DSP-4100

HF RADIO DSP MODEM

TECHNICAL MANUAL

870-4100
March 1, 2003 Printing

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FCC RADIO FREQUENCY EMISSIONS STATEMENT

U.S. Federal Communications Commission (FCC) Rules and Regulations, CFR47, Part 15, require inclusion of the following text in this manual.

INFORMATION TO THE USER (CFR47, 15.105)

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

P-MODE

The word "P-Mode" is the HAL designation for a communications protocol that may also be known as "Pactor", a registered trademark of the Spezielle Communications Systeme GmbH (SCS) firm in Hanau, Germany. HAL affirms that, to the best of its knowledge, "P-Mode" is compatible and interoperable with the protocol SCS calls "Pactor" and with the link establishment and weak signal modes of the protocol SCS calls "Pactor-II".

CHAPTER 1

INTRODUCTION

1.1 DSP-4100 Product Models

HAL Communications Corp. manufactures two variations of the DSP-4100 with model numbers DSP-4100 and DSP-4100/2K. DSP-4100 is shipped with the standard CLOVER protocol CLOVER-II, while the DSP-4100/2K is shipped with the high performance, high data rate protocol CLOVER-2000.

NOTE: The HAL DSP-4100 is distinctly different from the HAL DSP-4100/2K. However, a DSP-4100 can be upgraded to a DSP-4100/2K at the factory. Please contact HAL Communications Corp regarding pricing, shipping, and availability for hardware upgrades (see section 2.1.1 Software and Documentation Update).

1.2 DSP-4100 Product Variations

HAL Communications manufactures and distributes the HAL DSP-4100 and DSP-4100/2K HF Modem in several distinct variations including models manufactured for specific OEM HF communication systems. These model variations are specific to the system on which they operate and have a certain product ID. If you have an existing HF communication system utilizing the DSP-4100, please see that correct model is being installed. Please contact HAL or your authorized dealer if you have any questions regarding the HAL models and product IDs.

NOTE: HAL DSP-4100 and DSP-4100/2K HF modems sold factory direct are not OEM specific and have the HAL product ID num-ber. These modems will communicate with other modems sold factory direct. However, they will not communicate with certain OEM HF communication systems.

1.3 DSP-4100 Firmware Updates

HAL Communications Corp. may periodically release new firmware updates required to operate the on-board processors. Updates should be made using the terminal software provided with the DSP-4100. Please refer to the software Operations Manual to load new firmware. If you need assistance determining the current firmware version, contact technical support (see section 2.1.1 Software and Documentation Update).

NOTE: Firmware Updates must be obtained from HAL Communication Corp. or your authorized dealer. Uploading incorrect firmware to a DSP-4100 can cause the unit to become inoperable and require factory service.

1.4 DSP-4100 HF Modem Documentation

This DSP-4100 MANUAL describes the DSP-4100 hardware in detail. If you use the DSP-4100 modem with terminal software provided by another firm (so-called "3rd-party software"), use this manual when installing the DSP-4100 and to determine modem performance specifications.

If you desire to develop your own terminal software or learn more about CLOVER modes, you may wish to purchase one or more of the following Engineering Documents from HAL:

E2000	CLOVER Glossary of Terms
E2001	HAL DSP Modem Interface Command Specifications
E2004	Binary File Transfer Protocol
E2005	DSP-4100 Interface Specifications
E2006	CLOVER-II Waveform & Protocol
E2007	CLOVER-2000 Waveform & Protocol
E2009	Optimizing HF Data System Performance with CLOVER 2000
E2010	AT Dial Commands

Engineering Documents are available on the HAL website (www.halcomm.com) in the 'white sheets' section, and by mail. Please contact HAL's customer service department for more information on obtaining these documents.

CHAPTER 2

INSTALLATION AND SETUP

2.1 Unpacking and Inspection

Your DSP-4100 system includes the following materials:

1 - 900-04100 DSP-4100 Modem
1 - 870-04103 DSP-4100 Technical Manual
1 - 865-04101 DSPWin Software Diskette
1 - 870-04103 DSPWin Manual
1 - 970-04102 Accessory Bag

Accessory Bag includes:

1 - 310-16030 DC Power Plug
1 - 333-20090 9-Pin EIA Plug
1 - 333-20250 25-Pin EIA Plug
1 - 333-51220 9-Pin Metalized Shell
1 - 333-51229 25-Pin Metalized Shell

When opening the DSP-4100 shipping carton, carefully inspect it for any evidence of shipping damage. Any damage should be immediately reported to your shipping carrier. Be sure to save any damaged packing materials as the carrier will have to inspect them if you have a claim. Note that a damage claim must be filed by you with the shipping carrier — NOT HAL Communications. HAL will of course be glad to assist in such cases, but it is only the shipping carrier who can pay damage claims.

Check to be sure that all of the materials listed above are contained in your DSP-4100 package. If you find any materials missing, please contact your dealer or HAL Communications as soon as possible.

2.1.1 Software and Documentation Update

New versions of each program are available to all DSP-4100 owners as they are released by HAL Communications. Current versions of both the DSP-4100 programs and documentation updates may be obtained by contacting customer service.

DSP41.EXE available upon request.

Customer Service
HAL Communications Corp.
PO Box 365
Urbana, IL 61801-0365

Phone: 217-367-7373
(8AM - 5PM CST/CDT; Mon. - Fri.)
Fax: 217-367-1701
E-mail: halcomm@halcomm.com
Web: www.halcomm.com

2.1.2 Initial Startup

1. Connect a 10-18VDC (500mA min.) power source to the DSP-4100. Please use the included power plug. Other "coaxial" power plugs may appear to be correct but can often be intermittent. Additional DC power plugs may be purchased from HAL (HAL P/N 310-16030)

The center pin of the of the connector is positive.

2. Turn on the DSP-4100.

3. All front panel LED's should light for approximately 3 seconds. After which, the **STBY** LED should remain lit.

4. If the **STBY** and any combination of the **RX, TX,** or **ERR** LEDs are flashing, a section of flash memory is corrupted. If this occurs please call the HAL service department for assistance.

2.2 Radio System Connections

These limits should be compatible with practically all modern transceivers. DO NOT EXCEED THESE LIMITATIONS.

Table 2.1
DSP-4100 Radio I/O Connections (J1 = DE9S)

PIN	FUNCTION	I/O	LIMITS
1	Audio from receiver	+Input	2.8V p-p
2	Audio from receiver	-Input	2.8V p-p
3	FSK Output	Output	+50V@ 100 ma
4	Audio to Transmitter	+Output	+6dBm (1.5V)
5	Audio to Transmitter	-Output	+6dBm (1.5V)
6	Ground		
7	SEL-CAL Output	Output	
8	Push-to-Talk Output	Output	
9	Ground		

2.2.1 Audio Input

The DSP-4100 Audio Input (AF IN) is balanced. The Input impedance is 10,000 ohms, ±10%. This input can be directly connected to a wide variety of receiver output terminals including low-impedance speaker (4 - 16 ohms), line (600 ohms), headphone (2K ohms) or "recorder output" (10,000 ohms). A 600 ohm terminating resistor may be required to limit the voltage level to 1.0 V rms when a 0 dBm receiver output circuit is used. A matched terminating resistor is usually not necessary for other receiver connections. The maximum input level to the DSP-4100 should not exceed 2.8 volts peak-to-peak (1.0 V rms; +2 dBm). DSP41.EXE software includes tuning indicator bars which are used to adjust the receiver output level ("volume").

2.2.2 Audio Output

The DSP-4100 Audio Output (AF OUT) is balanced. The output impedance is 600 ohms, ±10%. The DSP-4100 audio output need not be terminated in a 600 ohm matching resistor. This output may be directly connected to a wide variety of transmitter audio input terminals including microphone (low or high-impedance), "phone patch", or "line" (600 ohm). The DSP-4100 AF OUT circuit includes a 10uF series capacitor to prevent DC loading of transmitter microphone inputs which have a DC bias voltage.

Two output level voltage ranges may be set by the position of a jumper on pins 1 and 2 of J2 behind the DSP-4100 rear panel. See Figure 2.1, Page 2.3. Turn off the power to the DSP-4100 before changing this jumper. The exact level may be set via the rear panel screw-driver potentiometer. The output level ranges are:

Table 2.2
AF Output Ranges

Jumper J2 1 to 2	NOMINAL	ADJUSTMENT RANGE
OPEN	-30bBm (25 mV rms)	-50 to -20 dBm (2.5 to 78 mV rms)
CLOSED	0dBm (775 mV rms)	-20 to +6dBm (78mV to 1.5 V rms)

All DSP-4100 units are shipped with jumper J2 in the 0 dBm position (J2 = closed) and the rear panel output control set for 0 dBm. This setting should be used when the DSP-4100 is connected to transmitters which have a separate 600 ohm, 0 dBm line audio input.

IMPORTANT

The DSP-4100 has an "FSK Output" that may be used for TOR, P-MODE and RTTY. However, the CLOVER-2000 waveform cannot be generated when transmitters are operated in the "FSK" mode. The DSP-4100 and CLOVER-2000 require that the transmitter be operated in an SSB mode and that the CLOVER audio tone signal be connected to the transmitter audio input. Either USB (Upper Side Band) or LSB (Lower Side Band) may be used with CLOVER-2000 if both stations are the same.

2.2.3 PTT Output

The DSP-4100 provides TX/RX control of the radio equipment via the PTT (Push-To-Talk) transistor output on the rear panel. This is shorted to ground in transmit state and is open circuit in receive state. The TX/RX PTT circuit may use either positive or negative polarity with a maximum open-circuit voltage (RX state) of 50 volts DC and a maximum closed circuit current (TX state) of 100 ma DC.

2.2.4 SEL-CAL Output

The SEL-CAL output of the DSP-4100 is an open-collector NPN transistor (MPS-A42) that switches to ground during an ARQ link. This output may be used to signal that the station has been called and linked in ARQ mode or to control frequency scanning radio systems. The rating of the switching transistor is +50 VDC maximum (open circuit) and 100 ma DC maximum (closed circuit).

The SEL-CAL output is normally open ("high") until the call sign of the local station (MYCALL) is recognized during an ARQ link request. When MYCALL is recognized, the SEL-CAL output shorts to ground ("low").

2.2.5 FSK Output & Option Selection

The DSP-4100 FSK output circuit may be used with modern transceivers that include an FSK input to transmit the FSK modes (e.g. TOR, RTTY, and P-MODE). HAL has provided four interface options that will work with current equipment. Please note that CLOVER-2000 cannot be transmitted using the transceiver FSK input because CLOVER-2000 is an 8-tone signal.

