MONOPULSE BEACON TEST SET (MBTS)

COMPUTER BASED INSTRUCTION

OPERATOR'S TRAINING COURSE

Document No. 100608, Rev. C

July 8, 2003

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1 GENERAL INFORMATION

1.1 Purpose

This self-paced training course will familiarize a technician with the installation and operation of a Monopulse Beacon Test Set (MBTS) and the associated Operator Control Subsystem (OCS). Course topics describe all modes of MBTS operation and the use and meaning of OCS controls and display indicators. Access to a MBTS/OCS system permits the implementation of the instructional sequences presented in Section 2, System Operation. Red text highlights actions to be performed by students on their systems.

1.2 Scope

This course covers information related to typical installation, basic operation, maintenance, basic troubleshooting, and general system knowledge of the MBTS System.

It is recommended that the student have access to a System Operations/Training Manual (FSE Document No. 100605). This manual is often referenced for additional information that is beyond the scope of this course.

1.3 System Requirements

This course is designed for viewing on a computer using Adobe Acrobat 4.0® or higher. It operates similar to an Internet browser and web page with hyperlinks.

1.4 Navigation Within This Course

This course makes extensive use of text links (shown in blue). The text links enable a student to immediately access a topic of interest. The "back" button control returns the course material to its previous topic. An interactive TABLE OF CONTENTS is included. This allows quick movement to desired sections within the manual. Additionally, Adobe Acrobat® "Bookmarks", on the left side of the screen, may be used to move throughout the course document.

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2 SYSTEM OPERATION

The course content of this section includes:

- A brief overview of the uses of the MBTS System
- A summary of the required MBTS system configuration, including system initialization and shutdown procedures
- An explanation of the OCS system status displays and controls
- A description of MBTS operational modes and mode settings

Upon completion of this section the student should be able to setup, operate, and shutdown the MBTS System. The student will also become familiar with the various operational modes and mode control settings of MBTS.

The procedures contained within this course are written with the expectation that the MBTS instrument is connected to, and controlled by, only the OCS. The availability of other radar system components or commercial test equipment, for calibration or other purposes, is not assumed. Please refer to Sections 2.1.1 and 6.0 of the System Operations/Training Manual for information about connecting the MBTS to a radar system.

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2.1 Overview of the Monopulse Beacon Test Set System

The MBTS is designed to assist in the maintenance, certification, and test of monopulse secondary surveillance radar (MSSR) systems and ATCBI-5 and earlier, non-MSSR, systems. (See Section 1.3 of the System Operations/Training Manual for additional information.)

Signals to and from the MBTS are typically coupled into the radar system between the radar transmitter/receiver and antenna. The MBTS detects and demodulates both Air Traffic Control Radar Beacon System (ATCRBS) and Mode S interrogations. The MBTS then generates reply signals that allow full characterization of ATCRBS and Mode S radar receiver performance.

The MBTS includes all the functions required for the certification of MSSR system sensitivity and target detection. The MBTS also gives field technicians the ability to test the MSSR from end-to-end, through the injection of ATCRBS or Mode S RF test target replies into the MSSR receiver. The primary functions of the MBTS include:

- Measuring and calibrating receiver sensitivity
- Measuring and calibrating fixed thresholds
- Measuring and calibrating Sensitivity Time Constant (STC) curves
- Measuring and calibrating delta/sum (Δ/Σ) and sum/omni (Σ/Ω) thresholds
- The test and alignment of the radar receiver system, using pulsed and CW signals

The MBTS system includes the MBTS instrument, the OCS - a Pentium based laptop computer running dedicated MBTS virtual instrument control software, and various dedicated RF and data cables.

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2.2 MBTS System Configuration

This section explains how to configure, start, and shutdown the OCS and the MBTS. Typical startup considerations are demonstrated and explained.

2.2.1 Connecting the OCS to the MBTS

2.2.1.1 Data Communication Cable

Connect the OCS (laptop computer) to the MBTS using the GPIB (IEEE-488) cable provided. The IEEE-488 adapter plugs into the OCS's PCMCIA slot. The MBTS IEEE-488 Connector is J12, located on the MBTS Rear Panel.

Connect power to the OCS and the MBTS. Use the AC/DC power supply provided with the OCS PC.

2.2.2 Starting the OCS and MBTS

Turn on both the OCS PC and the MBTS. The power switch for the MBTS is located on the bottom left of the MBTS Front Panel.

Observe the LEDs on the PCC Module (the module just above the MBTS power switch). The MBTS executes self-test diagnostics approximately 10 seconds after application of power. The PCC will then display a flashing green PROC LED. This indicates that the microcontroller within the PCC is operating normally.

Login on the OCS PC as User: Tech2 and Password: Tech2.

Select the OCS short cut icon on the desktop display. After a few seconds the Main OCS Screen will appear.

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2.2.3 Antenna Alarm Function

Because there are no APG signals available for use by the MBTS, an antenna alarm text message appears in the System Status display area soon after the initialization of the OCS software. ***When valid APG signals are not present the Antenna Alarm must remain off for the MBTS to function properly.***

Observe that the AZ LED on the MBTS PCC module is red.

Observe that red "Az Error" and yellow "OPS Suspended" warning messages are displayed in the alarm indicator section of the Main OCS Screen.

2.2.3.1 Disable the Antenna Alarm

Click on the Antenna Alarm Control to disable the Antenna Alarm function.

Observe that the AZ LED on the MBTS PCC module turns green.

Observe that the red "Az Error" message is replaced with a green "Az OK" message.

Observe that the yellow "OPS Suspended" message is replaced with a green "OPS OK" message.

Figure 1 Antenna Alarm Control

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2.2.3.2 Enabling the Antenna Alarm

After signals from an Antenna Pulse Generator are applied to the MBTS, clicking on the Antenna Alarm Control enables the Antenna Alarm Function. ***When valid APG signals are not present the Antenna Alarm must remain off for the MBTS to function properly.*** For this course the Antenna Alarm will always be disabled.

2.2.4 Shutdown

Always exit the Main OCS Screen as the first step in the shutdown of the MBTS System.

2.2.4.1 OCS Shutdown

Click the green ON Switch in the upper left menu area of the Main OCS Screen. This closes the OCS control panel.

The Windows desktop is displayed.

Select SHUTDOWN from the Windows "START" menu located in the lower left corner of the computer screen.

2.2.4.2 MBTS Shutdown

Exit the OCS program prior to shutting down the MBTS – See Section 2.1.4 of the System Operations/Training Manual.

Set the MBTS Power Switch to the OFF position.

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2.3 OCS System Status Indicators and Function Controls

This section of the training course explains the use of those OCS controls, available in the Main OCS Screen, that are not MBTS operating mode dependent. Included among these are the GPIB address control, the setup Save/Recall control, the Output Channel Selection control, and the GPIB interface control. Temperature compensation of the output level of the MBTS is also explained. This section also describes each of the various System Status Indicators seen in the System Status Display.

Upon completion of this section an operator will be able to configure the OCS to match the GPIB address of the MBTS (if it is set to other than default values), to save and recall OCS operating configurations, to select the output signal channel of the MBTS, and will be able to execute temperature compensation routines that adjust the output signal level of the MBTS. The operator will also have a rudimentary knowledge of the meaning of each of the OCS System Status indicators.

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2.3.1 System Status Indicators

Turn on the MBTS and OCS. Refer to the Starting the OCS section if needed.

Turn off the Antenna Alarm. See the Disable the Antenna Alarm section if needed.

Locate the System Status Display panel at the top right of the Main OCS Screen.

The System Status panel displays the condition of important MBTS operating functions. The OCS monitors these functions on a continuous basis. The conditions that trigger an alarm are described below and, more extensively, in Section 2.2.1 of the System Operations/Training Manual.

Green indicates that the function is operationally active and working properly.

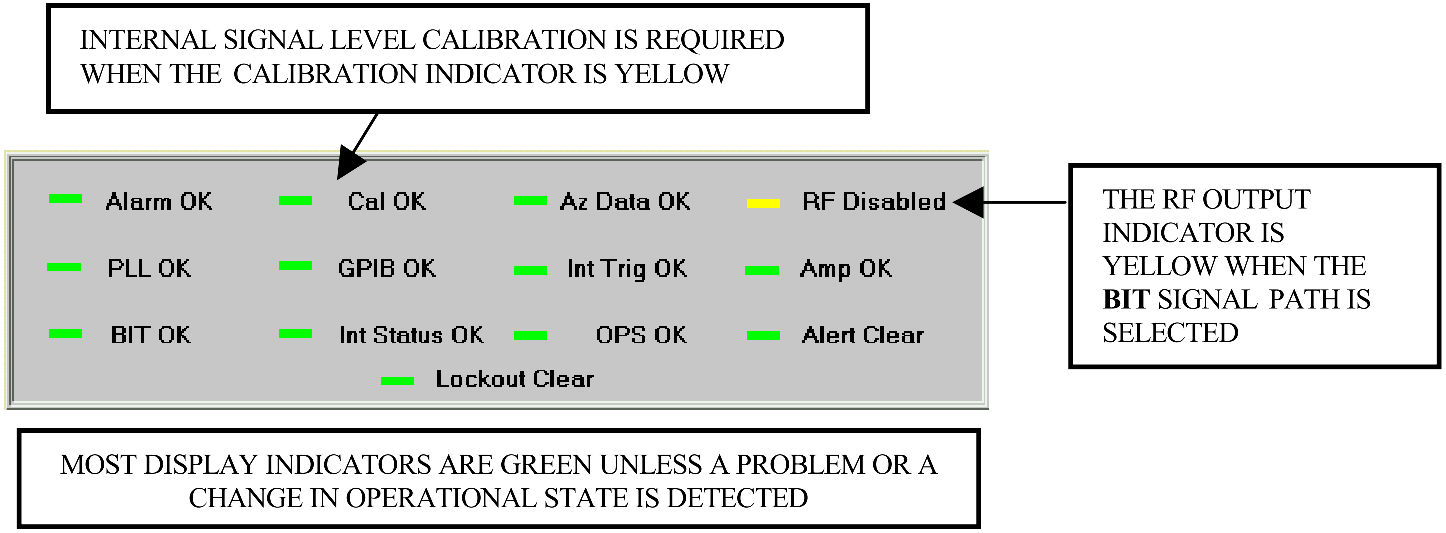
Yellow indicates that the function is either inactive or in an indeterminate state.

Red indicates that the function is in a failure mode. Critical function failures detected by the OCS force the MBTS into STANDBY Mode. Normal MBTS operations can resume only after the fault is corrected.

Blue indicates signal activity or a state that varies from default conditions. Lockout and Alert conditions, for instance, are indicated by this color.

Next

Figure 2 System Status Display



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2.3.1.1 Alarm Status Indicator

The Alarm Status Indicator displays the status of the ALARM status register of the MBTS. Functions monitored include fan status, output signal calibration process, internal temperature, and power supply voltages. A fault condition for any of these functions results in a red indicator and an "Alarm Error" message.

2.3.1.2 Phase Lock Indicator

The Phase Lock Indicator displays the status of the PLL status register of the MBTS. The condition of all MBTS phase locked loop circuits is monitored. Any detected fault condition results in a red indicator and a "PLL Error" message.

2.3.1.3 BIT Status Indicator

The BIT Status Indicator displays the status of that portion of INTERR status register of the MBTS related to BIT RF circuit test results. All RF control circuits are monitored. Any detected fault condition results in a red indicator and a "BIT Error" message.

2.3.1.4 Calibration Indicator

The CALIBRATION indicator turns yellow and displays a "Cal Output" message when a significant change in the operational temperature of the MBTS is detected. This indicator provides a reminder that the output level of the MBTS should be recalibrated. See the MBTS Internal Calibration section for details. When calibration of the MBTS is indicated, use the Temperature Calibrate control to adjust the output level of the MBTS.

2.3.1.5 GPIB Status Indicator

The GPIB Status Indicator displays the status of the GPIB link between the OCS and the MBTS. Any detected fault condition results in a red indicator and a "GPIB Error" message.

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2.3.1.6 Internal Status Indicator

The Internal Status Indicator displays the status of that portion of INTERR status register of the MBTS related to processor or memory function. Any detected fault condition results in a red indicator and an "Int Status Error" message.

2.3.1.7 RF Output Indicator

The RF Output Indicator is yellow whenever the output signal from the MBTS is disabled. It is green when the use of either Channel A or Channel B is selected.

2.3.1.8 Azimuth Status Indicator

The Azimuth Status Indicator is red, and a "Az Error" message is displayed, if errors are detected in data received from the azimuth pulse generator. Errors include lack of ARP or ACP data, improper ACP/ARP ratios, and improper rotation rates (high or low).

2.3.1.9 OPS Status Indicator

The OPS Status Indicator is yellow, and an "OPS Suspend" message is displayed, when MBTS operations are stopped or suspended. Changing target parameters, especially in Azimuth Gated Target Mode, may cause the generation of target replies to be temporarily suspended.

2.3.1.10 AMP Setting Status Indicator

The AMP setting Status Indicator is yellow, and a "AMP Conflict" message is displayed, if the settings of the Sum Output power, Delta/Sum ratio, or Sum/Omni ratio controls exceed the capabilities of the MBTS. Achieved signal levels from the Sum, Delta, and Omni outputs will not be as indicated by control settings.

Next

2.3.1.11 ALERT Activity Indicator

The ALERT Activity Indicator is blue and displays an "ALERT Active" message whenever the MBTS is set to generate replies with the Alert bit set. The Alert signal is generated in response to changes to the Mode 3/A code setting.

2.3.1.12 LOCKOUT Activity Indicator

The LOCKOUT Activity Indicator is blue and displays a "LOCKOUT Active" message whenever any reply Lockout condition is set in the MBTS. The Lockout condition is set in response to data commands received from radar system Roll-Call interrogations.

2.3.1.13 TRIG Status Indicator

The TRIG Status Indicator is yellow, and a "TRIG Conflict" message is displayed, if the settings of the internal trigger rate control and the range control are incompatible. Reply signals will not be generated at the rate indicated by the control settings. Trigger status is only checked when internal triggers are used to generate reply signals.

Next

2.3.2 Common OCS Function Controls

The Main OCS Screen contains a number of controls that are always displayed regardless of the selected MBTS operating mode. Included are the Output Channel Selection control, the GPIB Address Setup control, and the Setup Save/Recall control. The use of these controls is explained and demonstrated in the following sections. The procedure to temperature compensate the MBTS, through the use of the OCS is also demonstrated.

The OCS and MBTS should already be on and operating (see Section 2.3.1). The CW operating mode should be selected and highlighted on the Mode Select Panel.

Next

2.3.2.1 Output Channel Selection

The Output Channel Select control is used to select the active RF signal path for output signals generated by the MBTS. A complete description of the Output Selection can be found in Section 2.2.8 of the System Operations/Training Manual.

The MBTS will drive signals through one of three signal channels:

- Channel A Sum, Delta, and Omni Connectors, see the MBTS Rear Panel.
- Channel B Sum, Delta, and Omni Connectors, see the MBTS Rear Panel.
- BIT (Built-In Test). The BIT signal connections are internal to the MBTS.

The MBTS always initializes with the BIT path selected.

Select Channel A in the Output Channel Select control panel.

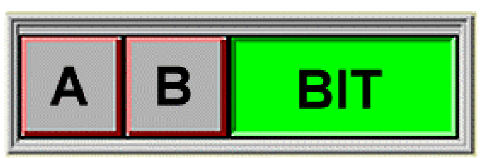
Hear the RF relays operate when you switch to or from the BIT selection.

Observe the RF Output Alarm indicator on the System Status Display and the RF OUT LED on the PCC module. Both are green when an external RF output channel is selected.

Select BIT in the Output Channel Select control panel.

Observe that the OCS RF Output Alarm on the System Status Display and the MBTS RF OUT LED are now yellow.

Figure 3 Output Channel Select



CLICK ON A CONTROL TO SELECT
AN OUTPUT CHANNEL
THE SELECTED CHANNEL WILL
THEN BE HIGHLIGHTED

Next

2.3.2.2 GPIB Address Setup

For the OCS to communicate with and control the MBTS the GPIB address of the MBTS must match the address indicated in the OCS IEEE-488 Address Control window, as illustrated below. If they do not match either the OCS IEEE-488 control setting or the setting of the MBTS IEEE-488 address switch must be changed. The GPIB address of the HP-8902A (used for signal level measurement in the Absolute Output Power Calibration Mode) must also match the setting displayed in the OCS IEEE-488 Address Control window.

The MBTS is delivered from the factory set to GPIB address 1. The HP-8902A is typically set to address 14. Information on setting the MBTS GPIB address is available in the IEEE-488 Address Switch section. The process outlined below demonstrates how the OCS IEEE-488 address control setting may be varied.

Click the up arrow on the MBTS GPIB Address control, setting it to 2.

Click OK (or hit the enter key) on all the error messages that appear.

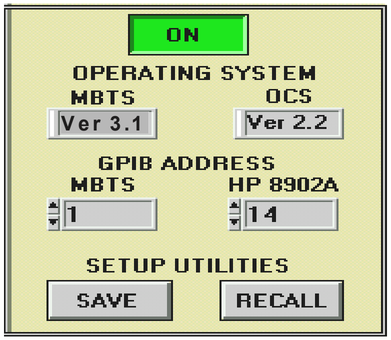
Observe the grayed out Mode Select Panel indicating that the system is not ready for use.

Observe the GPIB timeout messages that are generated.

Set the MBTS GPIB address back to 1.

Next

Figure 4 IEEE-488 Address Control Window



2.3.2.3 Setup Save/Recall

The control settings of the OCS CW Mode, Constant Range Ring Mode, and Azimuth Gated Target Mode may be saved to and recalled from files using the Save/Recall controls located in the IEEE-488 Address Control Window.

NOTE

Transponder code settings, viewed in the Reply Parameter Window, and Off-Boresight Calibration Mode settings are not saved. The OCS RECALL function always sets the MBTS to operate in the Azimuth Gated Target Mode with the BIT Channel selected.

Select the Azimuth Gated Target Mode.

Next

Change the RF Frequency setting to 1090.2 MHz. This control is located in the bottom right of the Azimuth Gated Target Mode OCS Screen.

Select SAVE in the IEEE-488 Address Control Window.

Enter *CBI_course* for the saved file name.

Click on the Save control. Always save to the default directory.

Change the RF Frequency setting back to 1090.0 MHz.

Select RECALL in the IEEE-488 Address Control Window.

Double click on the *CBI_course* file icon.

Select the Azimuth Gated Target Mode.

Observe that the RF Frequency setting is 1090.2 MHz.

Next

2.3.2.4 MBTS Internal Calibration

The CALIBRATION indicator, located on the System Status Display, turns yellow when a significant change in the operational temperature of the MBTS is detected. A yellow CALIBRATION indicator will normally be seen a few minutes after the system has been turned on and also occasionally as the MBTS unit warms up. It may also be seen if the operating ambient temperature changes significantly, at least 3 Cº, from when the MBTS was last calibrated. The yellow CALIBRATION indicator is a visible reminder that the output level of the MBTS may not be as accurate as it could be and should be recalibrated.

Observe the state of the Calibration Indicator. See the System Status Display.

Click on the Temperature Calibrate control located above the System Status display.

Observe the color of the Calibration Status indicator. It will have changed from yellow to green indicating that the temperature compensation and calibration process was completed without incident.

Next

2.4 MBTS Operating Mode Selection and Mode Controls

This section of the training course briefly explains the various operating modes of the MBTS, demonstrates how to use the OCS system to select an MBTS operating mode, and provides instruction as to how to use the controls applicable to each mode of operation. A complete description of each operating mode can be found in Section 2.3 of the System Operations/Training Manual.

Upon completion of this section an operator will be able to use the OCS to set the MBTS to any of its operational modes. The operator will also have a gained a rudimentary understanding of the use of the various controls available for each mode of operation.

Next

2.4.1 Mode Select Panel

The Mode Select control determines the operating mode of the MBTS. The operating mode of the MBTS is highlighted in bright green on the Mode Select Panel.

Locate the Mode Select Panel at the left of the Main OCS Screen.

Six mode selections are available. The primary modes of MBTS operation include the CW Mode, the Constant Range Ring Mode, and the Azimuth Gated Target Mode. MBTS calibration functions are accomplished through the use of the Cal Settings / Antenna Pattern Mode, the Off-Boresight Calibration Mode, and the Absolute Output Power Calibration Mode. The Standby/Diagnostics Mode is used to implement and display the results of MBTS self-diagnostic routines. A complete description of each operating mode can be found within Section 2.3 of the System Operations/Training Manual.

Figure 5 Mode Select Panel

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2.4.2 CW Mode

When in the 1090 MHz CW Mode the MBTS creates CW signals that are available at either set of Sum, Delta, and Omni output channels located at the rear panel of the MBTS. When in the 1060 MHz CW Mode the MBTS generates a 1060 MHz test signal at the front panel 1060 MHz RF output (J25) of the Reference Source Module. A complete description of the CW mode can be found in Section 2.3.1 of the System Operations/Training Manual.

Select the CW mode on the Mode Select Panel.

Observe that the system always defaults to 1090 MHz CW functions.

2.4.2.1 1060 MHz CW Mode

When set to this operating condition the MBTS generates a 1060 MHz CW test signal at J25 – 1060 MHz Test Output of the Reference Source Module, on the MBTS Front Panel. When this mode is enabled no signals are available at any of the 1090 MHz MBTS output ports.

Select the Disabled control under the Output 1060 label within the 1090 MHz CW Mode OCS Screen.

Observe the reduced set of available controls when the 1060 MHz CW Mode is selected. Note that the Output Channel Select control is disabled and grayed out. All output from MBTS rear panel signal ports is disabled when operating in the 1060 MHz CW Mode.

The Output Level control, on the 1060 MHz CW Mode OCS Screen, sets the power level of the 1060 MHz signal between -22 dBm and +8 dBm in 1dB increments.

Next

2.4.2.2 1090 MHz CW Mode

When set to this operating condition the MBTS generates unmodulated RF signals. When the Output Channel Select control is set to either A or B RF signals are routed to the 1090 MHz Reply Outputs and Sum Channel Interrogation Inputs on the MBTS Rear Panel and to the J27 & J28 – 1090 MHz Test Outputs of the three Upconverter Modules on the MBTS Front Panel. The Output Channel Select control does not affect signal presence at the Upconverter J26 - 70 MHz Test Output ports. The 1090 MHz CW Mode Control Functions diagram provides a graphical overview of output signal relationships and limitations. Section 2.3.1.2.1 of the System Operations/Training Manual contains additional information on CW Mode operations.

Select the Disabled control under the Output 1090 label on the 1060 MHz CW Mode OCS Screen.

Observe the additional available controls when the 1090 MHz CW Mode is enabled.

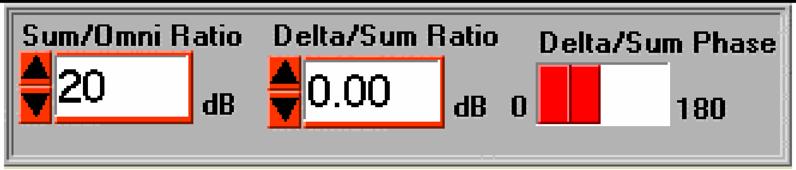
MBTS output signal amplitude, frequency, and phase may be set through the use of controls found on the 1090 MHz CW Mode OCS Screen. The function of these controls is explained in the following sections. Control parameters can be either typed in, and then selected (by use of the keyboard Enter key), or scrolled by use of the up/down arrows adjacent to the control selection window.

The OCS allows the operator to set the various amplitude controls to combinations that exceed the capability of the MBTS. When this occurs an "Amplitude Conflict" message is displayed in the System Status window.

