OPERATION AND SERVICE MANUAL

KU BAND UPCONVERTER

UCS SERIES

Part Number: TM USCK

THIRD EDITION

COMSAT RSI

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SECTION 1
GENERAL INFORMATION

1-1. INTRODUCTION

This instruction book contains installation, operation, maintenance, and parts information for the UCS singleband SATELLITE Ku BAND UPCONVERTER, manufactured by COMSAT RSI, Anghel Laboratories, Rockaway, New Jersey.

1-2. PURPOSE OF EQUIPMENT

The UCS upconverter is a fully synthesized upconverter having an input IF frequency of 70 (140) MHz and covering the Ku band output RF frequencies in up to 1kHz steps. It incorporates extensive monitor and control functions that are accessible from the front panel as well as through the remote RS-422 bus. The UCS upconverter is housed in an enclosure destined for mounting in a standard EIA 19-inch rack, requiring a 1.75-inch high vertical space.

1-3. SPECIFICATIONS

The specifications for the UCS upconverter are listed in Table 1-1. Mechanical dimensions for the unit are shown in Figure 2-1.

1-4. CONTROLS AND INDICATORS

All the operating controls and indicators for the UCS upconverter are located on the front and rear panels. The front panel is depicted in Figure 1-1 and incorporates, from left to right, a model number label, a two-line alpha-numeric backlit LCD display, a red LED summary alarm indicator, a tactile-feedback keypad, an IF monitor jack (BNC), an RF monitor jack (SMA) and the optional power switch (S1) location. When the unit is powered on, the LCD display indicates power on condition by displaying the major operating parameters. The various monitor and control functions are accessed by using the two MENU keys on the keypad. For detailed operating instructions, refer to Section 3-2.

The rear panel is depicted in Figure 1-2 and incorporates, from left to right, the power switch (S1), the power connector with fuse holder (J1), the forced air outlet, remote monitor and control connectors (J4, J5 and J6), chassis ground, the RF output connector (J3), the IF input connector (J2) and an optional external Reference Input connector (J7). Other openings in the rear panel are for cooling air inputs.

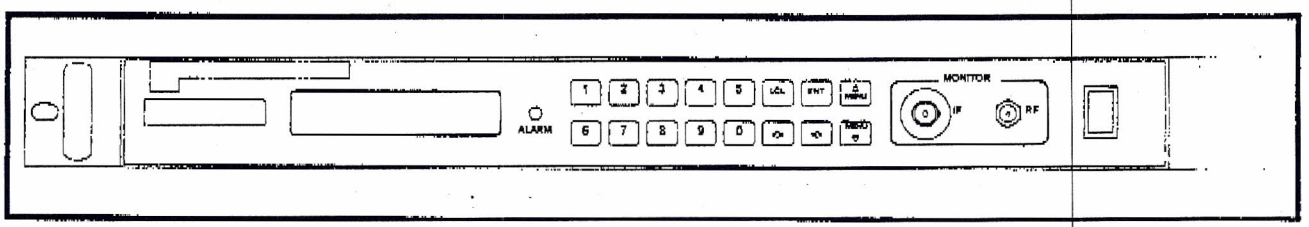

FIGURE 1-1. FRONT PANEL

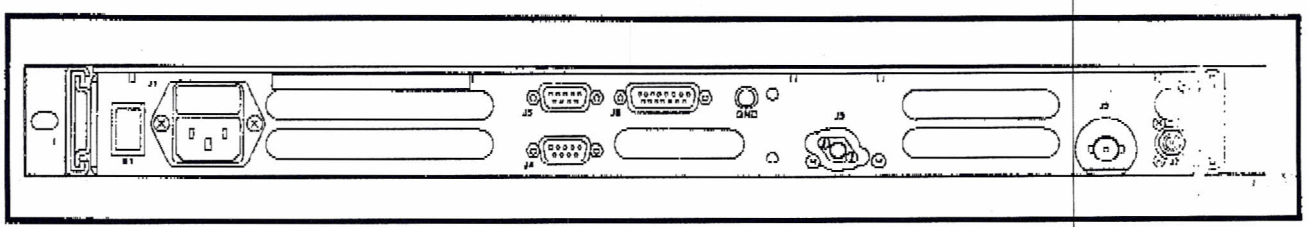

FIGURE 1-2. BACK PANEL

TABLE 1-1. UCS SINGLEBAND SPECIFICATION

RF OUTPUT CHARACTERISTICS

Frequency range *		12.750 - 13.250, 13.750 - 14.800 or 17.300 - 17.800 GHz
Step size *		1 kHz or 125 kHz
Impedance		50 ohms, SMA-F connector
Return loss		21dB Min., 23dB Typ.
RF Monitor		-20 dBc Nom., 50-ohms, SMA-F connector
Frequency Stability		+/-1x10^{-9}/day
		+/-2x10^{-8}, 0° to +50°C

IF INPUT CHARACTERISTICS

Frequency range *	70+/-20MHz (140+/-40MHz)
Input Power Range (nominal)	-70 to -15 dBm
Impedance	75 ohms, BNC-F connector, (50 ohms optional)
Return loss	26dB Min.

IF/RF PERFORMANCE

Frequency sense		Positive (no spectral inversion)	
Gain at Max. setting		29 - 34dB	
IF Attenuator		0 to 25dB Min. in 0.1dB step, (Local/Remote)	
L Band Attenuator		0 to 25dB Min. in 0.1dB step, (Local/Remote)	
Output 1 dB compression		+9dBm Min., +10dBm Typ.	
Gain variation	IF band	0.6dB p-p Max., 0.4dB p-p Typ.	
	RF band	1.5dB p-p Max., 1.0dB p-p Typ.	
Gain slope		0.02dB/MHz Max.	
Gain stability		+/-0.25dB/day Max. over any 10° C temp. change	
Group delay		+/-20MHz	+/-40MHz
	linear	0.012ns/MHz Max.	0.006ns/MHz Max.
	parabolic	0.004ns/MHz^2 Max.	0.002ns/MHz^2 Max.
	ripple	1ns p-p Max.	1ns p-p Max.
AM/PM conversion		0.1°/dB Max. to 0dBm output	
Noise figure		18dB Max., 16dB Typ.	
Spurious	carrier related	-60dBc Max. @ 0dBm output	
	non-car. related	-80dBm Max. (L Band attenuation >= 5dB)	
AC line spurs	fundamental	-40dBc Max.	
	sum of all harm.	-43dBc Max.	
Intermodulation distortion		40dBc Min. with 2 carriers @ 0dBm output	
Phase noise		-50dBc/Hz Typ. @	10Hz
		-70	100Hz
		-82	1kHz
		-88	10kHz
		-100	100kHz
		-118	1MHz

GENERAL

Temperature	operating	0 to 50°C
	storage	-50 to +70°C
Humidity		5 to 95% RH, non-condensing
Weight		19 pounds Typ.
Operating power		115, 220, 230 or 240V AC +/-10%, 47-63Hz
		90 VA Typ., 100 VA Max.

* see model number list in Appendix B

SECTION 2
INSTALLATION

2-1. UNPACKING AND INSPECTION

Remove the unit from its shipping container and inspect for any damage sustained during shipment. Save the packing material for reshipment back to the factory or to another site. Report any damage to the shipping forwarder in accordance with required procedures.

2-2. INSTALLATION REQUIREMENTS

The UCS upconverter is designed for mounting in a standard EIA 19-inch rack. The unit must be supported on the sides and space must be allowed at the rear of the unit to permit the flow of cooling air. The unit should be installed in an environment that is within the environmental envelope described in Table 1-1. Primary power must be made available that is within the specified limits.

2-3. MECHANICAL INSTALLATION

The mechanical configuration of the unit is shown in Figure 2-1. It is equipped with threaded inserts on either side for the installation of slides. Slides are not provided with the unit; however, it has been designed to be compatible with Model C-300-S-422-RC-3S, manufactured by General Devices of Indianapolis, Indiana, and they may be ordered as an option. The front panel is equipped with slots to accommodate user-supplied retaining screws.

CAUTION: Mounting the unit by only the front panel will cause extensive damage.

