Mark Arnold

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A Method of Interfacing the LD12 with a teletype

The design of the LD12 is such that I/O will take place under program control. Such control may or may not use the interrupt system available. In connection with the latter it should be noted that even if an interrupt is waiting to be serviced, the interrupt will not occur until an ION instruction is executed thereby enabling the interrupt. On the other hand, ION may be executed at any point in the program and the interrupt enable flip flop may be left set. Such action means that an interrupt requesting service at any time will be serviced, and the program must be designed to take care of the situation.

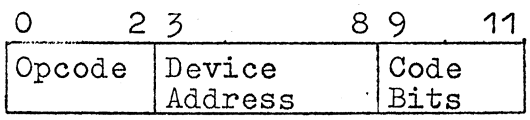
The set of instructions available presumes that I/O will be initiated by a "SKIP". Assume that it is desired to transmit a message to the teleprinter. Then the instruction sequence might appear as:

Address	Instruction	
100	6041	TSF - skip on teleprinter flag
101	5100	JMP. -1
102	5XXX	Branch to service routine for teleprinter

Following the SKIP, two other instructions are available singly or in combination:

6042 TCF - Clear teleprinter flag
6044 TPC - Load teleprinter and print
6046 TLS - Load teleprinter sequence (a combination of the two previous instructions)

The IOT instruction (Opcode 6) is used for all I/O. It is broken down as follows:



Code bits 11, 10 and 9 determine the action to be taken at CP0, CP1 and CP2 respectively. The presence of those bits at those times will cause the signals IOP1, IOP2 and IOP4 respectively. Column 6 of the instruction table in the Lab Manual will now look basically as follows:

	6
	IOT
CP0	IOP1=IR11 MUX=PC ALU=A+1 0 0000 0 PC(L)=IOS
CP1	IOP2=IR10 CLA=RDA
CP2	IOP4=IR9 MUX=I/O ALU=A B AC(L)=RDE

IOS stands for I/O SKIP. The skip will not occur unless the device addressed by bits 3 through 8 returns a signal on CP0 indicating that it is ready. IOP1, IOP2 and IOP4 appear as indicated previously. The additional action under CP1 and CP2 involves transfer of data from keyboard to accumulator. RDA and RDE are signals going to the UART directing (1) Reset Data Available, and (2) Place received data on data lines.

Figures 1, 2 and 3 are logic diagrams of the interface. Although in this case all gates are on the same board, the figures may be considered to be:

Figure 1 - Additions to CPU
Figure 2 - Printer Control
Figure 3 - Keyboard Control

The additions to the CPU are a compromise. The DM8095's, Hex Tri-State Buffers, were put in initially with the idea of using only one bus, since the UART outputs are also Tri-State. However, if only a teletype is to be interfaced, it is much simpler to keep the buses separate, particularly since an additiona set of buffers would otherwise be needed on the input to the MUX's for data being received. Also the UART only receives and transmits 8 data bits. The two DM8095's were left in because of the possibility of wishing to interface additional items in the future. Similarly, the 6 SN7404 inverters (one chip) are not essential if only interfacing the teletype. But by providing this buffer 8 additional addresses (devices) may be used if desired.

It can be seen that the CPU transmits 8 data bits from the accumulator, a 6-bit device address, and IOP1, IOP2 and IOP4. The CPU receives 8 data bits into the accumulator via the MUX's, the signal to skip, the interrupt request, and three signals from the UART; DS, RDE and RDA.

Figure 2 shows the logic which permits the UART to take parallel data from the accumulator and transmit it in serial form to the teletype. The address of the printer portion of the teletype control is 04. A 6041 instruction will cause an 04 to be received by the 6-bit Comparator(DM7160). This will give a correct comparison, and the Z line on the Comparator will go high and stay high throughout the execution cycle. At CP0, IOP1 will be generated since bit IR11 is on. Assuming that the Data Available flag is high, indicating that the UART is ready to receive data, an IOS signal will be generated thereby causing a SKIP to occur in the program. Since neither the 10-bit nor the 9-bit is on in the instruction register, nothing further will occur during this execution cycle.

Assume that the next instruction is 6046, meaning that both bits IR10 and IR9 are on. As before, the Comparator will acknowledge the address and its Z output will go high, but since IR11 is not on, no SKIP instruction can be generated. At CP1, IOP2 will be generated and the Data Available Flag will be cleared. The clearing of this flag prevents an IOS until TBMT goes down and then rises. A high TBMT indicates that the data bits holding register of the UART may be loaded with another character. IOP4 will also be generated on CP2 by the 6046 instruction because bit IR9 is on. The IOP4 pulse will cause a low signal at DS. TBMT is thereby sent low, and data on the IOD lines will be strobed into the data bits holding register when the DS signal rises. This rise will take place at the end of IOP4. In the meantime, the low on the DS line has been transmitted to the two tri-state hex buffers in the CPU, thereby taking them out of the high impedance state

and enabling them to put the contents of the accumulator on the IOD lines. When DS is strobed up, these data are accepted by the data bits holding register in the UART, and the UART begins transmitting the bits serially via SO to the teletype. When the serial transmission is completed, TBMT goes high, and the Data Available Flag goes high, thereby permitting another SKIP to take place at the appropriate time and another character to be transmitted.

Figure 3 shows the logic which permits the UART to take serial data from the teletype and transmit parallel data to the accumulator. Since the address of the keyboard is 03, the SKIP instruction is 6031. DA will go high when an entire character from the teletype is in the UART's receiver holding register. This signal, plus the address signal from the Comparator and IOP1, will generate an IOS signal and permit the SKIP to take place. The IOP1 pulse is ANDed with $\overline{IR10}$. It is generally necessary to clear the keyboard flag (6032) in housekeeping and other portions of any substantial program. If DA were high, such an instruction could cause an unwanted SKIP if IOP1 is not ANDed with $\overline{IR10}$.

As before, the instructions 6032, 6034 and 6036 are available. If 6032 is executed (IR10 bit on), RDA will go low thereby resetting DA. If 6034 is executed (IR9 bit on), RDE will go low enabling the UART to put data on the IORD lines. The RDA(LO) signal causes the accumulator to be cleared, and the RDE(LO) signal OR's the data on the 8 IORD lines into the accumulator. When another character is received into the UART's receiver holding register, DA is set, and the cycle may then be repeated starting with the generation of IOS.

Material required (assuming that modification for 4K memory has been made):

2	SN7400	Quad 2-Input Positive NAND gates
1	SN7402	Quad 2-Input Positive NOR gates
2	SN7404	Hex Inverters
3	SN7410	Triple 3-Input Positive NAND gates
1	SN7474	Dual D-Type Positive Edge-Triggered Flip-Flops with Preset and Clear
2	DM8095	Hex Tri-State Buffers
2	DM7160	6-Bit Comparator
1	AY-5-102	Universal Asynchronous Receiver/Transmitter (General Instrument)
1	NE555	Timer
7	14-Pin Sockets	
1	16-Pin Socket	
1	40-Pin Socket	
1	82 ohm, ½ watt Resistor	
1	160 ohm, ¼ watt Resistor	
4	1000 ohm, ¼ watt Resistors	
1	2200 ohm, ¼ watt Resistor	
1	43K, ¼ watt Resistor	
1	10K, ¼ watt Resistor	

1 .01 mfd Capacitor
1 .022 mfd Capacitor
-12 volt power supply for UART
1 14-Pin Interfacing Plug
2 16-Pin Adaptor Plugs

Installation of sockets and location of IC's and other components:

The following unused sockets should already be installed and available on the backboard:

16-Pin F14, F15, F16, H15, H16, L1, L2, L3, L4
14-Pin E17, G17, G18, G19, M17, M18, M19

It is assumed that all wiring which involved the 7489 memory has been removed. L1, L2, L3, L4, M17, M18, and M19 will not be used. Install the 16-pin socket in location B-19. Install the 40-pin socket in "UART1"; call this location D-18. Note that the pin numbers on the UART do not run in the same direction as the pin numbers on the other sockets. Install the 7 14-pin sockets in B20, B21, E18, E19, E20, E21 and G-20. IC's and other items will be installed in sockets as follows:

B19	Transistor Circuit
B20	NE555
B21	Connector to teletype
D18	UART
E17	SN7404
E18	SN7404
E19	SN7400
E20	SN7474
E21	SN7410
F14	DM7160
F15	DM7160
F16	Resistors (4)
G17	SN7402
G18	SN7400
G19	SN7410
G20	SN7410
H15	DM8095
H16	DM8095

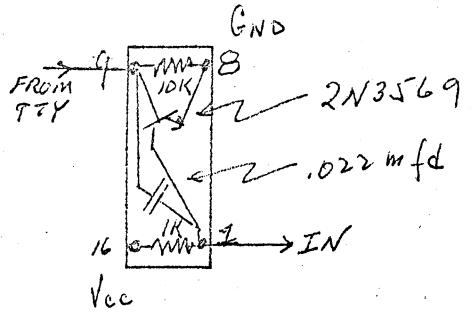
Use of Adaptor Plugs:

On one of the two adaptor plugs mount 4 resistors as follows:

1 1000 ohm resistor between pins 16 and 1;
1 1000 ohm resistor between pins 14 and 3;
1 160 ohm resistor between pins 12 and 5;
1 82 ohm resistor between pins 10 and 7.

This adaptor plug goes in the 16-pin socket at location F16. On the second adaptor plug mount:

1 1000 ohm resistor between pins 16 and 1;
1 10K resistor between pins 8 and 9;
1 .022 mfd capacitor between pins 9 and 1;
1 2N3569 (or equivalent switching transistor), emitter to pin 8, base to pin 9, collector to pin 1.

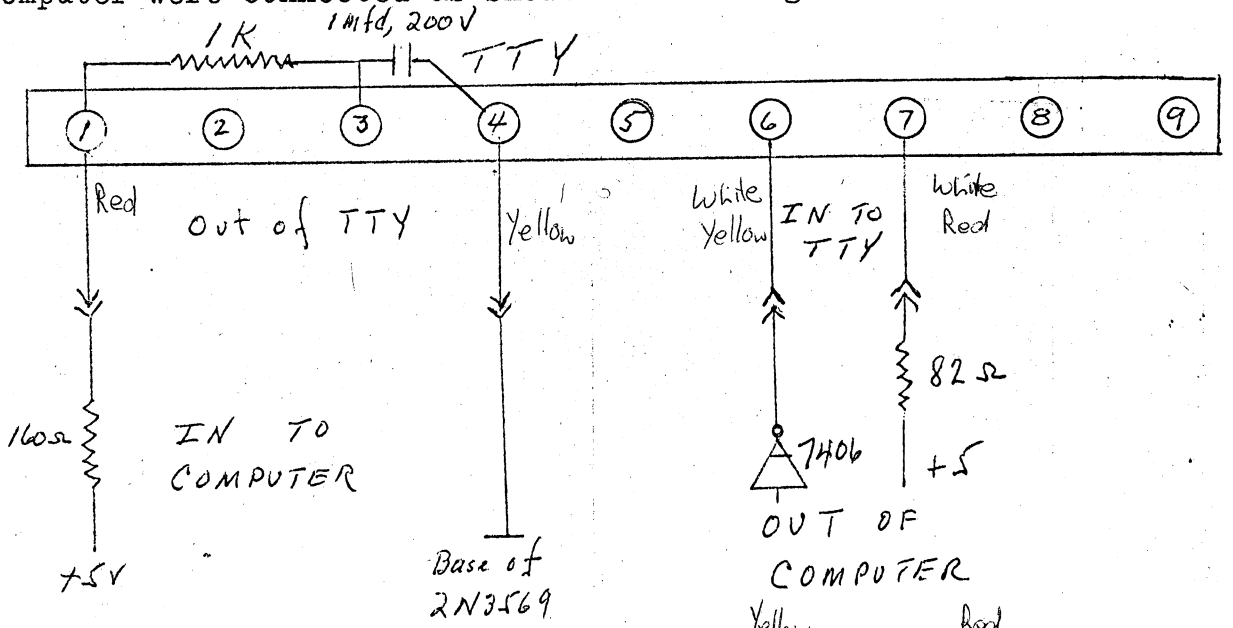


Sketch of connections on adaptor plug containing transistor and accompanying components.

