DESCRIPTION

1 INTRODUCTION

The Motorola MTR2000 Base Station / Repeater provides analog conventional and trunking capabilities in a reliable, software-controlled design. An innovative modular design and microprocessor-controlled Station Control Module (SCM) allows for superior station flexibility and simplified system upgrades.

Note

<u>All of the features described in this manual may not be currently supported</u>. Refer to the "Summary of Operating Features" section for a list of standard features, optional features, and planned future features.

Flexible Mechanical Design

All elements of the station are designed for EIA 48.3cm (19") rack mounting, allowing the equipment to be mounted in standard telephone-style equipment racks, or various sizes of Motorola cabinets. Figure 1 shows a typical 40W station.

Figure 1. MTR2000 Station

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11/28/03-UP

Electrical Design

Transmitter Circuitry

The station transmitter circuitry is designed for continuous duty operation and may be operated at full rated power. Output power is continually monitored by an internal directional coupler. The forward power voltage from the coupler feeds a power control loop which continually adjusts and maintains the desired output power. All adjustments are electronic, including deviation and output power.

Receiver Circuitry

The station receiver circuitry features multiple bandwidth (12.5kHz, 20kHz, 25kHz, and 30kHz) capability. Injection signals for the first and second mixers are generated by frequency synthesizer circuitry electronically controlled by the Station Control Module. All receive signals (analog) are detected and digitized before being sent to the Station Control Module, providing improved, consistent audio quality throughout the coverage area.

Station Control Module

The Station Control Module is microprocessor-based and features extensive use of ASIC and digital signal processing technology. The module serves as the main controller for the station, providing signal processing and operational control for the station modules.

Wireline Circuitry

The station wireline circuitry options provide a wide variety of telephone interfaces and control mechanisms such as Tone Control. Telephone line connections are easily made to the wireline circuitry via connectors on the rear of the station.

Trunking Capability

When equipped for trunking capability, the station can operate in Motorola's Smartnet™ or the most advanced wide-area trunking system – *SmartZone*. The station can operate as a remote voice channel or control channel repeater. The station interfaces to a Trunking Central Controller (TCC) which provides the call processing and channel assignment tasks.

Summary of Operating Features

Standard Features

The following are a few of the standard features:

- FRU maintenance philosophy (reducing down time).
- Easily programmed via Radio Service Software (RSS).
- Extensive Self-Test Diagnostics and Alarm Reporting through RSS.
- Expansion and upgrades performed by module replacement.
- Highly reliable and accurate continuous duty transmitter circuitry.
- Compatible (with appropriate options) with conventional analog signaling.
- Wide operating temperature range: -30°C to +60°C (-22°F to +140°F).
- Battery Backup Connector – allows connection to battery backup system which automatically reverts to battery backup operation in the event of ac power failure.
- RA/RT
- Wide voltage supply range (AC or DC), with no setup configuration.

Optional Features

The following are some of the leading optional features for the station:

- Double Circulator Option – provides additional isolation and intermodulation protection for rf-congested transmitter sites (not available on 350MHz stations).
- Microprocessor Radio Telephone Interconnect (MRTI) – allows connection of conventional station to the telephone network.
- 6809 Trunking – allows trunking repeater to operate as part of a *Smartnet* or *SmartZone* system; through Auxiliary I/O board (CLN1206).
- Wildcard Input/Output; through Auxiliary I/O board (CLN1206).
- Main Standby; through Auxiliary I/O board (CLN1206).
- Multi-coded Squelch Interface; through Zetron Model 38 Repeater Panel.
- Console Priority Interface; through 8-Wire Wireline Interface Board (CLN1205).
- Auxiliary Input/Output for conventional operation; through Auxiliary I/O board (CLN1206).

Features Not Offered

Please disregard any references to the following **items** since they are **not available for the MTR2000:**

- DC Remote control for the 4-wire Wireline Interface Board, CLN1203.
- Second Receiver configuration of the MTR2000.

2 STATION COMPONENTS

Figure 2 shows the modules and components that comprise a station.