2-4. ELECTRICAL CONNECTIONS

All electrical connections are made to the rear panel of the unit. The BNC and SMA connectors on the front panel are for periodic monitoring and are normally left open. Below is a description of each of the rear panel connectors and its interface requirements. The chassis ground is threaded for a #10-32 screw.

J1 POWER INPUT. This connector is an IEC 320-C14 male and will accept any compatible mating connector. The power cord supplied as standard with the unit is equipped with a NEMA 5-15P male plug at the opposite end and is compatible with most 115V AC supplies.

The unit is shipped from the factory to accept 115V AC. If 230V AC operation is required, disconnect power cord and remove the top cover from the unit. Referring to Figure 5-1, locate the connector P7 on the A4 (power supply) assembly. Remove the small PC board from the connector and change its orientation until the correct voltage can be read in the upper left hand corner of the PC board. Carefully reinstall the board into P7 and replace the 115V AC label on the rear of the unit with the alternate 230V AC label. Change the fuse from 5A to 2A per the instructions on the new label. Replace or modify the power cord per local requirements. Completely reassemble the unit before applying power.

Some units are manufactured witha a Universal Input Power supply that will accept voltages in the range of 90V to 264V AC. Refer to the rear panel of the upconverter for the proper input parameters.

CAUTION: Damage may result if the incorrect voltage is applied to the unit.

J2 IF INPUT. This connector is a BNC female. The BNC male mate (not supplied) should be compatible with the 75 (50)-ohm coax used to connect to the system.

J3 RF OUTPUT. This connector is an SMA female. The SMA male mate (not supplied) should be compatible with the 50-ohm coax used to connect to the system.

J4 SUMMARY ALARM. This connector is a 9-pin male miniature type "D" connector (M24308/3-1) with standard #4-40 female screw-lock hardware mounting. The mating shell, pins, and strain relief are not supplied. The pin function and pin-out is as follows:

Pin 1	Relay NC (closed for alarm condition)
Pin 2	Relay Common
Pin 3	Relay NO (closed for normal operation)
Pin 4	Switch Control, MS
Pin 5	Switch Control, MV
Pin 8	Switch Control, M0
Pin 9	Switch Control, M1

J5 SERIAL INTERFACE. This connector is a 9-pin female miniature type "D" connector (M24308/1-1) with standard #4-40 female screw-lock hardware mounting. The mating shell, pins, and strain relief are not supplied. The electrical interface to this connector is for a standard RS-422 bus. For bus protocol requirements, refer to Section 3-3. The convention used for the signals is a logic Hi for Mark (Rest) and a logic Lo for Space. The pin-out, on the converter side, is as follows:

Pin 3	RXD +	Pin 4	TXD +
Pin 5	Ground	Pin 6	TXD -
Pin 7	Alarm summary (open collector)		
Pin 9	RXD -		

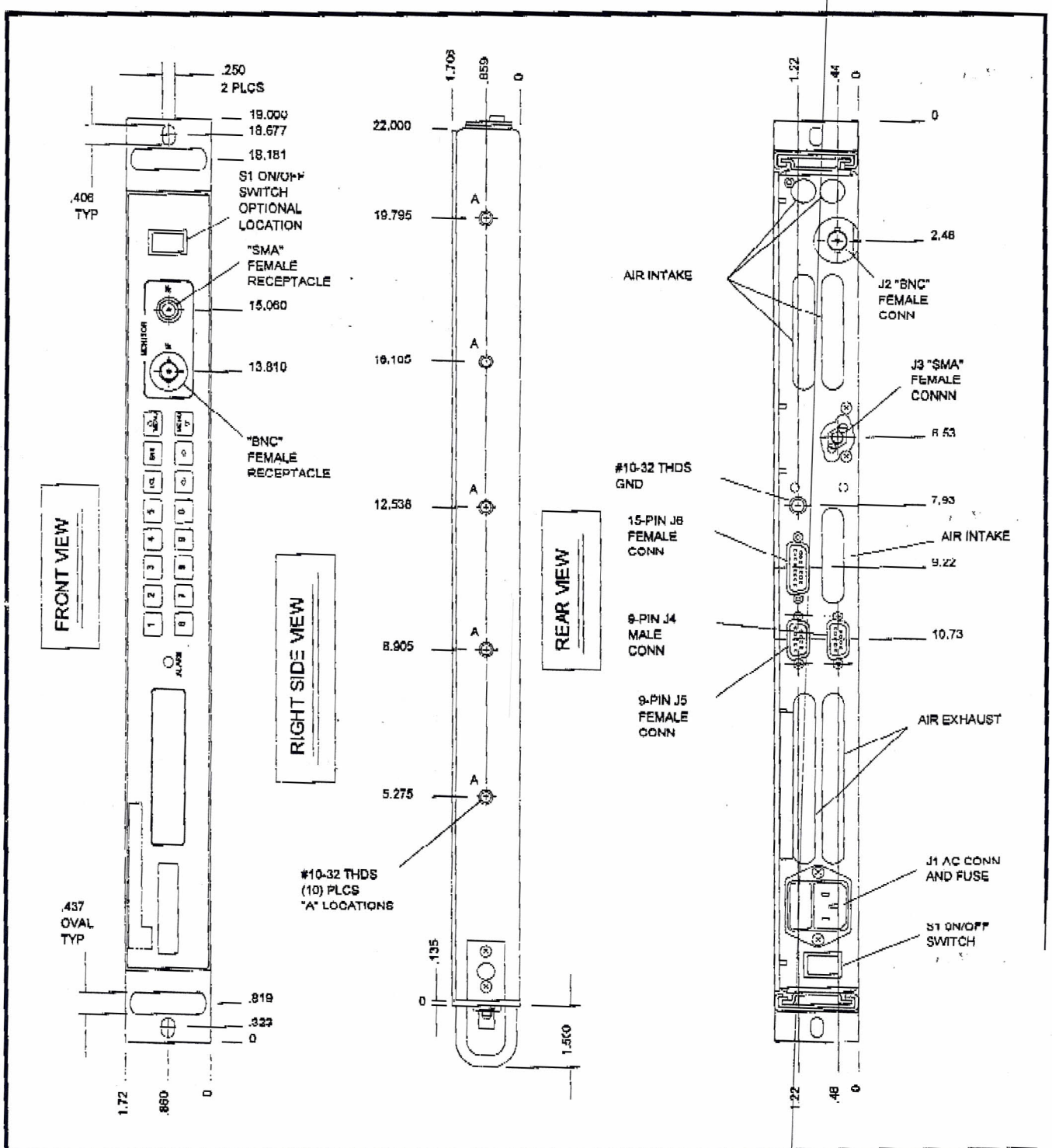

FIGURE 2-1. SINGLEBAND OUTLINE DRAWING

J6 XMT POWER DETECTOR. This connector is a 15-pin female miniature type "D" connector (M24308/1-2) with standard #4-40 female screw-lock hardware mounting. The purpose of this connector is to support an external power detector located on the coupled port of a power coupler at the output of the system power amplifier. The connector, detector and associated components are not supplied. The type of detector used is not limited; however, the unit was specifically designed to interface directly with Models N425A, N426A, and N427A manufactured by General Microwave Corporation of Amityville, New York. If any of these detectors is used, the upconverter will display power directly in dBm. Following is a pin-out of J6 and the recommended connections to the General Microwave detectors.

J6	Function	Detector
Pin 1	+15V DC @ 20mA max.	Pin A
Pin 3	-15V DC @ 20mA max.	Pin B
Pin 5	Feedback	Pin C
Pin 6	0 to -10V full scale	Pin D
Pin 7	Ground	Pin L
Pin 8	Zero (arm of pot)	Pin F

Regardless of which detector is used, it should be set to output 1 milliwatt full scale. Provision for zeroing the detector is inside the shelf, located on the A2 assembly (see Figure 5-1).

If a detector other than one of those specified is used, it should present a voltage output to pin 6 of J6 in the range of 0 to -10 volts, where the voltage is proportional to RF power and the full scale output of -10 volts corresponds to 1 milliwatt. The voltages available on pins 1 and 3 may be used providing the current ratings are not exceeded.

