MOTOROLA

EXCITER BOARD

MODELS TLD9831A-D (132–154 MHZ)
TLD9832A-D (150–174 MHZ)
CLX4000A (380–433 MHz)
TLE5971A-F (403–433 MHZ)
TLE5972A-F (438–470 MHZ)
TLE5973A-F (470–494 MHz)
TLE5974A-F (494–520 MHz)
TLF6920A-G (850–870 MHZ)
TLF6930A-G (935–941 MHz)

1 DESCRIPTION

The TLD9831A/32, CLX4000A, TLE5971 thru 74, TLF6920, and TLF6930 Exciter Boards are described in this section. A general description, identification of controls, indicators, and inputs/outputs, a functional block diagram, and functional theory of operation are provided. The information provided is sufficient to give service personnel a functional understanding of the module, allowing maintenance and troubleshooting to the module level. (Refer also to the Maintenance and Troubleshooting section of this manual for detailed troubleshooting procedures for all modules in the station.)

General Description

The Exciter Board (in conjunction with the Power Amplifier Module) provides the transmitter functions for the *Quantar* and *Quantro* stations. Contained within a slide–in module housing, the exciter board generates a low–level modulated rf signal which is input to the power amplifier module for further amplification and output to the transmit antenna.

These Exciter Boards differ only in the range of operation, as shown in the title of this section. Unless otherwise noted, the information provided in this section applies to all models.

Overview of Circuitry

The exciter board contains the following circuitry:

- Microprocessor — serves as the main controller for the exciter board; provides control, monitoring of signals, and interfaces with the Station Control Module microprocessor over a serial bus
- Frequency Synthesizer Circuitry— consisting of a phase–locked loop and VCO, generates a modulated rf signal at the transmitter carrier frequency
- Transmitter Power Control — generates a dc control voltage which controls the output power of the power amplifier module
- RF Switch — allows the microprocessor to turn on/off the exciter output signal to the power amplifier module

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2 CONTROLS, INDICATORS, AND INPUTS/OUTPUTS

Figure 1 shows the exciter module controls, indicators, and all input and output external connections.

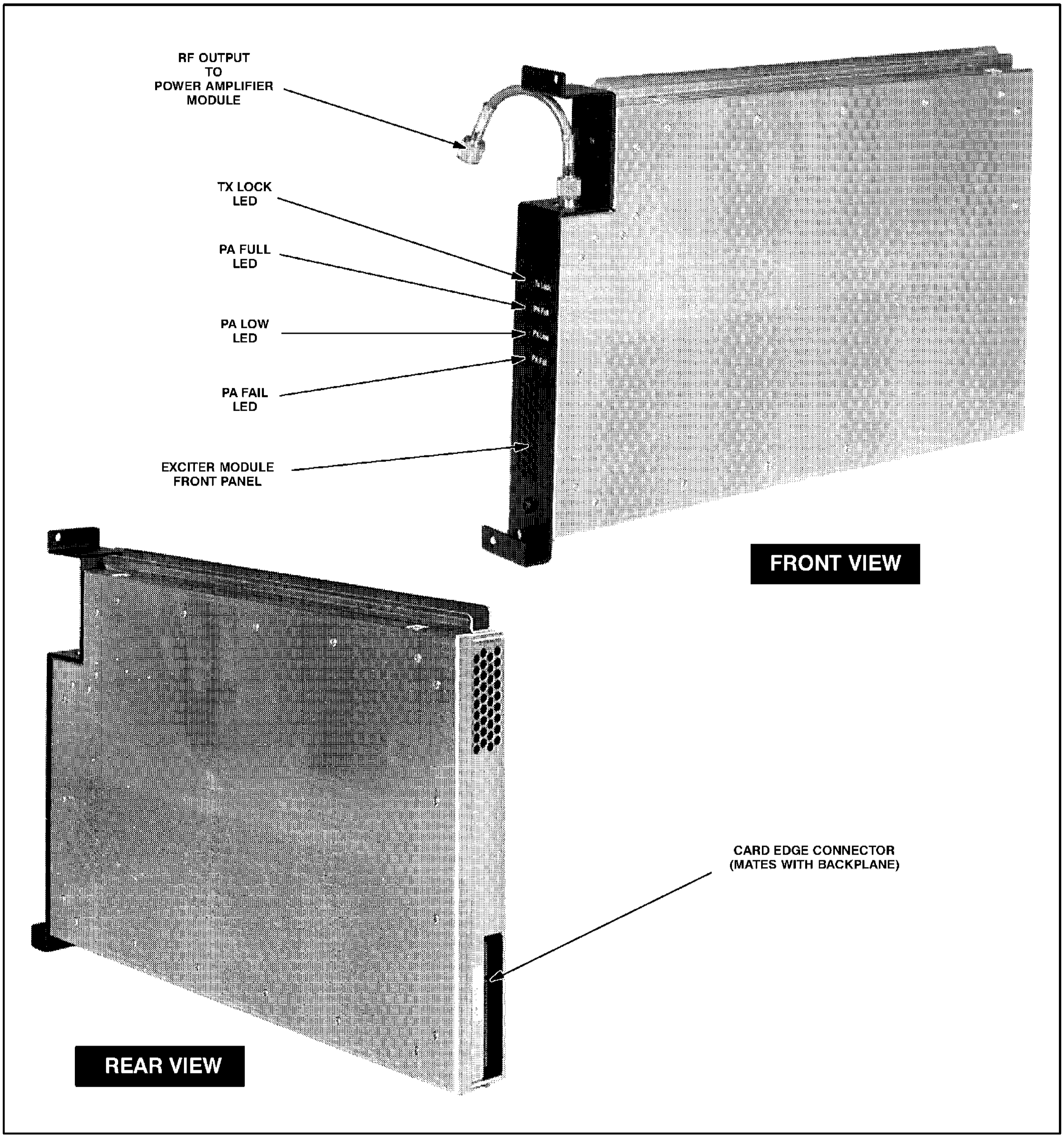

Figure 1. Exciter Module Controls, Indicators, and Inputs/Outputs

3 FUNCTIONAL THEORY OF OPERATION

The following theory of operation describes the operation of the exciter circuitry at a functional level. The information is presented to give the service technician a basic understanding of the functions performed by the module in order to facilitate maintenance and troubleshooting to the module level. Refer to Figure 2 for a block diagram of the exciter module.

Synthesizer and VCO Circuitry

Introduction

As mentioned previously, the exciter module generates a low–level modulated rf signal which is input to the power amplifier module. The rf carrier is generated by a frequency synthesizer consisting of synthesizer circuitry and VCO circuitry. Functional operation of these circuits is as follows.

Phase–Locked Loop

The phase–locked loop (PLL) IC receives frequency selection data from the microprocessor. Once programmed, the PLL IC compares a 2.1 MHz reference signal (from the Station Control Module) with a feedback sample of the VCO output. Depending on whether the feedback signal is higher or lower in frequency than the 2.1 MHz reference, correction pulses are generated. (The width of these correction pulses is dependent on the amount of difference between the 2.1 MHz reference and the VCO feedback.)

The up/down pulses from the PLL IC are fed to a charge pump which outputs a dc voltage proportional to the pulse widths. This dc voltage is then low–pass filtered and fed to the VCO as the *CONTROL VOLTAGE*. (Note that if a frequency change is requested by the microprocessor, the low–pass loop filter is momentarily bypassed to accelerate the frequency change.)

VCO

Note: *800 MHz and 900 MHz Exciter Modules have only one VCO which operates over the entire 900 MHz range.*

The dc control voltage from the synthesizer is fed to dual VCOs which generate the rf carrier signal. Within each band (VHF–R1, R2, UHF–R0, R1, R2, R3, R4, and 800 MHz), one VCO generates signals in the upper half of the band, while the other VCO generates signals in the lower half of the band. Only one VCO is active at a time. Selection of the active VCO is provided by a *BANDSHIFT* signal from the PLL IC.

The active VCO responds to the dc control voltage and generates the appropriate rf signal. This signal is fed through impedance matching, amplification, and filtering and is output to the RF Switch Circuitry. A sample of the output is returned to the PLL IC to serve as a VCO feedback signal.

Synthesizer and VCO Circuitry (Continued)

Modulation

The active VCO receives an audio/data modulation signal from the Station Control Module via two low–pass filters. This modulation signal modulates the active VCO to produce a modulated low–level rf carrier signal.

Low–frequency modulation signals (below the loop filter corner) tend to be interpreted by the PLL as VCO frequency error. A modulation compensation signal is added to the PLL control voltage to cancel out this effect and allow for low frequency modulation.

RF Switch Circuitry

The modulated rf signal from the VCO is fed through an attenuator to an rf switch circuit. Signal *TX ENABLE* from the microprocessor controls the switch. The rf signal is output to a mini–UHF connector mounted in a recess in the module front cover. An rf cable connects the exciter output to the power amplifier module.

Microprocessor Circuitry

Introduction

The microprocessor (μP) serves as the main controller for the exciter module circuitry. The μP provides the following functions.

Communications with Station Control Module

Data communications between the exciter μP and the Station Control Module μP is performed via a serial peripheral interface (SPI) bus. This bus allows the SCM μP to interrogate the exciter μP (to obtain status and alarm information) and to issue commands to the exciter μP (to select frequency and output power). The SPI bus is also used to allow the exciter μP to send data to the synthesizer PLL IC (to select frequency) and the D/A Converter IC (to control output power).

Monitoring External Signals

The exciter μP accepts input signals from various sources, including portions of the exciter circuitry and from the power amplifier module. These signals are input to the μP through analog multiplexers where they are monitored. The levels on these status lines are used by the μP to control the operation of the exciter circuitry and to report to the SCM μP.

EPROM

The μP operating program and various algorithms for frequency and output power control are stored in an EPROM. The μP accesses the EPROM via an address bus and a data bus.

Microprocessor Circuitry (Continued)

Output Control Signals

Various output control signals from the μP are fed to latches via the data bus. These signals include *PA KEY, TX ENABLE*, and the control signals for the front panel LEDs. Other control signals are provided to portions of the exciter module circuitry, as well as to the Power Amplifier Module.

