Section 4 Principles of Operation

4-1 Introduction

This section contains a functional description of the multichannel power amplifier (MCPA).

4-2 RF Input Signal

The maximum input power should not exceed the limits specified in table 1-1.

4-3 RF Output Load

The load impedance should be as good as possible (1.5:1 or better) in the working band for good power transfer to the load.

4-4 Amplifier Functional Description

The NTUM30DA amplifier (figures 1-1 and 4-1) is a linear, MCPA that operates in the 60 MHz frequency band from 1930 MHz to 1990 MHz with an instantaneous bandwidth of 20 MHz. The operating band is determined by the operating frequency selection(s) of the base station (refer to table 1-1). The amplifier produces 45 watts of output power when operated in mode 1 or 30 watts of output power when operated in mode 2. Each amplifier is a self-contained module and is functionally independent of any other amplifier module(s) in the system. Each amplifier module has an alarm board that monitors the amplifier performance. If a failure or fault occurs in an amplifier module, it is transmitted to the host system via an RS-485 interface.

The amplifier is compliant to the requirements of FCC rules with respect to spurious emissions (see table 1-1). Constant gain is maintained by continuously comparing active paths with passive references, and correcting for small variations through the RF feedback controls. All gain variations, for example those due to temperature, are reduced to the passive reference variations. The amplifier module is comprised of:

An input amplifier

1st Loop Phase & Gain

A driver amplifier

A main amplifier

A multifunction board

4-4.1 Input Amplifier

RF is fed to the input amplifier, which consists of an isolator at the input, bandpass filter, voltage variable attenuators (VVA), and phase shifters for gain control and phase sweeping functions. The circuits in this section of the amplifier are controlled by a microprocessor on the Multifunction board. At its output, the input amplifier splits the signal to the 1st Loop Phase and Gain circuit, and the carrier cancellation circuit.

4-4.2 1st Loop Phase & Gain

The 1st Loop Phase & Gain circuit is a predistortion amplifier. The input signal is predistorted such that it linearizes the output of the main amp at the rated output power of the MCPA. It also contains the main loop VVAs and phase shifters. All the predistortion voltages and loop voltages are controlled by a microprocessor.

4-4.3 Driver Amplifier

The driver amplifier consists of two stages of class AB amplification, which provide the approximately 40% of the gain in the 60 MHz frequency band from 1930 MHz to 1990 MHz.

4-4.4 Main Amplifier

The main amplifier employs two class AB amplification stages for maximum efficiency. It provides approximately 40% of the gain in the 60 MHz frequency band. The output from the main amplifier is typically higher than the rated output power of the MCPA, to allow for losses associated with the components in the remaining RF path. The RF signals are then applied to a delay line and directional coupler, where the distortion products are cancelled out and the amplifier power performance is monitored.

4-4.5 Multifunction Board

The multifunction board consists of feed forward loop control and alarm circuits. The MCPA communicates to the host system through the multifunction board, which gathers the status information of the amplifier and reports to the host system via the RS-485 interface when instructed. It also protects the MCPA from adverse conditions such as overpower, input overdrive, overvoltage, etc. A microprocessor on the multifunction board also controls two loops in the feedforward system.