This adaptor plug goes in the 16-pin socket at location ~~B-20~~. B-19

Connecting Teletype:

The input/output connections of individual teletypes vary considerably even though two teletypes may be the same model. It will be necessary to locate the two pins carrying the output of the rotary switch and the two pins leading to the solenoid. The teletype with which this interface was tested is one normally used with a TI960. In the back of the teletype near the 115V AC power lead there is a 9 position barrier terminal block. The teletype and the computer were connected as shown in the diagram:



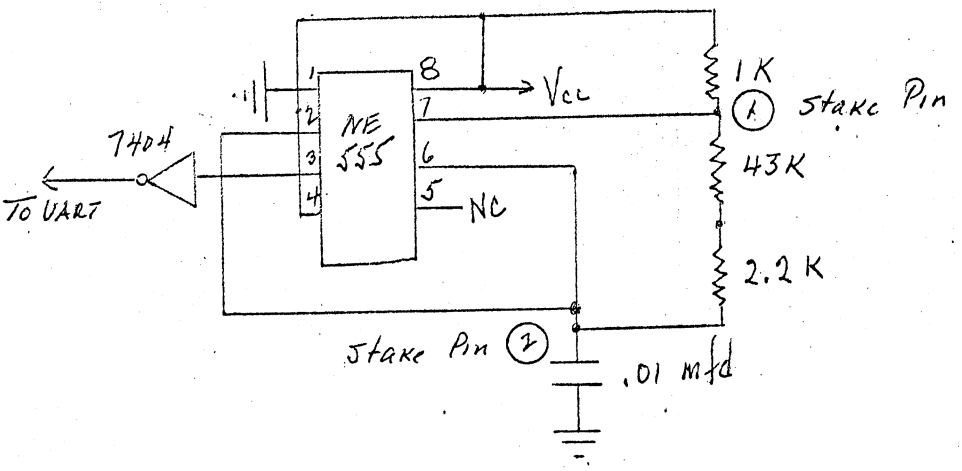
The two input pins to the computer are B21-13 and B21-9, and the two output pins from the computer are B21-6 and B21-2. Yellow Red White Yellow White Red
The four leads are run to the teletype via an Augat interfacing plug. Individual users may, of course, desire to use some other means of connection to the teletype. Make the following connections:

F16-16 to F16-14
F16-14 to F16-12
F16-12 to F16-10
F16-7 to B21-2
F16-5 to B21-9
J20 ~~[redacted]~~ to B21-6

B19-9 to B21-13
D18-25 to J13-11
B19-1 to E17-1
E17-2 to D18-20

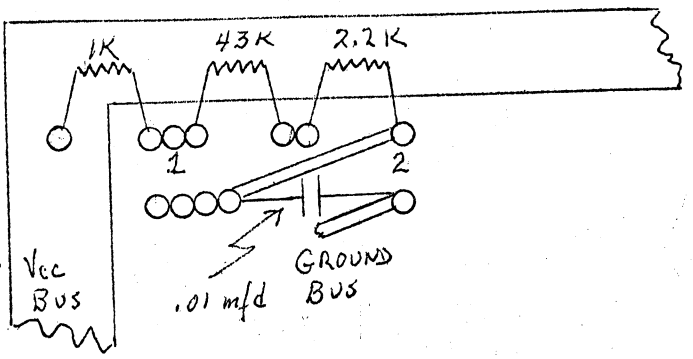
UART Timer:

The UART requires a clock which runs at 1760 Hertz (16 times the baud rate). This frequency is fairly critical and should be adjusted as accurately as possible. The values given below gave a free running frequency which varied between 1759 and 1767 Hertz over a period of three days. However, the resistance values may be ex pected to vary with different capacitors having the same nominal value. The timer circuit is:



The 2.2K resistor is the trimmer resistor. Neither the 43K resistor nor the 2.2 K resistor should be set permanently in place until it has been determined that the desired frequency has been obtained as closely as possible. A trim pot may be used, but the fixed resistors offer the advantages that nobody can twiddle the screw, and that jarring or any other shock will have little effect upon the adjustment.

In the upper left hand corner of the backboard (viewed from the rear) there are a series of pads having the appearance:



The numbers "1" and "2" are directly beneath two stake pins. The three resistors and the .01 mfd capacitor are to be connected as shown. All four components are inserted from the front of the board. The 1K resistor and the .01 mfd capacitor may be soldered permanently in place, but the 43K and 2.2K resistors should be soldered temporarily. Connect:

B20-1 to B20-7
B20-2 to B20-12
B20-4 to B20-14
B20-2 to Stake Pin 2
B20-13 to Stake Pin 1

Place an NE555 in socket B20. This is a 14-pin socket and the NE555 has only 8 pins. Pin 1 of the timer should go into pin 1 of the socket. Then the correspondence between pins is:

Timer	Socket
1	1
2	2
3	3
4	4
5	11
6	12
7	13
8	14

Connect a 5 volt power supply to the board and replace the 2.2K resistor as necessary to bring the timer frequency as close to 1760 Hertz as possible. It may also be necessary to change the 43K resistor because the calculated resistance is 40400 ohms. (See Signetics Application Manual (1974) page 6-79.) A change of 200 ohms will change the frequency about 15 Hertz. After this calibration is completed, solder the two resistors in permanently. Connect:

B20-3 to E17-3
E17-4 to D18-17
D18-17 to D18-40

Corrections to CPU Logic:

Figures 4 through 8 show the changes to be made in the CPU logic. Refer to figure 4. Disconnect:

E13-11 from G16-1

Connect

E13-11 to G18-1
G18-6 to G18-2
K19-5 to G18-4
G18-8 to G18-5
G18-3 to E17-5
E17-6 to G16-1

Refer to Figure 5. Disconnect:

K6-2 from G2-9
G2-6 from G2-10
G2-8 from K5-13

Connect:

K6-2 to G19-1
D18-18 to G19-2
G2-6 to G19-13
G19-12 to K5-13

Refer to Figure 6. Disconnect:
E12-3 from E12-9
E12-6 from E12-10
E12-8 from G1-9

Connect:
E12-3 to G19-3
D18-4 to G19-4
E12-6 to G19-5
G19-6 to G1-9

Refer to Figure 7. Disconnect:
K1-13 from K10-6
K13-5 from K10-6
K13-5 from M14-12

Connect:
K10-6 to M14-12
K1-13 to K13-5
K10-5 to G17-2
G17-4 to G17-3
K18-5 to G17-5
M6-11 to G17-6
G17-1 to K13-5

Refer to Figure 8. Disconnect:
K5-3 from K5-5
K5-5 from K4-5
K6-5 from K5-4
K5-4 from K5-9
K5-6 from M15-11

Connect:
K5-3 to G19-9
G18-4 to G17-8
K6-5 to K5-9
L5-3 to G19-11
G19-8 to M15-11
G17-5 to G19-10
G17-10 to K4-5
E13-1 to G17-9

Additions to CPU Logic. Refer to Figure 1.

Tri-State Output Buffers. Connect:
E9-1 to H16-2
E9-3 to H16-4
E9-5 to H16-6
J2-18 to H16-12
J2-20 to H16-14
J2-22 to H15-2
J2-1 to H15-4
J1-18 toH15-6
J1-20 to H15-10
J1-22 to H15-12
J1-1 to H15-14
H16-11 to D18-33
H16-13 to D18-32
H15-3 to D18-31
H15-5 to D18-30
H15-7 to D18-29
H15-9 to D18-28
H15-11 to D18-27
H15-13 to D18-26
E9-9 to H16-10

D18-23 to H16-1
H16-1 to H16-15
H16-15 to H15-1
H15-1 to H15-15

To generate IOP1, IOP2 and IOP4. Connect:
G1-2 to G20-1
G4-9 to G20-3
E13-2 to G20-9
G17-8 to G20-2
G20-2 to G20-4
G20-4 to G20-10
K19-1 to G20-13
K12-1 to G20-5
E12-5 to G20-11

Device Address Buffer. Connect:
G14-1 to E18-1
E11-4 to E18-3
E12-2 to E18-5
E12-12 to E18-9
M12-11 to E18-11
M12-12 to E18-13

Interrupts. Disconnect E5-12 from E5-7. Interrupt was grounded to prevent its acting. Connect:
E12-8 to E5-12
E10-4 to E12-9
G12-4 to E12-10

Printer Control. Refer to Figure 2. DM 7160's are 6-bit comparators with open collector outputs. They require a pull-up resistor at pin 9. The two 1K resistors on the adaptor plug at F16 are for this purpose.

Printer Control Address. Connect:
E18-2 to F14-14
E18-4 to F14-12
E18-6 to F14-10
E18-8 to F14-5
E18-10 to F14-3
E18-12 to F14-1
F14-2 to F14-4
F14-4 to F14-6
F14-6 to F14-15
F14-15 to F14-16
F14-11 to F14-7
F14-7 to F14-8
F14-9 to F16-1

Control Signals for Printer Control. Connect:
G20-12 to E17-9
G20-6 to E17-11
G20-8 to E17-13
E17-10 to E19-2
F16-1 to E19-1
E17-12 to E19-5
E19-1 to E19-4

Add
E19-10 to E19-2

E19-3 to E20-1
E19-6 to D18-23
D18-22 to E20-3
E20-4 to E20-2
E20-2 to E20-14
E20-5 to E10-3
E19-4 to E21-1
E17-8 to E21-2
E21-13 to E20-5
E21-12 to G18-9

Keyboard Control.

Connect Comparator for Keyboard Control Address. Connect:

Add
F14-13 to Vcc

F14-1 to F15-1
F14-3 to F15-3
F14-5 to F15-5
F14-10 to F15-10
F14-12 to F15-12
F14-14 to F15-14
F15-15 to F15-13
F15-13 to F15-8
F15-11 to F15-6
F15-6 to F15-4
F15-4 to F15-2
F15-2 to F15-16
F15-7 to F15-8
F15-9 to F16-3

Connect various control signals for Keyboard Control. Connect:

F16-3 to E19-9
E19-8 to D18-18
E19-9 to E19-12
E19-5 to E19-13
E19-11 to D18-4
G20-5 to G17-12
E17-9 to G17-11
G17-13 to E21-5
E19-12 to E21-4
D18-19 to E21-3
E21-6 to G18-10
E21-3 to G12-3

Connect incoming data from UART to MUX's. Note that the 4 most significant bits are to be grounded since transmission to and from the teletype is by bytes. Connect:

H12-15 to H12-7
H11-15 to H11-7
H10-15 to H10-7
H9-15 to H9-7
D18-5 to H8-15
D18-6 to H7-15
D18-7 to H6-15
D18-8 To H5-15
D18-9 to H4-15
D18-10 to H3-15
D18-11 to H2-15
D18-12 to H1-15

Finish control details in UART. Connect -12v power supply to D18-2. Pins 13 (PE), 14 (FE), 15 (OR), 24 EOC and 39 (EPS) may be left floating. The following pins must be grounded:

16	SWE	Status Word Enable. This places the status word bits (PE, FE, OR, DA, TBMT) onto the output lines.
21	XR	External Reset. Resets all registers. Sets SO, EOC and TBMT to a logical "1".

The following pins should be tied to Vcc:

34	CS	Control Strobe. A logical "1" will enter the control bits (EPS, NB1, NB2, TSB, NP) into the control bits holding regiater.
35	NP	No Parity. A logical "1" will eliminate the parity bit from the transmitted and received character.
36	TSB	Number of Stop Bits. A logical "1" selects two stop bits. A logical "0" selects one stop bit.
37, 38	NB2 NB1	Number of Bits/Character. A "11" selects 8 bits.