Exciter ID Resistor ROM

A resistor network ROM provides exciter ID information to the μP. This information defines in which band and range (e.g., VHF−Range 1, UHF, 900 MHz, etc.) the particular exciter is designed to operate.

Oscillator Circuitry

The clock signal for the μP is generated by internal circuitry and an external 8.0000 MHz crystal circuit.

TX Power Control Circuitry

A/D Converter

The TX Power Control Circuitry consists of an D/A converter and a custom Power Control IC. Upon station power−up, the exciter μP sends data to the D/A converter (via the SPI bus) to select the desired output power (in Watts) from the power amplifier. The D/A converter outputs a dc reference voltage proportional to the selected output power.

Power Control IC

The Power Control IC generates a dc power control voltage (V_CONT) which is fed to the power amplifier module to control the output power. A forward power detect (TX_VF) signal (dc voltage proportional to the output power from the power amplifier) is fed back to the Power Control IC. The Power Control IC compares the TX_VF signal with the POWER SELECT voltages from the A/D converter and adjusts V_CONT accordingly to obtain the selected output power. This “feedback and control loop” continually monitors the TX_VF signal and adjusts V_CONT to maintain a constant output power at the selected level.

Monitoring of Loop Status

A sample of the dc power control voltage (V_CONT) is fed back to the μP via the analog multiplexer to allow the μP to monitor the status of the power control loop. Inability of the power amplifier to output the selected power (as indicated by V_CONT going to the maximum level) results in the μP re−programming the A/D converter to select a lower output power level. If after two reductions in selected power the power amplifier still cannot output the selected power, the μP initiates “shut down” mode by selecting 0 Watts and turning the rf switch OFF.

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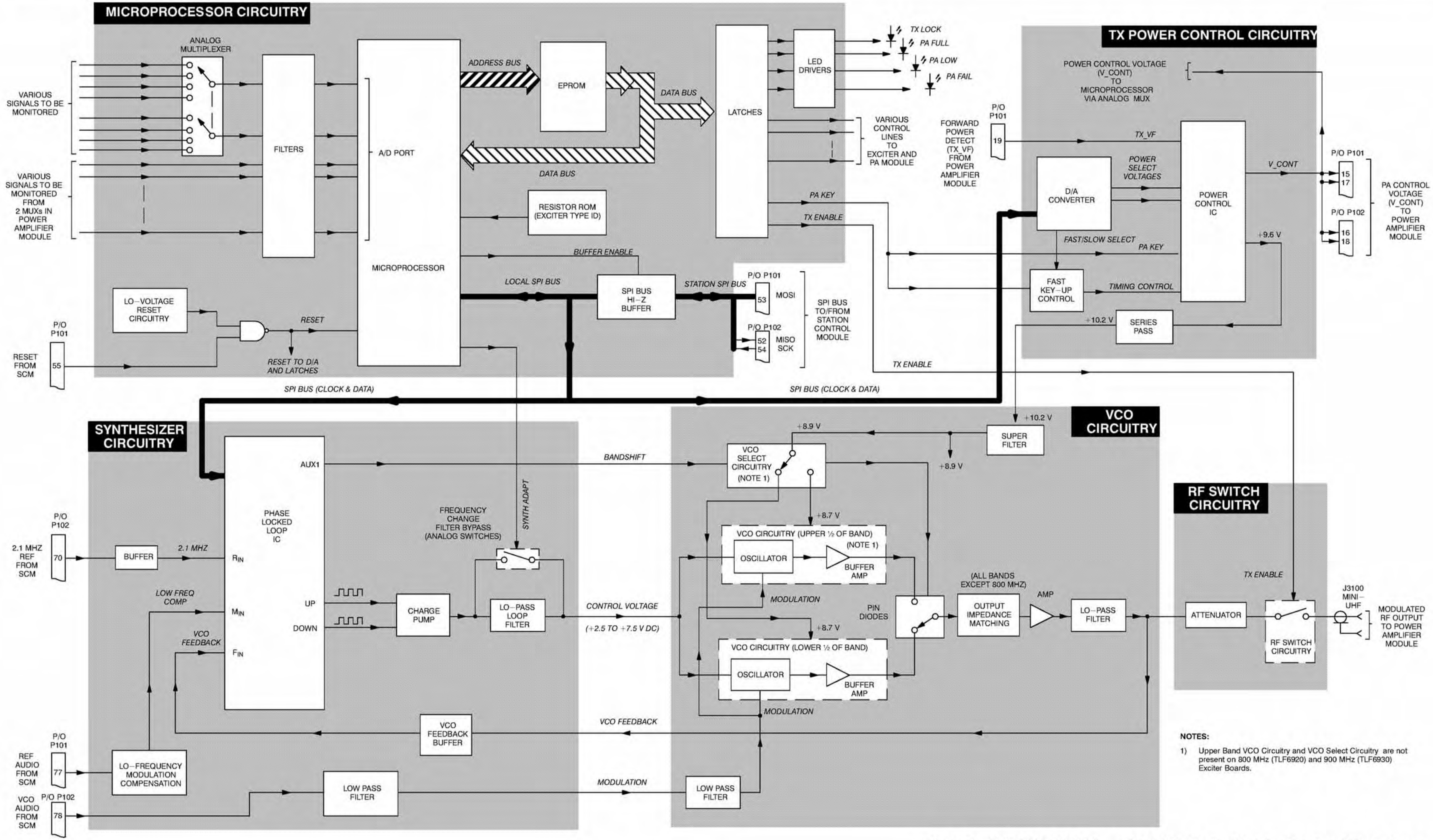

NOTES:

1) Upper Band VCO Circuitry and VCO Select Circuitry are not present on 800 MHz (TLF6920) and 900 MHz (TLF6930) Exciter Boards.

Figure 2. VHF, UHF, 800 MHz, and 900 MHz Exciter Modules Functional Block Diagram

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POWER AMPLIFIER MODULE

MODELS: TLD3110A (25W, 132–174 MHz)
TLD3101A (125W, 132–154 MHz)
TLD3102A (125W, 150–174 MHz)

1 DESCRIPTION

The Models TLD3110 and TLD3101/TLD3102 Power Amplifier Modules are described in this section. A general description, identification of controls, indicators, and inputs/outputs, functional block diagrams, and functional theory of operation are provided. The information provided is sufficient to give service personnel a functional understanding of the module, allowing maintenance and troubleshooting to the module level. (Refer also to the Maintenance and Troubleshooting section of this manual for detailed troubleshooting procedures for all modules in the station.)

General Description

The Power Amplifier Module (PA) accepts a low–level modulated rf signal from the Exciter Module and amplifies the signal for transmission via the site transmit antenna. The output power is continually monitored and regulated by a feedback and control loop, with a power output control voltage being generated by the transmitter control circuitry located in the Exciter Module.

The Models TLD3110 and TLD3101/TLD3102 PA Modules are very similar in design and function, with the major differences being the output power capabilities and operating frequency range. Unless otherwise noted, the information provided in this section applies to all three models.

Overview of Circuitry

The PA contains the following circuitry:

- Intermediate Power Amplifier (IPA) — low–level amplifier stage which is controlled by the transmitter control voltage from the Exciter Module; provides an output of approximately 0 to 10W
- Driver Power Amplifier (DPA) — contained in 25W PA only, provides final amplification of the IPA output; provides an output of 35W maximum
- Final Power Amplifier (FPA) — contained in 125W PA only, provides final amplification of the IPA output; provides an output of 160W maximum
- Circulator — provides PA module output isolation
- Harmonic Filter/Coupler — suppresses harmonic radiation and couples the PA output to the transmit antenna connector; also serves as a power meter
- Sense and Detect Circuitry — provides sense and detect signals for critical signal points throughout the circuitry; signals are monitored by the Exciter Module

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2 CONTROLS, INDICATORS, AND INPUTS/OUTPUTS

Figure 1 shows the PA controls, indicators, and all input and output external connections.

