.

3. Y1, a monostable, triggers when LT (Load Time--occurs during 32nd character display time) goes high, putting 25 usec pulse on output.

4. Pulse toggles K1-5, causing $\overline{RDAR}$ to go high, resetting RDA on UART.

5a. If it is a displayed character, pulse also causes data appearing on B1-B6 lines to be written into RAMs, also advances RAM address by 1.

5b. If it is a control character (E6 + E7 = 0), then I.C. "X1" decodes it and controls the proper operation. Write pulse is inhibited by N1-1 going low, holding J1-6 high.

6. At the end of the 32nd character display time, "B" reset (self scan) goes low and clears K1-6, allowing $\overline{RDAR}$ to go high, allowing RDA to go high as soon as the next character is received.

C. Address Logic

The address logic circuit is activated by receiving a control "O" or pressing the black "A" key (top row). The next two characters received determine the address location of the cursor position in the display (see operators manual).

The sequence of operation is as follows: (both H1 flip flops cleared)

1a. Control "O" received, G1-13 goes low, H1-7 high (J input), H1-10 low (K input), Y1-4 ($\overline{Q}$ output) pulses low, is inverted at G1-6 and clocks H1-9 high and H1-8 low.

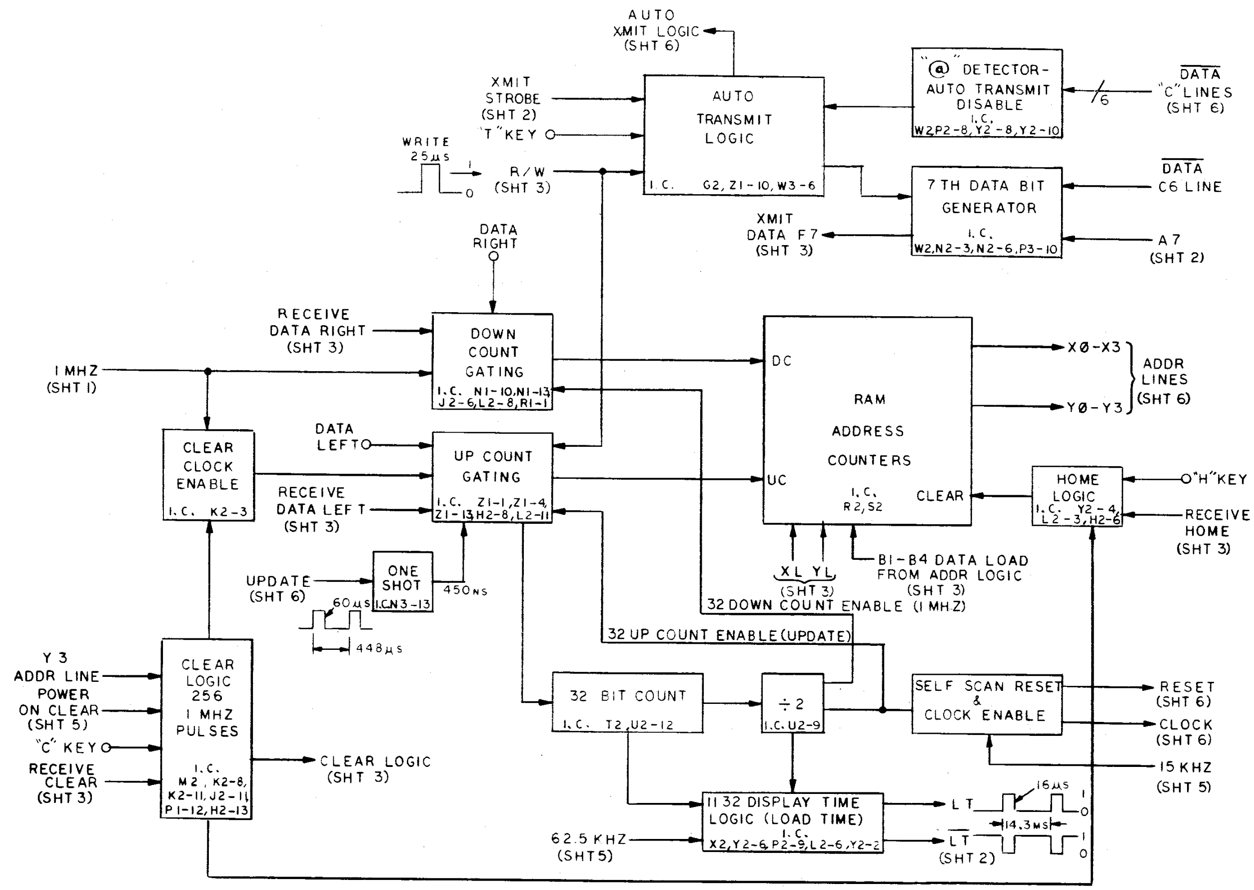
OR

1b. "A" key pressed, enabling 250KHz clock on G1-3, H1-7 high, H1-10 low, H1-9 latches high and H1-8 low on first clock pulse.

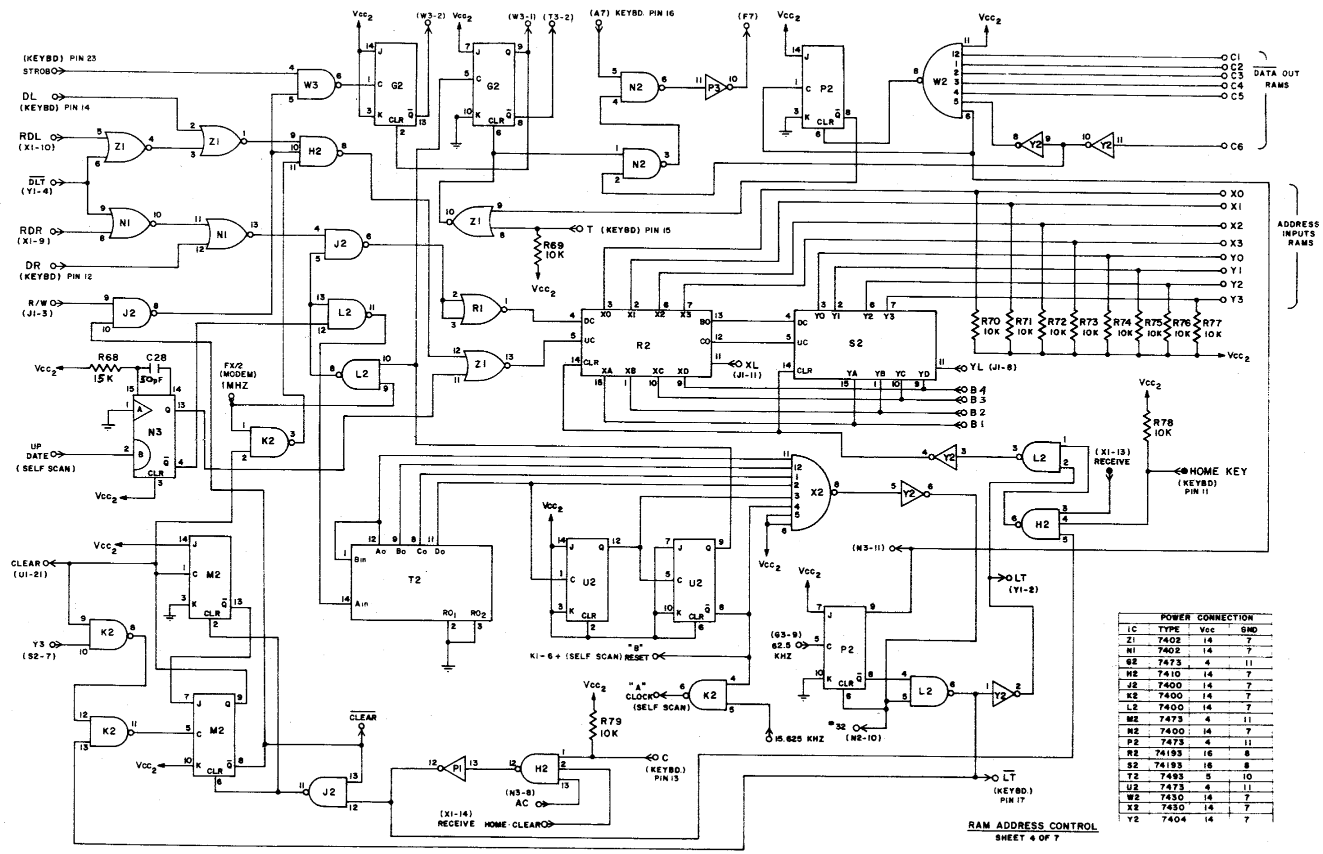
2. Circuit stays in that mode (unless cleared) until a character is received. Note that if either H1-8 or H1-13 is low, write pulse for memory is inhibited by G1-8 going high, forcing N1-1 low as in control character logic.

3. First character comes in, Y1-13 triggers, DLT (Data Load Time) pulses J1-13 high, J1-12 already high, B1-B4 data loaded into the "Y" address counter (I.C. S2). DLT also clocks H1-1 (H1-14 high, H1-3 low) and H1-12. $\overline{DLT}$ meanwhile clocks H1-5 and resets its condition. After first character received -- H1-8 and 9 reset, H1-12 and 13 set.

4. Second character comes in, Y1-13 triggers DLT on J1-9 goes high, J1-10 already high, J1-8 goes low, B1-B4 data loaded into the "X" address counter (I.C. R2). DLT also clocks H1-1 and resets H1-12 and 13 to complete address mode.



BLOCK DIAGRAM RAM ADDRESS CONTROL
SHEET 4



POWER CONNECTION			
IC	TYPE	Vcc	GND
Z1	7402	14	7
N1	7402	14	7
G2	7473	4	11
H2	7410	14	7
J2	7400	14	7
K2	7400	14	7
L2	7400	14	7
M2	7473	4	11
N2	7400	14	7
P2	7473	4	11
R2	74193	16	8
S2	74193	16	8
T2	7493	5	10
U2	7473	4	11
W2	7430	14	7
X2	7430	14	7
Y2	7404	14	7

RAM ADDRESS CONTROL
SHEET 4 OF 7

RAM ADDRESS CONTROL (SHEET 4)

This circuitry is responsible for the functioning of the self scan display and control of the memory address during each display scan.

A. The most important section is the self scan control logic. The sequence of operation is as follows:

   1. 15KHz clock enabled (to self scan), reset line to self scan high.

   2. Self scan displays character for 7 clock pulses (448 usec) then "update" pulse generated (60 usec positive pulse).

   3. Update pulse fed into I.C. N3-3 output is 450 nsec pulse (N3-13 and 4). (Note change in components: R68 now 15K, C28 now 50pF.)

   4. Pulse fed into RAM address counter update input through Z1-13 to R2-5. Pulse also fed into 64-count counter (I.C.s T2 and U2), increments count by 1.

   5. Steps 1-4 repeat 32 times.

   6. After 32nd update pulse, output of U2-9 and 8 switch, causing self scan reset to go low, and enabling 1MHz countdown clock (L2-10), disabling 15KHz self scan clock.

   7. RAM address counter (I.C.s R2 and S2) counts down 32 times. 64-count counter counts up another 32 times (at 1MHz rate), U2-9 and 8 reset causing self scan reset to go high, disabling 1MHz clock (L2-10), enabling 15KHz self scan clock.

   8. Sequence starts over again at #1 repeating continuously. Characters are shifted on the display by entering new characters (R/W pulse causes upcount on I.C. R2) or by pressing data right or data left keys.

B. LT (Load Time) is developed during the 32nd character display time (cursor position) and is used for synchronizing many functions. It is developed by:

   1. Output of X2 (pin 8) goes low after 31st update pulse (indicating 32nd character display time). P2-9 and 8 was reset, now P2-6 goes high.

   2. 62.5KHz clock on P2-5 toggles and latches P2-9 and 8 after 16 usec. The signal on P2-6 and P2-8 are gated together so L2-6 has a 16 usec pulse, inverted at Y2-2.

   3. When the 32nd update pulse is counted, X2-8 goes high, clearing P2-9 and 8.

C. Home Function

"Home" operates by clearing R2 and S2 RAM address counters during LT (cursor position) so that data in RAM address 0,0 is displayed in the right end of the self scan.

D. Clear Function

Clear operates by homing the RAM address counters, then cycling through all 256 addresses at a 1MHz rate while enabling the write circuit and encoding a blank on the B1-B6 data lines. This all occurs during the 32nd display time. The sequence is as follows:

1. Clear key pressed--R2 and S2 cleared when LT present, also causes M2-6 to go high, allowing $\overline{LT}$ to clock M2-5 (through K2-11). M2-9 and 8 set after $\overline{LT}$, M2-8 holds its M2-6 high through J2-13.

2. When M2-9 goes high, it enables the 1MHz clock on K2-3 which is fed into the upcount input of RAM address counter (R2-5). M2-8 ($\overline{CLEAR}$) goes to W1 (Sheet 3) where a blank is encoded on B1-B6 data lines (RAM input data). It also goes to J1-1 where it holds the write line high (J1-3).

3. As the 1MHz clock cycles the memory addresses, the Y3 address line (S2-7) goes high at the 128th clock pulse and low at the 256th clock pulse. This Y3 signal is fed through K2-8 and K2-11 into M2-5 which resets M2-9 and 8 and stops all clear functions.

4. M2-9 going high at the beginning and low at the end of the clear cycle clocks M2-1 which toggles and prevents the clear cycle from repeating. When the clear key is released, both M2 flip flops are held cleared.

E. The auto transmit circuit works by depressing the black "T" key which activates logic that switches the transmit data lines from the keyboard to the data output lines from the memory. Whatever character is in the cursor position of the display is transmitted out to the computer. As that character is received back, it is re-written into the same position in memory, the data is shifted left one position and the next character in memory is transmitted. Since the memory only stores the first 6 bits of the 7-bit ASCII code, the 7th bit must be derived by logic gating.

This is the reason why the CT256 cannot auto transmit control characters.

The 7th bit cannot be derived for control characters, and since the memory does not receive and store them anyway, they have to be transmitted manually via the keyboard. To allow entry of control characters such as carriage return, the detection of the @ symbol will cause auto-transmit to stop and the desired character may be manually transmitted. The @ symbol is detected in the cursor position and auto transmit cannot take place unless it is shifted out or a new character is entered manually.

To allow auto transmit to operate for half duplex circuits or where there is no echo back, connect pins 2 to 3 on the Aux/RS232 connector. This simply provides an echo back path through the XRS and RRS lines for any data transmitted.

The sequence of operation for auto transmit is:

1. Black "T" key pressed--Z1-10 goes high, enabling G2-6. After U2-9 goes low (beginning of scan cycle) G2-9 and 8 are set.

2. On sheet 6, G2-9 going high enables RAM data (D1-D6) to be transmitted, G2-8 disables keyboard data (A1-A6). W3-3 goes low activating TS (Transmit Strobe), causing a strobe pulse the next time LT is active.

3. The data on D1-D6 (the character in the cursor position) is transmitted out from the UART. The strobe pulse also clocks G2-1 through W3-6. G2-13 goes low allowing TS to return to high.

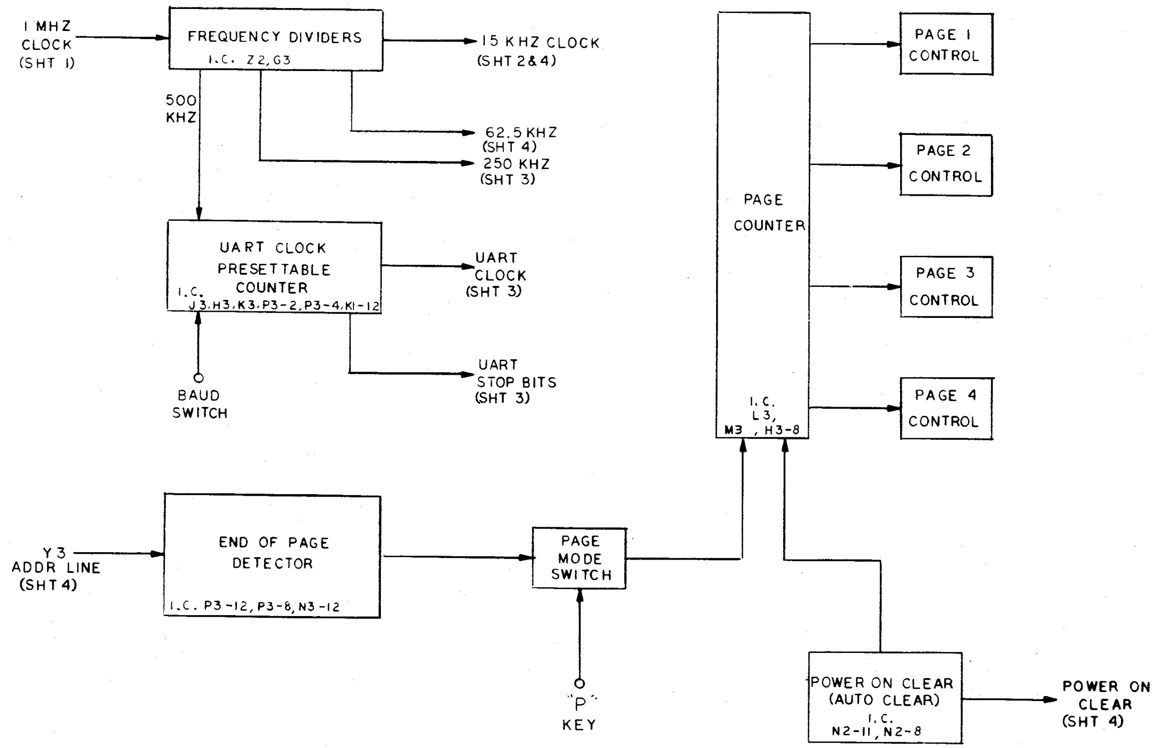
4. When the character is received back, a write pulse is generated (on R/W) and it toggles G2-1 causing G2-13 to go high. The write pulse also causes the data to shift one position to the left, putting a new character in the cursor position.

5. G2-13 going high causes W3-3 to go low, initiating another transmit strobe.

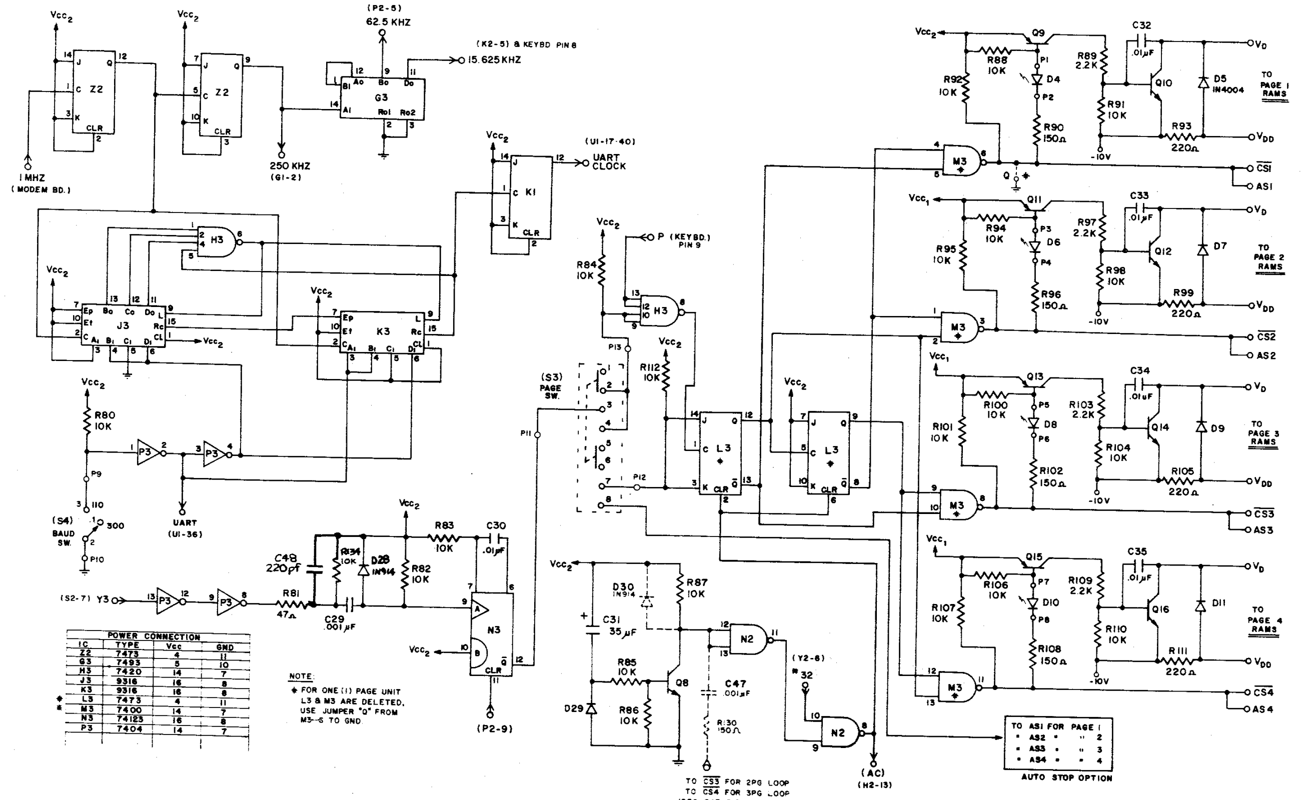
6. This cycle repeats steps 3-5 until the "T" key is released or an @ symbol is in the cursor position. If an @ symbol is detected:

   C1-C6 lines ($\overline{\text{DATA}}$ from RAMs) will all go high during the 32nd character display time, causing W2-8 to go low, clearing P2-8, forcing Z1-10 low, clearing the auto transmit circuit. P2-8 is set by moving the @ symbol from the cursor position, allowing P2-9 to toggle P2-1.

7. For auto transmit, the 7th data bit is generated by inverting the 6th bit and placing it on the F7 data line (see ASCII code chart). The A7 line from the keyboard is normally high unless a control or non-alpha key is pressed.



BLOCK DIAGRAM
PAGE SELECT CIRCUIT
SHEET 5



POWER CONNECTION				
	IC	TYPE	Vcc	GND
	Z2	7473	4	11
	G3	7493	5	10
	H3	7420	14	7
	J3	9316	16	8
	K3	9316	16	8
◆	L3	7473	4	11
◆	M3	7400	14	7
	N3	74123	16	8
	P3	7404	14	7

PAGE SELECT CIRCUIT
SHEET 5 OF 7

PAGE SELECT CIRCUIT (SHEET 5)

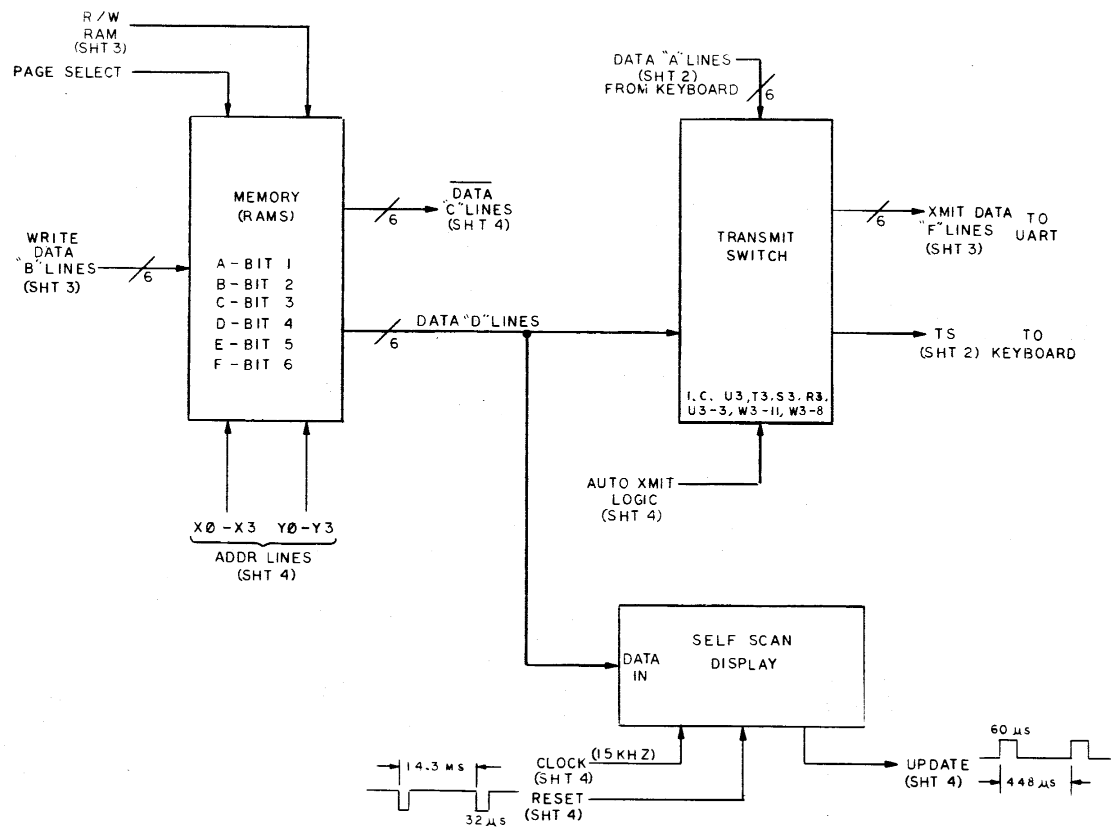
Page select consists of a 4-bit counter and gating for the page control circuitry. When a page is selected, the chip select line for that page is low, and Vd and Vdd are -10v. On the unselected pages chip select is high, Vd is off, and Vdd is reduced to -6v to reduce power drain.