The FSK output is a transistor output which can be set for open collector (O.C.) or pulled up to + 5 Volts D.C. (+5V) by the position of a jumper on pins 3 and 4 of J2 located behind the rear panel (see figure 2.1). There are two positions for J2. The Open Collector (O.C.) setting uses the jumper removed and +5 Volts D.C. is with jumper in place. Turn off the power to the DSP-4100 and use caution when moving the jumper plug.

Figure 2.1 DSP-4100 Rear Panel Connections

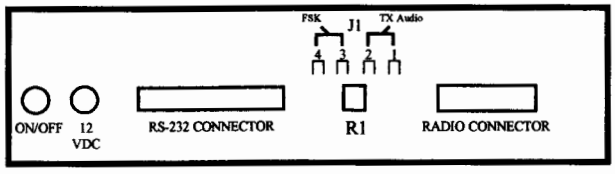

Table 2.3
DSP-4100 FSK Output Options

POLARITY	J2 JUMPER 3 to 4	MARK	SPACE
NORM	On	0V	Floating
REV	On	Floating	0V
NORM	Off	0V	+ 5V
REV	Off	+5V	0V

2.3 RS232 Serial Port Connections

All communications with the DSP-4100 are done through an RS232 Serial Port. The connections between the DSP-4100 serial port and the terminal should be shielded against any stray RF fields. Many times problems that seem to be either hardware or software are RF related. See Table 2.4 below for serial port information.

Table 2.4
DSP-4100 Serial Port Connections
(DB25 **Female**)

PIN	LABEL	Signal
1	Ground	Ground
2	TXD	Transmit Data
3	RXD	Receive Data
4	RTS	Request to Send
5	CTS	Clear to Send
6	DSR	Data Set Ready
7	Ground	Ground
8	DCD	Data Carrier Detect
9	NC	No Connection
10	NC	No Connection
11	NC	No Connection
12	SDCD	Secondary Port Data Carrier Detect
13	SCTS	Secondary Port Clear to Send
14	STXD	Secondary Port Transmit Data
15	NC	No Connection
16	SRXD	Secondary Port Receive Data
17	NC	No Connection
18	NC	No Connection
19	SRTS	Secondary Port Request to Send
20	DTR	Data Terminal Ready
21	NC	No Connection
22	NC	No Connection
23	NC	No Connection
24	NC	No Connection
25	CTRL	Extra Control Input

Note: 12,13,14,16, and 19 are connections for an optional secondary serial port used for customized control by some third-party programs, not HAL terminal software. Please, avoid making connections to these pins and pin 25.

Table 2.5
PC Serial Port Connections

9 PIN	25PIN	LABEL	Signal
1	8	DCD	Data Carrier Detect
2	3	RXD	Receive Data
3	2	TXD	Transmit Data
4	20	DTR	Data Transmit Ready
5	7	GND	Ground
6	6	DSR	Data Set Ready
7	4	RTS	Request to Send
8	5	CTS	Clear to Send
9	22	RI	Ring Indicator

Note: PCs may have 25 pin (DB25) Serial connectors. If 9 pin/25 pin adapters are used, verify all data lines are connected. Some adapters only connect the TXD, RXD, GND lines. 25 Pin female/25 pin male serial cables are recommended.

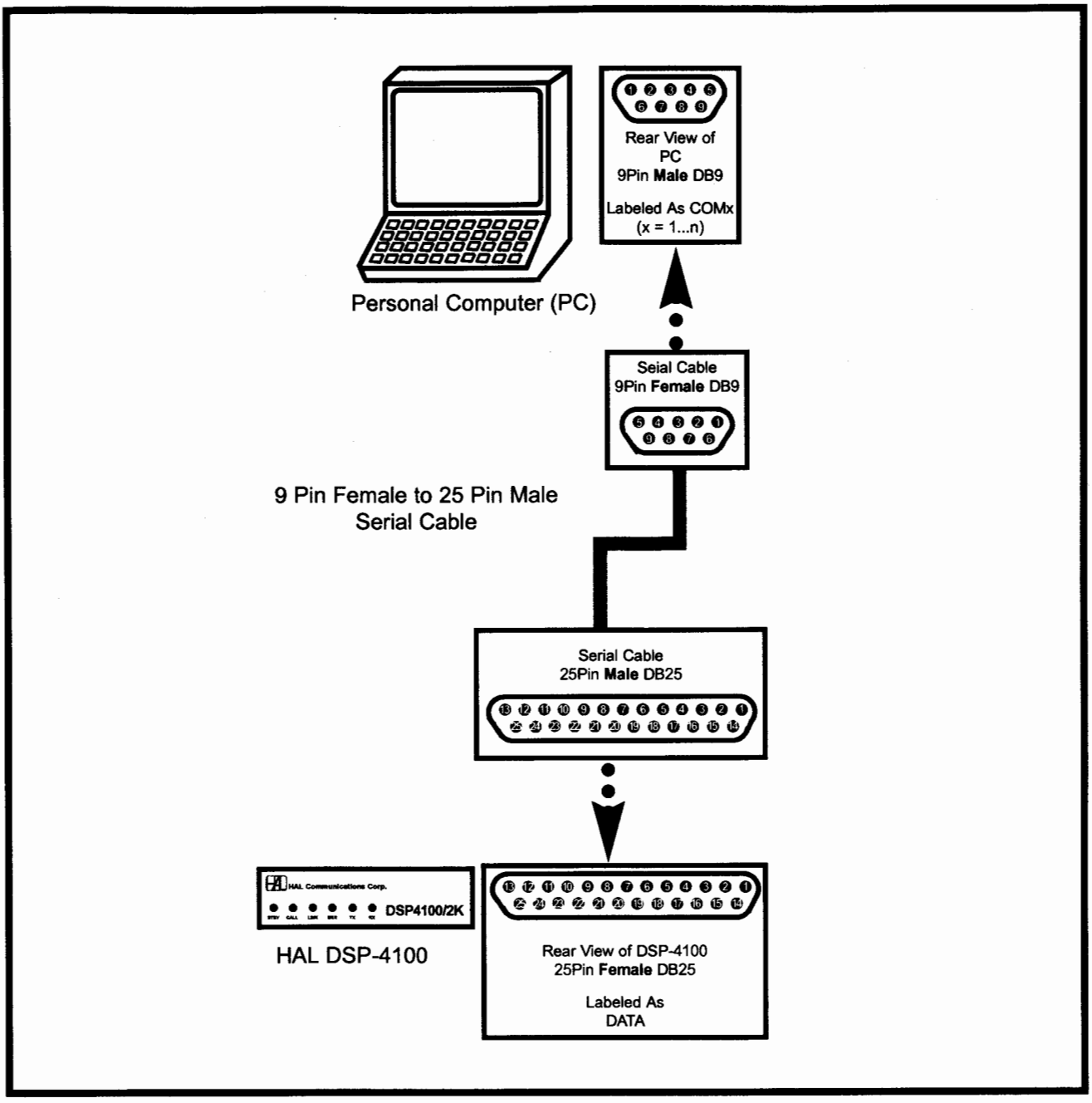

Figure 2.2
Serial Cable Specifications

CHAPTER 3

TECHNICAL DESCRIPTION

The HAL DSP-4100 is a DSP modem that will support a variety of HF radio communication protocols. The DSP-4100 operates from 12 VDC power. All commands and data are passed via an RS-232 serial I/O connector on the DSP-4100 rear panel. This connector also provides connection to a second serial I/O port which may be used as a "pass-through" between the terminal device and another serial I/O device. All I/O connections to the radio equipment are made via a DE-9S connection on the rear panel. The only rear panel adjustment is the modulator output level.

The DSP-4100 uses a dual processor architecture with a powerful 16 bit microprocessor controller and a fast DSP for audio processing. Operational software for the two internal processors is stored in non-volatile Flash ROM devices. However, for upgrade purposes, this software may also be revised by uploading new versions via the serial I/O port. As a result, the DSP-4100 is a powerful platform for implementing many different waveforms.

A block diagram of the DSP-4100 is shown in Figure 3.1. There are three major sections: 1) the Microprocessor section, 2) the DSP and audio section, and 3) the Power and I/O section. Each of these sections is described in this chapter.

3.1 DSP-4100 Controller

The DSP-4100 uses a 16 bit 68000 based microprocessor to control the board operations. This processor controls all board outputs, downloads application software into the DSP and its own RAM, and handles all communications with the PC application program.

3.1.1 Microprocessor Section

The DSP-4100 controller is a Motorola MC68EC000 16 bit microprocessor operating with a 10.24 MHz crystal oscillator clock. Figure 3.2 illustrates the microprocessor (U25), the Flash ROM (U20, U22) and RAM (U21, U23) memory. The DSP-4100 does not include Read Only Memory (EPROM) devices but instead uses a portion of the Flash ROM to store boot routines, lookup tables, and other fixed routines.

The memory devices connected to the microprocessor may be accessed as 8 bit bytes or 16 bit words. The microprocessor can access all external memory as 8 bit bytes on even and odd addresses or 16 bit words on even addresses only. Flash ROM U20 and ROM U22, enabled by LCS.L, store the high or even address data bytes, and RAM U21 and RAM U23, enabled by UCS.L, store the low or odd address data bytes.

The fixed "BOOT" area of Flash ROM base address is 00000H and RAM memory starts at 40000H. All memory and other board registers are mapped in memory address space; there are no I/O addresses used. Since none of the board level memory or registers require wait or idle states, the address strobe signal, AS.L, drives the access acknowledge signal, DTACK.L, through two inverters.

The DSP-4100 application software is stored in non-volatile Flash memory; new firmware is uploaded via the serial port. The BOOT ROM section of the Flash memory stores a boot-strap loading program and commonly used utility subroutines. The application program executes directly from the upload portion of the Flash ROM. The DSP code is transferred from a separate section from the Flash ROM during unit initialization.

The MC68EC000 has two possible board level interrupt sources: HREQ.L from the DSP and UINT.L from the serial port. The DSP-4100 microprocessor controller is reset when power is first applied. A dead-man timer automatically resets the microprocessor and starts running the power-on diagnostic routine.

3.1.2 Memory Decoding, Clocks, and Reset

Figure 3.3 illustrates the microprocessor memory decoding circuits, the clock oscillator and divider circuits, and the Flash memory programming voltage generator.

Since all board memory and registers are mapped in memory address space, one dual two line to four line decoder is used to enable individual ROM and RAM chips and other board registers. Note that the upper select signal UCS.L enables the upper ROM and RAM chips while the lower select signal LCS.L independently enables the lower ROM and RAM chips and other miscellaneous input and output registers. U15 and U28 decode all memory addressed. The DSP-4100 implements the address map shown in Table 3.1.

Note that all memory and peripheral devices operate without any externally added wait states.