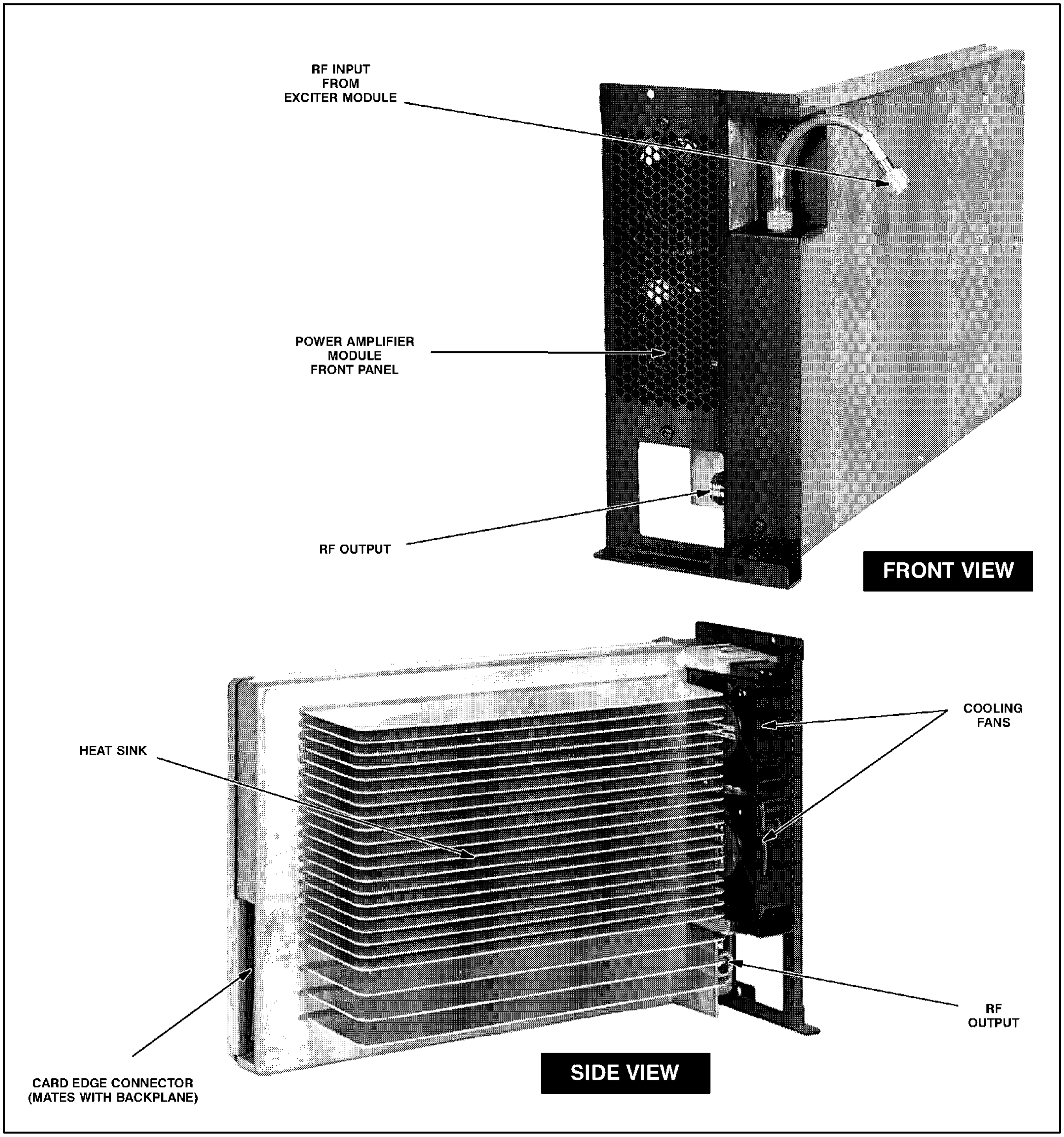

Figure 1. Power Amplifier Module Controls, Indicators, and Inputs/Outputs (125 W Model Shown)

3 FUNCTIONAL THEORY OF OPERATION

The following theory of operation describes the operation of the PA circuitry at a functional level. The information is presented to give the service technician a basic understanding of the functions performed by the module in order to facilitate maintenance and troubleshooting to the module level. Functional block diagrams are provided in Figure 2 (TLD3110, 25 W) and Figure 3 (TLD3101/TLD3102, 125 W). As mentioned previously, the four PA modules are similar in design and function. The following theory of operation applies to all four modules except where noted.

RF Signal Path

A low−level modulated rf signal (approximately +13 dBm) from the Exciter module is input to the PA module via a coax cable. The signal is input to the IPA and amplified to approximately 0 to 10W [depending on the dc power control voltage (V_CONT) from the Exciter Module].

The IPA output is fed to a DPA (25W) or an FPA (125W), where final amplification occurs. The output of the DPA (35W maximum) or FPA (160W maximum) is fed to a circulator, which passes the transmit signal to the harmonic filter/coupler, while routing all reflected power to a 50Ω load.

The output of the circulator is fed to the harmonic filter/coupler. This circuit provides highly selective bandpass filtering and couples the signal to an N−type connector mounted to the module casting. A coax cable routes the signal to an N−type connector mounted on an rf input/output connector bracket located on the rear of the station.

Output Power Control

A feedback and control loop configuration is used to regulate the PA output power. The Harmonic Filter/Coupler generates a dc voltage proportional to the PA Module output power. This voltage (TX_VF) is fed to the TX Power Control Circuitry in the Exciter Module. The TX_VF voltage is compared to reference voltages to generate a dc power control voltage (V_CONT).

Note that V_OMNI does not control the output level of the DPA directly but serves as on/off control for the DPA stage.

The dc power control voltage (V_CONT) is output from the Exciter Module and fed through filtering circuitry in the PA to a voltage translation and current limiting circuit. The output of this circuitry is V_OMNI, a dc voltage which controls the output power of the IPA.

Summary of Power Control Operation — By controlling the output level of the IPA (range of 0 to 10W), the output power of the PA module is established. The feedback and control loop (TX_VF fed back to Exciter Module resulting in V_CONT to control IPA output) continually monitors and maintains the proper output power from the PA.

Sense and Detect Circuitry

Introduction

The PA is equipped with several sense and detect circuits to provide status signals to the Exciter Module. In most cases, the Exciter Module microprocessor uses these signals to determine PA operating conditions and, in response, varies certain control signals to correct output power, turn on cooling fans, etc. The sense and detect circuits are described in the following paragraphs.

Current Sensing Circuitry (25W)

IPA and DPA current sense circuitry (comprised of two differential amplifiers and two sensing resistors) meters the current being drawn by the IPA and the DPA and outputs two dc signals directly proportional to the IPA and DPA currents. Circuit operation is described in the following paragraph.

In each of the current sense circuits, a differential amplifier measures the voltage drop across a sensing resistor and outputs a dc voltage directly proportional to the current through the resistor. The dc voltage (IPA_I or DPA_I) is fed to the Exciter Module (via an analog multiplexer and filtering circuitry) where it is used in calculating the current being drawn by the IPA or DPA.

Current Sensing Circuitry (125W)

IPA current sense circuitry (comprised of a differential amplifier and a sensing resistor) meters the current being drawn by the IPA and outputs a dc signal directly proportional to the IPA current. Circuit operation is described in the following paragraph.

The differential amplifier measures the voltage drop across a sensing resistor and outputs a dc voltage directly proportional to the IPA current. The dc voltage (IPA_I) is fed to the Exciter Module (via an analog multiplexer and filtering circuitry) where it is used in calculating the current being drawn by the IPA.

FPA current sense circuitry (comprised of two differential amplifiers and two sensing resistors) meters the current being drawn by the FPA (side A and side B) and outputs two dc signals directly proportional to the currents for side A and side B. Circuit operation is described in the following paragraph.

In each of the current sense circuits, a differential amplifier measures the voltage drop across a sensing resistor and outputs a dc voltage directly proportional to the current through the resistor. The dc voltages (FPA_I1_A and FPA_I1_B) is fed to the Exciter Module (via an analog multiplexer and filtering circuitry) where it is used in calculating the current being drawn by the FPA (side A or side B).

Sense and Detect Circuitry (Continued)

PA Temperature Sense

A thermistor and buffer circuit provides a dc voltage proportional to the PA temperature. This signal (PA_TEMP) is fed to the Exciter Module, which monitors the signal and reduces the PA output power [by reducing the dc power control voltage (V_CONT)] if the PA temperature exceeds set limits.

IPA, DPA, and FPA Detect Circuitry

Detection circuits provide a dc voltage approximately proportional to the rf outputs of the IPA, DPA (25W), and FPA (125W) stages. These dc signals (IPA_VF, DPA_VF, and FPA_VF, used for diagnostic purposes only) are fed to the Exciter Module via an analog multiplexer and filter circuitry.

Reflected Power Detect Circuitry

The Harmonic Filter/Coupler provides a dc voltage approximately proportional to the reflected power at the output of the stage. This dc signal (TX_VR) is fed to the Exciter Module via an analog multiplexer and filter circuitry. The signal indicates the amount of potentially harmful reflected power at the PA output. If the reflected power exceeds a set limit, the Exciter Module will shut down the PA.

V_OMNI Detect Circuitry

A voltage divider circuit provides a dc voltage approximately proportional to the V_OMNI control voltage from the Voltage Translator & Current Limiter circuit. This dc signal (V_OMNI*) is fed to the Exciter Module via an analog multiplexer and filter circuitry.

+14V Detect Circuitry

A voltage divider circuit provides a dc voltage approximately proportional to the +14 V dc input voltage from the station Power Supply Module. This dc signal (14.2V_REF*) is fed to the Exciter Module via an analog multiplexer and filter circuitry.

+28V Detect Circuitry (125W Only)

A voltage divider circuit provides a dc voltage approximately proportional to the +28 V dc input voltage from the station Power Supply Module. This dc signal (28V_REF*) is fed to the Exciter Module via an analog multiplexer and filter circuitry.

Cooling Fans Control Circuitry (125 W Models Only)

WARNING

The cooling fans in the PA Module are thermostatically controlled and may come on at any time during station operation. Keep fingers clear of fan blades.

The PA is equipped with a dual fan module to provide forced air cooling of the PA. The fan module is controlled by a FAN ON signal from the Exciter Module, which is fed to a driver circuit in the PA Module. The Fan Driver/Detect Circuitry controls the power to the fans via two feed–thru pins in the PA chassis which mate with the power connector on the slide–in fan module. The fans are turned on only when the temperature in the PA exceeds a set limit. It is normal for the fans to cycle on and off during station operation.

The Fan Driver/Detect Circuitry also monitors the current to the fans and feeds a dc detect voltage to the Fan Status Circuitry, which outputs a status signal indicating whether the fan current is above or below a predetermined range. The status signal (FAN_ALARM) is fed to the Exciter Module via an analog multiplexer and filter circuitry.

Power Amplifier ID Resistor ROM

A resistor network "ROM" provides power amplifier ID information to the Exciter Module via an analog multiplexer and filter circuits. This information includes the band and range in which the PA is designed to operate (e.g., VHF–Range 1, UHF, 900 MHz, etc.) and the maximum output power (e.g., 25 W, 125 W, etc.).