The automatic page change circuit operates by sensing the falling edge of Y3, after LT and before self scan reset (during #32 character display time). As a character is entered in the last position of a page, the write pulse advances the RAM address counter, Y3 falls, N3 triggers and N3-12 goes low for 25 usec, advancing the page counter.

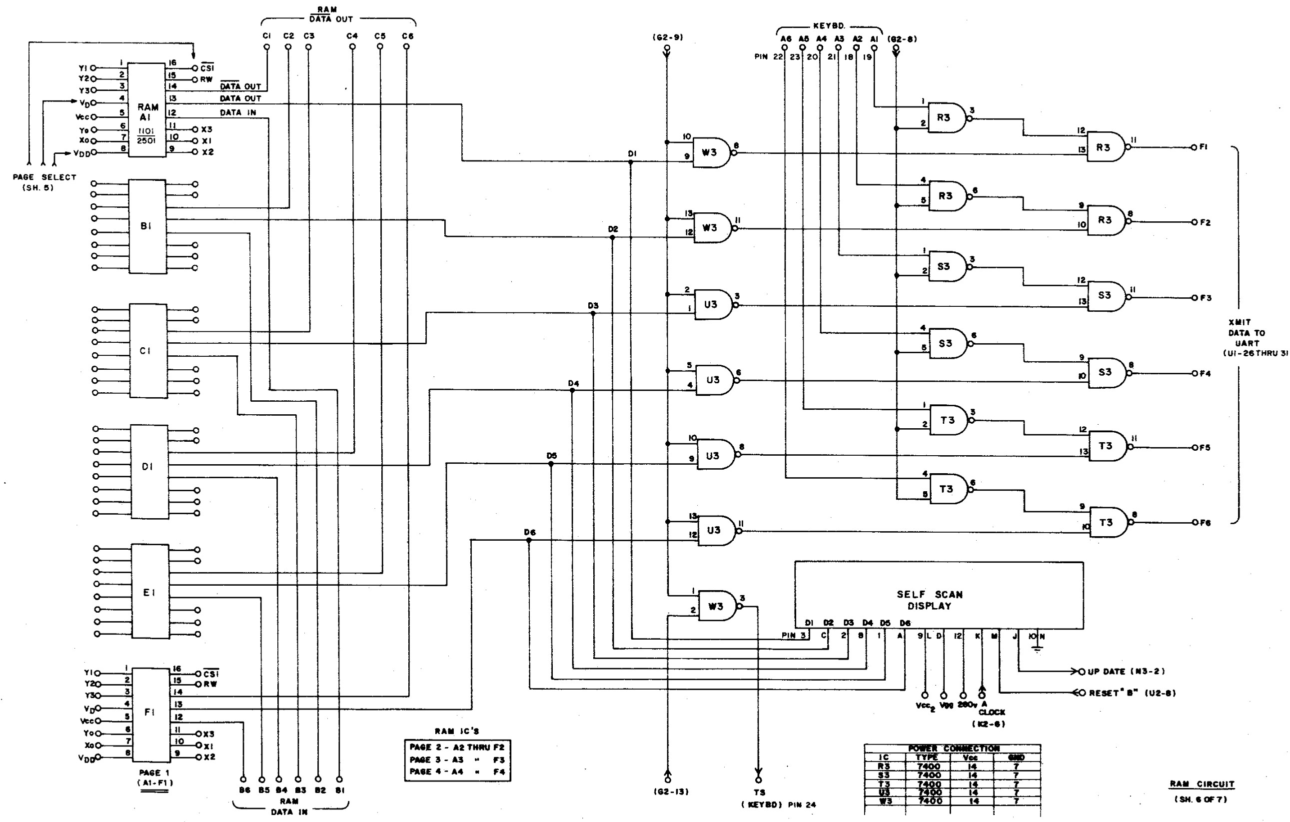
NOTE: Multipage units should have a 10K resistor in parallel with C48 (a 220pF capacitor) to provide the necessary level change for the "A" input of N3.

Sheet 5 includes the Power On Clear circuit which operates by the initial charge current through Q8 for C31. This results in N2-8 pulsing low every 14.3 msec for 400 usec when the unit is first turned on. C31 charges in about .5 sec. N2-8 goes to the clear circuit on Sheet 4.

Also on Sheet 5 are the dividers for all the timing signals used in the Comter. They are simple flip flop dividers except for the UART clock circuit. The UART clock frequency is determined by the preset count on I.C.s J3 and K3. The count is determined by switch S4 which also sets the number of stop bits in the serial data.



BLOCK DIAGRAM
RAM CIRCUIT
SHEET 6



RAM IC'S

PAGE 2 - A2 THRU F2	
PAGE 3 - A3 "	F3
PAGE 4 - A4 "	F4

POWER CONNECTION

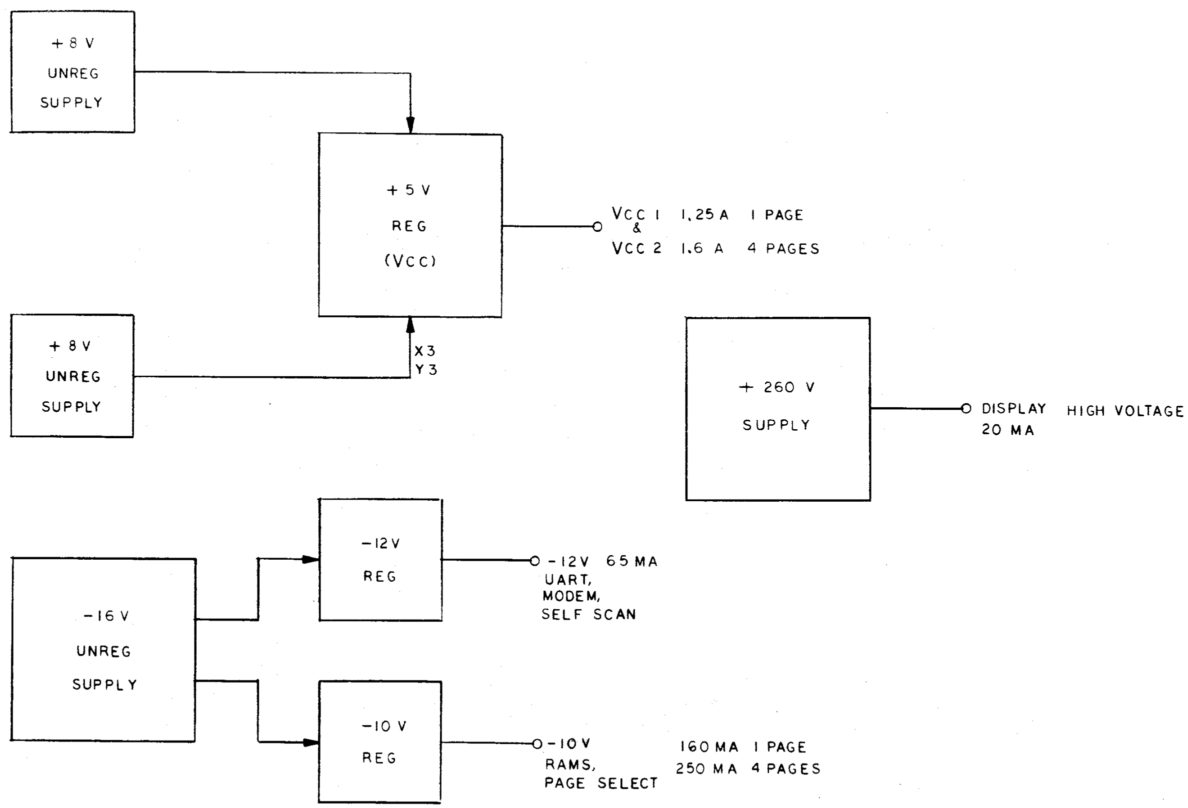
IC	TYPE	Vcc	GND
R3	7400	14	7
S3	7400	14	7
T3	7400	14	7
U3	7400	14	7
W3	7400	14	7

RAM CIRCUIT
(SH. 6 OF 7)

RAM CIRCUIT (SHEET 6)

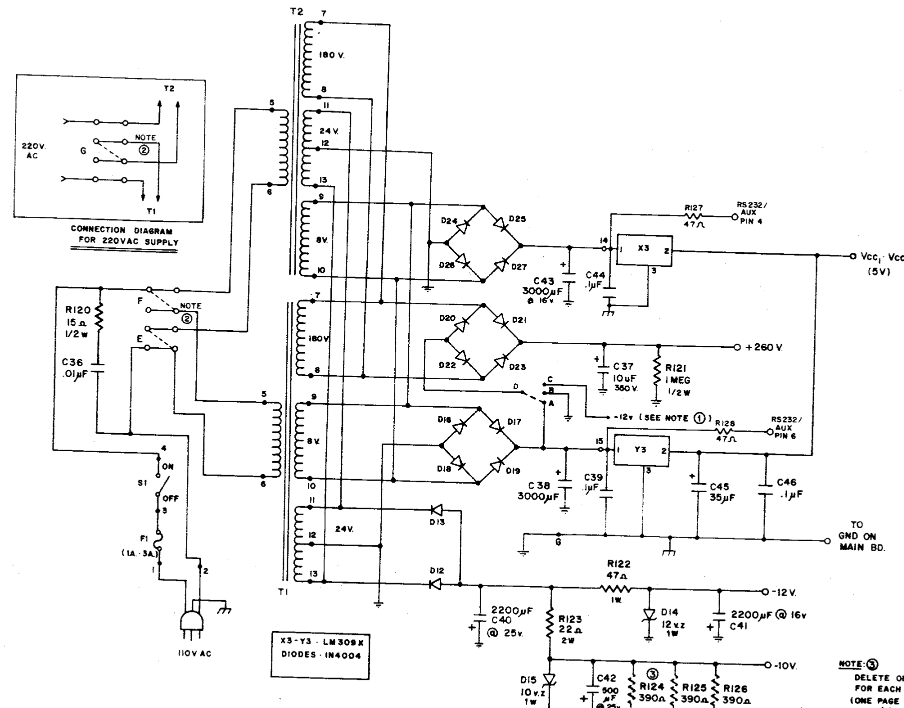
This shows the memory I.C.s orientation and the data input and output. The data input (B1-B6) comes from the receive circuit (Sheet 3) and the output data (D1-D6) goes to the display and the transmit switching circuit.

The self scan inputs the data, 15KHz clock and the reset signal and outputs the update pulse. Vcc is +5 volts, Vgg is -12 volts and the +260 volts runs the plasma display itself.



BLOCK DIAGRAM
POWER SUPPLY
SHEET 7

RS232/AUX JACK CONNECTIONS		
PIN	DESCRIPTION	CONNECTS TO
1	PROTECTIVE GROUND	CHASSIS GND
2	RS232 XMIT	MODEM-XRS
3	RS232 REC	MODEM-RRS
4	RS232 REQUEST TO SEND - +8v	47Ω TO X3-1
6	RS232 DATA SET READY - +8v	47Ω TO Y3-1
7	SIGNAL GND	MODEM GND
11	Vcc (+5v)	Y3-2
14	XS-TTL TRANSMIT INPUT	SWITCH 2-2
16	RS-TTL RECEIVE OUTPUT	SWITCH 2-4
18	FX (2MHZ) TTL-CLOCK	MODEM-FX
25	(-12v)	-12v MODEM



NOTE: ① DISPLAY VOLTAGE (+260v)

JUMPERS (USE ONLY ONE) POINT "D" TO-:

(A) - FOR AREAS OF LOW LINE VOLTAGE (LV) (LESS THAN 110V.)

(B) - FOR AREAS OF NORMAL LINE VOLTAGE (NV) (110-120V.)

(C) - FOR AREAS OF HIGH LINE VOLTAGE (HV) (GREATER THAN 120V.)

NOTE: ②

JUMPERS E+F ONLY FOR 110v OPERATION

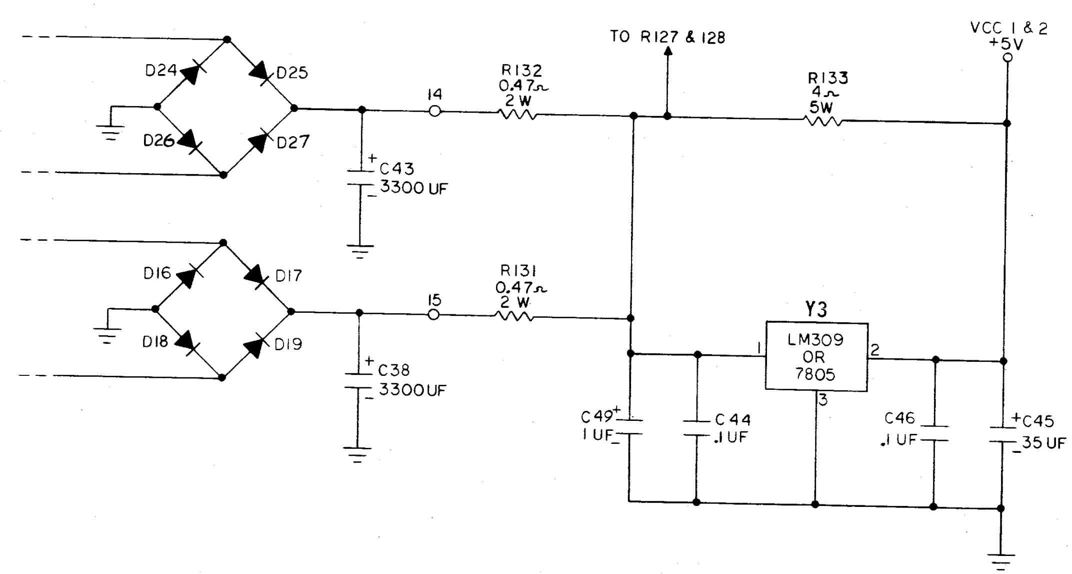
JUMPER G ONLY FOR 220v OPERATION

NOTE: ③

DELETE ONE 390Ω RESISTOR FOR EACH ADDITIONAL PAGE OF MEMORY (ONE PAGE UNIT HAS 3EA., 4 PAGE UNIT HAS NONE) IF USED.

+RS232/AUX CONNECTOR

CT-256
POWER SUPPLY
(SH. 7 OF 7)



POWER SUPPLY
SCHEMATIC UPDATE

POWER SUPPLY (SHEET 7)

The power supply has 4 outputs: +260 volts (20mA drain typical), +5 volts (Vcc1 & Vcc2: 1.2--1.6A typical), -10 volts (+60mA--300mA typical), -12 volts (65mA typical).

The transformers wired in parallel must be phased correctly (all windings in phase) or they will overheat or blow the fuse. Normal temperature rise for the transformers is 60°F above ambient temperature.

The Vcc regulators X3 and Y3 are 1-amp, 5-volt regulators. Usually one will work harder than the other due to slight differences in the output voltage. On units produced after July 1975, there is a modification that tends to balance current drain from the bridge rectifiers and uses one regulator bypassed by a 4 ohm resistor (see new schematic).

TROUBLESHOOTING AIDS FOR THE COMTER

A. General Guide

1. Troubleshooting TTL Logic
   Keep in mind the D.C. levels for TTL logic. A valid logic 0 is between -0.6v to +0.8v. A valid logic 1 is between +2.2v and +5.5v.

2. The first steps of troubleshooting the Comter (or any electronic gear) are:

   a. Identify the problem(s).

   b. Check power supply voltages. (Wrong voltages can cause many strange effects.)

   c. Isolate and repair the problems one at a time. Don't let the presence of several problems cause confusion.

3. Digital electronics is logical. If there is a situation that is not logical, you have isolated the problem or the information you have is incorrect or incomplete.

B. Specific Problems

1. Self Scan Display Indications
   An indication that the self scan display and associated logic is functioning properly is an orange glow across the full length of the display tube, visible from the top of the self scan.

   a. Missing or flickering dots on characters may be caused by the +260 volt supply being too low. If the dots appear to be missing or flickering in horizontal rows, it may be a defective self scan.

   b. Lights on left end only indicates either no 15KHz clock or defective self scan.

   c. Lights only in between left and right end indicates no 15KHz clock.

   d. Lights only on right end indicates it has scanned from left to right but has not been reset -- no reset.

   e. Does not light at all indicates no +260v or no clocking. Also could be defective self scan.

f. Notes on Self Scan Display

1) Self scan employs static sensitive MOS circuitry. Short edge connector pads together when connector removed.

2) Self scan display life may be shortened if operated at temperatures below 40°F or if left on in modes B, C or D described above (normally 20,000 hour life).

3) Self scan display unit comes preassembled and should not be tampered with. For repair of a suspected defective self scan, return to MITS. If customer damaged unit, $50 repair charge. If physically broken, consult MITS.

2. Comter Memory

a. Character displayed is different from character key pressed. This usually due to a defective RAM. Refer to the ASCII code chart to identify the missing or added bits. Check the circuitry from the keyboard to the RAMs to isolate the problem. Sometimes a single memory cell in a RAM will be defective. This will appear as a character always displayed incorrectly in a certain location in memory.

b. All "@" symbols displayed indicates that the page of memory selected isn't getting proper -10 volts on Vd and Vdd (page switching).

c. On 4 page units, check the Vcc voltage for page 4. There was a problem on some RAM boards (page expansion) that the Vcc hole for page 4 was not plated through properly. It gives confusing symptoms.

3. Keyboard

a. No characters entered when key pressed indicates mode switch is not in "LOCAL", or miswired. Check for 100 usec strobe on pin 23 of UART I.C. U1. If strobe OK, check serial data signal on XSO or RSI. If no strobe, check on keyboard I.C. S (see theory).

b. Check wiring of cable for problems of incorrect or no functions.

c. When operated in strong R.F. fields, the keyboard cable picks up signals causing Comter to malfunction. Shield keyboard cable if necessary.

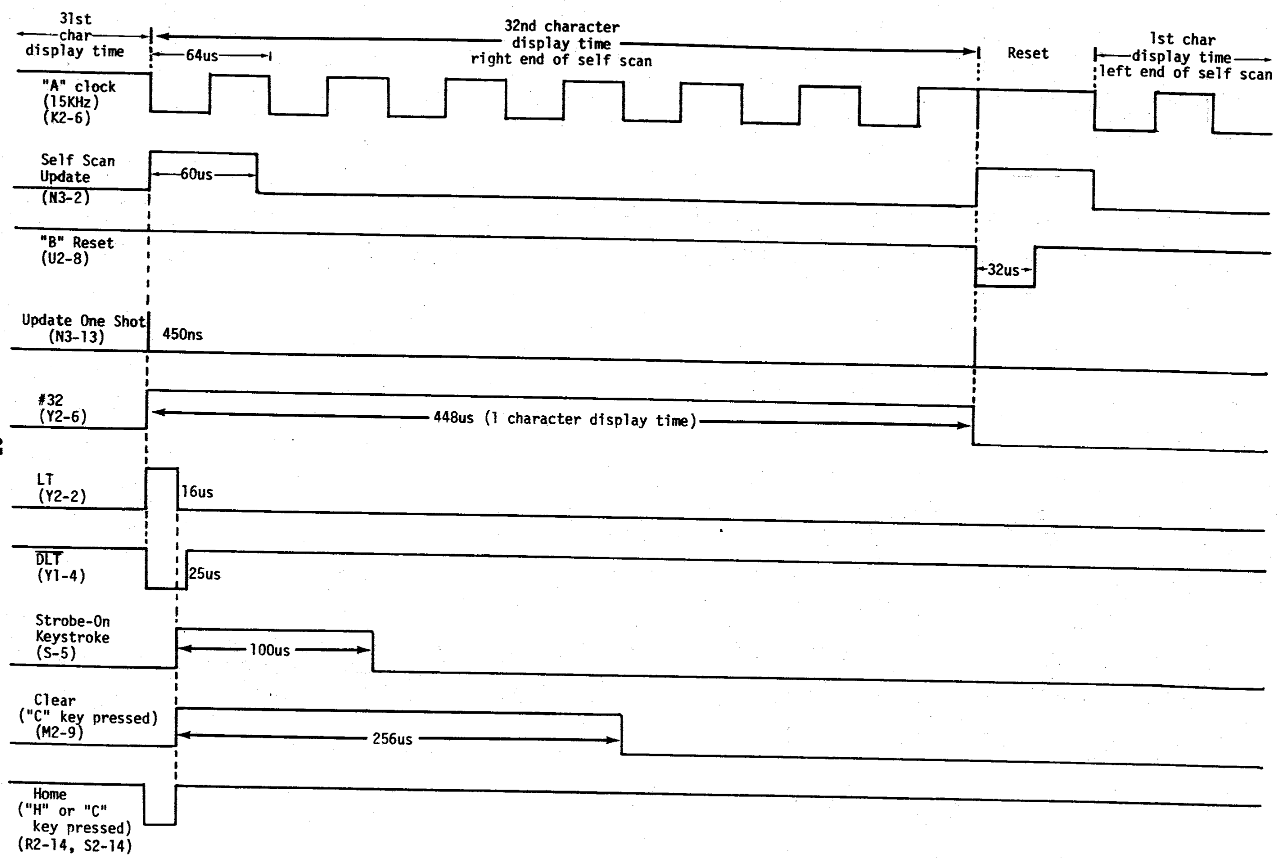
d. Character repeats when key is pressed is usually due to multiple strobe pulses caused by the "A" flip flop of I.C. R (7490) resetting due to noise on its Ro (pins 2 and 3) input. To correct this, add jumper wires to ground and Vcc from I.C. R to the right end of the board where Vcc and GND come in to the board. This reduces the noise on the left end of the PC board. Also, replacing I.C. R with a unit with a higher noise threshold can remedy the problem.

4. Modem Circuit Board (see Modem Parts Layout)

   a. Some difficulties can be caused by incorrect crystal frequency. When pressing control "G", bell tone speaker should sound (local mode), giving a 4KHz tone. If not, crystal probably too high a frequency. Check pins 1 and 2 of D for a 3 volt P-P sine wave, indicating good crystal. R43 and R45 may have to be lowered to 330 ohm for good operation.

   b. Doesn't work on acoustic coupler -- carrier light on -- indicates incorrect baud switch setting, or transmit speaker volume too low. Place in "TEL" mode, feed 2KHz signal into P/R jack or acoustic coupler microphone, listen for 1KHz tone from transmit speaker. Press key on keyboard to check for modulation. If tone too low level, boost level by paralleling R36 with 820 ohm resistor. If modem transmitting OK, check R29 for proper demodulator adjustment. Check for serial data at "RS".

   c. Doesn't work on acoustic coupler -- carrier light not on -- indicates microphone or filter circuit inoperative if 2KHz tone being received OK. See voltage and waveform listing for proper signals.



COMTER
TIMING SIGNALS DURING 32nd CHARACTER
DISPLAY TIME AND RESET

COMTER

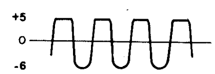
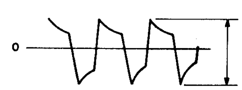
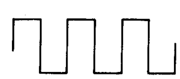
MODEM BOARD VOLTAGE & WAVEFORM TEST DATA

NOTE: All signals and voltages are measured with respect to ground.

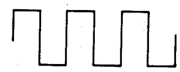
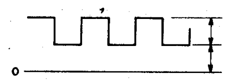
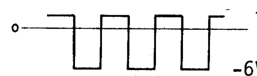
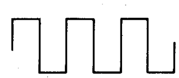
The voltage measurements were taken with a 20K ohms/V VOM.

The voltage measurements may vary ±10%.