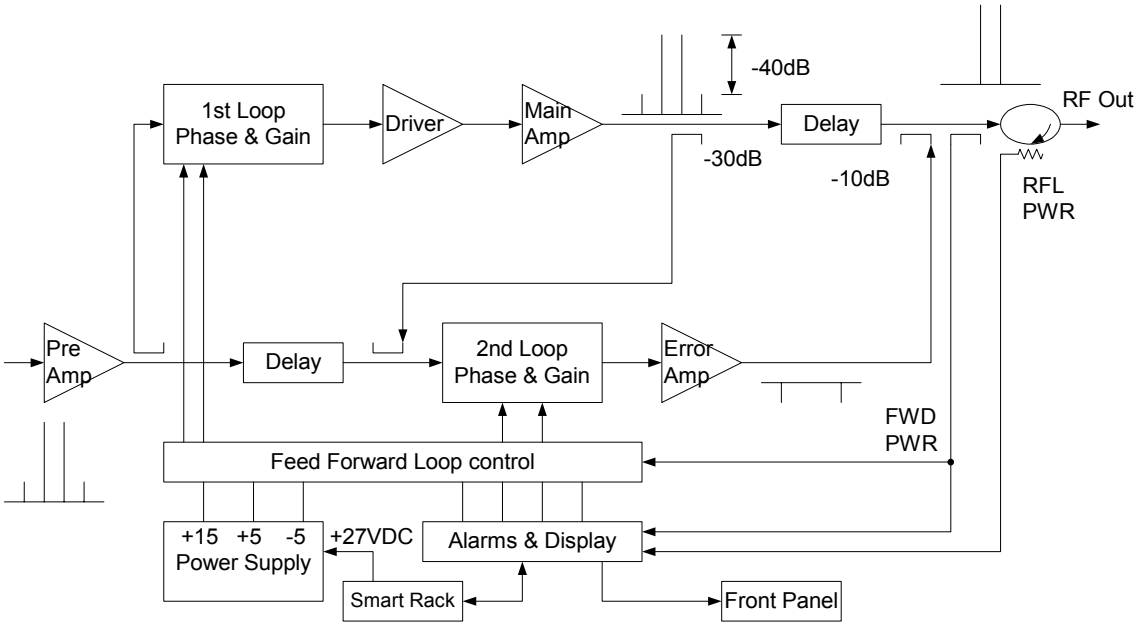

Figure 4-1 NTUM30DA Multichannel Power Amplifier Functional Block Diagram

4-5 Amplifier Module Cooling

Each amplifier module is contained within a thermally conductive chassis and properly mounted on an adequate thermal surface, which provides sufficient cooling when forced air is circulated over the heat sink fins to maintain the amplifier within the specified operating temperature range.

4-6 Power Distribution

Primary DC power for the amplifier is provided by the host system. The amplifier generates all the required voltages internally from the main source.

4-7 Amplifier Alarms

4-7.1 Minor Alarms

When a minor alarm condition occurs, the alarm is latched into a minor alarm condition. The amplifier alarm state is read by the BTS the next time the amplifier is poled by the BTS. After the alarm status is sent the minor alarm register is cleared, unless the alarm condition still exists. If the amplifier receives a “Enable Command” or “Clear Alarms Command”, all minor alarms will be cleared. If the amplifier is disabled, all minor alarms are also cleared.

Minor alarms do not directly affect amplifier functionality.

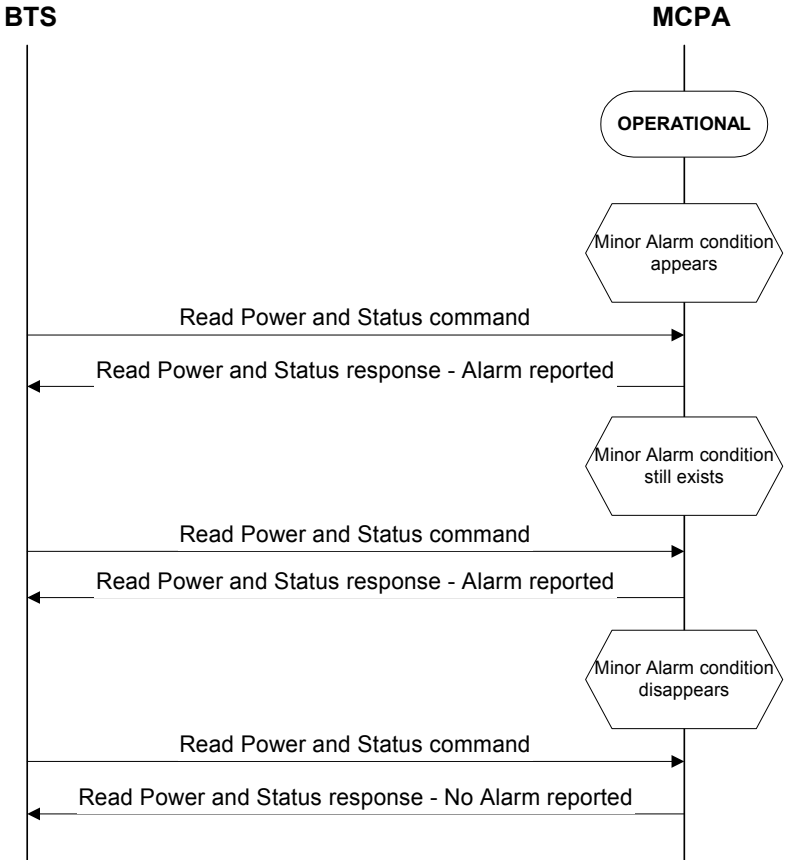

Figure 4-2 Minor Alarm Reporting Sequence

4-7.1.1 Main Loop Cancellation Alarm (1st Loop Alarm)