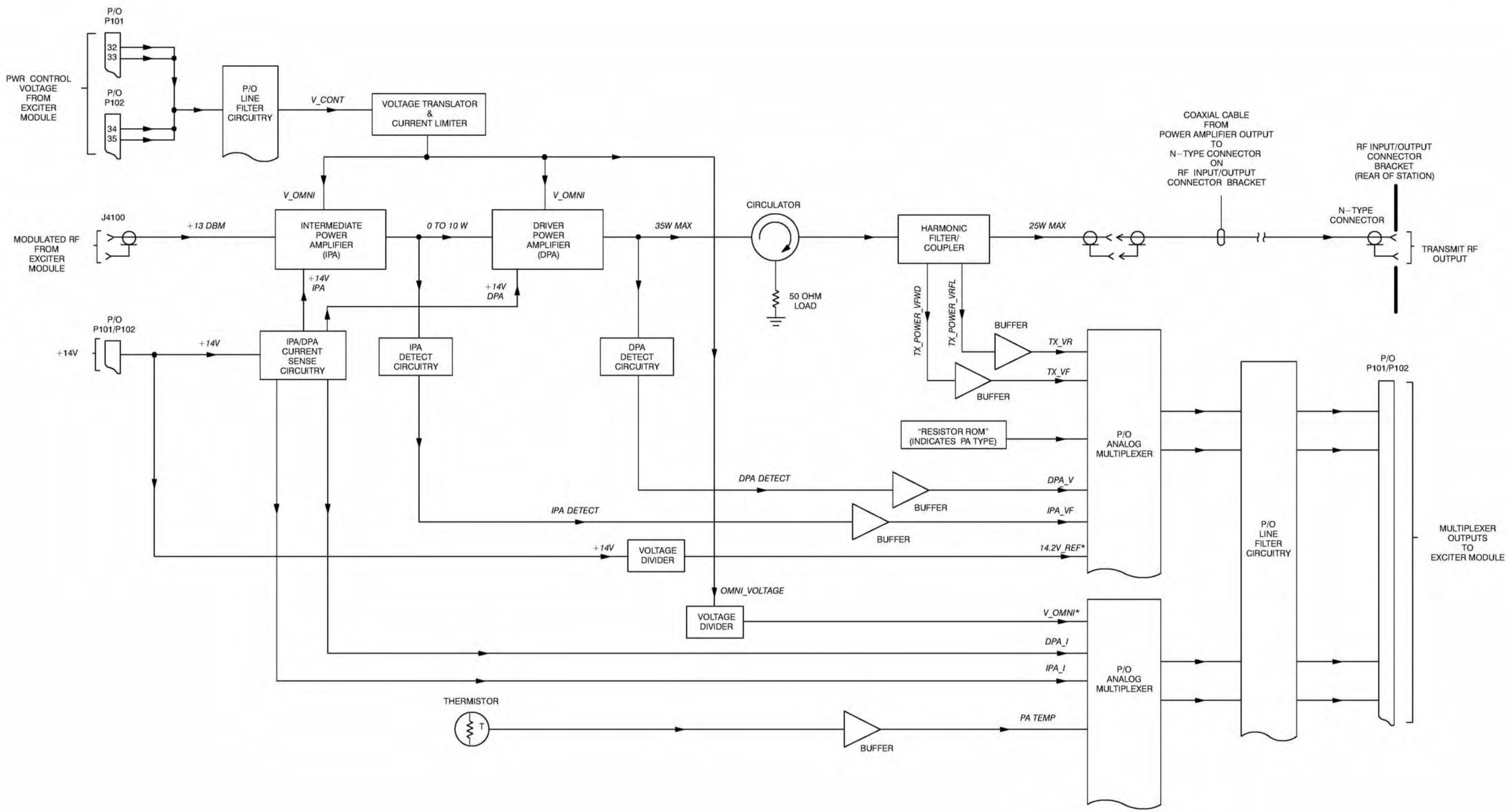

Figure 2. *TLD3110 25W Power Amplifier Module Functional Block Diagram*

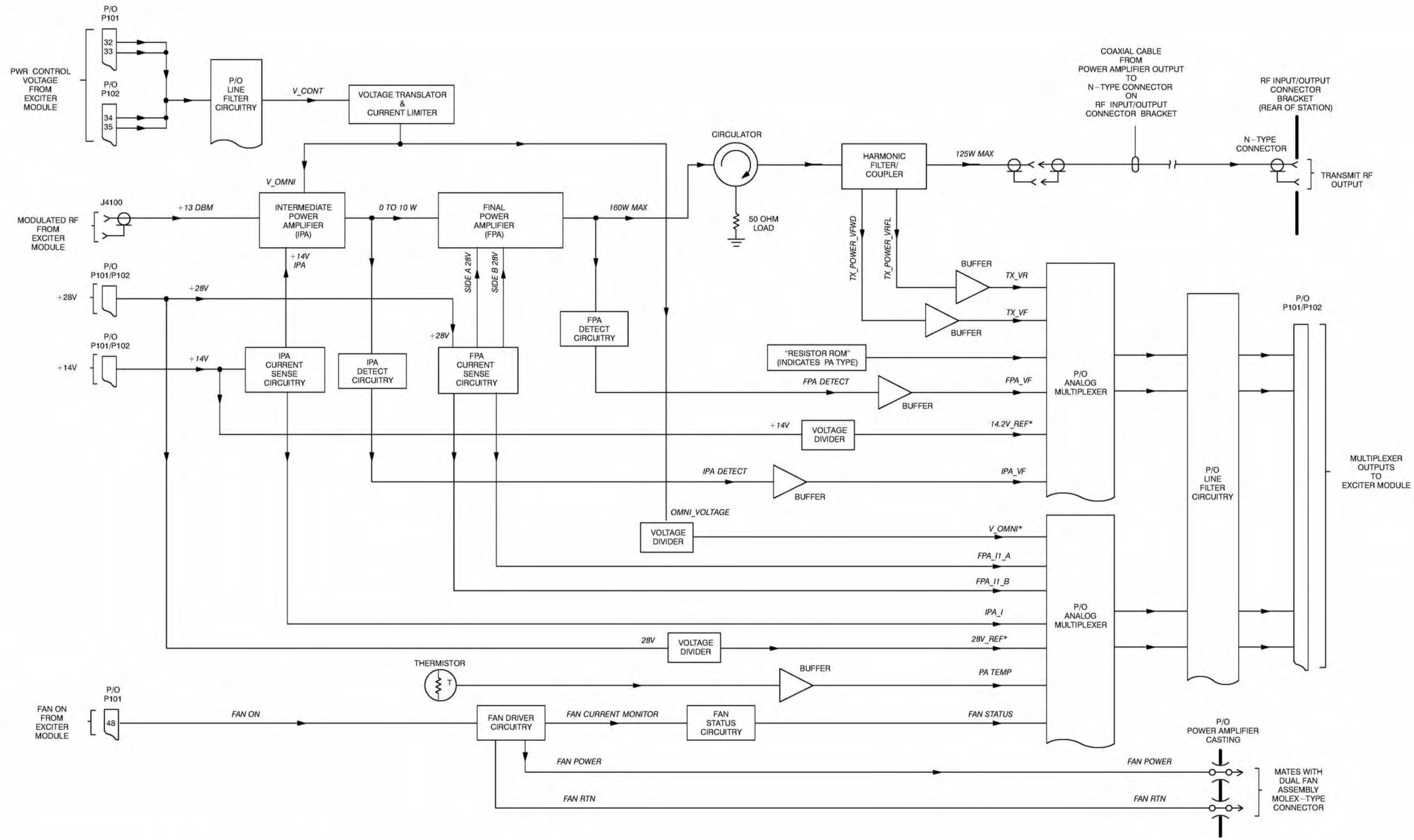

***Figure 3.** TLD3101/TLD3102 125W Power Amplifier Module Functional Block Diagram*

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POWER AMPLIFIER MODULE

MODELS: TLE2731A (25W, UHF Range 1)
TLE2732A (25W, UHF Range 2)
CTX1146A (110W, UHF Range 0)
TTE2061A (110W, UHF Range 1)
TTE2062A (110W, UHF Range 2)
TTE2063A (110W, UHF Range 3)
TTE2064A (100W, UHF Range 4)

1 DESCRIPTION

The Models TLE2731A, TLE2732A, CTX1146A, TTE2061A, TTE2062A, TTE2063A, and TTE2064A Power Amplifier Modules are described in this section. A general description, identification of controls, indicators, and inputs/outputs, functional block diagrams, and functional theory of operation are provided. The information provided is sufficient to give service personnel a functional understanding of the module, allowing maintenance and troubleshooting to the module level. (Refer also to the Maintenance and Troubleshooting section of this manual for detailed troubleshooting procedures for all modules in the station.)

General Description

The Power Amplifier Module (PA) accepts a low−level modulated rf signal from the Exciter Module and amplifies the signal for transmission via the site transmit antenna. The output power is continually monitored and regulated by a feedback and control loop, with a power output control voltage being generated by the transmitter control circuitry located in the Exciter Module.

These PA Modules are very similar in design and function, with the major differences being the output power capabilities and operating frequency range. Unless otherwise noted, the information provided in this section applies to all three models.

Overview of Circuitry

The PA contains the following circuitry:

- Intermediate Power Amplifier (IPA) — low−level amplifier stage which is controlled by the transmitter control voltage from the Exciter Module; provides an output of approximately 0 to 15W
- Driver Power Amplifier (DPA) — contained in 25W PA only, provides final amplification of the IPA output; provides an output of 35W max.
- Final Power Amplifier (FPA) — contained in 100/110W PAs only, provides final amplification of the IPA output; provides an output of 150W (CTX1146A) or 180W (all others) maximum
- Circulator — provides PA module output isolation
- Harmonic Filter/Coupler — suppresses harmonic radiation and couples the PA output to the transmit antenna connector; also serves as a power meter
- Sense and Detect Circuitry — provides sense and detect signals for critical signal points throughout the circuitry; signals are monitored by the Exciter Module

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2 CONTROLS, INDICATORS, AND INPUTS/OUTPUTS

Figure 1 shows the PA controls, indicators, and all input and output external connections.