The MC68EC000 system clock is provided by dividing the output of the 20.48 MHz clock (X1) by 2 to produce 10.24 MHz. This 10.24 MHz signal also clocks the Analog Interface Circuit (A/D and D/A, U3, Figure 3.8). X1 also provides the 20.48 MHz clock signal to the Digital Signal Processor (U11, Figure 3.7). A separate clock oscillator (X2) provides a 7.3728 MHz clock for the serial I/O UART (U10, Figure 3.4).

Transistor Q4 and Oscillator U26 generate a 12 VDC voltage which is used when Flash memory is reprogrammed. This programming voltage (VPROG) is normally set to +5 volts DC.

Table 3.1
DSP-4100 Address Map

Address Range	Signal	Description
00000H - 3FFFFH	ROML.L ROMH.L	ROM Memory Read (128K)
40000H - FFFFFH	RAM1L.L RAM1H.L	RAM Memory Read/Write (64K)
C0000H	CONTROL.L	Control Latch Write
C0010H	UART.L	Diagnostic Port (not used)
C0020H	HEN.L	DSP Read/Write
C0030H	Sanity Timer	
C0040H	LED.L	LED Control
C0050H	EECS.L	Serial EEPROM Control
C0060H	EEDO.L	Serial EEPROM Control

3.1.3 Serial I/O Port Circuitry

The serial I/O interface circuitry is shown in Figure 3.4. Two serial ports are supported in the DSP-4100. The dual USART device (U10) supports both ports. The data rate of both ports is the same and may be set via software command to rates from 1200 through 57,400 bps. The factory default setting is 9600 bps. Devices U7, U8, and U9 provide RS-232 level output and input signal levels for the primary and secondary serial ports. In normal operation, DSP-4100 control commands and data to be transmitted or received is passed via the primary port. Another serial device — such as the control port of an HF radio — may be connected to the DSP-4100 secondary serial I/O port (DB-25 pins 12,13,14,16,19). Upon receipt of a special command issued by the PC application program to the primary port, the DSP-4100 will divert all following data from the primary to the secondary port, bypassing the modem entirely. A second command will restore the primary port to modem command and data use. This capability allows a single com port on a lap-top or other portable computer to be used with the modem and control radio parameters as well. HAL DSP41.EXE terminal program does not support the secondary port.

3.1.4 Front Panel Indicator LED's

Six LED indicators are provided on the DSP-4100 front panel to show operational status of the modem. These indicators are decoded and driven by circuit U27, as shown in Figure 3.5. The LED status indications are:

Table 3.2
Front Panel Indicators

Name	Color	Indications when ON
STBY	Green	Standby and ready for use
CALL	Amber	Received its Selective Call
LINK	Green	Actively linked to another station
ERROR	Red	Receive error has been detected and is being corrected
TX	Red	Transmitter is turned ON and data is being sent
RX	Amber	Transmitter is OFF and the modem is in the receive state

3.1.5 PTT, FSK, and SELCAL Output Register; Hardware Reset Timer

Figure 3.6 shows the control latch register. Included on this latch are the PTT control output, the direct FSK output, the SELCAL output, and the hardware reset timer circuit. Note that the RESET.L signal clears all of the

outputs on this latch whenever a hardware reset is performed. The bit assignments for the control latch are shown in Table 3.3.

Table 3.3
DSP-4100 Control Latch

Bit	Description
7	(not assigned)
6	DSP Mode control signal B
5	DSP Mode control signal A
4	DSP Reset Output (active low)
3	(not assigned)
2	FSK Output (active high)
1	PTT Output (active high)
0	SELCAL Output (active high)

The FSK output is controlled by transistor Q1, the PTT output by transistor Q2, and the SELCAL output by transistor Q3. These outputs are all "open collector" and will only switch a positive voltage to ground. The ratings of the transistors should not be exceeded.

The hardware reset signal is controlled by the dead-man timer U24. During normal operation, this chip is continually re-triggered by 68STAT.L. However, should these pulses stop for more than about 250 ms, the hardware reset signal RESET.L is activated. In addition, the host PC application program may force a hardware reset with a certain I/O address that pulses RESETIN.

3.2 DSP-4100 DSP and Audio Section

3.2.1 DSP RAM

The DSP (U11) and associated 24 bit wide RAM (U4, U5, U6) is shown in Figure 3.7. During board initialization, the DSP program is downloaded from the Flash memory, through the MC68EC000 controller and into the DSP program RAM. The 8K 24-bit word DSP RAM is configured with 4K words of program memory, and 2K words each of X and Y data memory.

The DSP clock, DSPCLK, runs at a fixed 20.48 MHz rate, provided by X1 (Figure 3.3).

The DSP has one interrupt signal, HREQ.L, that it can use to interrupt the MC68EC000 during operation.

3.2.2 Audio Input/Output

The DSP-4100 audio input and output sections are very versatile. Once programmed, the DSP can generate nearly any audio waveform, and can receive and decode very complex audio signals, such as CLOVER-2000. As shown in Figure 3.8, the "Audio Interface Circuit" (AIC, U3) used in the DSP-4100 includes a 16 bit A/D converter to sample the input audio signal, and a 16 bit D/A converter to generate the audio output signal.

In the modulator audio output, two op amp sections (U2) provide a four-pole low pass filter with a design cutoff frequency of 3 kHz to filter any quantizing noise and clock leakage on the output of the D/A converter. Jumper option J2 is provided to select an audio output level of 0 dBm (jumper installed) or -30 dBm (jumper open). Transformer coupling permits a balanced or unbalanced 600 ohm output, depending on which is required.

The audio input circuitry is very simple. Due to the wide dynamic range of the A/D converter (U3), no input AGC or analog filtering is required. Transformer coupling between the audio input and the A/D converter permit either balanced or unbalanced input connections. The nominal input impedance is 10,000 ohms.

The Audio Interface Circuit operates with an internal clock of 10.24 MHz from U13 (Figure 3.3). The connection between U3 and the DSP is a serial data channel.

3.3 DSP-4100 Power and I/O Connections

Figure 3.9 summarizes all the DSP-4100 input and output connections. Connectors J1, J3, and J4 are located on the rear panel of the modem.

The DSP-4100 uses +5 VDC and -5 VDC for all circuits — analog or digital. The nominal +12 VDC input (18 V maximum) is converted to +5 VDC by regulator VR3. Voltage converter VR1 and regulator VR2 provide -5 VDC for the analog circuits. As described previously, Q4 and U26 (Figure 3.3) provide a 12 VDC programming signal to the Flash memory IC's.

3.4 DSP-4100 Options

The DSP-4100 has few board options. As illustrated in Figure 3.6, jumper field J5 is provided for access to test routines. The J5 test options are shown in Table 3.4.

Table 3.4
J5 Test Options

J5 Jumper	Routine
1	Start Flash Loader
2	Start TEST Routines (@9600 bps)
3	Start MONITOR Routines
R	Hardware Reset

The J5 jumper field is read only during DSP-4100 power-on initialization. Shorting J5 on positions #1, #2, or #3 forces the DSP-4100 to the routine shown above. Options #1 and #3 start with the serial port set to the value stored in EEPROM. Option #2, TEST, always runs at 9600 bps and it stores that value in EEPROM. Option #R produces a hardware reset each time these pins are shorted. The factory setting for J5 is with all pins open-circuited (no jumper and no options selected).

Jumper J2 may be changed to adjust the maximum modulator output level between -30 dBm or 0 dBm (600 ohm reference).

There are no user serviceable parts or adjustments on the board except for the options and the modulator output level adjustment. The removal of the DSP4100 board requires replacement of the +5 and -5 regulator insulators. Typical installations should require no changes in the factory settings.

