Section 3 INSTALLATION AND OPERATION

3.1 INSTALLATION - The FTS 4100 requires no special equipment for handling and installation. The required mating connectors are listed in Table 2.

TABLE 2 MATING CONNECTORS

Required Hardware	Description	Quantity
Output connector	SMA	3
Power input connector	Type DEM 9S	1
Control & monitor (C&M) connector	Type DCM 37P	1

3.1.1 Mounting

The FTS 4100 has been designed for mounting by means of ten 8-32 bolts that screw into the baseplate. Figure 5 is a bottom view of the tapped-hole mounting arrangement.

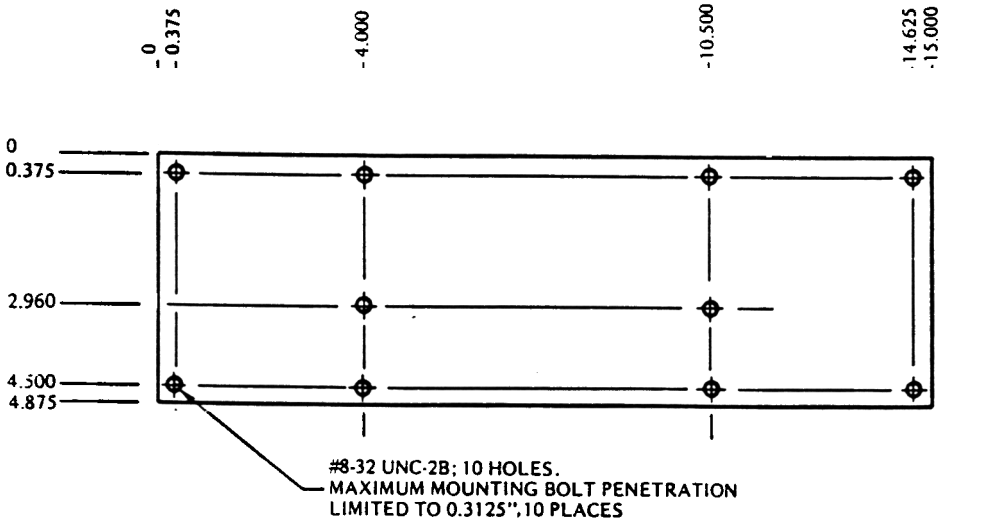


FIGURE 5. Bottom View of the FTS 4100 Showing the Mounting Configuration

3.1.2 Connections

Figure 6 shows front and rear end views of the FTS 4100, with the connector, indicator, and reset button arrangements. Pin numbers and functions are given in Figure 7.

3.1.3 Operating Controls

Four operational functions can be accessed through the C&M connector as follows:

1) Modulation, on/off. The 500 Hz modulation is turned on by momentarily (>10 ms) applying the 26 ±4 V dc input voltage to pin 14 of the control and monitor connector (C&M connector). Alternatively, an external source of 25 ±5 V dc, referenced to pin 13, can be used. The modulation is turned off by applying the voltage to pin 15.

2) Loop, open/closed. The frequency control loop is opened by momentarily (>10 ms) applying the 26 ±4 V dc input voltage to pin 16 of the C&M connector. Alternatively, an external source of 25 ±5 V dc, referenced to pin 13, can be used. The loop is closed by applying the voltage to pin 17.

3) Automatic lock, normal/inhibit. The automatic lock circuit functions normally if pin 26 of the C&M connector is open. Shorting pin 26 to pin 24 of the C&M connector inhibits the automatic lock feature.

4) Alarm indicator reset. The latching alarm indicator is reset by depressing the RESET button or by connecting pin 5 of the C&M connector to pin 24.