J7 EXTERNAL REFERENCE INPUT. This connector, if requested, is a type SMA female (BNC optional). The male mate (not supplied) should be compatible with the 50-ohm coax used to connect to the system.

2-5. OPERATIONAL CHECK

To verify that the basic functions of the unit are operational, it is recommended that the following check-out procedure be followed prior to final system integration. If there are any questions regarding performing the indicated operations, refer to section 3-2.

2-5.1. SETUP

Connect the unit to a primary power source and turn on the power switch at the rear of the unit. Verify that the LCD displays two lines of information. If the display contrast is not acceptable, refer to section 5-2.

Depress "LCL" button.

Menu down (two times) to set frequency. Using the numeric keys set to a Ku band frequency and depress "ENT" button.

Menu down (one times) to set L band atten. Set to 00.0dB.

Menu down (one times) to set IF atten. Set to 00.0dB.

Menu down (one time) to set mute control. Select "ON".

Menu down (one time) to set alarm mask set. Set to "11111111".

Menu down (two times) to set out this. Set to -40dBm.

Menu down (one time) to Clear Alarm His. Depress "ENT" button.

Depress "LCL" button.

2-5.2. LEVEL MONITOR

Connect a power meter to J3 and an input signal to J2 at a suitable frequency to obtain an on-channel output of +5.0dBm.

Menu up (two times) to output level. Verify that displayed level is within 1dB of +5.0dBm.

Reduce input IF power to obtain an output of 0.0 dBm. Depress "ENT" button. Verify that displayed level is within 1dB of 0.0dBm.

2-5.3. ATTENUATOR CONTROL

Connect an input signal to J2 at a suitable frequency to obtain an on-channel output of 0.0dBm.

Menu down (three times) to set L Band atten. Set attenuator to 5.0dB. Verify that the output drops to -5.0dBm +/-1dB.

Set attenuator to 10.0dB. Verify that the output drops to -10.0dBm +/-1dB.

Set attenuator to 15.0dB. Verify that the output drops to -15.0dBm +/-1dB.

Set attenuator to 20.0dB. Verify that the output drops to -20.0dBm +/-1dB.

Set attenuator to 25.0dB. Verify hat the output drops to -25.0dBm +/-1dB.

Return attenuator to 00.0dB.

Menu down (one time) to set IF atten. Repeat the same procedure.

2-5.4. MUTE CONTROL

Connect an input signal to J2 at a suitable frequency to obtain an on-channel output of +5.0dBm.

Menu down (eight times) to set out thrs. Set to 00dBm.

Menu up (three times) to set mute control. Select "OFF" and depress "ENT" button. Verify that the output level from the unit drops to mute level.

Select "ON" and depress "ENT" button. Verify that the output level returns to +5.0dBm.

Select "AUTO" and depress "ENT" button. Decrease the input signal by 15 dB. Verify that the output level from the unit drops to mute level and that the alarm led is lit.

Increase the input signal by 15 dB. Verify that the output level returns to +5.0dBm and that the alarm led is not lit.

Select "ON" and depress "ENT" button.

2-5.5. ALARMS

Connect an input signal to J2 at a suitable frequency to obtain an on-channel output of +5.0dBm. Verify that the operate display shows "ATTEN 00.0 DB".

Menu up (one time) to display fault code. Verify that the fault code shows "00000000". Verify that the alarm led is not lit.

On the 9-pin, male connector at the rear of the unit (J4), verify (using an ohmmeter) a low impedance between pins 2 and 3 and a high impedance between pins 1 and 2.

Return to the operate display (depress "LCL") and reduce the signal level to obtain an output of -10 dBm. Verify that display shows "LOCAL ALARM".

Menu up (one time) to display fault code. Verify that the fault code shows "00000011". Verify that the alarm led is lit.

On the 9-pin, male connector at the rear of the unit (J4), verify (using an ohmmeter) a low impedance between pins 1 and 2 and a high impedance between pins 2 and 3.

Menu down to set alarm mask. Set mask to "11111101".

Menu up to display fault code. Verify that the fault code shows "00000010". Verify that display shows "LOCAL ALARM" and that the alarm led is not lit.

Set alarm mask back to "11111111".

Set output threshold back to -40dBm or to the required operating level. Verify that alarm led is not lit.

Menu down (1 time) to clear alarm history. Depress the "ENT" button.

Depress the "LOCAL" button to return to the default menu.

2-6. SYSTEM INTEGRATION

To ensure that the upconverter is giving peak performance, it is necessary to set its gain structure to best match the system environment in which it is placed. The L band attenuator and IF attenuator can both be set at system level either by the front panel keypad or by the RS-422 bus. However, the IF attenuator must be set at the time of installation. To perform this adjustment, refer to section 5-2. This adjustment should be performed any time there is a system change that might change the level of the IF signal.

If the optional XMT detector is used (see Section 2-4), it must be calibrated to the characteristics of the system into which it is installed. Refer to Section 5-6 for the complete calibration procedure.

SECTION 3
OPERATION

3-1. GENERAL

The UCS upconverter can be operated either from the front panel keyboard or through the RS-422 serial bus. To eliminate the problems of two possible sources of control, four different operating modes have been established: LoCaL, ReMoTe, SET, and CALibrate. The unit always powers up in the **LCL** mode. From this mode either the keypad or the bus can use any of the monitor functions available and either can assume control. If the keypad assumes control, the unit enters the **SET** mode. In the **SET** mode, the bus still has the monitor functions available, but the control commands are disabled. The keypad relinquishes control in one of two ways: It returns to a monitor function (**LCL**) or, if no key is pressed for 30 seconds, it defaults to **LCL**.

The bus assumes control by issuing a control command, upon which the unit renters **RMT** mode. The keypad can return to **LCL** or **SET** mode at any time after the bus command is processed by making an appropriate entry.

The **CAL** mode can only be entered through the keypad and is used for bench checks and off-line situations.

3-2. LCD DISPLAY

The front panel backlit LCD display consists of two lines of 20 characters each. It is divided into four separate display areas or **windows.** The first 17 characters of the first line are defined as the **Information Window.** The last 3 characters of the first line are defined as the **Activity Window.** The first 17 characters of the second line are defined as the **Menu Window.** The last 3 characters of the second line are defined as the **Mode Window.** The thirteenth character of each line is always blank and is used as a separator. The purpose of each of the 4 windows is listed below:

Information Window displays data. In **LCL** modes, it displays the current operating conditions of the unit. In **SET** (or **CAL**) mode, it displays the data entered from the keypad.

Activity Window displays the current mute status of the unit. If the unit is muted, "OFF" is displayed. If the unit is not muted, "ON" is displayed.

Menu Window displays name of the menu selected by the keypad. For menu number 6, it displays "LOCAL ALARM" if there is any alarm condition in the unit or "ATTEN XX.X DB" if there is none, where XX.X represents the current L band plus IF attenuation value.

Mode Window displays the current mode status.

3-3. KEYPAD CONTROL

The front panel keypad, in conjunction with the LCD display can be used to control all the functions in the UCS upconverter. Each of the monitor and control functions is represented by a menu item as depicted in Table 3-1. The default menu item is number 6. This is the state that the unit always assumes upon power up or if left unattended for more than 30 seconds. All menu items above number 6 in Table 3-1 are monitor functions and all menu items below number 6 are control functions.

Any menu item can be selected by scrolling up or down using the appropriate "MENU" button. Depressing the "LCL" button returns the menu to item number 6 from any position in the menu. The "ENT" button can be used to update information while in any of the monitor functions. The "ENT" button does not change the menu selection.

The left/right arrows and the numbered buttons are used to enter data while in the control functions. The information window displays the cursor position and the number entries as they are made. This data is not transferred to the converter until the "ENT" button is pressed.

Below is a description of the menu items listed in Table 3-1:

SOFTWARE REV. The INFORMATION WINDOW displays the Software Revision Level.

TEMPERATURE. The INFORMATION WINDOW displays the ambient internal temperature of the unit in °C and °F. If the temperature rises up to +75°C (+167°F) the converter will go into the mute mode, lock the key pad and displays "UNIT TOO HOT". Turning the unit OFF and ON again will unlock the keypad.