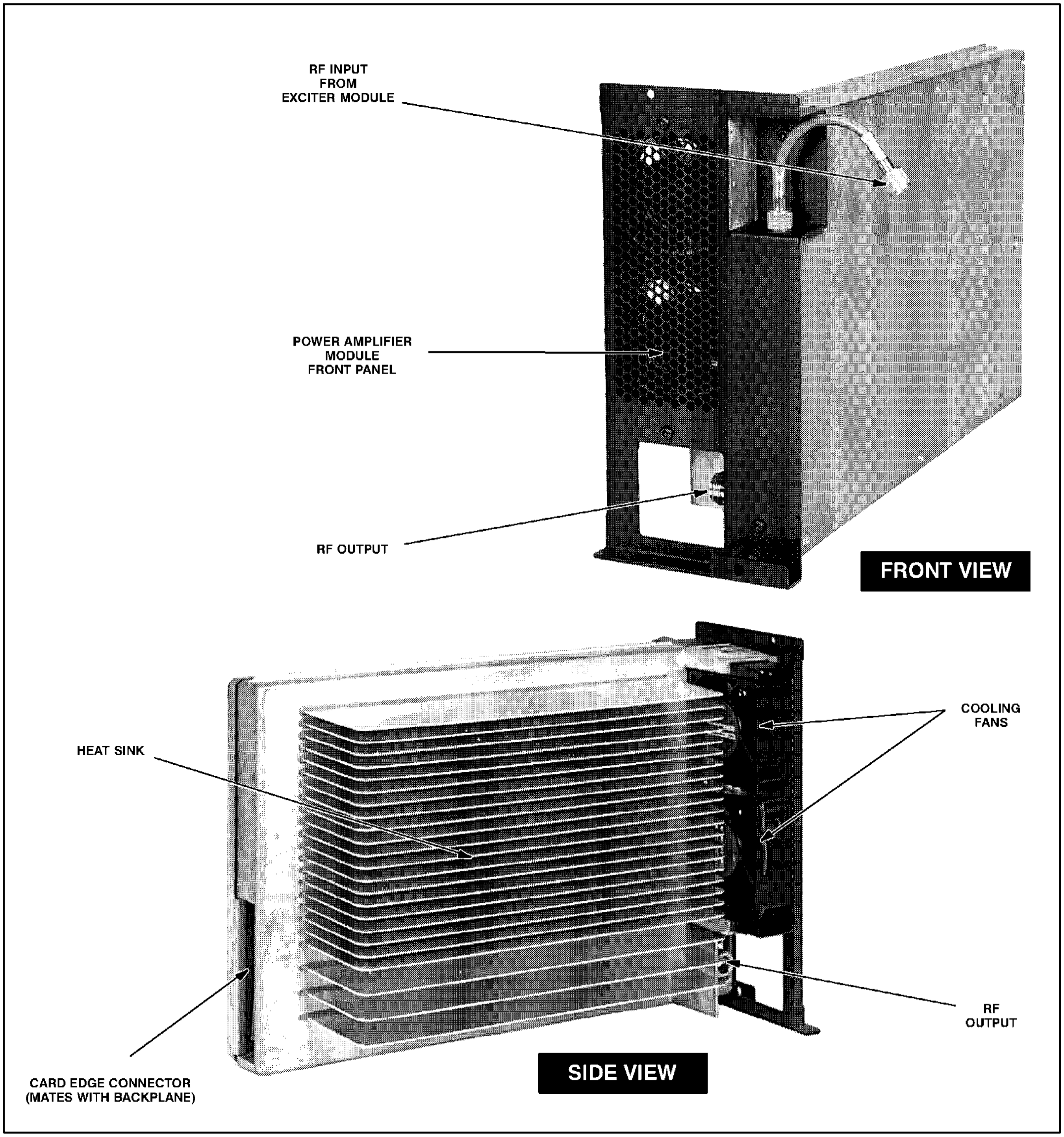

Figure 1. Power Amplifier Module Controls, Indicators, and Inputs/Outputs (110 W Model Shown)

3 FUNCTIONAL THEORY OF OPERATION

The following theory of operation describes the operation of the PA circuitry at a functional level. The information is presented to give the service technician a basic understanding of the functions performed by the module in order to facilitate maintenance and troubleshooting to the module level. Functional block diagrams are provided in Figure 2 (TLE2731A and TLE2732A, 25 W) and Figure 3 (CTX1146A/TTE2061A–63A, 110 W and TTE2064A, 100W). As mentioned previously, the five PA modules are similar in design and function. The following theory of operation applies to all four modules except where noted.

RF Signal Path

A low–level modulated rf signal (approximately +13 dBm) from the Exciter module is input to the PA module via a coax cable. The signal is input to the IPA and amplified to approximately 0 to 15W [depending on the dc power control voltage (V_CONT) from the Exciter Module].

The IPA output is fed to a DPA (25W) or an FPA (100/110W), where final amplification occurs. The output of the DPA (35W maximum) or FPA (150W maximum for CTX1146, 180W maximum for all others) is fed to a circulator, which passes the transmit signal to the harmonic filter/coupler, while routing all reflected power to a 50Ω load.

The output of the circulator is fed to the harmonic filter/coupler. This circuit provides highly selective bandpass filtering and couples the signal to an N–type connector mounted to the module casting. A coax cable routes the signal to an N–type connector mounted on an rf input/output connector bracket located on the rear of the station.

Output Power Control

A feedback and control loop configuration is used to regulate the PA output power. The Harmonic Filter/Coupler generates a dc voltage proportional to the PA Module output power. This voltage (TX_VF) is fed to the TX Power Control Circuitry in the Exciter Module. The TX_VF voltage is compared to reference voltages to generate and adjust a dc power control voltage (V_CONT).

Note that V_OMNI does not control the output level of the DPA directly but serves as on/off control for the DPA stage.

The dc power control voltage (V_CONT) is output from the Exciter Module and fed through filtering circuitry in the PA to a voltage translation and current limiting circuit. The output of this circuitry is V_OMNI, a dc voltage which controls the output power of the IPA.

Summary of Power Control Operation — By controlling the output level of the IPA (range of 0 to 15W), the output power of the PA module is established. The feedback and control loop (TX_VF fed back to Exciter Module resulting in V_CONT to control IPA output) continually monitors and maintains the proper output power from the PA.

Sense and Detect Circuitry

Introduction

The PA is equipped with several sense and detect circuits to provide status signals to the Exciter Module. In most cases, the Exciter Module microprocessor uses these signals to determine PA operating conditions and, in response, varies certain control signals to correct output power, turn on cooling fans, derate performance, etc. The sense and detect circuits are described in the following paragraphs.

Current Sensing Circuitry (25W)

IPA and DPA current sense circuitry (comprised of two differential amplifiers and two sensing resistors) meters the current being drawn by the IPA and the DPA and outputs two dc signals directly proportional to the IPA and DPA currents. Circuit operation is described in the following paragraph.

In each of the current sense circuits, a differential amplifier measures the voltage drop across a sensing resistor and outputs a dc voltage directly proportional to the current through the resistor. The dc voltage (IPA_I or DPA_I) is fed to the Exciter Module (via an analog multiplexer and filtering circuitry) where it is used in calculating the current being drawn by the IPA or DPA.

Current Sensing Circuitry (100/110W)

IPA current sense circuitry (comprised of a differential amplifier and a sensing resistor) meters the current being drawn by the IPA and outputs a dc signal directly proportional to the IPA current. Circuit operation is described in the following paragraph.

The differential amplifier measures the voltage drop across a sensing resistor and outputs a dc voltage directly proportional to the IPA current. The dc voltage (IPA_I) is fed to the Exciter Module (via an analog multiplexer and filtering circuitry) where it is used in calculating the current being drawn by the IPA.

FPA current sense circuitry (comprised of two differential amplifiers and two sensing resistors) meters the current being drawn by the FPA (side A and side B) and outputs two dc signals directly proportional to the currents for side A and side B. Circuit operation is described in the following paragraph.

In each of the current sense circuits, a differential amplifier measures the voltage drop across a sensing resistor and outputs a dc voltage directly proportional to the current through the resistor. The dc voltages (FPA_I1_A and FPA_I1_B) is fed to the Exciter Module (via an analog multiplexer and filtering circuitry) where it is used in calculating the current being drawn by the FPA (side A or side B).

Sense and Detect Circuitry (Continued)

PA Temperature Sense

A thermistor and buffer circuit provides a dc voltage approximately proportional to the PA temperature. This signal (PA_TEMP) is fed to the Exciter Module, which monitors the signal and reduces the PA output power [by reducing the dc power control voltage (V_CONT)] if the PA temperature exceeds set limits.

IPA, DPA, and FPA Detect Circuitry

Detection circuits provide a dc voltage approximately proportional to the rf outputs of the IPA (15W), DPA (25W), and FPA (100/110W) stages. These dc signals (IPA_VF, DPA_VF, and FPA_VF, used for diagnostic purposes only) are fed to the Exciter Module via an analog multiplexer and filter circuitry.

Reflected Power Detect Circuitry

The Harmonic Filter/Coupler provides a dc voltage approximately proportional to the reflected power at the output of the stage. This dc signal (TX_VR) is fed to the Exciter Module via an analog multiplexer and filter circuitry. The signal indicates the amount of potentially harmful reflected power at the PA output. If the reflected power exceeds a set limit, the Exciter Module will shut down the PA.

V_OMNI Detect Circuitry

A voltage divider circuit provides a dc voltage approximately proportional to the V_OMNI control voltage from the Voltage Translator & Current Limiter circuit. This dc signal (V_OMNI*) is fed to the Exciter Module via an analog multiplexer and filter circuitry.

+14V Detect Circuitry

A voltage divider circuit provides a dc voltage approximately proportional to the +14 V dc input voltage from the station Power Supply Module. This dc signal (14.2V_REF*) is fed to the Exciter Module via an analog multiplexer and filter circuitry.

+28V Detect Circuitry (100/110W Only)

A voltage divider circuit provides a dc voltage approximately proportional to the +28 V dc input voltage from the station Power Supply Module. This dc signal (28V_REF*) is fed to the Exciter Module via an analog multiplexer and filter circuitry. The PA output power is reduced when the detected voltage is below +27V dc.

Cooling Fans Control Circuitry (100/110 W Models Only)

WARNING

The cooling fans in the PA Module are thermostatically controlled and may come on at any time during station operation. Keep fingers clear of fan blades.

The PA is equipped with a dual fan module to provide forced air cooling of the PA. The fan module is controlled by a FAN ON signal from the Exciter Module, which is fed to a driver circuit in the PA Module. The Fan Driver/Detect Circuitry controls the power to the fans via two feed–thru pins in the PA chassis which mate with the power connector on the slide–in fan module. The fans are turned on only when the temperature in the PA exceeds a set limit. It is normal for the fans to cycle on and off during station operation.