Next

Figure 6 Monopulse Characteristics Control Panel

MODE OR CONTROL SELECTIONS MAY DISABLE
(GRAY OUT) THE USE OF THESE CONTROLS



2.4.2.2.1 Sum/Omni Ratio

The Sum/Omni Ratio control in the Monopulse Characteristics Control Panel sets the level of Omni Channel signals relative to that of the Sum Channel signals. The Sum/Omni ratio may be set from −28 to +20 dB in 1 dB increments. See Section2.2.7 of the System Operations/Training Manual for additional information on this topic.

Set the Sum/Omni Ratio to 7 dB.

2.4.2.2.2 Delta/Sum Ratio

The Delta/Sum Ratio control in the Monopulse Characteristics Control Panel sets the level of Delta Channel signals relative to that of the Sum Channel signals. The Delta/Sum Ratio may be set from −41.75 to +12.0 dB in 0.25 dB increments. In Constant Ring Mode the Boresight Control can disable the use of the Delta/Sum ratio control. Section 2.2.7 of the System Operations/Training Manual provides additional information on the use of the Delta/Sum Ratio control.

Set the Delta/Sum Ratio to −10.35 dB (by typing).

Observe how the OCS sets the control to the nearest .25 dB increment when you hit the Enter key.

Next

2.4.2.2.3 Delta/Sum Phase

The Delta/Sum Phase control in the Monopulse Characteristics Control Panel sets the phase of the Delta Channel signal relative to that of the Sum Channel signal. The Delta/Sum phase relationship can be set to either 0º or to 180º.

Set the Delta/Sum Phase to 180º.

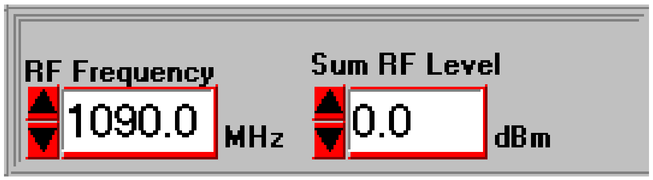
2.4.2.2.4 RF Frequency

The RF Frequency control in the RF Control Panel sets the output frequency of the MBTS Channel A and Channel B RF signals. The default operating frequency is 1090.0 MHz. Signal frequency can be adjusted from 1080.0 to 1100.0 MHz, in 0.2 MHz steps. Section 2.2.6 of the System Operations/ Training Manual provides additional information.

Change (by typing) the RF Frequency to 1140.0 MHz.

Observe the RF Frequency setting change to 1100.0 MHz, the maximum MBTS output frequency.

Figure 7 RF Control Panel



Next

2.4.2.2.5 Sum RF Level

The Sum RF Level control in the RF Control Panel sets the output amplitude of the MBTS Channel A and Channel B SUM RF signals. The Sum RF Level control may be set from −85.0 dBm to +10.0 dBm in 0.5 dB increments.

Set the Sum RF Level to −21 dBm.

Next

2.4.3 Constant Range Ring Mode

When operating in this mode, the MBTS generates pulsed RF replies in response to ATCRBS or Mode S RF interrogations, ATCRBS mode pair triggers, internal triggers, and external triggers. The amplitude of the Sum, Delta, and Omni pulsed reply signals are fixed at operator selectable settings. Reply generation is not gated by target azimuth position as it is in the Azimuth Gated Target Mode. Output signal connection options are the same as described in the 1090 MHz CW Mode section. A complete description of the Constant Range Ring mode can be found in Section 2.3.2 of the System Operations/Training Manual.

Select the Constant Range Ring mode on the Mode Select Panel.

Observe the appearance of the Constant Range Ring Mode OCS Screen. Note the additional controls that are available to set the operating conditions of this mode. Details concerning the operation of these are discussed in the following sections.

Observe the ten Mode LEDs of the PCC Module, located in the top left of the MBTS Front Panel. The states of these indicators provide an operator with a quick method of validating the trigger and reply settings of the MBTS. Check the MBTS trigger and reply control settings if operation is not as expected.

Next

2.4.3.1 Previously Described Control Functions

A number of Constant Range Ring Mode controls operate in the same manner as described in the CW Mode section. Refer to the description and use of the Sum/Omni Ratio, Delta/Sum Ratio, Delta/Sum Phase, RF Frequency, and Sum RF Level controls provided in the 1090 MHz CW Mode section.

2.4.3.2 Range

The Range Control (see the Constant Range Ring Mode OCS Screen) sets the timing of the MBTS so as to generate simulated target replies at a range of from 0.5 to 255 nautical miles. Two Range input fields are available. One sets Range in integer miles. The other sets Range in increments of 1/64 mile.

Set the range to 5 62/64 nmi.

Scroll the 1/64 mile Range control up four times.

Observe that the integer mile Range control is incremented to 6.

Scroll the integer mile control down to a setting of 0.

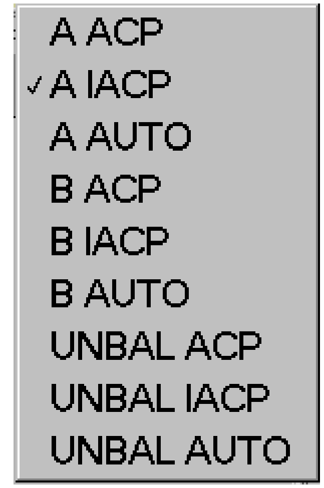
Observe that the minimum Range setting is limited to 32/64 nmi.

The OCS limits the MBTS range setting to values between 0.5 and 255 nautical miles.

Next

2.4.3.3 APG Input & Type

The APG Input control (see the Constant Range Ring Mode OCS Screen) selects the active Azimuth Data input channel and APG data type of the MBTS. APG signals may be applied to the MBTS through either balanced (J9) or unbalanced (J10 and J11) signal connections. See the MBTS Rear Panel to locate these data connectors. One of the two available balanced signal channels, A or B, may be selected.



The control also permits the manual or automatic selection of Antenna Change Pulses (ACP) or Improved Azimuth Change Pulses (IACP) data types.

Click the white area of the APG Input & Type field to activate the pop-up selection box (as seen to the right).

Select B ACP.

The APG INPUT A or B (ACP, IACP, AUTO) settings select balanced data from the RS-422 Channel A or B input connector J9. The APG UNBAL settings select input data from the 75 Ohm azimuth data input connectors J10 (ACP) and J11 (ARP). If A AUTO, B AUTO, or UNBAL AUTO is selected, the MBTS automatically determines if the APG signals are ACP or IACP data pulses.

The MBTS does not require APG data to operate in the Constant Range Ring Mode. In this case Disable the Antenna Alarm.

Sections 4.2.1.3 and 4.2.1.4 of the System Operations/Training Manual provide additional information on the use of the APG Input control.

Next

2.4.3.4 Target Type

The Target Type control (see the Constant Range Ring Mode OCS Screen) configures the MBTS to emulate either an ATCRBS transponder, a Mode S transponder, or to interlace the replies of both transponder types (50/50 mix). When the 50/50 mix is selected, the MBTS will respond with both ATCRBS and Mode S replies. When this selection is chosen, and a response from both target types is appropriate, the ATCRBS response will be generated.

Select Target Type Mode S.

2.4.3.5 Boresight

The Boresight Control (see the Constant Range Ring Mode OCS Screen) is only available while operating in the Constant Range Ring Mode. When Boresight is ON it sets the Delta/Sum Ratio to -36 dB and the Delta/Sum Phase to 0 degrees. This condition simulates a target in the middle of the antenna beam pattern.

Set Boresight to ON.

Observe that the Delta/Sum Ratio and Delta/Sum Phase controls, in the Monopulse Characteristics Control Panel, are disabled (grayed out).

Next

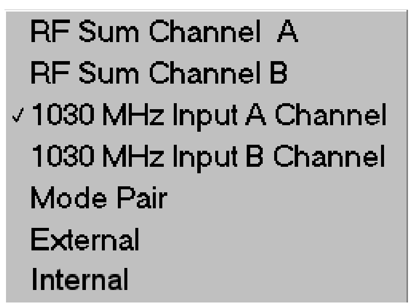
2.4.3.6 Trigger Source

A trigger signal is required for the MBTS to generate pulsed reply signals. The Trigger Source control, located in the Trigger Control Panel, allows the user to select one of a number of possible trigger signal sources. Trigger options, as seen in the Trigger Source Selection Window, include triggering from an internal pulse generator, from external pulses, from ATCRBS Mode Pair video signals, and from RF interrogations.

RF interrogations can be routed into the MBTS through four signal paths, the Sum Channel A or B connections (J1 and J4) or the 1030 MHz Channel A or B Interrogation Inputs (J7 and J8). See the MBTS Rear Panel for these connector locations. ATCRBS Mode Pair trigger signals or external trigger pulses are applied to J15, one of the PCC Module Front Panel Connectors. A free running pulse generator, internal to the PCC Module, may also be selected as the trigger source.

Section 2.2.4 of the System Operations/Training Manual contains additional information on the use of the Trigger Source control.

Figure 8 Trigger Source Selection Window



THE OPERATING MODE DETERMINES WHICH TRIGGER OPTIONS ARE AVAILABLE

Next

2.4.3.6.1 RF Sum Channel Interrogation Triggers

Some radar systems, such as the ATCBI-6, diplex the 1030 MHz interrogation and the 1090 MHz reply signals onto a single RF cable. For this type of system configuration, the MBTS is triggered from signals at either the Sum Channel A (J1) or the Sum Channel B (J4) connector. J1 and J4 are located on the MBTS Rear Panel. Sum Channel interrogation signal requirements are listed in Table 21.

Because Sum Channel interrogation signals are at a substantially higher signal level, up to 50 Watts peak, than the signals applied to the MBTS through the dedicated interrogation input channels, the configuration of the system should be thoroughly verified prior to the application of power.

2.4.3.6.2 1030 MHz Input Interrogation Triggers

The MBTS has two interrogation only signal input connections. The Channel A (J7) and Channel B (J8) interrogation inputs are located on the MBTS Rear Panel. To trigger from interrogation signals on these ports choose either the 1030 MHz Input Channel A selection or the 1030 MHz Input Channel B selection, as appropriate. The input signal requirements of these ports are listed in Table 9.

2.4.3.6.3 Mode Pair Triggers

ATCRBS Mode Pair pulse sequences can trigger replies from the MBTS. Mode Pair video signals are applied to the MBTS through J15, located on the front panel of the PCC Module. See the PCC Module Front Panel Connectors diagram to locate this connector on the front panel of the PCC Module. Mode Pair signal requirements are listed in Table 16.

Next

2.4.3.6.4 External Triggers

TTL level pulse signals may be used to trigger replies from the MBTS. Pulse trigger signals are applied to the MBTS through J15, located on the front panel of the PCC Module (refer to PCC Module Front Panel Connectors). The repetition rate of the applied pulse triggers can be up to 3,000 pulses per second. External Trigger signal requirements are listed in Table 16.

NOTE

The delay time entered into the associated Trigger Delay control must always be less than the time between trigger pulses. See the Trigger Delay section.

2.4.3.6.5 Internal Triggers

When this control option is selected, a repetitive pulse signal, generated within the PCC Module, triggers replies from the MBTS. The trigger signal can be set to operate at a pulse repetition frequency between 10 Hz and 1 KHz. The trigger rate and pulse width parameters of the internal trigger are set through the use of the Trigger PRF and Trigger Pulse Width controls.

Next

2.4.3.7 Trigger PRF

The Pulse Repetition Frequency (PRF) control, see Figure 29, sets the rate of internally generated pulse triggers. Control settings can be varied from 10 to 1,000 Hertz in 5 Hz increments. This field is only available when the Internal Triggers selection is made within the Trigger Source control.

Set the Trigger Source control to the Internal setting.

Set the PRF field to generate 50 triggers per second.

2.4.3.8 Trigger Delay

The Trigger Delay control, located in the Trigger Control Panel, sets a delay between an external trigger pulse (applied to J15 of the PCC Module) and the generation of a trigger output signal at J16 – Trigger Out. Refer to the PCC Module Front Panel Connectors section for connector location. The trigger delay value can be set from 0.0 to 3.0 milliseconds in increments of 62.5 nanoseconds. The timing of reply signals generated by the MBTS is unaffected by this function. This field is only available when the External Triggers selection is made within the Trigger Source control.

Set the Trigger Source to External.

2.4.3.9 Trigger Pulse Width

Trigger output pulses are created by the MBTS in response to every valid trigger signal. The Pulse Width control, located in the Trigger Control Panel, sets the width of the TTL trigger output signal at J16 – Trigger Out. The trigger output pulse width can be set from 0.1 to 5.0 microseconds in 0.1 microsecond increments.

Set the Trigger Source back to Internal.

Next

2.4.3.10 Interrogator Type

When the use of either Internal Triggers or External Triggers is chosen a radar interrogator type must be artificially assigned to each trigger signal for the MBTS to determine an appropriate reply response. The Interrogator Type control, within the Reply Control Panel, is used to make this assignment. Interrogator type choices are shown below in Figure 10, Interrogator Type Selections. The Interrogator Type setting is disregarded when RF interrogations or Mode Pair triggers are selected for use.

Set the Interrogator Type to simulate Mode S All-Call (S) Interrogations.

Figure 9 Reply Control Panel

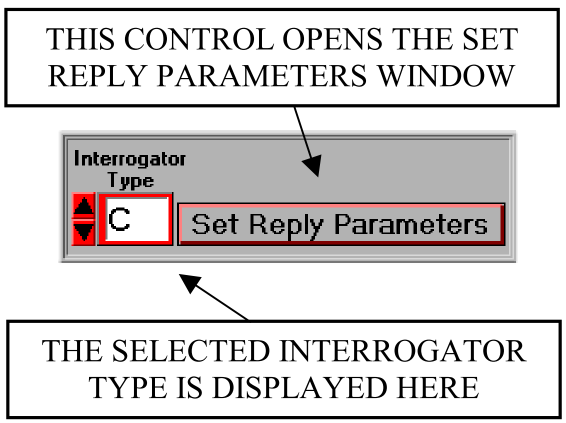
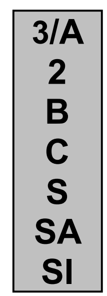


Figure 10 Interrogator Type Selections



Next

2.4.3.11 Set Reply Parameters

The controls within the Reply Parameter Window set all user variable code and pulse parameters for each transponder reply type. The Reply Parameter Window is activated through the use of the Set Reply Parameters control (see Figure 9).

Care should be exercised to enter appropriate reply parameters and code values into the available fields. It is possible for the MBTS to generate reply signals that are not valid to or recognizable by a radar system. Section 2.2.5.2 of the System Operations/Training Manual provides additional information on the use of controls within the Reply Parameters Window.

Select "Set Reply Parameters".

Set the Mode S Aircraft Address to A2956C.

Set the Mode S Interrogator ID to 8.

Select "Return" to get back to the main OCS menu.

Observe the Mode LEDs on the front panel of the PCC Module. The Mode S Detect and Reply LEDs will be illuminated, indicating that the MBTS is generating 50 internally triggered Mode S replies per second from simulated Aircraft #A2956C to simulated radar site #8.

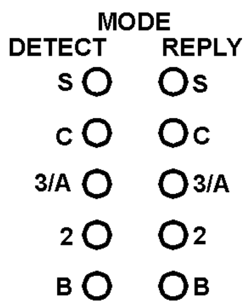
Next

2.4.4 Mode LEDs

The Mode Detect and Reply LEDs on the front panel of the PCC Module provide a quick way to verify the activity of the MBTS. The Detect LEDs display the type of the detected interrogation signals received from the selected Trigger Source. If detect LED activity is not as anticipated verify the Trigger Source selection.

The Reply LEDs display the type of transponder reply signal generated by the MBTS. If this is not as anticipated, verify the Target Type and the Interrogator Type selections.

Figure 11 PCC Mode Indicators



Select Constant Range Ring Mode.

Set the Trigger Source to Internal.

Change both the Target Type and the Interrogator Type, trying various combinations. Observe the Mode LEDs on the MBTS.

Next

2.4.5 Azimuth Gated Target Mode

When in the Azimuth Gated Target Mode the MBTS generates pulsed RF replies in response to trigger signals that occur when the azimuth position of the radar antenna correlates with the location of a target simulated by the MBTS. The amplitude of the Sum, Delta, and Omni pulsed reply signals vary, based upon antenna pattern characteristics and upon the timing of the received trigger signal. A constellation of from one to thirty-two simulated targets can be created by the MBTS. Unlike the Ring Mode of operation, reply generation is gated by target position. The Azimuth Gated Target Mode Function Block Diagram shows a typical system configuration.

Valid APG data must be provided to the MBTS for it to operate in the Azimuth Gated Target Mode. Refer to the APG Input & Type section for more information on this topic.

A complete description of the Azimuth Gated Target Mode can be found in Section 2.3.3 of the System Operations/Training Manual.

Select the Azimuth Gated Target mode on the Mode Select Panel.

Observe the appearance of the Azimuth Gated Target Mode OCS Screen. Details concerning the operation of the controls shown in this figure are discussed in the following sections.

Next

2.4.5.1 Previously Described Control Functions

The operation of the following controls has been described in previous sections. Please use the links provided if a review of control functionality is desired.

Range	Trigger Pulse Width	Interrogator Type
Target Type	Trigger Delay	Set Reply Parameters
Sum/Omni Ratio	Sum RF Level	APG Input & Type
RF Frequency		

2.4.5.2 Controls with Modified Functionality

The following controls work in a manner similar to as described in the Constant Range Ring Mode:

Trigger Source: Operation of the MBTS in the Azimuth Gated Target Mode requires the correlation of reply trigger signals with azimuth data signals from the APG source. This is not possible with internally generated triggers. Therefore, the internal trigger option is deleted from the Trigger Source selection control. The Trigger PRF control is deleted for the same reason.

The Delta/Sum Ratio and Delta/Sum Phase controls are only active when the Antenna Type control (see the Azimuth Gated Target Mode OCS Screen) is set to Manual.

Next

2.4.5.3 Northmark Offset

The Northmark Offset control (see the Azimuth Gated Target Mode OCS Screen) is used to align the constellation of targets generated by the MBTS with the orientation of the radar system. Entering an offset rotates the position of the entire target constellation relative to the azimuth location marked by the ARP signal. The Northmark Offset control setting is in IACP units only. The Northmark Offset value can be from 0 to 16383 in IACP units.

Set the APG Input & Type to "A IACP".

Set the Northmark Offset to 18 IACP units.

2.4.5.4 Az Extent

The Azimuth Extent control (see the Azimuth Gated Target Mode OCS Screen) sets the beamwidth of the selected antenna pattern. The MBTS generates target replies only when the difference between the position of the antenna pedestal and the position of an MBTS target is less than or equal to one half of the Azimuth Extent setting. Azimuth Extent can be set from 2.0 to 5.0 degrees in 0.2 degree increments.

2.4.5.5 Target Az

The First Target Azimuth control (see the Azimuth Gated Target Mode OCS Screen) sets the azimuth location of the "first", or reference, target. The azimuth location of any additional targets is determined relative to the position of the first target. The First Target Azimuth setting can be in degrees (0 to 359), ACP units (0 to 4095), or IACP units (0 to 13683), depending upon the setting of the Target AZ Units control.

All targets are placed so as to create an evenly spaced target constellation. For example, if the Target Count control is set to four, the target separation is 90 degrees. If the first target is located at an azimuth of 45 degrees, the second target is centered at 135 degrees, the third target is centered at 225 degrees, and the fourth target is centered at 315 degrees.

Next

2.4.5.6 Target AZ Units

The Target Azimuth Units control selects (see the Azimuth Gated Target Mode OCS Screen) the azimuth radial units applied to the first target location. Available settings are DEG (degrees), ACP, or IACP. The Target Azimuth location is automatically cleared and loaded into the MBTS if the Target Azimuth Units setting is altered.

2.4.5.7 Target Count

The number of simulated targets per antenna pedestal revolution can be set to 1, 2, 4, 8, 16, or 32. The targets are evenly distributed over the full 360 degrees of an antenna rotation. For example, if four targets are chosen, they are spaced every 90 degrees. Sixteen targets are spaced every 22.5 degrees. Refer to the Azimuth Gated Target Mode OCS Screen for control location.

Set the Target Az to 8.

Set the Target AZ Units to "DEG".

Set the # of Targets to 4.

Verify that the Target Az is still set to 8 degrees.

Next

2.4.5.8 Antenna Type

The Antenna Type control, located on the Azimuth Gated Target Mode OCS Screen, selects the use of one of five antenna beam patterns to formulate reply signals. The available Antenna Type choices are ASR-11/MSSR LVA, Five Foot Terminal Array, Six Foot EnRoute Array, a User Defined pattern, and a MANUAL setting.

The User Defined pattern, as delivered from FSE, does not simulate performance that can be achieved by an antenna. This pattern should be replaced with one that is calibrated to match the response of the antenna at the site where the MBTS is installed (see the Off-Boresight Calibration Mode). After calibration, the User Defined antenna pattern stored in the MBTS will closely match the monopulse characteristics of the radar system antenna. When selected, this pattern will enable the MBTS to generate reply signals with the most accurate monopulse characteristics.

The Manual control selection permits replies at fixed Delta/Sum Ratio and Delta/Sum Phase settings. This setting should only be used for specialized test scenarios.

2.4.5.9 Beamshaping

When Beamshaping is ON, the shape of the selected Antenna Type pattern determines the amplitude of a MBTS reply. In this case, the amplitude of the Sum Channel reply signal matches the Sum RF Level setting only when an interrogation trigger occurs at the center of a target azimuth location.

When Beamshaping is OFF the MBTS creates replies that have a constant Sum Channel response. All Sum Channel replies are at the level set by the Sum RF Level control.

The Beamshaping control (see the Azimuth Gated Target Mode OCS Screen) does not affect the monopulse characteristics of the reply signals generated by the MBTS. Proper Delta/Sum Ratio and Delta/Sum Phase relationships are always maintained.

Select the 5' Terminal Array and enable Beamshaping.

Next

2.4.6 Off-Boresight Calibration Mode

When in the Off-Boresight Calibration Mode the MBTS generates pulsed RF replies that can be analyzed by the radar system so as to create a calibrated, site specific, antenna pattern. When in this mode the MBTS responds only to valid Type 3/A ATCRBS trigger signals. Reply generation is not gated by target position as it is in the Azimuth Gated Target Mode.

Reply signals from the MBTS automatically sequence through all supported Delta/Sum Ratio and Delta/Sum Phase settings, encoding these settings into the ATCRBS reply data. The amplitudes of the Sum and Omni pulsed reply signals are fixed at operator selectable settings. See the Off-Boresight Calibration Mode Block Diagram.

Reply data recording and pulse amplitude analysis is accomplished by the radar system. Through these processes new and refined User antenna pattern files are created. Refer to the UPLOAD ANT BEAMSHAPE and UPLOAD ANT BORESIGHT sections for information on how to upload new User antenna files into the MBTS.

A complete description of the Off-Boresight Calibration mode can be found in Section 2.3.4 of the System Operations/Training Manual.

Select the Off-Boresight Calibration mode on the Mode Select Panel.

Observe the appearance of the Off-Boresight Calibration Mode Screen. Details concerning the operation of the controls shown in this figure are discussed in the following sections.

Next

2.4.6.1 Previously Described Control Functions

The operation of the following controls has been described in previous sections. Please use the links provided if a review of control functionality is desired.

Range	Sum/Omni Ratio	Sum RF Level
APG Input & Type	RF Frequency	Trigger Pulse Width

2.4.6.2 Controls with Modified Functionality

The following controls work in a manner similar to as described in the Constant Range Ring Mode:

Trigger Source: The Internal and External trigger control options are not available in the Off-Boresight Calibration Mode. The related Trigger PRF and Trigger Delay controls are also not available.

