Section

4

PRINCIPLES OF OPERATION

4-1. INTRODUCTION
This section contains a functional description of the Multicarrier Cellular Amplifier System.

4-2. RF INPUT SIGNAL
The maximum input power for all carrier frequencies should not exceed the limits specified in table 1-2. For proper amplifier loop balance, the out of band components of the input signals should not exceed -60 dBc. The input VSWR should be 2:1 maximum (or better).

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. If the amplifier is operated into a filter, it will maintain its distortion characteristics outside the signal band even if the VSWR is infinite, provided the reflected power does not exceed one watt. 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. -60 dBc).

4-4. SYSTEM FUNCTIONAL DESCRIPTION
The amplifier system is comprised of an MCR20XX Series (NTL107AC) subrack and one or two G3X-800 Series (NTL107AA) plug-in power amplifier modules. The G3H-800 amplifier is a linear, feed-forward power amplifier that operates in the 25 MHz frequency band from 869 to 894 MHz. A typical two module system is shown in figure 4-1. Power output specifications for a one or two module system are listed in table 1-2. Each amplifier is a self-contained plug-in module and is functionally independent of other amplifier modules. The amplifier modules are designed for parallel operation to achieve high peak power output, and for redundancy in unmanned remote locations. The subrack houses a two-way splitter and active power combiner, control assembly, true RMS detector, and back-plane/in-rush current assembly. The rear panel of the subrack has I/O connectors that interface with the host system, RF signal source, system antenna, and the system DC power source. The amplifier system can simultaneously transmit multiple carrier frequencies, at an average total power output of 110 watts (one amplifier module in a subrack unit) to 200 watts (two amplifier modules), with -68 dBc third order intermodulation distortion (IMD).

A composite RF signal from the base station radios is applied to the RF input (J9) of the subrack. From there the signal passes through a voltage variable attenuator (VVA), then a two-way splitter. Each leg of the splitter passes through an isolator, then the blind-mate connector to interface with the MCPA. The signal then returns to the subrack via the blind-mate connector after being amplified by the MCPA modules. The two high-power signals are combined by the active power combiner. The active power combiner has the capability of switching MCPA channels off-line by the use of RF switches. If an MCPA is not present, turned off, or faulted, the switch will open in that channel and physically disconnect that MCPA. The combiner maintains its low insertion characteristics when used in the single path configuration. Note that the splitter is not switched, therefore the power is automatically reduced by 3 dB, thus eliminating an output overdrive condition. The output of the combiner is fed through a coupler, then a receive-band filter. The amplified RF signal is available for use at the output of the receive-band filter (J2). The coupler is used to sample the output power to the true RMS detector. The true RMS detector will supply the microcontroller with an accurate average power regardless of the signal modulation type. The dynamic range is 25 dB. The power reading is used during the gain initialization phase when deploying the system or monitoring to detect excessive output power. In both cases the VVA will be adjusted accordingly. Two non-RF features of the subrack system are inrush current limiting and alarm status/serial interface ports. The inrush current limiting circuitry is used to minimize the instantaneous current demand when the MCPA is first DC powered-up. This is due to the high capacitance on the MCPA's DC input. The circuit is placed in series on the DC source before the MCPA. Voltage for the subrack is derived prior to the in-rush current limit circuitry. The circuitry is in a high impedance state upon DC power-up. When an MCPA is enabled the impedance is slowly brought down to nearly 0 ohms. This will allow the capacitors to charge over a longer period of time, thus reducing the high current drain on the power supply. The three ports on the rear of the subrack are for Form-C alarms (J1), RS485/Addressing serial communication (J7) and RS485 and RS232 serial communication (J8). The J1, J7, and J8 connectors are detailed in chapter 2 (see figures 2-2, 2-3, and 2-4, and tables 2-2, 2-3, and 2-4). The serial interface allows the user to acquire MCPA internal voltages and status, exercise MCPA and VVA control, upgrade MCPA or subrack firmware, and obtain true RMS power readings.