Grounded Wires on UART

D18-16 to B19-8
D18-21 to B19-8

Vcc'd wires on Uart

D18-34 to D18-35
D18-35 to D18-36
D18-36 to D18-37
[illegible]
D18-38 to E20-14

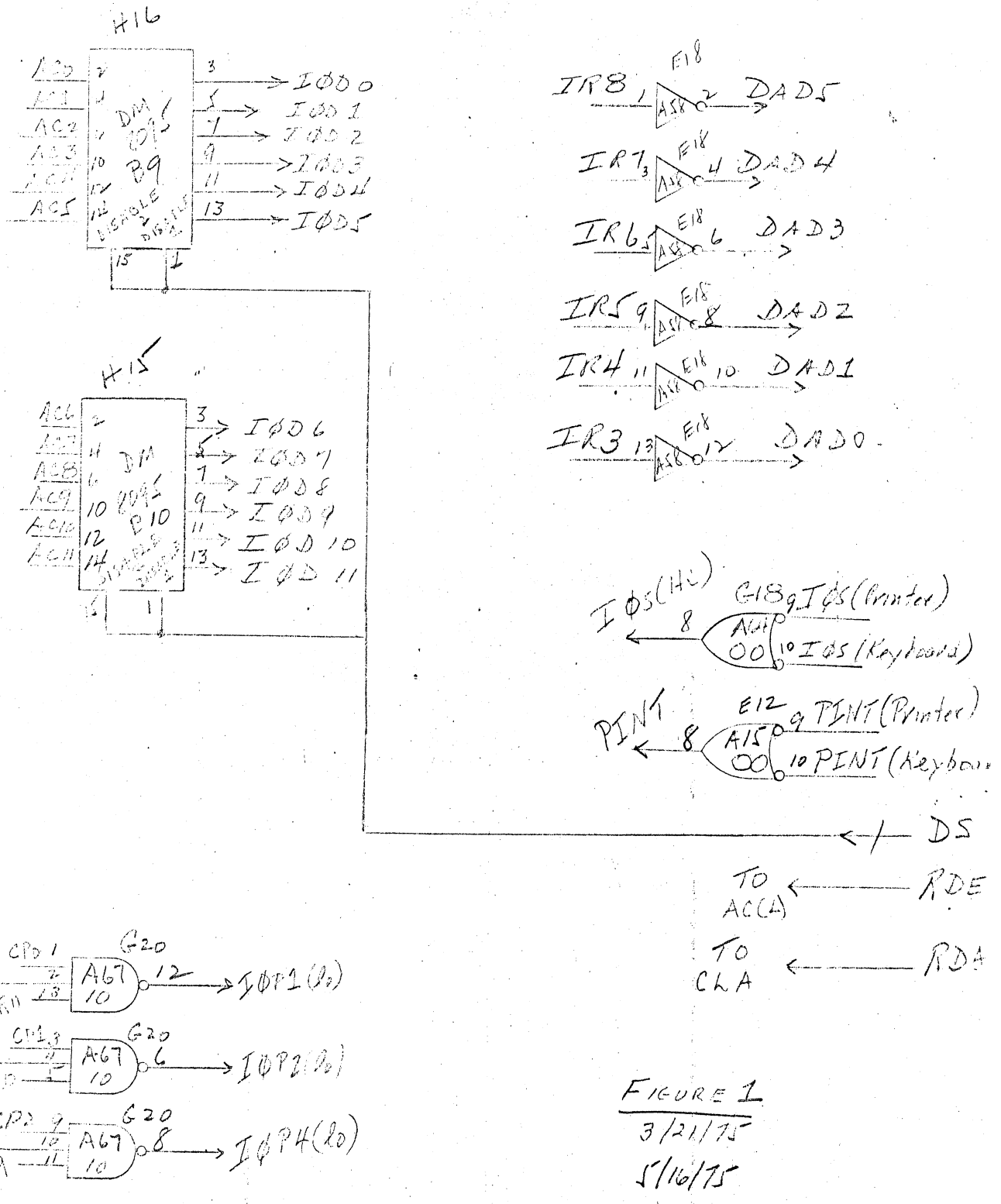


FIGURE 1

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5/16/75

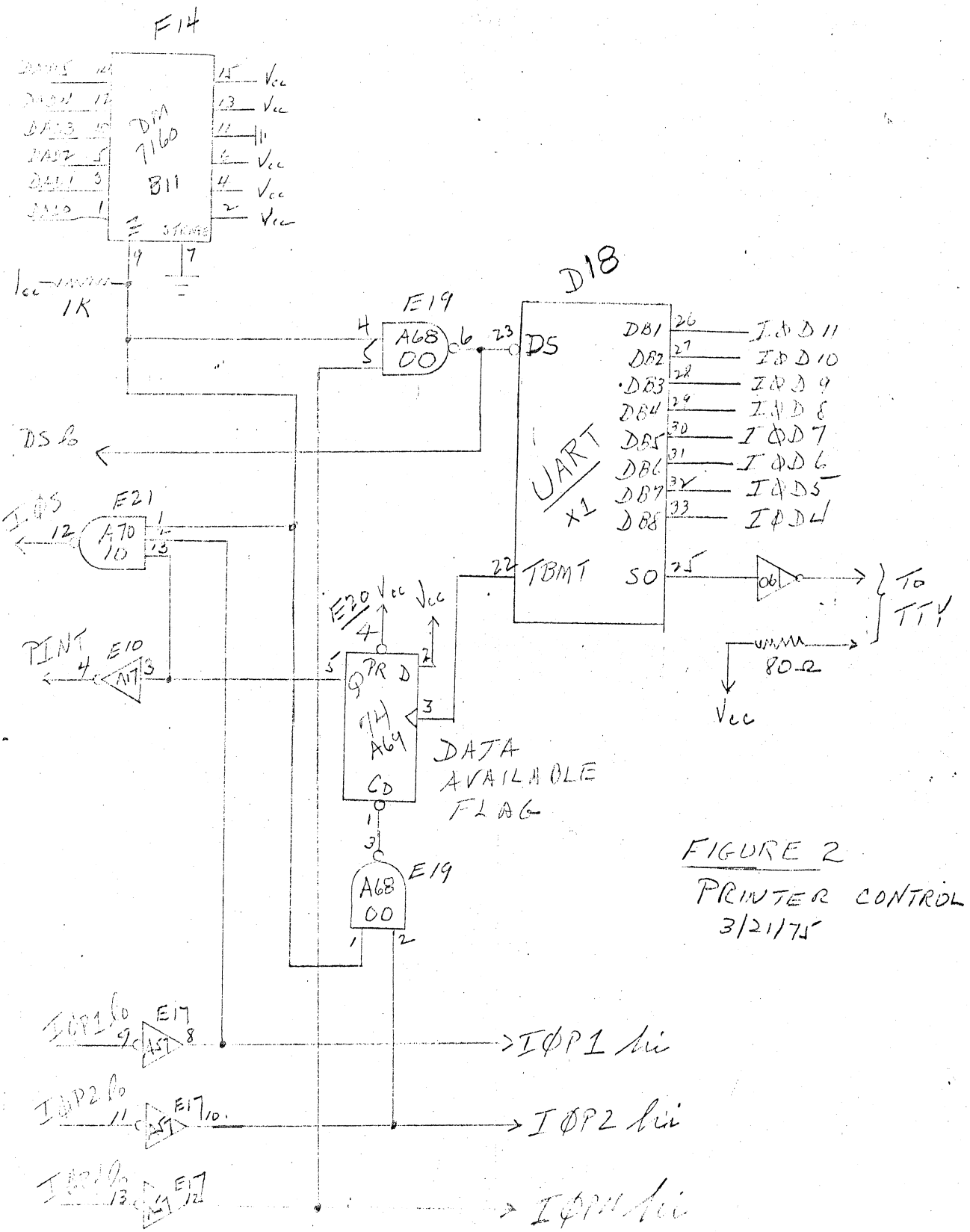

FIGURE 2
PRINTER CONTROL