The Fan Driver/Detect Circuitry also monitors the current to the fans and feeds a dc detect voltage to the Fan Status Circuitry, which outputs a status signal indicating whether the fan current is above or below a predetermined range. The status signal (FAN_ALARM) is fed to the Exciter Module via an analog multiplexer and filter circuitry.

Power Amplifier ID Resistor ROM

A resistor network “ROM” provides power amplifier ID information to the Exciter Module via an analog multiplexer and filter circuits. This information includes the band and range in which the PA is designed to operate (e.g., UHF, 800 MHz, etc.) and the maximum output power (e.g., 25 W, 110 W, etc.).

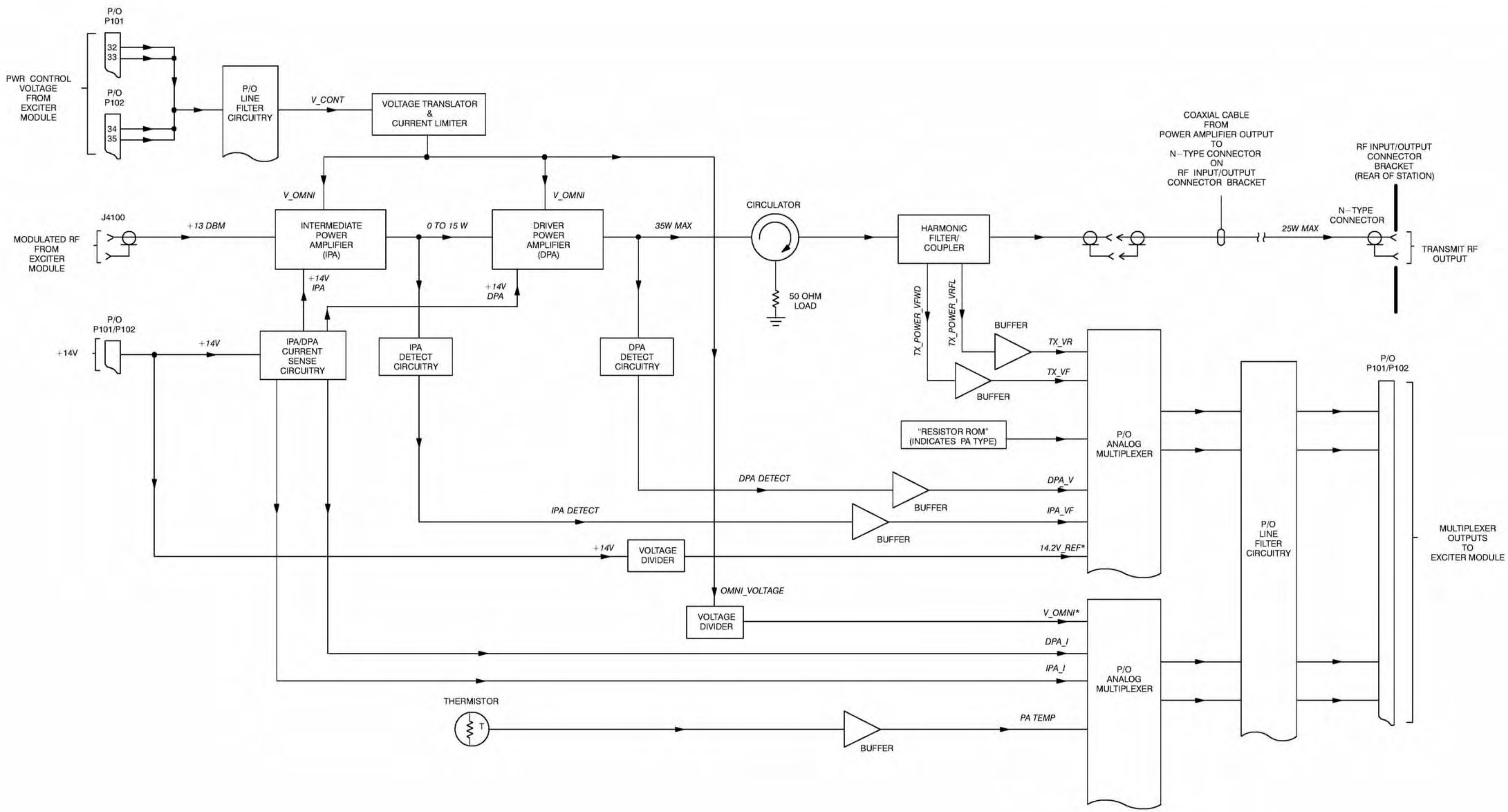

Figure 2. TLE2731A/TLE2732A 25W UHF Power Amplifier Module Functional Block Diagram

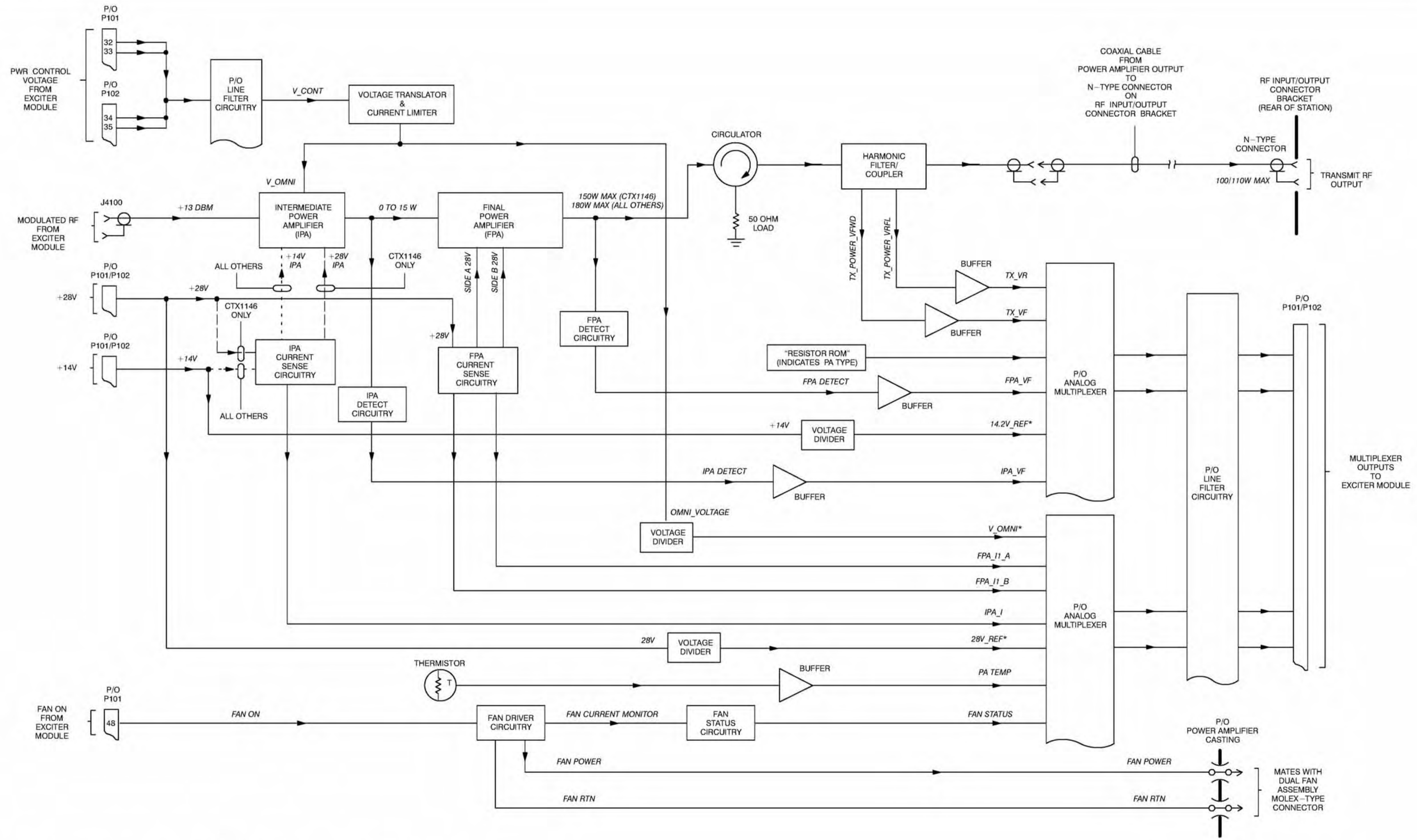

Figure 3. CTX1146A/TTE2061A−63A 110W UHF and TTE2064A 100W UHF Power Amplifier Module Functional Block Diagram

MOTOROLA

POWER AMPLIFIER MODULE

MODELS: TLF1940A (20W, 850–870 MHz)
TLF1930A (100W, 850–870 MHz
TLF1800A (100W, 935–941 MHz)

1 DESCRIPTION

The Models TLF1940A/TLF1930A 800 MHz and TLF1800A 900 MHz Power Amplifier Modules are described in this section. A general description, identification of controls, indicators, and inputs/outputs, functional block diagrams, and functional theory of operation are provided. The information provided is sufficient to give service personnel a functional understanding of the module, allowing maintenance and troubleshooting to the module level. (Refer also to the Maintenance and Troubleshooting section of this manual for detailed troubleshooting procedures for all modules in the station.)

General Description

The Power Amplifier Module (PA) accepts a low–level modulated rf signal from the Exciter Module and amplifies the signal for transmission via the site transmit antenna. The output power is continually monitored and regulated by a feedback and control loop, with a power output control voltage being generated by the transmitter control circuitry located in the Exciter Module.

The PA Modules described in this section are very similar in design and function, with the major differences being the output power capabilities and operating frequency. Unless otherwise noted, the information provided in this section applies to all four models.

