Surplus Power Amplifiers from Digital Communication Services

With the existence of the commercial digital communication services between 1.5 and 2.5 GHz., its easy to understand that eventually equipment from these services would become replaced because of obsolescence of replacements components, or because newer technology is better and more efficient. This paper along with the presentation will demonstrate the testing and utilization of one particular high power unit by armature standards, that was replaced because of failure.

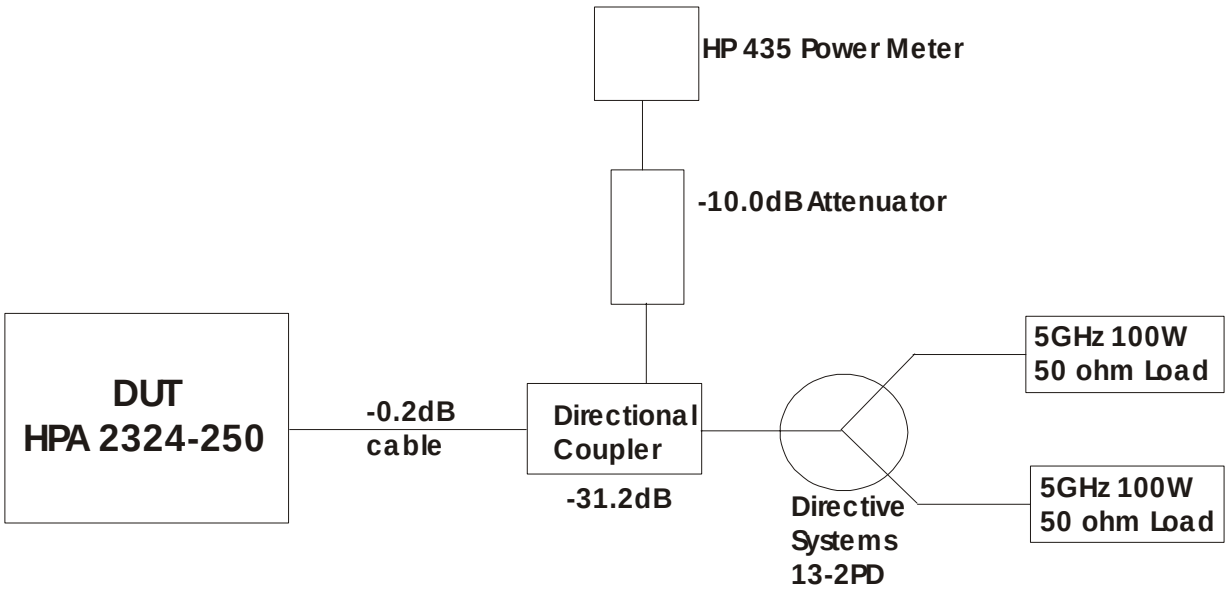
The "High Power" operation between 1.5 and 2.5 GHz include PCN/PCS phone service, various satellite up links, paging services and terrestrial satellite radio service. In particular, the terrestrial satellite radio service is utilized to produce coverage where the original satellite signal may be shielded by buildings, tunnels and dense foliage. The system is installed at common sites such as Cellular Telephone. There you will sometimes find phased antennas with equipment capable of producing ERP's approaching 100's of Kilowatts. The RF power generated could be from as many as eight separate high power amplifiers combined together. This paper/presentation is about one of those separate amplifiers. We will review its design, discuss how to test, and how to "Safely" use in the 2.3 GHz amateur band.

There are many different manufactures producing amplifiers in the 2.3 GHz. region. This allows the commercial providers 2nd and 3rd sources for power amplifiers. When you combine this with extended production time periods where improvements in technology and "Better Ideas" have been implemented, it results in different physical looking power amplifiers with the similar specifications. Bottom line is, your search could produce a unit that looks different but has similar specifications. BUT, to contradict this statement, It is an advantage for a manufactures to design as generically as possible, possibly producing a unit that looks identical but operates at a different frequency specifications.