3.1.4 Visual Status Indicators

Two status indicator lamps are provided on the FTS 4100 as follows:

1) Operation. The green OPERATION lamp is illuminated if all four of the following four conditions are satisfied:

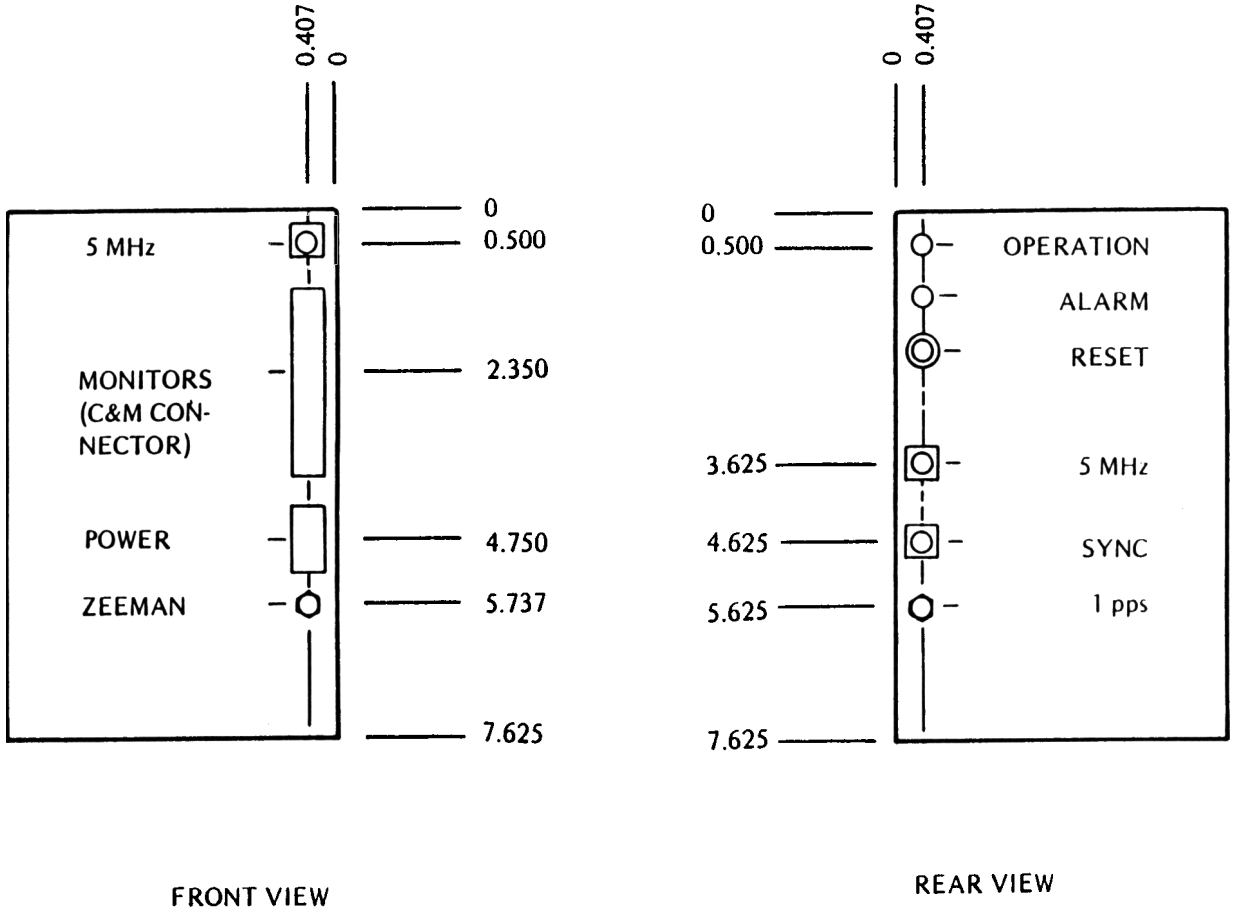
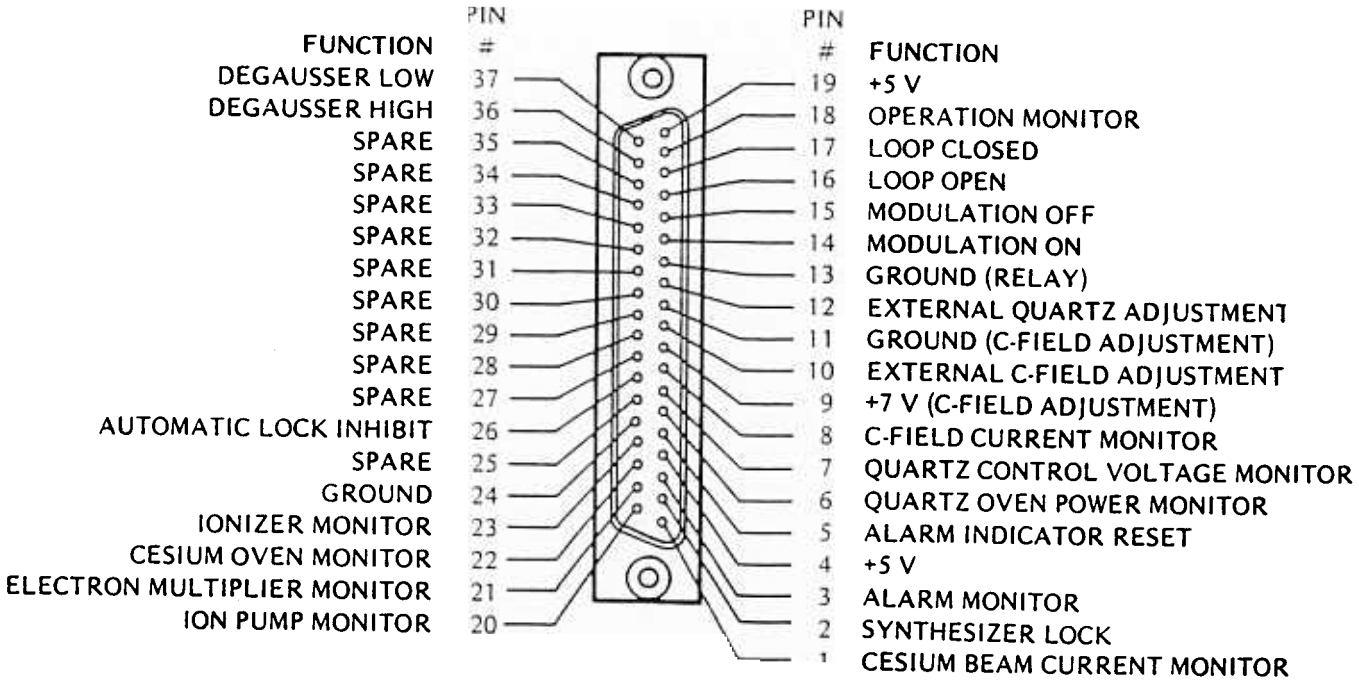
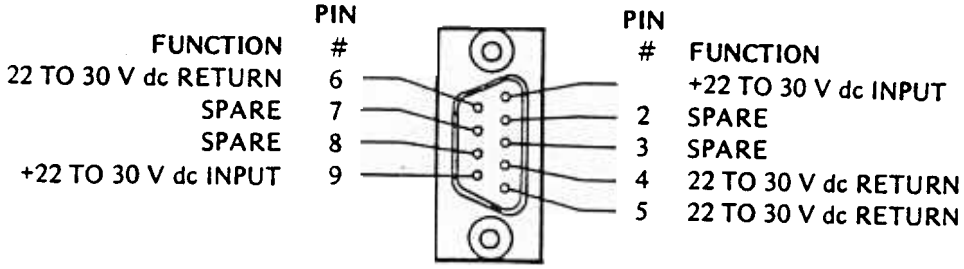


