PRINTER INTERFACE

PolyMorphic Systems

a. Assemble processor board serial option.

This option consists of a USART and associated circuits necessary for the conversion of parallel data to a serial data stream, and vice versa.

1. If you obtained the serial port option later than the processor board, you probably have not installed any of the processor board components included with the option. If this is the case, install the following sockets and components on the processor board (refer to processor board parts layout, fig. A-3, and photo of complete board following page 17):

CHECK	SCHEMATIC #	TYPE
(✓)	IC28 (socket only)	28 pin DIP socket
(✓)	42, 43 (sockets)	14 pin DIP socket
(✓)	C25, C30	0.1 μ F ceramic disc
(✓)	D3 (colored band points same direction as arrow)	1N4148 diode
(✓)	C43	10μ·F tantalum capacitor
(✓)	IC44	79L12 regulator

If you have a 4.Ø monitor ROM install "K" jumper otherwise ignore this instruction.

(✓) Install Jumper "K"

2. Now test for voltage regulation. Plug the board into a working backplane (always check to see that the power is off until the board is completely installed in the socket).

OK AT Both serial Ports

( ) Check pin 12 of the ribbon cable for -12V ± 0.6V. If the proper voltage is not present, check closely for solder bridges. Make sure this regulator is working right before proceeding.

3. Install the integrated circuits.

CHECK	IC #	TYPE	FUNCTION
(✓)	28	8251	USART
(✓)	29	MM5307	Baud rate generator
(✓)	31	74LS08	Quad AND gate

The processor board is now complete.

b. Assemble the serial mini-card option.

First decide whether the board will be used for RS-232C, 20ma current loop or 60ma current loop. (Note: open loop voltage of current loops must not exceed 24 volts.)

1. Install all resistors; refer to the parts layout (fig. A-5).

CHECK	SCHEMATIC #	DESCRIPTION
( )	R1 (20ma current loop only)	330Ω ¼W resistor
( )	R1 (60ma current loop only)	47Ω ¼W resistor
( )	R3	1000Ω ¼W resistor
( )	R4	220Ω ¼W resistor
( )	R6	1000Ω ¼W resistor

2. Install the diodes, making sure the colored band points in the same direction as the arrow etched on the board.

CHECK	SCHEMATIC #	DESCRIPTION
( )	D1	1N4148 diode
( )	D2	1N5252 or IN5254A zener diode

3. Install the DIP sockets.

CHECK	LAYOUT POSITION #	DESCRIPTION
( )	J1	16 pin DIP socket

( )	IC1, IC2	8 pin DIP socket
( )	IC3	14 pin DIP socket
( )	IC4	16 pin DIP socket
( )	IC5 through IC7	14 pin DIP socket

4. Install the capacitors.

CHECK	LAYOUT POSITION #	DESCRIPTION
( )	C1 through C6	0.1 μF ceramic disc

5. Install the transistor.

CHECK	SCHEMATIC #	DESCRIPTION
( )	Q1	2N5449 NPN transistor

6. Install the connectors.

( ) Mount the 25 pin connector on the top of the card. It is usually necessary to use a thin, stiff tool (such as an awl or screw-driver) or needle nose pliers to align individual pins with the PC card holes. Begin at one end and work toward the other, partially inserting each pin. Do not force the connector into position; it should slide into place with slight pressure if all 25 pins are oriented properly. Fasten the connector to the card with 4-40 screws, nuts, and lockwashers. Solder the pins.

( ) Orient the card so that the words "Serial I/O" are along the bottom edge. Orient the ribbon cable so that it runs left to right with the one colored wire (usually red) at the top. Insert the left ribbon cable plug into the card from the top. Pin 1 will be in the upper left, and the wires will enter the card from the right. Solder the 14 pins. For future reference, note that pin 1 of the unsoldered DIP plug is on the side nearest the colored wire.

7. ( ) Check carefully for solder bridges, unsoldered joints, and cold solder joints.

8. Install the integrated circuits. Note: the ICs marked with an asterisk (*) are MOS, and can sometimes be damaged by the

voltage present on your hands. Do not touch the pins on these chips any more than absolutely necessary. Install only the ICs used for your application.

FOR RS-232C APPLICATIONS

CHECK	SCHEMATIC #		DESCRIPTION
( )	IC3	74LS32	2 input OR gate
( )	IC4*	80C97 or 4503	Tri-state buffer
( )	IC5	1488	TTL to RS-232 interface
( )	IC6	1489A	RS-232 to TTL interface
( )	IC7	74LS04	Inverter

FOR CURRENT LOOP APPLICATIONS

CHECK	SCHEMATIC #		DESCRIPTION
( )	IC1	TIL116, MCT2, or 4N28	Opto-isolator*
( )	IC2	TIL116, MCT2, or 4N28	Opto-isolator*
( )	IC3	74LS32	2 input OR gate
( )	IC4*	80C97 or 4503 or 340097	Tri-state buffer
( )	IC7	74LS04	Inverter

Device Address Selection

Note the circled jumper pads in the Ø/1 area on figure A5. The Ø/1 jumper selects the device number assigned to this serial card. The serial I/O card is usually installed as device 1 when running a printer.

( ) If the jumper is connected between the lower hole and the Ø hole directly above it, port Ø is selected. ( ) If the lower hole is connected to the 1 hole above it and to the left, port 1 is selected. (Note that the lower left hole next to this area is not a jumper connection.)

The serial card is enabled by setting data bit 5 (D5 of bits DØ through D7) of output port 4 to the same value as the jumper-selected port, Ø or 1.

* Note these chips have 6 pins and are put at the top of the 8 pin sockets.