Overview of Circuitry

The PA contains the following circuitry:

- Intermediate Power Amplifier (IPA) — low–level amplifier stage which is controlled by the transmitter control voltage from the Exciter Module; provides an output of approximately 0 to 10W
- Driver Power Amplifier (DPA) — provides amplification (35W maximum) of the IPA output
- Final Power Amplifier (FPA) — contained in 100W PA only, provides final amplification of the IPA output; provides an output of 160W maximum
- Circulator — provides PA module output isolation
- Harmonic Filter/Coupler — suppresses harmonic radiation and couples the PA output to the transmit antenna connector; also serves as a power meter
- Sense and Detect Circuitry — provides sense and detect signals for critical signal points throughout the circuitry; signals are monitored by the Exciter Module

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2 CONTROLS, INDICATORS, AND INPUTS/OUTPUTS

Figure 1 shows the PA controls, indicators, and all input and output external connections.

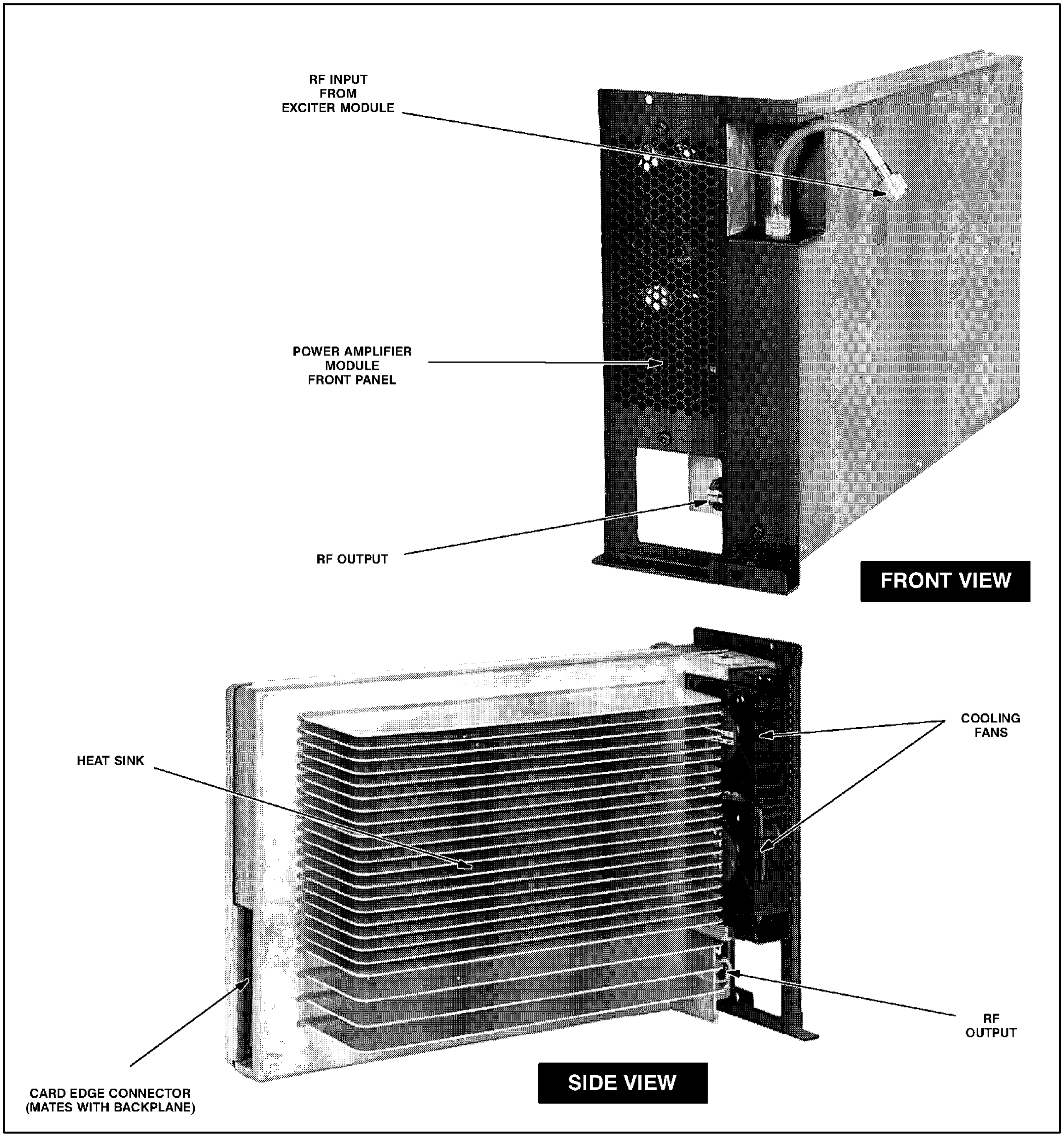

Figure 1. Power Amplifier Module Controls, Indicators, and Inputs/Outputs (100W Model Shown)

3 FUNCTIONAL THEORY OF OPERATION

The following theory of operation describes the operation of the PA circuitry at a functional level. The information is presented to give the service technician a basic understanding of the functions performed by the module in order to facilitate maintenance and troubleshooting to the module level. Functional block diagrams are provided in Figure 2 (TLF1940A, 20 W) and Figure 3 (TLF1800A and TLF1930A, 100 W). As mentioned previously, the four PA modules are similar in design and function. The following theory of operation applies to all four modules except where noted.

RF Signal Path

A low−level modulated rf signal (approximately +13 dBm) from the Exciter module is input to the PA module via a coax cable. The signal is input to the IPA and amplified to approximately 0 to 10W [depending on the dc power control voltage (V_CONT) from the Exciter Module].

On the 20W model, the IPA output is fed to a DPA which provides final amplification. On the 100W model, the IPA output is fed to a DPA and then to an FPA which provides final amplification. The output of the DPA (35W maximum) or FPA (160W maximum) is fed to a circulator, which passes the transmit signal to the harmonic filter/coupler, while routing all reflected power to a 50Ω load.

The output of the circulator is fed to the harmonic filter/coupler. This circuit provides highly selective bandpass filtering and couples the signal to an N−type connector mounted to the module casting. A coax cable routes the signal to an N−type connector mounted on an rf input/output connector bracket located on the rear of the station.

Output Power Control

A feedback and control loop configuration is used to regulate the PA output power. The Harmonic Filter/Coupler generates a dc voltage proportional to the PA Module output power. This voltage (TX_VF) is fed to the TX Power Control Circuitry in the Exciter Module. The TX_VF voltage is compared to reference voltages to generate a dc power control voltage (V_CONT).

Note that V_OMNI does not control the output level of the DPA directly but serves as on/off control for the DPA stage.

The dc power control voltage (V_CONT) is output from the Exciter Module and fed through filtering circuitry in the PA to a voltage translation and current limiting circuit. The output of this circuitry is V_OMNI, a dc voltage which controls the output power of the IPA.

Summary of Power Control Operation — By controlling the output level of the IPA (range of 0 to 10W), the output power of the PA module is established. The feedback and control loop (TX_VF fed back to Exciter Module resulting in V_CONT to control IPA output) continually monitors and maintains the proper output power from the PA.

Sense and Detect Circuitry

Introduction

The PA is equipped with several sense and detect circuits to provide status signals to the Exciter Module. In most cases, the Exciter Module microprocessor uses these signals to determine PA operating conditions and, in response, varies certain control signals to correct output power, turn on cooling fans, etc. The sense and detect circuits are described in the following paragraphs.

Current Sensing Circuitry (20W)

IPA and DPA current sense circuitry (comprised of two differential amplifiers and two sensing resistors) meters the current being drawn by the IPA and the DPA and outputs two dc signals directly proportional to the IPA and DPA currents. Circuit operation is described in the following paragraph.

In each of the current sense circuits, a differential amplifier measures the voltage drop across a sensing resistor and outputs a dc voltage directly proportional to the current through the resistor. The dc voltage (IPA_I or DPA_I) is fed to the Exciter Module (via an analog multiplexer and filtering circuitry) where it is used in calculating the current being drawn by the IPA or DPA.

Current Sensing Circuitry (100W)

IPA and DPA current sense circuitry (comprised of two differential amplifiers and two sensing resistors) meters the current being drawn by the IPA and the DPA and outputs two dc signals directly proportional to the IPA and DPA currents. Circuit operation is described in the following paragraph.

In each of the current sense circuits, a differential amplifier measures the voltage drop across a sensing resistor and outputs a dc voltage directly proportional to the current through the resistor. The dc voltage (IPA_I or DPA_I) is fed to the Exciter Module (via an analog multiplexer and filtering circuitry) where it is used in calculating the current being drawn by the IPA or DPA.

FPA current sense circuitry (comprised of two differential amplifiers and two sensing resistors) meters the current being drawn by the FPA (side A and side B) and outputs two dc signals directly proportional to the currents for side A and side B. Circuit operation is described in the following paragraph.

In each of the current sense circuits, a differential amplifier measures the voltage drop across a sensing resistor and outputs a dc voltage directly proportional to the current through the resistor. The dc voltages (FPA_I1_A and FPA_I1_B) is fed to the Exciter Module (via an analog multiplexer and filtering circuitry) where it is used in calculating the current being drawn by the FPA (side A or side B).

Sense and Detect Circuitry (Continued)

PA Temperature Sense

A thermistor and buffer circuit provides a dc voltage proportional to the PA temperature. This signal (PA_TEMP) is fed to the Exciter Module, which monitors the signal and reduces the PA output power [by reducing the dc power control voltage (V_CONT)] if the PA temperature exceeds set limits.

IPA, DPA, and FPA Detect Circuitry

Detection circuits provide a dc voltage approximately proportional to the rf outputs of the IPA, DPA, and FPA (100W only) stages. These dc signals (IPA_VF, DPA_VF, and FPA_VF, used for diagnostic purposes only) are fed to the Exciter Module via an analog multiplexer and filter circuitry.

Reflected Power Detect Circuitry

The Harmonic Filter/Coupler provides a dc voltage approximately proportional to the reflected power at the output of the stage. This dc signal (TX_VR) is fed to the Exciter Module via an analog multiplexer and filter circuitry. The signal indicates the amount of potentially harmful reflected power at the PA output. If the reflected power exceeds a set limit, the Exciter Module will shut down the PA.