FIGURE 6. Front and Rear Views Showing Connector and Indicator Placement

CONTROL AND MONITOR CONNECTOR PIN FUNCTIONS (C&M CONNECTOR)



POWER INPUT CONNECTOR PIN FUNCTIONS



NOTES: PINS 1 AND 9 ARE INTERNALLY CONNECTED
PINS 4, 5, AND 6 ARE INTERNALLY CONNECTED

FIGURE 7. Pin Numbers and Functions of the Control and Monitor and the Power Input Connectors

- The loop is closed.
- The modulation is on.
- The cesium beam current monitor reading is greater than 1.0 V.
- The frequency error of the 5 MHz quartz crystal oscillator is less than 2 to 3 x 10^{-10}.

2) Alarm. The Red ALARM lamp will illuminate if one or more of the four conditions listed above are not satisfied and will remain lighted until the RESET pushbutton switch is operated.

3.2 OPERATING INSTRUCTIONS

3.2.1 Start-up Procedure

Refer to Table 3 for start-up instructions for the FTS 4100. The locations of the connectors are shown in Figure 6, and the connector pin functions are listed in Figure 7.

CAUTION

THERE ARE NO FUSES IN THE FTS 4100. CAREFULLY OBSERVE THE MAXIMUM VOLTAGE RATING TO AVOID PERMANENT DAMAGE TO THE INSTRUMENT.

TABLE 3 START-UP PROCEDURE

STEP	PROCEDURE	NOTES
1	Connect the power input connector & apply the input power, 26 ±4 V dc.	Red ALARM lamp will light. Initial input current is approx. 1.8 A, decreasing to less than 1 A after 60 min.
2	Verify that the automatic lock function is not inhibited.	See Section 3.1.3.
3	Turn on the modulation.	See Section 3.1.3.
4	Close the frequency control loop.	See Section 3.1.3.
5	Allow 1 h for warm-up.	Warm-up is complete when green OPERATION lamp is continuously lit for 10 min. The OPERATION lamp may flash on and off during warm-up, indicating that the automatic lock circuit is searching for correct peak.
6	Inhibit the automatic lock circuit.	See Sections 2.5 and 3.1.
7	Reset the alarm lamp by depressing the RESET button.	See Section 3.1.3.
8	Synchronize the 1 pps output, if required.	See Section 3.2.6.

3.2.2 Restarting

If the power to the FTS 4100 is interrupted, use the procedures in Table 3, starting with step 1, to restart the instrument.

3.2.3 Monitors

In addition to the two visible indicators on the front, eight analog monitor signals and three discrete monitor signals are available at selected pins of the C&M connector. The functions monitored and the normal readings that should be obtained after warm-up are presented in Table 4. These monitors should be measured with respect to the ground available on pin 24 of the C&M conector. The monitors should be measured by using a meter with an input resistance of 1 megohm or greater.

3.2.4 C-Field Adjustment

The frequency of the FTS 4100 can be adjusted over a range of $\pm 1 \times 10^{-11}$ by using pins 9, 10, and 11 of the C&M connector. By placing a potentiometer (10 kiloohm or greater) between pins 9 and 11, with the center arm on pin 10, the magnetic field inside the cesium beam tube can be varied, thus adjusting the frequency. The strength of the magnetic field can be determined by applying an audio signal to the Zeeman input of the FTS 4100. The Zeeman signal (approximately 1 V rms) is in the region of 43 kHz. To measure the Zeeman frequency, turn off the modulation (step 1, Section 3.1.3), open the loop (step 2, Section 3.1.3), and apply a 1 V rms, 43 kHz sine wave to the Zeeman input. Then vary the signal voltage to maximize the cesium beam current and sweep slowly in frequency until the center of the central cesium beam resonance is reached. This frequency is the Zeeman frequency. To obtain an output frequency of exactly 5.000 MHz, the Zeeman frequency should be equal to 42.82 kHz. An adjustment in the C-field that causes a 1% change in Zeeman frequency will change the output frequency of the FTS 4100 by 3×10^{-12}.

