Principles of Operation

1-1 Introduction

This chapter contains functional descriptions of the G3L-929-135 Multi-Carrier Power Amplifier (MCPA).

1-2 RF Input Signal

The maximum input power for all carrier frequencies to the MCPA should not exceed the limits specified in **Error! Reference source not found.**

1-3 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 MCPA as possible. A VSWR of less than 1.5:1 across the working band of frequencies is satisfactory. If the MCPA is operated into a filter, it maintains its distortion characteristics outside the signal band even if 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).

1-4 Functional Description

The MCPA is a linear, feed-forward amplifier that operates in the frequency band from 935 MHz to 940 MHz with an instantaneous bandwidth of less than 5 MHz. Instantaneous bandwidth is the maximum frequency band that a set of two or more signals can occupy .The MCPA's instantaneous bandwidth is set automatically and does not require manual setup. The MCPA provides a gain of 63 dB. Typical outputs for different carrier types are specified in **Error! Reference source not found.**.

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

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

Refer to Figure 0-1 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

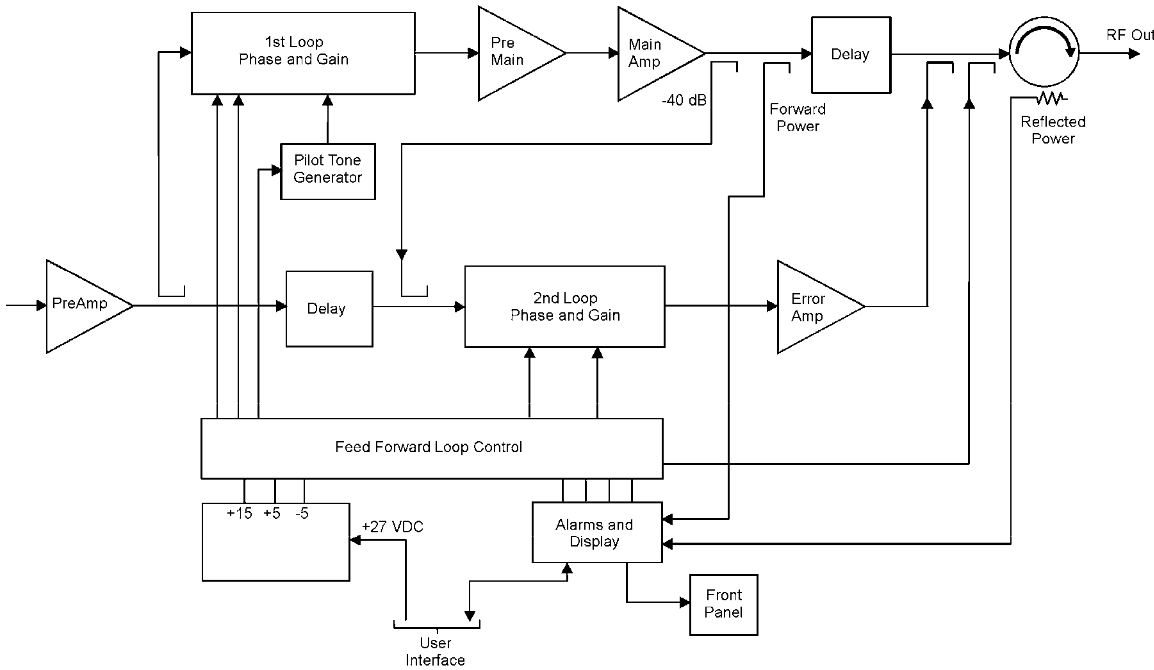

Figure 0-1. Functional Block Diagram

1-4.1 Preamplifier

The RF carriers are applied to the input port of the MCPA, 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.

1-4.2 Main and Error Amplifiers

The main amplifier provides a balance of gain and power and employs class AB amplification for maximum efficiency. The error amplifier and feed forward loops 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.

1-4.3 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 sub-rack. The fault is transmitted back to an external summary module via the external alarm interface connection on the front panel of the sub-rack.

1-4.4 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.

1-4.5 Pilot Tone Generator

A pilot tone is an internally generated signal, who’s precise frequency, phase, and amplitude is known. Passing through the amplifier, the pilot tone is distorted in the same way that signals are distorted. To accomplish this, the pilot tone signal is injected into the first loop and then detected at the feed-forward 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.

1-5 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 sub-rack. 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 sub-rack to allow adequate air volume to circulate over the heat sinks.

1-6 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.

1-7 *Amplifier Alarms*

The amplifier alarms are listed and described in Table 0-1. The front panel LEDs are described in Chapter 3.

Table 0-1. G3L-929-135 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	Input power decreases below APC threshold (-11.2 dBm)	Records output overpower event after system disabled
Automatic Power Control (APC)	Enabled if the output power is > 51.7 dBm ± 0.3 dB 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 51.6 ± 0.3 dB.	
Input Overdrive	Disable the MCPA immediately if the input RF power is more than –5.7 dBm	Major	Input power decreases below APC threshold (-11.2 dBm)	Records input overdrive event, system disable event, each auto recovery event*
High Temperature	Sensor temperature is > +85° C	Major	Amplifier auto-recovers when the sensor temperature drops to < +75° C.	Records over temperature event, system disable event, each auto recovery event,
Low Gain	Disable the MCPA if the gain of the MPCA is lower than +50 dB for a duration of 1 minute with input power no more than 33 dBm	Major (Blinking yellow LED display)	The amplifier attempts to increase gain to more than +50 dB. After 10 unsuccessful attempts, permanent shutdown.	Records low gain event, system disable event, each auto recovery event,
Reflected Power	Reverse RF output power is > +48.3 dBm for a duration of 1-minute	Major	MCPA waits 15 min before initiating autorecovery. Amplifier recovers if reverse power is below +48.3 dBm	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 < +29.5 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*

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Loop Fail	Loop convergence fail	Major	Loop converges. Tries to auto recover 10 times before permanent shut down.	Records internal DC fault event, system disable event, each auto recovery event*
Internal DC Fail	Internal voltages failed or out of range	Minor (no LED display)	Auto-recovery once the voltage is within the range. After 10 attempts, if still unsuccessful, permanent shutdown.	Records internal DC fail event, system disable event, each auto recovery event*
Device Fail	One or more output power devices fail	Major	10 auto-recovery attempts; if still unsuccessful, permanent shutdown..	Records device fault event