Operational description

4.1 Introduction

This section contains a functional description of the multi-carrier power amplifier.

4.2 RF Input Signal

The maximum input signal for all carrier frequencies must not exceed the limits specified in the electrical specifications. The input VSWR should be 2:1 maximum (or better).

4.3 RF Output Load

The load impedance should be as close as possible to 50 ohms (VSWR of 1.5:1 or less) over the 869-894 MHz operating frequency band to ensure maximum RF power transfer to the load.

4.4 System Functional Description

The MCPA amplifier is a multi-carrier, feed forward power amplifier, which operates from 869 to 894 MHz with a rated output power of 120W total (average). The amplifier employs feed forward carrier cancellation circuitry, providing extremely low intermodulation products, equal to or less than –63 dBc. The front panel of the amplifier contains the DC ON/OFF switch, and the status LEDs. The amplifier operates from a 26-28 VDC input power source, and provides a rear panel input/output (I/O) control and status interface to report all faults and alarms. Relay dry contacts are provided for the following fault conditions:

OVERPWR – Relay dry contact closure provided for remote notification in the event that the MCPA output is greater than 2 dB above the nominal operating power level. The MCPA power will need to be reset in order to clear this fault condition.

MINORFLT – Relay dry contact closure provided for remote notification in the event that the MCPA has encountered a minor fault condition, which has not caused shut down of the amplifier, but which will require attention as soon as possible in order to ensure uninterrupted operation. A TEMP WARNING or FAN ALARM will result in a MINORFLT condition and remote notification. The MCPA power will need to be reset in order to clear this fault condition.

MAJORFLT – Relay dry contact closure provided for remote notification in the event of a potentially damaging fault condition, which has resulted in shut down of the MCPA. Activation of the LOOP ALARM, VSWR ALARM, POWER SUPPLY ALARM, TEMP ALARM and OVERPOWER ALARMS will result in a MAJORFLT condition and remote notification. The MCPA power will need to be reset in order to clear this fault condition. TTL control inputs are provided at the I/O interface.

The Control and Status interface is an 8-bit asynchronous serial bus, which complies with the EIA/TIA 232-E type Standard for Electrical Characteristics for use in Balanced Digital Systems. The communications protocol is as follows:

- Half Duplex
- 1 Start bit
- 1 Stop bit
- 8 Data bits
- No Parity
- 9600 bits per second (baud)

The MCPA will respond to commands, and will send a response only when commanded first.

Although the MCPA contains no user-serviceable components (with the exception of the fan assemblies), the following paragraphs provide operating principles, and a general overview of its operation.

The amplifier is comprised of the following internal functional elements:

- Carrier Cancellation
- Main/Error Driver Amplifier
- Main Amplifier
- Error Amplifier
- DC/DC Function
- Microprocessor Control
- Loop Processor
- Pre-distorter

The main amplifier employs class AB amplification for maximum efficiency and low intermodulation distortion. The error amplifier and main/error driver amplifiers operate class A mode. The input RF signal is amplified by the carrier cancellation circuit, and then split into a signal and a reference path. The signal path is sent through the main driver amplifier, where the amplitude and phase are modified, based on the reference signal, and then amplified by the main amplifier. The signal is coupled to the carrier cancellation circuit where the 180 ° phase shifted and amplified signal meets the reference signal. At this point the combined signal, which has a canceled carrier (called the IMD signal), is sent to the IMD leg of the feed forward amplifier. The IMD signal is sent to the error driver amplifier and error amplifier. Signal amplitude and phase are adjusted from the input by the loop processor. The signal is re-injected into the main amplifier output signal, and the combined signal yields suppression of intermodulation products of -65 dBc minimum.

The following paragraphs describe each of the functional elements of the MCPA.

4.4.1 Main Amplifier

The main amplifier operates class AB, and provides approximately 29.5 dB of gain over the operating frequency band of 869-894 MHz. It operates from 27 VDC and utilizes 15 VDC to derive bias. The main amplifier is directly mounted to the heatsink. Within the main amplifier are temperature sensors, which detect the baseplate (heatsink) temperature. In the event that the heatsink temperature reaches approximately +80 °C, the TEMP WARNING (yellow) LED will be illuminated. Operation of the MCPA may continue during this condition. In addition, should the heatsink temperature further rise to approximately +90°C, bias to the internal amplifier is shut down to prevent damage during the over temperature condition. The TEMP ALARM (red) LED will be illuminated. Operation of the MCPA is inhibited until the heatsink temperature has returned to a safe operating level. The fault condition will automatically self-clear when the heatsink has cooled to a safe level, and normal operation will again be restored. The cause of any TEMP WARNING or TEMP ALARM condition should be investigated as soon as possible to ensure continuous uninterrupted MCPA operation.