3/21/75

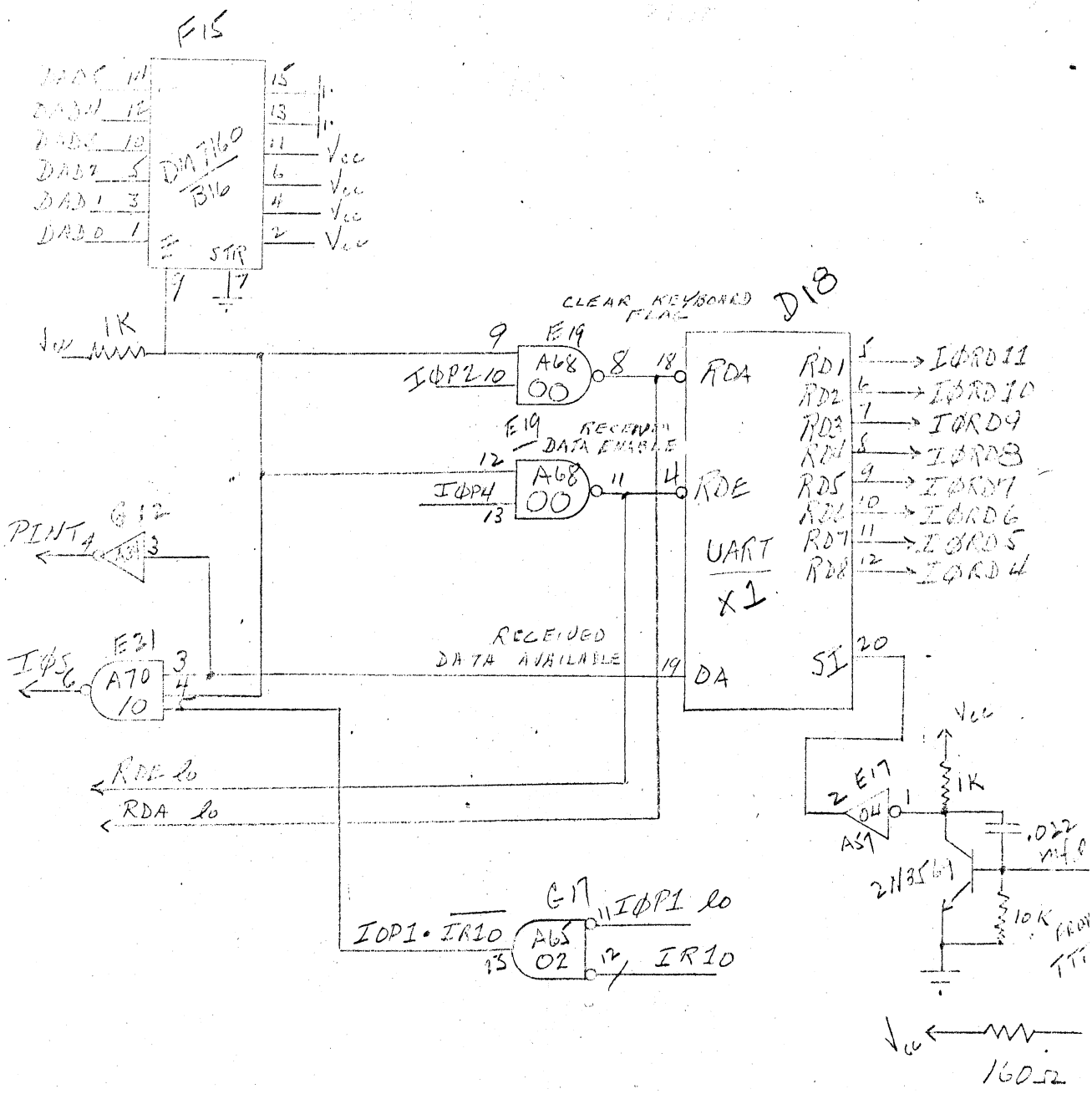

FIGURE 3
KEYBOARD
CONTROL
3/23/75

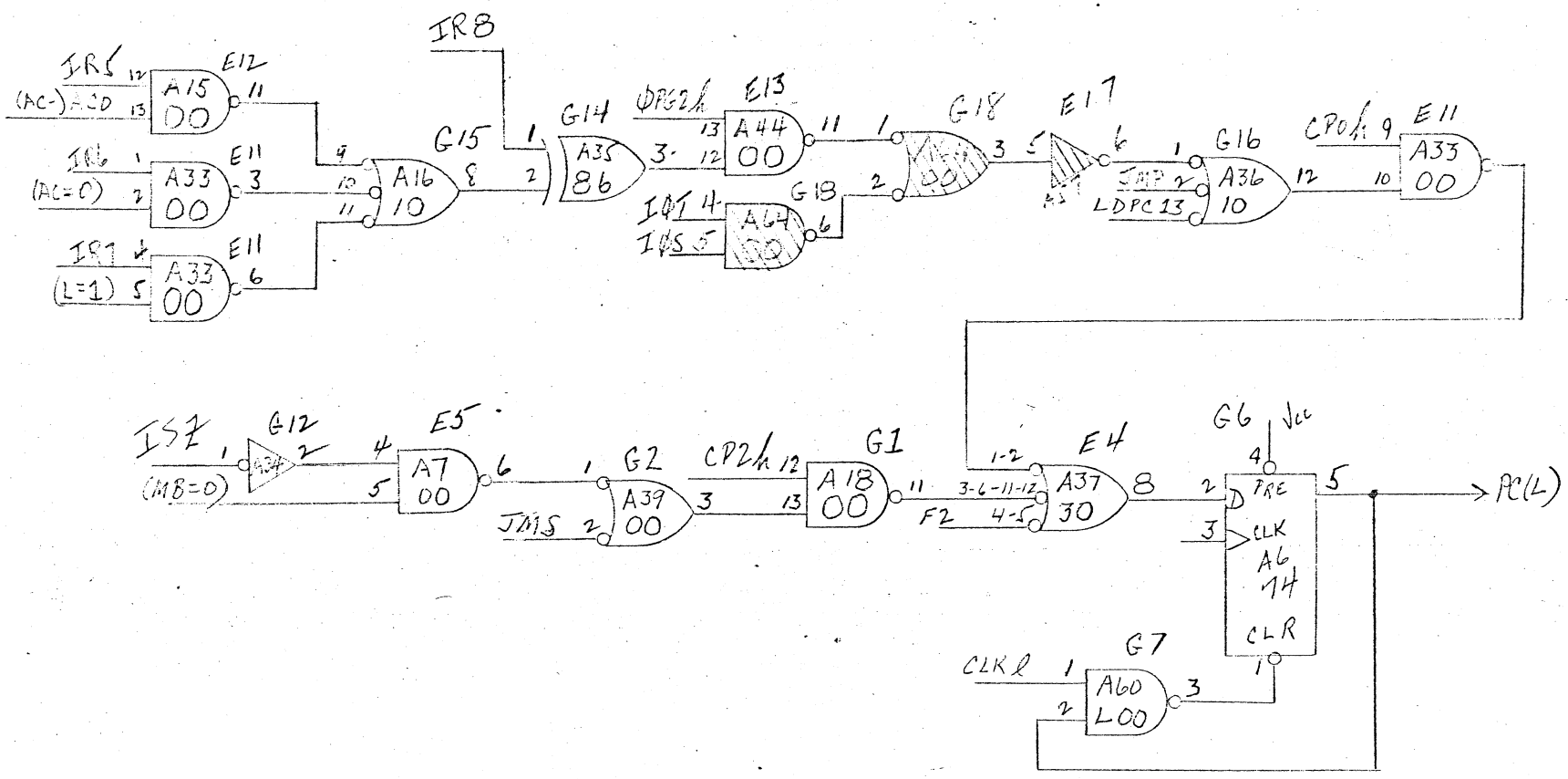

FIGURE 4

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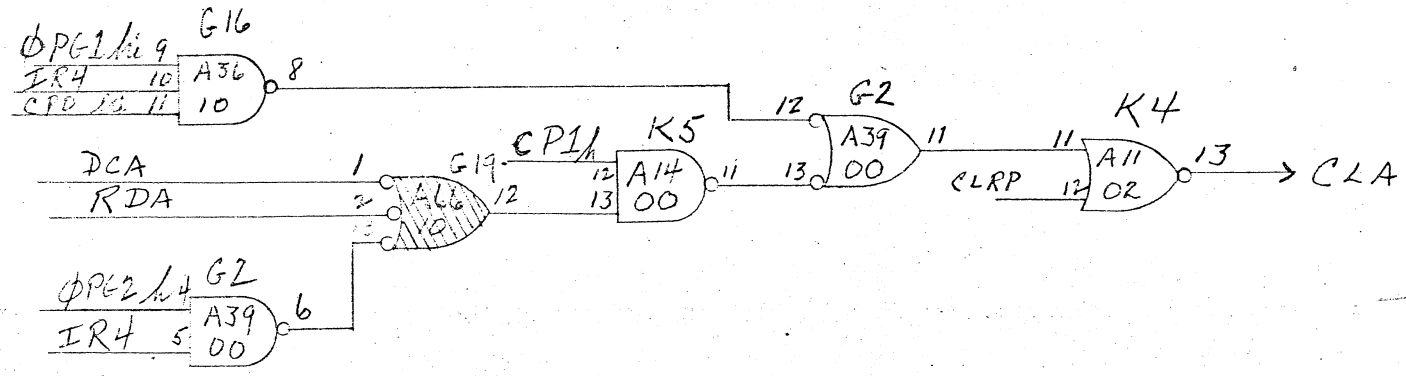

FIGURE 5

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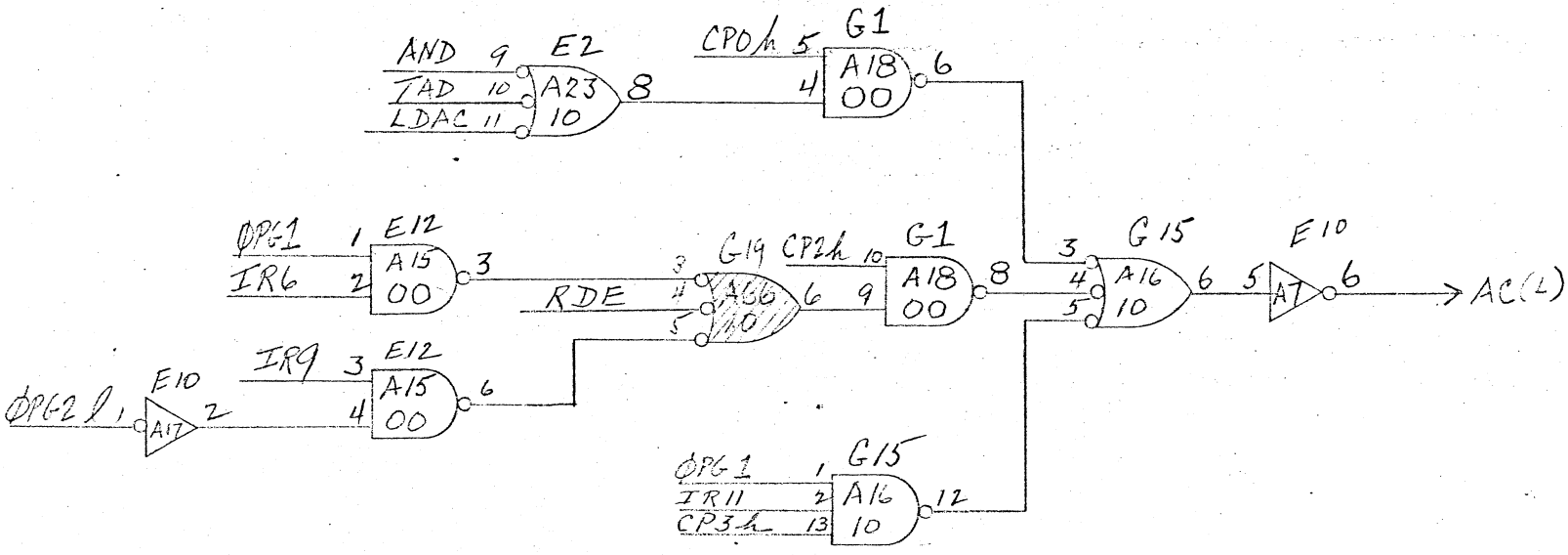