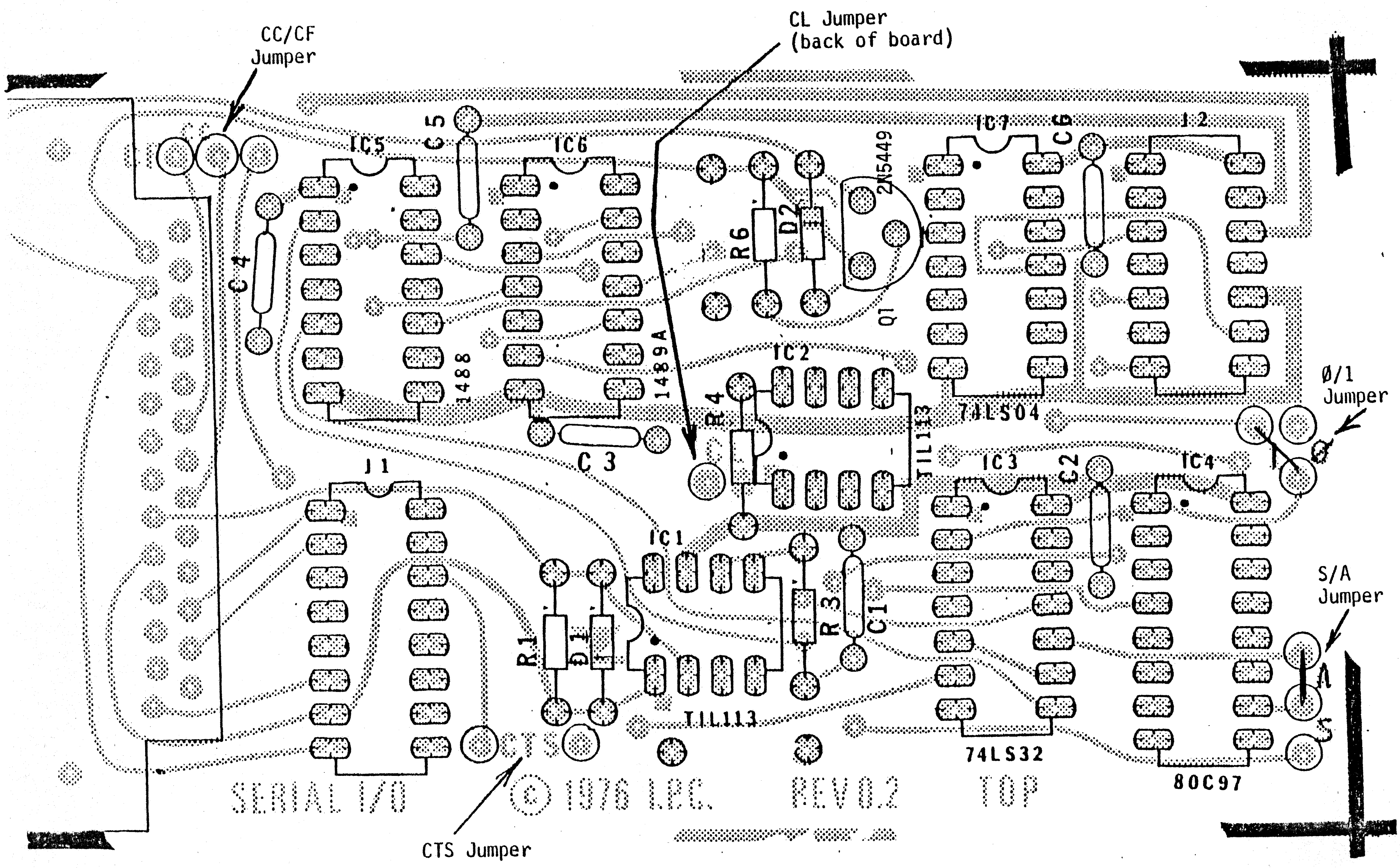

CC/CF Jumper
CL Jumper (back of board)
IC5
IC6
IC7
J2
C5
C6
C4
C3
C2
C1
2N5449
Q1
R6
D2
R4
R3
R1
D1
IC2
IC3
IC4
IC1
J1
1488
1489A
74LS04
74LS32
80C97
TIL113
Ø/1 Jumper
S/A Jumper
CTS Jumper
SERIAL I/O
© 1976 L.P.C.
REV 0.2
TOP

Figure A-5

9. The jumpers installed in this section select RS-232 or current loop operation (and variations of these). Section 9A describes current loop configuration and 9B the RS-232 configuration.

9A. Current loop configuration

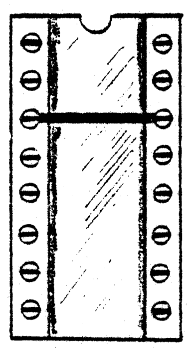
( ) Note the circled pads in the S/A area on figure A-5. Install a wire jumper from the middle hole to the bottom hole (A).*

( ) Note the CL area in figure A-5. These two pads must be jumpered together. One pad is concealed by R4; jumper on the back of the board.

( ) Install a jumper from pin 6 to pin 7 of IC6. The jumper may be soldered to these pins on the back of the board or inserted into the IC socket (soldering is preferred).

( ) Note the CTS area on the figure. Jumper the two pads in this area together.

( ) Wire the DIP plug with a single wire from pin 3 to pin 14 (as shown below) and insert into J1.



This completes the current loop wiring.

9B. RS-232 configuration

( ) Note the circled pads in the S/A area on figure A-5. Install a wire jumper from the middle hole to the bottom hole (S).