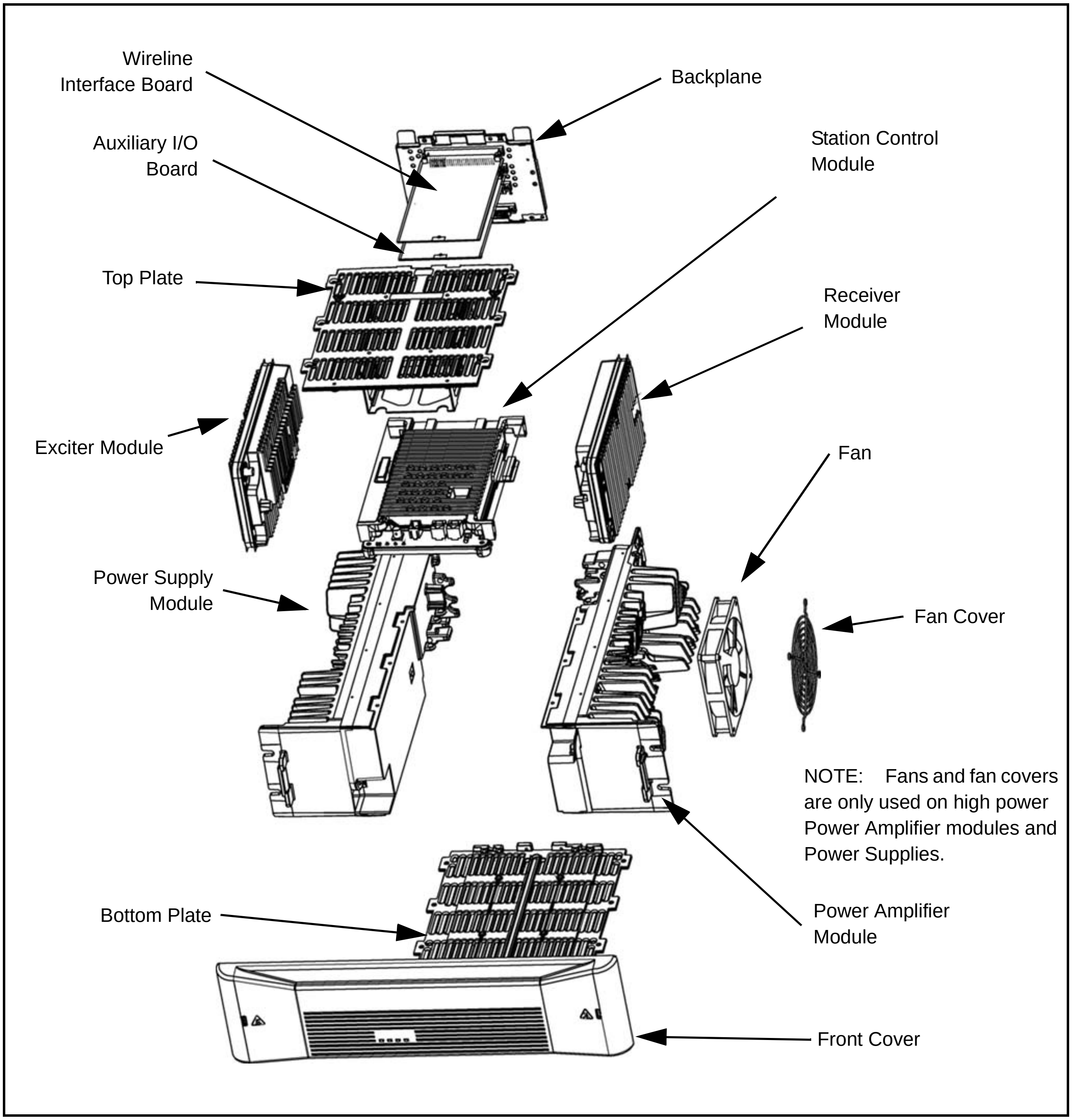

Figure 2. MTR2000 Station Components

3 FUNCTIONAL THEORY OF OPERATION

The following functional theory of operation provides an overview of the station circuitry. For a more thorough functional description of a particular module, refer to the STATION MODULES section of the appropriate band-specific Instruction Manual. The block diagram in Figure 3 supports the following functional theory of operation.

Transmitter Circuitry Operation

Introduction

The Transmitter Circuitry comprises two modules, the Exciter Module and the Power Amplifier (PA) Module. These modules combine to generate, modulate, and amplify the rf signal which is transmitted via the site transmit antenna. Modulation sensitivity and power output are adjusted electronically for each channel (through the Radio Service Software), under the direct control of the Station Control Module (SCM).