FIGURE 6
3/25/75

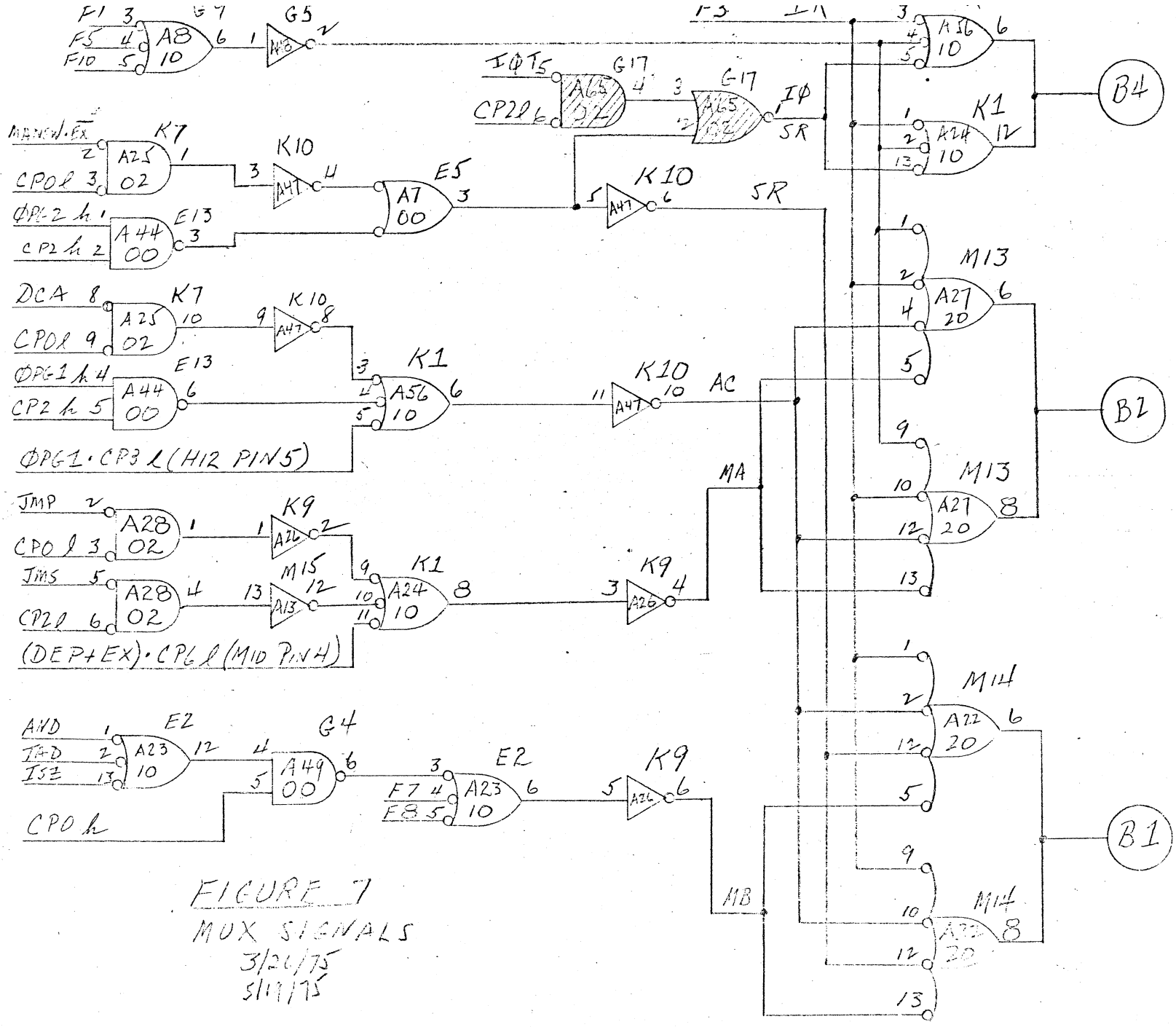


FIGURE 7

MUX SIGNALS

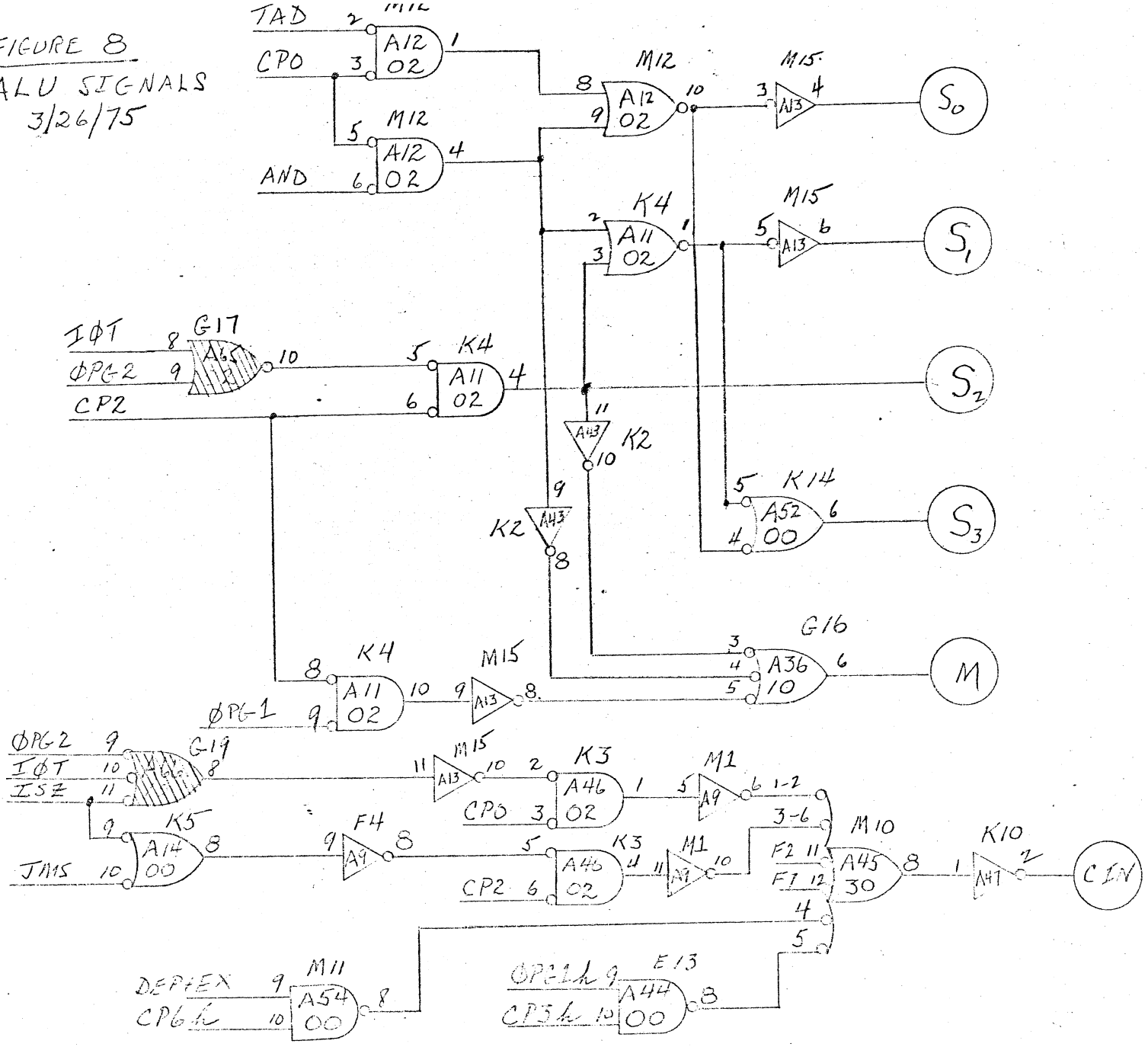
3/26/75

5/19/75

FIGURE 8

ALU SIGNALS

3/26/75



Paper Tape Reader Control for the LD14

This article contains the theory behind reader control and a reader control interface. This interface is designed only for the ASR 33 series teletypes and assumes that the teletype interface given in "A Teletype Interface for the LD14" has been completed. The reader control interface modifies the teletype. Therefore, it is important that all of this article be fully understood before the interface is built. It may be beneficial to procure the manufacturer's documentation for the teletype. A parts list is at the end of this article.

Paper tape reader control is needed when a program can't process data as fast as it is being read. This situation causes numerous aggravating errors. The solution to the problem is to use reader control which lets the reading occur under program control. In this manner data will be read only as fast as it can be processed.

Higher level languages such as FOCAL, LISP, and BASIC often require reader control. This is due to the fact that they must read a statement, recognize it, check for errors, and then create the corresponding set of machine instructions. As an example of this, think of the statement "FOR I=1 TO 7". Only twelve characters are read but much computation is done to generate the equivalent machine instructions. If the translation of the statements is slower than the reading, numerous errors develop. The result of this is that a program may be entered from the keyboard, edited, and then stored on paper tape. However if reader control is not used, it will be impossible to reload the program from the paper tape.

Disassemblers have a similar problem. They must read a machine instruction form the paper tape and then list the instruction and its mnemonic. This means that for every instruction that is read, on the average twelve characters will be printed. For example if a 5400 is read then the listing is 5400 JMP I 000. If reader control is not used when an instruction is read, while the twelve characters are being printed, twelve more frames (equals six instructions) will be read and disregarded.

It is necessary to describe the normal teletype reader operation before describing the reader control interface. Listed below are the steps involved in reading.

1. Reading is initiated, which causes the Dristributor Clutch Trip Coil (hereafter referred to as the Trip Coil) to be energized.
2. This causes the tape reader Trip Lever to be released.
3. This engages the Distributor Clutch and also energizes the tape reader feed magnet.
4. During the next revolution of the Distributor, one frame (row) of the paper tape will be read, the tape advanced one frame, and the data will be transmitted in serial form.
5. If the Trip Coil is still energized at the end of the Distributor revolution, the process is repeated.
6. Reading is stopped by shutting off the current flow in the Trip Coil circuit.

The initiation of the read depends upon the type of paper tape reader being used. (Refer to the schematics for normal reader operation of the manual and automatic readers. The schematics are at the end of this article.) The manual readers have a three position control: ON, OFF, and [illegible]. The read is started by putting the control lever in the ON position. This closes a switch which causes current to flow through the Trip Coil circuit. The automatic readers have a four position control: MANUAL START, AUTO, MANUAL STOP, and [illegible]. When the control lever is put in the MANUAL START position, a switch is momentarily closed. This switch closure allows a relay to be energized. This relay is found only in the automatic readers, has two contacts, and is called the TD relay.

The first contact closes a circuit which keeps the relay energized. The second contact closes the Trip Coil circuit.

Reader control is accomplished by the addition of another relay named the Reader Control Relay. This relay is placed in series with the Trip Coil. When this relay is opened, reading will stop. The energizing of this relay is controlled by the logic on the LD14 backpanel. At the end of this article is a schematic showing how the relay is placed in the Trip Coil circuit.

There are two important components in this modification. They are a two position toggle switch and a diode. The toggle switch, named the Reader Control Switch, is used to select either reader control operation, or normal operation. This allows the teletype to be used normally with other devices and also in the LOCAL mode. The diode is placed across the Reader Control Relay's coil to prevent backwards power surges. All the energy that is stored up in the coil while the control transistor is on is released when the transistor is shut off. This creates a current surge that flows backwards through the transistor if the diode is not used. It is important to avoid the current surge since it can burn up the transistor, or create voltage fluctuations. These voltage fluctuations can cause two frames to be read at a time or else cause data in the registers to be destroyed.

The control logic, which is also found at the end of this article, must recognize the conditions for starting and stopping the reading process. (Refer to "A Teletype Interface for the LD14" for information concerning the signals DR, INTKEYBL, SI, and UARTCLK.) A character should be read when the Data Recieved flag (DR) is cleared. The reading must stop when the start bit of the next character is detected. At this time the Reader Control Relay should be deenergized which will break the Trip Coil circuit and cause the Trip Coil to be deenergized. This causes the paper tape reader to stop after reading one frame.

It is important that the test is made on the start bit and not DR. If the test is done on DR, which indicates that a character has been recieved, the Distributor will have started a second revolution by the time DR is true. When DR comes true, the Trip Coil will be deenergized, and the distributor will stop at the end of the second revolution. In short, two frames will have been read. By testing on the start bit the problem is eliminated. The start bit is created early enough to allow the Distributor to be stopped at the end of the first revolution. A further reason for using the start bit is that it is common to all transmitted data.

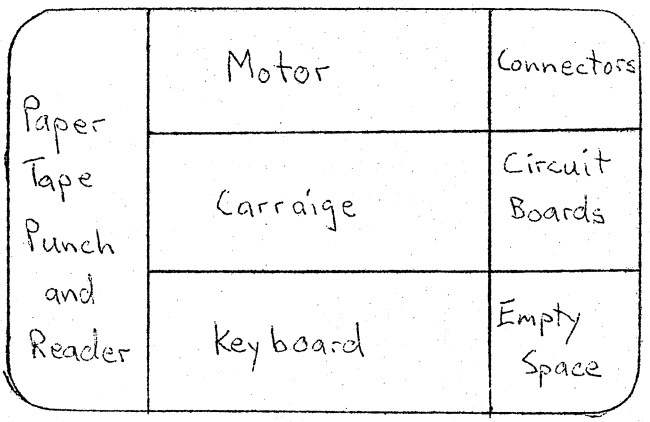
The flip flop is set by the start bit. (Remember that the start bit is a low voltage and will be detected by the flip flop.) The output of the flip flop is STOPRDR which indicates that the reading should stop. This flip flop is clocked by the UARTCLK because this clock runs fast enough that the start bit will be detected and cause the flip flop to be set. If the system had a fixed fast speed clock, it could be used instead of the UARTCLK. Since the LD14 clock is variable it can't be used.

INTKEYBL (equals DRL) is used to asynchronously clear the flip flop. This causes STOPRDR to become false in preparation for the next read. However since DR is true when INTKEYBL is true, the signal TAPRDR will not be generated until the DR flag is cleared. When the computer is initially turned on, it may be necessary to send one character from the keyboard to initialize the STOPRDR and DR flip flops.

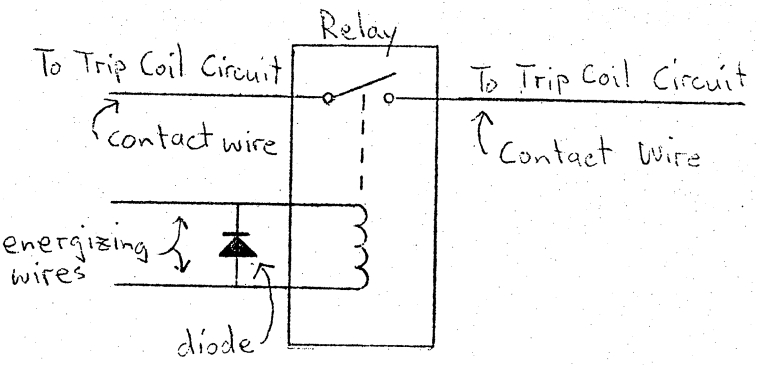
It would appear that the asynchronous clear of the STOPRDR flip flop could be avoided by using the DR as an input for pin two. This doesn't work when the program instructions are: 6036 KRB clear flag, read character
6032 KCC clear flag
The DR signal can be true for such a short time that the flip flop, which is clocked by UARTCLK, won't detect it. (Note: The INTERSIL uart clock, which runs at 3.5 MGHZ, is fast enough to avoid the problem, but the circuit has not been changed due to the fact that some customers are using a -12 volt uart which has a 1760 HZ uart clock.)

Teletype Modifications

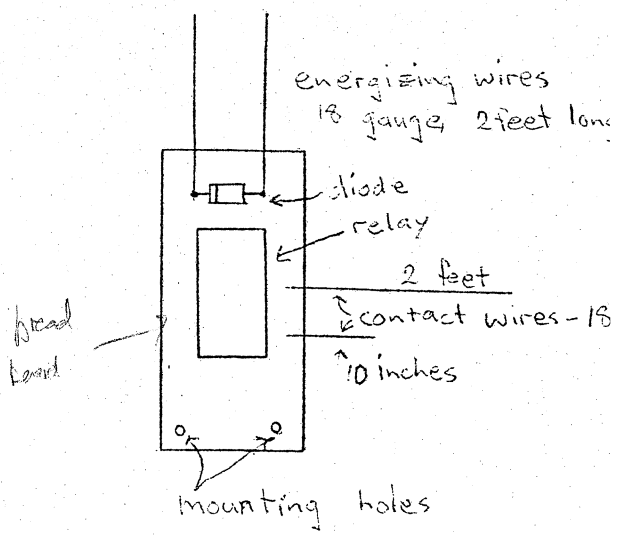
1. Refer to the schematic for the modification which is located at the end of this article.
2. Unplug the teletype and remove its cover.
3. Locate the connectors which are on the left side as you face the teletype back.
4. Locate the jack J6 connected to plug P6.
5. Locate the blue wire at J6-14. (The number 14 is marked faintly by one of the wires.) If the wire color does not agree, do not proceed with this modification unless the connection can be verified to agree with those of the schematic for normal teletype operation for the proper reader. CORRECTION: J6-14 IS BLUE ONLY FOR THE AUTO READERS. MANUAL READERS HAVE A GREEN WIRE. IF YOU HAVE A MANUAL READER, SUBSTITUE "GREEN" FOR "BLUE" IN THE FOLLOWING PAGES.
6. It is best to mount the relay and the diode on a piece of bread board (available at electronic stores) and then mount this inside the teletype.
7. It is necessary to drill a hole in the teleype chassis at some convenient spot and mount the Reader Control Switch there.