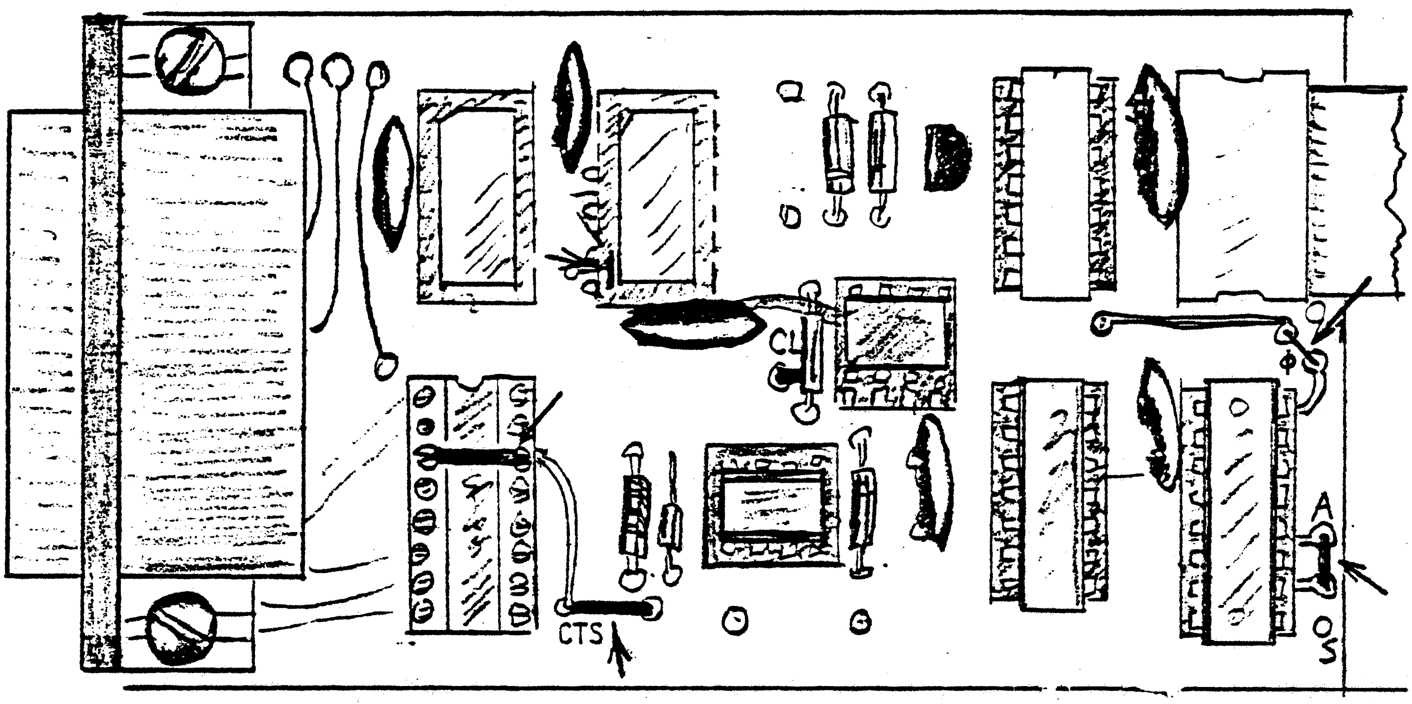
* Hole A is the top hole on the diagram

10. Test

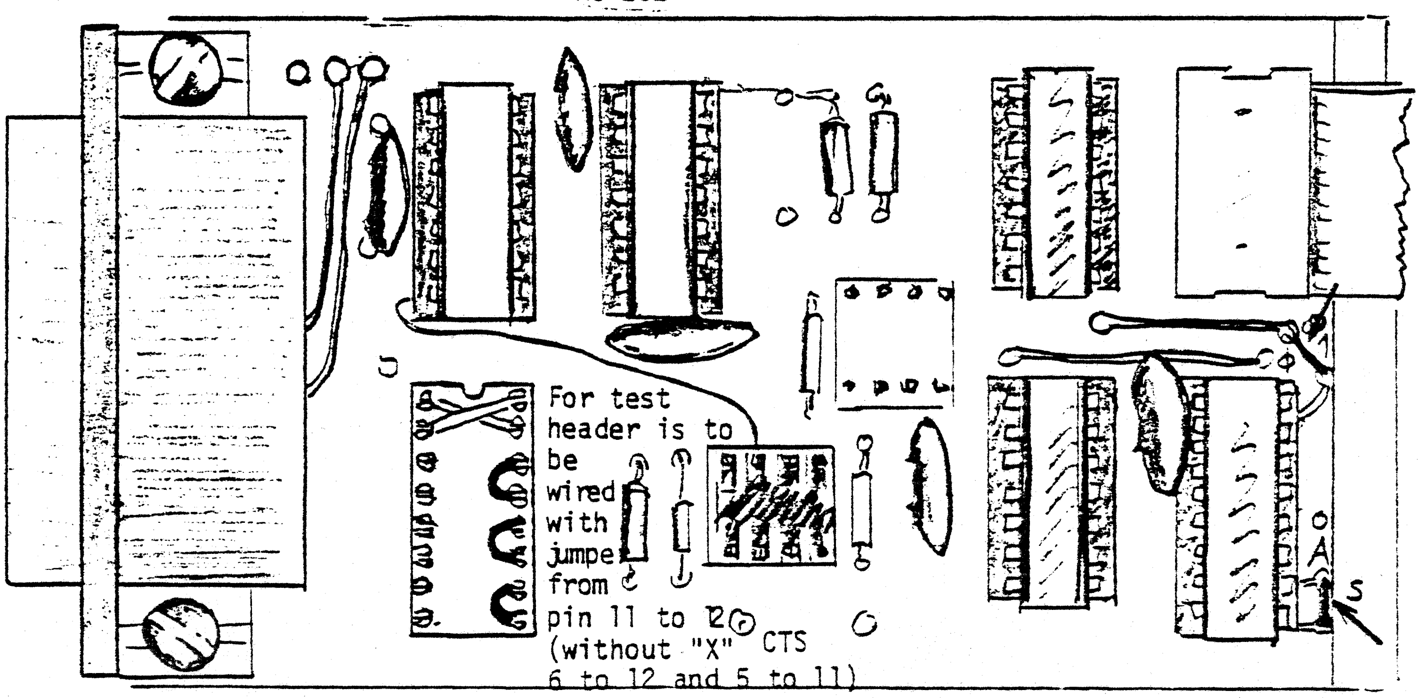
PRINTER INTERFACE
Jumper Connections

Temporarily wire a header according to the drawings below for your type of interface and install on the board.

CURRENT LOOP



RS-232



Before mounting the serial option card on the back panel, check to see that it is operating correctly. Attach the ribbon cable from the mini-card to the processor board, making sure that pin 1 is down.

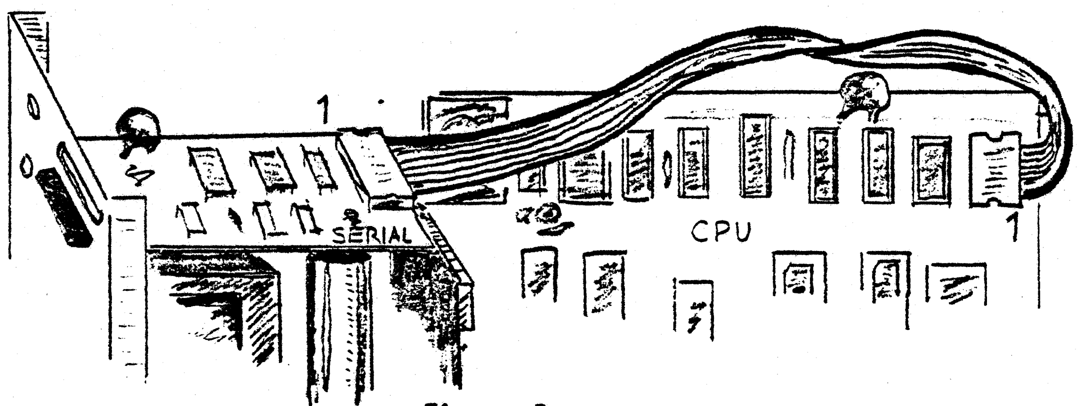


Figure D

Note that there are two output port connectors on the upper right corner of the processor board, connected in parallel. The serial option can be plugged into either port. Pre-bend the ribbon cable to clear the small components on the end of the board.

For current lopp connect:

( ) a 56Ø ohm resistor from pin 5 to pin 17; ( ) connect pins 19 and 24 together ( ) and 25 and 7 together.

Type in the following test program beginning at ØC8ØH. If you have a cassette board, save the program on cassette so it may be reloaded reaily.

```
                    ;
                    ; ******* SERIAL I/O TEST PROGRAM *******
                    ;
                    ;This program initializes the USART for 9600 baud
                    ;(asynchronous) and sends characters to itself.
                    ;
                    ;
                    ;Equates for 4.0 monitor
                    ;
0064                IORET   EQU     0064H   ;ISR return
00B8                ERROR   EQU     10111000B ;error mask
02AD                SETUP   EQU     02ADH   ;USART setup routine
0000                DAT     EQU     0       ;USART data port
0001                STAT    EQU     1       ;USART status/command port
0001                TBE     EQU     1       ;USART TX buffer empty flag
0002                RBF     EQU     2       ;USART RX buffer full flag
0392                CLEAR   EQU     0392H   ;sends form feed
039C                TABBER  EQU     039CH   ;sends horizontal tab
03D1                DEOUT   EQU     03D1H   ;puts 4-digit hex. number on scr
0C16                SRA4    EQU     0C16H   ;USART service routine entry
0C20                WH0     EQU     0C20H   ;Console In routine
0C24                WH1     EQU     0C24H   ;Console Out routine
                    ;
0C80                        ORG     0C80H   ;first avaliable RAM
                    ;
0C80 210000         START:  LXI     H,0     ;zero error counter
0C83 22F40C                 SHLD    EC
0C86 F3             LOOP:   DI
0C87 21CE0C                 LXI     H,ISR   ;enter new service routine
0C8A 22160C                 SHLD    SRA4    ;into ISR table