DEMODULATOR SECTION

TEST POINT		NO SIGNAL IN	ACOUSTIC SIGNAL IN	
IC A uA741 FILTER	Invert. Input Pin 2	OVDC		
	Non-Invert. Input Pin 3	OVDC	OVDC	
	Output Pin 6	OVDC (may be ±.1V)		
IC B uA741 FILTER	Invert. Input Pin 2	OVDC		
	Non-Invert. Input Pin 3	OVDC	OVDC	
	Output Pin 6	OVDC (may be ±.1V)		(2KHz)
IC C XR-210 (P.L.L.)	Volt.Comp. In Pin 1	OVDC		1.2V P-P +1VDC
	Phase Det. Out Pin 2	-4VDC		2.5V P-P +1VDC
	Phase Det. Out Pin 3	-6.25VDC		.1V P-P +1.1VDC
	Phase Det. In Pin 4	-5.5VDC		2V P-P (2KHz)
	Phase Det. Bias Pin 5	-5.5VDC	OVDC	
	Phase Det. In Pin 6	-5.0VDC		1.4V P-P OVDC
	V- Pin 7	-12VDC	-12VDC	

(cont.)

TEST POINT		NO SIGNAL IN	ACOUSTIC SIGNAL IN
Logic Output Pin 8 (cathode Z1)		+5VDC	 +5VDC / -0.5VDC (Demodulated data)
VCO Fine Tune Pin 9		-11.5VDC	-11.5VDC
VCO Keying Input (not used) Pin 10		-4VDC	-4VDC
VCO Gain & Sweep Control			
Pin 11		-7VDC	-0.25VDC
Pin 12		-6VDC	-0.5VDC
VCO Timing Capacitor			
Pin 13		+3VDC	+3VDC
Pin 14		+3VDC	+3VDC
VCO Output Pin 15		 +1V	2.5V P-P +2.5VDC (2KHz)
V+ Pin 16		+5VDC	+5VDC
Q2 (PNP Silicon EN2907)	E	+5VDC	+5VDC
	B	Open	+4.3VDC
	C	-7VDC	+4.3VDC
Q3 (PNP Silicon EN2907)	E	Open	+4.3VDC
	B	+5VDC	+3.6VDC
	C	-7VDC	+4.3VDC
Q4 (NPN Silicon CS4410/4437)	E	OVDC	OVDC
	B	OVDC	 +.7VDC / -1.5VDC / -6VDC
	C	+3VDC	 +3VDC / OVDC (2KHz)

(cont.)

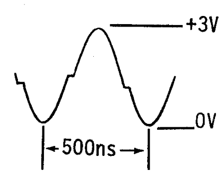
MODULATOR SECTION

Tests are made with no signal on the demodulator input. TTL logic voltage levels are used; logic 0 = -0.6v to +0.8v, logic 1 = +2.2v to +5.5v. The frequencies are within ±.05% of the values listed.

TEST POINT			MODULATOR INPUT XS = LOGIC 1	MODULATOR INPUT XS = LOGIC 0
IC H	Pin 1	Input	10160Hz-8us +pulse	8560Hz-8us +pulse
7420	Pin 2	Input	500KHz-sq. wave	500KHz-sq. wave
Dual Quad	Pin 4	Input	250KHz-sq. wave	250KHz-sq. wave
Input NAND	Pin 5	Input	125KHz-sq. wave	125KHz-sq. wave
	Pin 6	Output	10160Hz-500ns -pulse	8560Hz-500ns -pulse
	Pin 13	Input	+5VDC } mode switch	+5VDC } mode switch
	Pin 12	Input	+5VDC } in TEL	+5VDC } in TEL
	Pin 10	Input	1270Hz-sq. wave	1070Hz-sq. wave
	Pin 9	Input	1270Hz-sq. wave	1070Hz-sq. wave
	Pin 8	Output	1270Hz-sq. wave	1070Hz-sq. wave
IC J 9316/74161 Presettable 4-bit ctr.	Pin 2	Clock Input	2MHz	2MHz
	Pin 15	Ripple Carry Out.	125KHz-500ns +pulse	125KHz-500ns +pulse
IC K 9316/74161 Presettable 4-bit ctr.	Pin 2	Clock Input	2MHz	2MHz
	Pin 15	Ripple Carry Out.	10160Hz-8us +pulse	8560Hz-8us +pulse

2MHz CLOCK

IC D	Pins 1 & 2	2MHz sine wave
	Pin 6	2MHz square wave



ASCII CODE CHART

BITS B4	B3	B2	B1	CONTROL		NON ALPHA		FIELD CODES		LOWER CASE	
			B7	Ø	Ø	Ø	Ø	1	1	1	1
			B6	Ø	Ø	1	1	Ø	Ø	1	1
			B5	Ø	1	Ø	1	Ø	1	Ø	1
				0	1	2	3	4	5	6	7
Ø	Ø	Ø	Ø	NUL ϕ	DLE 16	SP 32	Ø 48	@ 64	P 8ϕ	` 96	p 112
Ø	Ø	Ø	1	SOH 1	DC1 17	! 33	1 49	A 65	Q 81	a 97	q 113
Ø	Ø	1	Ø	STX 2	DC2 18	" 34	2 5ϕ	B 66	R 82	b 98	r 114
Ø	Ø	1	1	ETX 3	DC3 19	# 35	3 51	C 67	S 83	c 99	s 115
Ø	1	Ø	Ø	EOT 4	DC4 2ϕ	$ 36	4 52	D 68	T 84	d 1ϕϕ	t 116
Ø	1	Ø	1	ENQ 5	NAK 21	% 37	5 53	E 69	U 85	e 1ϕ1	u 117
Ø	1	1	Ø	ACK 6	SYN 22	& 38	6 54	F 7ϕ	V 86	f 1ϕ2	v 118
Ø	1	1	1	BELL 7	ETB 23	' 39	7 55	G 71	W 87	g 1ϕ3	w 119
1	Ø	Ø	Ø	BS 8 ←	CAN 24	(4ϕ	8 56	H 72	X 88	h 1ϕ4	x 12ϕ
1	Ø	Ø	1	HT 9 →	EM 25	) 41	9 57	I 73	Y 89	i 1ϕ5	y 121
1	Ø	1	Ø	LINE FEED 1ϕ	SUB 26	* 42	: 58	J 74	Z 9ϕ	j 1ϕ6	z 122
1	Ø	1	1	HOME 11	ESC 27	+ 43	; 59	K 75	[91	k 1ϕ7	{ 123
1	1	Ø	Ø	FF CLEAR 12	FS 28	, 44	< 6ϕ	L 76	* ∿ 92	l 1ϕ8	: 124
1	1	Ø	1	CARR. RETURN 13	GS 29	- 45	= 61	M 77	] 93	m 1ϕ9	} 125
1	1	1	Ø	SO 14	RS 3ϕ	. 46	> 62	N 78	* { 94	n 11ϕ	∿ 126
1	1	1	1	SI ADDRESS 15	US 31	/ 47	? 63	O 79	* } 95	o 111	RUBOUT 127

DISPLAYED CHARACTER (columns 2–5)

*special form character for self scan display

HEX TO CHARACTER CODE FOR DATA COMMUNICATIONS

EBCDIC		EVEN PARITY ASCII	ODD PARITY ASCII	7-BIT ASCII		EBCD UC	EBCD LC	SELECTRIC UC	SELECTRIC LC
00	NUL	NUL		00	NUL				
01	SOH		SOH	01	SOH			O	!
02	STX		STX	02	STX	¢	@	T	t
03	ETX	ETX		03	ETX				
04	PF		EOT	04	EOT	*	8	$	4
05	HT	ENQ		05	ENQ				
06	LC	ACK		06	ACK				
07	DEL		BEL	07	BEL	H	h	?	1
08			BS	08	BS	:	4	%	5
09	RLF	HT		09	HT				
0A	SMM	LF		0A	LF				
0B	VT		VT	0B	VT	D	d	P	p
0C	FF	FF		0C	FF				
0D	CR		CR	0D	CR	RES		RES	
0E	SO		SO	0E	SO	BYP		BY	
0F	SI	SI		0F	SI				
10	DLE		DLE	10	DLE	<	2	@	2
11	DC1	DC1		11	DC1				
12	DC2	DC2		12	DC2				
13	DC3		DC3	13	DC3	B	b	+	=
14	RES	DC4		14	DC4				
15	NL		NAK	15	NAK				
16	BS		SYN	16	SYN				
17	IL	ETB		17	ETB				
18	CAN	CAN		18	CAN				
19	EM		EM	19	EM	O	o	I	i
1A	CC		SUB	1A	SUB	W	w	K	k
1B		ESC		1B	ESC				
1C	IFS		FS	1C	FS	UPPER CASE		UPPER CASE	
1D	IGS	GS		1D	GS				
1E	IRS	RS		1E	RS				
1F	IUS		US	1F	US	LOWER CASE		LOWER CASE	
20	DS		SP	20	SP	=	1	[±]	1
21	SOS	!		21	!				
22	FS	"		22	"				
23			#	23	#	A	a	G	g
24	BYP	$		24	$				
25	LF		%	25	%	R	r	S	s
26	EOB/ETB		&	26	&	Z	z	H	h
27	ESC/PRE	'		27	'				
28		(		28	(				
29			)	29	)	N	n	R	r
2A	SM		*	2A	*	V	v	D	d
2B		+		2B	+				
2C			.	2C	.	RS		RS	
2D	ENQ	–		2D	–				
2E	ACK	.		2E	.				
2F	BEL		/	2F	/	HT		HT	
30		0		30	0	;	3		
31			1	31	1	L	l	V	v
32	SYN		2	32	2	T	t	U	u
33		3		33	3				
34	PN		4	34	4	"	#	(	9
35	RS	5		35	5				
36	UC	6		36	6				
37	EOT		7	37	7	¬		–	-
38			8	38	8	>	7	*	8
39		9		39	9				
3A		:		3A	:				
3B			;	3B	;	G	g	'	'
3C	DC4	<		3C	<				
3D	NAK		=	3D	=	IL		IL	
3E			>	3E	>	PRE		PRE	
3F	SUB	?		3F	?				

EBCDIC		EVEN PARITY ASCII	ODD PARITY ASCII	7-BIT ASCII		EBCD UC	EBCD LC	SELECTRIC UC	SELECTRIC LC
40	SP		@	40	@	SP		SP	
41		A		41	A				
42		B		42	B				
43			C	43	C	+	&	J	j
44		D		44	D				
45			E	45	E	Q	q	O	o
46			F	46	F	Y	y	L	l
47		G		47	G				
48		H		48	H				
49			I	49	I	M	m	"	'
4A	¢		J	4A	J			E	e
4B	•	K		4B	K	U	u		
4C	<		L	4C	L	PN		PN	
4D	(	M		4D	M				
4E	+	N		4E	N				
4F	I		O	4F	O	PF		PF	
50	&	P		50	P				
51			Q	51	Q	K	k	•	•
52			R	52	R	S	s	N	n
53		S		53	S				
54			T	54	T	)	0	Z	z
55		U		55	U				
56		V		56	V				
57			W	57	W				
58			X	58	X	'	6	¢	6
59		Y		59	Y				
5A	!	Z		5A	Z				
5B	$		[	5B	[	F	f	Q	q
5C	*	\	\	5C	\				
5D	)		]	5D	]	BS		BS	
5E	;		Λ	5E	Λ	EOB		EOB	
5F	¬	—		5F	—				
60	-	`		60	`				
61	/		a	61	a	J	j	M	m
62			b	62	b	?	/	X	x
63		c		63	c				
64			d	64	d	(	9	)	0
65		e		65	e				
66		f		66	f				
67			g	67	g	I	i	Y	y
68			h	68	h	%	5	&	7
69		i		69	i				
6A	¦	j		6A	j				
6B	,		k	6B	k	E	e	:	;
6C	%	l		6C	l				
6D	—		m	6D	m	NL		NL	
6E	>		n	6E	n	LF		LF	
6F	?	o		6F	o				
70			p	70	p			#	3
71		q		71	q				
72		r		72	r				
73			s	73	s	C	c	F	f
74		t		74	t				
75			u	75	u	!	$	W	w
76			v	76	v	'	.	B	b
77		w		77	w				
78		x		78	x				
79	\		y	79	y	P	p	A	a
7A	:		z	7A	z	X	x	C	c
7B	#	{		7B	{				
7C	@		¦	7C	¦	EOT		EOT	
7D	'	}		7D	}				
7E	=	~		7E	~				
7F	"		DEL	7F	DEL	DEL		DEL	

COURTESY OF

ATLANTIC RESEARCH CORPORATION

5390 CHEROKEE AVENUE·ALEXANDRIA,VIRGINIA·22314

703·354·3400

MANUFACTURERS OF INTERSHAKE and DATA TEK 9600

EBCDIC	EVEN PARITY ASCII	ODD PARITY ASCII	8-BIT ASCII	EBCDIC	EVEN PARITY ASCII	ODD PARITY ASCII	8-BIT ASCII		FIELD DATA	6-BIT TYPESETTER		6-BIT TRANSCODE	BAUDOT	
										SHIFT	UNSHIFT		LTRS	FIGS
80		NUL	NUL	C0 {	@		@		00			SOH		
81 a	SOH		SOH	C1 A		A	A		01 &	E	e	A	E	3
82 b	STX		STX	C2 B		B	B		02 Λ	ELEVATE		B	LF	
83 c		ETX	ETX	C3 C	C		C		03 [	A	a	C	A	
84 d	EOT		EOT	C4 D		D	D		04]	SPACE		D	SP	
85 e		ENQ	ENQ	C5 E	E		E		05 SP	S	s	E	S	BEL
86 f		ACK	ACK	C6 F	F		F		06 A	I	i	F	I	8
87 g	BEL		BEL	C7 G		G	G		07 B	U	u	G	U	7
88 h	BS		BS	C8 H		H	H		08 C	RETURN		H	CR	
89 i		HT	HT	C9 I	I		I		09 D	D	d	I	D	$
8A		LF	LF	CA	J		J		0A E	R	r	STX	R	4
8B	VT		VT	CB		K	K		0B F	J	j	.	J	'
8C		FF	FF	CC	L		L		0C G	N	n	<	N	,
8D	CR		CR	CD		M	M		0D H	F	f	BELL	F	!
8E	SO		SO	CE		N	N		0E I	C	c	SUB	C	:
8F		SI	SI	CF	O		O		0F J	K	k	ETB	K	(
90	DLE		DLE	D0 }		P	P		10 K	T	t	&	T	5
91 j		DC1	DC1	D1 J	Q		Q		11 L	Z	z	J	Z	"
92 k		DC2	DC2	D2 K	R		R		12 M	L	l	K	L	)
93 l	DC3		DC3	D3 L		S	S		13 N	W	w	L	W	2
94 m		DC4	DC4	D4 M	T		T		14 O	H	h	M	H	#
95 n	NAK		NAK	D5 N		U	U		15 P	Y	y	N	Y	6
96 o	SYN		SYN	D6 O		V	V		16 Q	P	p	O	P	0
97 p		ETB	ETB	D7 P	W		W		17 R	Q	q	P	Q	1
98 q		CAN	CAN	D8 Q	X		X		18 S	O	o	Q	O	9
99 r	EM		EM	D9 R		Y	Y		19 T	B	b	R	B	?
9A	SUB		SUB	DA		Z	Z		1A U	G	g	SPACE	G	8
9B		ESC	ESC	DB	[		[		1B V	SHIFT		$	FIGS	
9C	FS		FS	DC		\	\		1C W	M	m	*	M	.
9D		GS	GS	DD	]		]		1D X	X	x	US	X	/
9E		RS	RS	DE	Λ		Λ		1E Y	V	v	EOT	V	;
9F	US		US	DF		—	—		1F Z	UNSHIFT		DLE	LTRS	
A0	SP		SP	E0 \		`			20)	THIN SPACE		—		
A1 ~		!	!	E1	a		a		21 —		3	/		
A2 s		"	"	E2 S	b		b		22 +	PF		S		
A3 t	#		#	E3 T		c	c		23 <	!	$	T		
A4 u		$	$	E4 U	d		d		24 =	ADD THIN SPACE		U		
A5 v	%		%	E5 V		e	e		25 >	EM SPACE		V		
A6 w	&		&	E6 W		f	f		26 #		8	W		
A7 x		'	'	E7 X	g		g		27 $		7	X		
A8 y		(	(	E8 Y	h		h		28 *	↓	↓	Y		
A9 z	)		)	E9 Z		i	i		29 (	@	—	Z		
AA	*		*	EA		j	j		2A %		4	ESC		
AB		+	+	EB	k		k		2B :	BELL		,		
AC	,		,	EC		l	l		2C ?			%		
AD		—	—	ED	m		m		2D !	.	,	ENQ		
AE		.	.	EE	n		n		2E .	EN SPACE		ETX		
AF	/		/	EF		σ	σ		2F @	QR		HT		
B0		0	0	F0 0	p		p		30 0		5	0		
B1	1		1	F1 1		q	q		31 1	(	)	1		
B2	2		2	F2 2		r	r		32 2	V RULE		2		
B3		3	3	F3 3	s		s		33 3		2	3		
B4	4		4	F4 4		t	t		34 4	EM LEADER		4		
B5		5	5	F5 5	u		u		35 5		6	5		
B6		6	6	F6 6	v		v		36 6	?	0	6		
B7	7		7	F7 7		w	w		37 7	EN LEADER		7		
B8	8		8	F8 8		x	x		38 8	&	9	8		
B9		9	9	F9 9	y		y		39 9	UPPER RAIL		9		
BA		:	:	FA	z		z		3A '	:	;	SYN		
BB	;		;	FB		{	{		3B ;	LOWER RAIL		#		
BC		<	<	FC	¦		¦		3C /	.	.	@		
BD	=		=	FD		}	}		3D .		1	NAK		
BE	>		>	FE		~	~		3E FF	QUAD CENTER		EM		
BF		?	?	FF	DEL		DEL		3F CR	RUBOUT		DEL		

TP-107-7-75

UNIVERSAL CODE CHART FOR DATA COMMUNICATIONS

Char	8-BIT ASCII BINARY	HEX	7-BIT ASCII BINARY	HEX	EVEN PARITY ASCII BINARY	HEX	ODD PARITY ASCII BINARY	HEX
A	11 000 001	C1	1 000 001	41	01 000 001	41	11 000 001	C1
B	11 000 010	C2	1 000 010	42	01 000 010	42	11 000 010	C2
C	11 000 011	C3	1 000 011	43	11 000 011	C3	01 000 011	43
D	11 000 100	C4	1 000 100	44	01 000 100	44	11 000 100	C4
E	11 000 101	C5	1 000 101	45	11 000 101	C5	01 000 101	45
F	11 000 110	C6	1 000 110	46	11 000 110	C6	01 000 110	46
G	11 000 111	C7	1 000 111	47	01 000 111	47	11 000 111	C7
H	11 001 000	C8	1 001 000	48	01 001 000	48	11 001 000	C8
I	11 001 001	C9	1 001 001	49	11 001 001	C9	01 001 001	49
J	11 001 010	CA	1 001 010	4A	11 001 010	CA	01 001 010	4A
K	11 001 011	CB	1 001 011	4B	01 001 011	4B	11 001 011	CB
L	11 001 100	CC	1 001 100	4C	11 001 100	CC	01 001 100	4C
M	11 001 101	CD	1 001 101	4D	01 001 101	4D	11 001 101	CD
N	11 001 110	CE	1 001 110	4E	01 001 110	4E	11 001 110	CE
O	11 001 111	CF	1 001 111	4F	11 001 111	CF	01 001 111	4F
P	11 010 000	D0	1 010 000	50	01 010 000	50	11 010 000	D0
Q	11 010 001	D1	1 010 001	51	11 010 001	D1	01 010 001	51
R	11 010 010	D2	1 010 010	52	11 010 010	D2	01 010 010	52
S	11 010 011	D3	1 010 011	53	01 010 011	53	11 010 011	D3
T	11 010 100	D4	1 010 100	54	11 010 100	D4	01 010 100	54
U	11 010 101	D5	1 010 101	55	01 010 101	55	11 010 101	D5
V	11 010 110	D6	1 010 110	56	01 010 110	56	11 010 110	D6
W	11 010 111	D7	1 010 111	57	11 010 111	D7	01 010 111	57
X	11 011 000	D8	1 011 000	58	11 011 000	D8	01 011 000	58
Y	11 011 001	D9	1 011 001	59	01 011 001	59	11 011 001	D9
Z	11 011 010	DA	1 011 010	5A	01 011 010	5A	11 011 010	DA
a	11 100 001	E1	1 100 001	61	11 100 001	E1	01 100 001	61
b	11 100 010	E2	1 100 010	62	11 100 010	E2	01 100 010	62
c	11 100 011	E3	1 100 011	63	01 100 011	63	11 100 011	E3
d	11 100 100	E4	1 100 100	64	11 100 100	E4	01 100 100	64
e	11 100 101	E5	1 100 101	65	01 100 101	65	11 100 101	E5
f	11 100 110	E6	1 100 110	66	01 100 110	66	11 100 110	E6
g	11 100 111	E7	1 100 111	67	11 100 111	E7	01 100 111	67
h	11 101 000	E8	1 101 000	68	11 101 000	E8	01 101 000	68
i	11 101 001	E9	1 101 001	69	01 101 001	69	11 101 001	E9
j	11 101 010	EA	1 101 010	6A	01 101 010	6A	11 101 010	EA
k	11 101 011	EB	1 101 011	6B	11 101 011	EB	01 101 011	6B
l	11 101 100	EC	1 101 100	6C	01 101 100	6C	11 101 100	EC
m	11 101 101	ED	1 101 101	6D	11 101 101	ED	01 101 101	6D
n	11 101 110	EE	1 101 110	6E	11 101 110	EE	01 101 110	6E
o	11 101 111	EF	1 101 111	6F	01 101 111	6F	11 101 111	EF
p	11 110 000	F0	1 110 000	70	11 110 000	F0	01 110 000	70
q	11 110 001	F1	1 110 001	71	01 110 001	71	11 110 001	F1
r	11 110 010	F2	1 110 010	72	01 110 010	72	11 110 010	F2
s	11 110 011	F3	1 110 011	73	11 110 011	F3	01 110 011	73
t	11 110 100	F4	1 110 100	74	01 110 100	74	11 110 100	F4
u	11 110 101	F5	1 110 101	75	11 110 101	F5	01 110 101	75
v	11 110 110	F6	1 110 110	76	11 110 110	F6	01 110 110	76
w	11 110 111	F7	1 110 111	77	01 110 111	77	11 110 111	F7
x	11 111 000	F8	1 111 000	78	01 111 000	78	11 111 000	F8
y	11 111 001	F9	1 111 001	79	11 111 001	F9	01 111 001	79
z	11 111 010	FA	1 111 010	7A	11 111 010	FA	01 111 010	7A
0	10 110 000	B0	0 110 000	30	00 110 000	30	10 110 000	B0
1	10 110 001	B1	0 110 001	31	10 110 001	B1	00 110 001	31
2	10 110 010	B2	0 110 010	32	10 110 010	B2	00 110 010	32
3	10 110 011	B3	0 110 011	33	00 110 011	33	10 110 011	B3
4	10 110 100	B4	0 110 100	34	10 110 100	B4	00 110 100	34
5	10 110 101	B5	0 110 101	35	00 110 101	35	10 110 101	B5
6	10 110 110	B6	0 110 110	36	00 110 110	36	10 110 110	B6
7	10 110 111	B7	0 110 111	37	10 110 111	B7	00 110 111	37
8	10 111 000	B8	0 111 000	38	10 111 000	B8	00 111 000	38
9	10 111 001	B9	0 111 001	39	00 111 001	39	10 111 001	B9
SP	10 100 000	A0	0 100 000	20	10 100 000	A0	00 100 000	20
!	10 100 001	A1	0 100 001	21	00 100 001	21	10 100 001	A1
"	10 100 010	A2	0 100 010	22	00 100 010	22	10 100 010	A2
#	10 100 011	A3	0 100 011	23	10 100 011	A3	00 100 011	23
$	10 100 100	A4	0 100 100	24	00 100 100	24	10 100 100	A4
%	10 100 101	A5	0 100 101	25	10 100 101	A5	00 100 101	25
&	10 100 110	A6	0 100 110	26	10 100 110	A6	00 100 110	26
'	10 100 111	A7	0 100 111	27	00 100 111	27	10 100 111	A7
(	10 101 000	A8	0 101 000	28	00 101 000	28	10 101 000	A8
)	10 101 001	A9	0 101 001	29	10 101 001	A9	00 101 001	29
*	10 101 010	AA	0 101 010	2A	10 101 010	AA	00 101 010	2A
+	10 101 011	AB	0 101 011	2B	00 101 011	2B	10 101 011	AB
,	10 101 100	AC	0 101 100	2C	10 101 100	AC	00 101 100	2C
-	10 101 101	AD	0 101 101	2D	00 101 101	2D	10 101 101	AD
.	10 101 110	AE	0 101 110	2E	00 101 110	2E	10 101 110	AE
/	10 101 111	AF	0 101 111	2F	10 101 111	AF	00 101 111	2F