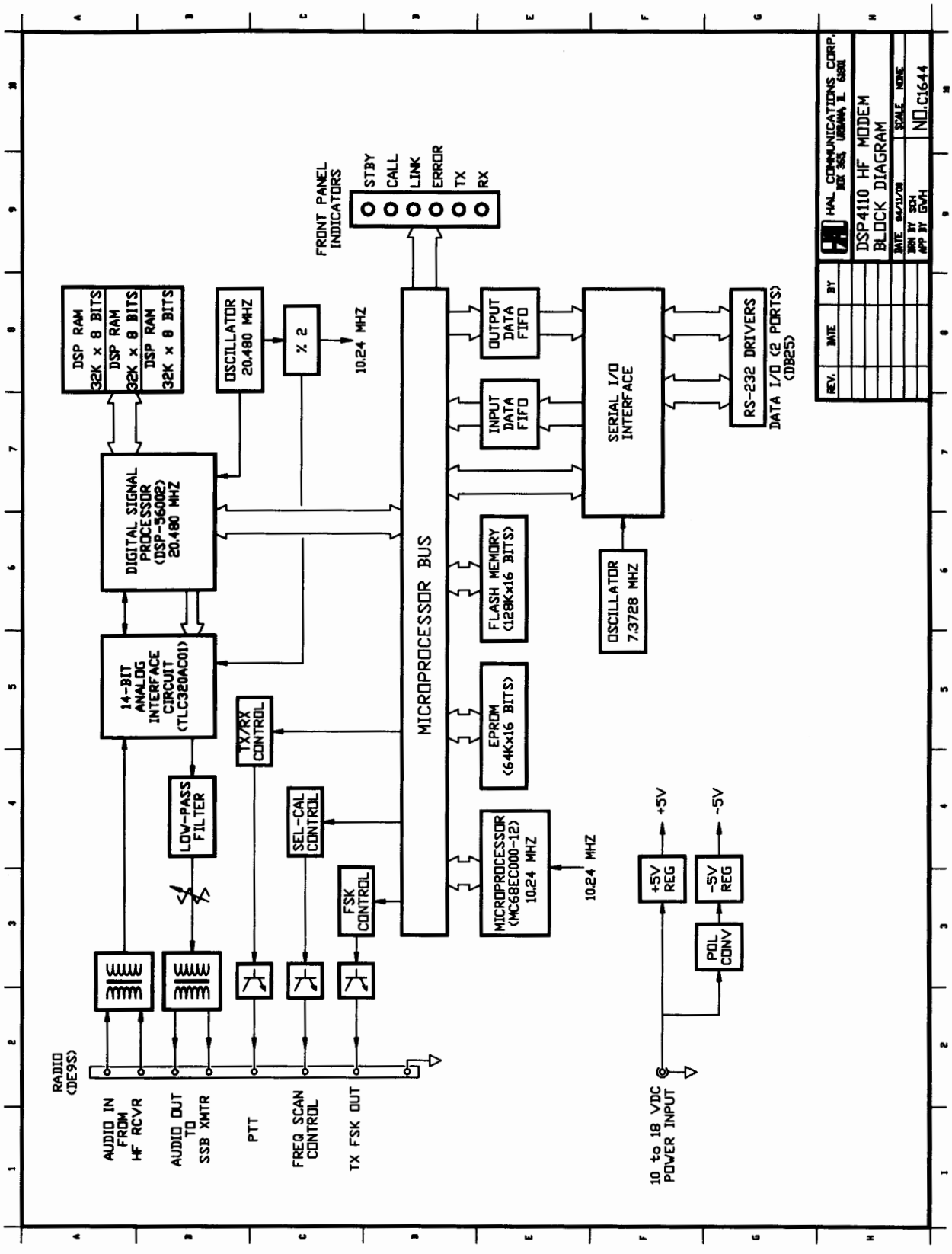

Figure 3.1 DSP-4100 Block Diagram

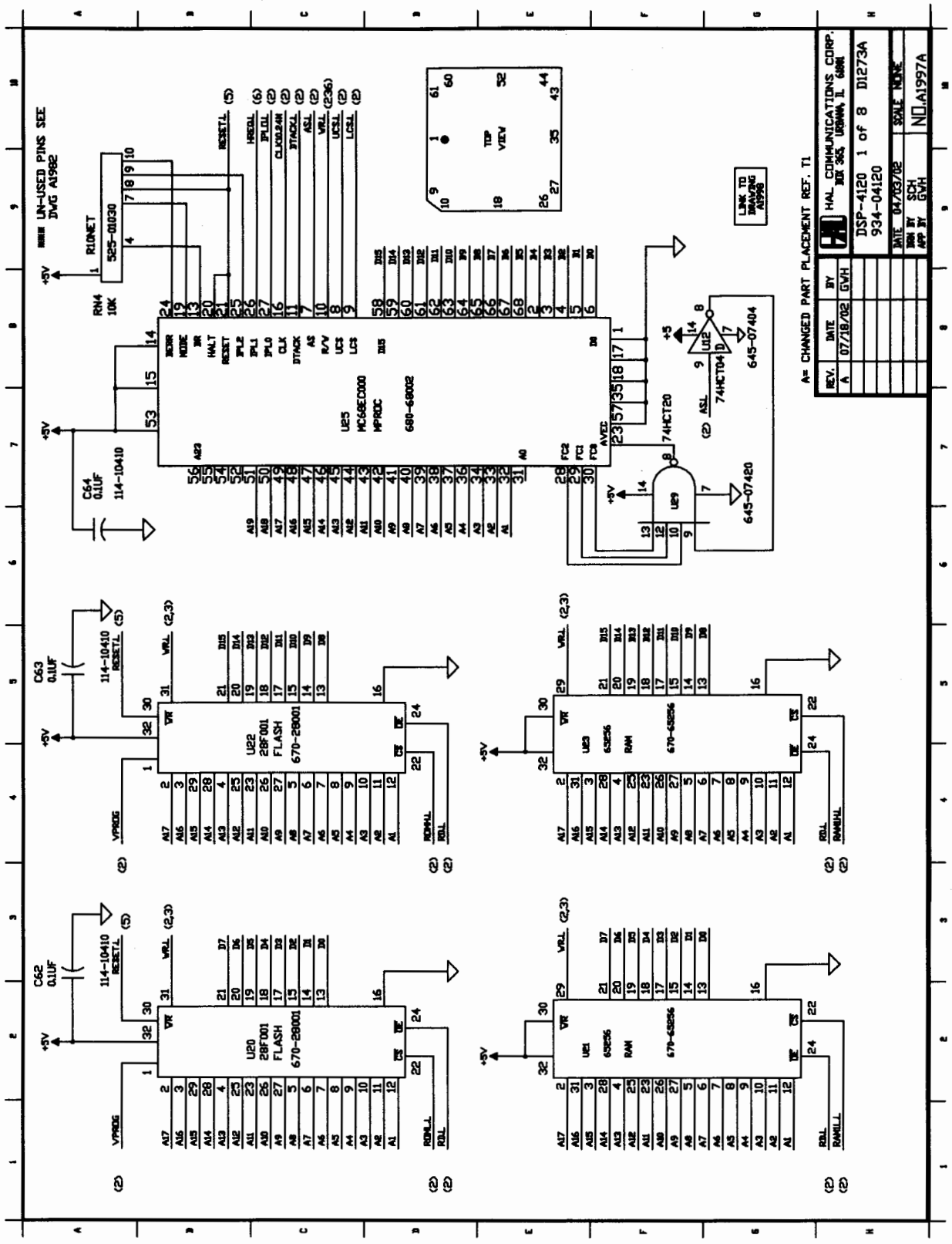

Figure 3.2 Control Processor, RAM, Flash ROM

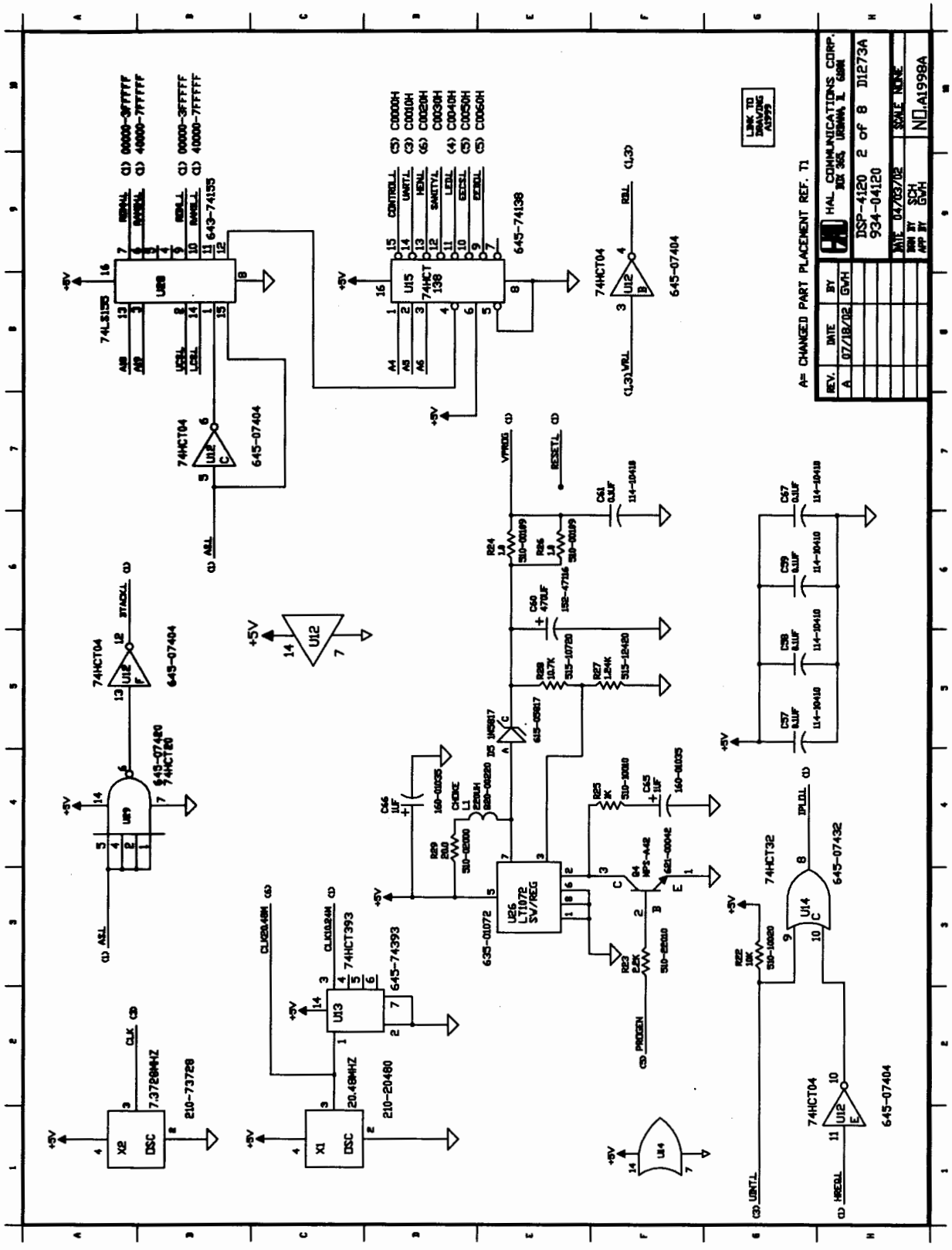

Figure 3.3 Clocks, Control, Programming Power Supply

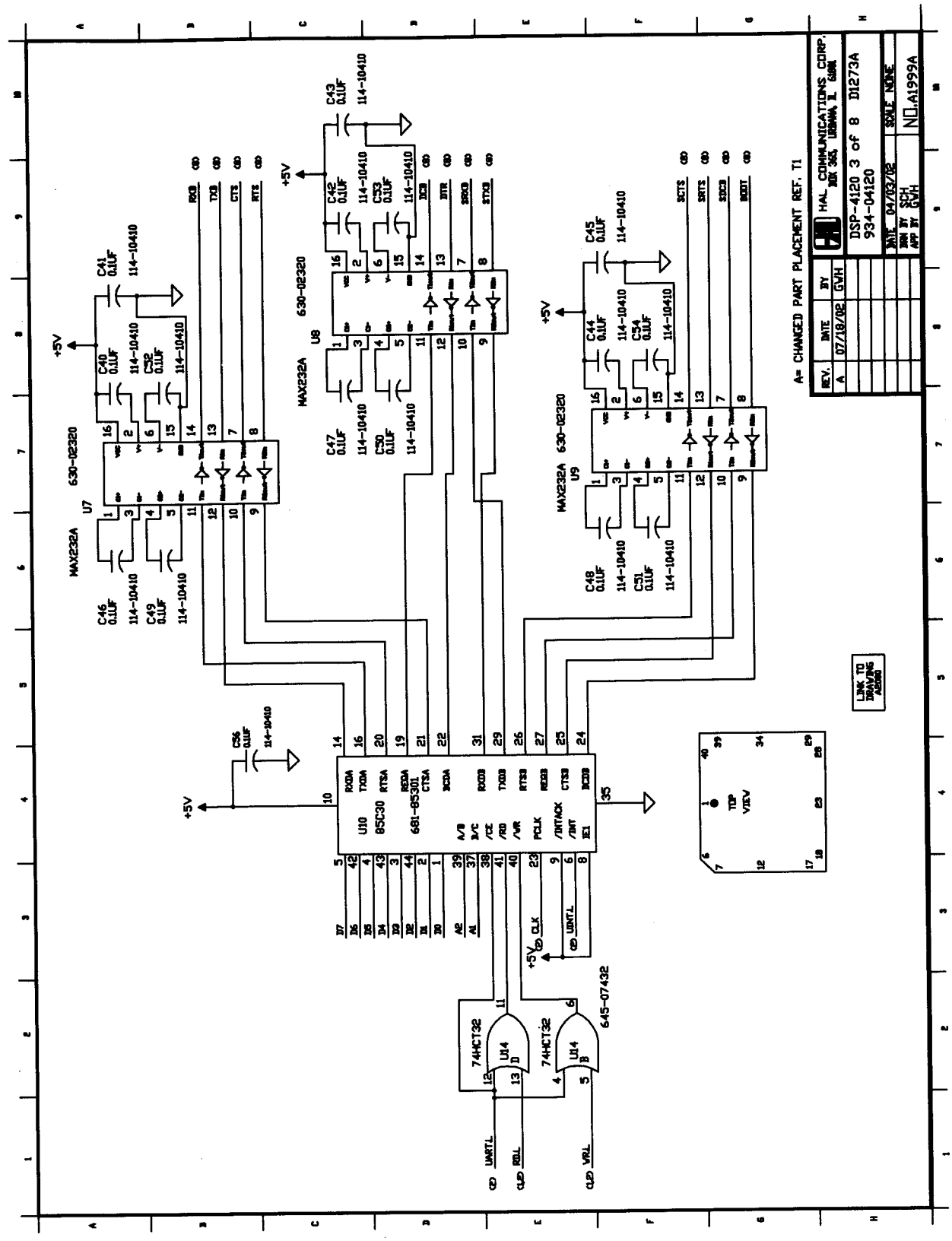

Figure 3.4 Serial I/O Port

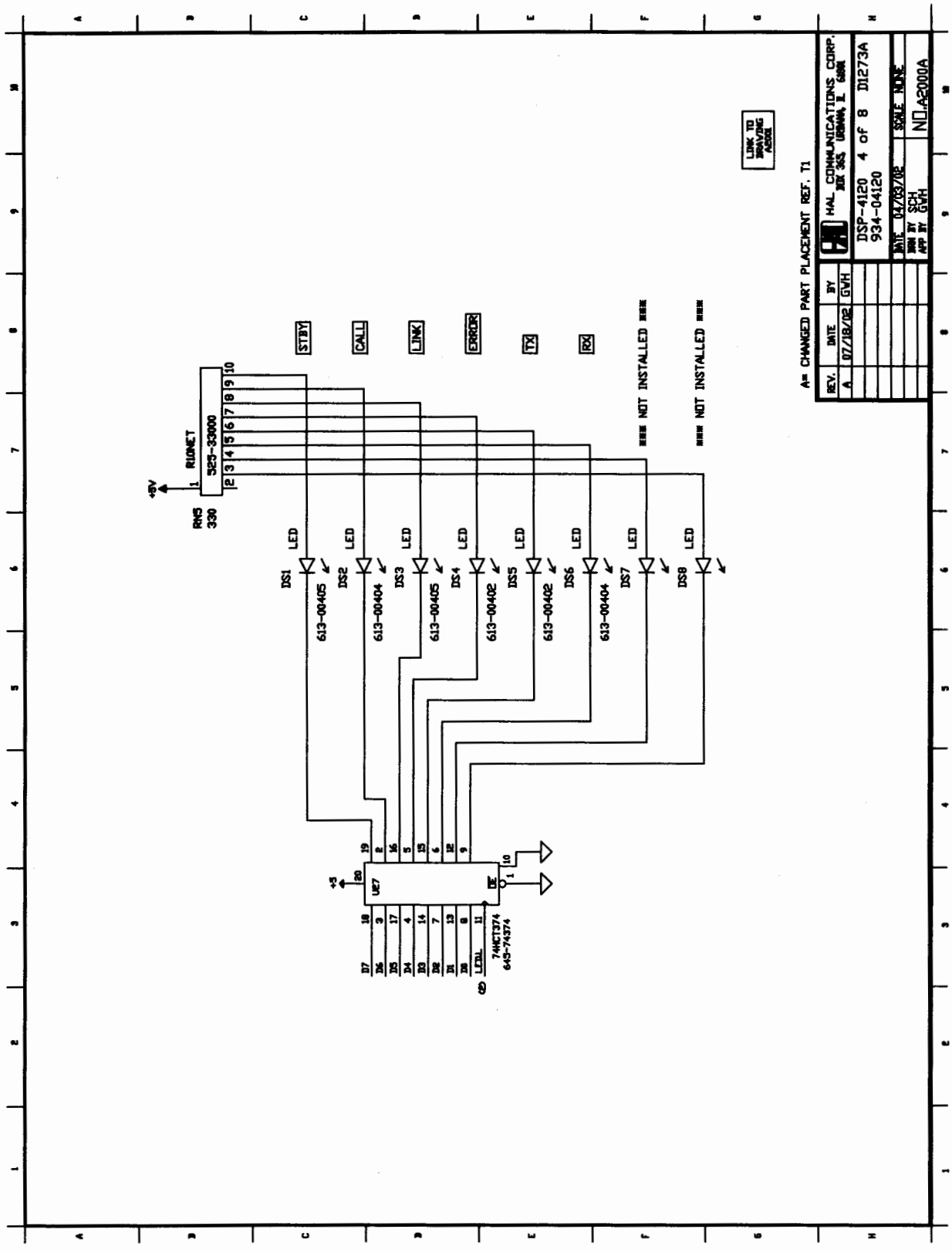

Figure 3.5 Front Panel Indicators

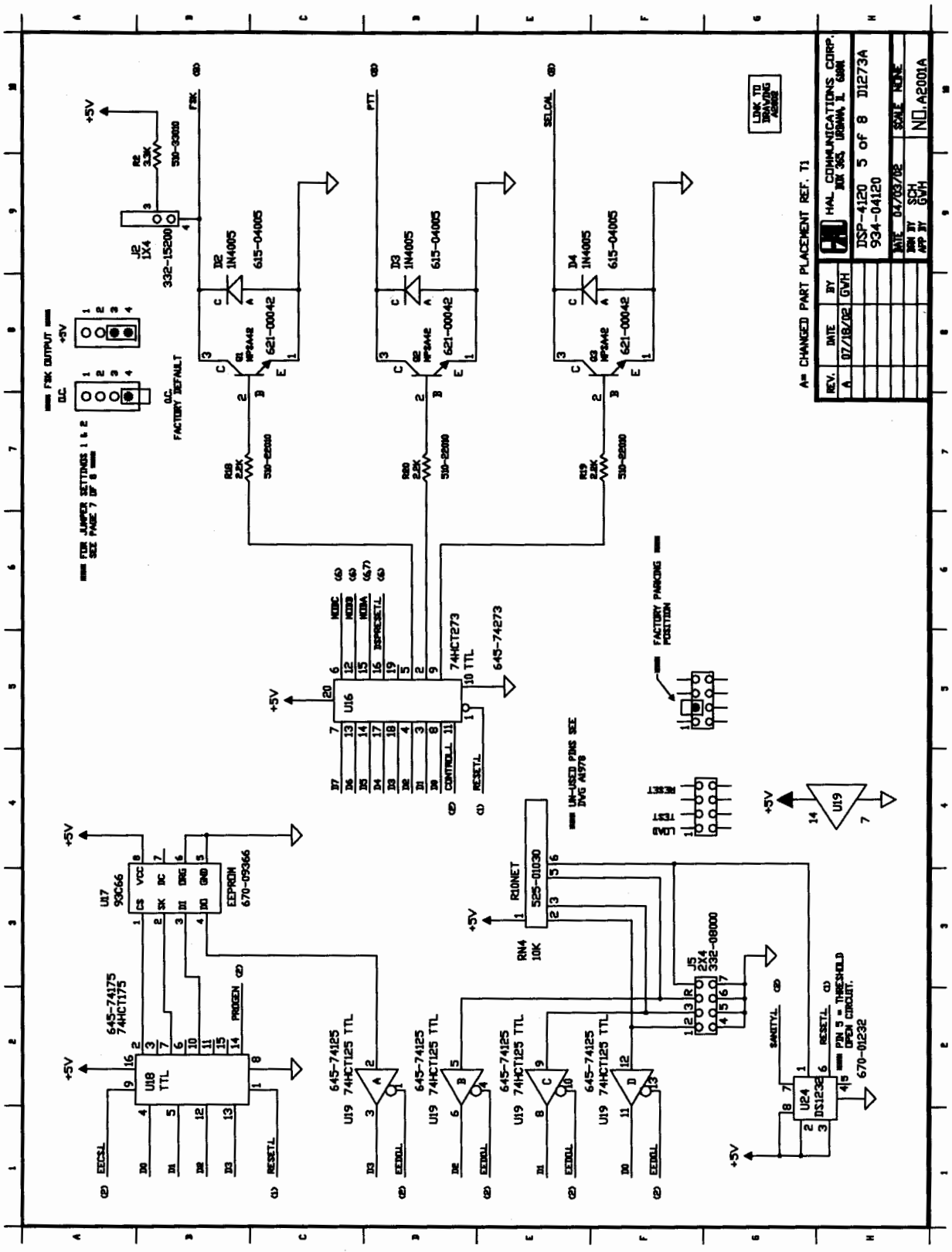

Figure 3.6 Sanity Timer, FSK, PTT, SEL-CAL Outputs

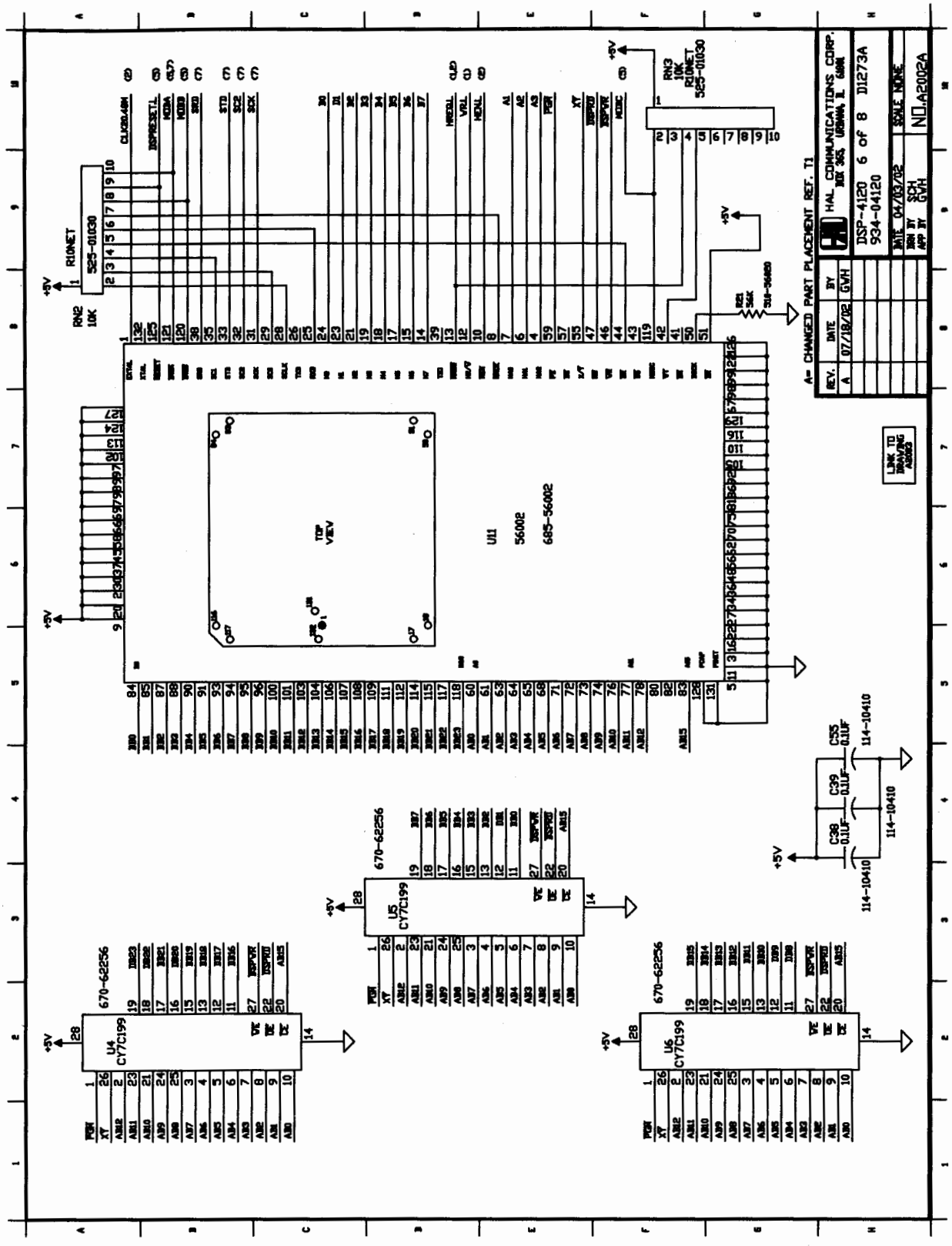

Figure 3.7 Digital Signal Processor, DSP RAM

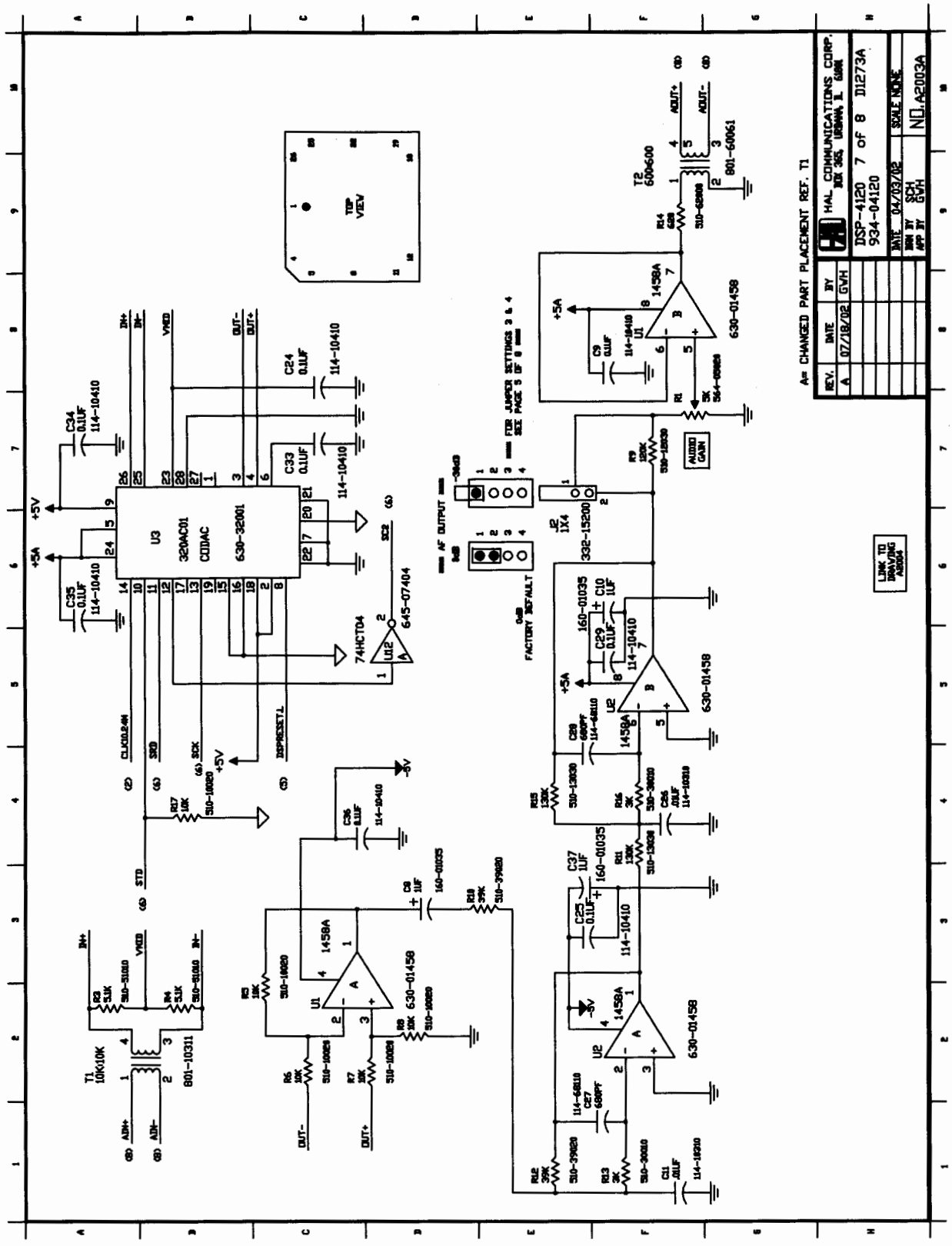

Figure 3.8 A/D, D/A, Audio I/O

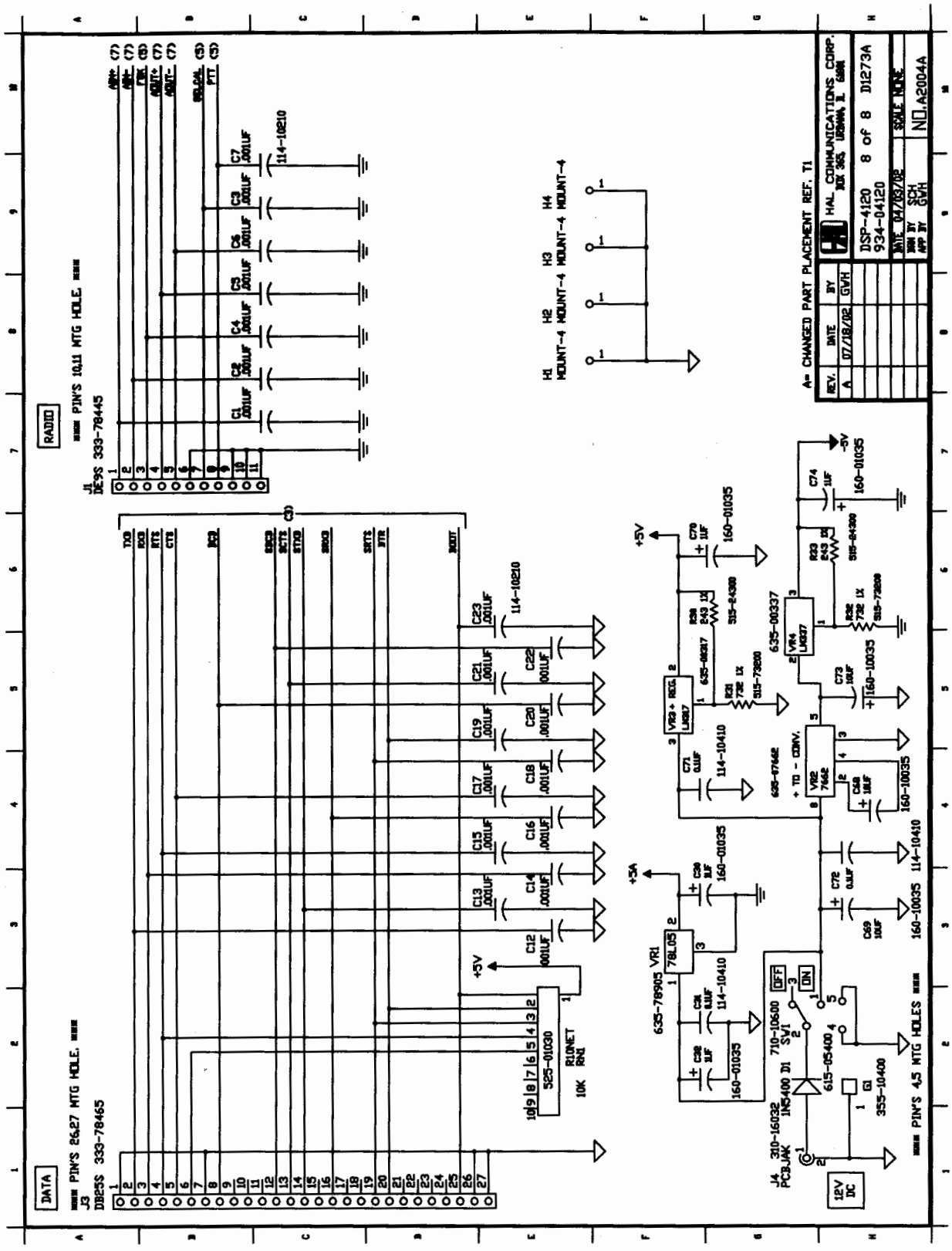

Figure 3.9 Voltage Regulators, Rear Panel Connectors

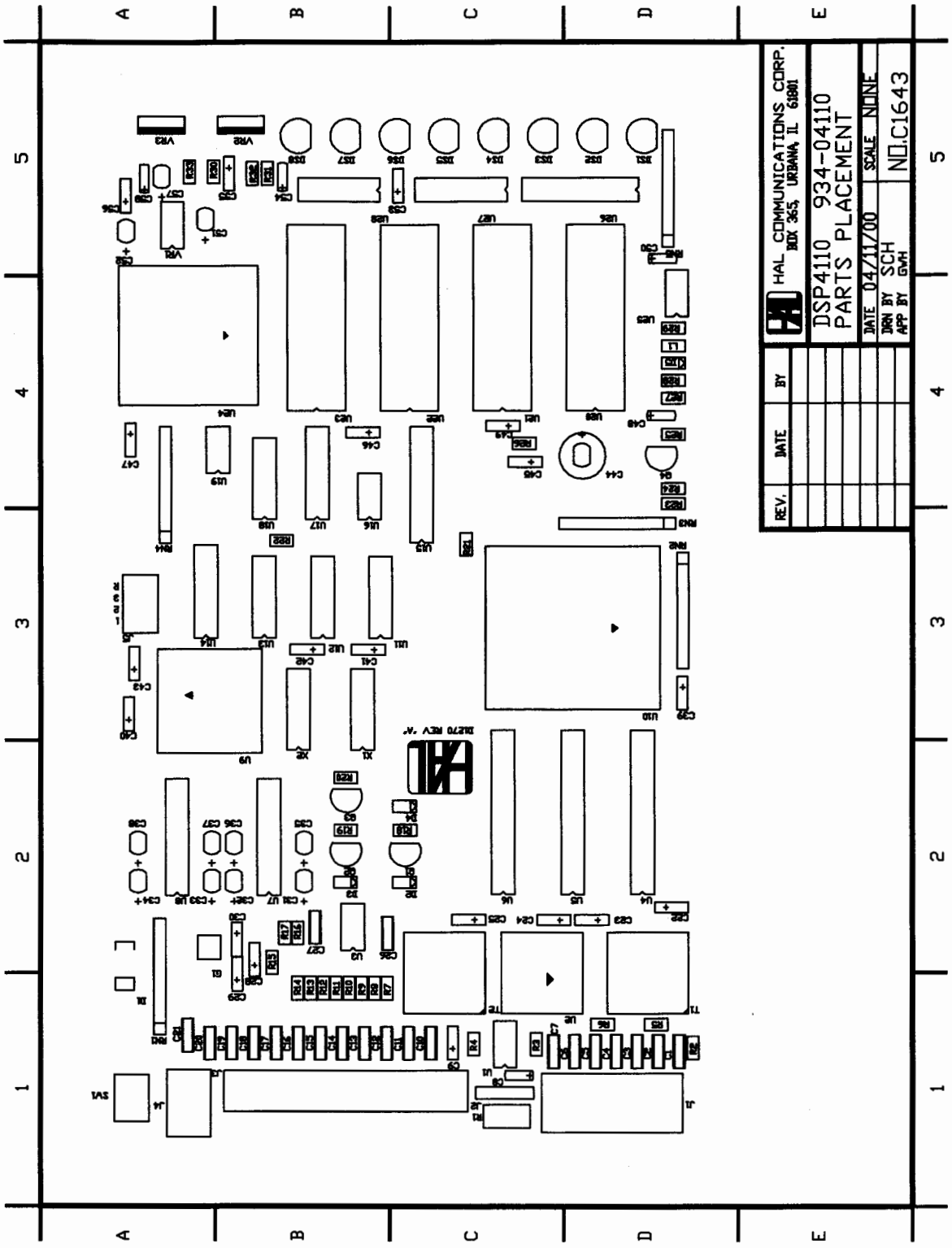

Figure 3.10 DSP-4100 Parts Placement

CHAPTER 4

IN CASE OF DIFFICULTY

This chapter provides general guidance in case your DSP-4100 hardware and/or software no longer function correctly. Please read all sections before attempting maintenance or returning a DSP-4100 to the factory.

4.1 User Adjustments and Alignment

The DSP-4100 circuitry is completely digital and has *no* alignment controls. However, there are user-settable jumpers and an output level control which might be incorrectly set. The correct procedures to set these options are discussed in the manual sections shown in Table 4.1 below. Before considering any other maintenance procedures, re-read the referenced section and confirm that each option is set correctly.

Table 4.1
User-Set Options

Setting	Function	Manual Section
J1	Test Options & RESET	Section 3.4; Table 3.4
J2	FSK Level	Section 2.2.5; Table 2.3
J2A	Modulator Output Range	Section 2.2.2; Table 2.2
R1	Modulator Output Level	Section 2.2.2; Table 2.2

Unless changes have been made in the PC or radio system, none of these options should have changed from when the DSP-4100 was first installed.

4.2 DSP-4100 Hardware Problems

DSP-4100 hardware problems will generally be caused by one or more of the following situations:

1. Incorrect power connector: The DSP-4100 uses a coaxial DC power plug. The correct plug is HAL P/N 310-16030. Additional plugs may be purchased directly from HAL. The correct dimensions of the plug barrel are: 2.5 mm ID x 5.5 mm OD x 9.5 mm long. Use ONLY the correct plug! Many "all purpose" plugs look similar but do not provide reliable connection.

2. Inadequate power supply capacity. The DSP-4100 requires a stable +12 to 18VDC power supply. While a 250 ma power supply will support normal operation of the DSP-4100, a supply with a capacity of 500 ma is required when programming the Flash ROM.