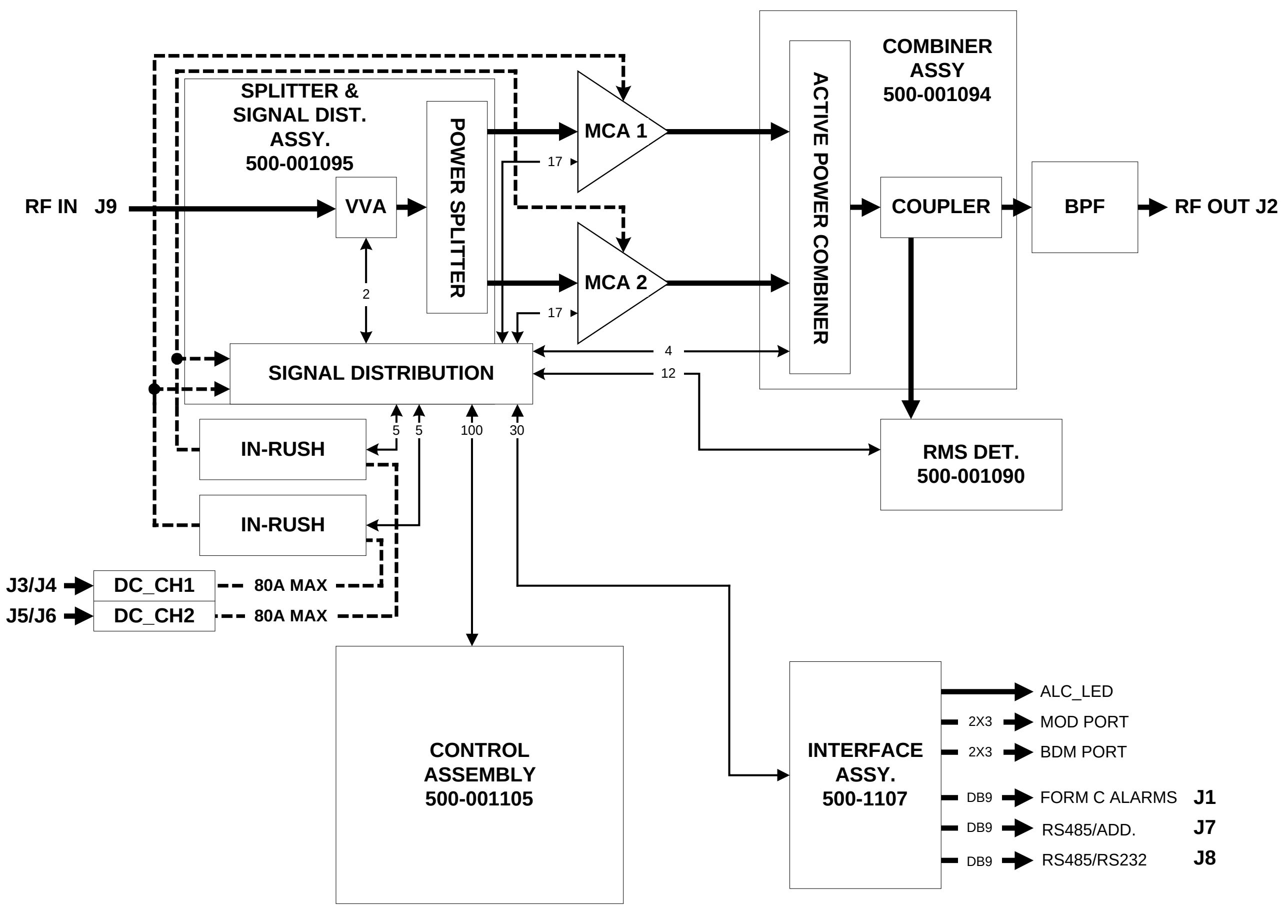

Figure 4-1. MCR20XX Series (NTL107AC) Two Module Amplifier System

4-5. MCR20XX Series (NTL107AC) SUBRACK

The MCR20XX Series (NTL107AC) subrack (see block diagram figure 4-1) is not field repairable. The subrack functions are described in section 4-4.

