Chapter 4 Principles of Operation

4-1 Introduction

This chapter contains a functional description of the G3L-850-135 Multi-Carrier Power Amplifier (MCPA).

4-2 RF Input Signal

The maximum input power for all carrier frequencies to the amplifier should not exceed the limits specified in Table 1-2

4-3 RF Output Load

For good power transfer to the RF load, the load impedance should be as closely matched to the output impedance of the amplifier as possible. A VSWR of less than 1.5:1 across the working band of frequencies is satisfactory. If the amplifier is operated into a filter, it maintains its distortion characteristics outside the signal band even if the VSWR is infinite. A parasitic signal of less than one-watt incident on the output will not cause distortion at a higher level than the normal forward distortion (i.e. -65 dBc).

4-4 Functional Description

The Multi-Carrier Power Amplifier (MCPA) is a linear, feedforward amplifier that operates in the frequency band from 869 MHz to 894 MHz with an instantaneous bandwidth of less than 25 MHz (refer to Table 1-2 for amplifier specifications). The instantaneous bandwidth is the maximum frequency band that a set of two or more signals can occupy .The amplifier's instantaneous bandwidth is set automatically and does not require any manual setup. The amplifier provides a gain of 63 dB. Typical outputs for different carrier types are specified in Table 1-2.

Each amplifier is a self-contained module and is functionally independent of any other MCPA in a system. The amplifiers are designed for parallel operation to achieve a high peak power output. Each MCPA has an alarm board that monitors the amplifier performance. If a failure or fault occurs in an MCPA, it is transmitted to a subrack system via the D-sub 21WA4 connector located at the rear of the module. The subrack reports all alarms to the host system.

Continuously comparing active paths with passive references, and correcting for small variations through RF feedback controls maintain constant gain. All gain variations, for example those due to temperature, are reduced to the passive reference variations.

Refer to Figure 4-1 for the amplifier functional block diagram. The amplifier consists of the following major functional blocks:

- Preamplifier
- Main amplifier
- Error amplifier
- Alarm monitoring and control
- First and second loop control circuits
- Pilot tone generator