V_OMNI Detect Circuitry

A voltage divider circuit provides a dc voltage approximately proportional to the V_OMNI control voltage from the Voltage Translator & Current Limiter circuit. This dc signal (V_OMNI*) is fed to the Exciter Module via an analog multiplexer and filter circuitry.

+14V Detect Circuitry

A voltage divider circuit provides a dc voltage approximately proportional to the +14 V dc input voltage from the station Power Supply Module. This dc signal (14.2V_REF*) is fed to the Exciter Module via an analog multiplexer and filter circuitry.

+28V Detect Circuitry (100W Only)

A voltage divider circuit provides a dc voltage approximately proportional to the +28 V dc input voltage from the station Power Supply Module. This dc signal (28V_REF*) is fed to the Exciter Module via an analog multiplexer and filter circuitry.

Cooling Fans Control Circuitry (100 W Models Only)

WARNING

The cooling fans in the PA Module are thermostatically controlled and may come on at any time during station operation. Keep fingers clear of fan blades.

The PA is equipped with a dual fan module to provide forced air cooling of the PA. The fan module is controlled by a FAN ON signal from the Exciter Module, which is fed to a driver circuit in the PA Module. The Fan Driver/Detect Circuitry controls the power to the fans via two feed–thru pins in the PA chassis which mate with the power connector on the slide–in fan module. The fans are turned on only when the temperature in the PA exceeds a set limit. It is normal for the fans to cycle on and off during station operation.

The Fan Driver/Detect Circuitry also monitors the current to the fans and feeds a dc detect voltage to the Fan Status Circuitry, which outputs a status signal indicating whether the fan current is above or below a predetermined range. The status signal (FAN_ALARM) is fed to the Exciter Module via an analog multiplexer and filter circuitry.

Power Amplifier ID Resistor ROM

A resistor network "ROM" provides power amplifier ID information to the Exciter Module via an analog multiplexer and filter circuits. This information includes the band and range in which the PA is designed to operate (e.g., VHF–Range 1, UHF, 900 MHz, etc.) and the maximum output power (e.g., 25 W, 125 W, etc.).

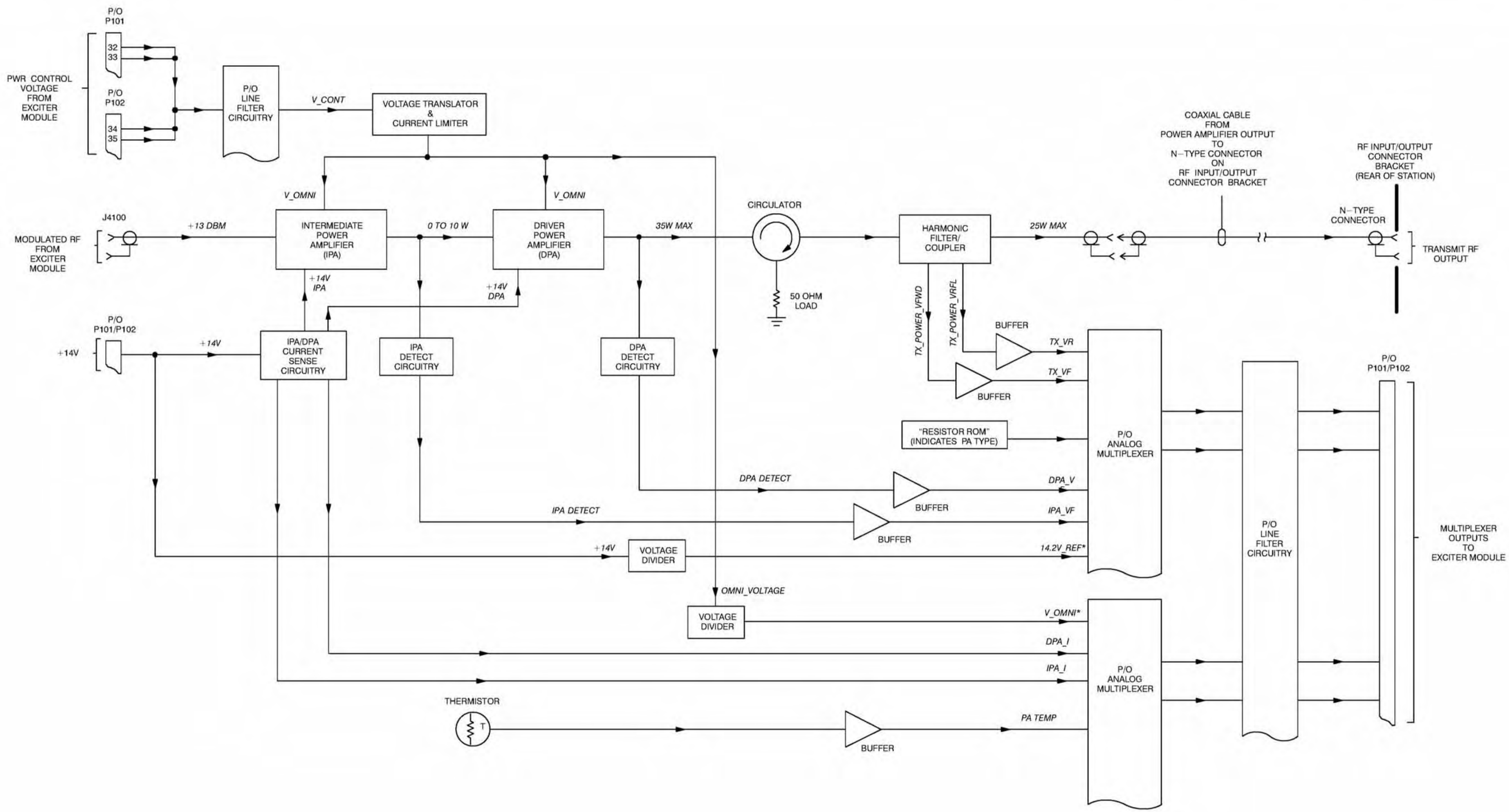

Figure 2. TLF1940A (800 MHz) 20W Power Amplifier Module Functional Block Diagram

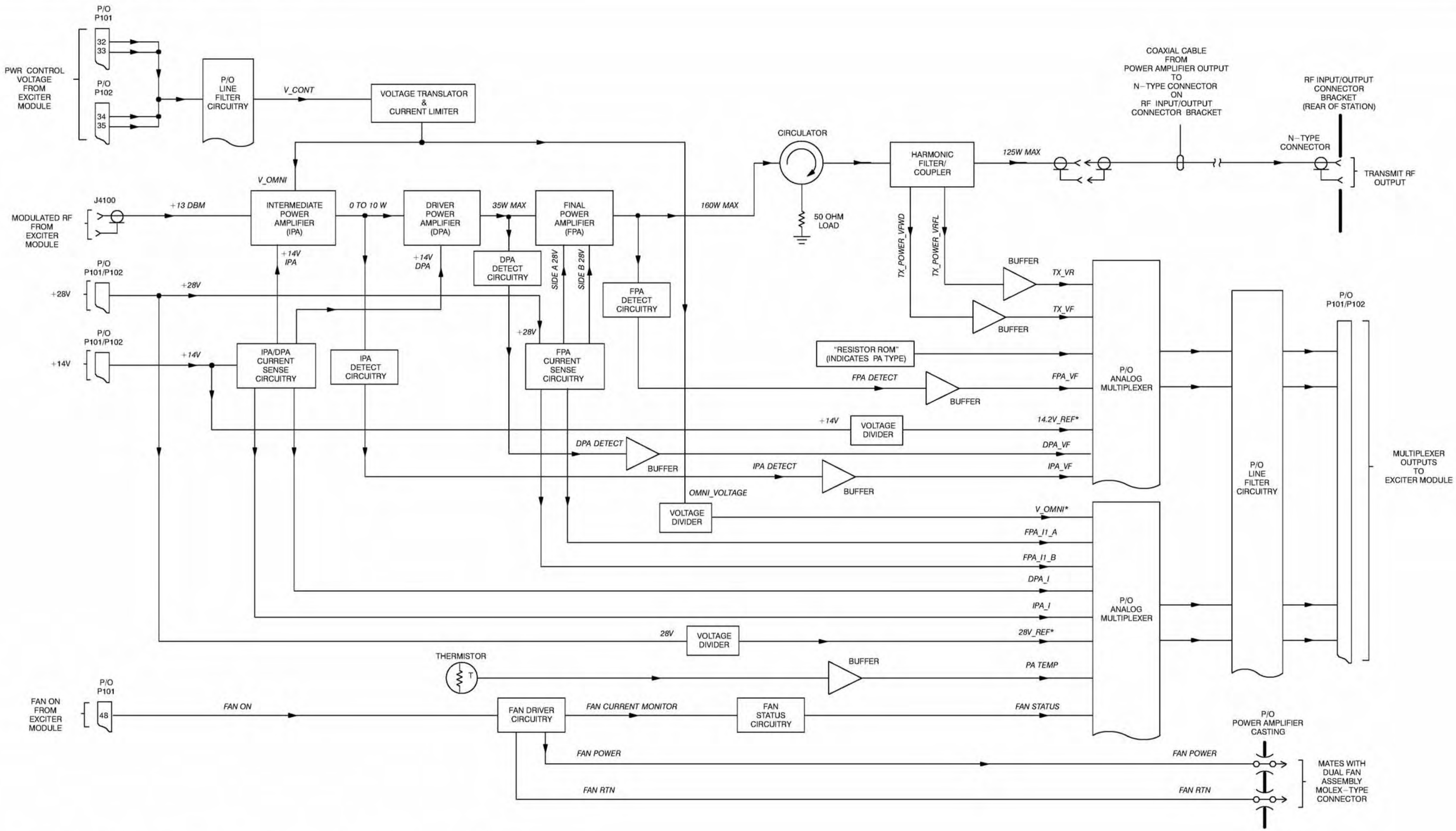

Figure 3. TLF1930A (800 MHz) and TLF1800A (900 MHz) 100W Power Amplifier Module Functional Block Diagram

END OF PART 6