Char	EBCDIC BINARY	HEX	6-BIT TRANSCODE BINARY	HEX	6-BIT TYPESETTER BINARY		HEX
A	11 000 001	C1	000 001	01	000 011		03
B	11 000 010	C2	000 010	02	011 001		19
C	11 000 011	C3	000 011	03	001 110		0E
D	11 000 100	C4	000 100	04	001 001		09
E	11 000 101	C5	000 101	05	000 001		01
F	11 000 110	C6	000 110	06	001 101		0D
G	11 000 111	C7	000 111	07	011 010		1A
H	11 001 000	C8	001 000	08	010 100		14
I	11 001 001	C9	001 001	09	000 110		06
J	11 010 001	D1	010 001	11	001 011		0B
K	11 010 010	D2	010 010	12	001 111		0F
L	11 010 011	D3	010 011	13	010 010		12
M	11 010 100	D4	010 100	14	011 100		1C
N	11 010 101	D5	010 101	15	001 100		0C
O	11 010 110	D6	010 110	16	011 000		18
P	11 010 111	D7	010 111	17	010 110		16
Q	11 011 000	D8	011 000	18	010 111		17
R	11 011 001	D9	011 001	19	001 010		0A
S	11 100 010	E2	100 010	22	000 101		05
T	11 100 011	E3	100 011	23	010 000		10
U	11 100 100	E4	100 100	24	000 111		07
V	11 100 101	E5	100 101	25	011 110		1E
W	11 100 110	E6	100 110	26	010 011		13
X	11 100 111	E7	100 111	27	011 101		1D
Y	11 101 000	E8	101 000	28	010 101		15
Z	11 101 001	E9	101 001	29	010 001		11
a	10 000 001	81					
b	10 000 010	82					
c	10 000 011	83					
d	10 000 100	84					
e	10 000 101	85					
f	10 000 110	86					
g	10 000 111	87					
h	10 001 000	88					
i	10 001 001	89					
j	10 010 001	91					
k	10 010 010	92					
l	10 010 011	93					
m	10 010 100	94					
n	10 010 101	95					
o	10 010 110	96					
p	10 010 111	97					
q	10 011 000	98					
r	10 011 001	99					
s	10 100 010	A2					
t	10 100 011	A3					
u	10 100 100	A4					
v	10 100 101	A5					
w	10 100 110	A6					
x	10 100 111	A7					
y	10 101 000	A8					
z	10 101 001	A9					
0	11 110 000	F0	110 000	30	110 110	U	36
1	11 110 001	F1	110 001	31	111 101	U	3D
2	11 110 010	F2	110 010	32	110 011	U	33
3	11 110 011	F3	110 011	33	100 001	U	21
4	11 110 100	F4	110 100	34	101 010	U	2A
5	11 110 101	F5	110 101	35	110 000	U	30
6	11 110 110	F6	110 110	36	110 101	U	35
7	11 110 111	F7	110 111	37	100 111	U	27
8	11 111 000	F8	111 000	38	100 110	U	26
9	11 111 001	F9	111 001	39	111 000	U	38
SP	01 000 000	40	011 010	1A	000 100	S/U	04
!	01 011 010	5A			100 011	S	23
"	01 111 111	7F					
#	01 111 011	7B	111 011	3B			
$	01 011 011	5B	011 011	1B	100 011	U	23
%	01 101 100	6C	101 100	2C			
&	01 010 000	50	010 000	10	111 000	S	38
'	01 111 101	7D					
(	01 001 101	4D			110 001	S	31
)	01 011 101	5D			110 001	U	31
*	01 011 100	5C	011 100	1C			
+	01 001 110	4E					
,	01 101 011	6B	101 011	2B			
-	01 100 000	60	100 000	20	101 001	U	29
.	01 001 011	4B	001 011	0B	111 100	S/U	3C
/	01 100 001	61	100 001	21			

6-BIT TRANSCODE: (NO LOWER CASE)

6-BIT TYPESETTER:
CAPS = "SHIFT"
LC = "UNSHIFT"
UNSHIFT 011 111 1F
SHIFT 011 011 1B

Char	EBCD BINARY C 124 8AB		HEX	SELECTRIC BINARY C 124 8AB		HEX	FIELD DATA BINARY	HEX
A	0 100 011		23	1 111 001		79	000 110	06
B	0 010 011		13	1 110 110		76	000 111	07
C	1 110 011		73	1 111 010		7A	001 000	08
D	0 001 011		0B	0 101 010		2A	001 001	09
E	1 101 011		6B	1 001 010		4A	001 010	0A
F	1 011 011		5B	1 110 011		73	001 011	0B
G	0 111 011		3B	0 100 011		23	001 100	0C
H	0 000 111		07	0 100 110		26	001 101	0D
I	1 100 111		67	0 011 001		19	001 110	0E
J	1 100 001		61	1 000 011		43	001 111	0F
K	1 010 001		51	0 011 010		1A	010 000	10
L	0 110 001		31	1 000 110		46	010 001	11
M	1 001 001		49	1 100 001		61	010 010	12
N	0 101 001		29	1 010 010		52	010 011	13
O	0 011 001		19	1 000 101		45	010 100	14
P	1 111 001		79	0 001 011		0B	010 101	15
Q	1 000 101		45	1 011 011		5B	010 110	16
R	0 100 101		25	0 101 001		29	010 111	17
S	1 010 010		52	0 100 101		25	011 000	18
T	0 110 010		32	0 000 010		02	011 001	19
U	1 001 010		4A	0 110 010		32	011 010	1A
V	0 101 010		2A	0 110 001		31	011 011	1B
W	0 011 010		1A	1 110 101		75	011 100	1C
X	1 111 010		7A	1 100 010		62	011 101	1D
Y	1 000 110		46	1 100 111		67	011 110	1E
Z	0 100 110		26	1 010 100		54	011 111	1F
0	01 010 100	L	54	01 100 100	L	64	110 000	30
1	00 100 000	L	20	00 100 000	L	20	110 001	31
2	00 010 000	L	10	00 010 000	L	10	110 010	32
3	00 110 000	L	30	01 110 000	L	70	110 011	33
4	00 001 000	L	08	00 000 100	L	04	110 100	34
5	01 101 000	L	68	00 001 000	L	08	110 101	35
6	01 011 000	L	58	01 011 000	L	58	110 110	36
7	00 111 000	L	38	01 101 000	L	68	110 111	37
8	00 000 100	L	04	00 111 000	L	38	111 000	38
9	01 100 100	L	64	00 110 100	L	34	111 001	39
SP	01 000 000	—	40	01 000 000	—	40	000 101	05
!	01 110 101	U	75	00 000 001	L	01	101 101	2D
"	00 110 100	U	34	01 001 001	U	49		
#	00 110 100	L	34	01 110 000	U	70	100 110	26
$	01 110 101	L	75	00 000 100	U	04	100 111	27
%	01 101 000	U	68	00 001 000	U	08	101 010	2A
&	01 000 011	L	43	01 101 000	U	68	000 001	01
'	01 011 000	U	58	01 001 001	L	49	111 010	3A
(	01 100 100	U	64	00 110 100	U	34	101 001	29
)	00 100 100	U	54	01 100 100	U	64	100 000	20
*	00 000 100	U	04	00 111 000	U	38	101 000	28
+	01 000 011	U	43	00 010 011	U	13	100 010	22
,	01 110 110	L	76	00 111 011	*	3B	101 110	2E
—	00 000 001	*	01	00 110 111	L	37	100 001	21
.	00 110 111	L	37	01 010 001	*	51	111 101	3D
/	01 100 010	L	62	00 000 111	L	07	111 100	3C

EBCD:
CAPS = "UC"
LC = "LC"
LC 00 011 111 1F
UC 00 011 100 1C

SELECTRIC:
CAPS = "UC"
LC = "LC"
LC 00 011 111 1F
UC 00 011 100 1C

FIELD DATA: (NO LOWER CASE)

EBCD and SELECTRIC:
UPPER CASE (U)
LOWER CASE (L)
EITHER (*)

Char	BAUDOT	BINARY		HEX
A	–	00 011		03
B	?	11 001		19
C	:	01 110		0E
D	$	01 001		09
E	3	00 001		01
F	!	01 101		0D
G	&	11 010		1A
H	#	10 100		14
I	8	00 110		06
J	'	01 011		0B
K	(	01 111		0F
L	)	10 010		12
M	.	11 100		1C
N	,	01 100		0C
O	9	11 000		18
P	0	10 110		16
Q	1	10 111		17
R	4	01 010		0A
S	Bell	00 101		05
T	5	10 000		10
U	7	00 111		07
V	;	11 110		1E
W	2	10 011		13
X	/	11 101		1D
Y	6	10 101		15
Z	"	10 001		11
0		10 110	F	16
1		10 111	F	17
2		10 011	F	13
3		00 001	F	01
4		01 010	F	0A
5		10 000	F	10
6		10 101	F	15
7		00 111	F	07
8		11 010	F	1A
9		11 000	F	18
SP		00 100	—	04
!		01 101	F	0D
"		10 001	F	11
#		10 100	F	14
$		01 001	F	09
'		01 011	F	0B
(		01 111	F	0F
)		10 010	F	12
,		01 100	F	0C
—		00 011	F	03
.		11 100	F	1C
/		11 101	F	1D

BAUDOT:
(NO LOWER CASE)
"LETTERS" 11 111 1F
"FIGURES" 11 011 1B

COURTESY OF

ATLANTIC RESEARCH CORPORATION

5390 CHEROKEE AVENUE · ALEXANDRIA, VIRGINIA · 22314
703-354-3400

MANUFACTURERS OF INTERSHAKE and DATA TEK 9600

UNIVERSAL CODE CHART FOR DATA COMMUNICATIONS

Char	8-BIT ASCII BINARY	HEX	7-BIT ASCII BINARY	HEX	EVEN PARITY ASCII BINARY	HEX	ODD PARITY ASCII BINARY	HEX
:	10 111 010	BA	0 111 010	3A	00 111 010	3A	10 111 010	BA
;	10 111 011	BB	0 111 011	3B	10 111 011	BB	00 111 011	3B
<	10 111 100	BC	0 111 100	3C	00 111 100	3C	10 111 100	BC
=	10 111 101	BD	0 111 101	3D	10 111 101	BD	00 111 101	3D
>	10 111 110	BE	0 111 110	3E	10 111 110	BE	00 111 110	3E
?	10 111 111	BF	0 111 111	3F	00 111 111	3F	10 111 111	BF
@	11 000 000	C0	1 000 000	40	11 000 000	C0	01 000 000	40
[	11 011 011	DB	1 011 011	5B	11 011 011	DB	01 011 011	5B
\	11 011 100	DC	1 011 100	5C	01 011 100	5C	11 011 100	DC
]	11 011 101	DD	1 011 101	5D	11 011 101	DD	01 011 101	5D
^	11 011 110	DE	1 011 110	5E	11 011 110	DE	01 011 110	5E
—	11 011 111	DF	1 011 111	5F	01 011 111	5F	11 011 111	DF
`			1 100 000	60	01 100 000	60	11 100 000	E0
{	11 111 011	FB	1 111 011	7B	01 111 011	7B	11 111 011	FB
¦	11 111 100	FC	1 111 100	7C	11 111 100	FC	01 111 100	7C
}	11 111 101	FD	1 111 101	7D	01 111 101	7D	11 111 101	FD
~	11 111 110	FE	1 111 110	7E	01 111 101	7E	11 111 110	FE
ACK	10 000 110	86	0 000 110	06	00 000 110	06	10 000 110	86
BEL	10 000 111	87	0 000 111	07	10 000 111	87	00 000 111	07
BS	10 001 000	88	0 001 000	08	10 001 000	88	00 001 000	08
CAN	10 011 000	98	0 011 000	18	00 011 000	18	10 011 000	98
CR	10 001 101	8D	0 001 101	0D	10 001 101	8D	00 001 101	0D
DC1	10 010 001	91	0 010 001	11	00 010 001	11	10 001 001	91
DC2	10 010 010	92	0 010 010	12	00 010 010	12	10 010 010	92
DC3	10 010 011	93	0 010 011	13	10 010 011	93	00 010 011	13
DC4	10 010 100	94	0 010 100	14	00 010 100	14	10 010 100	94
DEL	11 111 111	FF	1 111 111	7F	11 111 111	FF	01 111 111	7F
DLE	10 010 000	90	0 010 000	10	10 010 000	90	00 010 000	10
EM	10 011 001	99	0 011 001	19	10 011 001	99	00 011 001	19
ENQ	10 000 101	85	0 000 101	05	00 000 101	05	10 000 101	85
EOT	10 000 100	84	0 000 100	04	10 000 100	84	00 000 100	04
ESC	10 011 011	9B	0 011 011	1B	00 011 011	1B	10 011 011	9B
ETB	10 010 111	97	0 010 111	17	00 010 111	17	10 010 111	97
ETX	10 000 011	83	0 000 011	03	00 000 011	03	10 000 011	83
FF	10 001 100	8C	0 001 100	0C	00 001 100	0C	10 001 100	8C
FS	10 011 100	9C	0 011 100	1C	10 011 100	9C	00 011 100	1C
GS	10 011 101	9D	0 011 101	1D	00 011 101	1D	10 011 101	9D
HT	10 001 001	89	0 001 001	09	00 001 001	09	10 001 001	89
LF	10 001 010	8A	0 001 010	0A	00 001 010	0A	10 001 010	8A
NAK	10 010 101	95	0 010 101	15	10 010 101	95	00 010 101	15
NUL	10 000 000	80	0 000 000	00	00 000 000	00	10 000 000	80
RS	10 011 110	9E	0 011 110	1E	00 011 110	1E	10 011 110	9E
SI	10 001 111	8F	0 001 111	0F	00 001 111	0F	10 001 111	8F
SO	10 001 110	8E	0 001 110	0E	10 001 110	8E	00 001 110	0E
SOH	10 000 001	81	0 000 001	01	10 000 001	81	00 000 001	01
STX	10 000 010	82	0 000 010	02	10 000 010	82	00 000 010	02
SUB	10 011 010	9A	0 011 010	1A	10 011 010	9A	00 011 010	1A
SYN	10 010 110	96	0 010 110	16	10 010 110	96	00 010 110	16
US	10 011 111	9F	0 011 111	1F	10 011 111	9F	00 111 111	1F
VT	10 001 011	8B	0 001 011	0B	10 001 011	8B	00 001 011	0B

EBCDIC

Char	BINARY	HEX
:	01 111 010	7A
;	01 011 110	5E
<	01 001 100	4C
=	01 111 110	7E
>	01 101 110	6E
?	01 101 111	6F
@	01 111 100	7C
\	11 100 000	E0
—	01 101 101	6D
`	01 111 001	79
{	11 000 000	C0
¦	01 101 010	6A
}	11 010 000	D0
~	10 100 001	A1
¢	01 001 010	4A
¬	01 011 111	5F
|	01 001 111	4F
ACK	00 101 110	2E
BEL	00 101 111	2F
BS	00 010 110	16
BYP	00 100 100	24
CAN	00 011 000	18
CC	00 011 010	1A
CR	00 001 101	0D
DC1	00 010 001	11
DC2	00 010 010	12
DC3	00 010 011	13
DC4	00 011 100	3C
DEL	00 000 111	07
DLE	00 010 000	10
DS	00 100 000	20
EM	00 011 001	19
ENQ	00 101 101	2D
EOB	00 100 110	26
EOT	00 110 111	37
ESC	00 100 111	27
ETB	00 100 110	26
ETX	00 000 011	03
FF	00 001 100	0C
FS	00 100 010	22
HT	00 000 101	05
IFS	00 011 100	1C
IGS	00 011 101	1D
IL	00 010 111	17
IRS	00 011 110	1E
IUS	00 011 111	1F
LC	00 000 110	06
LF	00 100 101	25
NAK	00 111 101	3D
NL	00 010 101	15
NUL	00 000 000	00
PF	00 000 100	04
PN	00 110 100	34
PRE	00 100 111	27
RES	00 010 100	14
RLF	00 001 001	09
RS	00 110 101	35
SI	00 001 111	0F
SM	00 101 010	2A
SMM	00 001 010	0A
SO	00 001 110	0E
SOH	00 000 001	01
SOS	00 100 001	21
STX	00 000 010	02
SUB	00 111 111	3F
SYN	00 110 010	32
UC	00 110 110	36
VT	00 001 011	0B

6-BIT TRANSCODE

Char	BINARY	HEX
<	001 100	0C
@	111 100	3C
BEL	001 101	0D
DEL	111 111	3F
DLE	011 111	1F
EM	111 110	3E
ENQ	101 101	2D
EOT	011 110	1E
ESC	101 010	2A
ETB	001 111	0F
ETX	101 110	2E
HT	101 111	2F
NAK	111 101	3D
SOH	000 000	00
STX	001 010	0A
SUB	001 110	0E
SYN	111 010	3A
US	011 101	1D

6-BIT TYPESETTER

Char	BINARY	HEX
:	111 010 S	3A
;	111 010 U	3A
?	110 110 S	36
@	101 001 S	29
¥	101 000 S/U	28
UNSHIFT	011 111	1F
SHIFT	011 011	1B
BEL	101 011	2B
RET	001 000	08
RUBOUT	111 111	3F
ELEVATE	000 010	02
THIN SP	100 000	20
ADD TH SP	100 100	24
EM SP	100 101	25
EN SP	101 110	2E
QR	101 111	2F
V RULE	110 010	32
EM LEAD	110 100	34
EN LEAD	110 111	37
U RAIL	111 001	39
L RAIL	111 011	3B
Q CENT	111 110	3E
PF	100 010	22

EBCD

Char	BINARY C 124 8AB		HEX
:	00 001 000	U	08
;	00 110 000	U	30
<	00 010 000	U	10
=	00 100 000	U	20
>	00 111 000	U	38
?	01 100 010	U	62
@	00 000 010	L	02
UPPER CASE (U)			
LOWER CASE (L)			
EITHER (*)			
¢	00 000 010	U	02
¬	00 110 111	U	37
|	01 110 110	U	76
UC	00 011 100		1C
LC	00 011 111		1F
BS	01 011 101		5D
BYP	00 001 110		0E
DEL	01 111 111		7F
EOB	01 011 110		5E
EOT	01 111 100		7C
HT	00 101 111		2F
IL	00 111 101		3D
LC	00 011 111		1F
LF	01 101 110		6E
NL	01 101 101		6D
PF	01 001 111		4F
PN	01 001 100		4C
PRE	00 111 110		3E
RES	00 001 101		0D
RS	00 101 100		2C
UC	00 011 100		1C

SELECTRIC

Char	BINARY C 124 8AB		HEX
:	01 101 011	U	6B
;	01 101 011	L	6B
=	00 010 011	L	13
?	00 000 111	U	07
@	00 010 000	U	10
[	00 100 000	U	20
]	00 100 000	L	20
–	00 110 111	U	37
UPPER CASE (U)			
LOWER CASE (L)			
EITHER (*)			
¢	01 011 000	U	58
±	00 100 000	U	20
°	00 000 001	U	01
UC	00 011 100		1C
LC	00 011 111		1F
BS	01 011 101		5D
BY	00 001 110		0E
DEL	01 111 111		7F
EOB	01 011 110		5E
EOT	01 111 100		7C
HT	00 101 111		2F
IL	00 111 101		3D
LC	00 011 111		1F
LF	01 101 110		6E
NL	01 101 101		6D
PF	01 001 111		4F
PN	01 001 100		4C
PRE	00 111 110		3E
RES	00 001 101		0D
RS	00 101 100		2C
UC	00 011 100		1C

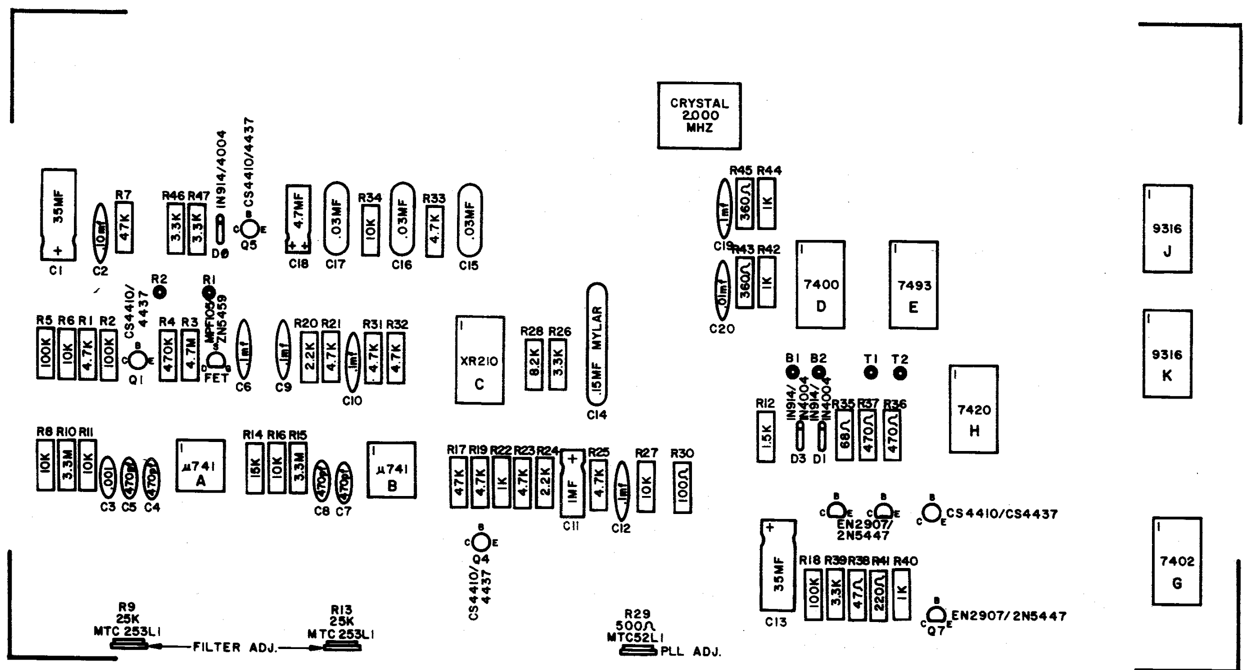
FIELD DATA

Char	BINARY	HEX
:	101 011	2B
;	111 011	3B
<	100 011	23
=	100 100	24
>	100 101	25
?	101 100	2C
@	101 111	2F
[	000 011	03
]	000 100	04
^	000 010	02
CR	111 111	3F
FF	111 110	3E
PER	111 101	3D