ALARM HISTORY. The INFORMATION WINDOW displays the last 5 alarms. The alarm on the right is the most recent one. The format is in Hex and the

TABLE 3-1. KEYPAD CONTROL MENU

ITEM NUMBER	FUNCTION	FUNCTION	MODE
1	SOFTWARE REV	MONITOR	LCL
2	TEMPERATURE	MONITOR	LCL
3	ALARM HISTORY	MONITOR	LCL
4	XMT LEVEL	MONITOR	LCL
5	OUTPUT LEVEL	MONITOR	LCL
6	FAULT CODE	MONITOR	LCL
7	(DEFAULT STATE)	MONITOR	LCL
8	RECALL MEMORY	CONTROL	SET
9	SET FREQUENCY	CONTROL	SET
10	SET L BAND ATTEN	CONTROL	SET
11	SET IF ATTEN	CONTROL	SET
12	SET MUTE CONTROL	CONTROL	SET
13	SET ALARM MASK	CONTROL	SET
14	SET MEMORY	CONTROL	SET
15	SET OUT THRS	CONTROL	SET
16	CLEAR ALARM HIS	CONTROL	SET
17	SET DEV ADDRESS	CONTROL	SET
18	CALIBRATE	CONTROL	SET

two digits represent the Alarm1 and Alarm2 from left to right. See Fault Code below for details.

XMT LEVEL. The INFORMATION WINDOW displays the power level of the system transmitter in dBm. In order for this function to work properly, the optional external detector (see Section 2-4) must be installed and the coupling value for the detector must be entered into the unit using the CAL mode (see section 2-6 and 5-6).

OUTPUT LEVEL. The INFORMATION WINDOW displays the power level of the RF output of the converter in dBm. This reading is only useful for the upper 15 dB of the converter's dynamic range.

FAULT CODE. The INFORMATION WINDOW displays an 8-bit binary word, representing the status of up to 7 internal alarms. A "0" indicates the alarm senses a normal operational status and a "1" indicates an alarm condition. The alarms, reading from left to right, are:

Alarm1
Power supply monitor 1 (+18V and -15V)
Power supply monitor 2 (+15V and +5V)
PLO lock alarm
Synthesizer lock alarm

Alarm2
Reserved for future use
Reserved for future use
Output level alarm
Summary alarm (1 if there is an alarm condition)

(DEFAULT STATE). The INFORMATION WINDOW displays the center RF output frequency of the unit in 1kHz resolution and the MENU WINDOW displays the current L-Band plus IF attenuation value or an alarm warning. This menu position can be reached from any other menu position by pressing the "LCL" button.

RECALL MEMORY. The converter incorporates a memory capable of storing up to 100 different frequencies and attenuation values.
The INFORMATION WINDOW displays a two digit number corresponding to a memory location and only its current frequency value. Use the left/right arrow button to scroll through the memories, or the numeric keys to enter a specific memory location. Pressing the "ENT" button will recall the memory and set the converter accordingly.

SET FREQUENCY. The INFORMATION WINDOW displays the current operating frequency with a cursor on the first digit. A new frequency can be selected using the left/right arrows and the numbered buttons. If a frequency outside the permitted frequency band is entered, the original frequency will be maintained.

SET L BAND ATTEN. The INFORMATION WINDOW displays the current attenuation value of the converter's L-Band attenuator with a cursor on the first digit. A new attenuation value can be selected using the left/right arrows and the numbered buttons. If a value greater than 29.9 dB is entered, the original value will be maintained.

SET IF BAND ATTEN. The INFORMATION WINDOW displays the current attenuation value of the converter's IF attenuator with a cursor on the first digit. A new attenuation value can be selected using the left/right arrows and the numbered buttons. If a value greater than 29.9 dB is entered, the original value will be maintained.

SET MUTE CONTROL. The INFORMATION WINDOW displays the current status of the mute function. The status can be changed by using the left/right arrows. The three choices are:

ON	The converter is not muted.
OFF	The converter is muted.
AUTO	The converter mute is controlled by the summary alarm.

SET ALARM MASK. The INFORMATION WINDOW displays the current status of the alarm mask, which is an 8-bit binary word. The mask can be changed bit-by-bit using the left/right arrows and the numbered buttons. A "1" in a given bit allows that alarm to affect the summary alarm, whereas a "0" inhibits it. The order of the individual alarms is the same as that for the alarm status (see above). The summary alarm cannot be masked.
NOTE: In this menu an alarm condition can be simulated. Change the summary alarm bit to "0", press the "ENT" button, the Alarm LED will light (or go off if there is an alarm). Pressing a "MENU" or "LCL" button will clear the test.

SET MEMORY. The converter incorporates a memory capable of storing up to 100 different frequencies. The INFORMATION WINDOW prompts the user for a numerical entry, 00-99, corresponding to the memory to be set. Upon the entry of a memory number,

the window displays the current value for that memory with the cursor on the first digit. A new frequency can be selected using the left/right arrows and the numbered buttons. If a frequency outside the permitted frequency band is entered, the original frequency will be maintained in that memory location.

The current L-Band and IF Attenuator values will also be stored automatically.
NOTE: When used as a back-up converter with a redundancy switch (Model RS-XXX), memories 01 through 04 are reserved to duplicate the values in the primary converter. (See Appendix E for details).

SET OUT THRS. The INFORMATION WINDOW displays the low-level threshold for the output level alarm. The value can be set or changed by using the numbered buttons.

CLEAR ALARM HIS. The INFORMATION WINDOW display "00 00 00 00 00".
Pressing the "ENT" button will erase the last 5 alarms and set the alarm history menu back to "00".

SET DEV ADDRESS. The INFORMATION WINDOW displays the ASCII character representing the current device address for BUS CONTROL applications (see section 3-4). The unit is shipped with the ASCII character "1" as the device address. It can be changed by using the left/right arrows.

CALIBRATE. See Section 5-6 for the use of the CALIBRATE function.

3-4. BUS CONTROL

The UCS upconverter can be monitored and controlled from an appropriate remote device through an RS-422 interface. The interface protocol chosen incorporates a specific device address for each converter, thereby permitting up to 63 converters or similar slave devices to be parrall-connected on a single four-wire bus.

The DATA FORMAT supports a standard asynchronous ASCII format with one start bit, eight data bits (LSB first), one stop bit, and no parity. Baud rate is fixed at 9600 baud.

The COMMAND FORMAT for the remote monitoring and controlling device is as follows:
STX | ADDRESS | COMMAND | (DATA) |ETX | CHECKSUM

STX is the ASCII start-of-text character, 02(hex).

ADDRESS is the device address, selectable from the front panel of the converter, and is a single ASCII character in the range of 31(hex) through 6F(hex).

COMMAND is a single ASCII character in the range of 30(hex) through 37(hex). The function of each command character is described in Table 3-2.

DATA is a string of ASCII characters that form a part of certain control functions. The length of the data string may be up to 9 characters, depending upon the requirements of the specific control command. The data requirements for each of the command functions are described below.

ETX is the ASCII end-of-text character, 03(hex).

CHECKSUM is the bit-by-bit eXclusive OR of all characters in the data stream, from the STX to the ETX characters, inclusive.

The RESPONSE FORMAT for the converter is as follows:
ACK/NAK | ADDRESS | COMMAND | (DATA) | ETX | CHECKSUM

If the command received by the converter is in the correct format, then the first character returned is the ASCII character **ACK** 06(hex). If the command character or the data stream is not valid, then the first character returned is **NAK** 15(hex).

ADDRESS is the device address, as described above.

COMMAND is a repeat of the function command requested by the controlling device.

DATA is a string of ASCII characters that form a part of certain responses. The length of the data string may be up to 32 characters. The data format for each of the command responses is described below.

ETX is the ASCII end-of-text character, 03(hex).

CHECKSUM is the bit-by-bit eXclusive OR of all characters in the data stream, from the ACK/NAK to the ETX characters, inclusive.

The converter ignores any command that contains an address other than its own.