3. Incorrect voltage or excessive current: Exceeding the voltage or current rating of any of the radio I/O connections may damage DSP-4100 components. The maximum rating of each connection is shown in Table 2.1; do not exceed these limits. Static electricity or lightning is a common way that one or more of these limits may be exceeded.

4. Radio problems: Faults in the transmitter or receiver may at first appear to be DSP-4100 problems. Confirm that radio controls are set correctly and that the radio equipment operates as it should.

5. Transmitter RFI into PC or modem: Radio frequency interference (RFI) can be a major problem, particularly if transmitter energy invades the PC itself. A good RF ground connection (1/4" wide shield braid) should always be made between the cabinets of the PC and the radio equipment. All cables should be shielded and as short as possible — no more than ten feet long. Test for transmitter RFI by transmitting at very low power into a well shielded dummy load (1 to 10 Watts). If the DSP-4100 works correctly with low power into a dummy load but not with normal power to the antenna, the RFI problem *must* be cured before the DSP-4100 may be used to its full potential.

6. RFI to the receiver: This may be heard in the form of "birdie" signals at various frequencies. As in the case of transmitter RFI, good grounding, shielding, and short cables are the best cures. Also, "modern" PC cabinets and CRT monitors (made since 1991) have *considerably* better shielding and RFI suppression than their predecessors. Pre-1991 slow PC's (PC-XT, etc.) tended to generate less RFI than faster models ('286, etc.). Since 1991, this no longer appears to be the case as modern '386 PC's are often quieter than early PC-XT's.

4.3 Software Problems

The relative ease by which DSP-4100 may be upgraded or changed can cause unanticipated problems. This is particularly true when new factory upgrade files are uploaded. Whenever new files from HAL are loaded and used, be sure to use all of the new files provided and do not mix old and new versions of the files. This is particularly true of mixing different releases of ?.S28 (68000 software) and ?.LOD files (DSP software). If your modem was provided as part of a communications system provided by a firm other than HAL, be careful about mix-ing HAL files with the communications systems files. The two are probably not compatible. Some commercial ver-sions of the DSP-4100 may be used only with the system software provided with the modem and may not work at all with standard HAL software.