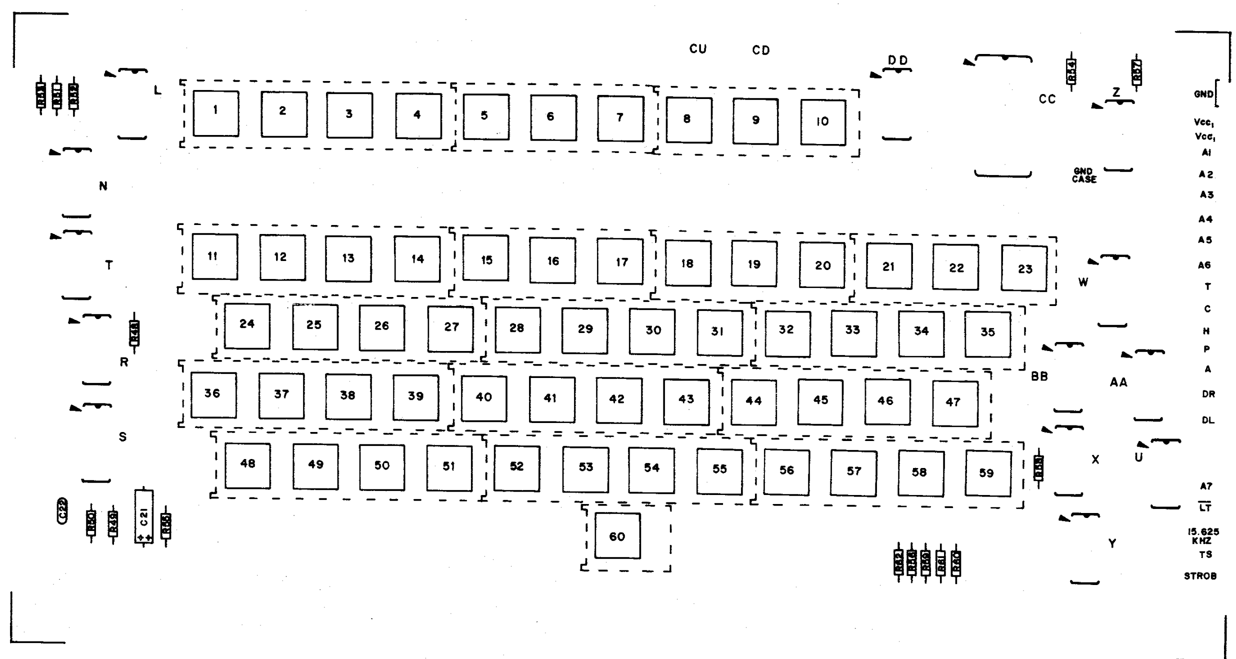
BAUDOT

Char	BINARY		HEX
:	01 110	F	0E
;	11 110	F	1E
?	11 001	F	19
FIGS	11 011		1B
LTRS	11 111		1F
CR	01 000		08
LF	00 010		02

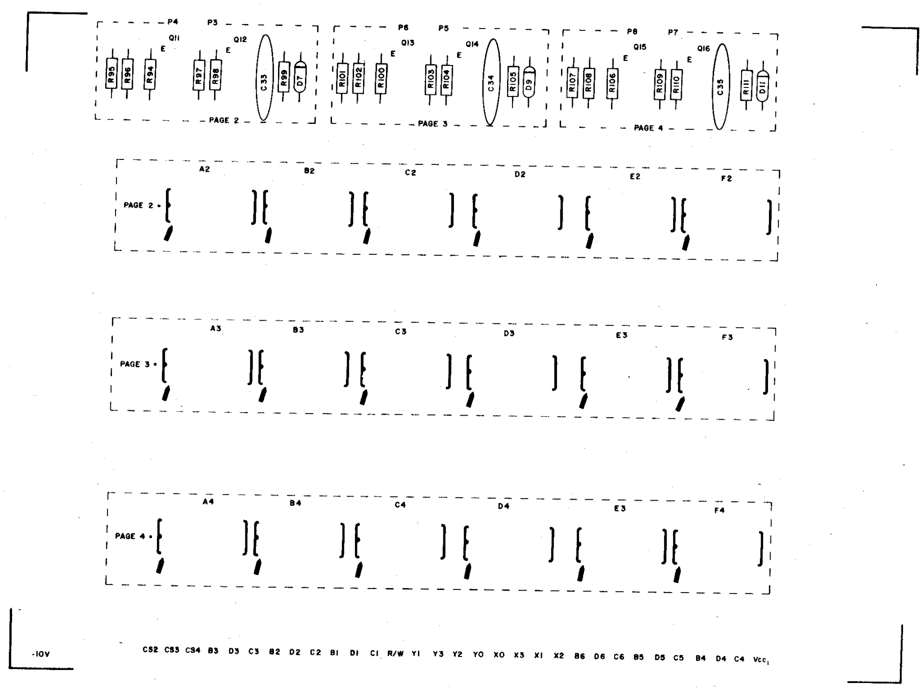
TP 104-8-75



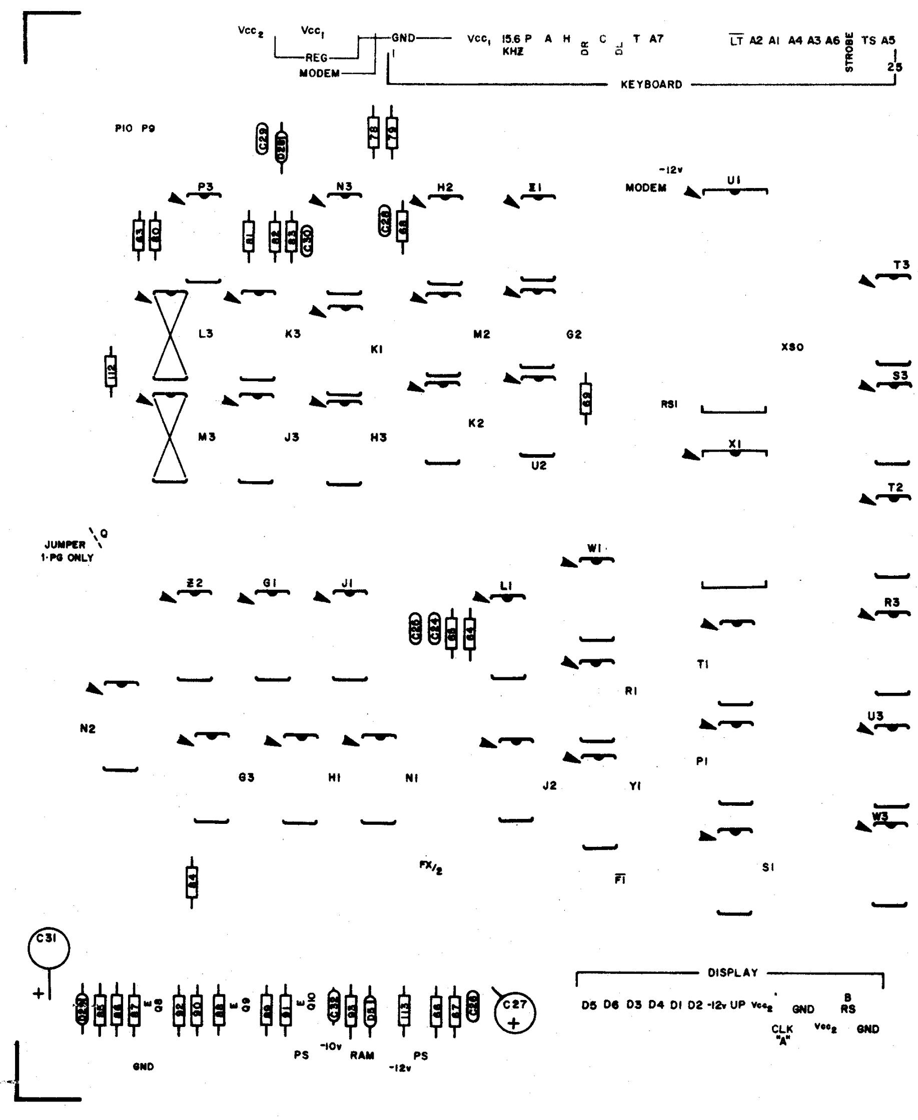
COMTER 256
MODEM BOARD
PARTS LAYOUT



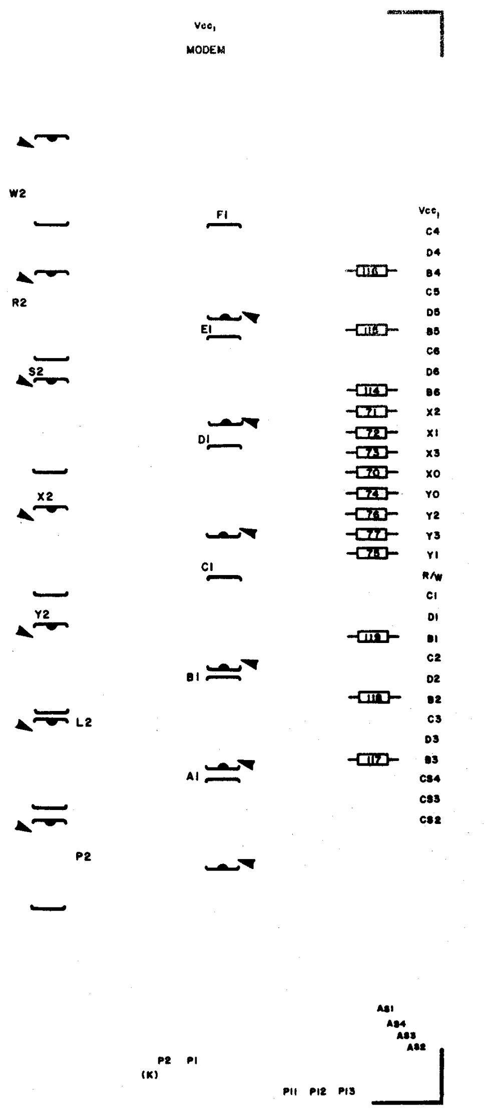
COMTER 256
KEYBOARD
PARTS LAYOUT



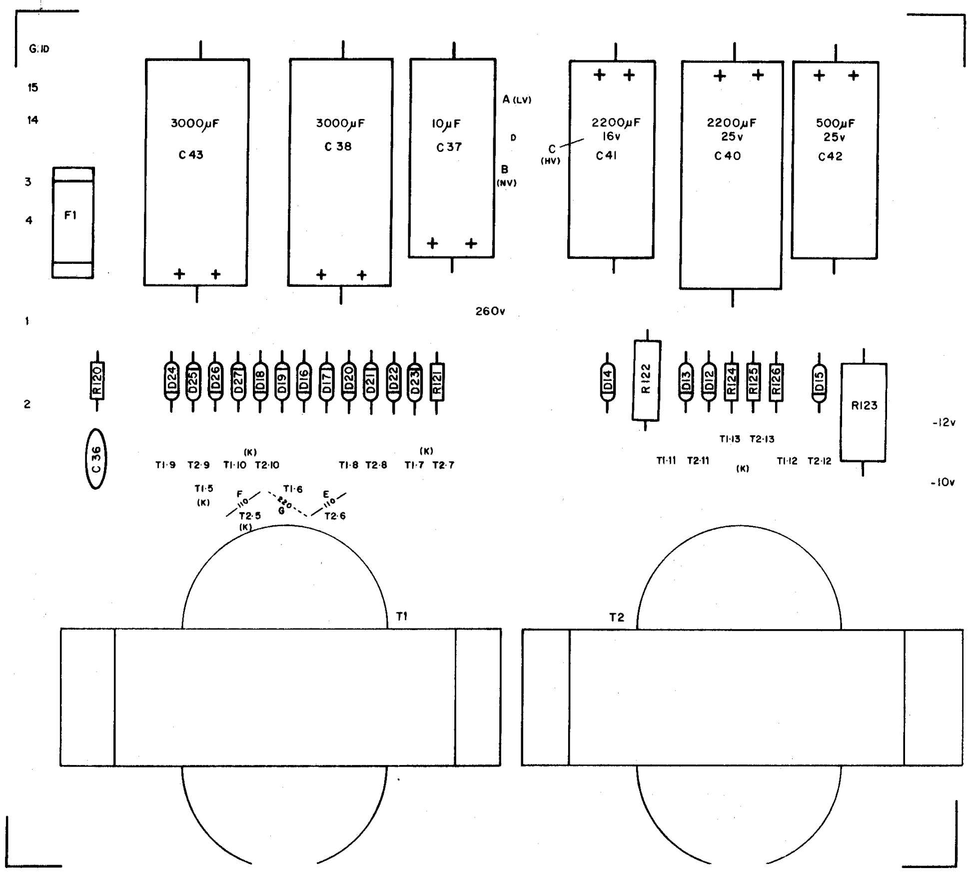
COMTER 256
RAM BOARD
PARTS LAYOUT



Vcc2 Vcc1 REG MODEM GND 1 Vcc1 15.6 KHZ P A H DR C DL T A7 LT A2 A1 A4 A3 A6 STROBE TS A5 25
KEYBOARD
P10 P9
MODEM
U1
XSO
RS1
JUMPER 1-PG ONLY
FX/2
DISPLAY
D5 D6 D3 D4 D1 D2 -12v UP Vcc2 GND B RS
CLK "A" Vcc2 GND
GND
PS -10v RAM PS -12v
C31
C27



COMTER 256
MAIN PC BOARD
PARTS LAYOUT



COMTER 256
POWER SUPPLY BOARD
PARTS LAYOUT

Operator's Manual

MITS COMTER 256

COMPUTER TERMINAL

DESIGNED TO GIVE EVERYONE ACCESS TO THE SOPHISTICATED WORLD OF COMPUTERS.

MITS INC. ®
"Creative Electronics"

6328 LINN, N.E., P.O. BOX 8636,
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505/265-7553

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TABLE OF CONTENTS

Written by David Bunnell

INTRODUCTION

Computers are not elusive, science fiction monsters that can only be understood by scientists and wizards! Computers are relatively simple machines that can and should be used by a great number of people.

If you were going to build a house, chances are you wouldn't attempt to build it with just a hammer and a saw. You'd want access to a whole range of tools that expand what you can do with your hands and increase the speed at which you do it. The computer is simply a tool that expands your mental power. It allows you to perform mental procedures over and over again without getting bored and it allows you to do these procedures at an incredible rate of speed.

In this introduction we are going to briefly discuss some of the developments in the computer industry that have made the mental power of the computer available to many people who could not understand or afford it in the past. If you are already familiar with these things or if you become bored, go ahead and skip this introduction.

....

Several years ago, an interesting concept was developed which seemed to promise to give individuals and small businesses and local school systems access to a very costly computer. This concept, called time-sharing, revolved around a centrally located computer system which could be connected to outlying terminals through the telephone system. This meant that many who did not need nor could not afford a complex system of their own could still have access to all the sophisticated computer processes. They would simply share the cost of the computer along with sharing the amount of ultilization time.

The only problems were that the cost of the computer terminal was relatively high and the availability of people trained to use the computer was relatively low. This second problem was at least partially solved by a group of scientists at

Dartmouth College when they developed a new computer language called BASIC language. With BASIC language people with little or no technical background could learn how to program. This is because BASIC language is just what it says it is, namely BASIC. For example, when you want to instruct the computer to PRINT something and you are using BASIC language, you simply type the word PRINT on your terminal keyboard followed by whatever it is you want the computer to print. The word for NEW in BASIC language (when you are entering a NEW program) is NEW. The word for END (when you want to END a program) is END. BASIC is BASIC. It is simple and understandable.

Still, much of the instructional material relating to BASIC language was coated with technical concepts and language. BASIC was BASIC but the words used to describe its use were @#$#@¢%&*(&[#$%@&! Recently, a few computer courses have been developed that make the understanding of BASIC language and its various EXTENDED forms simple and readily understandable. Among the best of these courses (we think) is the one developed by MITS for its time-share users. This course, which was written for use with the Comter 256, teaches the technical and non-technical person how to program EXTENDED BASIC in a straightforward manner. It is available to Comter 256 owners at a reduced cost (see enclosed brochure).

Of course, you can use your Comter 256 with any of the other computer languages like Fortran, or Algol. Languages are a function of the "software" that is stored in the computer. What language or languages you use depends upon your needs and upon the computer system you hook up to.

Another, less apparent factor in the "computer revolution" has been the increased sophistication of programmable calculators. The trend has been to develop a programmable calculator that looks like and in many ways functions like a computer. Recently marketed calculators have had increased memory size and expanded programming capability.

While the sophistication of programmable calculators has increased so has their cost. Instead of shelling out $9000.00 for a programmable calculator, many people are now realizing it is much more practical to buy a computer terminal, like the Comter 256, and hook up to a time-share system. The Comter 256 can perform all the functions of a sophisticated programmable calculator and do much, much more. You can use your Comter to run "system" programs already stored in the time-share computer or you can use it to develop and run your own programs.

Because of its low cost, the introduction of the MITS Comter 256 has had a dramatic impact. The Comter 256 has features not usually available on terminals several times its price. Its built-in acoustic coupler makes computer hookup much simpler and saves extra costs. The auto-transmit feature allows the operator to transmit data or program material to the computer line-by-line instead of typing it directly into the computer, saving computer time and your money. The tape play/record feature gives it virtually unlimited memory capability.

With the MITS Comter 256, with BASIC language and simplified instructions, and with an ever expanding network of time-share systems, it is becoming apparent that computer power will be available to everyone who is wise enough to see its many advantages. The barriers of cost and understanding have been removed.

TERMINAL/COMPUTER INTERACTION

This section contains a generalized explanation of how the Comter 256 communicates with the computer via the telephone. If you're not interested in this background information, or if you are already aware of it, you may also skip this section.

....

Once the terminal is "on-line" to the computer (see following section), information is entered through the keyboard. This information may be in the form of calculations, if you are using the computer for calculations, or it may be a program, or it may be instructions to the computer telling it to run a program that is already stored in the computer's library. In any case, this information consists of data and instructions written with letters, numbers, and symbols. But these do not make sense to the computer if they are in the form of letters, numbers and symbols. They must be changed to electrical pulses. To quickly demonstrate what is meant, let's follow a single letter through the process that moves it from the depression of the key on the terminal through the telephone system to the computer.

The foundation of computer/terminal communication is the simple fact that electronic pulses are either "on" or "off". If you were to press the "T" key on your terminal keyboard, circuitry within the terminal would convert the "T" into a binary code consisting of two numbers, 1 and 0 (where "1" represents "on" and "0" represents "off"). The code for T looks like this: 0010101.

All computers use a predetermined code called the ASCII code. No matter what kind of computer your system has, it will recognize "0010101" as "T".

If your terminal is hardwired, the electronic pulses representing "T" will go directly to the computer. However, if your terminal is connected to the computer via the telephone, the pulses must first be converted to audio tones before they can be transmitted over the phone lines. This conversion takes place in a unit in your terminal called the MODEM (stands for MODulator-DEModulator). The "0's" in the code for "T" are converted to tones with a frequency of 1070 Hz, while the "1's" are converted to tones with a frequency of 1270 Hz. The tones are then relayed through your terminal's acoustic coupler to the phone handset, then over the phone lines to the computer.

Once the audio tones reach the computer, they go through another MODEM where they are changed back to digital "1's" and "0's" ("on" and "off") representing the letter "T". The 0010101 is then shunted through the computer circuitry and is stored in the computer's memory until it, along with codes for other letters, symbols, and numbers is "enacted" upon.

At the same time "T" is stored in the computer, it is "echoed" back to the terminal display....so you can see what has been entered. All of this information goes through the same processes as before. The digital code in the computer is converted to audio tones; they are transmitted through the telephone system to the acoustic coupler on your terminal. The audio signal is converted to the digital code and then the terminal converts this code back to a "T" on your display. The fantastic thing is all of this is done at such a high rate of speed, you have the impression that characters on the display appear simultaneously with the depression of each key.

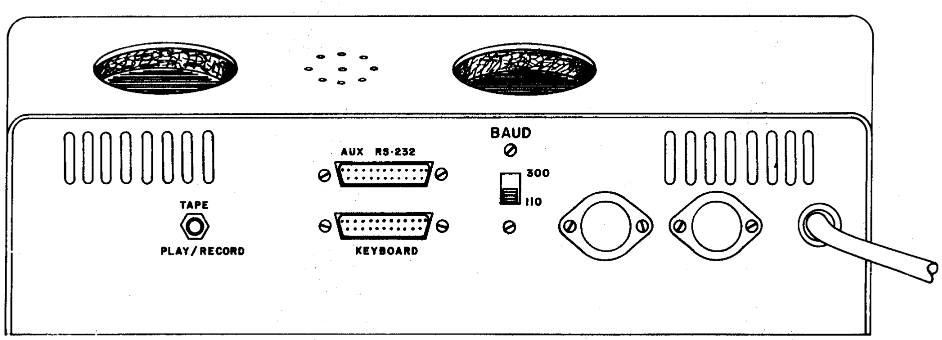
CONNECTING YOUR 256 TO THE COMPUTER

The Comter 256 can either be directly connected to a computer (hardwired) or it can be indirectly connected to a computer via the telephone. In the following section we will examine each of these procedures.

HOW TO HARDWIRE YOUR TERMINAL

You will note that the Comter 256 comes in two parts. We will refer to the part with the keyboard as the keyboard unit and the part with the display as the display unit.

The first step is to connect the keyboard unit to the display unit. This is done by plugging the connector plug from the keyboard unit cable into the connector socket on the back of the display unit labeled "KEYBOARD" (see drawing).



Most computers have interconnect cables with DB25P standard connector plugs. If the computer you're hardwiring your terminal to has an interconnect cable with a standard connector plug, you're in good shape. All you have to do is plug the connector plug into the connector socket on the back of the display unit labeled "AUX RS-232" (see drawing on previous page).

If the computer you're hardwiring your terminal to has an interconnect cable with some other type of plug, you'll have to replace this plug with a DB25P standard connector plug. When doing this, note that the connector socket on the Comter is in compliance with EIA standards "RS 232". This means that the receive wire of the interconnect cable should be connected to pin 2 of the connector plug, the transmit wire should be connected to pin 3 and the ground wire to pin 7. These are the only connections that need to be made.

Once you have successfully hardwired your terminal to the computer, set the BAUD switch on the back panel of the display unit at the "110" setting, and make the following switch settings on the front of the display unit:

1. Set the POWER switch to ON
2. Set the MODE switch to IN/OUT
3. If you have more than one page of memory, set the PAGE switch to AUTO. If you have one page of memory, set the PAGE switch to MAN.

When the PAGE light on the front of your display lights, you are ready to go. (The CARRIER light lights only when the terminal is connected via the telephone.)

HOW TO GO "ON-LINE"

As in hardwiring your terminal, the first step in "going on line" or connecting your Comter 256 to the computer via the telephone is to connect the keyboard unit to the display unit. This is accomplished by plugging the connector plug from the keyboard unit cable to the connector socket on the back of the display unit labeled "KEYBOARD". (see drawing)

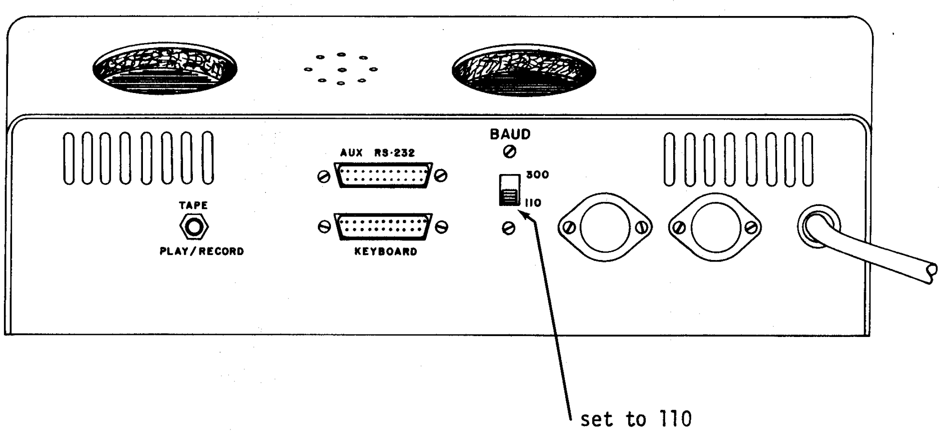
Once you have accomplished this, the next thing to do is make the following switch settings:

A. Back panel of display unit

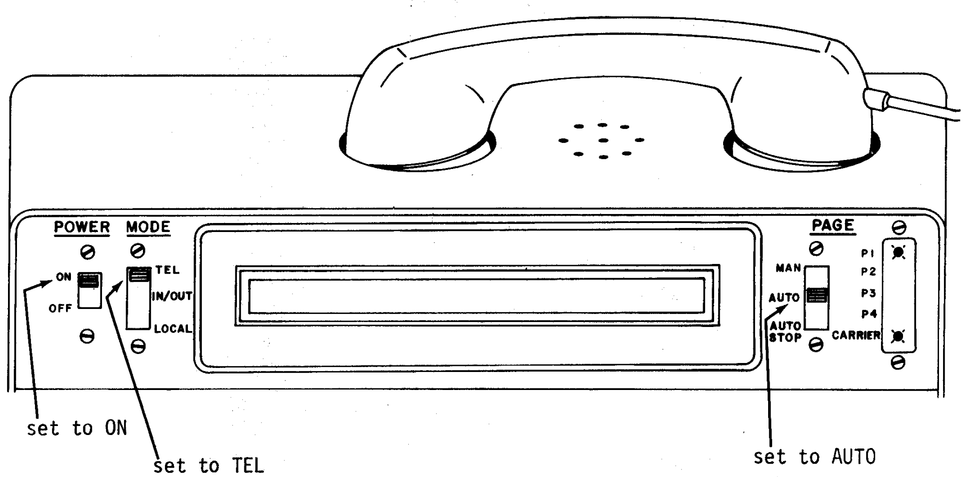
   1. Set the BAUD switch to 110

B. Front panel of display unit

   1. Set the PAGE switch to AUTO
   2. Set the MODE switch to TEL
   3. Set the POWER switch to ON



.....Front Panel drawing on following page



Once you have made the proper switch settings you are ready to connect your terminal to the computer:

1. Call the computer phone number that has been supplied to you by your time-share system. If it is busy, hang up, wait a moment, and dial the number again. A high pitched tone will indicate that you have made the proper connection.
2. Orient the hand set of your phone so that the transmitter end (the end with the cord) is on the right side of the terminal (the side with the PAGE switch). Maintaining this orientation, place the hand set firmly into the two large holes on top of the display unit.
3. A CARRIER light is located below the PAGE numbers on the right front of your terminal. When this lights you are connected to the computer.