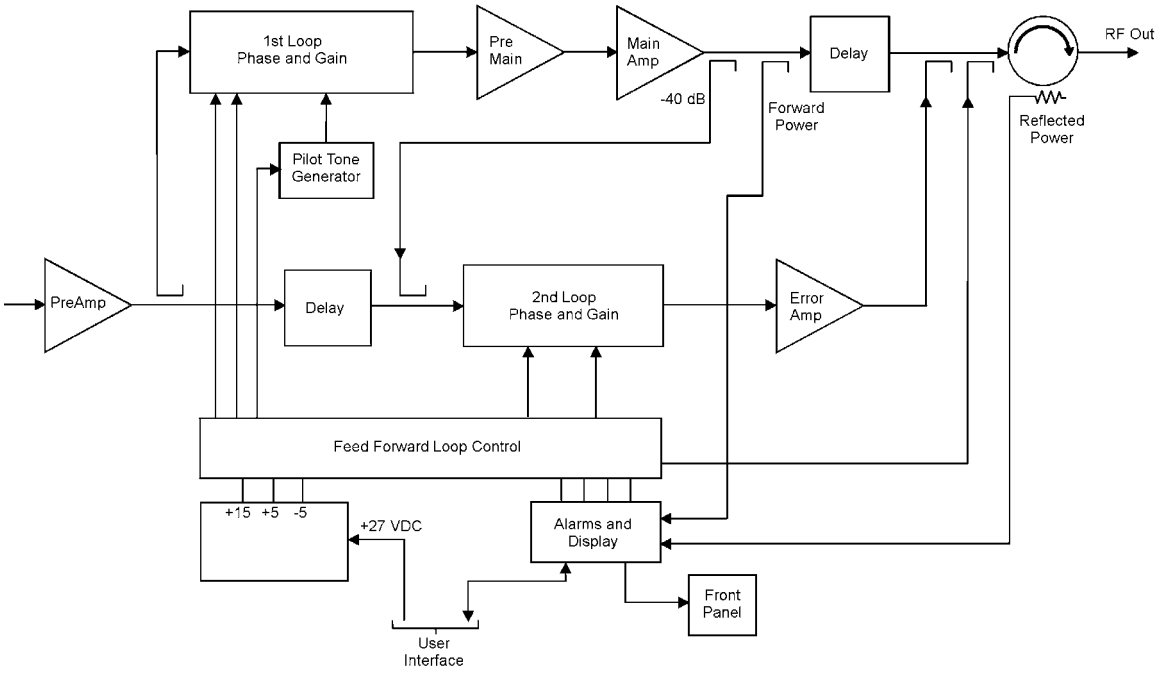

Figure 4-1. Functional Block Diagram

4-4.1 Preamplifier

The RF carriers are applied to the input port of the amplifier, where they are fed to the preamplifier stage. The preamplifier provides two stages of class-A mode-amplification. The output of the preamplifier is then split into two paths, one to the main amplifier and one to the error amplifier.

4-4.2 Main and Error Amplifiers

The main amplifier provides the balance of gain and power (refer to Table 1-1 for amplifier specifications). The main amplifier employs class AB amplification for maximum efficiency. The error amplifier and feed forward loops are used to correct signal distortion introduced by non-linearity in the class AB main amplifier. The error amplifier operates in class A mode. The RF signal from the preamp is coupled to an attenuator and phase shifter in the first feed-forward loop where it is phase shifted by 180 degrees and amplified in the pre-main amplifier. The output from the pre-main amplifier is fed to the class AB main amplifier. The signal output from the main amplifier is sampled using a coupler, and the sample signal is combined with the main input signal and input to the second feed-forward loop.

The error signal is attenuated, phase shifted 180 degrees, then fed to the error amplifier where it is amplified to a level identical to the sample output from the main amplifier. The output from the error amplifier is then coupled back and added to the output from the main amplifier. The control loops continuously make adjustments to cancel out any distortion in the final output signals.

4-4.3 Alarm Monitoring and Control

The alarm logic controls the +5 Vdc bias voltage that shuts down the amplifier. During routine operation, all normal variations are automatically compensated for by the feed-forward loop control. However, when large variations occur beyond the adjustment range of the loop control, a

loop fault occurs. When this happens, an alarm indicator is illuminated on the front panel of the subrack. The fault is transmitted back to an external summary module via the external alarm interface connection on the front panel of the subrack.

4-4.4 First and Second Loop Control Circuits

The primary function of the first loop is to amplify the carrier signals and isolate an error signal for the second loop. The primary function of the second loop is to amplify the error signal to cancel out spurious products developed in the main amplifier. The input signal is amplified by a preamplifier and fed to a coupler and delay line. The signal from the coupler is fed to the attenuator and phase shifter in the first loop. The first loop control section phase shifts the main input signals by 180 degrees and constantly monitors the output for correct phase and gain.

The second loop control section obtains a sample of the distortion added to the output signals by the main amplifiers. The signal is phase shifted 180 degrees, then fed to the error amplifier where it is amplified to the same power level as the input sample. The signal is then coupled to the error signal of the main amplifier output. The final output is monitored by the second loop and adjusted to ensure that the signal distortion and intermodulation distortion (IMD) on the final output is cancelled out.

4-4.5 Pilot Tone Generator

A Pilot Tone is an internally generated signal, who's precise frequency, phase, and amplitude is known. The basic idea of injecting a pilot tone is that if the pilot signal is suppressed at the amplifier output, then the distortion created by the main amplifier is also suppressed. To accomplish this, the pilot tone signal is injected into the first loop and then detected at the feedforward output of the second loop. The pilot tone is coupled off of the main amplifier, thus creating a second pilot tone, attenuated and phase shifted 180 degrees to be used as the reference. This second pilot tone is then amplified in the error amplifier and mixed with the signals from the main signal path. Ideally, the two pilot tones, both amplified, should cancel each other out. If they do not cancel each other out, as determined by an output detector, the information is fed back to control the gain and phase of both the main and error amplifier paths such that the output distortion is minimized.