During normal operation, if the 1st Loop is not locked for 30 seconds a Main Loop Cancellation Alarm is declared. During power-up, the BTS waits for 30 seconds to allow the 1st Loop to lock. When the main amplifier is first turned on, the Main Loop Cancellation Alarm ON is on until the loops converge. The BTS allows 30 seconds for the alarm to clear after putting the amplifier into Operational mode before reporting the alarm.

4-7.1.2 Error Loop Cancellation Alarm (2nd Loop Alarm)

During normal operation, if the 2nd Loop is not locked for 30 seconds a Error Loop Cancellation Alarm is declared. During power-up, the BTS waits for 30 seconds to allow the 2nd Loop to lock. When the error amplifier is first turned on, the Error Loop Cancellation Alarm ON status is on until the loops converge. The BTS allows 30 seconds for the alarm to clear after putting the amplifier into Operational mode before reporting the alarm.

Detected loss of pilot signal with the error amplifier on, also leads to an Error Loop Cancellation Alarm.

4-7.1.3 Gain Alarm

The gain alarm is caused by either of the following conditions:

- No output power with a nominal input power.
  (P_{in} > -3.8 dBm and P_{out} < 25 dBm for five seconds.
- P_{in} > +2.5 dB for five seconds.

4-7.1.4 Partial Failure of Main Amplifier Alarm (Transistor/Device Fail)

A sensor detects a main or error amplifier transistor failure. A transistor failure is detected as follows:

- When the main and error amplifiers are first turned on and converged, the Main VVA and Error VVA convergence points are compared to the Default Main VVA and Default Error VVA values (with temperature compensation). If either of the VVAs is significantly lower than its default value, the Partial Failure of Main Amplifier alarm is set.
- After the above test is performed, the Main VVA and Error VVA are continually monitored. If the Main VVA or Error VVA significantly drop then the Partial Failure of Main Amplifier alarm is set.

4-7.1.5 Over Temperature Warning Alarm

The MCPA will alarm if the temperature exceeds the normal operation temperature threshold (90ºC internal temperature sensor) for five seconds. This threshold is a few degrees below the Over Temperature Shutdown Alarm.

4-7.1.6 Power Supply Warning Alarm

The MCPA monitors the non-converter voltages, 15V, 5V and -5V power supply voltages and alarms when of any of these DC voltages fail for at least five seconds. The normal operating range for these voltages is: 15V $\pm$ 1.5V, 5V $\pm$ 0.5V and –5V $\pm$ 0.5.

4-7.1.7 High DC Power Consumption Warning Alarm

If input DC power exceeds 375W in Mode 1 or 300W in Mode 2, for five seconds, the High DC Power Consumption Warning Alarm is set.

4-7.2 Major Alarms

When a major alarm condition occurs, the alarm is latched into a major alarm condition. The amplifier alarm state is read by the BTS the next time the amplifier is poled by the BTS. After the alarm status is sent the major alarm register is not cleared. If the amplifier receives a "Enable Command" or "Clear Alarms Command", all major alarms will be cleared. If the amplifier is disabled, all major alarms are also cleared.

Major alarms cause the amplifier to enter a STANDBY state, and the transceiver(s) associated with the amplifier will be off-the-air. The error amplifier and main amplifier are turned off.