4-6. G3X-800 SERIES (NTL107AA) AMPLIFIER MODULE

The amplifier module, figure 4-2, has an average power output of 110 watts with intermodulation products suppressed to better than -65 dBc below carrier levels. The amplifier provides an amplified output signal with constant gain and phase by adding approximately 30 dB of distortion cancellation on the output signal. Constant gain and phase is maintained by continuously comparing active paths with passive references, and correcting for small variations through the RF feedback controls. All gain and phase variations, for example those due to temperature, are reduced to the passive reference variations. The amplifier module is comprised of:

- Delay lines
- Couplers
- Preamplifiers
- Main amplifier
- Error amplifier
- Two feed-forward loops with phase-shift and gain controls
- DC/DC power regulator
- Alarm monitoring, control and display panel

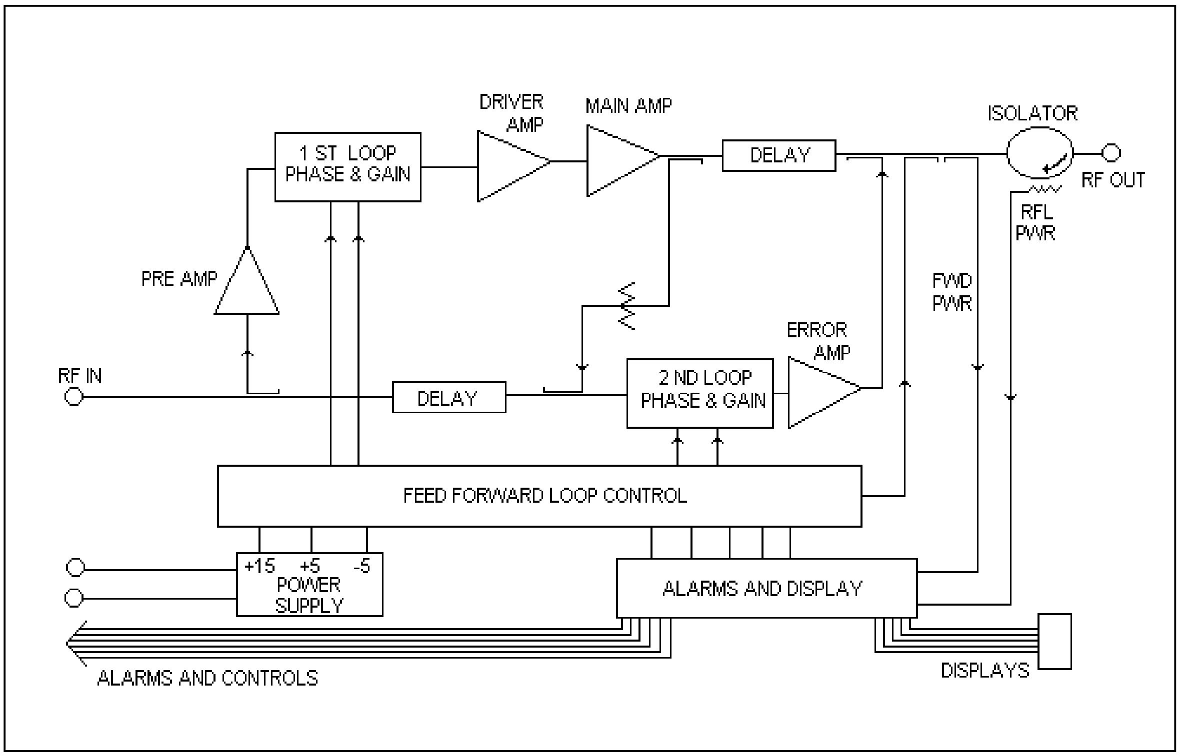

Figure 4-2. G3X-800 Series (NTL107AA) Power Amplifier Module Functional Block Diagram

The main amplifier employs class AB amplification for maximum efficiency. The error amplifier and feed forward loops are employed to correct signal nonlinearities introduced by the class AB main amplifier. The error amplifier operates in class AB mode. The RF input signals are coupled and amplified by a preamp, then fed to an attenuator and phase shifter in the first feedforward loop. The main signal is phase shifted by 180 degrees and amplified in the premain amplifier. The output from the driver amplifier is fed to the class AB main amplifier. The output from the main amplifier is typically 160 watts. The signal is output to several couplers and a delay line.