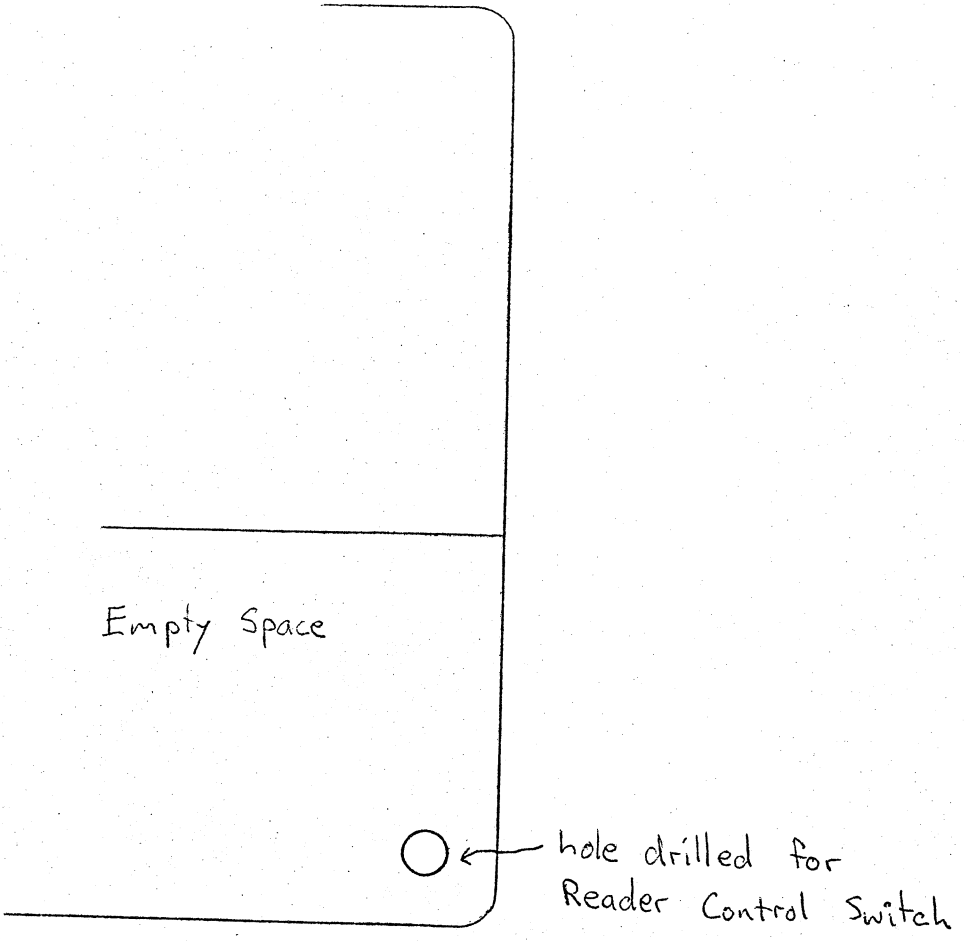
Top View - General Organization (cover removed)



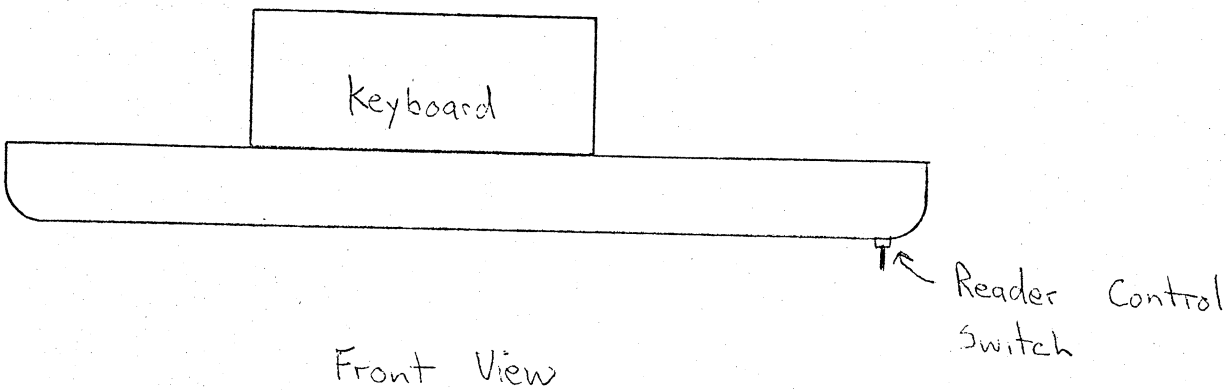
Relay Schematic



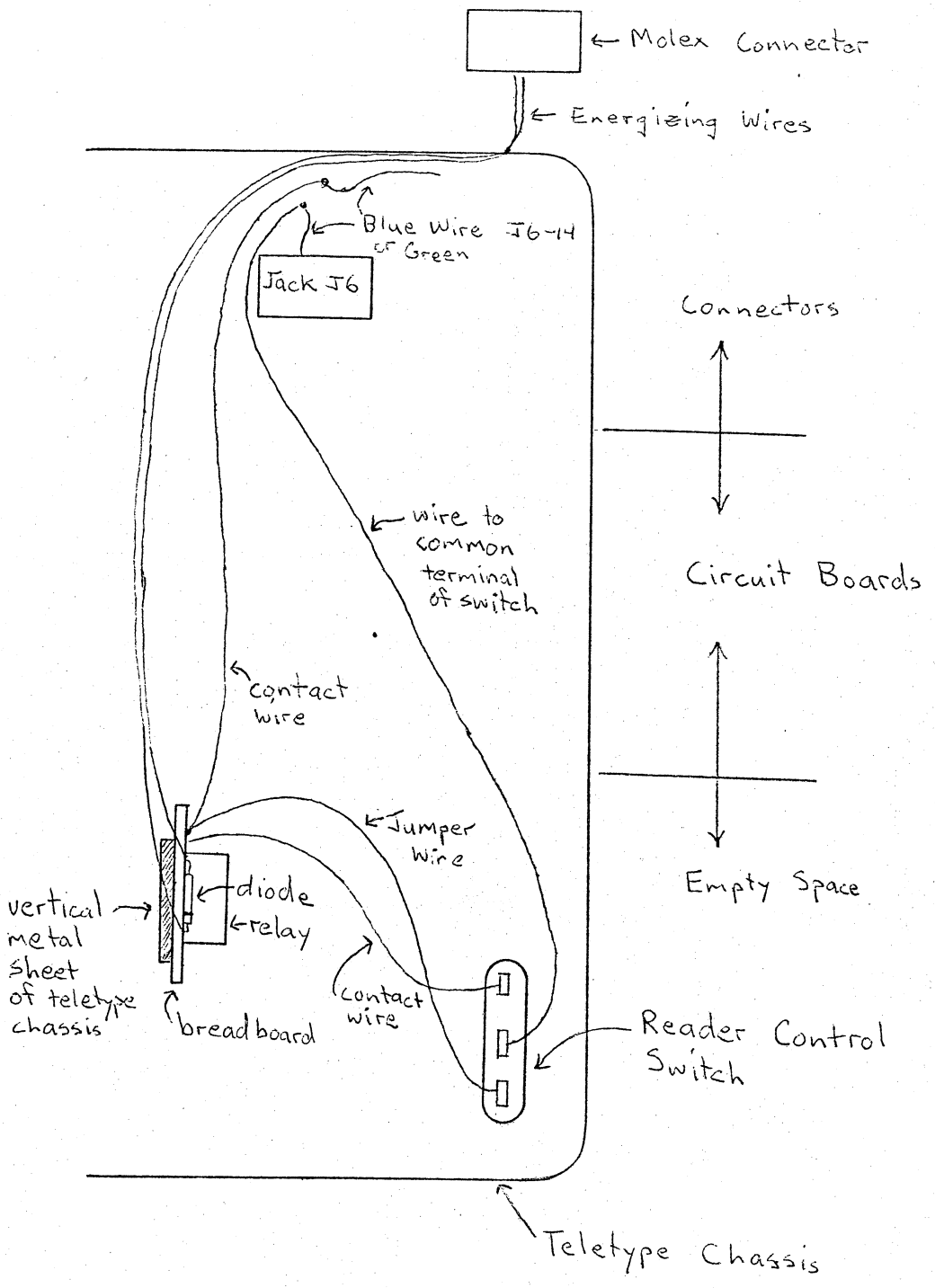
Physical Layout



Top View



Front View



Top View

Note: For the wire J6-14, it will be blue in an automatic reader and in a manual reader it will be green.

Reader Control Relay Connections

1. Locate the blue wire at connector J6-14. If the wire color doesn't agree, don't proceed with this modification unless the connection can be verified to agree with those of the schematic for normal teletype operation for the proper reader. CORRECTION: J6-14 WILL BE GREEN FOR MANUAL READERS; BLUE FOR AUTO RDR
2. Cut the blue wire at J6-14, 1 to 2 inches away from the jack.
3. Splice and solder a 2 foot wire to the piece of blue wire remaining in the jack. Insulate the connection with electrical tape.
4. The free end of the 2 foot wire will be soldered to the common tap of the Reader Control Switch. This wire should have a length longer than is needed. The wire may be shortened before it is soldered to the switch.
5. Splice and solder the free end of the cut blue wire to one of the Reader Control Relay contact wires. Insulate the connection with electrical tape.
6. Solder the other Reader Control Relay contact wire to the Reader Control Switch such that there is a connection between the contact wire and the common pin when the switch is in the on position.
7. Solder a wire from the remaining switch terminal to the contact wire that is spliced to the cut blue wire. This wire should run from the relay board to the switch.

Testing the Relay Connections

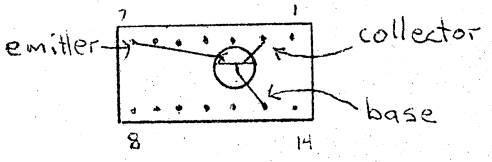
The relay should have been installed so that when it is not energized, the contacts are open and the Trip Coil circuit is broken. To test this:

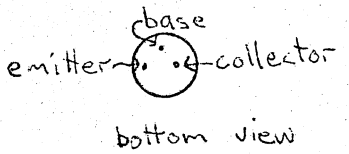
1. Put the teletype in the LOCAL mode.
2. Put the Reader Control Switch in the ON position.
3. Put paper tape in the reader. Start the reader. The reader should not run.
4. Put the Reader Control Switch in the OFF position. The reader should read.

Control Logic

Refer to the logic diagram at the end of this article. All socket locations and wire listings are in external notation.

1. The reader control transistor should be mounted on a 14 pin adapter board as shown. This is inserted in socket E19.

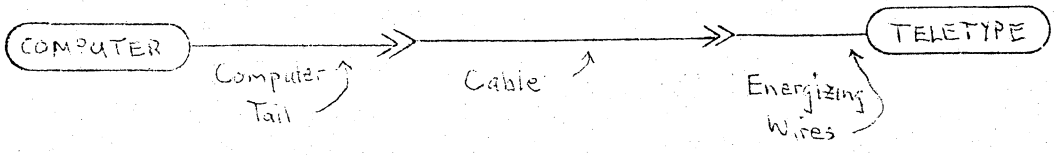




2. An SN74LS109 should be placed in location L17.
3. Make these connections.

SIGNAL	FROM	TO
DR	C20-11	E7-11
FRDRELAY	B21-14	-----
INHIBYBI	C6-10	L17-5
SI	D18-20	L17-3
STOPRDR	L17-7	E7-12
TAPRDR	E7-13	E9-13
TORELAY	E19-2	B21-1
UARTCLK	D18-40	L17-4
(11)-B58	L17-16	L17-1
(10)-B58	L17-9	L17-2

4. Interface Plug -- Short wires should be soldered to B21-1 and B21-14 (signals TORELAY and FRMRELAY). These should terminate in a molex connector. The energizing wires of the Reader Control Relay should also terminate in a molex connector. Then a cable may be used to connect the computer to the teletype.



This cable could be part of the teletype interface cable if that cable has 6 or more wires and the connectors have 6 or more pins. (Refer to "A Teletype Interface for the LD14".) It is important that the cable connection is such that ERMRELAY is connected to the Reader Control Relay energizing wire that is connected to the cathode of the diode (the diode side that has the band).

Reader Operation

1. Upon turning the computer on, it may be necessary to send a character from the teletype to initialize the STOPRDR and DR flip flops.
2. Put Reader Control ON.
3. Put the control lever on ON or MANUAL START. The reader shouldn't read at this point. (For automatic readers, a click should be heard as the TDC relay energizes.)
4. Start the program.

Some notes. It is faster to load programs without reader control. The mechanical delay in the Reader Control Relay slows things down. By loading, I mean loading done with binary tapes using the RIM or BIN loaders. These are Digital Equipment Corporation loaders. When loading a program written in a language such as BASIC, reader control is probably necessary.
When programming for the LD14 just remember that a character will be read only when the DR flag is cleared. A 6032 and 6036 will read a character. A 6034 and a 6036 will load the accumulator with the character.