Target Type: The control setting is limited to ATCRBS only.

Next

2.4.7 Absolute Output Power Calibration Mode

When required, the Absolute Output Power Calibration Mode is used to create a new output power calibration file. This file, located on the OCS, can be uploaded to the MBTS using the Cal Settings / Antenna Pattern Mode. After implementing this process the output power level of the MBTS will meet specification requirements.

For each MBTS output signal level setting the OCS adjusts attenuator and gain circuits within the MBTS, and through measurement feedback from an HP-8902A Measuring Receiver (with an HP 11722A Power Sensor), determines the best attenuator control value. The OCS controls the entire measurement process, including the HP-8902 and the MBTS, through an IEEE-488 interface. The OCS must be set to GPIB address 0, the MBTS to GPIB address 1, and the HP-8902 to GPIB address 14. See the Absolute Output Power Calibration Test Setup diagram for the required process configuration. Clicking on the Calibrate control starts the measurement process.

The HP-8902 Tuned Receiver section must be calibrated prior to beginning the Absolute Output Power Calibration process. Refer to the HP-8902 User's Manual for information on this topic.

A complete description of the Absolute Output Power Calibration mode can be found in Section 2.3.5 of the System Operations/Training Manual.

Select the Absolute Output Power Calibration mode on the Mode Select Panel. Observe the appearance of the Absolute Output Power Calibration Screen.

Next

2.4.8 Standby/Diagnostics Mode

This operational mode displays the operating status of the MBTS as determined by Built-In-Test (BIT) diagnostics. All output amplitude and signal phase controls are monitored by BIT. Other functions that are monitored include power supply voltages, phase lock status of all PLL circuits, internal temperature, APG status, processor status, and memory functions. Controls are available to start an internal BER loop test and to initiate a new BIT self-test routine. Control and display descriptions are given below. A complete description of the Standby/Diagnostics mode can be found in Section 2.3.6 of the System Operations/Training Manual.

Select the Standby/Diagnostics mode on the Mode Select Panel.

A red "LOADING CURRENT VALUES" message displays for approximately 15 seconds when this mode is first activated. During this period the MBTS runs a series of Built-In-Test (BIT) SELF TEST diagnostics that check the performance of all control circuits. The test results are displayed in the Standby/Diagnostics Status Register Display. These results can be used to analyze and investigate operational problems (see the Troubleshooting and Repair section for more information).

Next

2.4.8.1 PLL ERROR

Clicking the PLL ERROR control, see Figure 23, updates the Phase Locked Loop (PLL) Status Panel.

2.4.8.1.1 Phase Locked Loop (PLL) Status Panel

The upper-most display panel reports the Phase Lock status for each PLL circuit in the MBTS. A green status display indicates a normal (locked) operating state. A red status display indicates an unlocked condition.

The MBTS may not meet specification requirements if PLL failures are indicated. Trouble analysis recommendations, based upon the status of the display indicators, are found in Section 5.2.1 of the System Operations/Training Manual.

REF PLL: PLL in the Reference Source Module.

RGC PLL: PLL in the Reply Generator Module.

IDR PLL: PLL in the Interrogation Demodulator Module.

1100BIT PLL: 1100 MHz PLL in the BIT Module.

70BIT PLL: 70 MHz PLL in the BIT Module.

Next

2.4.8.2 ALARM

Clicking the ALARM control, see Figure 23, updates the Equipment Status Panel.

Turn off the MBTS (leave the OCS running in Standby/Diagnostics Mode).

Turn on the MBTS and wait approximately 30 seconds for the PROC LED heartbeat.

Observe the red AZ LED on the MBTS Front Panel.

Click the Alarm Control. This will update the Equipment Status Panel on the OCS.

Observe the red ANT ROT and APG alarms on the OCS.

Select CW Mode and Disable the Antenna Alarm.

Observe the green AZ LED on the MBTS Front Panel.

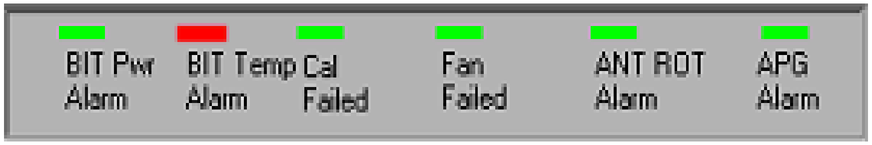
Select Standby/Diagnostics Mode.

Observe the ANT ROT and APG alarms on the OCS change from red to green.

Next

2.4.8.2.1 Equipment Status Panel

The middle display panel reports the general operating status of the MBTS. Green indicates a normal operating state. Red indicates an out of tolerance condition.



BIT Pwr Alarm: Power Supply Status. ***Do not operate the MBTS if this alarm is red.*** See the Power Supply and Chassis Temperature Panel.

BIT Temp Alarm: Internal Temperature Status. This alarm is red if the internal temperature of the MBTS is not within 0ºC and 65ºC. See the Power Supply and Chassis Temperature Panel. ***Do not operate the MBTS if the ambient or internal temperatures exceed design tolerances***.

Cal Failed: Sum Channel temperature compensation process status. A failure means that the output level accuracy of the MBTS may not meet specification requirements.

Fan Failed: Cooling Fan Status. Red means that the fan has stopped rotating. ***Do not operate the MBTS if the fan has failed.***

ANT ROT Alarm: Antenna Rotation Alarm. The rotation rate of the APG signal is not between 4 and 15 revolutions per minute. This alarm is disabled when you Disable the Antenna Alarm.

APG Alarm: ARP and ACP Alarm. An alarm occurs when the ratio of ACP to ARP pulses is not within 4096 ±2 or 16384 ±2, or when either signal is not detected. This alarm function is inactive when you Disable the Antenna Alarm.

Next

2.4.8.3 SELF TEST

This control, see Figure 23, starts a new BIT verification sequence. The Built-In-Test (BIT) diagnostics test:

- All output amplitude controls
- All output phase controls
- Power supply voltages
- Phase lock of all PLL circuits
- Internal temperature
- APG status
- Processor status and memory functions

Click the SELF TEST control.

Observe the Mode LEDs during the 15 seconds required by the test process.

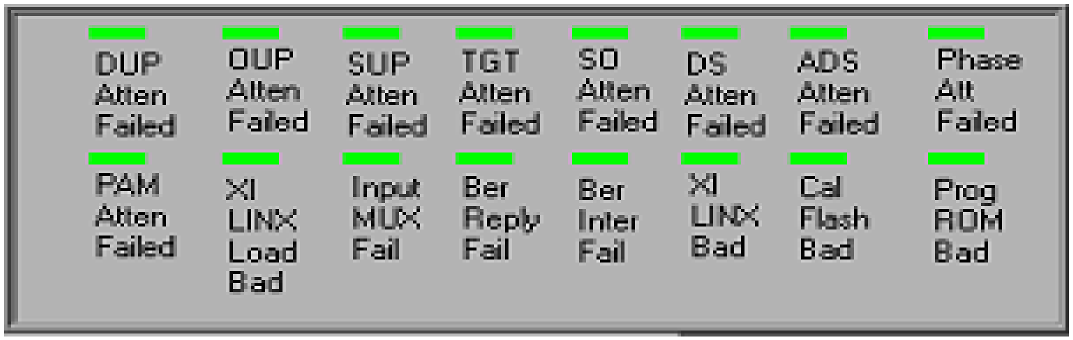
All major MBTS system functions are evaluated. When complete, test results are displayed in the BIT Function Status Panel. Test failures are indicated by a RED status display.

Next

2.4.8.3.1 BIT Function Status Panel

The BIT Function Status Panel indicates the detailed results of the BIT process. A green status display indicates a normal operating state. A red status display indicates an out of tolerance condition.

Operation of the MBTS with BIT Function failures is not recommended. Trouble analysis recommendations are found in Section 5.2.1 of the System Operations/Training Manual.



DUP Atten Status: Delta Channel Upconverter Module attenuator circuit status.

OUP Atten Status: Omni Channel Upconverter Module attenuator circuit status.

SUP Atten Status: Sum Channel Upconverter Module attenuator circuit status.

TGT Atten Status: Reply Generator Module and the Sum Channel Upconverter Module target level attenuator circuit status.

SO Atten Status: Reply Generator Module Sum/Omni ratio setting attenuator circuit status.

Next

DS Atten Status: Reply Generator Module Delta/Sum ratio setting attenuator circuit status.

ADS Atten Status: Reply Generator Module Aux Delta/Sum ratio setting attenuator circuit status.

Phase Att Status: Reply Generator Module phase modulator circuit status.

PAM Atten Status: Reply Generator Module pulse amplitude modulator circuit status.

XILINX Load Status: A failure means that either the factory Xilinx FPGA data in the FLASH ROM is corrupt or that there is a problem with the Xilinx hardware.

Flash CAL Status: A failure means that the factory calibration constants in the FLASH ROM are corrupt.

BER Reply Status: Not used.

BER Inter Status: The status of a BER measurement process is indicated. A failure means that a BER of less than $1x10^{-4}$ was measured.

XILINX Status: A failure means the user downloaded Xilinx FPGA data in the FLASH ROM is corrupt.

Cal Flash Status: A failure means that the user downloaded calibration constants in the FLASH ROM are corrupt.

Prog ROM Status: A failure means the user downloaded program in the FLASH ROM is corrupt.

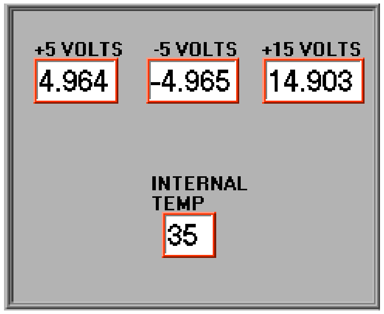
Next

2.4.8.4 BIT STATUS

This control, see Figure 23, updates the status of the power supply voltage readouts and the chassis internal temperature display in the Power Supply and Chassis Temperature Panel.

Click the BIT STATUS button.

2.4.8.4.1 Power Supply and Chassis Temperature Panel



The lower center of the display screen includes readouts of the three power supply voltages and of the chassis internal temperature.

Voltage Indicators. The measured output voltage of each power supply is indicated. The ±5V supplies are expected to be within ±0.25 volt of nominal values. The output of the +15V supply is expected to be within ±0.5 volt of the nominal value. If any of the voltages fall out of the expected operational window then a BIT PWR ALARM is generated in the Equipment Status Panel. Power supply voltage measurements can be verified at the MBTS Front Panel test points.

Temperature Indicator. The measured internal temperature of the MBTS is indicated. The MBTS will operate with an internal temperature between 0°C and +65°C. If the measured temperature falls out of the design window then a BIT TEMP ALARM is generated in the Equipment Status Panel.

NOTE

After warm-up the internal temperature of the MBTS is 10 Cº to 15 Cº above ambient.

Next

2.4.8.5 START BER

This control, see Figure 23, starts the Bit Error Rate (BER) test process. The BER test includes the generation of interrogation signals by the BIT Module, the demodulation of these signals by the IDR Module, and an evaluation of the demodulated data by the PCC Module. The PCC Module controls the entire BER test process. It records the number of errors detected and the total number of data samples. These, along with a calculated BER, are displayed in the lower right hand corner of the Standby/Diagnostics Status Register Display.

Click the START BER control.

Observe the decreasing BER and the increasing sample count. 50,000 error free samples are required to yield a BER of 2.0E-5.

The BER test process continues until stopped.

Click the STOP BER control to halt the test.

Next

2.4.9 Cal Settings / Antenna Pattern Mode

The Cal Settings/Antenna Patterns Mode contains tools for uploading new calibration data and user defined antenna pattern files into the MBTS. The Cal Settings / Antenna Patterns Data window also displays all of the calibration factors currently in use by the MBTS.

WARNING

Changing the calibration and antenna parameters of the MBTS can significantly alter the performance of the MBTS. Do not make any such changes without a thorough understanding of the processes involved.

Most calibration factors cannot be changed unless the Configuration Switch on the side of the PCC Module is set to allow this operation. When the User Switch 1 is set to a value of 1 a red "Write Protected" message appears in the top-center of the Cal Settings / Antenna Pattern Data Display indicating that new calibration factors cannot be entered into the MBTS.

Select the Cal Settings / Antenna Pattern mode on the Mode Select Panel.

Observe the appearance of the Cal Settings / Antenna Pattern Data Display.

A complete description of the Cal Settings / Antenna Pattern mode can be found in Section 2.3.7 of the System Operations/Training Manual.

Next

2.4.9.1 VIEW CURRENT SETTING

The VIEW CURRENT SETTING control refreshes all of the displayed information. The information displayed in the Cal Settings / Antenna Pattern Data Display is not automatically updated after uploading new calibration settings.

2.4.9.2 UPLOAD CAL TARGET TABLE

This control allows a new output level calibration table, called a CALTGTTABLE in the GPIB command set, to be chosen and uploaded into the MBTS. The calibration file created in the Absolute Output Power Calibration Mode, Raw Levels.txt, is properly formatted for this process. (File format requirements are listed in the CALTGTTABLE command description within the Monopulse Beacon Test Set IEEE-488 Command Set, FSE document number 100681.)

Next

2.4.9.3 UPLOAD ANT BEAMSHAPE

This control uploads a new Beamshape file into the MBTS. The Beamshape file defines the Sum Channel response characteristics of the User Defined antenna pattern over 256 adjacent IACP azimuth locations. The file must be formatted as described in the BEAMSHAPE command description of the Monopulse Beacon Test Set IEEE-488 Command Set, FSE document number 100681.

A new Beamshape file is typically created after running the MBTS in the Off-Boresight Calibration Mode.

The two files that are used to formulate a User Defined antenna pattern, Beamshape and Boresight, can be uploaded into the MBTS independent of the Configuration Switch setting.

2.4.9.4 UPLOAD ANT BORESIGHT

This control uploads a new Boresight file into the MBTS. The Boresight table defines the Delta Channel amplitude and phase characteristics of the User Defined antenna pattern over 256 adjacent IACP azimuth locations. The file must be formatted as described in the BORESIGHT command description of the Monopulse Beacon Test Set IEEE-488 Command Set, FSE document number 100681

A new Boresight file is typically created after running the MBTS in the Off-Boresight Calibration Mode.

The two files that are used to formulate a User Defined antenna pattern, Beamshape and Boresight, can be uploaded into the MBTS independent of the Configuration Switch setting.

Next

2.4.9.5 CALSOTABLE DISPLAY

This table displays the calibration factors of the S/O Ratio Offset. These values are applied as a correction factor to the Sum output level for each S/O ratio setting, keeping the absolute level of the Sum Channel output signal within specified requirements.

2.4.9.6 CALUCATTEN DISPLAY

This displays the gain correction factors applied to each Upconverter signal path. These values are applied as a correction factor to the output level of each Upconverter, keeping the absolute level of the output signals within specified requirements.

Next

2.4.9.7 CALTGTTABLE DISPLAY

This table displays the raw output power level correction factors. These values determine the Sum output level, keeping the absolute level of the output signals within specified requirements. These values are modified by the UPLOAD CAL TARGET TABLE command.

2.4.9.8 CAL BIT LEVEL DISPLAY

This displays the CAL BIT LEVEL setting, which is used to correct the output level of the MBTS whenever temperature changes are detected. It is ***not recommended*** that this calibration setting be altered from factory set values.

2.4.9.9 CAL A/B OFFSET DISPLAY

This displays the CAL A/B OFFSET setting, which is used to align the response of Output Channel B with that of Output Channel A. It is ***not recommended*** that this calibration setting be altered from factory set values.

2.4.9.10 CAL TEMP LIMIT DISPLAY

This displays the CAL TEMP LIMIT, in Cº. This value is the range through which the operating temperature of the MBTS may vary without causing a yellow Calibration Indicator. The center of this range is the temperature of the MBTS when the last Calibration process was performed. It is ***not recommended*** that this calibration setting be altered from factory set values.

Next

This completes the hands on training portion of this manual.

The following sections provide additional detailed information regarding the use and operation of the MBTS system.

Next

3 TECHNICAL DESCRIPTION

The MBTS contains eight modules; one Reply Generator Module, three Upconverter Modules, one Reference Source Module, one Interrogation Demodulation Receiver (IDR) Module, one Built In Test (BIT) Module, and one Process Control and Communications (PCC) Module. The function of each module is briefly described in the following text. Each module is integrated into the MBTS Front Panel. A complete description of each module can be found in Section 3.2 of the System Operations/Training Manual.

The Process Control and Communications (PCC) Module controls all functions within the MBTS. It contains circuits that process received interrogation and azimuth data from which reply responses are created in real time. It processes all user GPIB or serial commands. And, it monitors the status of all RF processes.

The Reply Generator Module generates and sets the primary characteristics of the Sum, Delta, and Omni RF signals. It contains the circuits that set the target signal level, the Sum/Omni ratio, the Delta/Sum ratio, and the Delta/Sum phase. Each of these functions is controlled by signals from the PCC Module.

Each Upconverter Module translates one of the three 70 MHz output signals of the Reply Generator to 1090 MHz. Channel A, or Channel B, or BIT output signals are available from each Upconverter. Each Upconverter also has three front panel test ports, one at 70 MHz, and two at 1090 MHz.

The Reference Source Module generates low noise 16 MHz reference signals and three phase equivalent 1020 MHz LO signals. The 16 MHz signals are used as a reference by the PLL circuits within the other modules. The LO signals, at +13 dBm, are routed to each of the three Upconverter Modules to convert the 70 MHz IF signals to 1090 MHz.

The Interrogation Demodulation Receiver (IDR) Module receives and demodulates interrogation signals from the radar system. RF interrogation signals may be selected from either of the Sum Channel inputs (diplexed with the reply signals) or from either of the two dedicated rear panel inputs. Demodulated data, PAM and DPSK, is routed to the PCC Module and to front panel test ports.

The Built In Test (BIT) Module includes circuits to test the reply generation and interrogation demodulation processes. It also measures the status of other system parameters such as power supply voltage and operating temperature.

Additional front panel controls and interfaces include the Power Switch, Power Supply Test Points, and two Sum/Delta Phase Adjust devices.

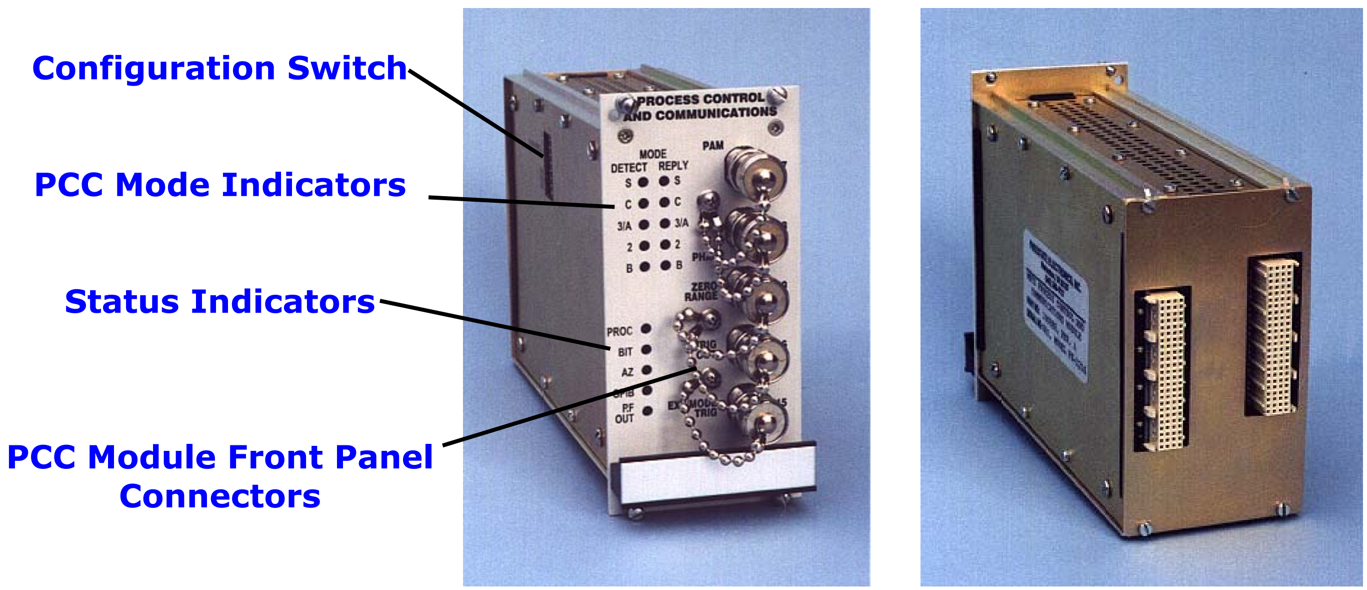
System interfaces and data connections are found on the MBTS Rear Panel.

3.1 Process Control and Communications (PCC)

The primary functions of the PCC Module include:

- Interpretation and analysis of ATCRBS and Mode S radar interrogation signals
- Generation of signals to control the timing and amplitude characteristics of simulated transponder reply responses
- Performance verification of all MBTS interrogation/reply systems through the implementation of Built In Test functions
- Support of operator functions and settings communicated to the MBTS from the Operator Control System (OCS) via an IEEE-488 interface

Figure 12 PCC Module Front and Rear Views



3.1.1 PCC Switches

The PCC module uses an 8-position Configuration Switch, accessible through the module side cover, to set the GPIB bus address (see Figure 13).

3.1.1.1 IEEE-488 Address Switch

Switch A1 denotes the Least Significant Bit (LSB), and A5 denotes the Most Significant Bit (MSB) of the GPIB address switch (see Figure 13).

3.1.1.2 Configuration Switch

When switch USER 1 (see Figure 13) is set to Position 1 overwriting of the internal calibration tables and factors is prevented. When set to position 0, any of the calibration tables internal to the MBTS can be erased or overwritten.

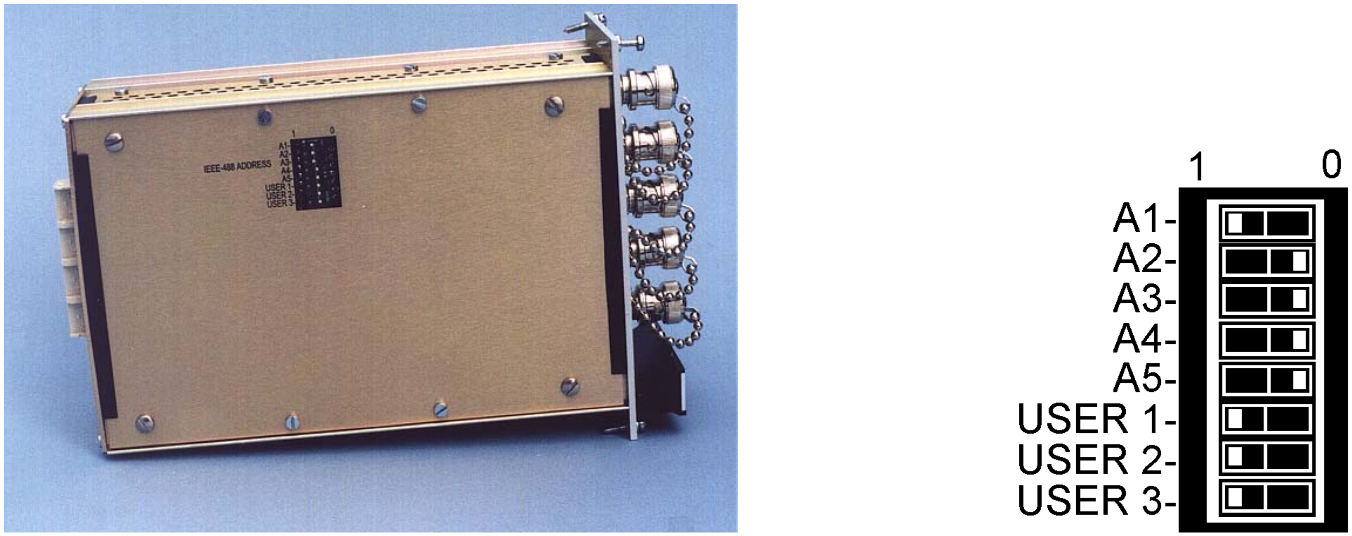
CAUTION

Keep the USER 1 switch set to position 1 to prevent overwriting factory set calibration tables and factors.