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 sampled 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.

The primary function of the first loop is to provide 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 fed to a coupler and delay line. The signal from the coupler is amplified by a preamplifier and 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 amplifier, phase shifts the signals by 180 degrees, then feeds it to the error amplifier. It is then amplified to the same power level as the input sample and coupled onto the main output signal. The final output is monitored by the second loop and adjusted to ensure that the signal distortion and IMD on the final output is canceled out.

4-6.1. MAIN AMPLIFIER

The input and output of the amplifier employ two-stage, class AB amplifiers which provide approximately 25 dB of gain in the 25 MHz frequency band from 869 to 894 MHz. The amplifier operates on +27 Vdc, and a bias voltage of +5 Vdc, and is mounted directly on a heat sink which is temperature monitored by a thermostat. If the heat sink temperature exceeds 85 °C, the thermostat opens and a high temperature fault occurs. The alarm logic controls the +5 Vdc bias voltage which shuts down the amplifier.

4-6.2. ERROR AMPLIFIER

The main function of the error amplifier is to sample and amplify the signal distortion level generated by the main amplifier, to a level that cancels out the distortion and IMD when the error signal is coupled onto the main signal at the amplifier output. The error amplifier is a balanced multistage, class AB amplifier, has 51 dB of gain and produces an 80-watt output. The amplifier operates on 27 Vdc and a bias voltage of +5 Vdc, and is mounted directly on a heat sink.

4-6.3. AMPLIFIER MONITORING

In the main and error amplifier modules, all normal variations are automatically compensated for by the feedforward loop control. However, when large variations occur beyond the adjustment range of the loop control, a loop fault will occur. The alarms are displayed on the front panel indicators and output via a 21-pin connector on the rear of the module to the subrack summary board for subsequent remote monitoring via the ALARMS connector. Refer to paragraph 2-5 as well as figure 2-2 and table 2-2 for a description of the ALARMS connector.

4-6.4. AMPLIFIER MODULE COOLING

Although each amplifier module contains its own heat sink, it is cooled with forced air. Four fans are used for forced air cooling and redundancy. The fans, located on the front and rear of the amplifier module, draw air in through the front of the amplifier and exhaust hot air out the back of the module. The fans are field replaceable.

4-7. POWER DISTRIBUTION

Primary DC power for the system is provided by the host system to the MCR20XX Series (NTL107AC) subrack. The subrack supplies each amplifier module with +27 Vdc directly and via the RF power splitter/combiner. The amplifier module has a DC/DC converter that converts the +27 Vdc to +15 Vdc, +5 Vdc and -5 Vdc.

4-8. INTERMODULATION

The G3X-800 amplifier is designed to deliver a 100-watt composite average power, multicarrier signal, occupying a bandwidth less than or equal to 25 MHz, in the bandwidth from 869 to 894 MHz. The maximum average power for linear operation, and thus the amplifier efficiency, will depend on the type of signal amplified.

4-8.1 TWO TONE INTERMODULATION

When measured with two equal CW tones spaced anywhere from 30 kHz to 20 MHz apart, and at any power level up to the average power, the third order intermodulation products will be below -65 dBc

4-8.2 MULTITONE INTERMODULATION

Adding more tones to the signal will lower individual intermodulation products. If the frequencies are not equally spaced, the level of intermodulation products gets very low. When the frequencies are equally spaced, those products fall on top of each other on the same frequency grid. The average power of all intermodulation beats falling on the same frequency is called the composite intermodulation; it is -65 dBc or better.

4-9. ALARMS

The presence of several plug-in amplifier alarms can be detected at the ALARMS connector on the subrack rear panel. Refer to table 2-2 and figure 2-2 for a description of the connector.