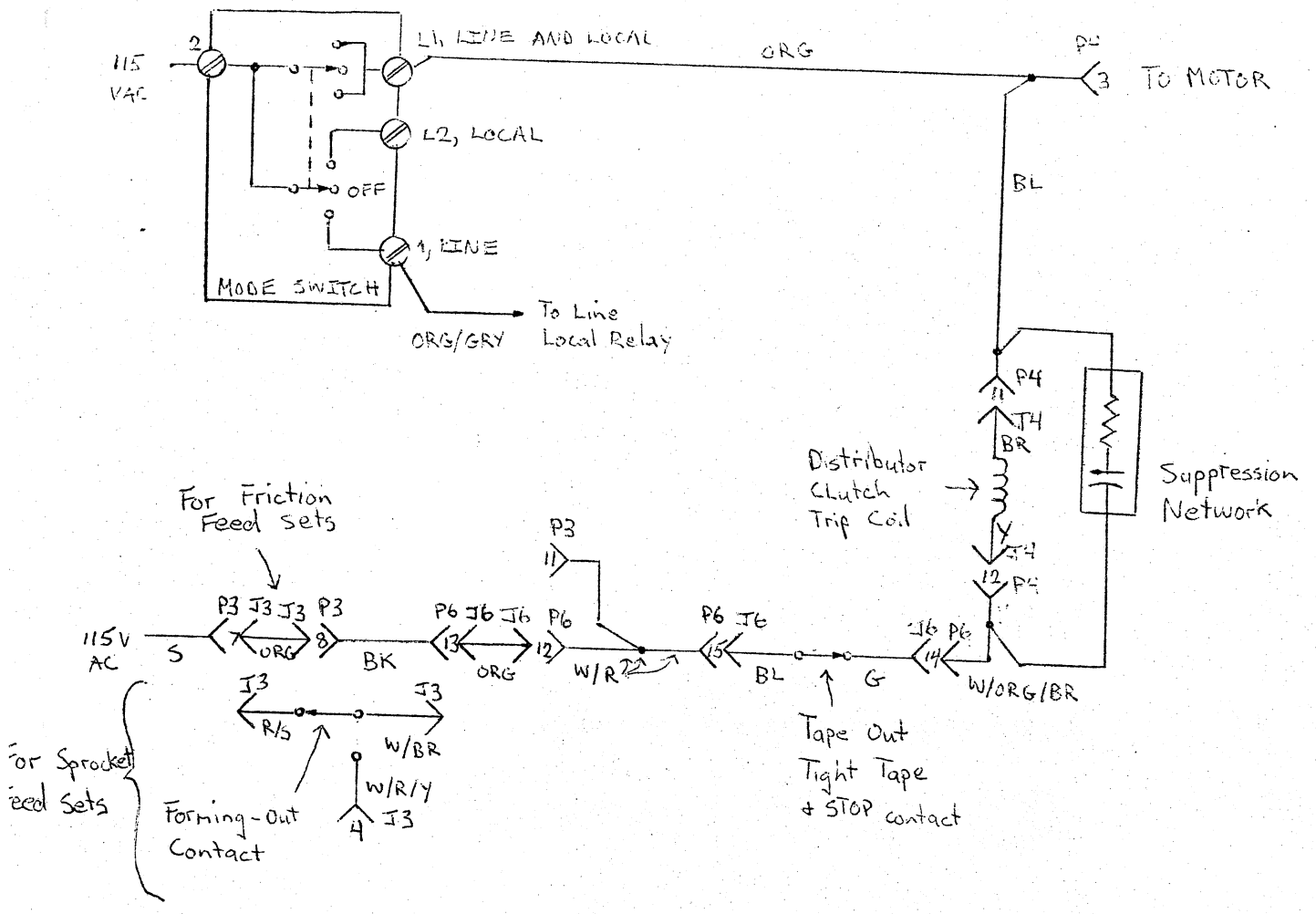
Testing Reader Control

Three tests exist. They are:

1. The test given under the heading "Testing the Relay Connections".
2. A simple echo test. (Refer to "A Teletype Interface for the LD14".) In the LOCAL mode, punch a test tape such as, "Now is the time for all good men to come to the aid of their country." Now put the teletype on LINE and echo the test tape to the printer. Put reader control on. To test the reader control, vary the clock speed. The reading of the tape should vary with the clock speed.
3. Create a test tape as mentioned in the above test. Put reader control on. Load and execute the following program. The starting address is 0000.

LOCATION	INSTRUCTION	MNEMONIC
0000	6032	KCC
0001	6031	KSF
0002	5201	JMP 1
0003	6034	KRS
0004	3215	DCA 15
0005	7001	IAC
0006	7440	SZA
0007	5202	JMP 5
0010	1215	TAD 15
0011	6046	TLS
0012	6041	TSF
0013	5212	JMP 12
0014	5200	JMP 0

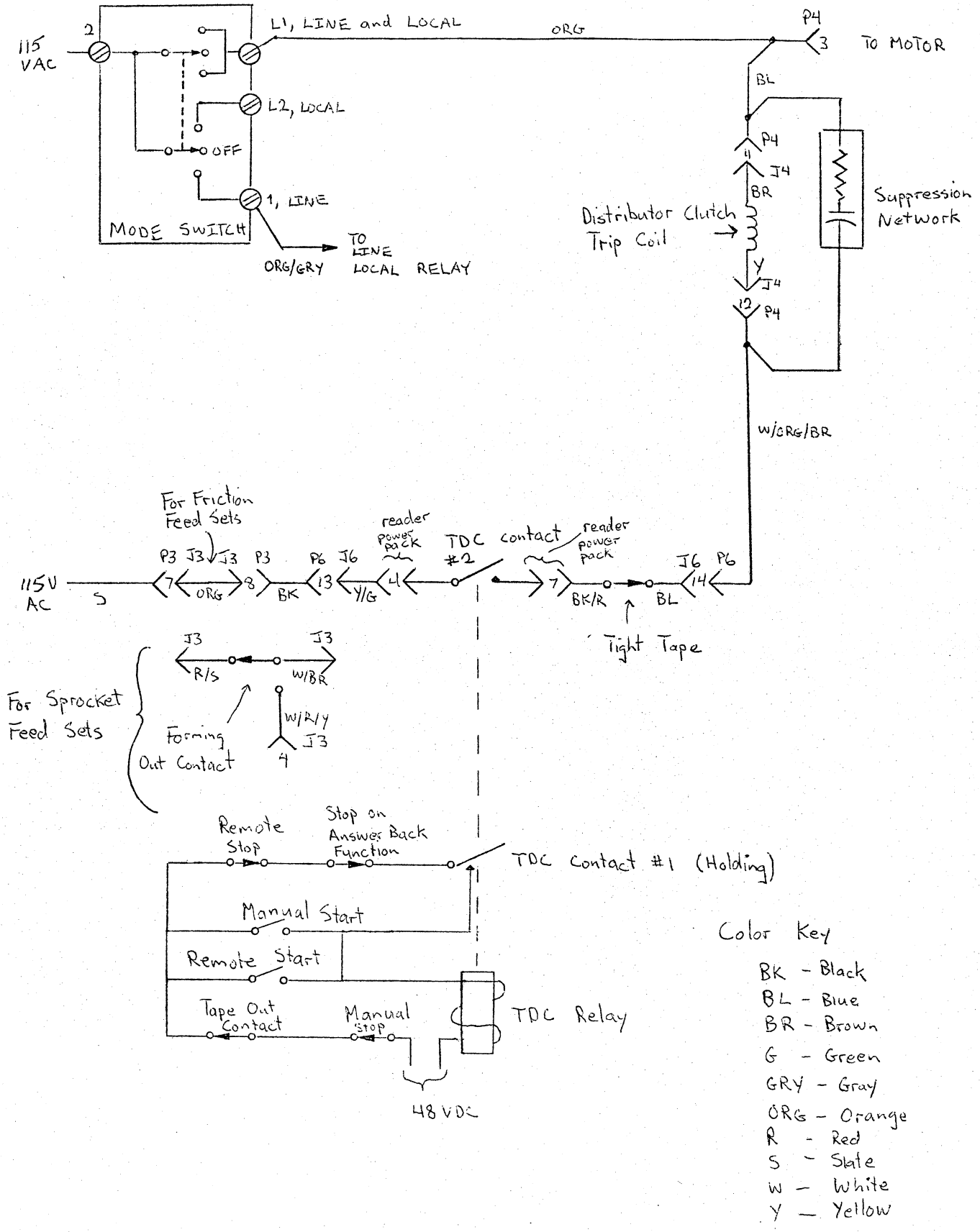
Normal Circuit - Manual Reader



Color Key

BK - Black
BL - Blue
BR - Brown
GRY - Green Gray
ORG - Orange
R - Red
S - Slate
W - White
Y - Yellow