3.1.1.3 Switches USER 2 and USER 3

Switches USER 2 and USER 3 (see Figure 13) are for special factory procedures only. For normal MBTS operation these should remain in position 0. Both switches need to be set to Position 1 to enable the use of software and firmware field upgrades.

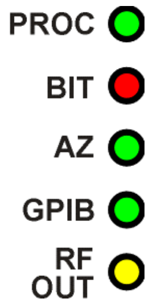
Figure 13 PCC Module Side View Showing Setup Switches and Detail



3.1.2 Status Indicators

Five status LEDs are included on the PCC Module front panel. Green indicates the function is operationally active and working properly. Yellow indicates the function is inactive or in an indeterminate state. Red indicates the function is in a failure mode.

Figure 14 Status Indicators



3.1.2.1 PROC LED

The PCC Module processor LED normally flashes green once a second.

3.1.2.2 BIT LED

This LED monitors internal temperature, power supply voltages, etc.

3.1.2.3 AZ LED

The Azimuth Detection LED turns red if APG signals are missing or out of spec. This indicator is always green if the Antenna Alarm is disabled (see Section 2.2.3.1).

3.1.2.4 GPIB LED

The GPIB LED indicates the status of communications over the IEEE-488 interface. The LED is green when the interface is active.

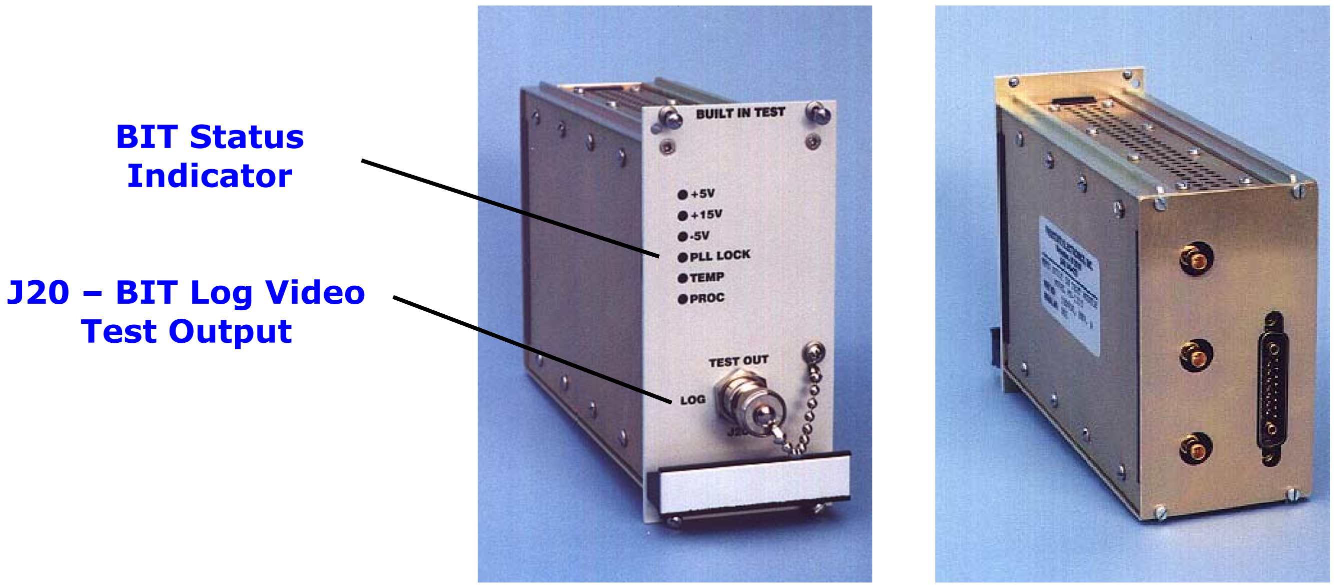
3.1.2.5 RF OUT LED

The RF OUT LED is green when any of the primary RF output channels is selected for use and yellow when the BIT signal path is selected.

3.2 Built In Test (BIT)

The BIT Module verifies the basic performance of the MBTS. BIT measurements are performed when the MBTS powers up and upon operator request.

Figure 15. Built In Test Module Front and Rear Views



3.2.1 J20 – BIT Log Video Test Output

The signal level of the selected BIT RF input is monitored at the BIT LOG TEST OUT port, (J20). The connector is located on the front panel of the Built In Test (BIT) Module. When not in use this test port should be terminated with the attached 50 Ohm load.

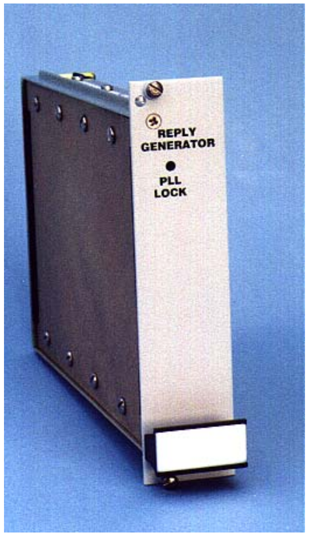
Table 1. J20 – Log Video Test Output

Connector Name	Log Video Test Out
Connector Reference Designator	J20
Connector Location	BIT Module Front Panel
Connector Type	BNC
VSWR/Impedance	1.5:1, 50 Ohm
Output Level	Log video representation of the level of the selected RF signal (Omni, Sum, or Delta signal Channels), 0.6 Volts to 1.7 Volts into 50 Ohms
Signal Frequency	At the rate of BIT test pattern sequence

3.3 Reply Generator

The Reply Generator Module produces three 70 MHz Intermediate Frequency (IF) target reply signals: Sum; Delta; and, Omni. The Process Control and Communications (PCC) Module controls the amplitude and phase relationship of these signals to simulate ATCRBS and Mode S target replies. The 70 MHz output signals from this module feed the three Upconverter Modules where the signals are converted to 1090 MHz target reply signals.

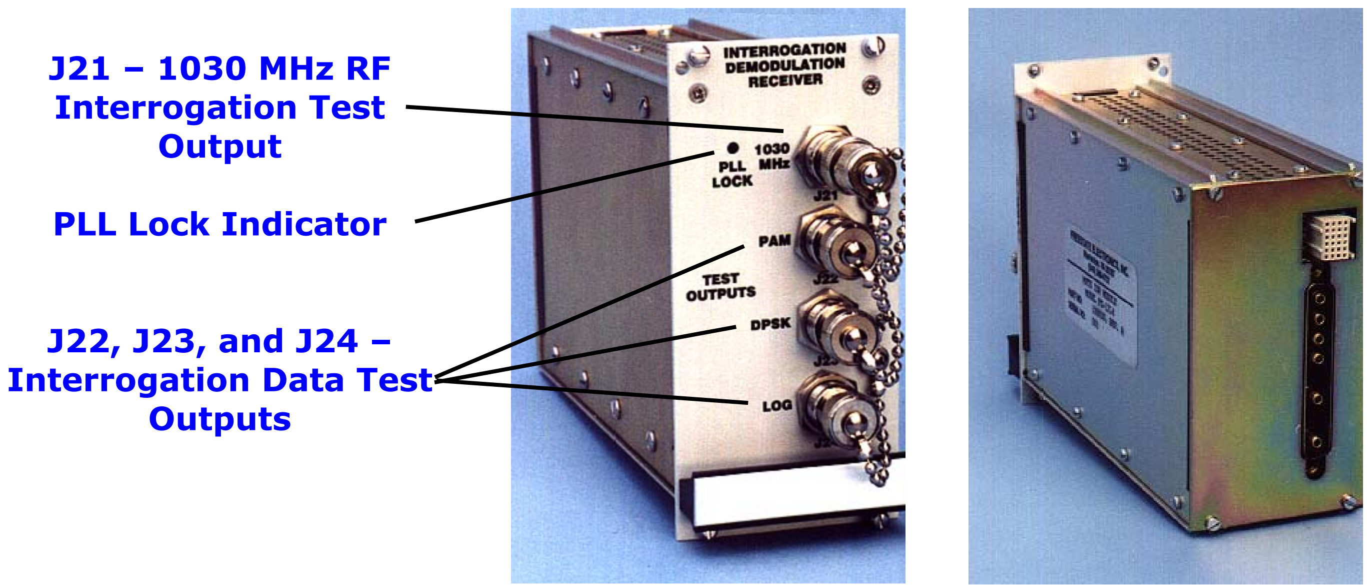
Figure 16 Reply Generator Front and Rear Views



3.4 Interrogation Demodulation Receiver (IDR)

The Interrogation Demodulation Receiver Module selects a 1030 MHz signal from one of the MBTS Rear Panel connectors, either the Channel A input (J7), the Channel B input (J8), the Sum Channel A input (J1), the Sum Channel B input (J4), or the BIT Channel input and translates it down to an IF of 60 MHz. PAM and DPSK output data is then generated from the 60 MHz IF signal. These data outputs are routed to the PCC Module for further processing.

Figure 17 IDR Module Front and Rear Views



3.4.1 J21 – 1030 MHz RF Interrogation Test Output

The selected 1030 MHz interrogation signal (CH A, CH B, Sum CH A, Sum CH B, or BIT) may be monitored at the 1030 MHz TEST OUT port, J21, of the Interrogation Demodulation Receiver (IDR) Module. This connector is a type BNC. When not in use this test port should be terminated with the external 50 Ohm load.

Table 2. J21 – 1030 MHz RF Interrogation Test Out

Connector Name	1030 MHz RF Test Out	
Connector Reference Designator	J21	
Connector Location	IDR Module Front Panel	
Connector Type	BNC	
VSWR/Impedance	1.5:1, 50 Ohm	
Input Level	Not Applicable	
Output Level	Channel A or B:	30 dB below the level of the applied input signal, -45 dBm to -10 dBm, nominal
	Sum Channel A or B:	55 dB below the level of the applied input signal, -45 dBm to -10 dBm, nominal
	BIT:	20 dB below the level of the applied BIT signal
Signal Frequency	1030 MHz	

3.4.2 J22, J23, and J24 – Interrogation Data Test Outputs

Demodulated interrogation data may be monitored at PAM (J22), DPSK (J23), and Log Video (J24) test ports on the front panel of the Interrogation Demodulation Receiver (IDR) Module. When not in use these test ports should be terminated with the supplied 50 Ohm load (J24) or dust cover (J22 and J23).

Refer to:

Table 3. J22 – PAM Video Test Out

Table 4. J23 – DPSK Video Test Out

Table 5. J24 – Log Video Test Out

Table 3. J22 – PAM Video Test Out

Connector Name	PAM Video Test Out
Connector Reference Designator	J22
Connector Location	IDR Module Front Panel
Connector Type	BNC
VSWR/Impedance	75 Ohm
Output Level	TTL
Data Type	Demodulated PAM from the selected interrogation signal
Data Rate	At the rate of the applied interrogation pulse sequence

Table 4. J23 – DPSK Video Test Out

Connector Name	DPSK Video Test Out
Connector Reference Designator	J23
Connector Location	IDR Module Front Panel
Connector Type	BNC
VSWR/Impedance	75 Ohm
Output Level	TTL
Data Type	Demodulated DPSK from the selected interrogation signal. Applicable only to Mode S interrogations.
Data Rate	4 Mbits/second

Table 5. J24 – Log Video Test Out

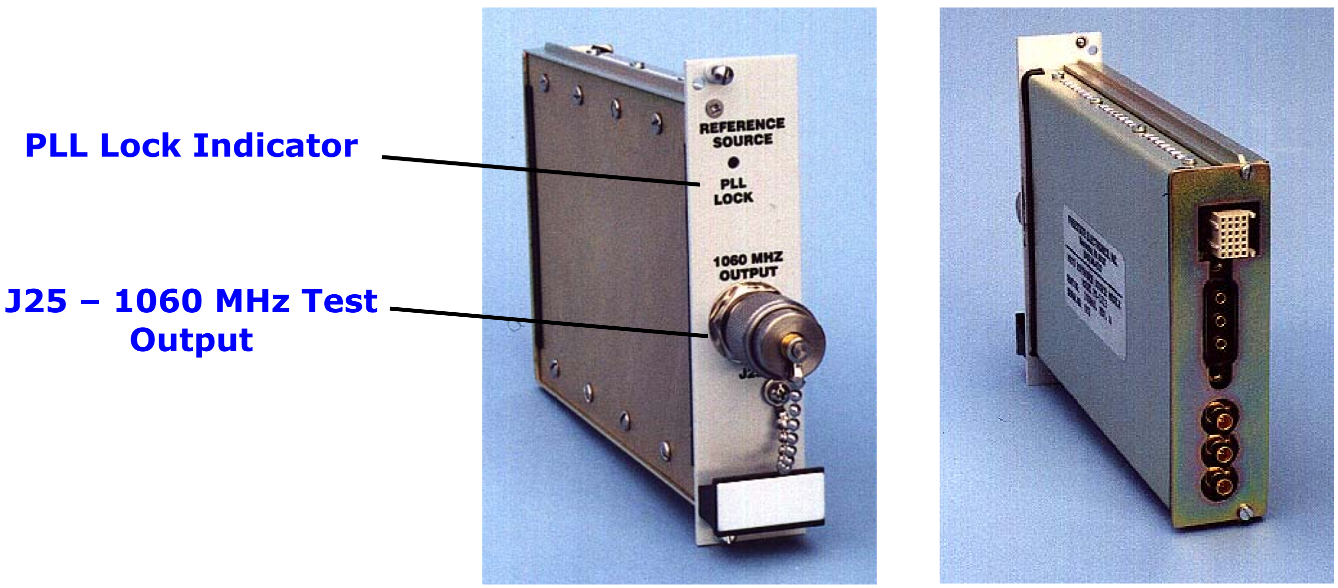
Connector Name	Log Video Test Out
Connector Reference Designator	J24
Connector Location	IDR Module Front Panel
Connector Type	BNC
VSWR/Impedance	1.5:1, 50 Ohm
Output Level	Log video representation of peak pulsed power level of RF input Interrogation signal; approximately +1.4 Volts @-15 dBm in, 2.0 Volts @+20 dBm in
Data Rate	At the rate of applied interrogation pulse sequence

3.5 Reference Source

The Reference Source Module generates:

- A 16 MHz reference signal to phase lock the oscillator circuits of other MBTS modules.
- Three phase stable 1020 MHz LO signals for use in each of the three Upconverter Modules.
- A 1060 MHz test signal for calibration and alignment of the MSSR system.

Figure 18 Reference Source Module Front and Rear Views



3.5.1 J25 – 1060 MHz Test Output

1060 MHz test and alignment signals are available at the Reference Source Module 1060 MHz Test Output connector (J25). J25 is a type N connector.

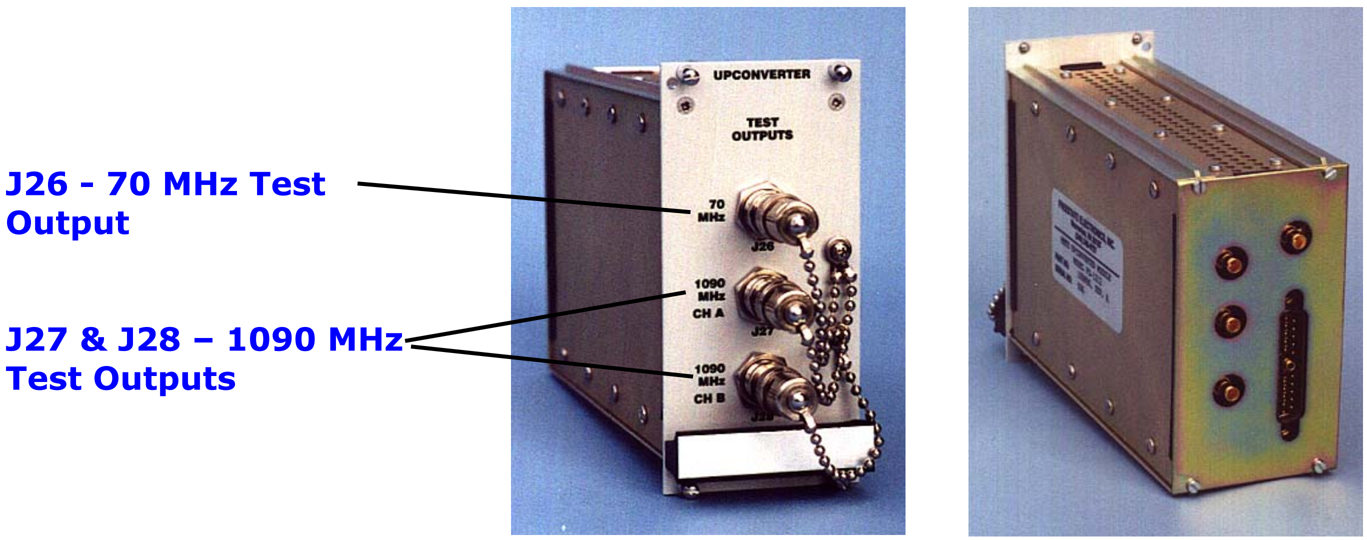
Table 6. J25 – 1060 MHz Test Output

Connector Name	1060 MHz Test Out
Connector Reference Designator	J25
Connector Location	Reference Source Module Front Panel
Connector Type	N
VSWR/Impedance	1.5:1, 50 Ohm
Input Level	Not Applicable
Output Level	Operator selectable, -22 to +8 dBm The signal is only available when operating in the 1060 MHz CW Mode
Signal Frequency	1060 MHz

3.6 Upconverter Module

The three (Sum, Difference, and Omni) Upconverter Modules translate the signal from the Reply Generator up to the 1090 MHz output frequency.

Figure 19 Upconverter Front and Rear Views



3.6.1 J26 - 70 MHz Test Output

70 MHz IF test signals are available at the front panel of each of the three Upconverter Modules. The output signal type, Delta, Sum, or Omni, is determined by the location of the Upconverter Module in the MBTS chassis. ***It is important to terminate this port with the included 50 Ohm load when it is not in use***.

Table 7. J26 – 70 MHz Test Output Connector

Connector Name	70 MHz Test Out
Connector Reference Designator	J26
Connector Location	On each of the three Upconverter Module front panels, (Sum, Delta, or Omni)
Connector Type	BNC
VSWR/Impedance	1.5:1, 50 Ohm
Output Level	Approximately 15 dB below the level of signals at the applicable Sum, Omni, or Delta Channel rear panel output
Signal Frequency	70 MHz, nominal

3.6.2 J27 & J28 – 1090 MHz Test Outputs

1090 MHz, Channel A and Channel B test signals may be monitored at the front panel of each of the three Upconverter Modules. Terminate these ports, using the attached 50-Ohm loads, when they are not in use.

Table 8. J27 & J28 – 1090 MHz Target Reply Test Outputs

Connector Name	1090 MHz Test Out
Connector Reference Designator	J27, Channel A J28, Channel B
Connector Location	On each of the three Upconverter Module front panels (Sum, Delta, or Omni)
Connector Type	BNC
VSWR/Impedance	1.5:1, 50 Ohm
Output Level	Approximately 20 dB below the level of signals at the applicable Sum, Omni, or Delta Channel rear panel output
Signal Frequency	1090 MHz nominal, Operator selectable, 1080 to 1100 MHz in 200 kHz steps

3.7 Additional Front Panel Interfaces

3.7.1 Power Switch

The MBTS AC power switch is located in the lower left corner of the MBTS Front Panel.

3.7.2 Power Supply Test Points

The Power supply test points provide a means to externally measure the voltage of each output of the internal power supplies. The black test point is connected to chassis ground. The three yellow test points are +15V, +5V, and -5V DC.

3.7.3 Sum/Delta Phase Adjust

Two precision phase adjustment devices, one for output Channel A and one for output Channel B, are accessible through the MBTS Front Panel. These devices match the phase of the Delta RF output signal to that of the SUM RF output. The phase adjusters are set at the factory to achieve the proper phase characteristics at the output of the MBTS. During system integration adjustment of these may be required to match the phase characteristics of the MBTS to radar site requirements.

See System Phase Matching and Section 6.2.1 of the System Operations/Training Manual for more information.

3.7.4 1090 MHz Reply Outputs and Sum Channel Interrogation Inputs

The 1090 MHz Channel A and Channel B target reply output signal connectors are located on the MBTS Rear Panel. In some system configurations the Sum signal connectors, J1 and J4, also connect the 1030 MHz radar interrogation pulses into the MBTS. Type N female connectors are used in all cases. Connector reference designators are:

J1 - SUM Channel A Target Reply Output (and SUM Channel A Radar Interrogation Input)

J2 - DELTA Channel A Target Reply Output

J3 - OMNI Channel A Target Reply Output

J4 - SUM Channel B Target Reply Output (and SUM Channel B Radar Interrogation Input)

J5 - DELTA Channel B Target Reply Output

J6 - OMNI Channel B Target Reply Output

3.7.5 1030 MHz Radar Interrogation Inputs

1030 MHz Channel A and Channel B radar interrogation signals connect to the MBTS Rear Panel connectors J7 and J8.

Table 9. J7 and J8 - Channel A and B Interrogation Inputs

Connector Name	J7 - 1030 MHz Interrogation Input, Channel A J8 - 1030 MHz Interrogation Input, Channel B
Connector Reference Designator	J7 and J8
Connector Location	MBTS Rear Panel
Connector Type	"N"
VSWR/Impedance	1.5:1 maximum, 50 Ohms
Interrogation Input Level	-15 dBm to +20 dBm, peak
Output Level	Not Applicable
Signal Frequency	1030 MHz, nominal

3.7.6 RS-422 Balanced APG Data Inputs

Balanced (RS-422) ACP and ARP azimuth data signals connect to the MBTS Rear Panel connector J9. Unbalanced (75 Ohm APG Data Inputs) data may also be connected into the MBTS.

Table 10. J9 – RS-422 Antenna Azimuth Data Inputs

Connector Name	RS-422 Antenna Azimuth Data Inputs
Reference Designation	J9
Connector Location	MBTS Rear Panel
Connector Type	DB-15 female
Data Format	Compatible with all standard radar system platforms
Pulse Frequency	ARP – 1 pulse every 4 to 15 seconds ACP – 4096 pulses per ARP IACP - 16384 pulses per ARP
Balanced Electrical Inputs	Conforms with all RS-422 specifications, 0.0 to 5.0 volts (differential)
Signals Connections	pins 1, 6, 7, 13, 14, and 15 – No Connection
	pin 2 – Channel A +ACP
	pin 3 – Channel B +ACP
	pin 4 – Channel A +ARP
	pin 5 – Channel B +ARP
	pin 8 – Signal Ground
	pin 9 – Channel A -ACP
	pin 10 – Channel B -ACP
	pin 11 – Channel A -ARP
	pin 12 – Channel B -ARP

3.7.7 75 Ohm APG Data Inputs

J10 – 75 Ohm Azimuth ACP Input and J11 - 75 Ohm Azimuth ARP Input connect Unbalanced APG data to the MBTS Rear Panel. RS-422 Balanced APG Data Inputs may also be connected into the MBTS.