3.2.5 Quartz Crystal Oscillator Adjustment

The frequency of the unlocked quartz crystal oscillator can be varied over a range of $\pm 2 \times 10^{-7}$ by opening the loop and applying a voltage between -15 and 15 V dc to pin 12 of the C&M connector, referenced to the ground on pin 24. Varying the voltage will tune the frequency through the satellite resonances of the cesium beam tube. The primary application of this mode is for emergency operation of the standard in the event of a malfunction of the frequency control loop.

3.2.6 Pulse Synchronization

The 1 pps output is automatically synchronized, within 100 ns to the rising edge of a pulse applied to the SYNC coaxial connector. The synchronizing pulse must be positive going, 3 V minimum to 10 V maximum pulse amplitude into 50 ohm, with a rise time of less than 50 ns.

Connect the synchronizing pulse source to the SYNC connector for at least 1 s to ensure pulse time coincidence.

3.2.7 Maintenance

Repair and servicing of the FTS 4100 is normally performed by Frequency and Time Systems, Inc.; see FTS Warranty Statement for information on the service policy. FTS will provide technical support to enable qualified users to perform field service. Contact the factory for additional information.

TABLE 4. MONITOR SIGNALS OF THE FTS 4100

MONITOR	PIN NUMBER	VOLTAGE (V dc)	DESCRIPTION
Cesium beam current	1	0 to 5	A measure of the cesium beam current.The value varies from unit to unit between 1.5 and 3.5 V dc; it may change as much as 30% over the temp. range and should rise about 35% when the the modulation is turned off.
Quartz oven power	6	0 to 5	A measure of the power input to the quartz oven. It is nominally 4.6 V dc at turn-on and 3.5 V dc when the quartz crystal oven is warmed up at room temperature.The monitor voltage will fall as the ambient temperature is raised.
Quartz control voltage	7	0 to 5	A measure of the quartz oscillator aging. The monitor is set to approximately midscale at the factory and will vary with aging of the quartz oscillator.
C-field current	8	0 to 5	A measure of the current in the C-field.It normally reads 3.5 V and should not change over time or temperature.
Ion pump	20	0 to 5	A measure of the vacuum level in the cesium beam tube.The normal reading is 0 V dc; it may read high (approx. 0.2 V dc) when the tube is turned on after a long storage period.The monitor should return to 0 V dc after the ion pump has restored the tube vacuum.

TABLE 4. MONITOR SIGNALS OF THE FTS 4100 (continued)

MONITOR	PIN NUMBER	VOLTAGE (V dc)	DESCRIPTION
Electron multiplier	21		A measure of the electron multiplier voltage.It typically reads 2.1 to 2.4 V dc and should not change over time or temperature.
Cesium oven	22	0 to 5	A measure of power input to the cesium oven. It is 2.4 V dc at turn-on and 0.5 V dc when the oven is warmed up at room temperature The monitor voltage will fall as the ambient temperature is raised.
Ionizer	23	0 to 5	A measure of the ionizer voltage. It is typically 3.6 to 4.1 V dc and may change ±5% over the temperature range.
Synthesizer lock	2	0 or 5	An indicator of whether the synthesizer is locked. Pin 2 is at 5 V dc if the synthesizer is locked and 0 V dc if it is unlocked. The synthesizer should lock up within 10 s of turn-on and should remain locked until power is interupted.
Alarm	3*	0 or 5	An indicator of whether the alarm is is on or off. Pin 3 is at 0 V dc if the alarm indicator is on; otherwise,it is at approximately 5 V dc.
Operation	18*	0 or 5	An indicator of whether the standard is operating normally.Pin 18 is at 0 V dc if the operation light is on; otherwise,it is approximately 5 V dc.

*Pins 3 and 18 connect to the collectors of transistor switches that operate the ALARM & OPERATION lamps. The indicated voltages appear at these pins if the lamps are connected and functional. A +5 V dc source is provided at pins 4 and 19 to permit operation of external lamps or other monitoring devices, if required.