4-5 Amplifier Module Cooling

The amplifier is cooled by forced air flowing over its heat sink, which is provided by external fans mounted on the MCPA subrack. The fans are field replaceable. Each amplifier, when properly cooled, maintains the amplifier within the specified operating temperature range. Six inches of free space are required at both the front and rear panels of the subrack to allow adequate air volume to circulate over the heat sinks.

4-6 Power Distribution

Primary DC power for the amplifier is provided by the host system. The amplifier module has a DC/DC converter and voltage regulator that converts the +27 Vdc to +15 Vdc, +5 Vdc, and -5 Vdc for internal use.

4-7 Amplifier Alarms

Causes for MCPA alarms are given in Table 4-1. Conditions external to the amplifier should be investigated before replacing the amplifier, particularly if more than one amplifier exhibits a critical alarm. Alarm conditions are reported to the amplifier subrack via RS-485 or TTL interfaces. Other than the front panel LEDs (described in chapter 3), there are no other visual aids for the technician.

Table 4-1. G3L-850-135 Alarm States

Major Alarm *- Causes MCPA RF section to be disabled*			***Minor Alarm*** *- Does not cause MCPA RF section to be disabled*	
Amplifier Alarm	**Definition**	**Amplifier Mode**	**Auto-Recovery**	**Event/Fault Log**
Output Overpower	Disable the MCPA immediately if the output power is >2 dB over rated power.	Major	No auto recovery. Requires manual reset. Output power must be decreased to < 2 dB over rated power.	Records output overpower event after system disabled
Automatic Power Control (APC)	Enabled if the output power is > 50 dBm Note: If the MCPA cannot compensate the gain to maintain compliance, the Output Overpower or Input Overdrive Faults will protect the MCPA.	Minor (Yellow LED display)	Amplifier auto-recovers when the output power drops below the rated maximum output power.	Records APC event and auto-recovery event if auto-recovery successful
Input Overdrive	Disable the MCPA immediately if the input RF power is > -6.0 dBm	Major	No auto recovery. Requires manual reset. Input power must be decreased to < -6.6 dBm.	Records input overdrive event, system disable event, each auto recovery event*
High Temperature	Sensor temperature is > +88° C	Major	Amplifier auto-recovers when the sensor temperature drops to < +73° C.	Records over temperature event, system disable event, each auto recovery event,
Reflected Power	Reverse RF output power is > +47.8 dBm for a duration of 1-minute	Major	No auto-recovery. Requires manual reset. Reverse power must be < 50% of the maximum rated forward output power.	Records high reflected power event, each auto recovery event*
High Voltage	Disable the MCPA immediately if the supply DC voltage > +30.5 Vdc	Major	Auto-recovery when the supply voltage drops to < +30.0 Vdc	Records supply DC fault event, system disable event, each auto recovery event*
Low Voltage	Disable the MCPA immediately if the supply DC voltage < +20.5 Vdc	Major	Auto-recovery when the supply voltage increases to > +24 Vdc	Records low voltage event, system disable event, each auto recovery event*

Major Alarm *- Causes MCPA RF section to be disabled*			***Minor Alarm*** *- Does not cause MCPA RF section to be disabled*	
Amplifier Alarm	**Definition**	**Amplifier Mode**	**Auto-Recovery**	**Event/Fault Log**
Loop Fail	Loop convergence fail	Major	Loop converges. Tries to auto recover 10 times before permanent shut down. 2 minutes and 5 seconds for each try.	Records internal DC fault event, system disable event, each auto recovery event*
Internal DC Fail	Internal voltages fail or out of range	Minor (no LED display)	Auto-recovery once the voltage is within the range. No shutdown until Linearization alarm occurs.	Records internal DC fail event, system disable event, each auto recovery event*
Device Fail	One or more output power devices fail	Minor (no LED display)	No auto-recovery. No shutdown until Linearization alarm occurs.	Records device fault event