Table 11. J10 – 75 Ohm Azimuth ACP Input

Connector Name	75 Ohm ACP Input
Connector Reference Designator	J10
Connector Location	MBTS Rear Panel
Connector Type	BNC
VSWR/Impedance	75 Ohm
Input Level	TTL
Signal Frequency	Variable, 4096 or 16384 pulses per ARP (Antenna rotation rate within 4 to 15 RPM)

3.7.8 IEEE-488 Connector

J12 - IEEE-488 Connector Pin Designations is located on the MBTS Rear Panel.

The IEEE-488 port provides a communication interface between external GPIB devices and the PCC CPU microprocessor. The MBTS IEEE-488 Command Set (FSE Document No. 100606) lists the commands, responses, and data formats that are required for proper communication with and control of the MBTS. A Configuration Switch sets the PCC IEEE-488 bus address.

Table 12. J12 - IEEE-488 Connector Pin Designations

Pin Number	Designation	Pin Number	Designation
pin 1 -	DIO1	pin 13 -	DIO5
pin 2 -	DIO2	pin 14 -	DIO6
pin 3 -	DIO3	pin 15 -	DIO7
pin 4 -	DIO4	pin 16 -	DIO8
pin 5 -	EIO	pin 17 -	REN
pin 6 -	DAV	pin 18 -	GND
pin 7 -	NRFD	pin 19 -	GND
pin 8 -	NDAC	pin 20 -	GND
pin 9 -	IFC	pin 21 -	GND
pin 10 -	SRQ	pin 22 -	GND
pin 11 -	ATN	pin 23 -	GND
pin 12 -	SHIELD	pin 24 -	LOGIC GND

3.7.9 Auxiliary RS-232 Control Port

J13 – Auxiliary RS-232 Control Port is located on the MBTS Rear Panel. The serial interface conforms with the protocols listed in ANSI/TIA/EIA-232F. The Auxiliary RS-232 Control Port uses the same command structure as the IEEE-488 interface. The interface operates at 9600 baud, 8 data bits, 1 stop bit and no parity bit. Handshaking should be turned off.

Table 13. J13 – Auxiliary RS-232 Control Port

Connector Name	Auxiliary RS-232 Control Port
Connector Reference Designator	J13
Connector Location	MBTS Rear Panel
Connector Type	DB-9 Female
Signals	pin 2 - TX Data pin 3 - RX Data pin 5 - Ground

3.7.10 AC Power

AC power is applied to the MBTS Rear Panel.

Table 14. J14 - AC Power Input Connector

Connector Name	AC Power
Connector Reference Designator	J14
Connector Location	MBTS Rear Panel
Connector Type	3 Prong IEC
Input Level	105 to 265 Volts AC
Maximum Current Draw	0.8 Amperes
Signal Frequency	50 to 60 Hz

3.7.11 Fuse

The MBTS is protected by Fuse F1 on the MBTS Rear Panel. F1 is a 3AG Type fuse that is rated at 1 Ampere and 250 VAC.

4 STANDARDS AND TOLERANCES

4.1 MBTS General Operating Characteristics

The MBTS mounts in a 7-inch (4U) high opening of a standard 19-inch rack or equipment cabinet. It is designed for indoor operation only.

Table 15. MBTS General Operating Characteristics

Characteristic	Specification
Weight	35 pounds
Size	Front Panel - 7 x 19 (H X W) inches Rear Panel - 7 x 17.625 (H x W) inches Depth - 14 inches
Power	115 to 230 VAC, 50-60 Hz, 60 Watts, typical
Temperature	Operating: +10°C to 50°C Storage: -20°C to +70°C
Relative Humidity	0% to 90%, non-condensing
Altitude	Operating: 10,000 feet Storage/Shipping: 20,000 feet
Shock and Vibration	Normal bench handling

4.2 MBTS Signal Interfaces

Signal interfaces are located on the rear and front panels of the MBTS. The primary interrogation and target reply signal connectors are located on the MBTS chassis rear panel. The 75 Ohm ACP and ARP azimuth inputs, the RS-422 ACP and ARP azimuth inputs, the IEEE-488 control, the RS-232 control, and the AC power input are also located on the chassis rear panel. Video, IF, and RF test inputs and outputs are located on the front panels of the various plug-in modules.

4.2.1 Rear Panel Signal Interfaces

Refer to Figure 40 MBTS Rear Panel for rear panel connector information.

4.2.2 Front Panel Connectors

Refer to Figure 39 MBTS Front Panel for front panel connector information.

5 MAINTENANCE AND REPAIR

5.1 Periodic Maintenance

Periodically the physical condition and the electrical performance of the MBTS should be verified. Maintenance schedules should be based upon the environment in which the MBTS operates. If the MBTS is used in a hot or dusty environment maintenance should occur much more frequently than suggested below.

5.1.1 MBTS Cleaning

Every six months the physical condition of the MBTS should be inspected for the accumulation of dust or dirt.

Check the ventilation holes on the bottom and top panels of the chassis. Remove all Upconverter Modules. Inspect the top and bottom panels of each of these modules.

NOTE

Insert each Upconverter Module back into the slot from which it was extracted. Failure to do so will require realignment and possibly recalibration of the MBTS.

Clean module covers with a soft brush and vacuum cleaner, as required. All modules should be removed and cleaned if the Upconverter modules are found to be dirty. The chassis interior, especially the fan blades below the Upconverter Modules, should be thoroughly cleaned using a soft brush and vacuum cleaner.

If the exterior of the MBTS should require additional cleaning, it can be wiped with a clean cloth that has been moistened with a spray type of household cleaner. Do not spray the cleaner directly onto any surface of the MBTS.

5.1.2 Output Level Calibration

It is recommended that the output level of the MBTS be verified at least yearly. The calibration process is briefly described in the Absolute Output Power Calibration Mode section of this manual. A complete description of the Absolute Output Power Calibration mode can be found in Section 2.3.5 of the System Operations/Training Manual.

Read and thoroughly understand the information provided in the System Operations/Training Manual before attempting to recalibrate the MBTS.

5.2 Troubleshooting and Repair

The MBTS includes extensive Built In Test (BIT) features. Some MBTS performance parameters are continuously monitored and are displayed on the OCS control panel as described in OCS System Status section of this manual. Other performance parameters are checked only when the Standby/Diagnostics Mode has been selected.

The BIT process assumes that the BIT Module functions properly. BIT testing insures the functionality, not the absolute accuracy, of each RF control. Always verify the results of the BIT process, by repeating the test sequence or through the use of external test equipment, before proceeding with either Module Replacement or unit replacement.

If the MBTS has operational issues, use the Standby/Diagnostics Mode and the MBTS Trouble Diagnostics table to evaluate the problem. A thorough understanding of the MBTS is critical for detailed fault analysis. See Section 3.1 of the System Operations/Training Manual for information on this topic.

5.2.1 Module Replacement

Replacing, instead of repairing, a faulty module is a valid maintenance strategy if the following limitations are understood and can be overcome.

Gain and phase variations within Reply Generator Modules and Upconverter Modules are of major importance. These differences are equalized at the factory through the use of calibration constants stored in the PCC Module. The replacement of the Reply Generator, an Upconverter, or the PCC may result in less than specified performance. It is recommended that the MBTS unit be returned to the factory, in its original configuration, if diagnostics indicate that any of these three modules are found to be faulty.

The BIT Module, the IDR Module, and the Reference Source Module may be replaced without concern for the above issues.

Module removal requires the use of a small flat-blade screwdriver. Each module is held in place with either two or four captive screws. Loosen the screws and pull the module away from the chassis through the use of the front panel handle. When replacing the module use caution not to over tighten the screws that hold the module to the chassis.

6 INSTALLATION, INTEGRATION, AND CHECKOUT

6.1 Installation

The MBTS can be operated from a tabletop or it can be installed into a standard 19-inch equipment rack. If operated on a tabletop, the chassis bottom and top must be clear of any obstructions so as to allow proper ventilation.

Hinged brackets for mounting the MBTS into a standard EIA/RETMA 19-inch equipment rack or cabinet are included as part of the chassis as shown below in Figure 20. The brackets are shown in the retracted position.

Figure 20. MBTS Chassis Rack Mount Brackets

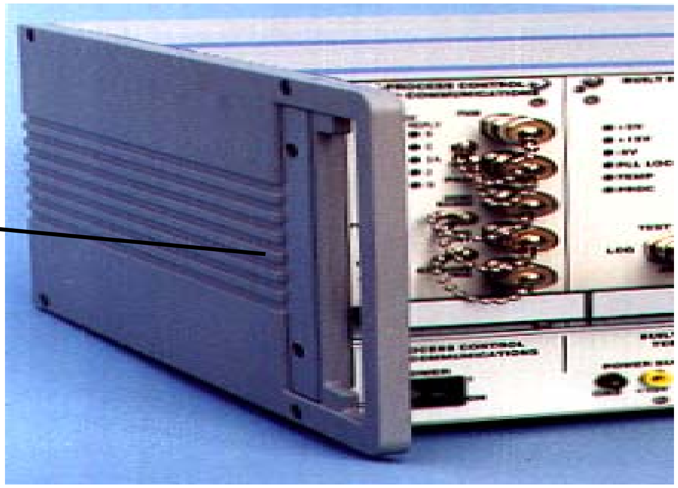
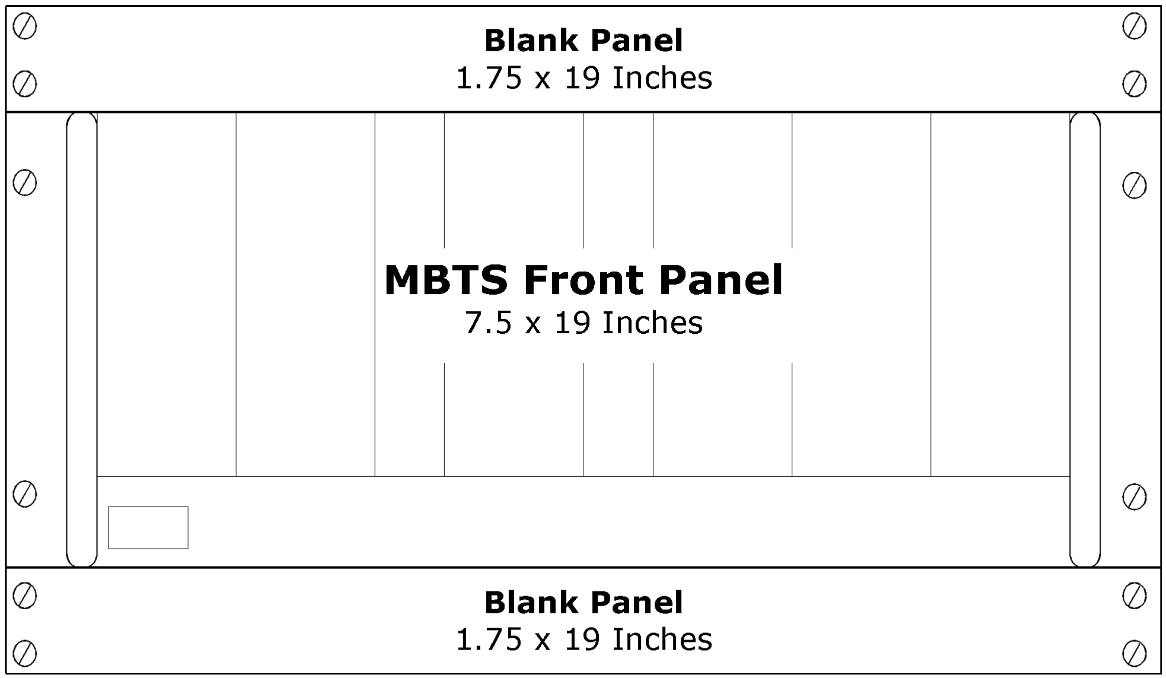


Figure 21. Recommended Rack Mount Configuration



The MBTS front panel is 7.5 inches high, but a minimum opening of 10.5 inches is recommended for mounting it into an equipment rack. As shown above, 1.75 inch high blank panels should be mounted above and below the chassis to allow adequate air flow through the MBTS.

6.2 Integration

The MBTS system consists of the MBTS, an Operator Control Subsystem (OCS), phase-matched RF cable sets, and an azimuth data cable. Refer to the **Error! Reference source not found.** for a detailed listing of items delivered with the MBTS System. The OCS consists of a laptop Pentium computer configured with MBTS control software and an IEEE-488 interface. The MBTS and OCS communicate through the IEEE-488 interface. Refer to Connecting the OCS to the MBTS.

To integrate the MBTS with a radar system review the operational characteristics and requirements of the radar system and of the MBTS. Use the Azimuth Gated Target Mode Function Block Diagram to assist in planning connections to the radar system. Refer to the MBTS Rear Panel for connector locations. Section 6.2 of the System Operations/Training Manual has additional information.

Two sets of phase-matched cables are delivered with the MBTS system. Each set consists of three twenty-five foot long cables. The cables of each set should be attached to a single channel of Sum, Omni, and Delta outputs at the rear panel of the MBTS. Do not mix the cables of the two sets between the outputs of the different channels. The attachment point of the other end of the phase matched RF cables is radar system dependent. For the ATCBI-6 radar, however, this connection is usually made at the coupled port of the 20dB dual directional coupler located at the top of the transmit/receive cabinet. ***Consult with the site engineer to verify the location of all signal connections***.

The MBTS operates on 115/230 VAC 50-60 Hz power. This should be provided at J14 - AC Power Input Connector.

APG signals from the radar system antenna pedestal must be connected to the MBTS. Use either the balanced APG input connection J9 – RS-422 Antenna Azimuth Data Inputs, or the unbalanced APG input connections J10 – 75 Ohm Azimuth ACP Input and J11 - 75 Ohm Azimuth ARP Input.

A 25-foot APG interface cable is provided with the MBTS System to connect signals from the APG outputs of the radar system with the balanced inputs of the MBTS. A special APG adapter cable is also provided with MBTS Systems delivered to ASR-11 equipped radar sites. Attach this adapter cable to the free end of the 25-foot APG cable and to the APG outputs of the ASR-11.

6.2.1 System Phase Matching

For the MBTS to work properly with the radar system, the signals from the Delta and Sum outputs must exhibit the correct phase properties at the radar inputs. Consult with the site engineer as to signal phase requirements. Sum/Delta Phase Adjust controls, one for each Delta signal channel, provide the means to alter the phase of MBTS outputs to meet system requirements. Ninety-degree phase adapter cables, one for each RF channel, are also provided with the MBTS system for this purpose.

To set the phase relationship of the Sum and Delta channel signals, first disconnect the phase matched cables from the signal coupler located at or near the radar transmitter/receiver. Connect the cables to a Vector Voltmeter (such as an HP 8508) using the Sum Channel output signal from the MBTS as the reference. Operate the MBTS in CW Mode. Set the Sum RF Level of the MBTS to 0 dBm. Set the Delta/Sum Ratio to −20 dB. Set the Output Channel Selection control to either Channel A or B as appropriate. Monitor the Sum/Delta phase relationship as displayed by the Vector Voltmeter while varying the phase adjustment device appropriate for the signal channel in use. Set the Delta/Sum Phase relationship as required. Use the 90º adapter cables if necessary. Once the proper phase relationship has been established place the MBTS into the desired operational state, usually either Constant Range Ring Mode or Azimuth Gated Target Mode. The MBTS may now be reconnected to the radar system.

Signal phasing issues are demonstrated when responses generated by the MBTS, and as displayed on the radar target screen, appear as splits around a single target azimuth, or when target replies are transitory – are displayed on one, but not all sweeps, of the radar. Note that this condition is similar to when the MBTS is set for a low output signal level.

6.2.2 Antenna Pattern Calibration

To optimize the output characteristics of the MBTS a new User Antenna Pattern should be created that matches the characteristics of the antenna used by the radar system. To begin this process, place the MBTS in the Off-Boresight Calibration Mode. When in the Off-Boresight Calibration Mode the MBTS generates pulsed RF replies in which the monopulse setting of a reply sequence is encoded into the reply data transmission. The reply data from the MBTS is recorded and analyzed by the radar system. Consult with the site engineer for procedures and processes for setting the radar for data collection, data analysis, and to generate a new Boresight antenna file. Software to analyze MBTS signals received by the radar system is not provided with the MBTS system.

A new Boresight file is created as a result of the analysis process (a new Beamshape file may also be created but is not an absolute necessity). See the UPLOAD ANT BEAMSHAPE and UPLOAD ANT BORESIGHT sections, which describe uploading these files to the MBTS. When operating the MBTS in Azimuth Gated Target Mode make sure that the User antenna pattern is selected.