Exciter Module Operation

The Exciter Module, which interfaces directly to the SCM, generates a modulated rf signal at the desired transmit frequency and sends this signal to the PA for amplification. The circuitry operates as follows.

The transmit synthesizer and VCO (voltage-controlled oscillator) circuitry on the Exciter Module accept frequency programming data from the SCM (via the SPI bus) and generate an rf carrier at the specified frequency. The VCO is directly modulated by transmit audio / data from the SCM. The resulting modulated rf signal (at a level of approximately +12 dBm) is then fed to the PA.

Power Amplifier Module Operation

The PA modules are designed for continuous-duty operation across all bands and power levels. The actual circuit stages employed in a PA depend on the specific frequency band, power output level and intermodulation requirements. All PA modules contain an Intermediate Power Amplifier (IPA) at the input, a low-pass filter / directional coupler at the output, and diagnostic and power control circuitry.

High power (100 W) PA modules employ a single internal circulator to protect the PA from transmitter intermodulation and antenna mismatch (VSWR). The low power 30 W PA module employs two internal circulators. All PA stages and circulators are broad-band devices and require no tuning to operate at the station site.

The modulated rf signal from the Exciter Module is input to the IPA in the PA Module, and amplified to within a range of 0 to 10 W (depending on power control signals from the SCM). In PA Modules operating below 600 MHz, the rf signal is fed to either a Butterfly Module (30W / 40 W PA models) or a Dual Device Module (DDM – 100 W PA models). In PA Modules operating above 600 MHz, a 15 W driver is introduced between the Pre-driver stage and the Final Module. The gain of the Pre-driver stage is controlled by a power control voltage which is derived from power control signals (from the SCM) and high VSWR / thermal protection circuitry on the PA output board.

A combination of hardware and software controls are used to regulate the power output level. To set the power and current limits, the SCM provides software control through a D / A converter connected to the SPI bus. This control relies on various monitored PA signals which are fed back to the SCM via an A / D converter (also connected to the SPI bus).

The directional coupler is essentially a calibrated wattmeter which feeds a dc voltage proportional to the output power to the power control circuitry to serve as the feedback signal in the power control loop. Under normal operating conditions, the power control circuitry compares this dc voltage from the directional coupler to a reference voltage from the D / A converter which represents the desired output power. Based on the comparison, a power control voltage is generated to control the output power from the PA Module.

The modulated rf signal is amplified by the Driver / Final Module and is output to the site transmit antenna via a circulator and a harmonic filter / coupler. During excessive output VSWR, the ratio of the forward and reflected voltages from the directional coupler may be used to reduce, or turn off, the transmitter power. Additional circuitry is also provided to reduce output power during excessive current drain and high temperature conditions, and to control the fan used in high power PA Modules.

Receiver Circuitry Operation

Introduction

The Receiver Circuitry accepts receive rf signals from the site receive antenna, performs filtering and dual conversion, and outputs a digitized receive signal to the Station Control Module. The receiver module utilized may have either an internal varactor-tuned preselector filter, or an external metal preselector filter.

Receiver Module Operation

The receive signal is input from the site receive antenna to the receiver module, or to an external preselector filter (a separate assembly attached to the rear of the station which provides highly selective bandpass filtering). The signal is fed through a low-pass filter, varactor-tuned preselector (if external preselector is not used), rf amplifier and image filter to the rf input of the first mixer. The filtered signal is mixed with an injection signal generated by the receive synthesizer / VCO, resulting in a first i-f (intermediate frequency) signal. The injection signal frequency is determined by frequency programming data from the Station Control Module via the SPI bus. The specific frequency of the first i-f depends on the frequency band of the station.

The first i-f signal is filtered and input to a custom receiver IC. This component contains circuitry for generating the second injection signal, mixing down the first i-f to 450 KHz, amplification and A / D (analog-to-digital) conversion of the second i-f signal, resulting in a digitized receive signal. This signal is fed as differential data to the Station Control Module.

Station Control Module Operation

Introduction

The Station Control Module (SCM) is the microprocessor-based controller for the station. Major components include an MC68356 microprocessor, which combines a 68302 Integrated Multiprotocol Processor (IMP) with a 56002 Digital Signal Processor (DSP), a DSP ASIC device, and several Codec filter devices.