The main components of this amplifier was manufactured by MPD of New York. Its has a multi-stage preamplifier for a 10 mW drive level, driving a single high power amplifier. The output of this amplifier is divided 5 ways and the signals drive 5 more identical power amplifiers before being re-combined. There is a digital signal control board and a separate power supply board that routes the input DC power to all modules in the unit. It is a very basic and simple design that is easily modified for a push to talk circuit. This unit in particular had a blown preamplifier so 3-5 watts was required to drive the final two stages. If you are thinking this would be a great unit to have, Please review the following list of facts generated not to scare anyone, but to allow one to understand how serious an amplifier this and others amplifiers from this service are.

1. It weighs 95 lbs. and measures 30” x 24” x 7” high. 5" of the height dimension is heat sink fins with fans attached
2. It has brackets for hanging on a wall.
3. It has a DIN output connector, N input.
4. It should operate with 10 to 50 mW of RF drive if amplifier is operating correctly.
5. This unit is specified to operate at 250 Watts output, 24/7/365!
6. This amplifier *does not need* to be optimized for 2304 MHz.
7. A well regulated power supply with Voltage sensing should be utilized. Somewhere around 24-28 VDC @ 120 amps would be a good place to start for some serious output power!

Except for the 120 amps of current specification, you are ready to go, right? I thought I was! Lets discuss some testing problems. First examine the block diagram of the test setup remembering that his amplifier will produce 250 watts of output power.



Notice the power divider with two separate loads? Who has a dummy load at 2.3 GHz that can dissipate +200 watts? Not in my Ham shack! In fact, my final test setup was a 4 way power divider and 4 separate 100 watt loads. Also note the directional coupler and additional attenuation to allow the HP435 to measure 1KW full scale. The cable and other coaxial components need the ability to work correctly at these high levels with out dangerous RF radiation! Then once the RF power dissipation problem is solved, the +120 amps of supply current need to be adressed. Why so much current? Examine the Freescale/Motorola data sheet.

Freescale Semiconductor
Technical Data

Document Number: MRF19125
Rev. 6, 4/2006

RoHS

RF Power Field Effect Transistors

N-Channel Enhancement-Mode Lateral MOSFETs

MRF19125R3
MRF19125SR3

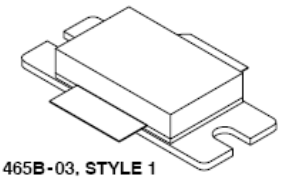
1930-1990 MHz, 125 W, 26 V
LATERAL N-CHANNEL
RF POWER MOSFETs

Designed for PCN and PCS base station applications with frequencies from 1900 to 2000 MHz. Suitable for TDMA, CDMA and multicarrier amplifier applications.

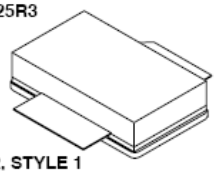
- Typical 2-Carrier N-CDMA Performance for V_{DD} = 26 Volts, I_{DQ} = 1300 mA, f1 = 1958.75 MHz, f2 = 1961.25 MHz
  IS-95 CDMA (Pilot, Sync, Paging, Traffic Codes 8 Through 13)
  1.2288 MHz Channel Bandwidth Carrier. Adjacent Channels Measured over a 30 kHz Bandwidth at f1 -885 kHz and f2 +885 kHz. Distortion Products Measured over 1.2288 MHz Bandwidth at f1 -2.5 MHz and f2 +2.5 MHz. Peak/Avg. = 9.8 dB @ 0.01% Probability on CCDF.
  Output Power — 24 Watts Avg.
  Power Gain — 13.6 dB
  Efficiency — 22%
  ACPR — -51 dB
  IM3 — -37.0 dBc
- Capable of Handling 5:1 VSWR, @ 26 Vdc, 1960 MHz, 125 Watts CW Output Power

Features

- Internally Matched for Ease of Use
- High Gain, High Efficiency and High Linearity
- Integrated ESD Protection
- Designed for Maximum Gain and Insertion Phase Flatness
- Excellent Thermal Stability
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 inch Reel.