Figure 22 Main OCS Screen

THE MAIN OCS CONTROL PANEL
SHOWN OPERATING IN CW MODE
EACH OPERATING MODE HAS A UNIQUE SET OF CONTROLS

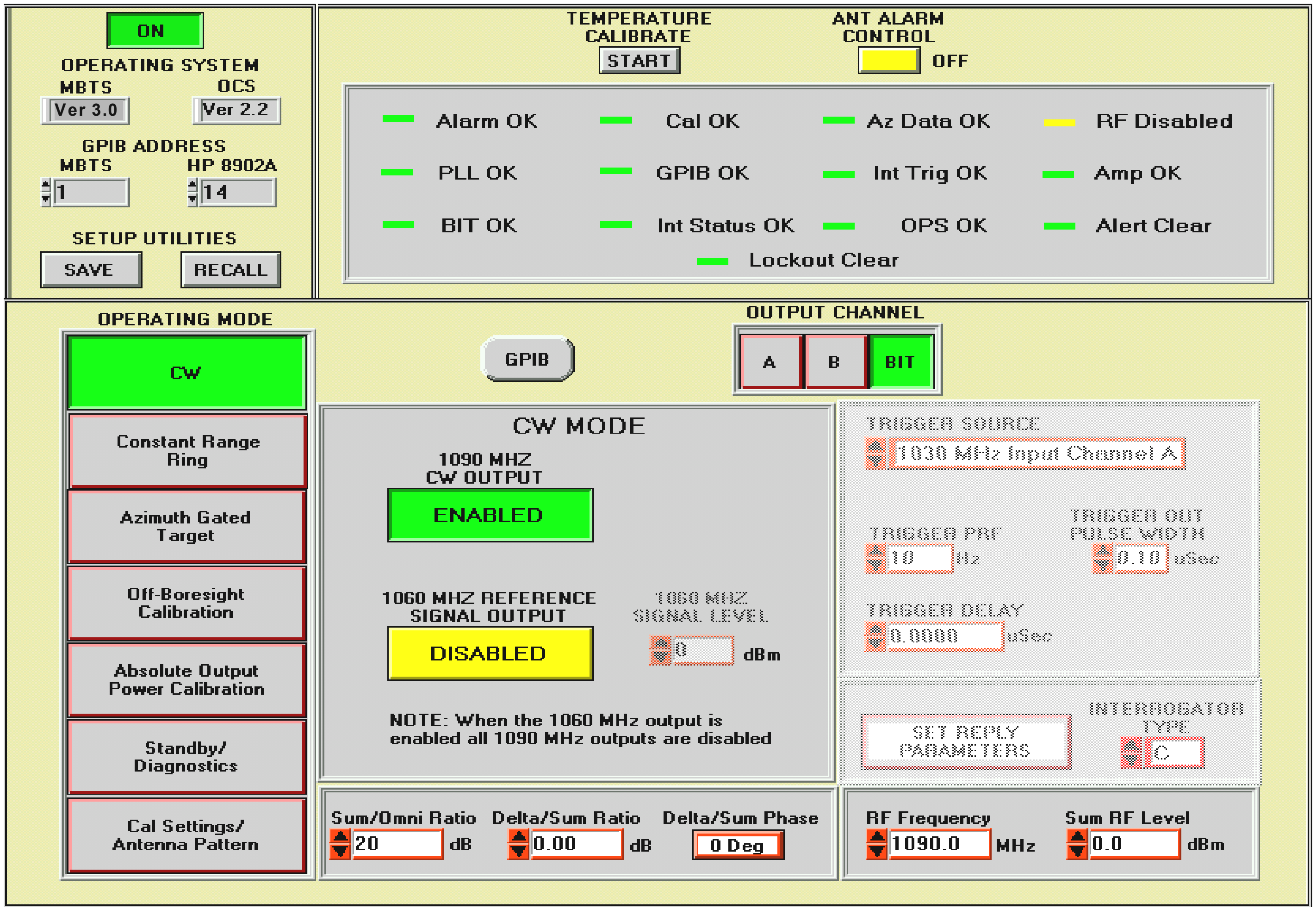


Figure 23 Standby/Diagnostics Status Register Display MODIFY

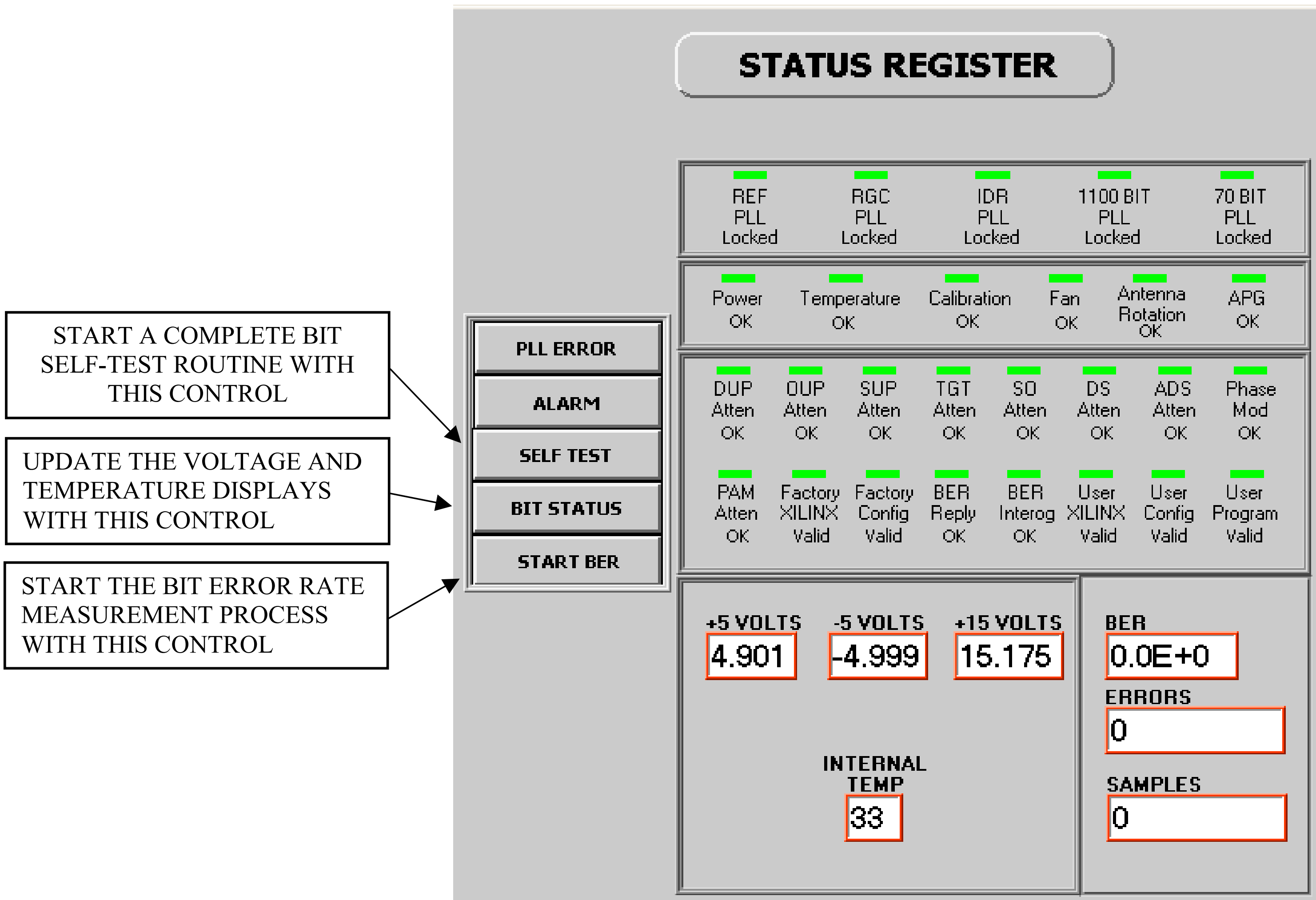


Figure 24 1060 MHz CW Mode OCS Screen

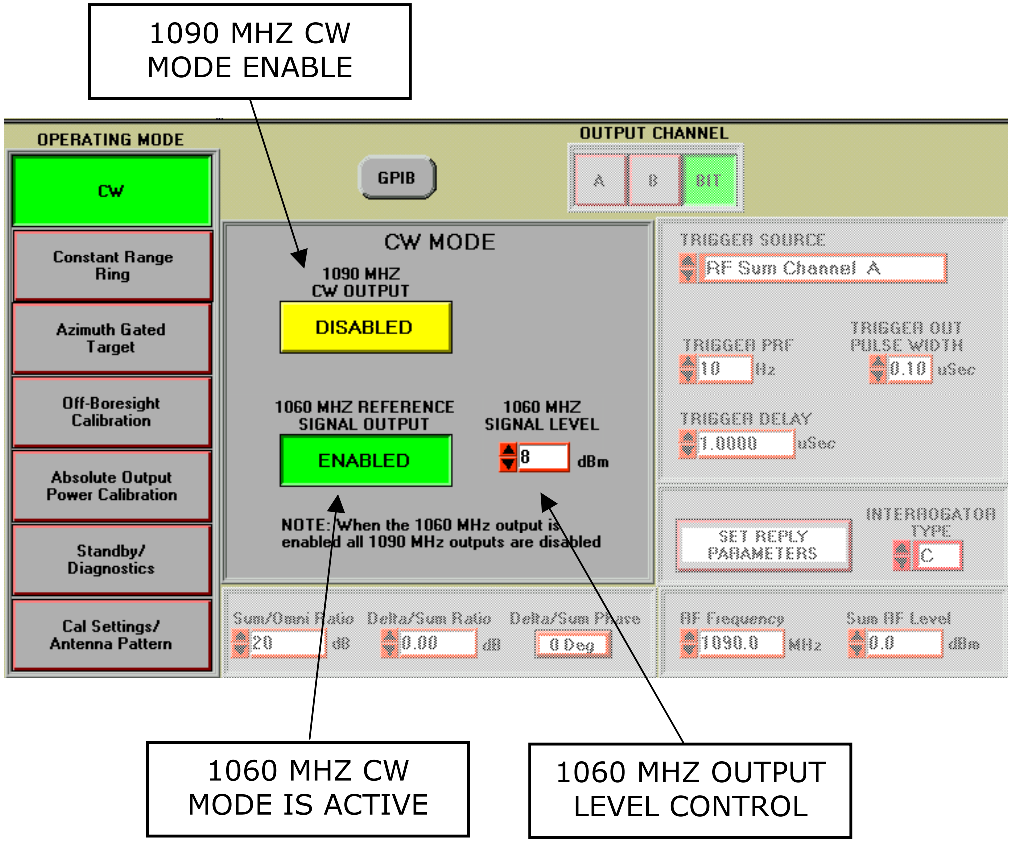


Figure 25 1090 MHz CW Mode OCS Screen

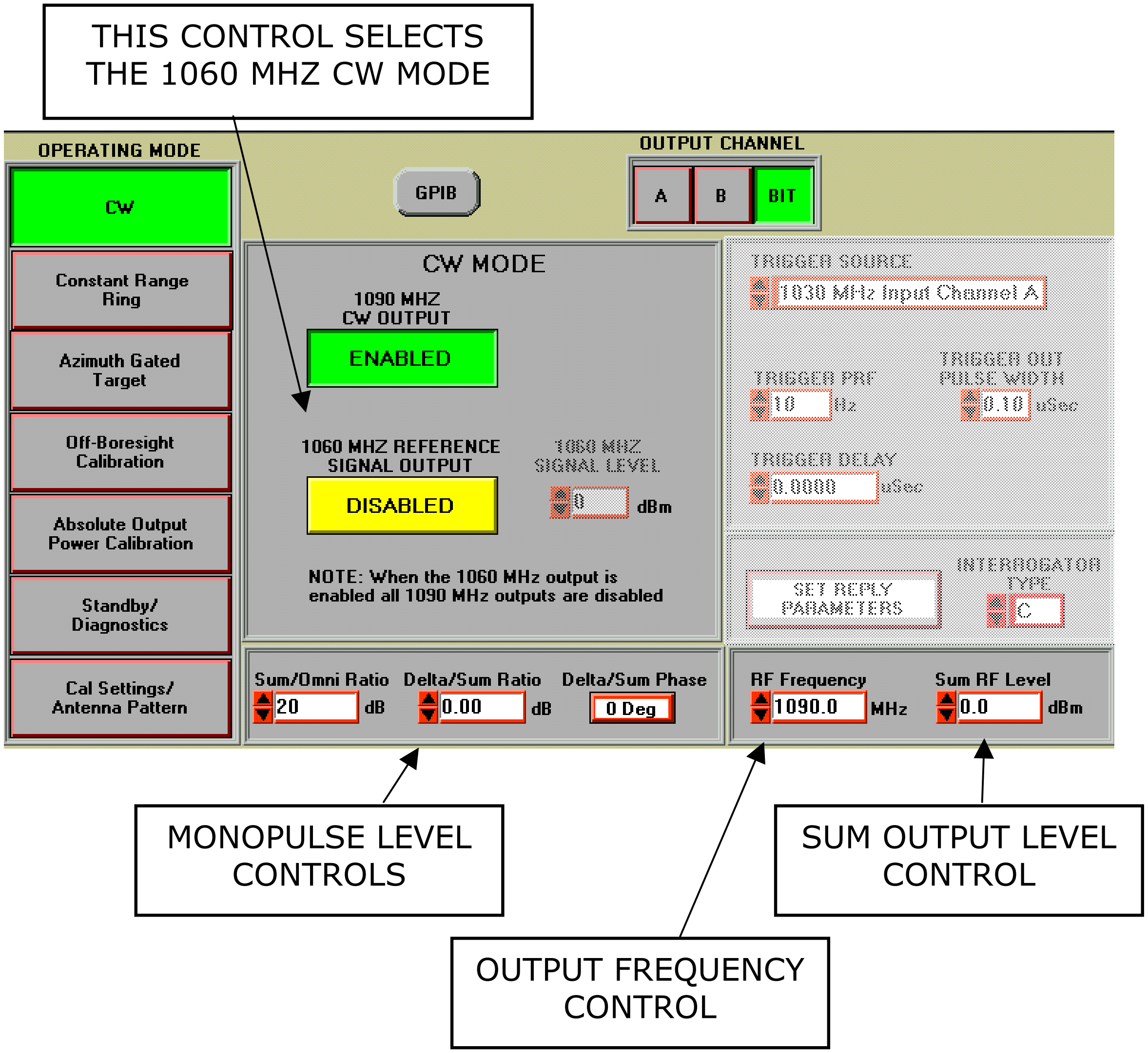


Figure 26 1090 MHz CW Mode Control Functions

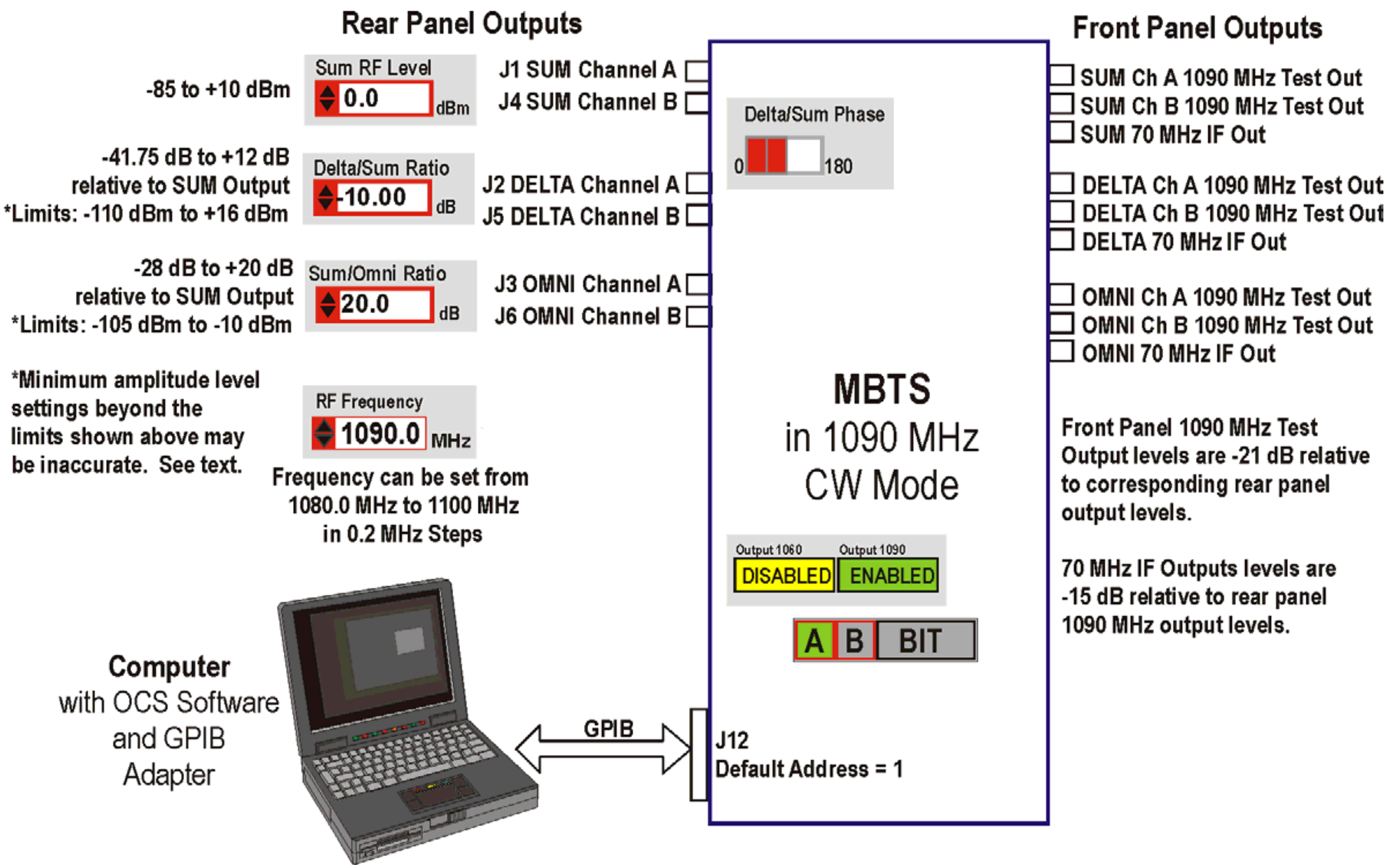


Figure 27 Constant Range Ring Mode OCS Screen

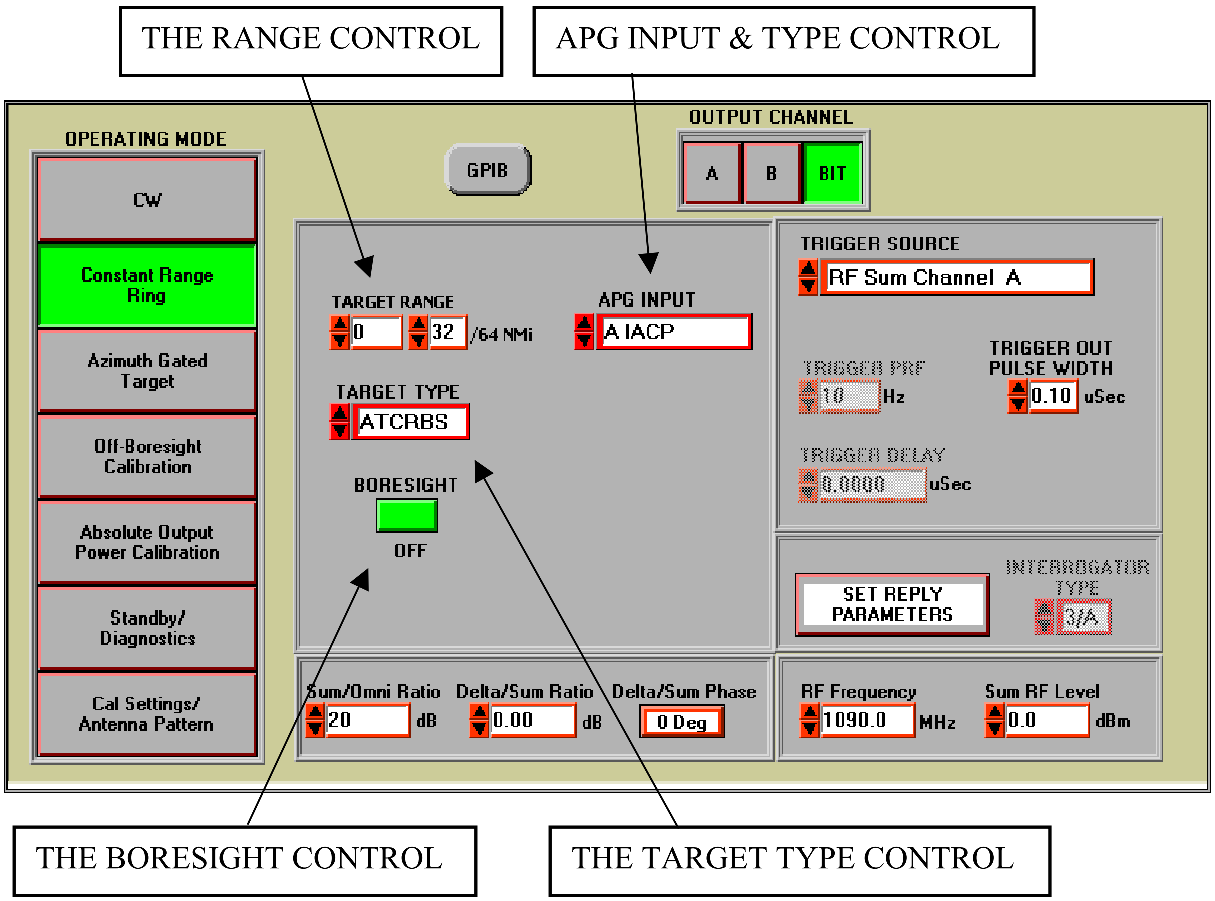


Figure 28 Constant Range Ring Mode Functional Block Diagram

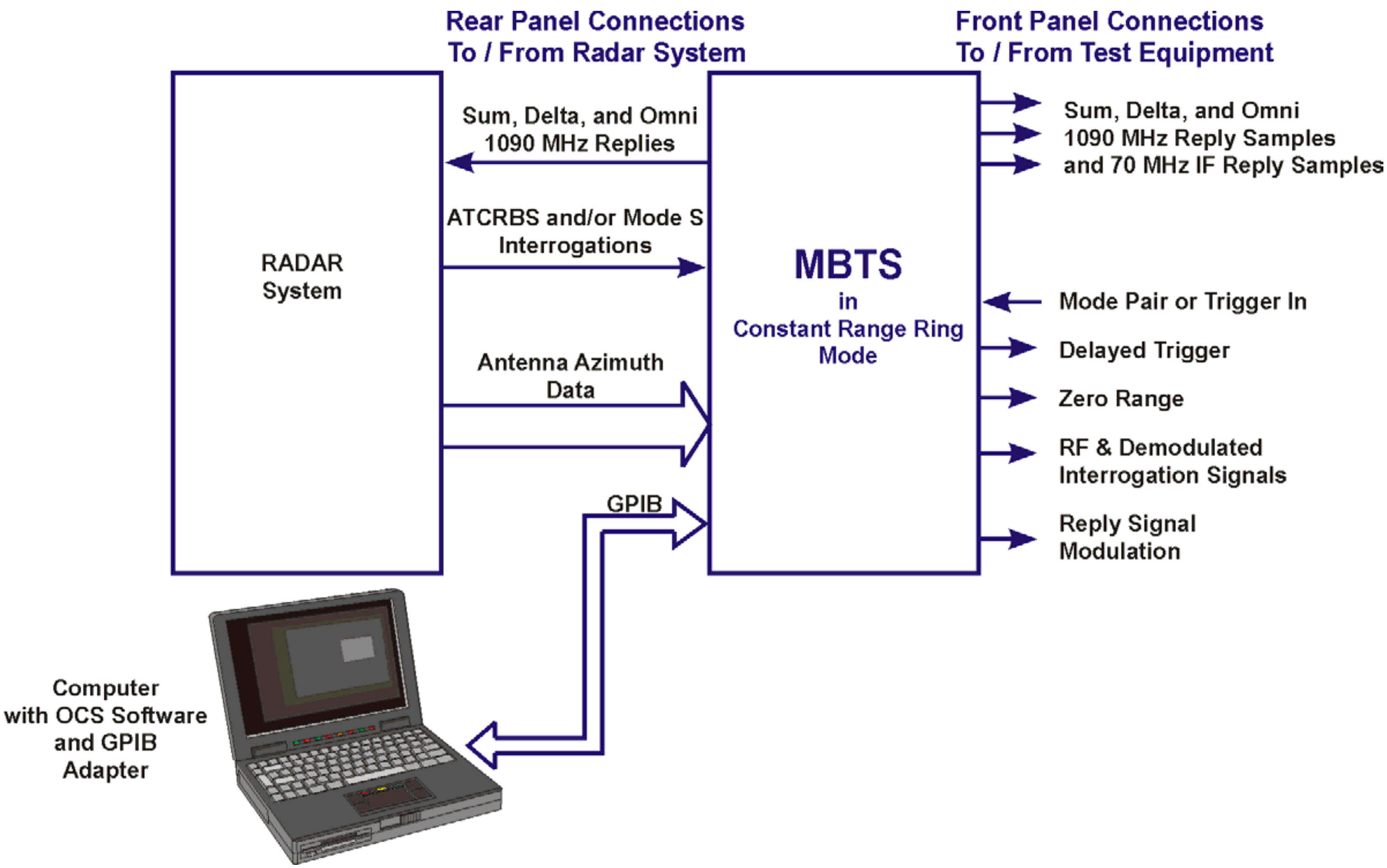


Figure 29 Trigger Control Panel

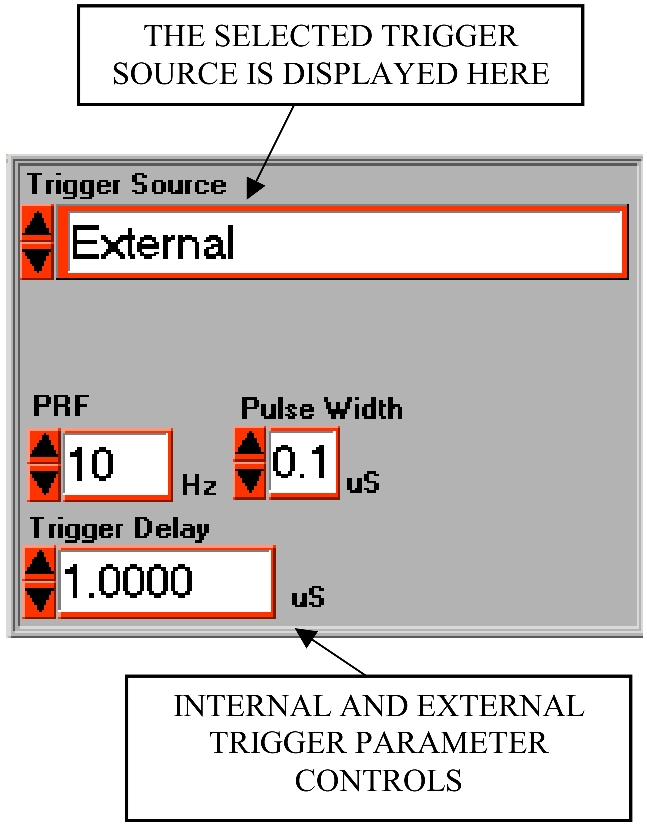