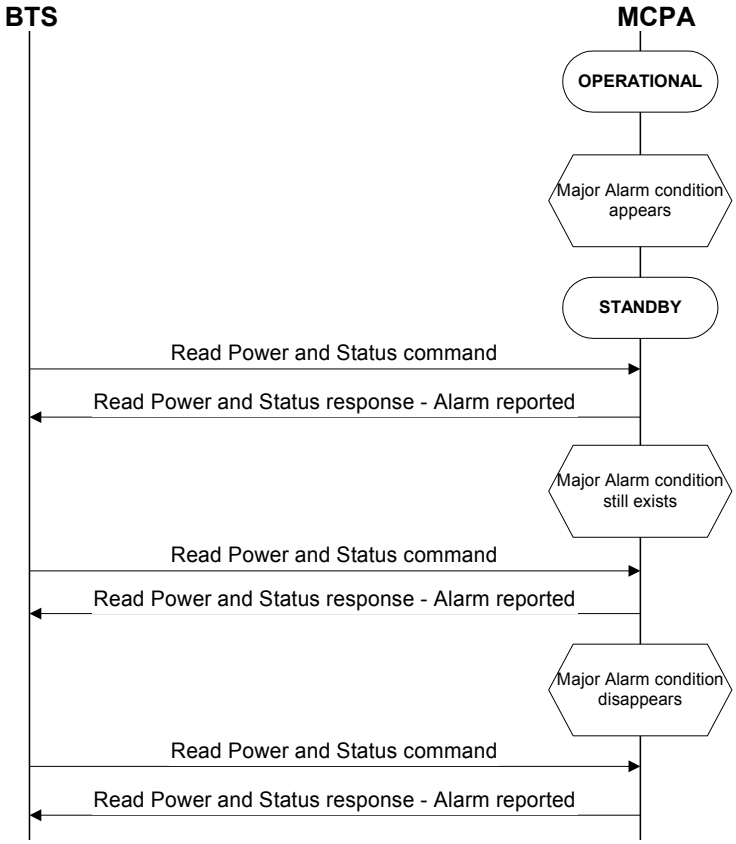

Figure 4-3 Major Alarm Reporting Sequence

4-7.2.1 Over Temperature Shutdown Alarm

The MCPA will alarm if the base plate temperature exceeds the temperature threshold at which the MCPA can be damaged (95ºC) for five seconds. This condition does not auto-recover and will require a reset command when the condition is corrected and the amplifier module has cooled sufficiently.

4-7.2.2 Power Supply Shutdown Alarm

The MCPA monitors the converter power supply output voltages, 28V (23V in Mode 2) and 9V, and sets the Power Supply Shutdown Alarm if a power supply converter fails for five seconds or longer. The alarm is set under the following conditions and does not auto-recover:

- 28V > 30.8V or 28V < 24.8V in Mode 1 or 24V > 25.75V or 24V < 20.25V in Mode 2.
- 9V > 9.9V or 9V < 8.1V

4-7.2.3 High DC Power Consumption Shutdown Alarm

If input power exceeds 417W in Mode 1 or 330W in Mode 2, for one second, the High DC Power Consumption Shutdown Alarm is set.

Table 4-1 Alarm Summary

Alarm Definition	Implementation	Persistence Time
Temperature Overload (Major)	Temp Sensor Temperature > 90ºC	5 seconds
High Temperature (Minor)	Temp Sensor Temperature > 85ºC	5 seconds
DC/DC Converter Shutdown (Major)	9V or 28V (23V in Mode 2) more than 10% out of tolerance	5 seconds
DC Voltage Regulation Failure (Minor)	5V, -5V, +15V more than 10% out of tolerance	5 seconds
DC Power Consumption Overload (Major)	Mode 1: Input DC power > 417W Mode 2: Input DC power > 330W	1 second
High DC Power Consumption (Minor)	Mode 1: Input DC power > 375W Mode 2: Input DC power > 300W	5 seconds
Gain Control (Minor)	1. Input Power > +2.5 dB OR 2. Input Power > -3.8 dB AND Output Power < 25 dBm	5 seconds (both)
Partial Failure of Main Amplifier (Minor)	Main Amp or Error Amp transistor failure detected.	---
Main Cancellation Loop (Minor)	1st Loop Error > 2.5V (No persistence when amplifier first enabled.)	30 seconds
Error Cancellation Loop (Minor)	2nd Loop Error > 2000 (No persistence when amplifier first enabled.) Loss of Pilot detected.	30 seconds (on item 1)