0C8D CDAD02                 CALL    SETUP   ;setup USART
0C90 1FAA405E               DB      1FH,0AAH,40H,5EH,10,0
0C94 0A00
                                    ;9600 baud, async. 8-bits w/ odd parity
0C96 FB                     EI              ;enable interrupts
0C97 3E27                   MVI     A,27H   ;turn on USART
0C99 D301                   OUT     STAT
0C9B 0C             LOOP1:  INR     C       ;wait 1/2 sec.
0C9C C29B0C                 JNZ     LOOP1
0C9F 04                     INR     B
0CA0 C29B0C                 JNZ     LOOP1
0CA3 CD9203                 CALL    CLEAR   ;clear screen
0CA6 2AF20C                 LHLD    CTR     ;get character count
0CA9 EB                     XCHG
0CAA CDD103                 CALL    DEOUT   ;display  count
0CAD 210000                 LXI     H,0     ;clear counter
0CB0 22F20C                 SHLD    CTR
0CB3 CD9C03                 CALL    TABBER
0CB6 2AF40C                 LHLD    EC      ;increment error counter
0CB9 EB                     XCHG
0CBA CDD103                 CALL    DEOUT   ;display count
0CBD DB01                   IN      STAT
0CBF EE80                   XRI     80H     ;invert DSR flag
0CC1 E6B8                   ANI     ERROR   ;any errors?
```

```
0CC3 CA860C              JZ      LOOP      ;if 0, loop back
0CC6 13                  INX     D         ;if errors,
0CC7 EB                  XCHG              ;increment error counter
0CC8 22F40C              SHLD    EC
0CCB C3860C              JMP     LOOP
                ;
                ;Interrupt service routine
                ;
0CCE DB01       ISR:     IN      STAT      ;get status
0CD0 E602                ANI     RBF       ;receiver full?
0CD2 C2E60C              JNZ     READ
0CD5 DB01                IN      STAT
0CD7 E601                ANI     TBE       ;transmitter empty?
0CD9 CA6400              JZ      IORET     ;spurious interrupt
0CDC 21F60C     WRITE:   LXI     H,CH      ;increment character
0CDF 34                  INR     M
0CE0 7E                  MOV     A,M
0CE1 D300                OUT     DAT       ;send it
0CE3 C36400              JMP     IORET
0CE6 DB00       READ:    IN      DAT       ;get character
0CE8 2AF20C              LHLD    CTR       ;increment character count
0CEB 23                  INX     H
0CEC 22F20C              SHLD    CTR
0CEF C36400              JMP     IORET
                ;
                ;TEMP. STORAGE
                ;
0CF2            CTR:     DS      2         ;char. ctr.
0CF4            EC:      DS      2         ;error ctr.
0CF6            CH:      DS      1         ;character to transmit
                ;
0000                     END
```