4.4 Operational Problems

CLOVER-2000 is a new waveform and new protocol. Some operations which are in fact "normal" may at first appear to be a "problem". Typical situations which may produce confusing results are:

1. CLOVER-2000 may be operated either in Upper or Lower Side Band, but both stations must be the same.

2. CLOVER-2000 signals must be tuned correctly at the *receiver*. Optimum performance will be obtained only when tuning is correct. However, the CLOVER modem must also obtain frequency, phase, and time synchronization from the received signal. To minimize the effects of noise and short-term ionosphere variations, a running- average integration is computed over a .5 second period (approximate length of a data pulse). Each time the receiver tuning control is adjusted, the integration process is disturbed and that data block will usually be "damaged" — data will not be recovered and a repeat will be necessary in ARQ mode. Further, it may take receipt of several more data blocks to regain synchronization. CLOVER-2000 transmissions also use long blocks — 1 to 5 seconds long. The tuning indicators are updated only *once per data block*. Receiver tuning adjustments at a faster rate will not produce useful results and may in fact confuse the system. The following guidelines are recommended:

    a. Tune the receiver *slowly*. One increment per data block is sufficient.

    b. Avoid the temptation to make small, frequent receiver adjustments.

3. CLOVER-2000 adaptive ARQ mode measures receive signal parameters and then sets the optimum transmit modulation mode *from the other station*. If your station appears unable to send data at a fast rate, it is due to receive conditions *at the other station* and usually *not* transmit problems at your station.

4. If it appears that many stations have difficulty transmitting data to you at a high rate, it *could* be due to a problem in your receiving equipment, particularly if these also appear to be strong and stable signals. Typical receiver parameters which can limit CLOVER performance are:

    a. Receiver AGC set to FAST mode distorts 8P2A or 16P4A — use the SLOW AGC setting

    b. Always use the standard SSB receiver filter.

    c. Noise limiter or blanker distorts CLOVER — turn OFF.

    d. Receiver drift can exceed CLOVER compensation; retune as required.