TABLE 3-2. BUS COMMAND LIST

HEX Command	Function	Command data	Response data format
30	Device number	none	see Note 1
31	Status poll	none	see Note 2
32	Set frequency	Format XXXXX.XXX Freq in MHz 9 ASCII chars	see Note 3
33	Set L-Band attenuator	Format XX.X dB of attn 4 ASCII chars	see Note 3
34	Step attenuator (L-Band attn)	Format + to increment - to decrement by 0.5 dB 1 ASCII char	see Note 3
35	Set alarm mask	See Note 4	see Note 3
36	Mute control	30H mutes conv 31H unmutes conv 32H mute on summary alarm 1 ASCII char	see Note 3
37	Set IF atten	Format XX.X dB of attn 4 ASCII chars	see Note 3

SECTION 4
THEORY OF OPERATION

4-1. INTRODUCTION

This section gives a general description of the operation of the UCS upconverter unit, including the way in which the various subassemblies work together to achieve the desired operational parameters. Each one of the subassemblies in the unit is assigned a sequential "A" designator. These subassemblies are shown in Figure 4-1 with their designators and descriptive titles. The electrical interconnections between them are also shown in this figure.

4-2. POWER SUPPLY

The primary power input supplied to the fused connector J1 is routed to the power switch. This primary power is subsequently delivered to the power supply board, A4, the voltage selection board and the power transformer T1. The selection of input voltage range is described in Section 2-4. The power supply assembly consists of a power transformer T1 with multiple secondary windings and a bank of rectifiers and regulators on the power supply board A4. It generates one unregulated voltage and 5 regulated voltages. The unregulated voltage (12V DC, typically) drives the cooling blower, A3. The 5 regulated voltages are routed to the interconnect board, A2, where they are distributed to the other assemblies as required to power the remainder of the converter. These voltages are as follows:

+ 24V (not used in Ku upconverter)
+ 18V (for A2, A8, A11 assemblies).
+ 15V (for A2, A5, A9, A12 assemblies)
+ 5V (for A2, A5, A8 assemblies)
- 15V (for A2, A5, A12 assemblies)

4-3. FREQUENCY REFERENCE

The frequency reference for the upconverter is derived entirely from the 10MHz reference oscillator, A9. This ovenized crystal oscillator determines the frequency stability and the close-to-carrier phase noise characteristics of the unit. It is equipped with a screwdriver tuning adjustment to compensate for long-term aging drift. See section 5-2 for frequency adjustment.

The output of the reference oscillator is fed into the PLO, A11 or directly into the Synthesizer/PLO. The PLO includes a two-way power divider and routes the 10 MHz reference signal to the synthesizer.

Refer to Appendix D for information on External References.

4-4. PLO

The fixed-frequency local oscillator for the first conversion in the upconverter chain is the PLO, A11. Employing a single loop design, it generates a LO1 signal at 1,150MHz which is phase-locked to a 10MHz reference signal. In addition to the LO1 output, the PLO provides a 10MHz output signal for the synthesizer and an alarm signal which provides an indication if the internal loop is out of lock.

The PLO has an internal 10 MHz two-way power divider and provides an output which is used for the synthesizer.

4-5. SYNTHESIZER

The agile local oscillator for the second conversion in the upconverter chain is the LO2 frequency synthesizer, A8. It provides an output frequency corresponding to a parallel BCD input word of 32 bits. Its step size is 1kHz and its frequency band is model number dependent. Its output frequency is phase-locked to a 10 MHz reference signal. In addition to the LO2 output, the synthesizer provides an alarm signal which provides an indication if any of the internal loops is out of lock.

4-6. SYNTHESIZER/PLO

UCS upconverters with 125 kHz step size may be equiped with a Synthesizer/PLO module, A8, instead of a separate PLO and Synthesizer (A11 and A8).

This module provides two output signals:

-the agile local oscillator, LO2, for the second conversion in the upconverter chain. The output frequency corresponds to a serial BCD input word, the step size is 1 or 125 kHz and its frequency band is model number dependent.

- the fixed frequency local oscillator, LO1, for the first conversion in the upconverter chain. The output frequency is 1,150 MHz.

Both output frequencies are phase-locked to a 10 MHz reference signal. In addition to the LO1 and LO2 outputs, the Synthesizer/PLO module provides an alarm signal which provides an indication if any of the internal loops is out of lock.

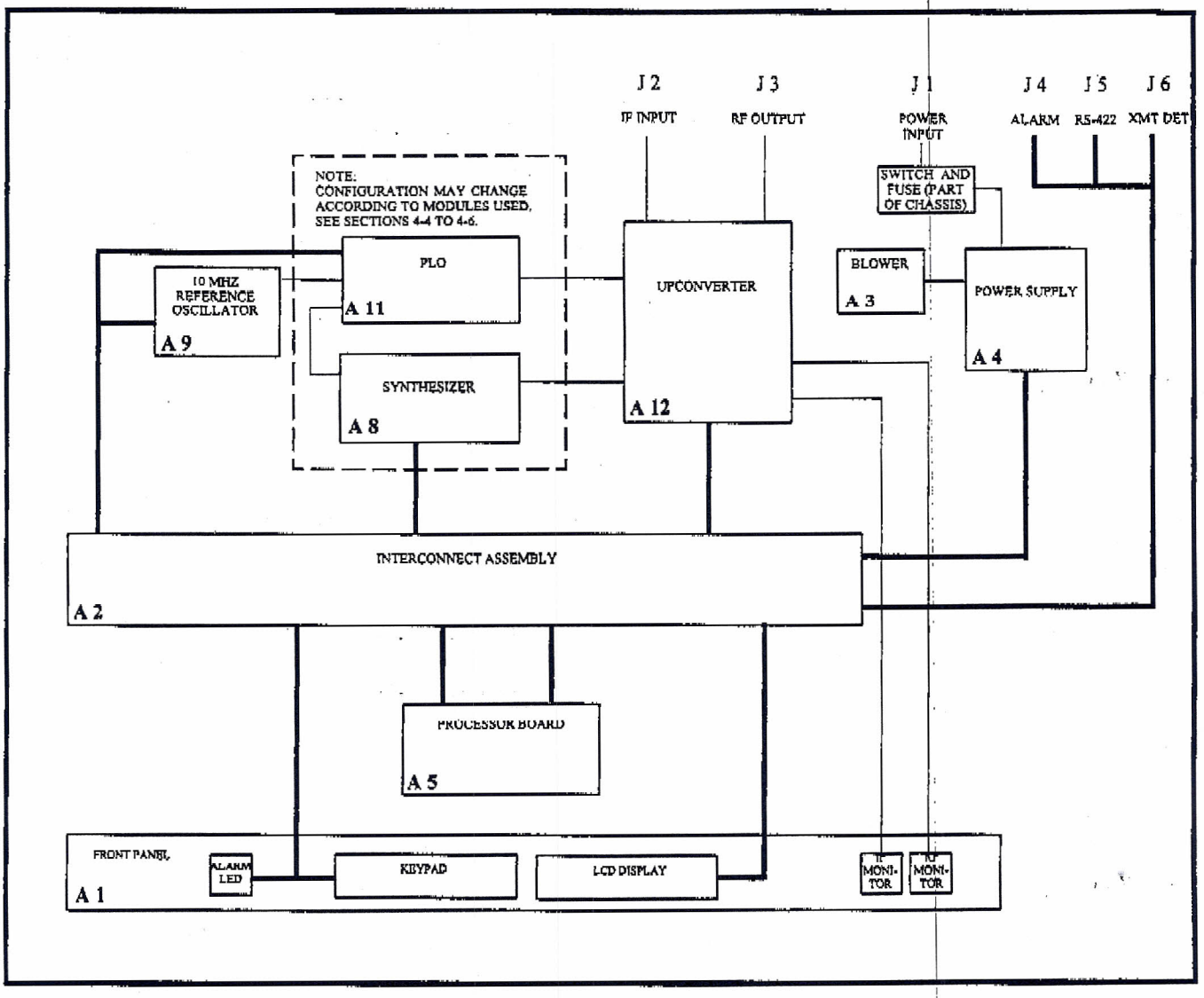

FIGURE 4-1. UCS SINGLEBAND BLOCK DIAGRAM

4-7. CONVERTER

The heart of the multiband converter is the upconverter module, A12. A functional block diagram is depicted in Figure 4-2. The signal path is shown horizontally across the top of the figure, with the various monitor and control functions below. The signal path involves two conversions, with an L-Band section at 1,220 MHz (1,290 MHz for 140 MHz IF). Both conversions are non-inverting, resulting in no net spectral inversion.