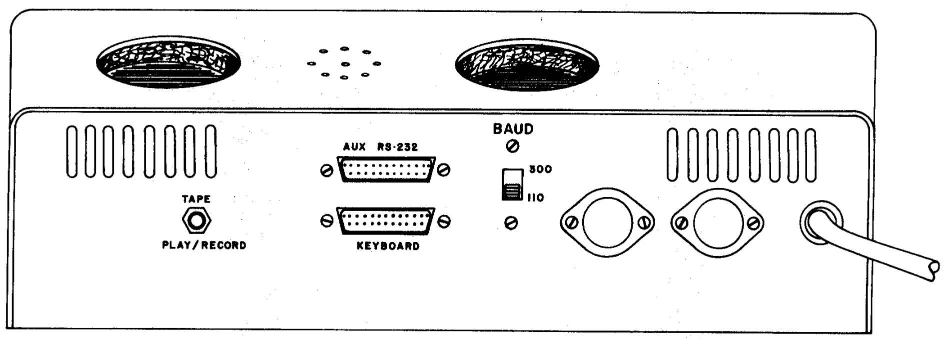
Most time-share systems require that you enter an account number before you can actually begin communicating with the computer. The procedure for doing this should be supplied by your time-share system.

COMTER FUNCTIONS

In the section that follows, we will outline the functions of the Comter 256. This will include an inspection of the switches, input jacks, connector sockets, etc., on the front and back panels of the display unit as well as a look at the keyboard and the special function keys.

....

BACK PANEL



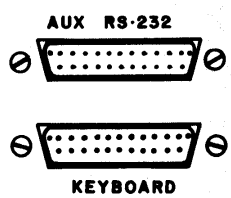
TAPE

PLAY/RECORD

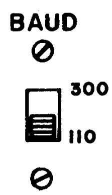
This is a minature phone jack used to connect a tape recorder to your terminal. You can use any kind of tape recorder, though we recommend that you use at least a medium quality casset tape recorder (about $50). This should provide you with adequate tape integrity.

A tape recorder can be used to record data directly from the computer when the Comter is connected via the telephone. Since the recorder records the audio tones that go in and out of the modem, it cannot be used to record data when you are in LOCAL mode or hardwired to the computer.

You can also use a tape recorder to transmit data from the tape to the terminal's memory. This operation takes place in IN/OUT mode and is not dependent on whether you are hardwired or "on line" to the computer. A more complete description of the tape recorder feature can be found on page 27 .



These are two connector sockets. The top socket is used for "hardwiring" or connecting the terminal directly to a computer.* The bottom socket is used to connect the terminal's display unit to the terminal's keyboard unit.

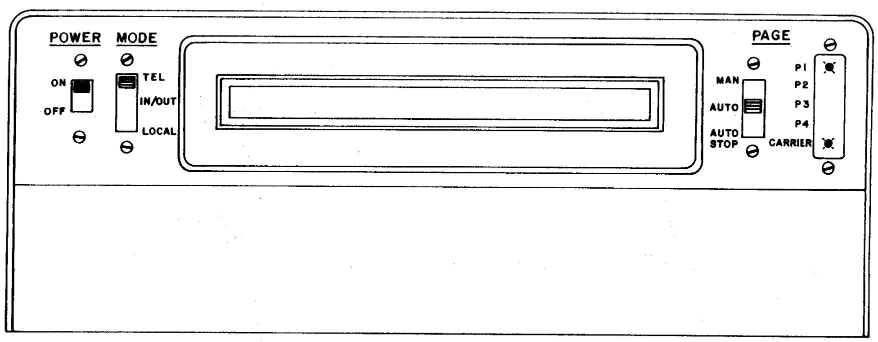


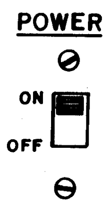
The BAUD switch determines data transmission and reception rates. At a 110 BAUD setting, characters will appear across your display at a rate of 10 characters per second. At a 300 BAUD setting, characters will appear at a rate of 30 per second.

It should be noted that most computers are set up to accept the 110 setting. In order to use the 300 setting you need to be connected to a computer with a 300 BAUD line.

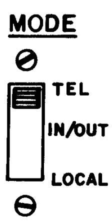
*NOTE: The RS-232 socket can be used to connect any peripheral device, such as a printer or teletype, to the Comter, as long as the device is RS-232 compatible.

FRONT PANEL

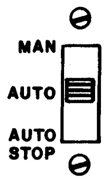




Used for turning the Comter ON and OFF.

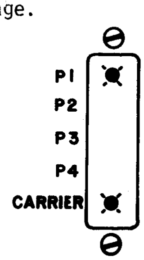


This switch determines the mode of operation your terminal is in. TEL is the setting you want to use when the Comter is "on-line" or connected by TELephone to a computer. IN/OUT is the setting to use when the Comter is hardwired to a computer or when playing back a tape. LOCAL is the setting for operating the terminal by itself. One use of LOCAL mode is to edit a program that is stored in the terminal's memory (this is something you'll want to do before you auto-transmit a program).



If your Comter 256 has one page of memory, then this switch doesn't concern you too much. Just keep it set in either the MANual or AUTOmatic position.

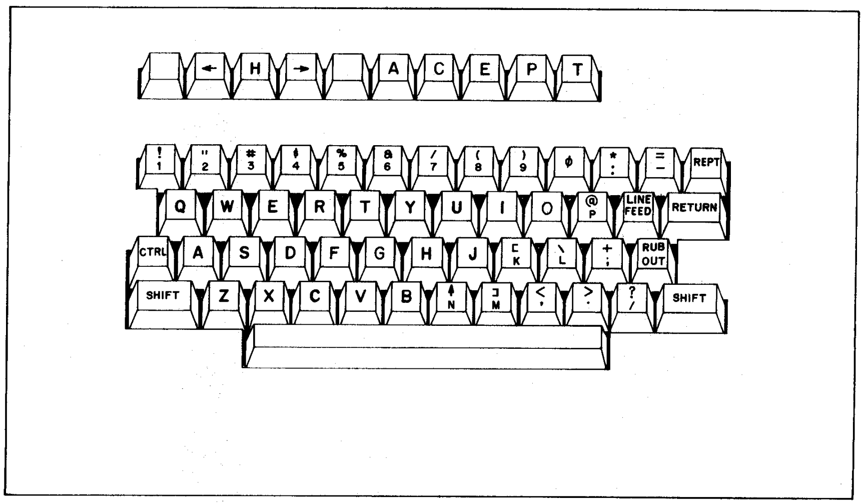
If your Comter has more than one page of memory, then the PAGE switch takes on a greater significance. In the MANual position you have to select the page you want by using the Page key (P key in the upper row of the keyboard). In the AUTOmatic position, the terminal memory will automatically switch from Page 1 to Page 2 once the 256 positions of Page 1 are filled, and so forth. In AUTOmatic STOP the terminal memory will switch as in the AUTOmatic position except it will stop on the last page <u>and</u> continue writing on that page.



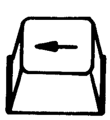
This is the Front Panel Indicator. P1-P4 indicates which page of memory is being displayed. The light at P1 in this drawing means that the first page of memory is currently in use. It should be noted that this light should always come on whenever you turn the Comter ON.

The CARRIER light on the bottom of the Front Panel Indicator lights whenever you are properly connected to a computer via the telephone. It does not light when you are hardwired to a computer.

KEYBOARD



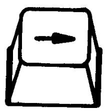
The keyboard of your Comter 256 is a standard ASCII encoded keyboard with TTY-33 format. For our purposes, the keyboard is very similar to a typewriter keyboard. The function of most of the keys is obvious. There are, however, a number of special function keys that need to be explained in some detail. It is these special function keys that we are concerned about in the following section.



All the keys on the top row of the keyboard are special function keys, with the exception of the two blank keys which have no function.

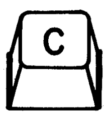
The particular key at the left is called the DATA LEFT key. Depressing this key moves the characters on your display one space to the left. Used in conjunction with the DATA RIGHT key and the REPT (repeat) key, the DATA LEFT key is handy for reading and re-reading data stored in your terminal's memory.

This is the HOME key. The HOME position is the first position on each page of your terminal's memory. If you want to return your display to the beginning of a particular page, you depress this key.

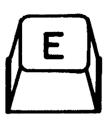


DATA RIGHT. Depressing this key moves the characters on your display one space to the right. It's functions are the same as the DATA LEFT key.

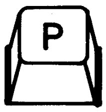
ADDRESS Key. You can use this key to return your display to any particular position on your terminal's memory. To really understand how this key works, you need to understand how the terminal's memory and address systems function. A complete discussion of this can be found on pages 20-26.



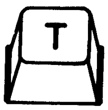
CLEAR Key. The CLEAR key clears a page of memory. If the PAGE switch is set to MANual, pressing this key enters blanks into all the 256 memory locations of the selected page and returns the display to the HOME position. If the PAGE switch is set to AUTOmatic and if your terminal has more than one page of memory, pressing the CLEAR key will clear the selected page <u>and</u> automatically advance the terminal to the next page of memory. Repeatedly pressing the CLEAR key will clear all the pages of memory.



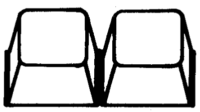
ESCAPE key. Depressing this key sends a message to the computer telling to stop whatever operation it is performing. The function of the ESCAPE key may vary from system to system.



PAGE KEY. If you only have one page of memory, you needn't worry about this key. If you have more than one page of memory, depressing this key will advance your display to the next page of memory.

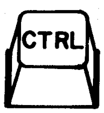


TRANSMIT KEY. This key is used to auto-transmit programs to the computer. An explanation of this procedure can be found on page 29.

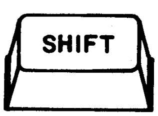


BLANK KEYS. The two remaining keys in the top row of your keyboard are blank keys. They do absolutely nothing.

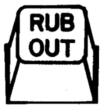
Now, let's take a look at the other special function keys on the Comter's keyboard:



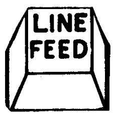
This is the CONTROL key. Used in conjunction with other keys on the keyboard, it allows entry of special control signals to the computer. For example, pressing the CONTROL key at the same time as the G key instructs the computer to ring the bell built into the Comter at that particular point in the program. We're not sure that you'll want to do much bell ringing; in any case, a listing of the control functions can be found on page 31.



SHIFT key. This key functions the same as a SHIFT key on a typewriter. That is, it allows entry of the upper case characters that are indicated on some of the keytops.



* RUB OUT key. When you are "on-line" or hardwired to the computer, you can use this key to delete (rub out) a previous character. Say that you wanted to enter the word HELLO and you entered the first four characters as HELK. By pressing the RUB OUT key at this point, you indicate to the computer that it should delete the last character. On your display the character will not actually be deleted. Instead a } symbol will appear after the K to indicate that K has been rubbed out. NOTE: The RUB OUT key does not function in LOCAL mode.



LINE FEED key. This key has no function on the CT256 unless you are hooked up to a printout device. It is received as a space on your display.

* This key is the Carriage RETURN. It instructs the computer that you are at the end of a line in a program. It is received as a space on your display.

REPT (repeat) key. This key causes a character to be entered repeatedly. For example, pressing the REPT key at the same time that you are pressing the T key will cause T to be entered repeatedly. The REPT key is a handy key to use in conjunction with either the DATA LEFT or DATA RIGHT key. By pressing the REPT key at the same time you are pressing the DATA LEFT key, the characters in your terminal's memory will move across the display from right to left.

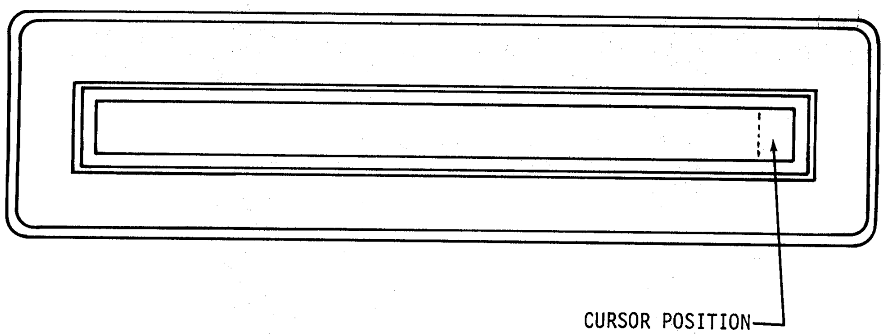
* Function of Basic Language only.

COMTER DISPLAY, MEMORY, & ADDRESS

In the following section we are going to discuss three interrelated topics: the Self-Scan T.M. display, the memory system, and the address system.

....

SELF-SCAN DISPLAY



The display on your Comter 256 is a 32 character self-scan unit. Data appearing on the display screen moves into view at the right of the screen. The rightmost position is called the cursor position and every character is entered there. However, you do not see the character until it shifts one space to the left (this occurs automatically).

The concept of the cursor position is a very important one. You need to understand this concept in order to understand the terminal's memory system.

The only time a character will appear in the cursor position is when all the "memory positions" of a page of memory are filled. The character that will appear in the cursor position will not be the one you have just entered, rather, it will be the character that happens to occupy that particular memory position.

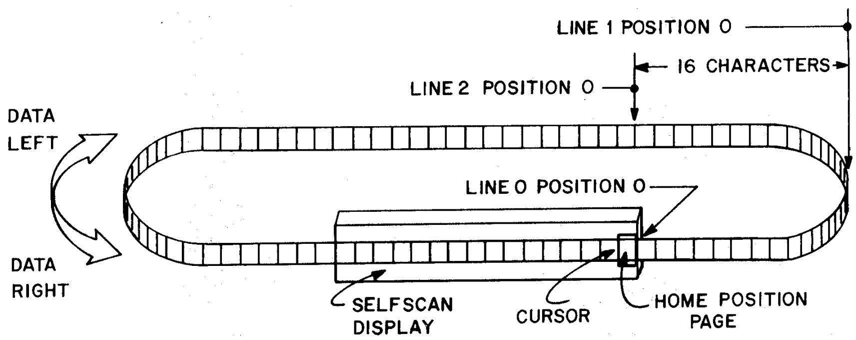
This will become clearer to you as we discuss the Comter's memory.

....

MEMORY

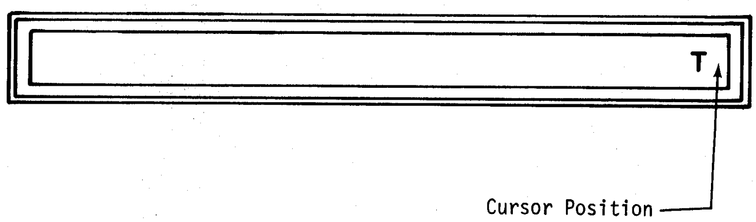
Each terminal has one "page" of memory which stores 256 characters. You have the option of adding up to three additional "pages" of memory, giving you a total storage of 1024 characters. There are, of course, advantages to having more than one page of memory.

An easy way to visualize the relationship between the memory and the display is with the following drawing.

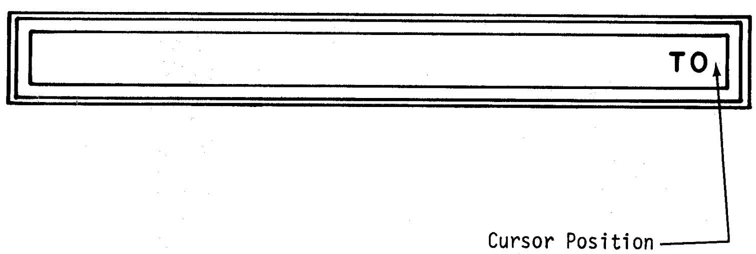


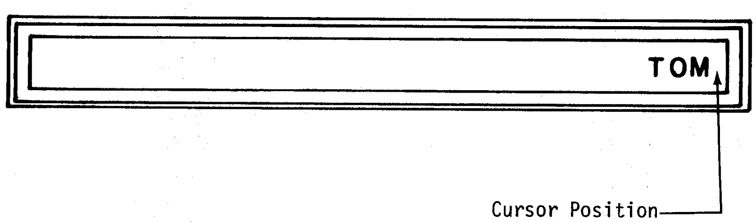
This drawing shows the 256 memory locations of one page of memory as a circle passing through the display. The starting location on the circle is line 0, position 0, and it is called the HOME position. There is a HOME key (H on the top row) and pressing this key will place memory location 0,0 in the cursor position. Turning the power ON or pressing the CLEAR key will also place location 0,0 in the cursor position.

If the memory in your Comter is blank and you press the "T" key, the display will look like this:



Adding an "O" and a "M" will have these results:

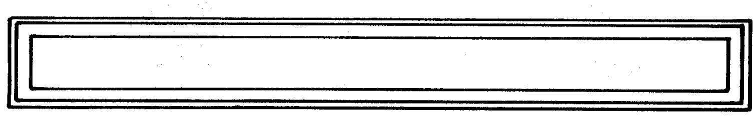




If you are using your Comter and an odd character shows up in the cursor position, this is merely an indication that the memory is full. The next character you enter will replace the "odd" character.

Now, if your Comter has more than one page of memory and you are in AUTOmatic mode, there is one or two other complications that you need to be aware of. For the purposes of illustration, let's say that your display looks like this:

and when you enter the next character, an "R", your display suddenly looks like this:



Don't be alarmed!!!! All this means is that one page of memory has been filled and the Comter has "jumped" to the next page of memory. The "R" that you entered, but didn't see, is in the last memory location of the filled page. If you wish to review this"lost" data, you can return the display to the filled page with the PAGE switch. You now will be able to see the "R".

Now, suppose that instead of a blank display, you got something like this when you entered "B":

ABG!TKFONCE>HYZ JPS"3KD7$XR9MLA@E

This means that the Comter has "jumped" to the next page of memory <u>and that that page already has characters stored in its memory locations</u>. As you continue entering data, the new data will replace old data in this particular page.

Something to keep in mind in relation to this is that PAGE ONE of the Comter is automatically CLEARed when you turn the power ON. If you have more than one page of memory, we recommend that you CLEAR the additional pages by repeatedly depressing the CLEAR key each time you turn the terminal ON.

ADDRESS SYSTEM

The address system allows you to "address" or locate each of the memory positions ih the Comter's memory. Instead of visualizing one page of memory as a circle passing through the display, now visualize one page of memory as a 16 x 16 x 6 matrix (see drawing). The horizontal and vertical lines making up the front surface of this matrix create storage locations for 256 characters. Since each character consists of a six digit binary code called the ASCII code, each of the 256 storage locations are actually a column of six cubes (RAM 1 to RAM 6)

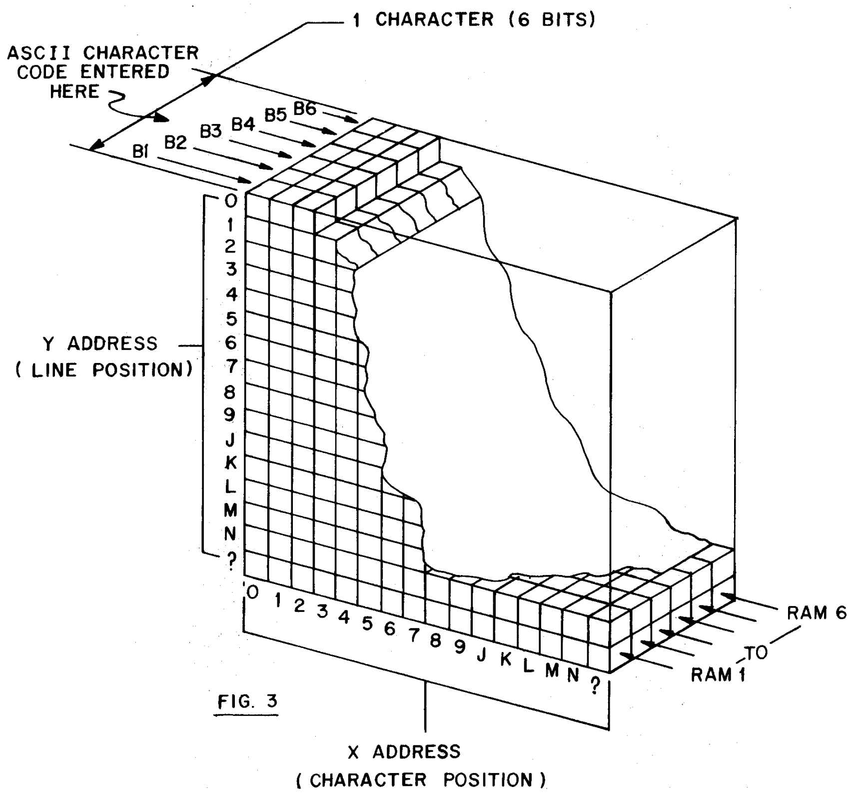
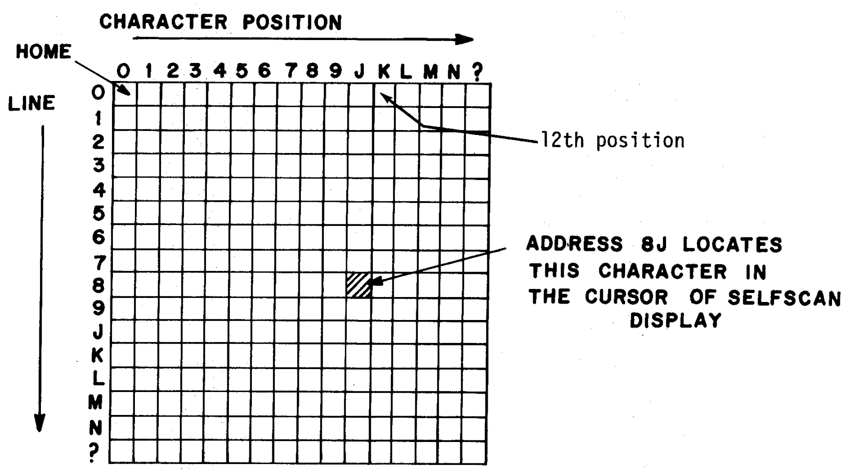


FIG. 3

Looking straight on at the front surface of the matrix (see below) you can see that the horizontal rows are called lines, while the vertical columns are called positions. The first position in the terminal's memory is the HOME position and it is at location 0,0. To put the HOME position of the terminal's memory in the cursor position of the terminal's display, all you have to do is press the HOME key. Turning the power ON or pressing the CLEAR key will also accomplish this.



Now, suppose you wanted to start a program at the 12th position of a particular page of memory. Looking at the above chart, you can see that the 12th position is at line 0, position K. By pressing the ADDRESS key (A on the top row), followed by 0 and K, position 12 will be in the cursor position.

Using this procedure you can put any memory position in the cursor position. To put position 139 in the cursor position, you press the ADDRESS key followed by 8 and J. Just remember that following the ADDRESS key you first press the line number followed by the character position.

CONNECTING A TAPE RECORDER TO THE 256

To connect a tape recorder to the Comter 256, you need: (1) a tape recorder, and (2) a shielded connector cable with a standard, minature phone plug (3.5 millimeter). The type of recorder you use is up to you, though we recommend that you use at least a medium quality (cost greater than $50) or better cassette recorder, along with a good quality recording tape.

To understand how the recorder works you have to understand that what you are recording is the audio tones from the acoustic coupler. Therefore, you can't record when you are in LOCAL mode or IN/OUT mode. You can only record when you are in TEL mode and thus connected to the computer via the acoustic coupler, i.e., the telephone.

Making a recording is as simple as connecting the phone plug to the TAPE PLAY/ RECORD jack on the back panel of the CT256 and the other end to the "mic." input on your tape recorder. Once you have connected to the computer and the phone is in the top of the terminal, you can set the audio level of the tape recorder. If the recorder has an automatic level control, use it; if not, record at a "0" DB level (maximum undistorted level). As long as your recorder is set on RECORD, you will be able to record all the data that is transmitted between the terminal and the computer.

What you want to record is, of course, up to you. You'll probably want to record program output. For instance, if you have a program that lists an inventory, you can record the inventory for later playback. Another suggestion is that once you have entered a program into the computer and have found that the program works, that you instruct the computer to "LIST" the program. You can then record the program and save it on a tape instead of storing it in the computer's memory.

To play a recording back into the terminal's memory, connect the phone plug to the TAPE PLAY/RECORD jack on the back panel of the CT256 as before. Now, instead of plugging the other end into the "mic." input on your tape recorder, plug it into the "speaker" or "ear" input. Set the Comter in the IN/OUT mode and turn the volume of the recorder up until the carrier light is brightly lit (but no further). Set the recorder to PLAY and whatever information is on the tape will appear across the Comter display and be stored in the memory.

HOW TO AUTO-TRANSMIT

To auto-transmit means to transmit data (usually a program) from the terminal's memory directly to the computer. This procedure, which is accomplished by the use of the TRANSMIT (T) key in the top row your terminal's keyboard, is restricted by the size of your terminal's memory. If you only have one page of memory, you will find auto-transmitting of limited use.

The first step to auto-transmitting a program is to load the program into the Comter's memory. This can be a program that you have written down or it can be a program that is stored on tape. It should, however, be a program that you have tested and found to work.