To test an RS-232 configuration connect pins together on RS-232 plug as follows:

	pin	to	pin
( )	2		3
( )	4		5
( )	6		2Ø
( )	17		24

and plug into serial board under test.

Execute the program at ØC8ØH. The display will blank and 2 four digit hex numbers will appear in the upper left hand corner of the screen. The first number is the count of characters transmitted through the USART (should be approx. 26Ø to 28Ø). The 2nd number is the error count and should be zero (Ø). If it is not the data being transmitted thru the serial board and back to the USART is in error. If the 1st number is zero no data at all is getting thru.

This program outputs data to the serial port at 9600 baud, then reads it back in and checks for parity errors. If there are no errors, (second number on the screen is zero) and data is getting through (first number on the screen greater than 260) your printer interface is working. If not procede with the troubleshooting section.

11. Trouble Shooting

If your board does not work turn off the power and check that all the chips are in their proper places. Are the 1488 and 1489 in correctly?* It's easy to switch them accidentally. Is the header in upside down? Make sure all the jumpers are correctly installed.

If all these things check out, turn the power back on and start the program again (you will have to reload it). Check to see that all the power supplies are getting to the board. (± 12, +5). The power can be checked on the ribbon cable connector. Be sure not to skip this step. 90% of all problems are caused by faulty power supplies.

If all the power supplies check out correctly, check to see that the board is selected. This can be done by checking with a logic probe on Pin 1 of the 8ØC97. A logical "0" indicates the board is selected.

If all these things check out, start tracing signals along the data and** control paths. This can be done with a logic probe for the most part, but do not attempt to use it at the output of the 1488, or input of the 1489, or the current loop output or input lines as it is not designed for these voltages. To check these points use a voltmeter. When using the voltmeter, check for DC on the control lines, and AC on the signal lines. The outputs of the 1488 sing from plus/to minus 12 volts and are inverting, so be careful you do not over-range your meter. Similar caution should be used when checking the current loop operation.

*(RS-232 only)

**Refer to section #13 Theory of Operation

Now connect up to the external serial device you intend to use. Perform the step below that conforms to your application.

( ) RS-232: In most cases, the external device comes equipped with a mating plug. If this is so in your application, plug it into the 25 pin connector on the mini-card. If the device does not have a plug, provide one, wiring it in conformance to the RS-232 wiring chart presented earlier. RS-232 requires plug part no. DB-25P.

( ) Current loop - external current source: In most current loop applications, the external device provides a current source. If yours does not, you must make provision for a current source. (refer to the next paragraph).

Refer to the following chart of current loop pin descriptions for the 25 pin connector, and to the schematic.

PIN		
17	CLI+	current loop input -- positive
18	CLI-	current loop input -- negative
24	CLO+	current loop output -- positive
25	CLO-	current loop output -- negative

The other pins are not used in current loop applications.

( ) Current loop - internal current source:

A current source may be provided by mounting 2 resistors on the mating plug. The resistors should be:

560	½W	for 20MA operation (ASR/KSR-33 TTY)
180	1W	for 60 MA operation

( ) Connect one resistor from pin 5 to pin 17 of the plug.

( ) Connect the other resistor from pin 5 to pin 24 of the plug. Refer to the following chart, the schematic and the example (ASR/KSR-33 teletype) for device connection.