The 70 (140)MHz IF comprises both fixed gain and variable attenuator elements. The combination permits setting the level to the first mixer at the optimum point for best signal-to-noise performance without suffering from intermodulation products. The coupled IF monitor point before the first mixer is 20dB lower than the level presented to the mixer: thus, to present a -10dBm level to the mixer, the IF attenuator is set to obtain a -30dBm level at the coupled port on the front panel.

The amplifier stages in the 70 (140)MHz IF chain can be shut off to mute the converter. The mute control input mutes the converter if the input is grounded.

Both the first and second mixers require +10 +/-3dBm LO drive levels.

The upconverter is equipped with an analog, electronically-variable L-Band and IF attenuators. These are intended primarily to permit the user to control transmit power within the system.

The RF output path has a coupler/detector operating in a voltage-linear mode. Because of physical constraints in the unit, the detector is only useful over a 10-15dB range. Its accuracy is not dependable below -5dBm.

4-8. MONITOR AND CONTROL

The monitor and control functions of the UCS upconverter are contained in the A2 and A5 assemblies. All of these functions are controlled by the microprocessor and software on the A5 processor board. The processor board interfaces to the remote RS-422 bus through an RS-232 to RS-422 translator located on the A2, interconnect board. It interfaces to the rest of the converter and front panel through I/O ports.

The software is stored in ROM while the current operating and monitoring settings and memories are stored in NVRAM (min 10 years lifetime). Upon startup the software scans the NVRAM. If no error is detected, the last settings before shut down, will be restored or else the "ALARM" LED will be lit, and the user will be prompted to "hit any key" to restore the default settings and start the initialization process.

The interconnect board, A2, performs multiple functions. As mentioned above, it serves as power distribution for the entire unit. In addition it does the following functions:

- Routes digital frequency selection information from the I/O board to the synthesizer.
- Routes digital alarm information from the PLO and the synthesizer to the I/O ports.
- Routes the analog level monitor signal from the converter module to the I/O ports.
- Monitors the +18V, +15V, +5V, and -15V supply voltages and sends alarm signals to the I/O ports if any is out of tolerance.
- Performs analog scaling functions on the L-Band and IF attenuator control so that the analog signal from the I/O port is compatible with the attenuator circuit in the upconverter module.
- Performs analog scaling functions on the external transmitter detector signal so that it will be compatible with the input on the I/O port.
- Performs the RS-232 to RS-422 translation for the remote control bus.
- Performs the digital level translation necessary for the signal from the I/O port to drive the converter mute function.
- Contains the form "C" relay and necessary driver for the I/O port to provide a summary alarm relay output. Also contains the driver for the summary alarm LED on the front panel.

The detailed inter-relation between the hardware and software required to make the UCS upconverter perform as described in Section 3 is beyond the scope of this publication. It is the intention that the foregoing description be sufficiently detailed to enable a knowledgeable user to make optimum use of the many powerful features embodied in the unit, and, should a problem occur, enable a knowledgeable technician to trace the problem to its source.

4-9. REDUNDANCY SWITCH USE

The details for the use of the UCS upconverter with the RS-XXX Redundancy Switch are outlined in Appendix E.

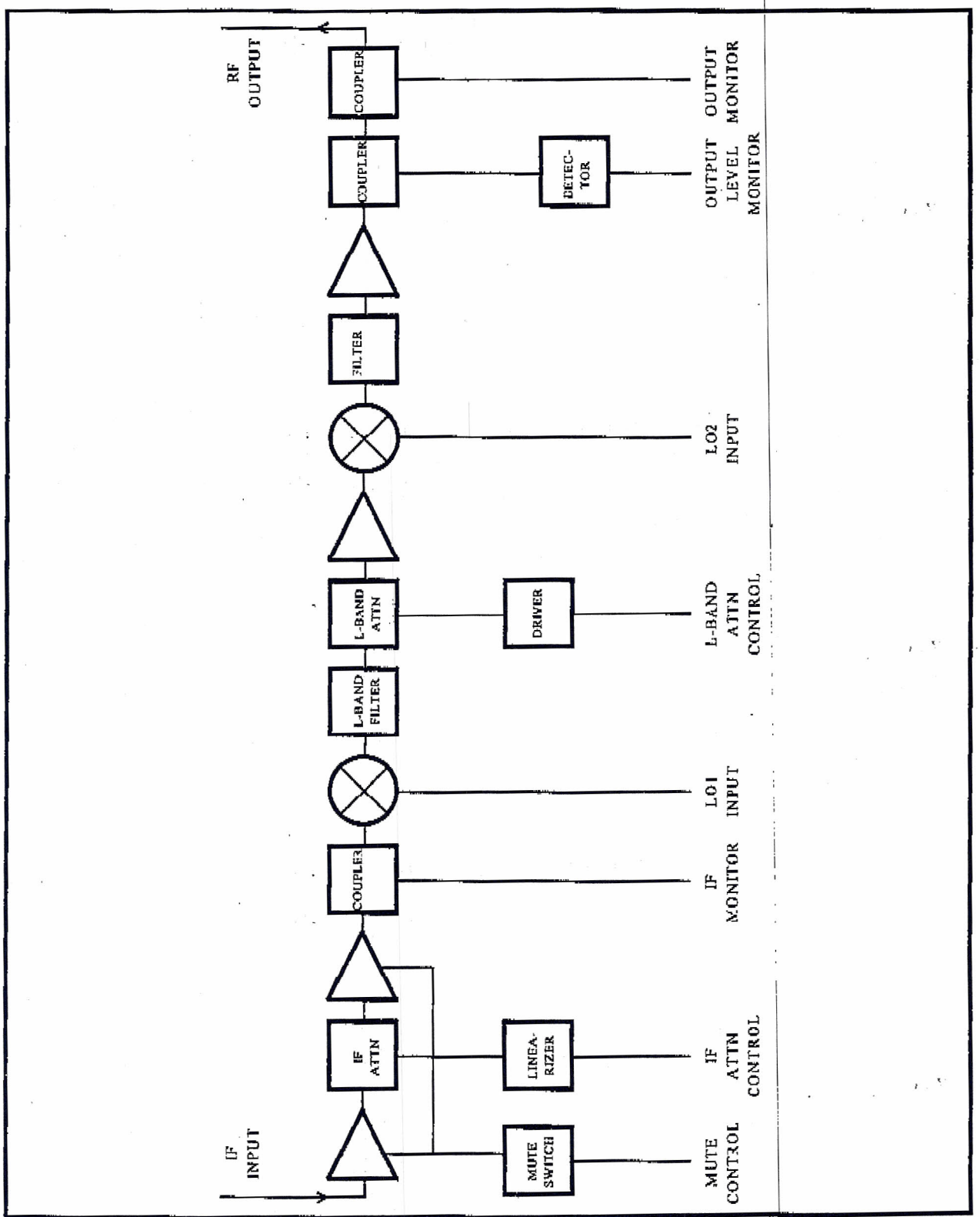

FIGURE 4-2. UPCONVERTER MODULE BLOCK DIAGRAM

SECTION 5
MAINTENANCE

5-1. INTRODUCTION

The UCS upconverter is constructed with up to nine basic integrated modules. The purpose of this section is to provide the necessary information for regular maintenance on the unit and, in case of difficulty, for locating the fault. Section 6 provides the parts information necessary to obtain replacement modules. It is not within the scope of this publication to provide service information on the modules themselves. Any attempt to service the individual modules will void any warranty or exchange policies that may be in effect.

5-2. REGULAR MAINTENANCE

The UCS upconverter is practically maintenance-free. Regular maintenance items include routine cleaning and periodic adjustment of the 10MHz Reference Oscillator. The time interval for each of these must be determined at the system level as each is dependent upon service conditions and system requirements.