Figure 30 Reply Parameter Window

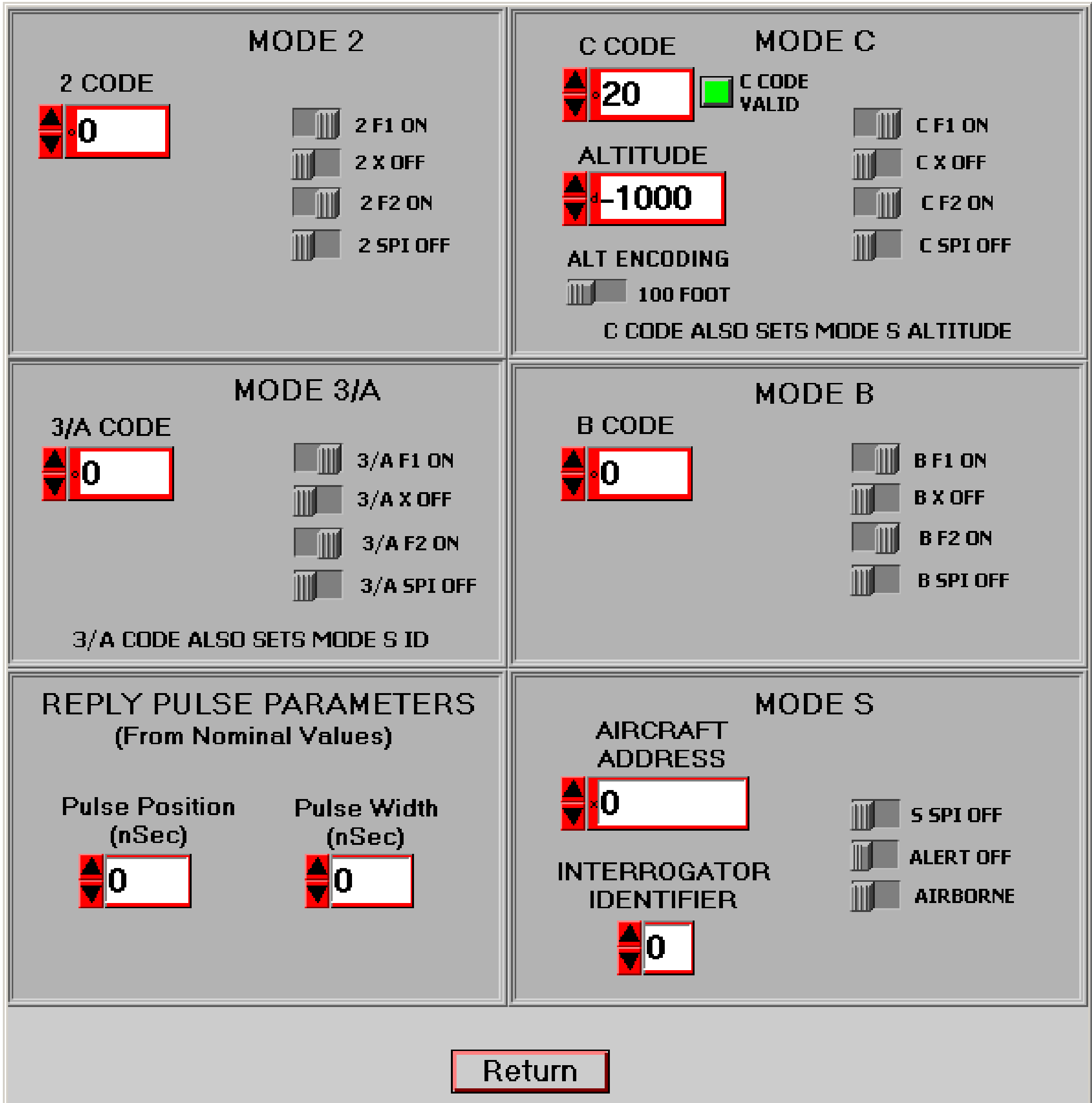


Figure 31 Azimuth Gated Target Mode OCS Screen

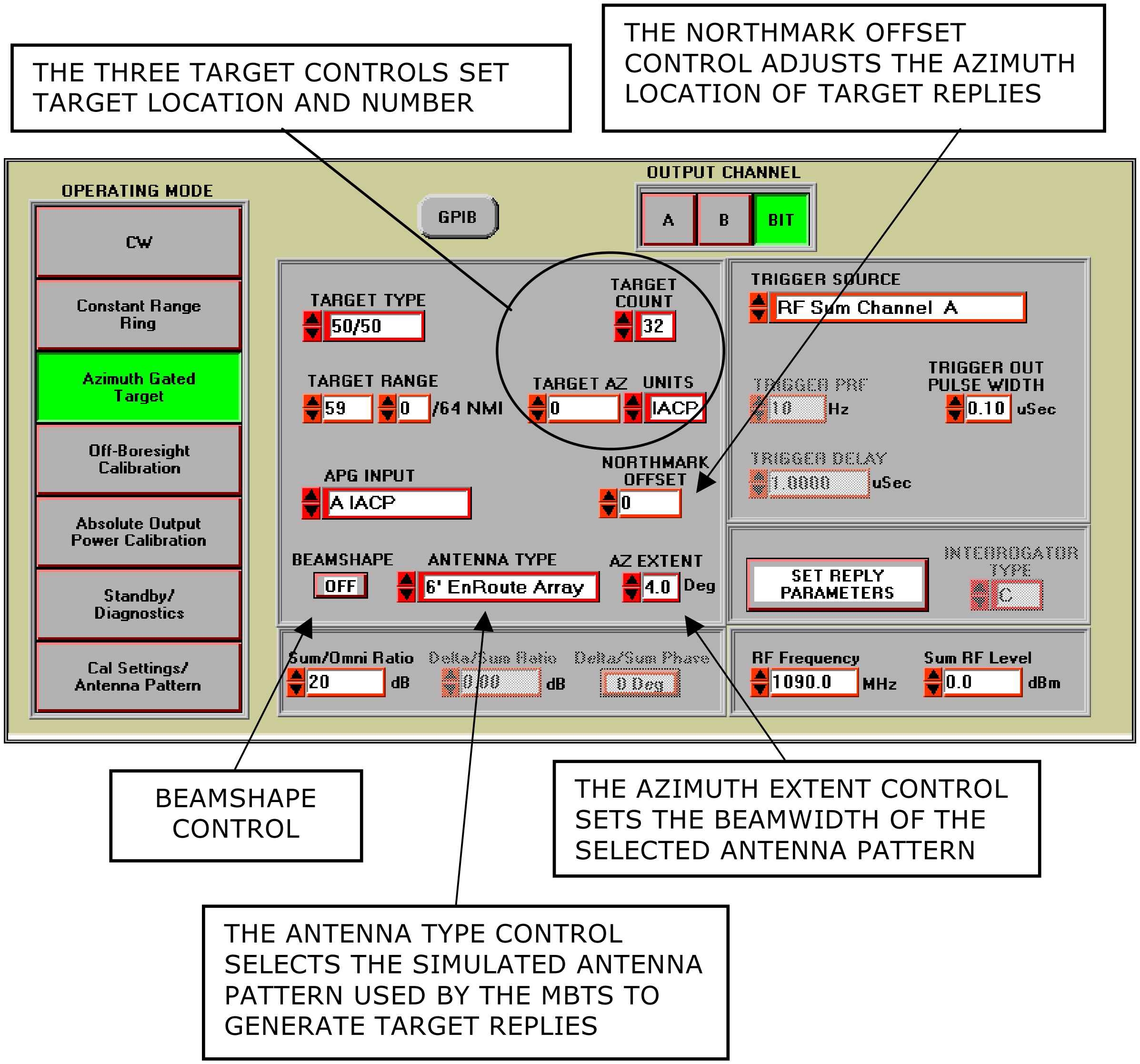


Figure 32 Azimuth Gated Target Mode Function Block Diagram

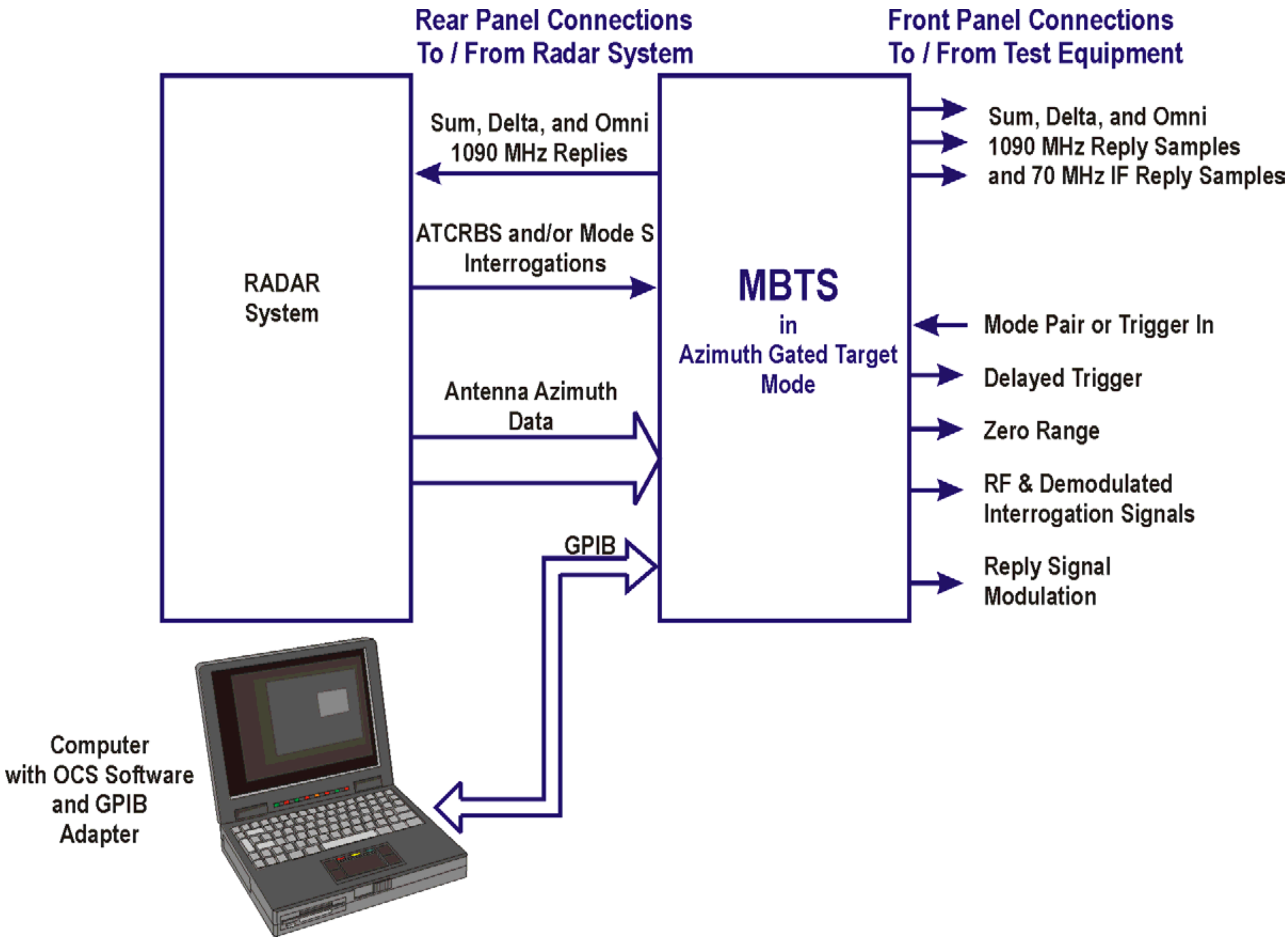


Figure 33 Off-Boresight Calibration Mode Screen

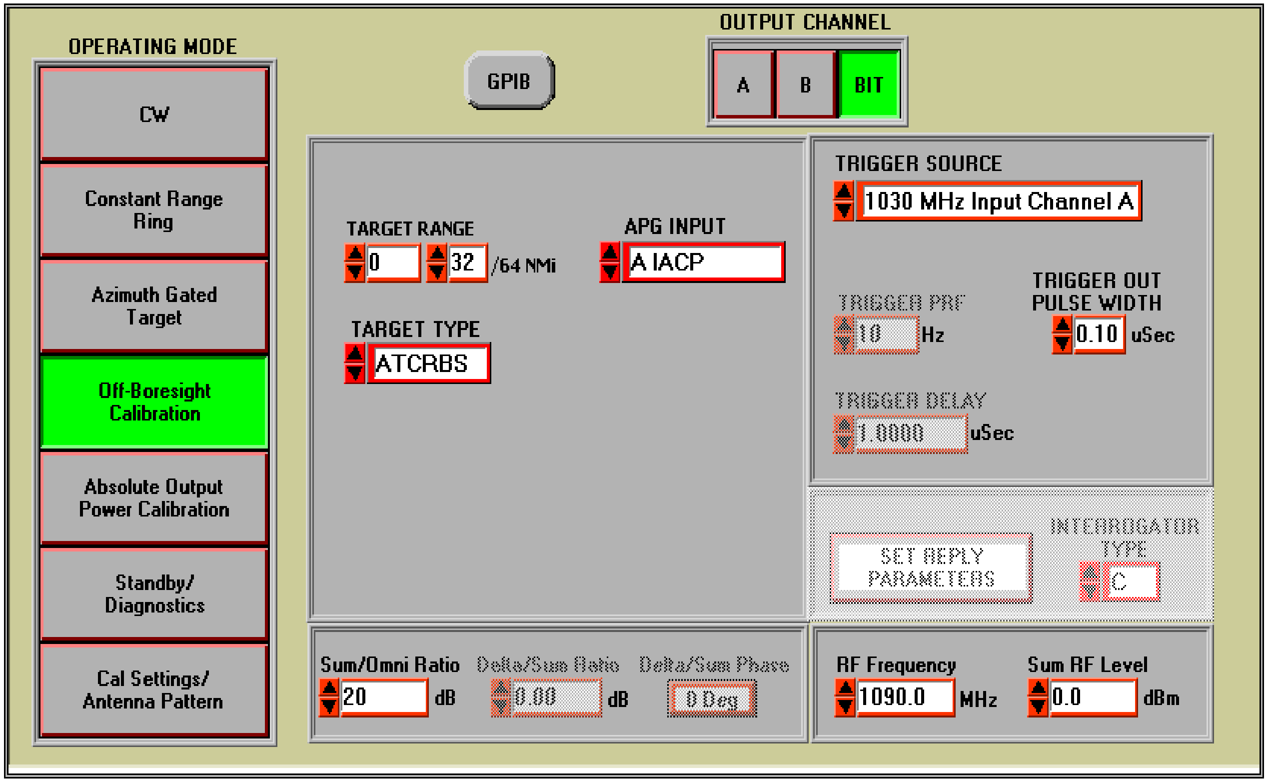


Figure 34 Off-Boresight Calibration Mode Block Diagram

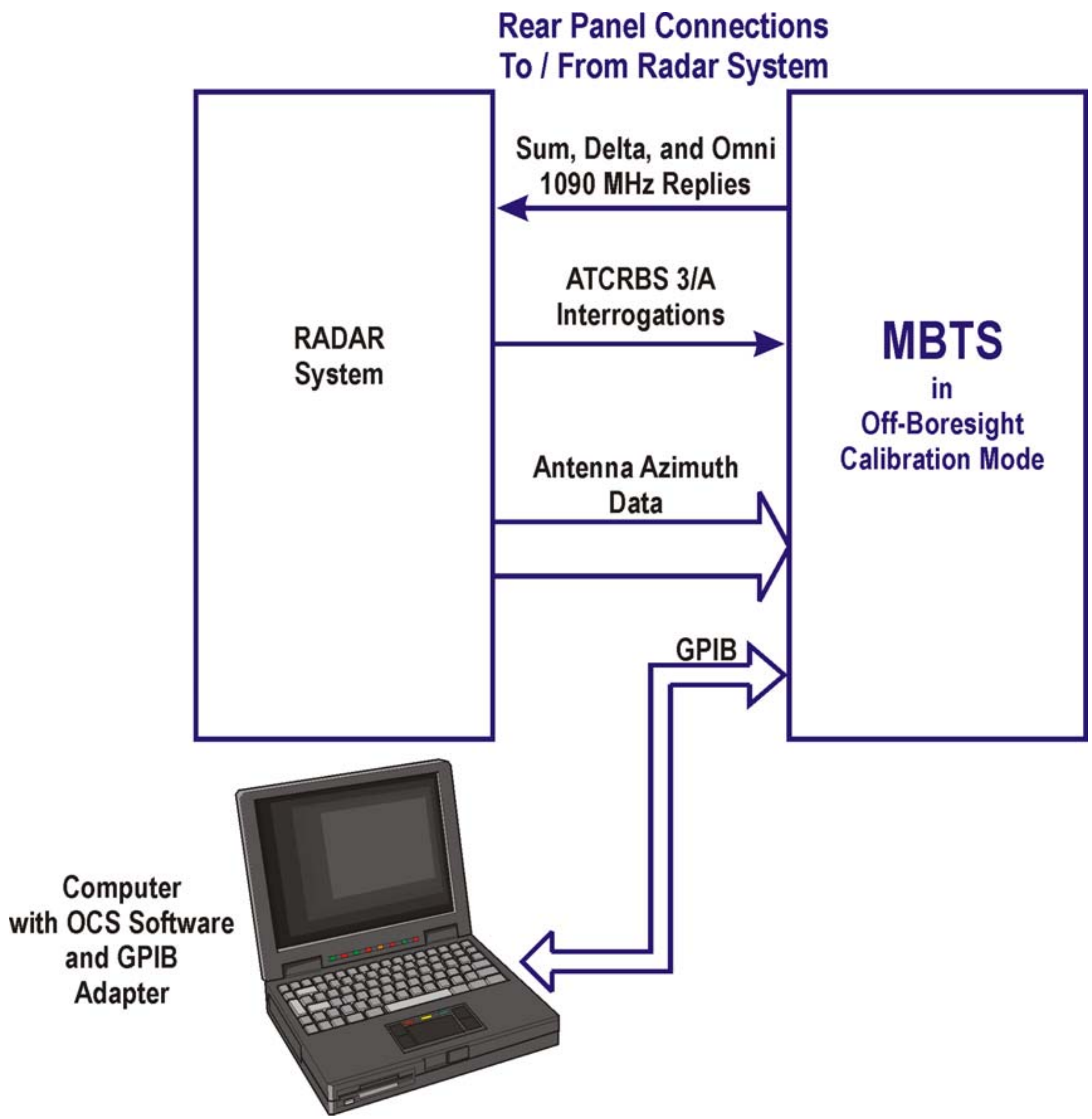


Figure 35 Cal Settings / Antenna Pattern Data Display MODIFY

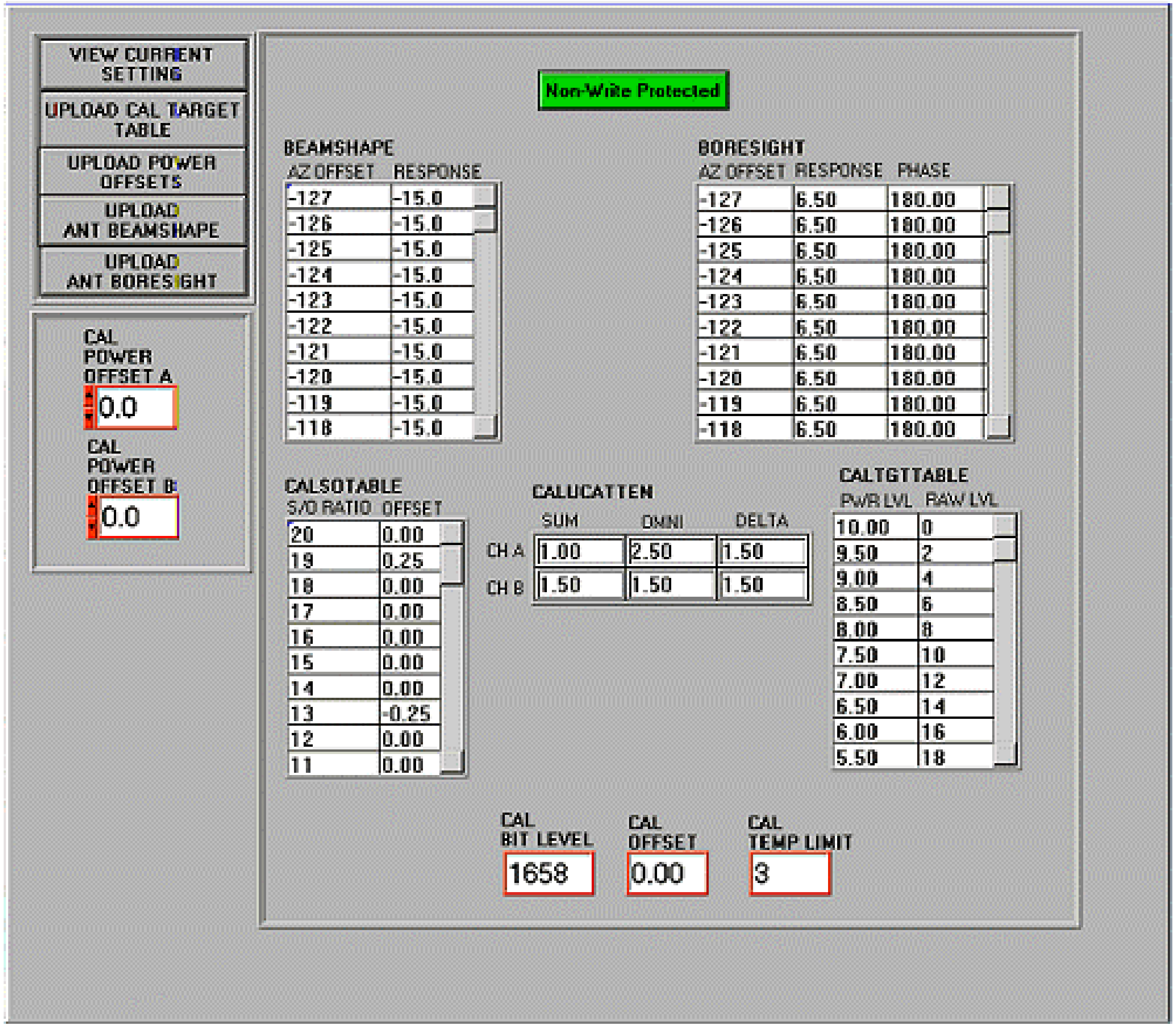


Figure 36 Absolute Output Power Calibration Test Setup

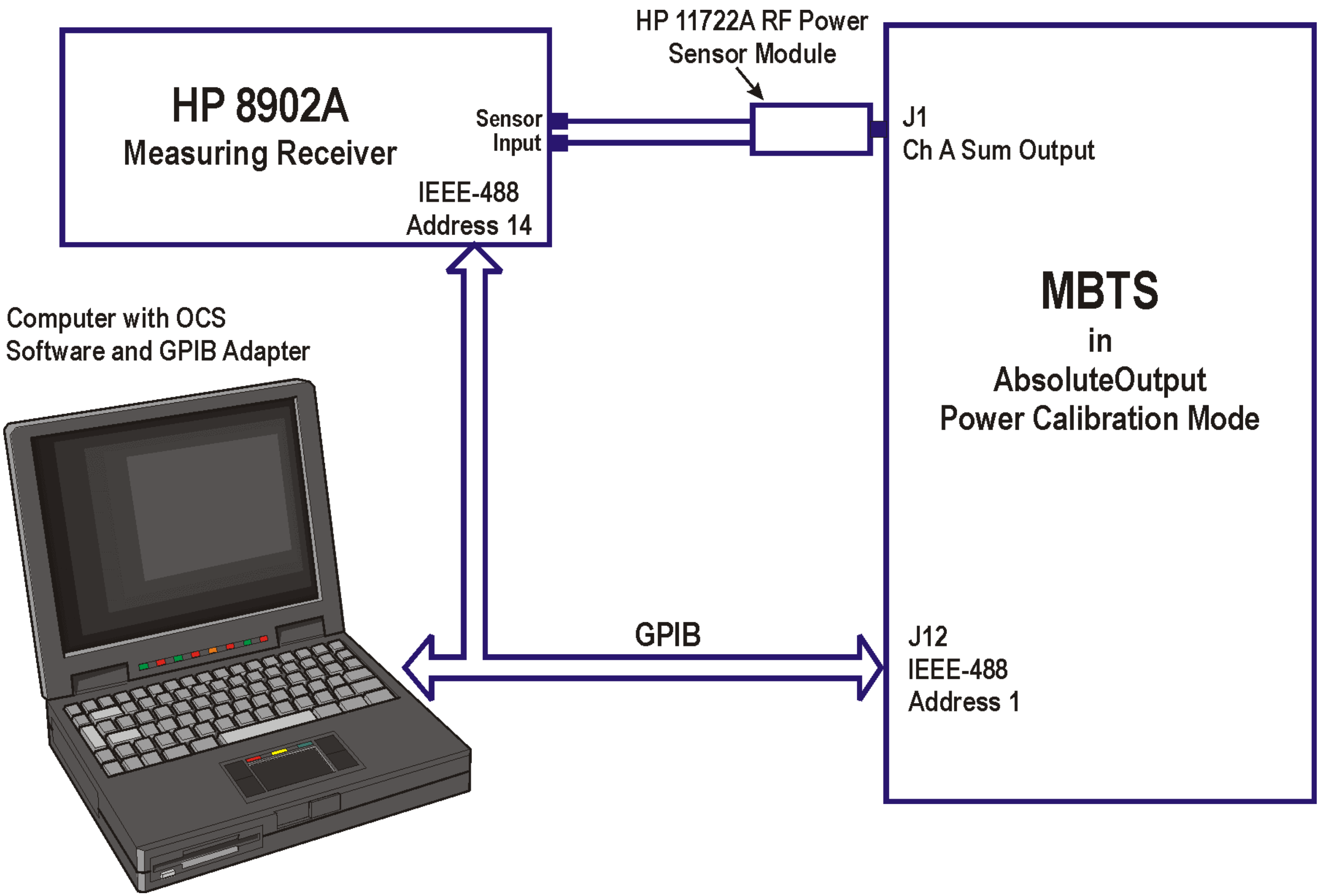


Figure 37 Absolute Output Power Calibration Screen

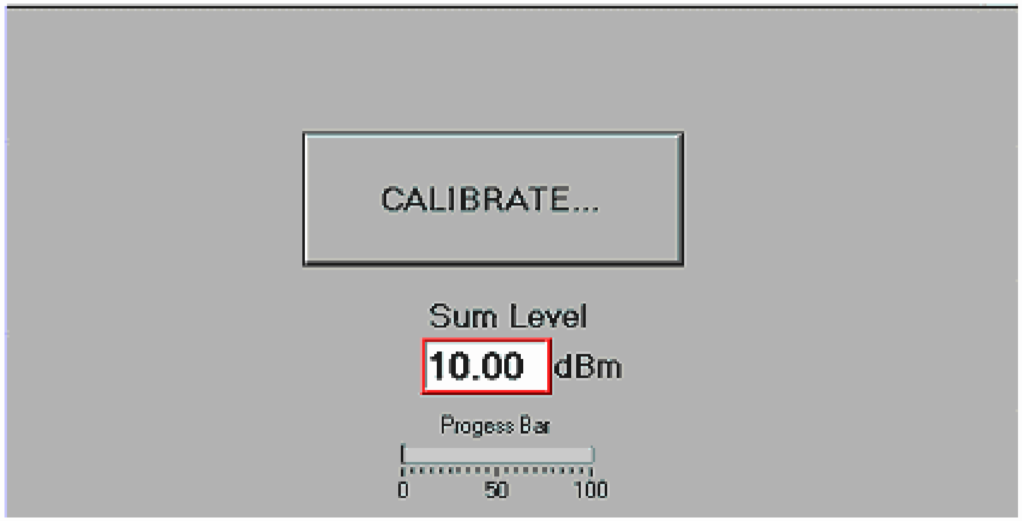
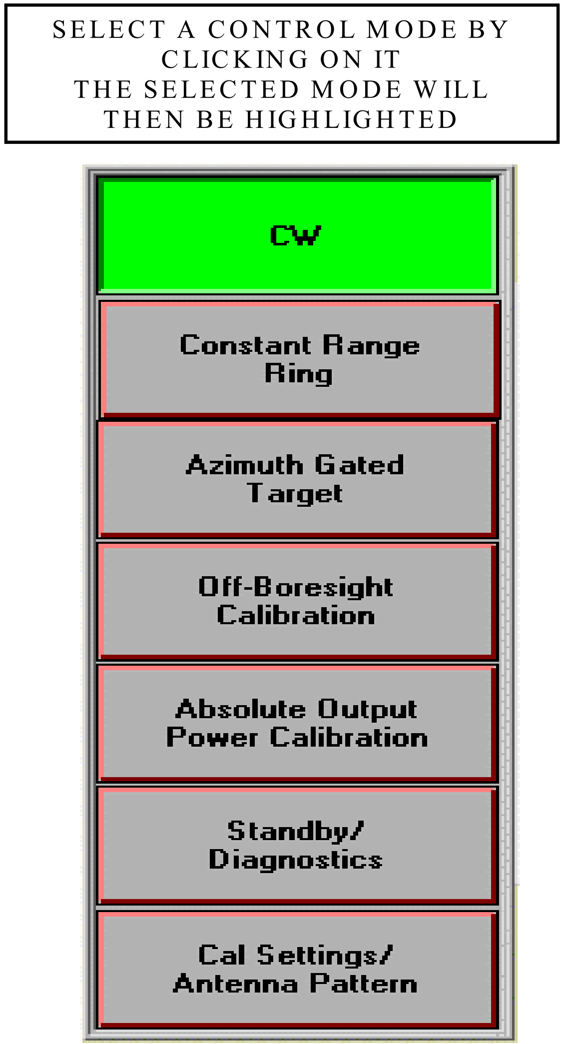