18 Current loop input (positive) - to keyboard contacts on TTY

25 Current loop output (positive) - to magnet driver on TTY

1 signal ground - return lead for both signal paths (negative)

The RS-232 standard was originally developed as an interface between a terminal or computer and a dataset. However, it has been extended to many other devices as well. Our terminology will define one of the interconnected devices to be a terminal device and the other to be the controlling device. For instance, the TXD line is the line over which the terminal device transmits data to the controlling device; the RXD line is the line over which the terminal device receives data. In most applications involving a system like th e one we are dealing with here, the external device is the terminal and the computer itself is the controlling device. The RS-232 standard definitions for the lines between controlling and terminal devices are:

PIN		
1	protective ground	
2	TXD	Transmit data from terminal to controlling device.
3	RXD	Receive data sent from controlling device to terminal.
4	RTS	Request to send -- terminal device asks controller for permission to transmit.
5	CTS	Clear to send -- controller grants permission.
6	DSR	Data set ready -- controlling device is ready.
7	signal ground	
8	DCD	Data carrier detect -- data set indicates carrier present
9 through 16 are not used here.		
17	RXD	Receive clock -- controlling device sends clock signal to terminal.
18 and 19 not used here.		
20	DTR	Data terminal ready -- terminal device indicates it is ready.
21 through 23 are not used.		
24	TXC	Transmit clock -- terminal transmits clock signal to controlling device.
25 is not used.		

The DIP plug wiring layout depends on whether the computer is the controlling device or the terminal device and whether the device is synchronous or asynchronous.

RTS signal

The USART must receive a clear to send signal to send characters if this is not provided by the device being interfaced the RTS and CTS signals may be tied together at pins 14 and 13 of the DIP plug.

Clock

The USART must have a clock in order to receive data. If the clock is not sent over the device interface (it is not a synchronous device) pins 9 and 10 of the DIP plug should be wired together.

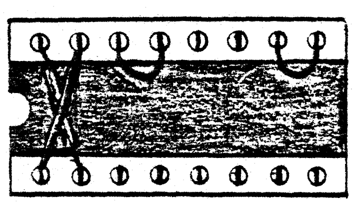
Data Paths

Note that the data paths are interchanged (by wiring the DIP plug straight through or by wiring pin 1 to pin 15, pin 2 to pin 16, etc.) depending upon whether we are the terminal or the controller.

Following are examples of wiring for a Decwriter (300 band serial printer), a Diablo 1620 Hytype (300 baud letter quality printer) and a 103 type dataset.

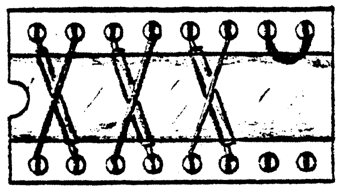
Decwriter

This is an asynchronous device and requires no other signals than the data going to and from it. Pins 9 and 10 are shorted to connect the baud rate generator output to the USART receive clock input. Pins 13 and 14 are connected to route the request to send signal from the USART to the clear to send on the USART to enable transmitting.

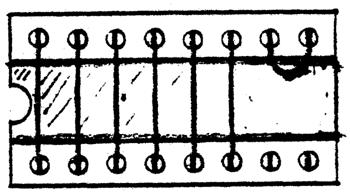


Diablo Hytype

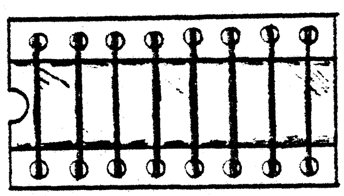
The Hytype is asynchronous, but requires assertion of the clear to send and data set ready lines before it will send or receive.



103 Moden (Data Set). The 103 Moden is also asynchronous. The data and control paths are reversed since the modern supplies the clear to send and data set ready signal to the USART (it is the controlling device).



Synchronous Modem. Same as 103 Modem but must be provided with clocks.



13. Theory of Operation

Theory of operation and schematic for the portion of the serial option installed on the processor board is covered in the discussion of the processor board.

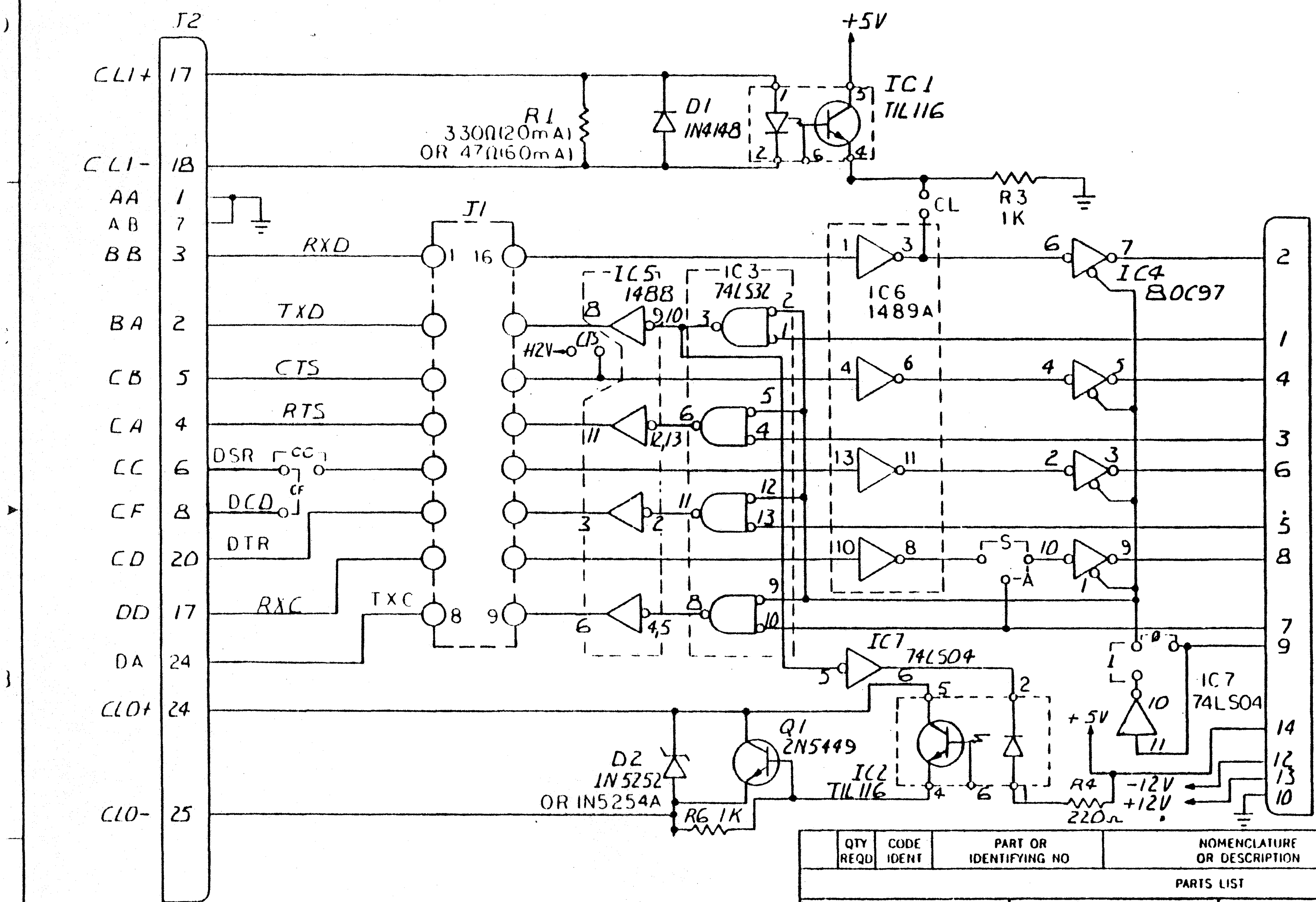
The serial mini-card is, in essence, a level shifter. The serial port on the processor board outputs and accepts TTL level signals, while RS-232 and current loop serial devices do not.