CLEANING. Cooling for the unit is done by drawing ambient air in through various openings in the left side and rear and forcing it out through an opening in the rear next to the power switch. Any particulate matter suspended in the air can thus be deposited inside the unit. A build-up of matter may eventually restrict air flow and lead to overheating in the unit. The air holes and the interior of the unit should be cleaned at periodic intervals to insure cool and reliable operation. Remove the cover and use a soft brush or vacuum, paying special attention to the impeller of the blower. **Solvents or aqueous solutions of any kind should never be used inside the unit.** After cleaning, inspect the unit to insure that the cabling and connectors are intact before replacing the cover.

The front panel surface should be cleaned as required to remove hand oils, dust and dirt. Use a soft cloth dampened with a mild detergent and water. **Strictly avoid the use of harsh chemicals or strong solvents** that might damage the panel and render the unit inoperative.

FREQUENCY ADJUSTMENT. The accuracy of the frequency conversion of the upconverter is entirely dependent upon the 10MHz reference oscillator. Because of aging drift in this oscillator, it may be necessary to adjust it periodically. To do this, refer to Figure 5-1 and locate the access screw on the left side of the unit just behind the front panel. Remove the access screw and set the frequency using a **small flat, insulating screwdriver.** When making this adjustment, the frequency can be monitored in one of two ways: Inject a known 70 (140) MHz signal into the input of the unit and monitor the frequency of the output, comparing it to the selected channel frequency; or, remove the cover of the unit and measure the frequency of the PLO at connector A11J2. This should be exactly 1,150.000MHz if the reference oscillator is correctly set. After setting the oscillator frequency, replace the access screw in the reference oscillator before returning the unit into service.

WARNING! WHEN OPERATING THE UNIT WITH THE COVER OFF, KEEP CLEAR OF THE POWER SUPPLY AND BLOWER ASSEMBLIES (A3 AND A4). FAILURE TO DO SO COULD RESULT IN SERIOUS PERSONAL INJURY!

In addition to the periodic maintenance requirements, there are several other customer adjustment which can be made on the upconverter. These are not normally required for regular maintenance, but should be checked during initial system installation and may be included as part of a regular system calibration procedure. These items are listed below.

LCD CONTRAST. The contrast of the LCD display is dependent upon the electrical bias applied to it from the A5 assembly. To change the bias, refer to Figure 5-1 and locate the hole next to P9 on the A2 assembly. Make adjustment using a **small flat, insulating screwdriver.**

WARNING! WHEN OPERATING THE UNIT WITH THE COVER OFF, KEEP CLEAR OF THE POWER SUPPLY AND BLOWER ASSEMBLIES (A3 AND A4). FAILURE TO DO SO COULD RESULT IN SERIOUS PERSONAL INJURY!

IF ATTENUATOR ADJUSTMENT. The upconverter is equipped with a variable attenuator in the 70 (140) MHz IF chain. This attenuator can be controlled through the front panel or the remote and must be set at the time of installation. To set this attenuator to its optimum point, connect the system's IF output signal to J2 of the unit and a power meter to the IF monitor port on the front panel. With the system operating at its normal level, set the attenuator for a power reading of -30dBm. This adjustment should be performed any time there is a system change that might affect the level of the IF signal.