5. CLOVER-2000 uses long data blocks and multi-level modulation to obtain high data throughput. However, the ARQ transmit/receive protocol operates much slower than other popular ARQ modes — AMTOR, PACTOR, or packet radio. It must be remembered that all aspects of CLOVER ARQ mode occur at a slow rate and that major changes must occur in increments of 5.5 seconds (ARQ frame time). Have patience and wait for CLOVER to finish its assigned task before rushing into a new mode or assuming that something is not quite right.

4.5 User Service

The DSP-4100 does not require periodic alignment or renewal of any component. Components should be replaced only if they fail and not as a part of any routine maintenance procedure. As a general rule, component replacement should be done at the factory under controlled ESD (Electro-Static Discharge) conditions. Before returning the DSP-4100 to the factory, please check the following:

1. All jumpers and option switches are set correctly.

2. All socketed components are fully seated in their sockets.

3. Cables to the DSP-4100 are installed and are not open or shorted.

4. All other features of your computer and radio equipment function correctly.

If the all items are correct, contact the factory to arrange for return and repair.

4.6 Customer Service

Customer service personnel may be contacted directly via telephone, FAX, or Internet.

Before contacting customer service, have the model number, serial number, software version numbers, and name or original ordering customer available.

Customer Service
HAL Communications Corp.
PO Box 365
Urbana, IL 61801-0365

Phone: 217-367-7373
(8AM - 5PM CST/CDT; Mon. - Fri.)
Fax: 217-367-1701
E-mail: halcomm@halcomm.com
Web: www.halcomm.com

4.7 Returning Equipment for Factory Repair

If your equipment must be returned to HAL for repair, please do the following:

1. Call, FAX, or write to HAL and obtain a *Return Authorization.*

2. *ALWAYS* include the following information *in the package containing the item to be repaired:*

   a. Your name, and address for return of the repaired equipment. *Give a street address if at all possible.*

   b. Model, serial number, and approximate purchase date of returned item.

   c. If the warranty period has expired, the payment means you prefer. For warranty details see LIMITED WARRANTY.

   d. A *short but informative* description of the problems. "Broken" is too short: 2 or more pages is usually too much!

   e. The shipping carrier or means by which the equipment should be returned to you. HAL will use UPS (Brown Label) shipping unless otherwise directed.