RS-232 uses -12V low level and +12 V high level states.

ICs 5 and 6 are interface chips between TTL and RS-232 level voltages.

The current loop low level is defined as the absence of current flow. High level is the presence of flow. Opto-isolator IC2 switches the current according to the TTL level signal present at pin 1. Diode D2 limits the voltage present to 24V. On the receiving end, opto-isolator IC1 switches +5V to provide a TTL signal at pin 4.

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED



QTY REQD	CODE IDENT	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION		ZONE

PARTS LIST

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES
TOLERANCES ON
FRACTIONS ± DECIMALS X ± XX ± XXX ± ANGLES ±

MATERIAL

FINISH

DO NOT SCALE DRAWING

CONTRACT NO.

DR BY Garcia P 6/14/76
CHK BY
APPROVED BY J.D.A. 8/14/76

NEXT ASSY	USED ON
APPLICATION	

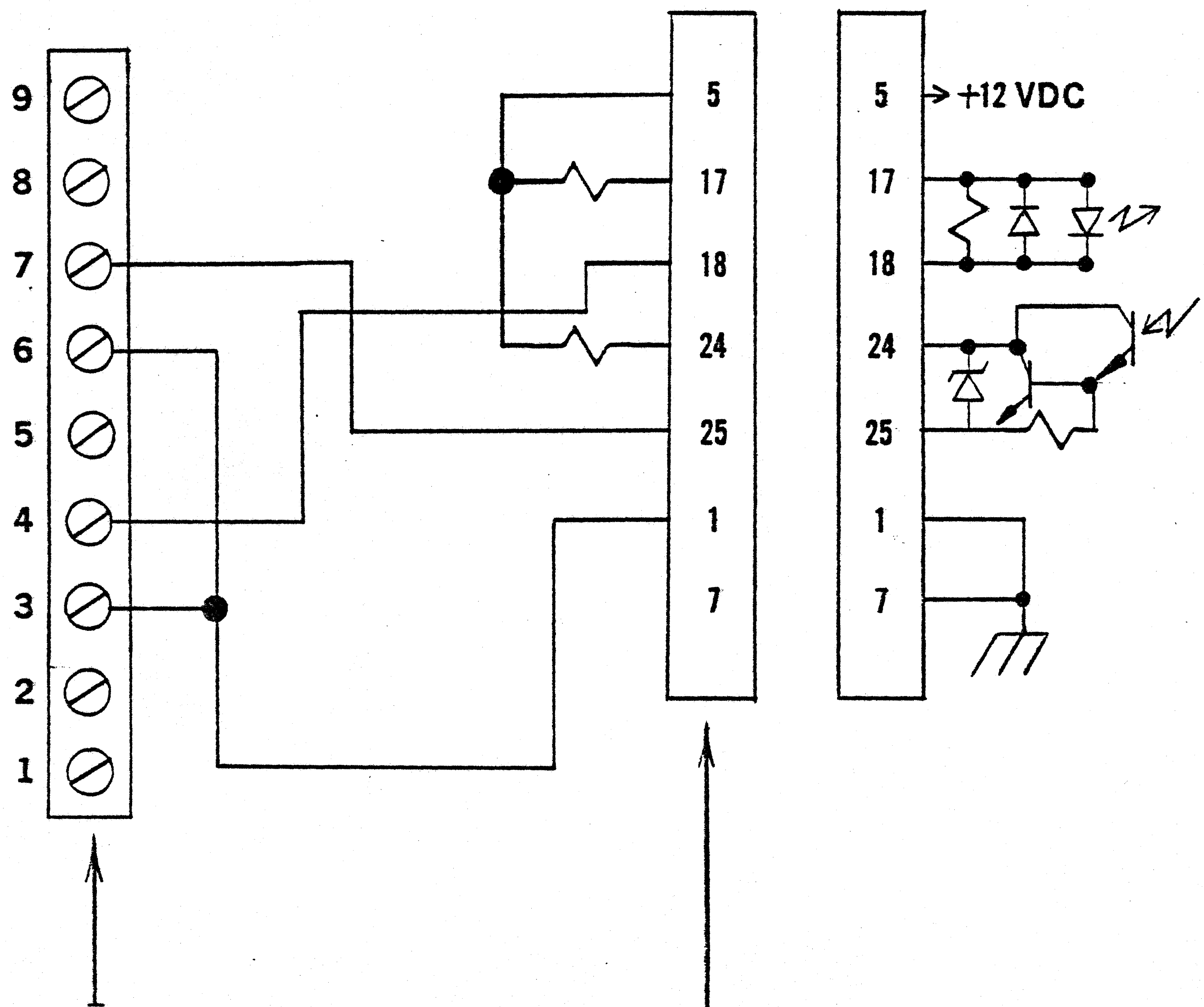
POLYMORPHIC SYSTEMS GOLETA, CALIFORNIA

SCHEMATIC DIAGRAM SERIAL I/O INTERFACE

SIZE C | CODE IDENT NO | DWG NO 90020

SCALE NONE | SHEET 1 OF 1

CURRENT LOOP (INTERNAL CURRENT SOURCE)

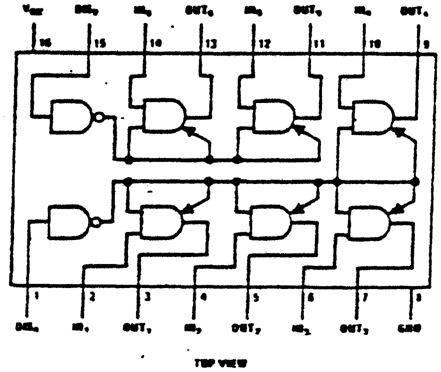


TERMINAL
STRIP 151411
IN ASR/KSR-33
TELETYPE
(WIRED FOR 20mA FULL DUPLEX OPERATION)*

DB-25P (CANNON)