Station Control Module Operation

The MC68356 forms the heart of the SCM. The 68302 portion is the Host Microprocessor (µP), which serves as the controller for the SCM and operates from station software stored in FLASH memory. This software determines the system capabilities of the station. The Host µP communicates with the station modules and the SCM circuitry via address and data buses, three SCI (Serial Communication Interface) ports, and an SPI bus.

The DSP portion of the MC68356, with the support of the DSP ASIC, perform the necessary digital processing for the station audio and data signals. The DSP circuitry interfaces with the Receiver Module (receive audio), the Exciter Module (VCO modulation signal), the Wireline Interface Board (wireline audio), and external audio devices (microphone and speaker).

The 2.1 MHz Reference Oscillator generates the reference signal used by the Receiver and Exciter Modules.

Wireline Interface Board Operation

Introduction

The Wireline Interface Board (WIB) serves as the interface between the customer analog telephone lines and the serial data signals of the station. WIBs are offered to handle 2-wire, 4-wire and 8-wire configurations. In general, the WIB processes and routes all wireline audio signals between the station and the landline equipment (such as consoles, modems, etc.). Landline-to-station and station-to-landline audio signals are connected to the WIB via copper pairs at the rear of the station.

Wireline Interface Board Operation

The WIB contains a PCM Codec-filter device to perform the audio digitization and reconstruction, as well as the band-limiting and smoothing required by PCM systems. Analog signals are routed as follows:

- Inbound analog signals are converted to digital signals and routed to the SCM as wireline transmit data (WL TxD).
- Outbound PCM data signals are converted to analog signals and routed to the Line 2 output.
- A latch receives control signals from the SCM (via the SPI bus) to control the gating of the audio signals.

Note

For a list of the actual features supported, refer to the "Summary of Operating Features" on page 3, or the MTR2000 System Planner.

Auxiliary I/O Board Operation

Introduction

The Auxiliary I/O Board serves as the interface between the customer auxiliary equipment and the Station Control Module (SCM). In general, the Auxiliary I/O Board routes all auxiliary equipment control signals between the SCM and the auxiliary equipment (e.g., a trunking controller).

Auxiliary I/O Board Operation

The Auxiliary I/O Board contains SPI Input Buffers and associated circuitry which provides an input signal path from auxiliary equipment to the station SCM.

The input circuitry supports 16 general purpose inputs:

- 14 are transistor buffered inputs; 16V maximum, 10kΩ.
- 2 are opto isolated inputs; 60mA forward current, 3V dropout voltage, 2kV isolation.

The Auxiliary I/O Board contains SPI Output Latches and associated circuitry which provides an output signal path from the station SCM to auxiliary equipment.

The output circuitry supports 16 general purpose outputs:

- 14 are open collector transistor outputs; maximum 400V, 50mA sink current
- 2 are dry contact outputs (relay); maximum 250V, 1A)

Power Supply Module Operation

Power Supply Modules are offered to handle:

- ac or dc input power
- low power (250W) or high power (500W) station requirements

A high power Power Supply Module (500W) is used in a station with a high power Power Amplifier Module (e.g., rated at 100W or 75W output power).

A low power Power Supply Module (250W) is used in a station with a low power Power Amplifier Module (e.g., rated at 40W output power), or if the station is configured as a Satellite Receiver.

ac Input Power

The 250W models generates the +5.1V and +14.2V operating voltages for the station modules.

The 500W models generates the +5.1V, +14.2V, and +28V operating voltages for the station modules.

These modules include a connection for battery backup.

The 250W and 500W ac input Power Supply Modules are switching-type power supplies.

Power Supply Module CLN1221 supports all MTR2000 low power stations. These modules accept an ac input: of: 85 to 264Vac, 47 to 63 Hz. No Power Factor Correction choke is required for low power stations.

Power Supply Module CLN1220 supports MTR2000 high power stations installed outside of the European Union (and within the European Union prior to January 1, 2001). These modules accept an ac input: of: 85 to 264Vac, 47 to 63 Hz.