When you are writing a program directly into the terminal's memory (LOCAL mode) for later auto-transmission, there are two things to keep in mind:

1. Leave enough blank space at the beginning of PAGE 1 to allow for the sign-on message from the computer.
2. End each line of the program with an @ symbol (shift P) and leave three blank spaces following the @ symbol before beginning a new program line.

When you are loading a program into the terminal's memory from a tape (IN/OUT mode) you have to remember the following:

1. Leave enough blank space at the beginning of PAGE 1 to allow for the sign-on message from the computer.
2. Once you have entered the program into the terminal, put the terminal back in LOCAL mode and edit the program by adding an @ symbol at the end of each program line.
3. Some programs that you store on tape may not be written to allow three spaces after the @ symbol. These programs have to be entered directly into the terminal's memory instead of being entered via tape play back.

Once the program has been entered into the Comter's memory (with an @ symbol at the end of each line), it is a good idea to go over the program to make sure that there aren't any errors. The reason for caution here is very simple: if you auto-transmit an erroneous instruction to the computer, the computer will respond with an error message and thereby wipe out part of the Comter's memory.

Assuming that the program stored in the Comter's memory is correct, set the memory at the HOME position of PAGE 1. Then connect the terminal to the computer and enter your account number (if required).

You are now ready to auto-transmit. Depress the TRANSMIT key (T in the top row) and hold it down. The first line of the program will be auto-transmitted to the computer and transmission will automatically stop once the @ symbol at the end of line 1 is in the cursor position. Press the RETURN key and you are ready to auto-transmit the second line of the program.

Continue with this procedure until you have transmitted the entire program to the computer. Be sure to enter a RETURN at the end of each program line.

CONTROL FUNCTIONS

If you are entering a program and you press the key, the characters in your display will immediately move one space to the left. If you want to instruct the computer to move the characters in your display one space to the left at that point in the program, then you enter a control H. That is, you press the CONTROL key at the same time you are pressing the H key.

The primary function of control characters then, besides ringing bells, is to provide control over the format of program output. A list of CT256 control characters follows:

CONTROL G	Bell (tone)
CONTROL H	Backspace (data left)
CONTROL I	Advance space (data right)
CONTROL J	Line feed (received as space on CT256)
CONTROL K	HOME
CONTROL L	CLEAR plus HOME
CONTROL M	RETURN
CONTROL N	Data up (received as space on CT256)
CONTROL O	Address function (next two characters determine display position)

Service

Should you have a problem with your computer terminal, it can be returned to MITS for repair. If the unit is still under warranty, any defective part will be replaced free of charge. The purchaser is responsible for all postage.

If you return your unit to us for repair, pack it in a sturdy cardboard container and surround it on all sides with a thick layer of packing material. You can use shredded newspaper, foamed plastic or excelsior. The packed carton should be neatly sealed with gummed tape and tied with a stout cord. Be sure to tape a letter containing your name and address, a description of the malfunction, and the original invoice (if the unit is still under warranty) to the outside of the box.

Mail the carton by parcel post or UPS--for extra fast service, ship by air parcel post. Be sure to insure the package.

SHIP TO: MITS, Inc.
6324 Linn Ave. N.E.
Albuquerque, New Mexico 87108

All warranties are void if any changes have been made to the basic design of the machine or if the internal workings have been tampered with in any way.

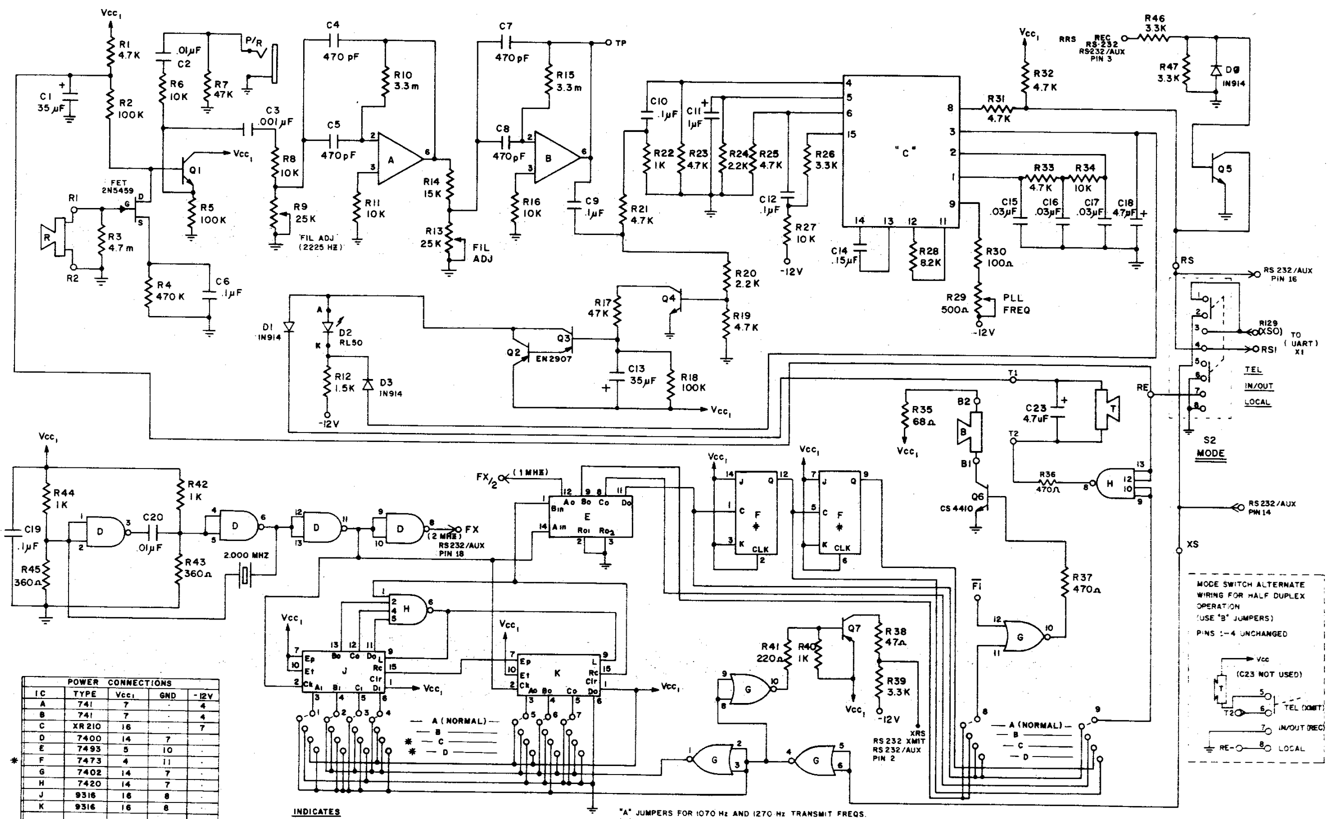
DUE TO MATERIAL SHORTAGES, THE CT-256 THEORY OF OPERATION AND TROUBLESHOOTING MANUAL IS NOT IN PRINT AT THIS TIME. THESE ARE THE COMPLETE SET OF SCHEMATIC DIAGRAMS FOR THE TERMINAL.

YOU WILL RECIEVE YOUR COPY OF THE THEORY OF OPERATION AND TROUBLESHOOTING MANUAL IMMEDIATELY UPON ITS PRINTING.

SHOULD YOU HAVE ANY TROUBLE WITH YOUR UNIT, CHECK OVER ALL OF THE WIRING AND SOLDERING. THE MOST COMMON PROBLEMS WITH KITS ARE WIRING ERRORS OR IMPROPER SOLDERING.

IF YOU HAVE FURTHER PROBLEMS WITH YOUR UNIT, FEEL FREE TO CONTACT MITS FOR ASSISTANCE.

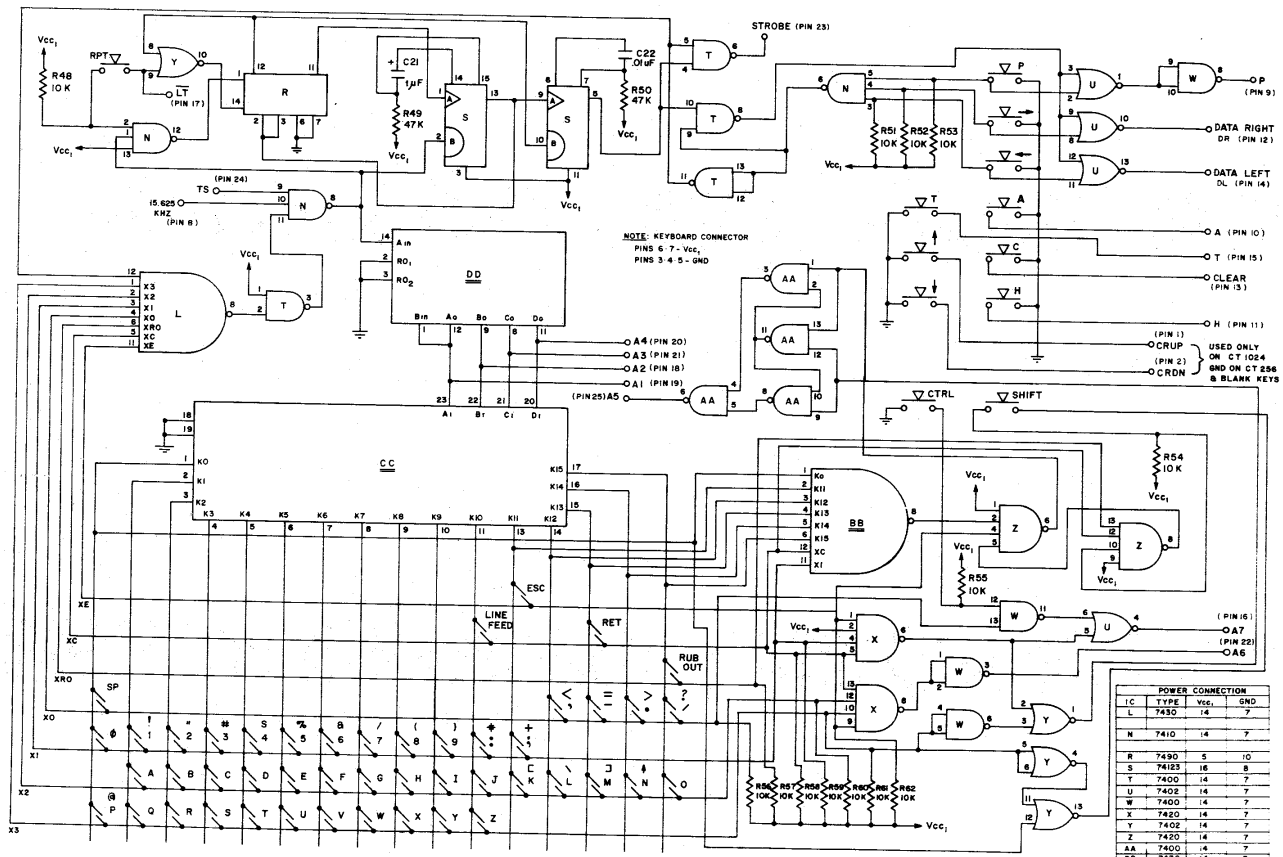
WE REGRET ANY INCONVENIENCE THIS MAY CAUSE AND THANK YOU FOR YOUR PATIENCE.



POWER CONNECTIONS

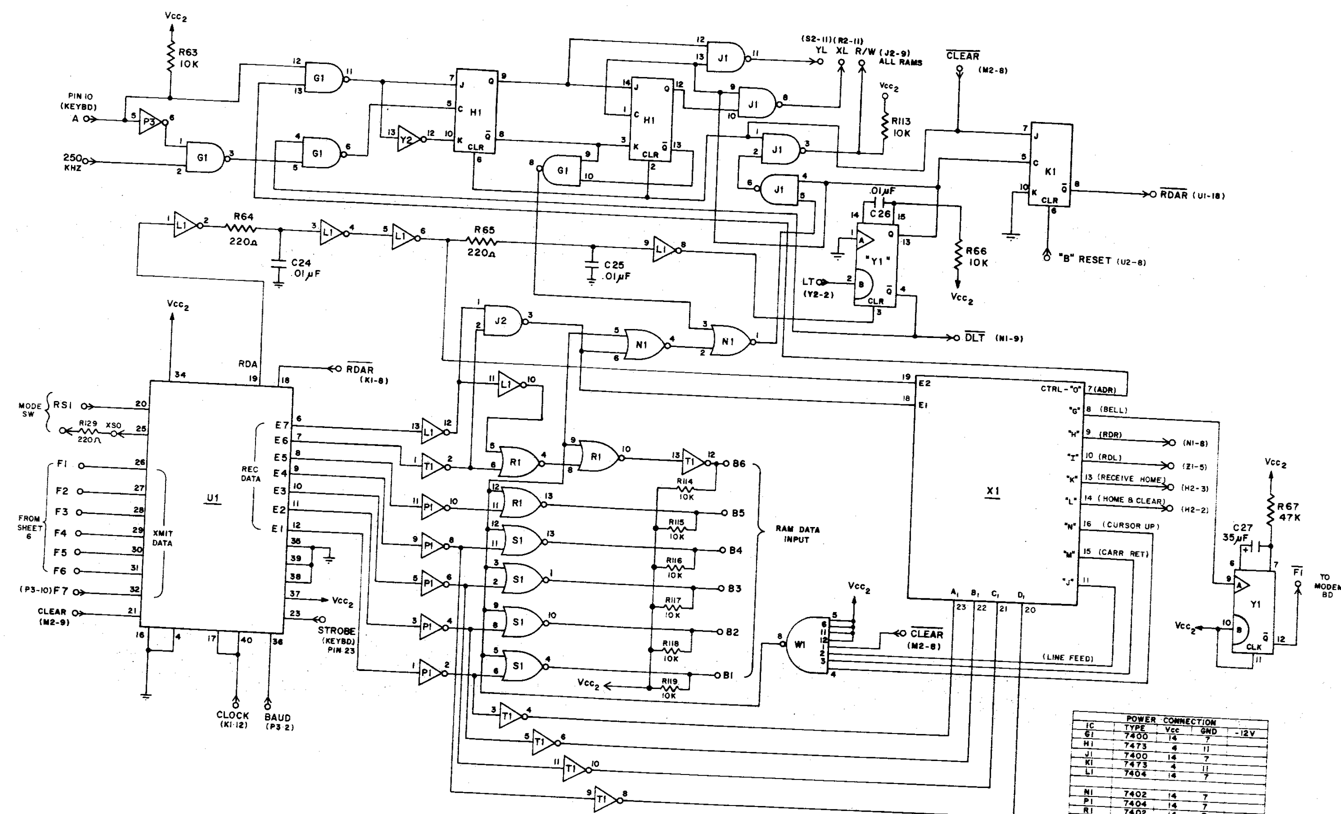
	IC	TYPE	Vcc_1	GND	-12V
	A	741	7	-	4
	B	741	7	-	4
	C	XR210	16	-	7
	D	7400	14	7	-
	E	7493	5	10	-
✱	F	7473	4	11	-
	G	7402	14	7	-
	H	7420	14	7	-
	J	9316	16	8	-
	K	9316	16	8	-

MODEM CIRCUIT
SHEET 1 OF 7



POWER CONNECTION			
IC	TYPE	Vcc1	GND
L	7430	14	7
N	7410	14	7
R	7490	5	10
S	74123	16	8
T	7400	14	7
U	7402	14	7
W	7400	14	7
X	7420	14	7
Y	7402	14	7
Z	7420	14	7
AA	7400	14	7
BB	7430	14	7
CC	74154	24	12
DD	7493	5	10

KEYBOARD CIRCUIT
SH 2 OF 7



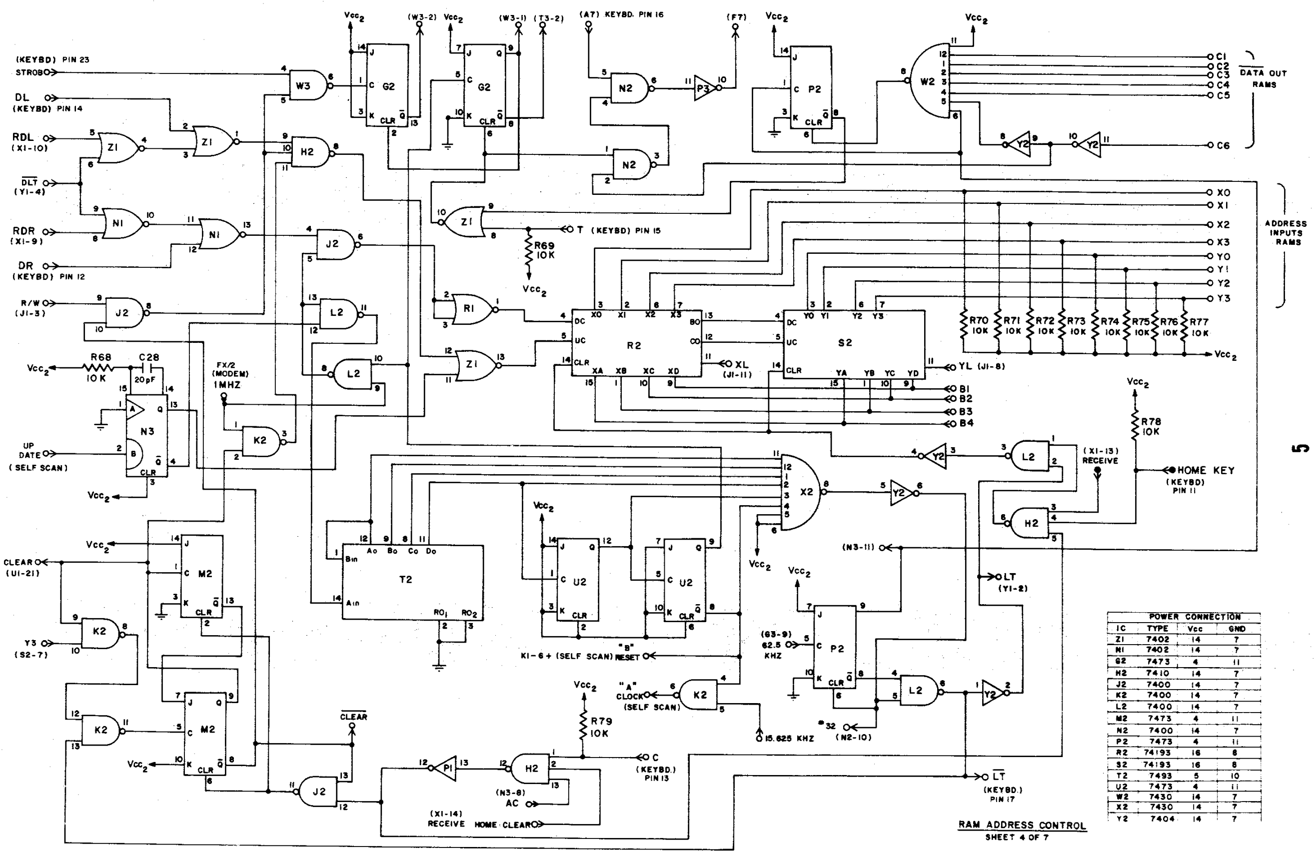
RECEIVE CIRCUIT

(SHEET 3 OF 7)

	IC	TYPE	Vcc	GND	-12V
	G1	7400	14	7	
	H1	7473	4	11	
	J1	7400	14	7	
	K1	7473	4	11	
	L1	7404	14	7	
	N1	7402	14	7	
	P1	7404	14	7	
	R1	7402	14	7	
	S1	7402	14	7	
	T1	7404	14	7	
*	U1	2502	1	3	2
	W1	7430	14	7	
	X1	74154	24	12	
	Y1	74123	16	8	

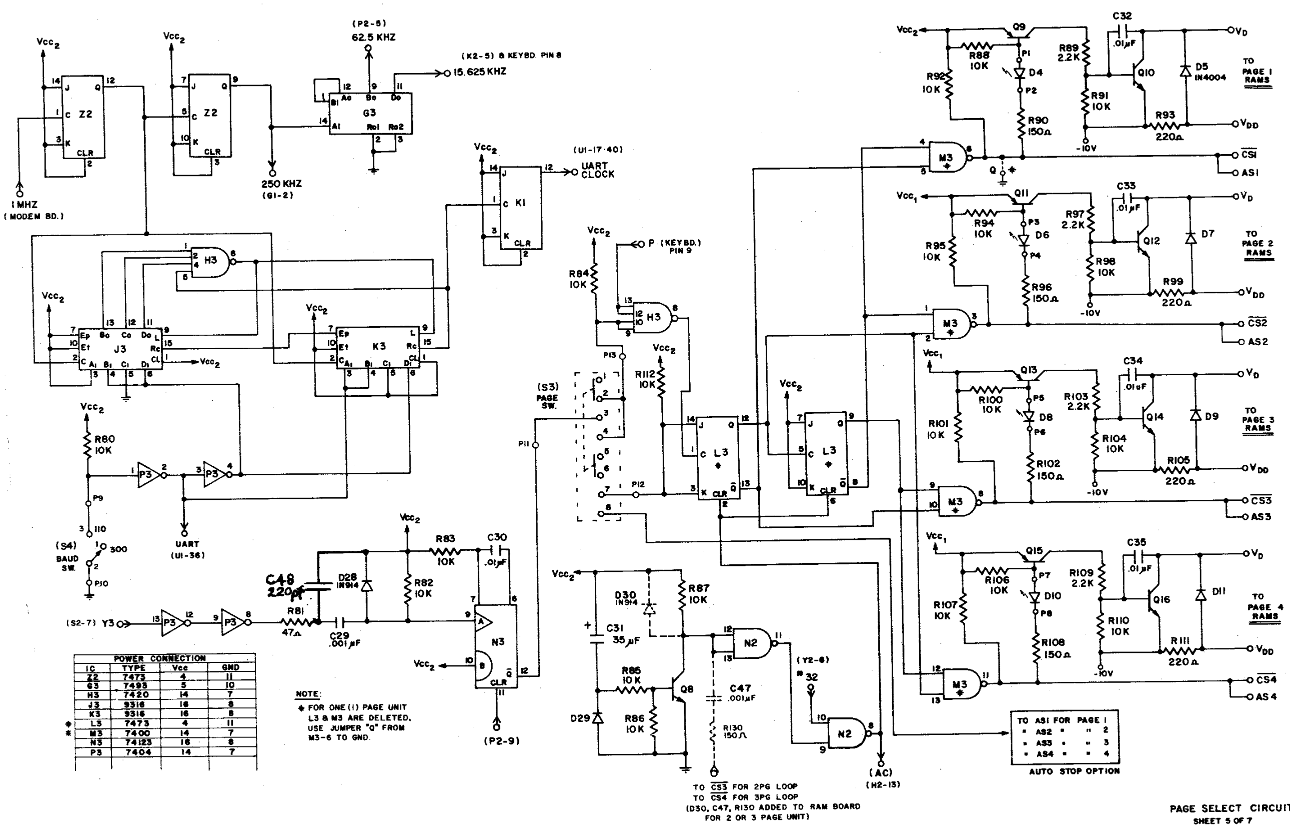
POWER CONNECTION

* - DENOTES IC TYPE 1883 ARE EQUAL



POWER CONNECTION			
IC	TYPE	Vcc	GND
Z1	7402	14	7
N1	7402	14	7
G2	7473	4	11
H2	7410	14	7
J2	7400	14	7
K2	7400	14	7
L2	7400	14	7
M2	7473	4	11
N2	7400	14	7
P2	7473	4	11
R2	74193	16	8
S2	74193	16	8
T2	7493	5	10
U2	7473	4	11
W2	7430	14	7
X2	7430	14	7
Y2	7404	14	7