CONNECTOR

*SEE TELETYPE MANUAL FOR CONFIGURATION.

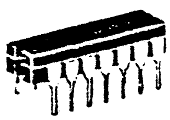
SERIAL I/O MINICARD
CHIP PINOUTS



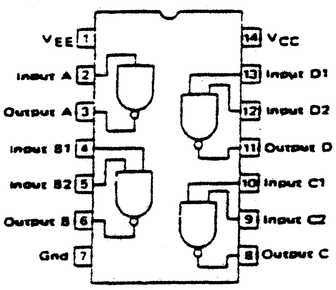
MM70C97/MM80C97

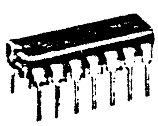
MC1488

L Suffix
CERAMIC PACKAGE
CASE 632
TO-116



PIN CONNECTIONS

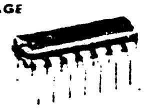


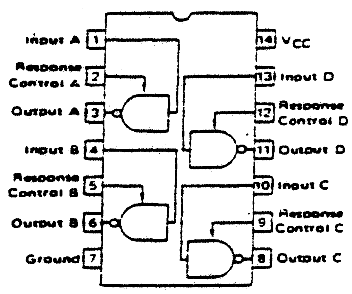


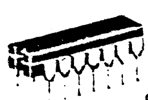
P Suffix
PLASTIC PACKAGE
CASE 646

P SUFFIX
PLASTIC PACKAGE
CASE 646

MC1489AL

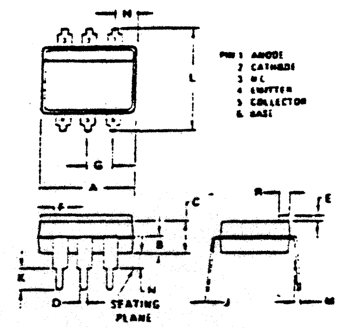






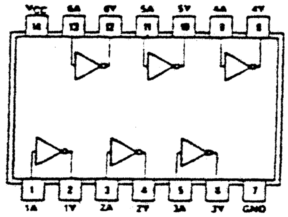
L SUFFIX
CERAMIC PACKAGE
CASE 632
TO-116

TIL 116
4N28
MCT2

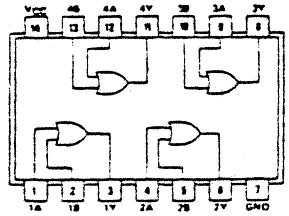


DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	8.38	8.89	0.330	0.350
B	1.40	1.65	0.055	0.065
C	2.92	3.18	0.115	0.125
D	0.41	0.51	0.016	0.020
E	0.64	0.89	0.025	0.035
F	1.14	1.40	0.045	0.055
G	2.54 BSC		0.100 BSC	
H	1.57	1.83	0.062	0.072
J	0.23	0.28	0.009	0.011
K	2.54	3.30	0.100	0.130
L	7.37	7.87	0.290	0.310
M	–	10°	–	10°
N	–	1.27	–	0.050
R	1.52	1.78	0.060	0.270

CASE 673-03



SN5404/SN7404(J, N)
SN54H04/SN74H04(J, N)
SN54L04/SN74L04(J, N)
SN54LS04/SN74LS04(J, N, W)
SN54S04/SN74S04(J, N, W)



SN5432/SN7432(J, N, W)
SN54LS32/SN74LS32(J, N, W)