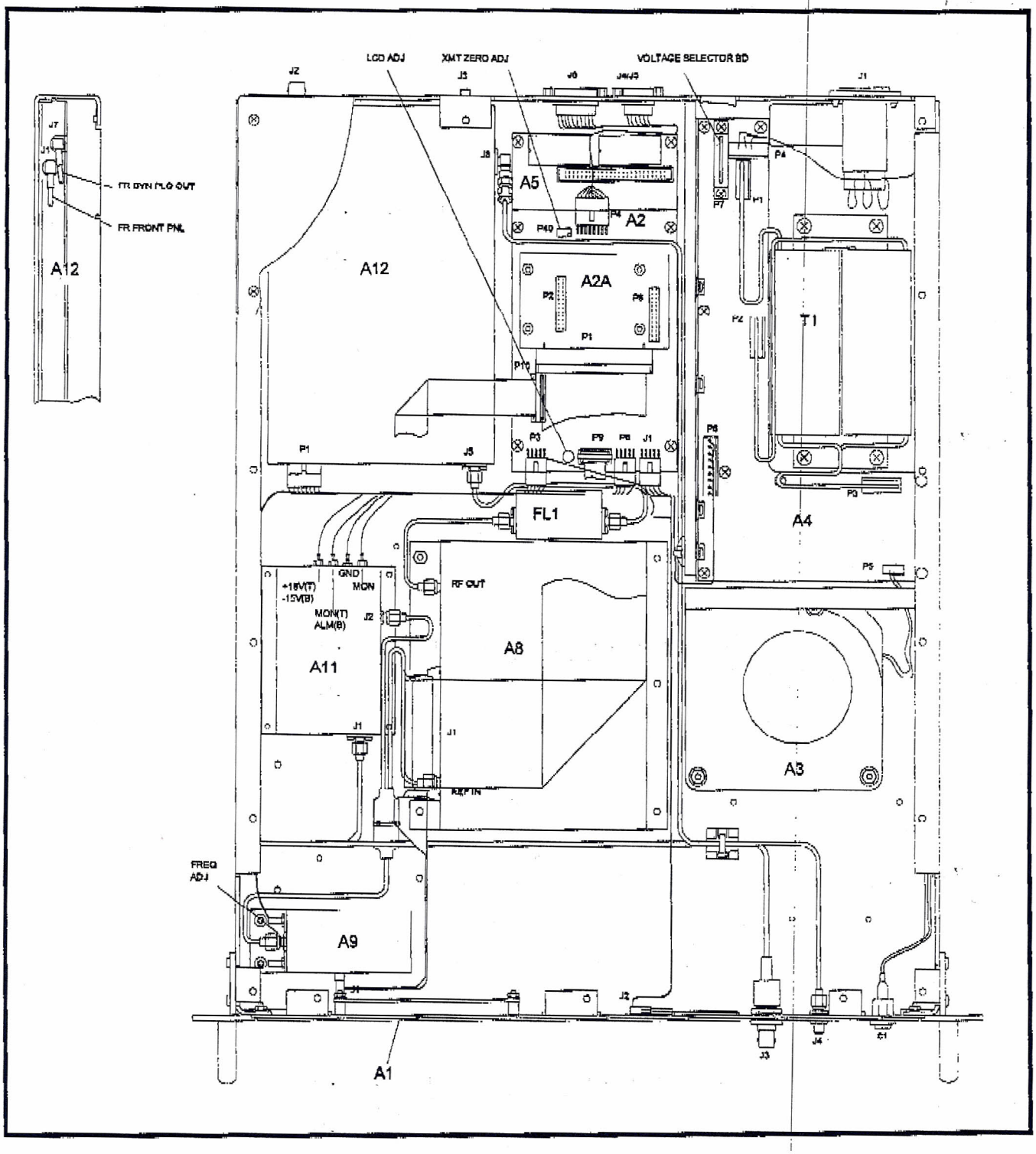

FIGURE 5-1a. ASSEMBLY UCS SINGLEBAND CONVERTER

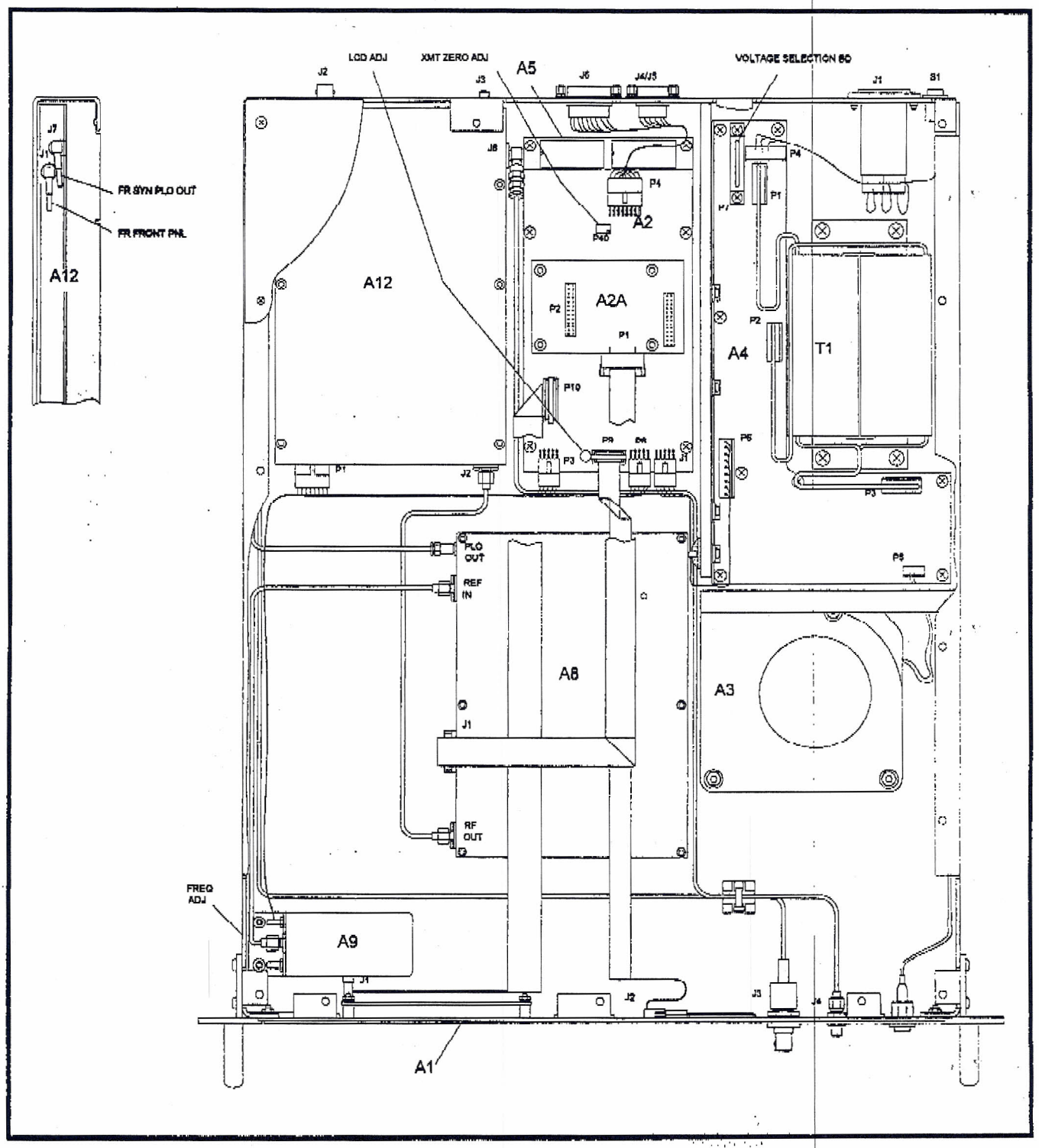

FIGURE 5-1b. ASSEMBLY UCS SINGLE BAND CONVERTER WITH SYNTHESIZER/PLO

XMT DET ZERO ADJUSTMENT. When using an external power detector (see Section 2-4), it may be necessary to make an adjustment for zero power. Referring to Figure 5-1, locate the XMT DET ZERO ADJUSTMENT on the A2 assembly. With the external detector terminated into a passive load, set this screwdriver adjustment to obtain a voltage null between pins 6 and 7 of J6 on the rear panel.

WARNING! WHEN OPERATING THE UNIT WITH THE COVER OFF, KEEP CLEAR OF THE POWER SUPPLY AND BLOWER ASSEMBLIES (A3 AND A4). FAILURE TO DO SO COULD RESULT IN SERIOUS PERSONAL INJURY!

5-3. PERFORMANCE CHECKS

Basic performance checks for the UCS upconverter are given in Section 2-5.

5-4. REMOVAL AND REPLACEMENT

To effect removal and replacement of the UCS upconverter in the system, refer to the applicable system manual. To remove and replace a module in the unit, refer to Figure 5-1. All hardware mounting is done with standard #2-56, #4-40, and #6-32 hardware. Exact location of screws, nuts, washers, and spacers should be noted when a module is removed so that the replacement module can be assembled in a like manner. Likewise, if any of the cabling is repaired or disturbed, the affected cables should be dressed and anchored as before. Tighten all hardware and ensure that the unit is free of loose parts before replacing cover and returning to service.

5-5. TROUBLE ANALYSIS

Should a difficulty arise in the operation of the upconverter, a repair should only be attempted by a qualified technician. The operational instructions are given in Section 3 and the theory of operation is presented in Section 4 of this publication. You should be thoroughly familiar with the contents of both sections before attempting a repair. In addition to these two sections, the tables of Section 6 show all of the cables and wires which interconnect the various modules. The point of origin for each signal is denoted by an asterisk and the function of each interconnecting wire is given. Levels are given where applicable, and all logic lines are TTL/CMOS compatible and assumed true unless preceded by the / character. Detailed description of the microprocessor board is beyond the scope of this publication and unless you are particularly knowledgeable in the area, detailed troubleshooting of the A5 assembly should not be attempted. If a problem is traced to that area, replacement of that module is suggested, along with the LCD display. Although detailed troubleshooting is discouraged, do not overlook possible problems with the interconnecting cables.

5-6. CALIBRATION

The CALIBRATE function is accessible from the front panel of the unit (see Section 3-3.) To enter CAL mode from the CALIBRATE menu item, use the left/right arrows to select the letter "W" in the information window, then depress "ENT". The "MENU" buttons can then be used to scroll through the 6 different calibration constants which can be changed in the **CAL** mode. To change a given constant, use the left/right arrows and the number keys. Use the "ENT" button to validate any changes and the "LCL" button to exit **CAL** mode. Below is a listing of the calibration constants and a description of each.

L ATTEN CURVE. This constant is normally 0.550 and determines the shape factor of the L band attenuator. If the ATTEN GAIN constant is set for correct full scale operation and the low-to-mid ranges exhibit excessive error, then the ATTEN CURVE constant should be altered by a small percentage. After changing the ATTEN CURVE constant, the ATTEN GAIN constant must be corrected before evaluating the results. This constant comes calibrated from the factory; however, it may need alteration if the A12 module is replaced.

L ATTEN GAIN. This constant is nominally about 1.000 and determines the full scale accuracy of the L band attenuator. It comes calibrated from the factory; however, it may need alteration if the A12 module is replaced.

IF ATTEN CURVE. This constant is normally 0.250 and determines the shape factor of the IF attenuator. If the ATTEN GAIN constant is set for correct full scale operation and the low-to-mid ranges exhibit excessive error, then the ATTEN CURVE constant should be altered by a small percentage. After changing the ATTEN CURVE constant, the ATTEN GAIN constant must be corrected before evaluating the results. This constant comes calibrated from the factory; however, it may need alteration if the A12 module is replaced.

IF ATTEN GAIN. This constant is nominally about 8.400 and determines the full scale accuracy of the IF attenuator. It comes calibrated from the factory;

however, it may need alteration if the A12 module is replaced.

OUTPUT DET. This constant is nominally about 03.800 and determines the power conversion factor for the display of the RF output power level. It comes calibrated from the factory; however, it may need alteration if the A12 module is replaced.

XMT OFFSET. This constant is set at the time of installation of the unit into the system (see Section 2-6). The XMT OFFSET is expressed in dB and represents the RF coupling value between the transmitted power and the power delivered to the XMT detector head. For example, if the power level reaching the antenna is 50 KW (+77 dBm) and the detector is registering 0.5 milliwatt (-3 dBm), then the net coupling value is (+77 - (-3)) = 80 dB. In this case, the XMT OFFSET should be set to 80.000. Once this constant is set, it will remain intact unless the converter is changed or the antenna feed configuration is changed.

All of the calibration constants are stored in the ROM and the NVRAM installed on the A5 board. If changes need to be made only the NVRAM will be updated.

NOTE: If an initialization process is initiated during start-up, the NVRAM will be reprogrammed with the original values and any of the changes need to be reentered.