Power Supply Module DLN6458 supports MTR2000 high power stations installed in European Union (EU) countries after January 1, 2001. This module operates in conjunction with a Power Factor Correction choke and accepts an ac input: of: 180 to 264Vac, 47 to 63 Hz.

dc Input Power

The 250W dc-only Power Supply Module accepts a dc input (10.8 to 16Vdc). The output voltages are:

- the input filtered voltage.
- a regulated 5.1 Vdc.

The 500W dc-only Power Supply Module is a switching-type power supply which accepts a dc input (21 to 32Vdc).

The output voltages are:

- the input filtered voltage.
- a regulated 5.1 Vdc.
- a regulated 14.2 Vdc.

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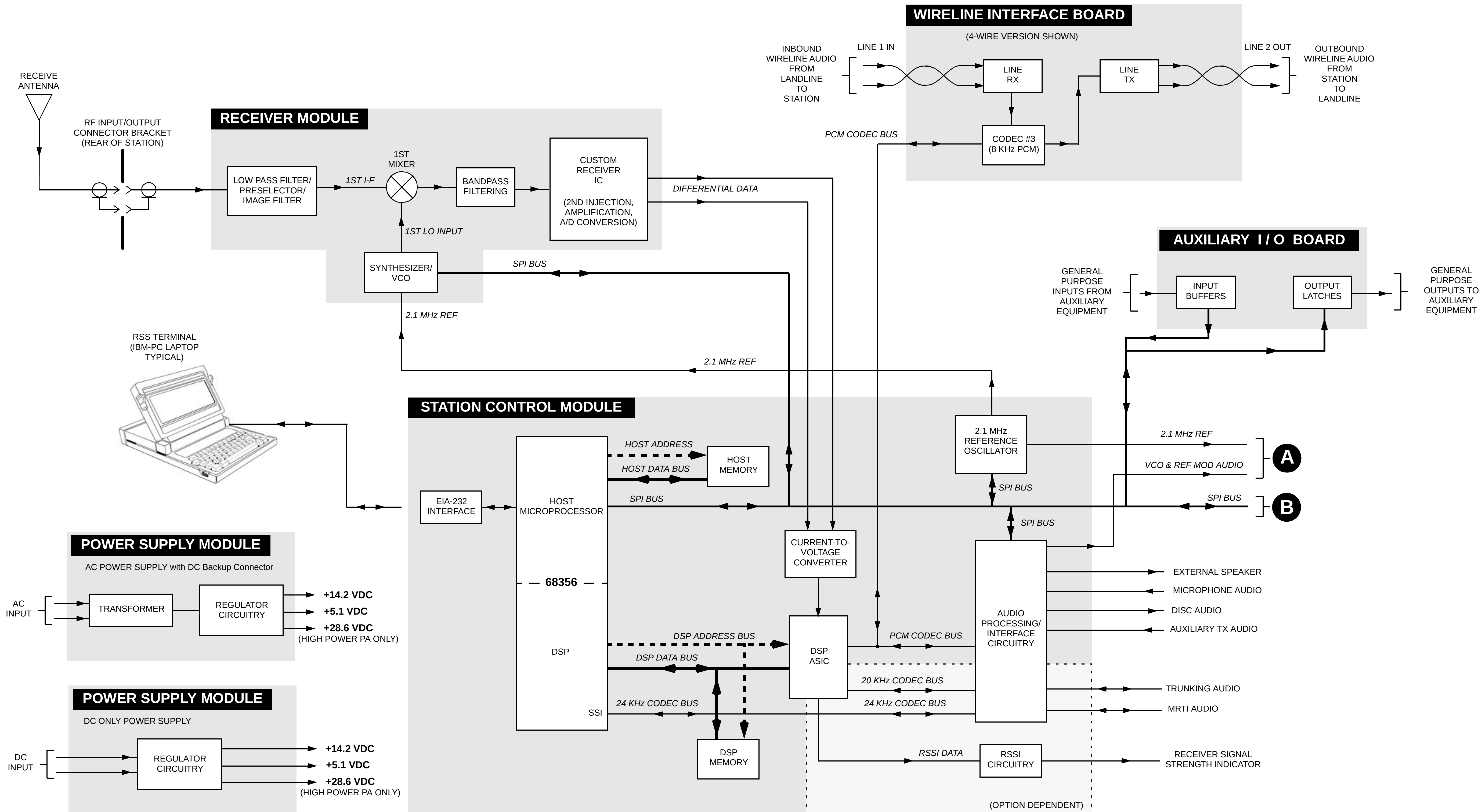