3. Carefully pack the DSP-4100 and protect it from shipping damage. The original HAL carton is a good choice if it is available and undamaged. A new carton may be purchased from HAL.

4. Insure the DSP-4100 for its full value.

5. Clearly mark HAL's name, address, and "ATTN: SERVICE" on the shipping box.

The HAL service department attempts to repair all equipment within 30 days of its arrival at HAL. If the repairs cannot be made within 30 days, you will be notified by mail of the approximate shipping date. You may call the HAL service department to confirm repair dates.

If you require rush service of your DSP-4100, please notify HAL and we will make all attempts possible to expedite your repair. However, our service time is often conditional upon arrival of parts which is not within our control. Also, please understand that testing takes time and that each hardware repair should be "burned-in" for an extended period (24 hours) and re-tested.

Also, be sure that you have thoroughly checked all other equipment connected to the DSP-4100 and that the DSP-4100 is actually at fault. It takes much longer to test a device that is in fact not defective. We must charge for all repair time, including time spent testing a device that is not defective. A thorough examination of the problem by you and a clearly written description of problems noted will save time and money for both of us.

CHAPTER 5

SPECIFICATIONS

INPUT/OUTPUT:

AF IN: Audio from receiver;
30 mV to 3 V rms (-30 to +10 dBm);
Zin = 10,000 ohms

AF OUT: Audio output to transmitter;
2.5 mV to 1.5 V rms (-50 to +6 dBm);
Zout = 600 ohms

PTT: Push-To-Talk TX/RX control output
+50 VDC open-circuit (RX) maximum
+100 ma DC closed-circuit (TX) maximum

FSK: FSK transmit data output
+50 VDC open circuit maximum
+100 ma DC closed circuit maximum

SEL-CAL: Selective Call control output
+50 VDC open circuit maximum
+100 ma DC closed circuit maximum

CLOVER-2000 WAVEFORM:

Tone Pulses: 8 Tone pulses, spaced 250 Hz and 2 ms apart; amplitude shaped for -50 dB composite side-lobe suppression.

TONE PULSE	FREQUENCY
Fc (center)	1500.0 Hz
1	625.0 Hz
2	1625.0 Hz
3	875.0 Hz
4	1875.0 Hz
5	1125.0 Hz
6	2125.0 Hz
7	1375.0 Hz
8	2375.0 Hz

Frequency Spectra: Fc ±1500 Hz;
Bandwidth = 2000 Hz @ -50 below peak level.

TX Crest Factor: Peak/Average ≤ 2:1 (voltage)
≤ 6 dB (power)

CCIR Emission: 2K0H J2 DEN or 2K0H J2 BEN

Modulation: 62.5 baud, all modulation formats

Modulation Format: Five modulation modes using Phase Shift Modulation (PSM), Amplitude Shift Modulation (ASM), Frequency Shift Modulation, and multiple combinations.

MODE	DESCRIPTION	RATE
16P4A	16PSM + 4 ASM	3000 bps
8P2A	8PSM + 2 ASM	2000 bps
8PSM	8-ary PSM	1500 bps
QPSM	Quadrature PSM	1000 bps
BPSM	Binary PSM	500 bps

Error Correction: Reed-Solomon (GF(2e8)) data encoding.
Block Sizes = 17, 51, 85, 255 bytes
Coding Efficiency = 60%, 75%, 90%

CLOVER-2000 PROTOCOL:

CLOVER Control Block (CCB): Underlying synchronizing and control signaling layer for all CLOVER transmissions.

CCB Format: Always same or more robust than data blocks. BPSM/17/60 for all ARQ transmissions.

ARQ Mode: One transmitter to one receiver point-to-point mode. Reed-Solomon forward error correction coding. Repeat transmission of uncorrectable data blocks. Adaptive selec tion of waveform modulation for 5 ranges: 210, 140, 105, 70, or 35 bytes-per-second (byps). Automatic transmitter power control.

CLOVER-II WAVEFORM:

Tone Pulses: 4 tone pulses, spaced 125 Hz and 8 ms apart; amplitude shaped via Dolph-Chebychev for -60 dB composite side-lobe compression.

Channels: 4 tone channels; Channel #4 is default in PC-CLOVER

F	CH. 1	CH. 2	CH. 3	CH. 4
Fc	750.0 Hz	1250.0 Hz	1750.0 Hz	2250.0 Hz
1	562.5 Hz	1062.5 Hz	1562.5 Hz	2062.5 Hz
2	687.5 Hz	1187.5 Hz	1687.5 Hz	2187.5 Hz
3	812.5 Hz	1312.5 Hz	1812.5 Hz	2312.5 Hz
4	937.5 Hz	1437.5 Hz	1937.5 Hz	2437.5 Hz

Frequency Spectra: Fc ±250 Hz; Bandwidth = 500 Hz @ -50 below peak level.

TX Crest Factor: Peak/Average ≤ 2:1 (voltage)
≤ 6 dB (power)

CCIR Emission: 500H J2 DEN or 500H J2 BEN

Modulation: 31.25 baud, all modulation formats

Modulation Format: Six modulation modes using Phase Shift Modulation (PSM), Amplitude Shift Modulation (ASM), Frequency Shift Modulation, and multiple combinations.

MODE	DESCRIPTION	RATE
16P4A	16PSM + 4 ASM	750 bps (ARQ Only)
8P2A	8PSM + 2 ASM	500 bps (ARQ Only)
8PSM	8-ary PSM	375 bps
QPSM	Quadrature PSM	250 bps
BPSM	Binary PSM	125 bps
2DPSM	Dual Diversity BPSM	62.5 bps (FEC Only)

Error Correction: Reed-Solomon (GF(2e8)) data encoding.
Block Sizes = 17, 51, 85, 255 bytes
Coding Efficiency = 60%, 75%, 90%

CLOVER-II PROTOCOL:

CLOVER Control Block (CCB): Underlying synchronizing and control signaling layer for all CLOVER transmissions.

CCB Format: Always same or more robust than data blocks. 2DPSM/17/60 for all FEC transmissions. BPSM/17/60 for all ARQ transmissions.

FEC Mode: One transmitter to multiple receiver broadcast mode. Reed-Solomon forward error correction coding. Data throughput set in 6 ranges: 60, 40, 30, 20, 10, or 5 bytes-per-second (byps)

ARQ Mode: One transmitter to one receiver point-to-point mode. Reed-Solomon forward error correction coding. Repeat transmission of uncorrectable data blocks. Adaptive selection of waveform modulation for 5 ranges: 60, 40, 30, 20, or 10 bytes-per-second (byps). Automatic power control of transmitters.

LISTEN Mode: Monitor all FEC or ARQ CLOVER transmissions. Identify call signs of all CLOVER signals. Identify and track waveform of received signals.

CW ID: Morse code (20 wpm) identification of station call sign. Optional ON/OFF and 10-minute automatic timer.

FSK MODES:

MODES: TOR (SITOR), P-Mode, Baudot RTTY, ASCII RTTY

FSK TONES: 500 Hz through 3000 Hz, programmable

FSK RTTY: Codes: Baudot / CCITT#2, ASCII
Data Rates: Baudot: 45, 50, 57, 75 Baud
ASCII: 75, 110 Baud

TOR (SITOR): Specification: CCIR-476 & CCIR-625
Modes: ARQ, FEC, SEL-FEC, Listen
Data Rate: 100 Baud

P-Mode: Modes: Auto-ARQ, FEC, Listen
Data Rates: 100 / 200 Baud

HARDWARE:

AUDIO I/O:	TI TLC-320AC01/2 16 Bit A/D & D/A Converter; Transformer isolated audio input and output
DSP:	24-bit DSP-56001A @ 20.48 MHz
CONTROL:	16-bit 68EC000 Control Processor @ 10.24 MHz
MEMORY:	Flash ROM loaded via serial I/O port
DATA PORT:	Serial RS-232 Control/Data Port; to 57,600 bps (DB25)
POWER:	+10 to +18 VDC @ 250 ma power (500 ma to program ROM)
INDICATORS:	STBY, CALL, LINK, ERR, TX, RX
RADIO I/O:	RX Audio, TX Audio, PTT, FSK, SEL-CAL (DE9)

MECHANICAL:

CABINET:	Black,Extruded 5.25" x 1" Aluminum
CONNECTORS:	Radio: DE-9S Connector Data: DB-25S Connector Power: 5.5/2.5 mm Coaxial Connector
WEIGHT:	2.75 lbs (1.25 kg) net, 5.0 lbs (2.3 kg) shipping

LIMITED WARRANTY

HAL Communications Corp. of Urbana, Illinois, hereby warrants to the purchaser that the product herein described shall be free from defects in materials and workmanship, and from failure of operation from ordinary use, for a period of one year from the date of sale to the purchaser.

In the event of a defect in materials or workmanship during the warranty period, HAL Communications Corp. will, at its own expense, repair the defective unit and replace any defective parts. Cost of shipping the unit to HAL Communications Corp. as well as costs of removal and reinstallation of the unit shall be paid by the purchaser. HAL Communications Corp. will pay the shipping costs incurred in returning the unit to the purchaser. To obtain warranty service, the customer should:

1. Notify the customer service department of any suspected defects as soon as possible. Customer service may be contacted via phone, FAX, mail, or e-mail at:

Customer Service
HAL Communications Corp.
PO Box 365
Urbana, IL 61801-0365

Phone: 217-367-7373
(8AM - 5PM CST/CDT; Mon. - Fri.)
Fax: 217-367-1701
E-mail: halcomm@halcomm.com
Web: www.halcomm.com

2. At the time of notification, identify the serial number, and the possible defect.

3. HAL Communications will issue a Return Authorization Number at this time.

4. Return the unit, freight prepaid. Include in the shipping carton a reference to the Return Authorization Number and a brief description of the problem.

Correct installation, use, maintenance, and repair are essential for proper performance of this product. The purchaser should carefully read the equipment manual. The purchaser will be billed for labor and shipping charges on any unit determined by HAL to be in working order when received for repair.

This warranty does not apply to any defect which HAL Communications Corp. determines is due to any of the following:

1. Improper maintenance or repair, including the installation of parts or accessories that do not conform to the quality and specifications of the original parts;

2. Misuse, abuse, neglect, improper installation, or improper operation, including improper AC power and RF grounding techniques.

3. Accidental or intentional damage.

All implied warranties are limited in duration to a period of one year from the date of purchase by the original retail purchaser. HAL Communications Corp. disclaims any liability for incidental or consequential damages arising out of the use of, or inability to use, this product. This warranty gives you specific legal rights, but there may be additional rights.