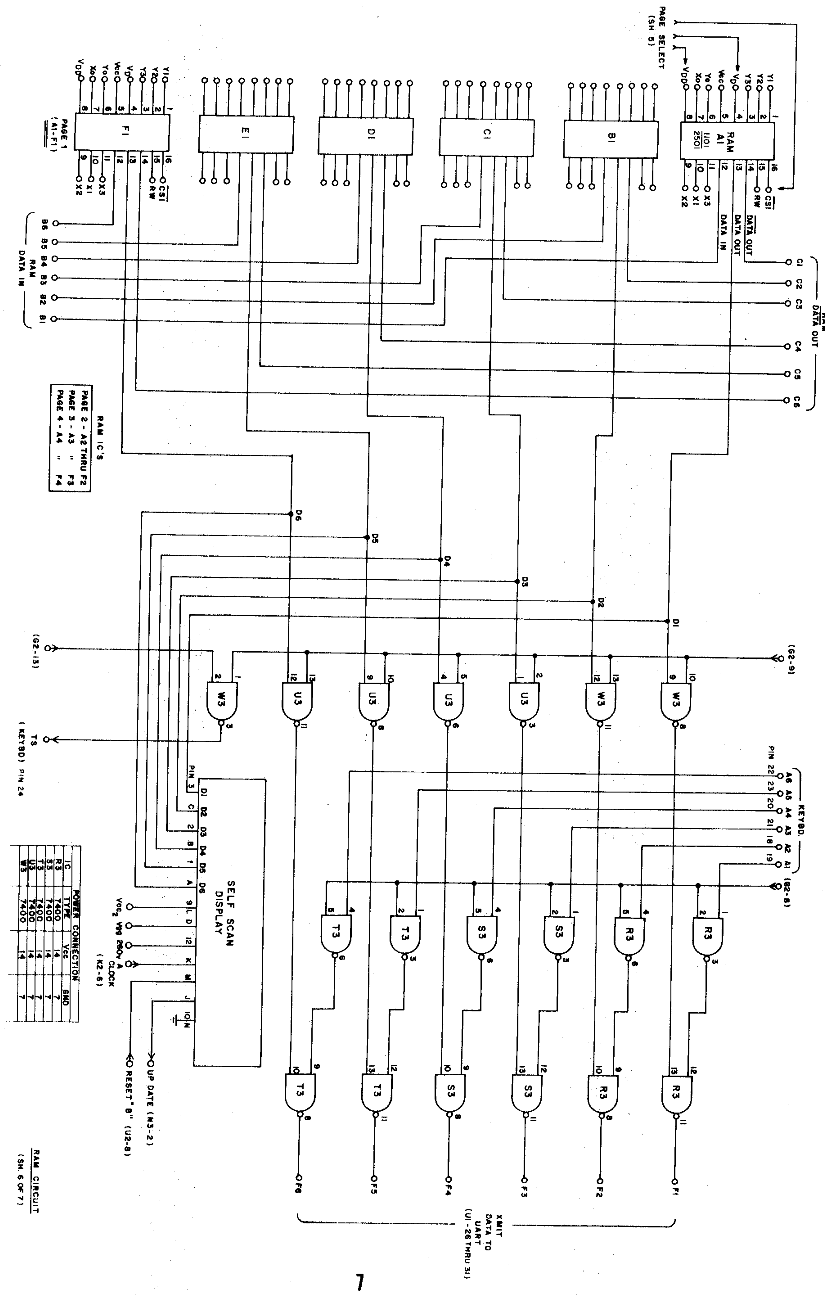
RAM ADDRESS CONTROL
SHEET 4 OF 7



POWER CONNECTION			
IC	TYPE	Vcc	GND
Z2	7473	4	11
G3	7493	5	10
H3	7420	14	7
J3	9316	16	8
K3	9316	16	8
* L3	7473	4	11
* M3	7400	14	7
N3	74123	16	8
P3	7404	14	7

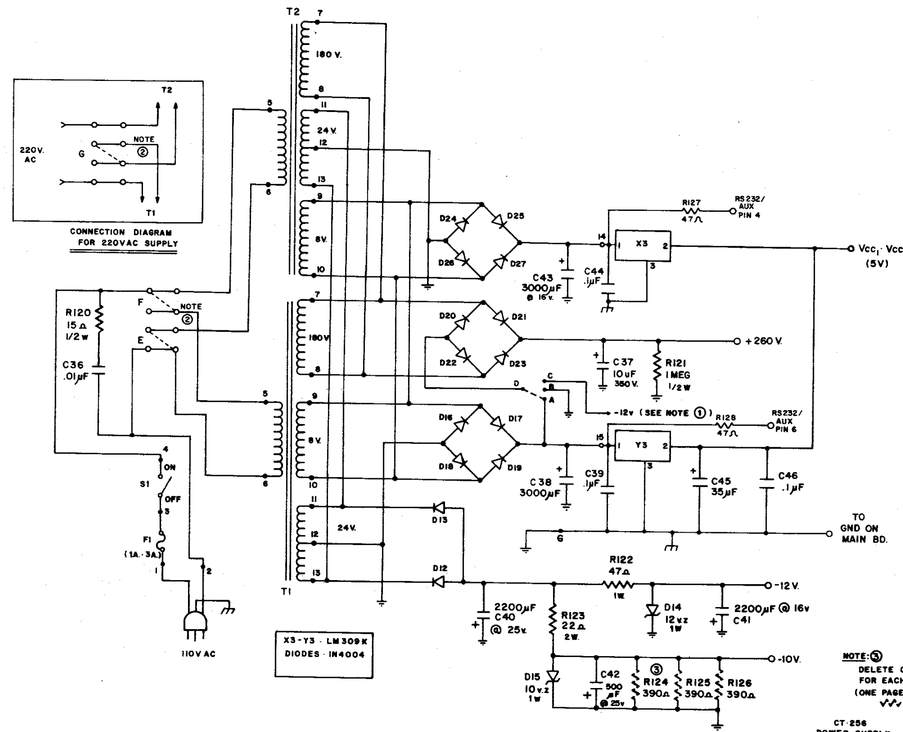
NOTE:
* FOR ONE (1) PAGE UNIT L3 & M3 ARE DELETED, USE JUMPER "Q" FROM M3-6 TO GND.

PAGE SELECT CIRCUIT
SHEET 5 OF 7



RAM A1 1101 2501
B1
C1
D1
E1
F1
PAGE 1 (A1-F1)
PAGE SELECT (SH. 5)
DATA OUT
DATA IN
RAM DATA OUT
RAM DATA IN
RAM IC'S
PAGE 2 - A2 THRU F2
PAGE 3 - A3 " F3
PAGE 4 - A4 " F4
SELF SCAN DISPLAY
KEYBD.
TS (KEYBD) PIN 24
CLOCK (K2-6)
UP DATE (N3-2)
RESET "B" (U2-8)
XMIT DATA TO UART (U1-26 THRU 31)
POWER CONNECTION
IC TYPE Vcc GND
R3 7400 14 7
S3 7400 14 7
T3 7400 14 7
U3 7400 14 7
W3 7400 14 7
RAM CIRCUIT (SH. 6 OF 7)

RS232/AUX JACK CONNECTIONS		
PIN	DESCRIPTION	CONNECTS TO
1	PROTECTIVE GROUND	CHASSIS GND
2	RS232 XMIT	MODEM-XRS
3	RS232 REC	MODEM-RRS
4	RS232 REQUEST TO SEND - +8v	47Ω TO X3-1
6	RS232 DATA SET READY - +8v	47Ω TO Y3-1
7	SIGNAL GND	MODEM GND
11	Vcc (+5v)	Y3-2
14	XS-TTL TRANSMIT INPUT	SWITCH 2-2
16	RS-TTL RECEIVE OUTPUT	SWITCH 2-4
18	FX (2MHZ) TTL-CLOCK	MODEM-FX
25	(-12v)	-12v MODEM



NOTE: ① DISPLAY VOLTAGE (+260v)

JUMPERS (USE ONLY ONE) POINT "D" TO-:

(A) - FOR AREAS OF LOW LINE VOLTAGE (LV) (LESS THAN 110 V.)

(B) - FOR AREAS OF NORMAL LINE VOLTAGE (NV) (110-120 V.)

(C) - FOR AREAS OF HIGH LINE VOLTAGE (HV) (GREATER THAN 120 V.)

NOTE: ②

JUMPERS E+F ONLY FOR 110v OPERATION

JUMPER G ONLY FOR 220v OPERATION

NOTE: ③

DELETE ONE 390Ω RESISTOR FOR EACH ADDITIONAL PAGE OF MEMORY (ONE PAGE UNIT HAS 3EA., 4 PAGE UNIT HAS NONE) IF USED.

CT-256
POWER SUPPLY
(SH. 7 OF 7)

+RS232/AUX CONNECTOR

CT-256 ASSEMBLY MANUAL ERRATA SHEET

PLEASE READ THIS BEFORE BEGINNING

NOTE: The following addition to the Main PC Board Assembly must be made after completion of page 16 of the Assembly Manual.

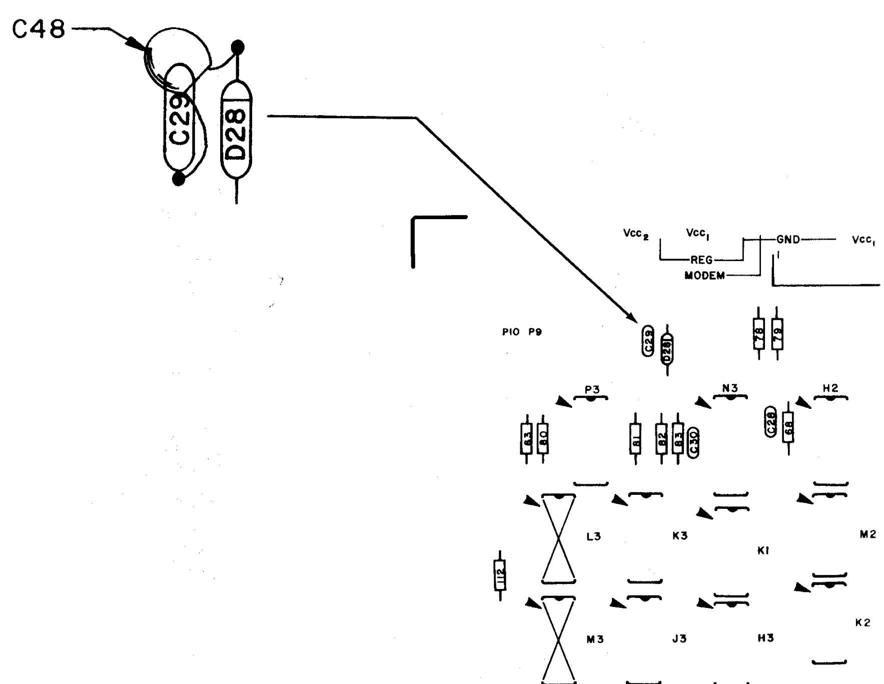
( ) Capacitor C48 (220pf) must be installed onto the Main PC Board.

( ) This capacitor is to be installed between two components already installed on the board, C29 and D28. These are located near the back left corner of the board.

( ) Referring to the silk-screen drawing below, bend the leads of C48 as necessary to fit between the lower lead of C29 and the banded side of D28.

( ) Attach the capacitor to the two components already installed making sure the leads do not short to any other lands.

( ) Solder the capacitor in place and clip off any excess lead lengths. Bend the capacitor over flat against the board.



CT-256

ASSEMBLY MANUAL

Table of Contents

Written by James B. Vice

PRINTED IN U.S.A.

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"Creative Electronics"
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ALBUQUERQUE, NEW MEXICO 87108

ASSEMBLY HINTS

Before beginning the construction of your unit, it is important that you read the "Kit Assembly Hints" booklet. Pay particular attention to the section on soldering because most problems in the CT-256 occur as the result of poor soldering. Failure to heed the warnings in the "Kit Assembly Hints" booklet may cause you to void your warranty.

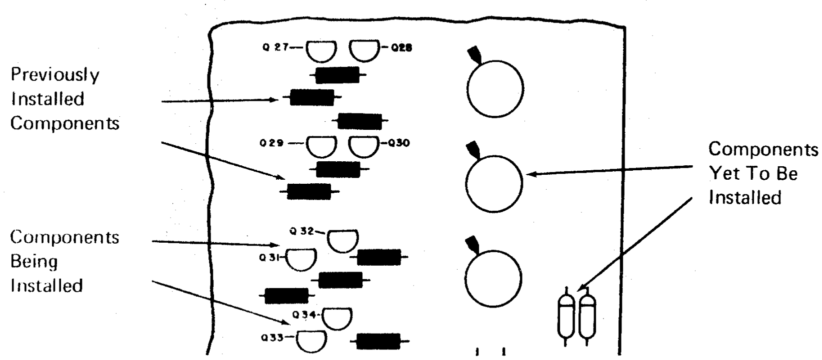
The type of soldering iron used is critical. Use a 30-40 watt iron with a chisel tip, such as an Ungar 776 with a 7155 tip. The delicate soldering necessary for this unit precludes using a blunt-tipped iron.

Each component should be installed in the order presented in the assembly instructions. Each component must be placed in its correct position on the board. There are drawings throughout the assembly instructions which will aid you in installing the components correctly. Some components (diodes, integrated circuits, some capacitors, and transistors) have special orientations on the board. These special orientations are called out in the assembly instructions; it is important that you note them carefully before installing the components.

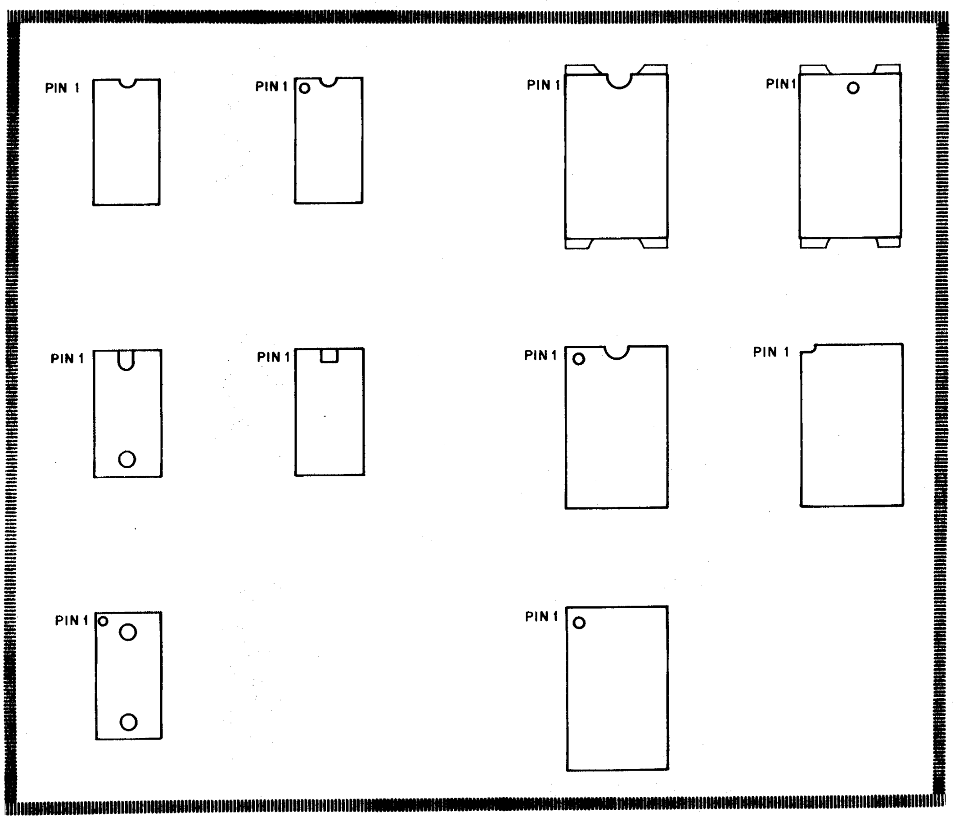
After a component has been soldered to the board, check it off in the space provided on the page. Before going on to a new page, check to make sure all the components on that page have been installed.

Check the contents of your kit against the enclosed parts list to make sure you have all the required components, hardware and parts. The components are in plastic envelopes; do not open them until you need the components for an assembly step. You will need the tools called for in the "Kit Assembly Hints" booklet.

To assist you in assembling your unit, a coding system is used to identify the components already installed, components being installed, and components to be installed later. Compare each page with your circuit board to ensure that all components are installed before going on to a new page.



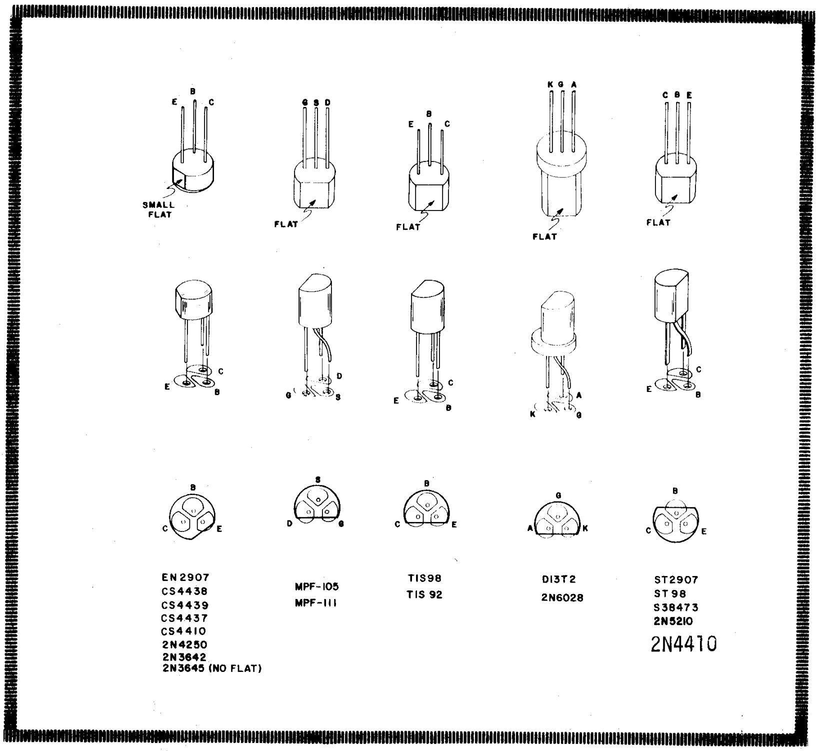
IC ORIENTATION CHART



INTEGRATED CIRCUITS (IC's) CAN COME WITH ANY ONE OF, OR A COMBINATION OF, SEVERAL DIFFERENT MARKINGS. THESE MARKINGS ARE VERY IMPORTANT IN DETERMINING THE CORRECT ORIENTATION FOR INSTALLATION. REFER TO THE ABOVE DRAWING TO DETERMINE THE POSITION OF PIN 1 OF THE IC AND USE THIS INFORMATION TO ORIENT IT AS DESCRIBED IN THE ASSEMBLY MANUAL.

WARNING: IF THE IC's ARE NOT PROPERLY ORIENTED DURING INSTALLATION, IT MAY RESULT IN PERMANENT DAMAGE TO YOUR UNIT.

TRANSISTOR IDENTIFICATION CHART



IN THE ILLUSTRATION ABOVE THE OUTLINE OF EACH TYPE OF TRANSISTOR IS SHOWN OVER THE PADS ON THE CIRCUIT BOARD WITH THE CORRECT DESIGNATION FOR EACH OF THE THREE LEADS. USE THIS INFORMATION TOGETHER WITH THE INFORMATION IN THE ASSEMBLY MANUAL FOR THE CORRECT ORIENTATION OF THE TRANSISTORS AS YOU INSTALL THEM.

THE FOLLOWING IS A LIST OF POSSIBLE SUBSTITUTIONS; IF ANY OTHERS ARE USED YOU WILL RISK DAMAGING YOUR UNIT:

2N4410 = CS4410 = CS4437, CS4438, TIS98, ST98, S38473 (NPN)
EN2907 = ST2907, CS4439 (PNP)

FOR SUBSTITUTIONS REFER TO THE INFORMATION ABOVE TO DETERMINE THE CORRECT ORIENTATION FOR THE THREE LEADS.

Integrated Circuit Installation

There are up to fifty possible integrated circuits (IC's) to be installed on the Main PC Board. Seven of these are MOS IC's, which require special handling and will be installed later in the assembly procedure.

Two of the IC's, L3 and M3, are marked with large "X's" on the silk-screened side of the PC board. If your kit has only one page of memory (no expansion), these two IC's will not be installed.

( ) Remove the IC from its holder. If there are any bent pins, straighten these using needle-nose pliers. Ensure that you choose the IC with the correct part number as you install each one. (see component layout)

( ) Orient the IC so that its notched end corresponds with the notch printed on the PC board, and pin 1 of the IC corresponds with the pad marked with an arrowhead on the board.

NOTE: If the IC does not have a notch on one end, refer to the "IC Orientation Chart" in the front of this manual for identification of pin 1.

( ) When you have the correct orientation, start the pins on one side of the IC into their respective holes on the silk-screened side of the PC board. DO NOT PUSH THE PINS IN ALL THE WAY. If you have difficulty getting the pins into the holes, use the tip of a small screwdriver to guide them.

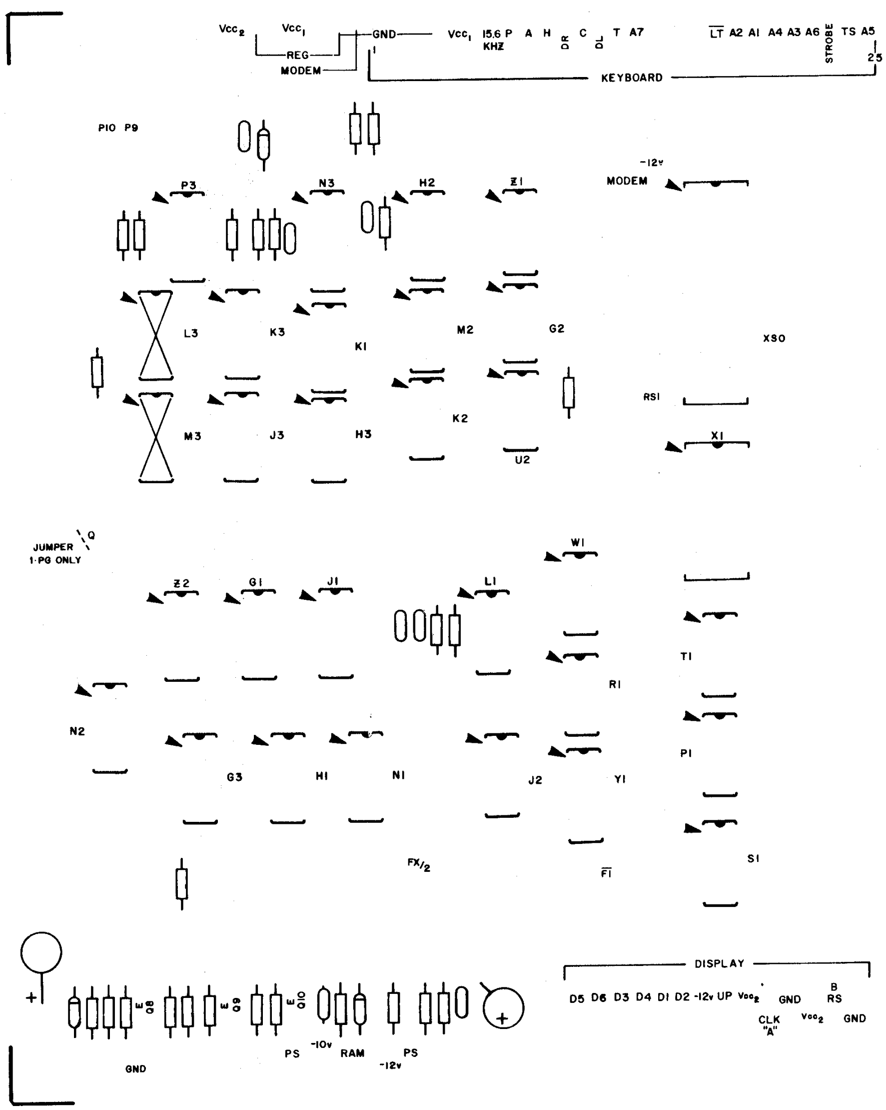
( ) Start the pins on the other side of the IC into their holes in the same manner. When all of the pins have been started, set the IC in place by gently rocking it back and forth until it rests as close as possible to the PC board. Make sure that the IC is perfectly straight and as close as possible to the board; then tape it in place with a piece of masking tape.

( ) Turn the board over and solder each pin to the foil pattern on the back side of the board. Be sure to solder each pin, and make sure you do not leave any solder bridges.

( ) Turn the board over again and remove the piece of masking tape.

Use this same procedure to install each of the IC's. Be sure that you have the correct part number and the correct orientation as you install each one.

REMEMBER: Do not install IC's L3 and M3 if you have only one page of memory in your kit.



Vcc2
Vcc1
REG
MODEM
GND
1
Vcc1
15.6 KHZ
P
A
H
DR
C
DL
T
A7
LT
A2
A1
A4
A3
A6
STROBE
TS
A5
25
KEYBOARD
P10 P9
-12v
MODEM
P3
N3
H2
Z1
L3
K3
K1
M2
G2
XSO
RS1
K2
M3
J3
H3
U2
X1
JUMPER
1-PG ONLY
Q
W1
Z2
G1
J1
L1
T1
R1
N2
G3
H1
N1
J2
Y1
P1
S1
FX/2
F1
DISPLAY
D5 D6 D3 D4 D1 D2 -12v UP Vcc2
GND
B
RS
CLK "A"
Vcc2
GND
Q8
Q9
Q10
GND
PS
-10v
RAM
PS
-12v