Figure 3. MTR2000 Station Functional Block Diagram (Sheet 1 of 2)

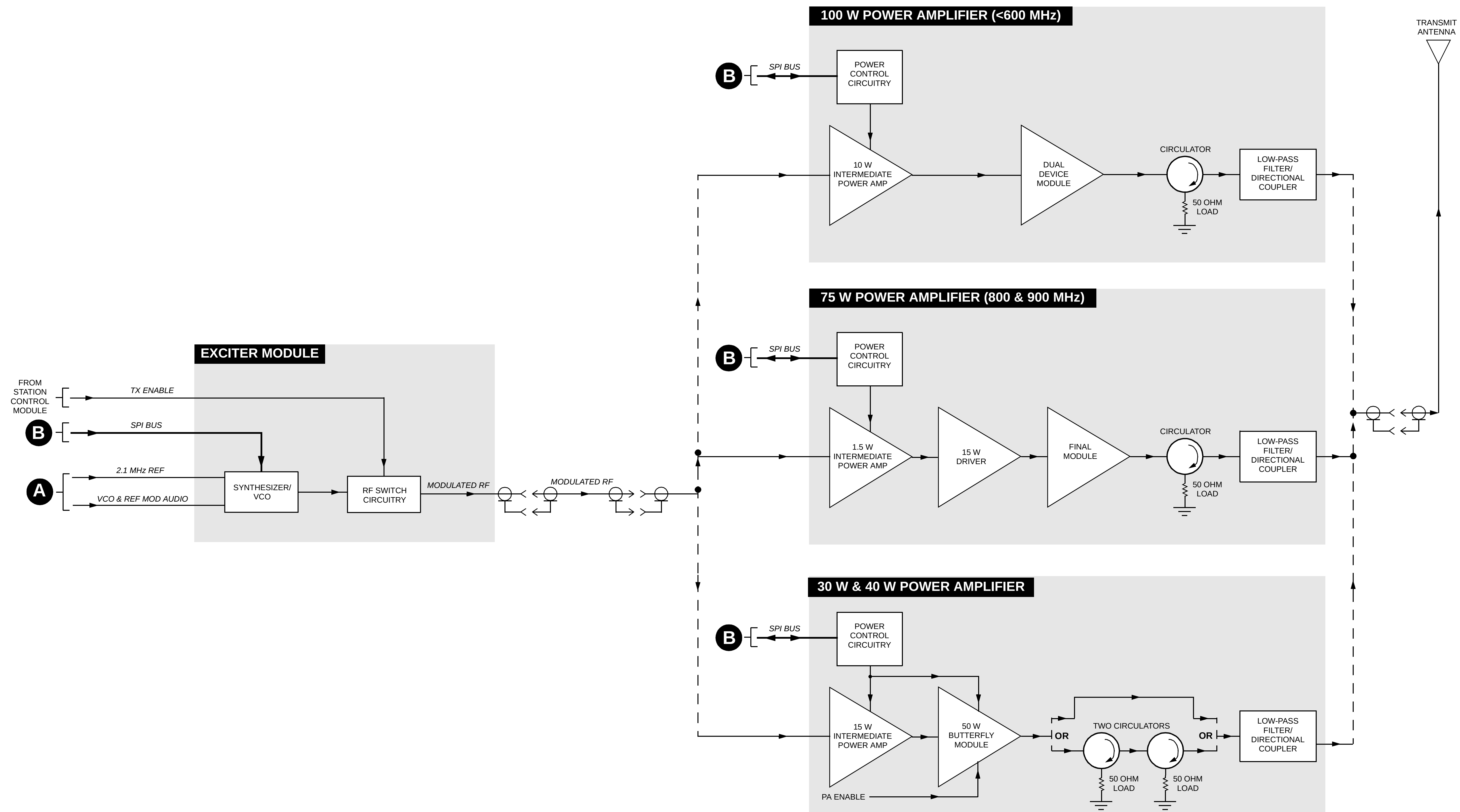

Figure 3. **MTR2000 Station Functional Block Diagram (Sheet 2 of 2)**