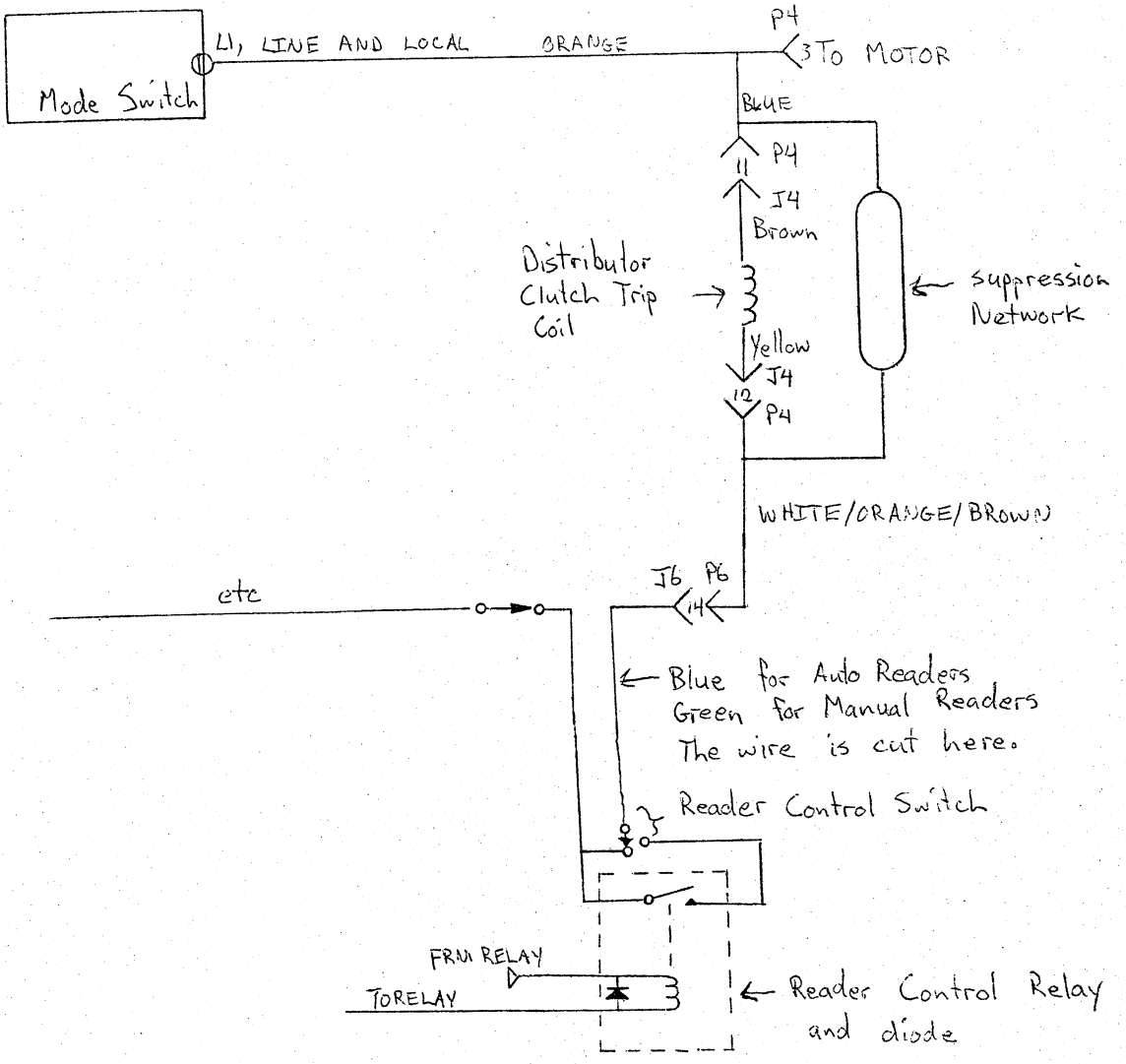
Normal Circuit - Auto Reader



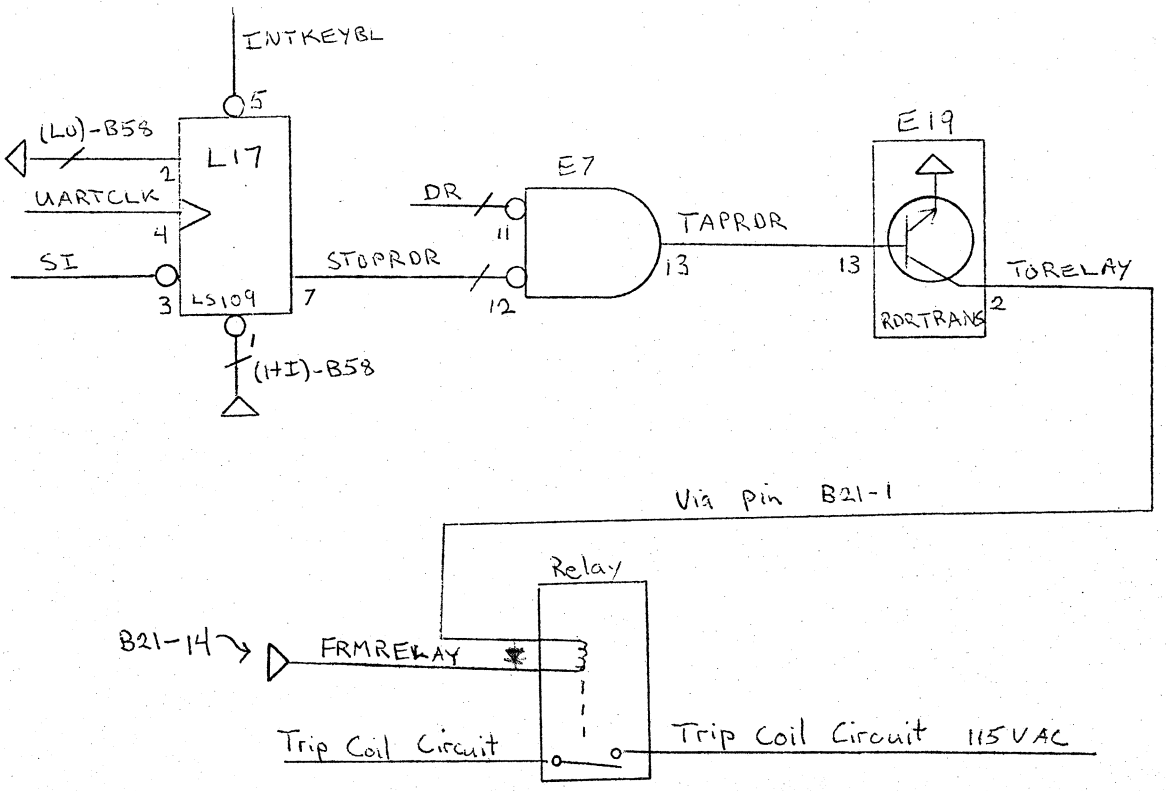
Color Key

BK - Black
BL - Blue
BR - Brown
G - Green
GRY - Gray
ORG - Orange
R - Red
S - Slate
W - White
Y - Yellow

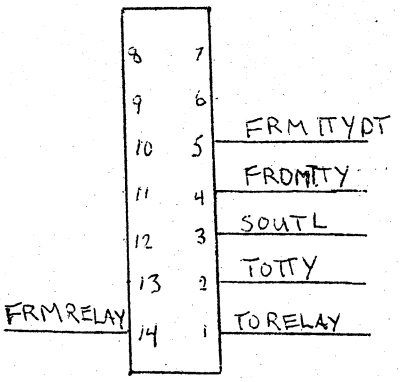
Modified Trip Coil Circuit



CONTROL LOGIC



B21 - ALL Output signals



For your computer - pin

PARTS FOR PAPER TAPE READER CONTROL

Chip Type	Quantity	Number of pins
SN74LS109	1	16

Transistor Circuit Requires

1	14 pin socket
1	Adapter, Wiring Board — 14 pin, molded (Robinson-Nugent manufactures these — type MPB-143)
1	2N3569 Switching Transistor

Interface Requires

1	Relay: Switching Voltage 5-6 Volts DC Current Rating 125 ma (Radio Shack sells a relay that will suffice) Must Switch 115V AC

The above items require

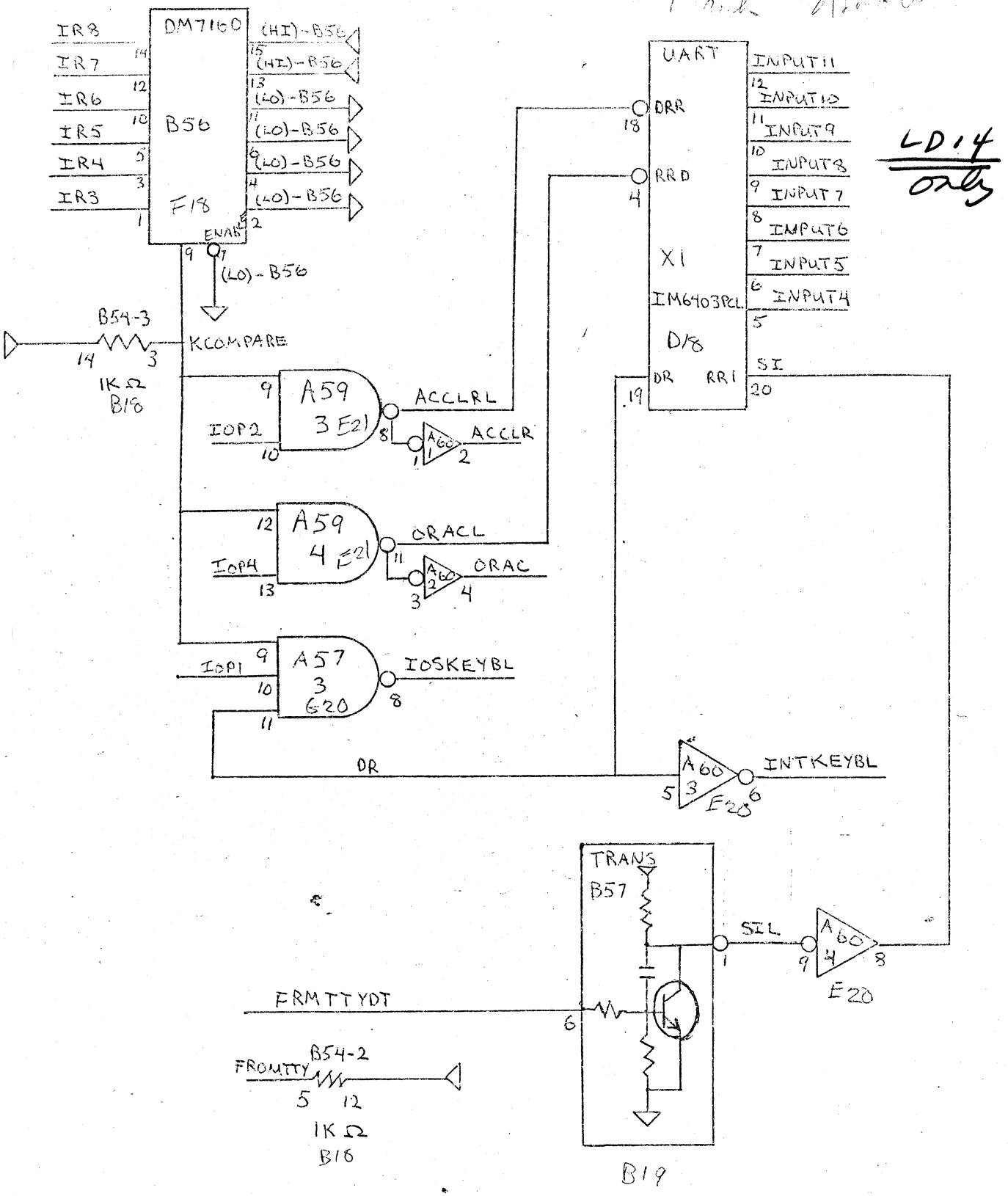
1	14 pin socket	These sockets are supplied with the backpanel.
1	16 pin socket	

1 1N4007 Diode or equivalent

Keyboard Interface

Mark Nimke

LD14 only

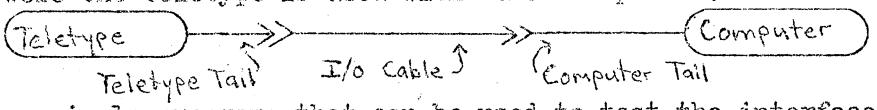


MARK ARNOLD LD14

3. The following connections must be made.

Signals		Computer-- Int	-- Ext	P2 connector pins
TOTTY	solder cable to front side (not wirewrap side) of INT A62 - EXT B21	A62-2	B21-2	8
SOUTL		A62-3	B21-3	7
FROMTTY		A62-4	B21-4	5
FRMTTYIDF		A62-5	B21-5	6

4. As long as these connections are made, the I/O cable can have any configuration. We prefer to have the following cables because it permits flexibility in component placement and teletype usage. This applies primarily to situations were the teletype is used with other computers.



TEST PROGRAMS

Here are some very simple programs that can be used to test the interfaces.

Print one character

This program is useful for testing the teleprinter interface.

Octal Location	Contents	Mnemonic
0000	6044	TPC
0001	1020	TAD 20
0002	6041	TSF
0003	5002	JMP 2
0004	6046	TLS
0005	7200	CLA
0006	5001	JMP 1
0020	0301	letter a

Location 20 may contain the code for any character. An A is a 301. This program will obviously not type a carraige return unless you set location 20 to the proper code in which cause you would only do carraige reutrns. The next program avoids this.

Print all possible characters

This is a variation of the first program.

Octal Location	Contents	Mnemonic
0000	6044	TPC
0001	1020	TAD 20
0002	6041	TSF
0003	5002	JMP 2
0004	6046	TLS
0005	5001	JMP 1
0020	xxxx	data

Echo program

This program recieves a character from the keyboard and then prints it on the teleprinter. This is a good test of the keyboard and teleprinter interfaces.

Octal Location	Contents	Mnemonic
0000	6032	KCC
0001	6031	KSF
0002	5001	JMP 1
0003	6034	KRC
0004	6046	TLS
0005	6041	TSF
0006	5005	JMP 5
0007	5000	JMP 0

(DO NOT WIPE OUT PROGRAM)

LOCN	INST						
X000	7300	START	CLA + CLL	7600	~~0000~~		7600
1	1245		TAD BEGIN				~~7044~~
2	3244	~~7044~~	DCA ADDR	7044		3044	~~1644~~
3	1242		TAD ONES	1642	~~1040~~	1642	~~7334~~
4	3644	7344	DCA X ADDR		3044	3344	~~1144~~
5	1242		TAD ONES			1244	~~7044~~
6	7041		CIA				
7	1644		TAD X ADDR				
10	7440		SZA		~~7040~~		
11	4232		JMS ERROR		4632	20	
12	7300		CLA + CLL		~~7400~~	24	
13	3644		DCA X ADDR		7244		
14	7041		CIA			4 11	
15	1644		TAD X ADDR				
16	7440		SZA				
17	4232		JMS ERROR				
20	7300	7400	CLA + CLL		~~7500~~	7 6 100	
21	1244		TAD ADDR		~~3244~~		
22	7041		CIA		~~7341~~	step s 303	
23	1246		TAD TOP				
24	7450	7456 NOW	SNA		~~7500~~		
25	5246		JMP RESTART				
26	7300		CLA + CLL			~~0020~~	
27	1244		TAD ADDR				
30	7001		IAC		2301		
31	5202		JMP START + 2				
32		ERROR	BSS 1		~~4400~~		
33	7402	7426	HLT		~~7020~~ TO VIEW AC		
34	7300		CLA + CLL				
35	1244		TAD ADDR				
36	7402	~~7430~~	HLT		TO VIEW ADDR		
37	5632		JMP & ERROR				
40	7400	~~7000~~ RESTART	NOP		7000 (CAN INSERT HLT)		
41	5200	~~5000~~	JMP START		~~5000~~		
42	7777	ONES	OCT 7777B				
43	0000	ZEROES	OCT 0000				
44		ADDR					
45	X047	BEGIN	OCT X047				
46	7777	TOP	OCT 7777				