Figure 38 Mode Select Panel



CW Mode

Constant Range Ring Mode

Azimuth Gated Target Mode

Off-Boresight Calibration Mode

Absolute Output Power Calibration Mode

Standby/Diagnostics Mode

Cal Settings / Antenna Pattern Mode

Figure 39 MBTS Front Panel

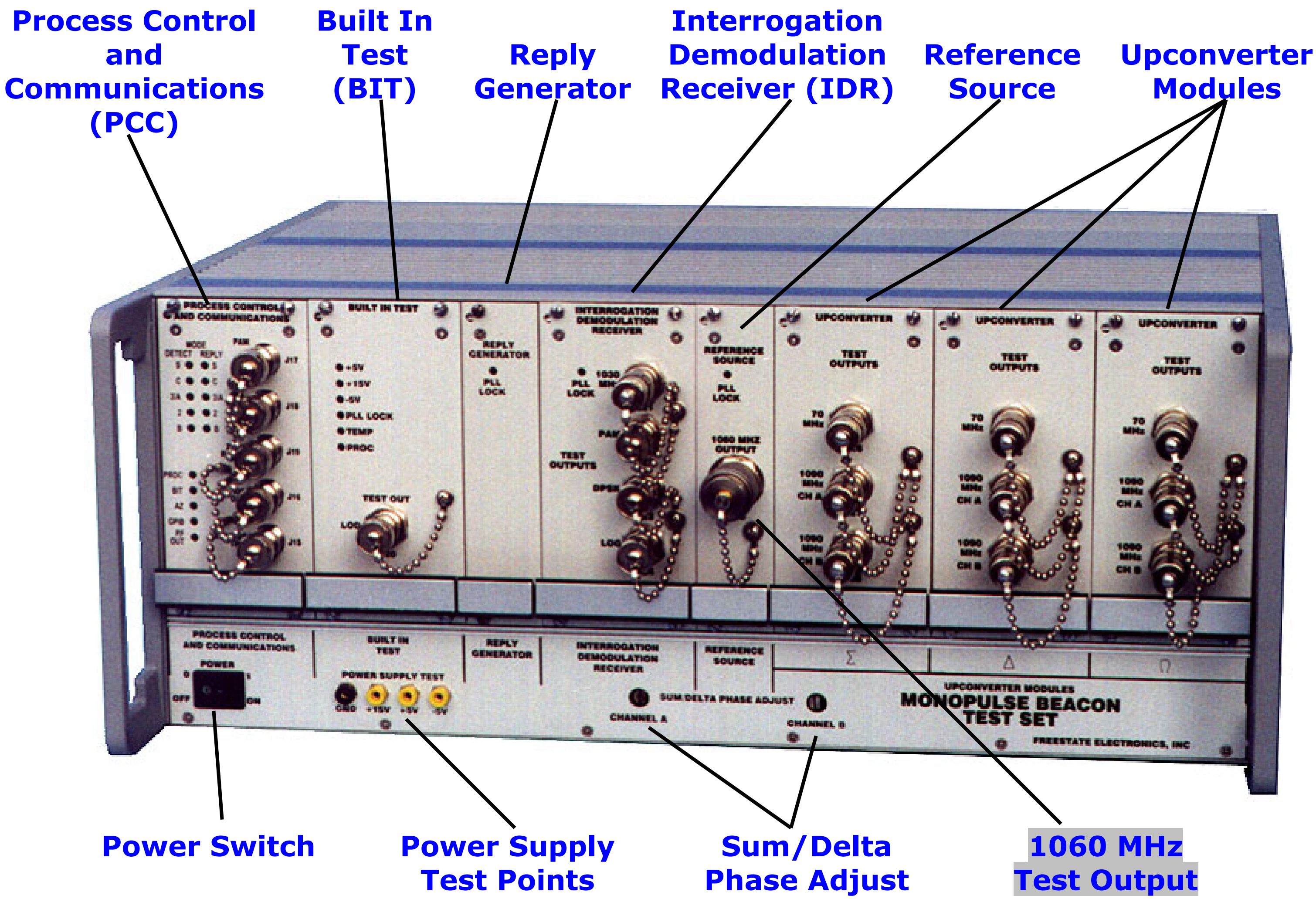


Figure 40 MBTS Rear Panel

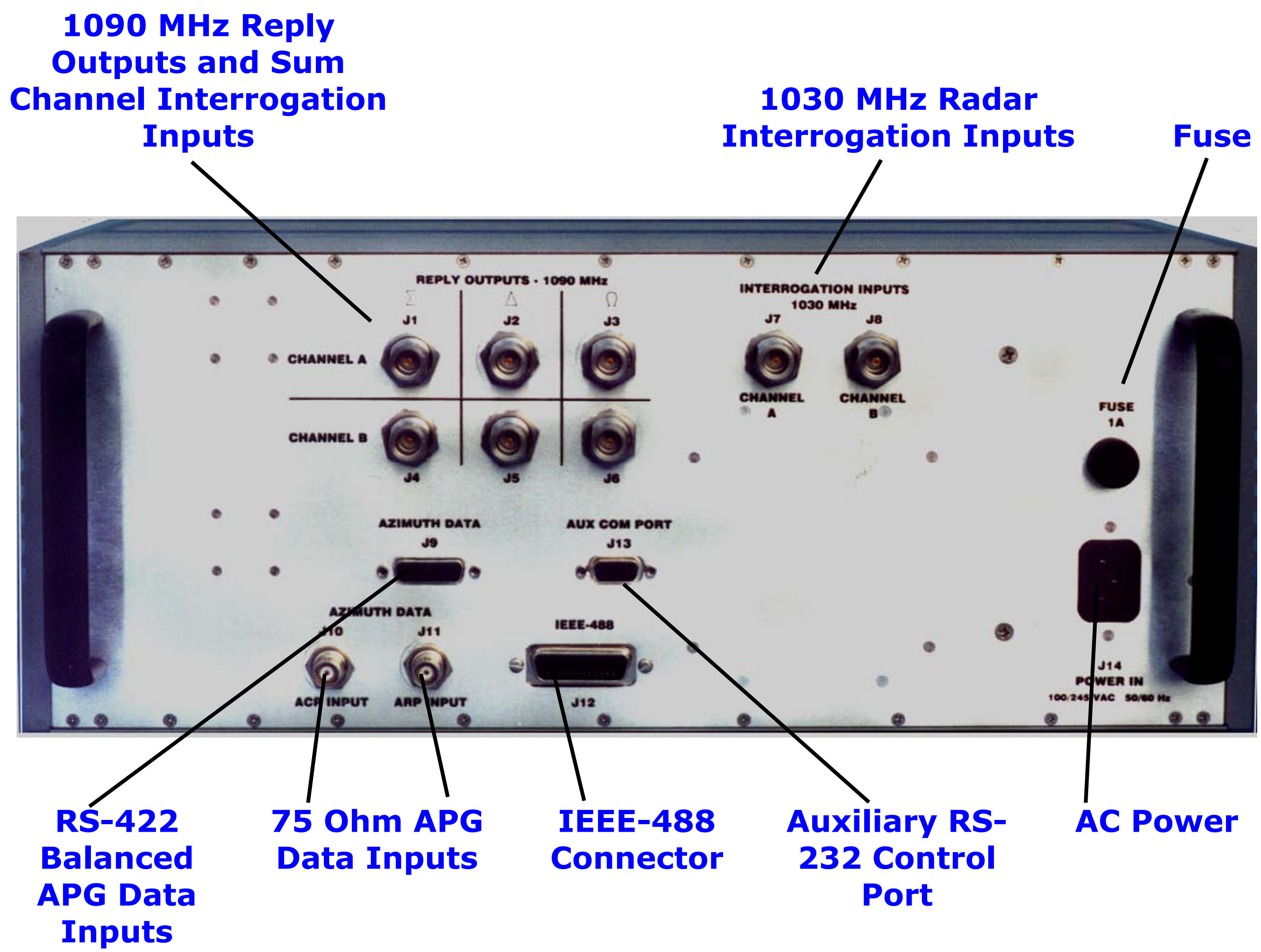


Figure 41 PCC Module Front Panel Connectors

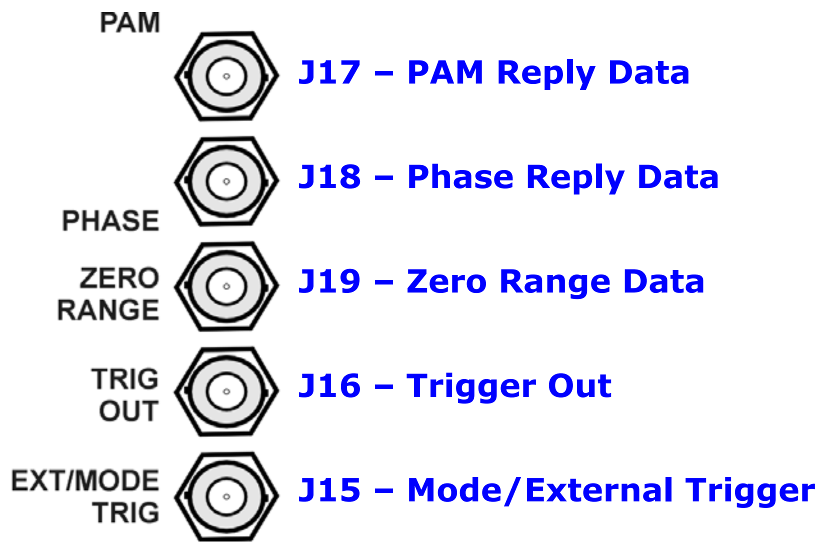


Table 16. J15 – Mode/External Trigger

Connector Name	Mode/External Trigger
Connector Reference Designator	J15
Connector Location	PCC Module Front Panel Connectors
Connector Type	BNC
Signal Description	Trigger signal input for target reply generation
VSWR/Impedance	75 Ohm
Input Level	TTL Compatible, Trigger occurs on rising edge of input pulse, or per ATCRBS Mode Pair specifications
Pulse Width/Timing	Pulse width = 0.1 μSec, minimum; ATCRBS Mode Pair specifications applicable to all Mode Pair trigger signals
Signal Frequency	Up to 3000 trigger signals per second

Table 17. J16 – Trigger Out

Connector Name	Trigger Out
Connector Reference Designator	J16
Connector Location	PCC Module Front Panel Connectors
Connector Type	BNC
Signal Description	Trigger output pulse created by MBTS in response to every valid trigger signal
VSWR/Impedance	75 Ohm
Output Level	TTL Compatible
Signal Frequency	At the rate of detected triggers, pulse width user variable from 0.1 to 5.0 μSec

Table 18. J17 – PAM Reply Data

Connector Name	PAM Reply Data
Connector Reference Designator	J17
Connector Location	PCC Module Front Panel Connectors
Connector Type	BNC
Signal Description	Pulse amplitude modulating sequence applied to target reply circuits of the MBTS
VSWR/Impedance	75 Ohm
Output Level	TTL Compatible, low enable
Pulse Width/Timing	Set by ATCRBS and Mode S data specifications, operator variable pulse width and pulse timing

Table 19. J18 – Phase Reply Data

Connector Name	Phase Reply Data
Connector Reference Designator	J18
Connector Location	PCC Module Front Panel Connectors
Connector Type	BNC
Signal Description	Phase modulating signal applied to the target reply circuits of the MBTS
VSWR/Impedance	75 Ohm
Input Level	Not Applicable
Output Level	TTL Compatible, TTL 1 = 0º Sum/Delta phase, TTL 0 = 180º Sum/Delta phase
Signal Frequency	Data rate dependent upon reply requirements

Table 20. J19 – Zero Range Data

Connector Name	Zero Range Data
Connector Reference Designator	J19
Connector Location	PCC Module Front Panel Connectors
Connector Type	BNC
Signal Description	Zero range marker of RF target reply signal, Target range delay begins coincident with this signal
VSWR/Impedance	75 Ohm
Input Level	Not Applicable
Output Level	TTL Compatible, rising edge indicates zero range of target reply
Signal Frequency	Data rate and signal timing dependent upon reply requirements

Table 21. J1 - SUM Channel A Target Reply Output (and SUM Channel A Radar Interrogation Input)

Connector Name	1090 MHz Target Reply Output, Sum Channel A (and 1030 MHz Radar Interrogation Input, Sum Channel A)
Connector Reference Designator	J1
Connector Location	MBTS Rear Panel
Connector Type	"N"
VSWR/Impedance	1.5:1 maximum, 50 Ohms
Interrogation Input Level	+27 dBm to +47 dBm, peak, 1030 MHz
Reply Output Level	Adjustable, -85 dBm to +10 dBm
Output Signal Frequency	1090 MHz nominal, 1080 MHz to 1100 MHz, adjustable in 200 kHz increments

Table 22. J2 - DELTA Channel A Target Reply Output

Connector Name	1090 MHz Target Reply Output, Delta Channel A
Connector Reference Designator	J2
Connector Location	MBTS Rear Panel
Connector Type	"N"
VSWR/Impedance	1.5:1 maximum, 50 Ohms
Input Level	Not Applicable
Reply Output Level	Adjustable, less than -110 dBm to +16 dBm
Signal Frequency	1090 MHz nominal, 1080 MHz to 1100 MHz, adjustable in 200 kHz increments

Table 23. J3 - OMNI Channel A Target Reply Output

Connector Name	1090 MHz Target Reply Output, Omni Channel A
Connector Reference Designator	J3
Connector Location	MBTS Rear Panel
Connector Type	"N"
VSWR/Impedance	1.5:1 maximum, 50 Ohms
Input Level	Not Applicable
Reply Output Level	Adjustable, less than -100 dBm to -10 dBm
Signal Frequency	1090 MHz nominal, 1080 MHz to 1100 MHz, adjustable in 200 kHz increments

Table 24. J4 - SUM Channel B Target Reply Output (and SUM Channel B Radar Interrogation Input)

Connector Name	**1090 MHz Target Reply Output, Sum Channel B (and 1030 MHz Radar Interrogation Input, Sum Channel B)**
Connector Reference Designator	J4
Connector Location	MBTS Rear Panel
Connector Type	"N"
VSWR/Impedance	1.5:1 maximum, 50 Ohms
Interrogation Input Level	+27 dBm to +47 dBm, peak, 1030 MHz
Reply Output Level	Adjustable, -85 dBm to +10 dBm
Signal Frequency	1090 MHz nominal, 1080 MHz to 1100 MHz, adjustable in 200 kHz increments

Table 25. J5 - DELTA Channel B Target Reply Output

Connector Name	1090 MHz Target Reply Output, Delta Channel B
Connector Reference Designator	J5
Connector Location	MBTS Rear Panel
Connector Type	"N"
VSWR/Impedance	1.5:1 maximum, 50 Ohms
Input Level	Not Applicable
Reply Output Level	Adjustable, less than -110 dBm to +16 dBm
Signal Frequency	1090 MHz nominal, 1080 MHz to 1100 MHz, adjustable in 200 kHz increments

Table 26. J6 - OMNI Channel B Target Reply Output

Connector Name	1090 MHz Target Reply Output, Omni Channel B
Connector Reference Designator	J6
Connector Location	MBTS Rear Panel
Connector Type	"N"
VSWR/Impedance	1.5:1 maximum, in/out, 50 Ohms
Input Level	Not Applicable
Reply Output Level	Adjustable, less than -100 dBm to -10 dBm
Signal Frequency	1090 MHz nominal, 1080 MHz to 1100 MHz, adjustable in 200 kHz increments

Table 27. J11 - 75 Ohm Azimuth ARP Input

Connector Name	75 Ohm ARP Input
Connector Reference Designator	J11
Connector Location	MBTS Rear Panel
Connector Type	BNC
VSWR/Impedance	75 Ohm
Input Level	TTL
Signal Frequency	Variable, 1 pulse per antenna revolution (Antenna rotation rate within 4 to 15 RPM)

Table 28. MBTS Trouble Diagnostics

Indicated Problem	Problem Area	Suggestions
REF PLL alone or if any other PLL indicators active	Reference Source Module If no other PLL issues indicated, the LO circuit is problematic. If multiple PLL faults indicated, the crystal oscillator or output buffer is problematic.	Replace Reference Source Module
RGC PLL	Reply Generator Module PLL circuit If no other PLL issues indicated This condition may cause many other fault conditions	Replace Reply Generator Module Check Reference Signal into the module
IDR_PLL	IDR Module PLL circuit If no other PLL issues indicated	Replace IDR Module Check Reference Signal into the module
1100BIT PLL	BIT Module 1100 MHz PLL circuit If no other PLL issues indicated	Replace BIT Module Check Reference Signal into the module
70BIT PLL	BIT Module 70 MHz PLL circuit If no other PLL issues indicated	Replace BIT Module Check Reference Signal into the module
BIT Pwr Alarm	One of the three power supply voltages is non-compliant This condition may cause many other fault conditions	Check displayed power supply voltage measurements Replace appropriate Power Supply
BIT Temp Alarm	Internal temperature of MBTS is out-of-specification	Turn off MBTS. Do not operate until ambient conditions are within +10ºC and +50ºC.
Cal Failed	MBTS output level could not be properly calibrated MBTS may operate but not with specified output level accuracy	Check ambient temperature Check MBTS Calibration (see Section 5.1.2)

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Table 28. MBTS Trouble Diagnostics (cont)

Indicated Problem	Problem Area	Suggestions
Fan Failed	Fan has stopped rotating	Replace Fan Check wiring to Fan The MBTS should not be operated for more than fifteen minutes at a time with this failure
ANT ROT Alarm	The antenna rotation rate is higher or lower than expected	Check the APG Input & Type selections Check the APG signals into the MBTS Disable the Antenna Alarm
APG Alarm	Data from the APG source is not as required	Check the APG Input & Type selections Check the APG signals into the MBTS Disable the Antenna Alarm
DUP Atten	Attenuator circuit within the Delta Channel Upconverter	Note if ADS Atten fault exists. If so check this fault first Replace Delta Channel Upconverter
OUP Atten	Attenuator circuit within the Omni Channel Upconverter	Note if TGT Atten fault exists. If so check this fault first Replace Omni Channel Upconverter
SUP Atten	Attenuator circuit within the Sum Channel Upconverter	Note if SO Atten fault exists. If so check this fault first Replace Sum Channel Upconverter
TGT Atten	Target Level Attenuator circuit within the Reply Generator This condition may cause many other fault conditions	A) Verify attenuator performance at the Omni Upconverter 70 MHz test port Replace the Reply Generator Module B) Verify 32 dB gain step in Sum Channel Upconverter Replace the Reply Generator Module

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Table 28. MBTS Trouble Diagnostics (cont)

Indicated Problem	Problem Area	Suggestions
SO Atten	Sum/Omni Attenuator circuit within the Reply Generator This condition may cause many other fault conditions (TGT Atten and OUP Atten may be OK)	Verify attenuator performance at the Sum Upconverter 70 MHz test port Replace the Reply Generator Module
DS Atten	Delta/Sum Attenuator circuit within the Reply Generator This condition may cause many other fault conditions (TGT Atten, OUP Atten, SO Atten, and SUP Atten may be OK)	Verify attenuator performance at the Sum Upconverter 70 MHz test port Replace the Reply Generator Module
ADS Atten	Aux Delta/Sum Attenuator within the Reply Generator Applies to the Sum and Omni channels outputs	Verify which attenuator section is faulty; at the Sum Upconverter 70 MHz test port, or Omni Upconverter 70 MHz test port Replace the Reply Generator Module
Phase Att	Phase Modulator circuit within the Reply Generator Module	Check Delta/Sum phase at output of MBTS Replace the Reply Generator Module
PAM Atten	Pulse Amplitude Modulator circuit within the Reply Generator Module	Check operation of circuit at rear panel of MBTS Replace the Reply Generator Module
XILINX Load Status	Xilinx or Flash ROM of PCC Module	Reprogram Flash ROM of PCC Module Replace PCC Module
Flash CAL Status	Flash ROM of PCC Module	Reprogram Flash ROM of PCC Module Replace PCC Module
BER Reply Status	Should never be problematic	Rerun test process

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Table 28. MBTS Trouble Diagnostics (cont)

Indicated Problem	Problem Area	Suggestions
BER Inter Status	Interrogation Demodulation Circuits	Check IDR data outputs Replace IDR Module Check PCC operation with Mode Pair Triggers Replace PCC Module
XILINX Status	Xilinx used in PCC Module	Replace PCC Module
Cal Flash Status	Flash ROM of PCC Module	Retest Reprogram Flash ROM Replace PCC Module
Prog ROM Status	Flash ROM of PCC Module	Retest Reprogram Flash ROM Replace PCC Module