CASE 465B-03, STYLE 1
NI-880
MRF191225R3



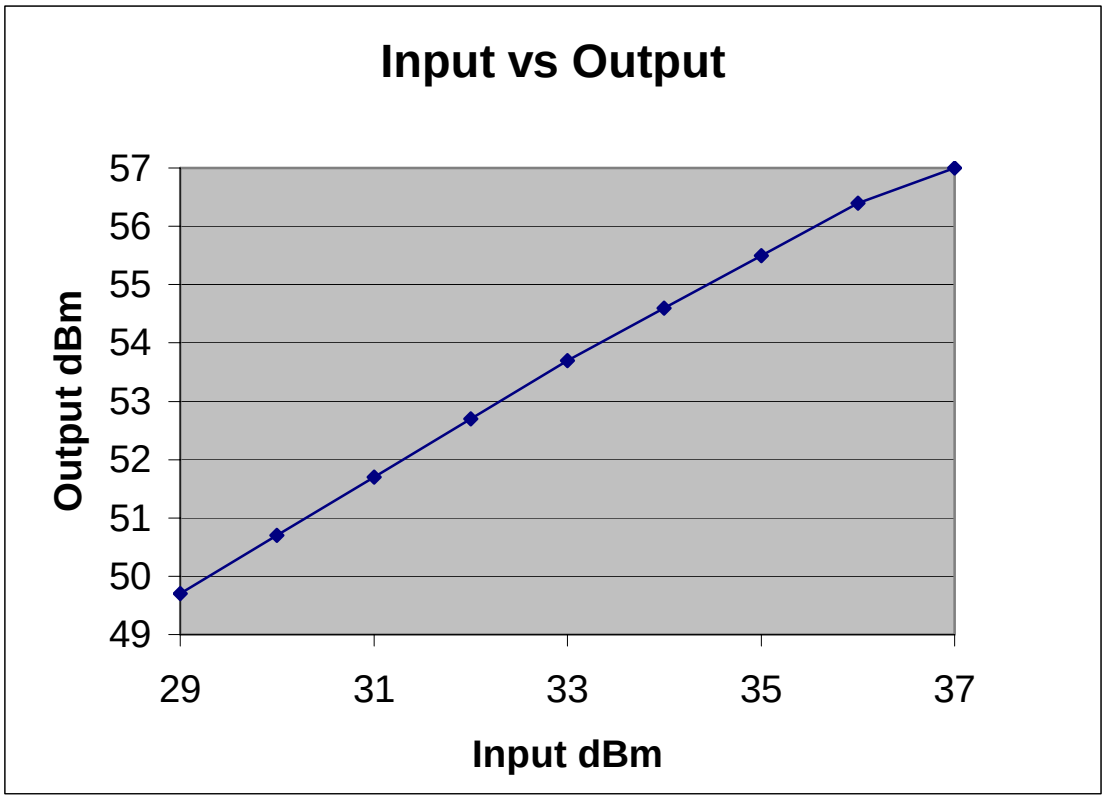
CASE 465C-02, STYLE 1
NI-880S
MRF19125SR3

This is one MOSFET. It is specified to produce 125 watts of CW output power @ 1960 MHz. Other data in the spec sheet, (See the Freescale web site) says the same power can be produced @ 2304 with a reduced gain of 11 to 12 dB and less efficiency.

In this amplifier, the first High power amplifier has two of these MOSFETs combined. That assemble drives five more, two MOSFET assemblies. That makes a total of 12 MOSFETs utilized to generate 250 watts output. Each MOS FET will also draw 10 amps of current in operation.

The test set up shown in the block diagram was utilized and the data shown in the graph and chart was the final result of the amplifier's performance. The results show that this is more than enough amplifier for amateur use. Amplifiers at this power level and frequency will immediately test the quality of one's 2.3 GHz system. Cables, connectors, relays, antennas, and RF measuring equipment need to be of the highest quality, and rated for the power levels these amplifiers can produce.

Failure of this could cause safety issues and harm oneself and others. Please be careful when testing and using. This unit in particular has much more potential than I dare to find out about with the equipment I have. Maybe some other day. Enjoy the presentation at Microwave Update.



Input dBm	Gain (dB)	RF Pout in dBm	Watts	DC Power Amps	Watts	Eff %
+31	20.7	51.7	147	35	840	17.5
+32	20.7	52.7	187	45	1080	17.3
+33	20.7	53.7	235	56	1344	17.4
+34	20.6	54.6	287	70	1680	17.1
+35	20.5	55.6	365	90	2160	16.8
+36	20.5	56.5	450	110	2640	17
*+37	~20.0	57.0	500	123	2941	17

NOTE: All Data recorded at +24.0VDC

* +37dBm Input Data is a interpolation due to lack of power supply current capability!