4.4.2 Error Amplifier

The main function of the error amplifier is to amplify the distortion products generated by the main amplifier. These distortion products are amplified and precisely phaseshifted (180° with those at the output), such that when they are combined with the main signal at the output of the amplifier, the result is cancellation of the distortion products. The error amplifier operates class A, has 57 dB of gain, and produces 2 watts of output. The amplifier operates from 27 VDC, and utilizes 15 VDC to derive bias. The error amplifier is mounted to the heatsink, and utilizes an output circulator to protect the error amplifier output. The load port of the circulator is connected to a detector to monitor reflected power. The resulting analog voltage is monitored by the microprocessor to prevent operation and damage to the MCPA in the event of excessive load VSWR. In the event of a load VSWR of greater than 3.0:1, the microprocessor will cause the

MCPA to go into a VSWR FAULT mode, and remove bias to the internal amplifier for protection. Illumination of the front panel VSWR alarm indicator confirms this condition. The fault condition may be reset by re-setting power to the MCPA.

4.4.3 Amplitude and Phase Adjustment
The two loops are controlled via the microprocessor through the main and error driver amplifiers. The amplifiers include vector control circuitry to adjust amplitude and of the RF signals. The microprocessor controls the amplitude and phase adjustments of the two loops. The loop processor responds to the amplitude and phase of the IMD loops. In the event of a failure of the loops or processor, the front panel LOOP alarm indicator will be illuminated, and further operation of the MCPA will be inhibited. The fault condition may be reset by re-setting power to the MCPA.

4.4.4 Amplifier Module Cooling
The amplifier is cooled via forced air through the heatsink. Two rear fans are used to draw air through the heatsink. The fans are field replaceable and are monitored for fan faults. In the event of a fan failure, the front panel FAN alarm indicator will be illuminated. Operation of the MCPA will continue, however, at some point, the TEMP WARN/ALARM circuitry may be activated due to reduced cooling, and may inhibitMCPA operation (refer to paragraph 4.4.1). The fan(s) are externally mounted and are easily replaced without removal of any of the MCPA covers, and without the need to shut down the MCPA.

4.5 Power Distribution
The amplifier employs a DC/DC converter to regulate the amplifier sub-circuits to the required voltage, based on a 26-28 VDC input. The power supply board converts the input voltage to +/-5V, and +/-15V used by the loop processor and microprocessor. Internal monitoring circuitry monitors the supply voltages, and activates the front panel POWER SUPPLY alarm LED indicator in the event of a fault. Operation of the MCPA is inhibited following detection of this fault . The fault condition may be reset by resetting power to the MCPA.

4.6 Intermodulation Distortion Performance
The MCPA amplifier is designed to deliver a 120W average power, multicarrier signal, with extremely low intermodulation products, over the passband of 869-894 MHz.

4.6.1 Intermodulation Distortion
When measured with fifty (50) random phase sets, intermodulation products are below -63 dBc.

4.7 Description of Operating Modes

4.7.1 **Default** mode
When **initially** powered up (or installed into the shelf), the MCPA amplifier defaults to the standby mode after a brief initialization sequence is completed. During the initialization sequence, the LEDs on the front panel will briefly illuminate.

4.7.2 **Standby** Mode:
(All LEDs off) The MCPA has not had the DC power switch pressed and is not biased on. Low level communication (e.g. between the subrack and amplifier) is enabled.

4.7.3 **DC On** Mode
(DC Switch LED – ON) The front panel DC on switch has been depressed, and the integral LED indicator is illuminated. When used with the Ericsson Amplifier Technologies subrack, the subrack acknowledges the initial operation of the module and configures the subrack to insert the module into the combining circuit, provided the module does not indicate an alarm which would shutdown the module. Thus the module system will reconfigure itself automatically as the additional modules are (DC) powered-up, to effectively use the new module.

4.7.4 **Enable** Mode
(DC Switch and Enable LED – ON) The MCPA is amplifying the signal. (When used with Ericsson Amplifier Technologies subrack, all power is being combined.)

4.7.5 **Shutdown** Mode
Any of these LEDs ON: VSWR, OVER PWR, TEMP/WARN, LOOP or PWR SPLY The MCPA amplifier has turned itself off for protection. All alarm indications are latched, and the amplifier is shutdown. The amplifier can be reset by pressing the DC switch. If the alarm still exists, the amplifier will re-enter the shutdown mode.

4.7.6 **ALC** Mode
(Blinking OVER PWR LED) The module supports power limiting to mitigate an overdrive condition. When the OVER PWR LED blinks, the module has entered the ALC mode. In the ALC mode, the module limits the maximum transmit power to 0.5 dB above nominal output power by reducing the gain of the MCPA. The gain of the MCPA is continuously adjusted to maintain this limited value. If the loop circuits can no longer maintain the limited value due to excessive input power, the MCPA will protected itself by shutting down and indicate a overdrive condition with a steady OVER PWR LED indication. After 30 seconds, the MCPA will turn back on in the minimum gain setting, and attempt to limit power once again. If the power is still too high during the subsequent attempt, the module will overdrive again and shutdown. The re-enable sequence will be performed three times before the module remains shutdown, and will require re-initialization (power up sequence) in order to reset.

If the output power is below the limited value during a subsequent attempt, the gain of the module will be increased until either the limited value is reached, or nominal gain is restored.

4.7.7 **Locking** Mode
(Blinking LOOP LED) The locking mode is used to indicate that the module is unable to minimize IMD performance, and is attempting to adjust loop coefficients. During this mode IMD performance may not meet specified values. The module will attempt to improve performance for 1 minute. If unable to improve performance during this period, the module will indicate a loop alarm and enter the shutdown mode.