“REAL” Solid State Power at VHF / UHF

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“REAL” Solid State Power at VHF/ UHF

- New Power Transistor Technology
- Replacements for “2 x 4CX250’s” in 50, 144, 222 & 432 MHz Power Amplifiers
- Update on 1296 / 2304 MHz Power Amplifiers

New Power Transistor Technology

- Previous Drivers of RF Power Transistor Technology was the needs of Mobile & Cellular Radio systems
- With HDTV conversions and Desire for Energy Efficiency, Broadcasting is the new driver in the VHF/ UHF spectrum

New Power Transistor Technology

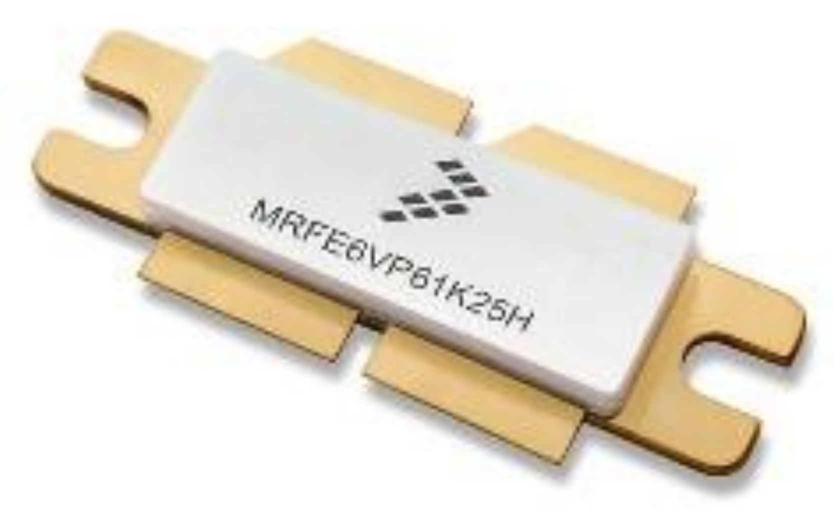
- A New Class of Very Rugged LDMOS High Power Devices has emerged from Freescale (x Motorola, & NXP (x Philips)

- Long Life Expectancy with a High Tolerance of Extreme Mismatch Conditions (50:1 VSWR!)

New Power Transistor Technology

- Delivering 1250 W CW at 80% Efficiency with 20 dB gain up to 600 MHz with a 50 V Supply
- Smaller Units available for 300 & 600 W
- UHF units for 470-870 MHz at 450 W still with 20 dB gain
- Units for~250 W CW for ISM at 1300 MHz

Solid State Replacements for 2 x 4CX250Bs !

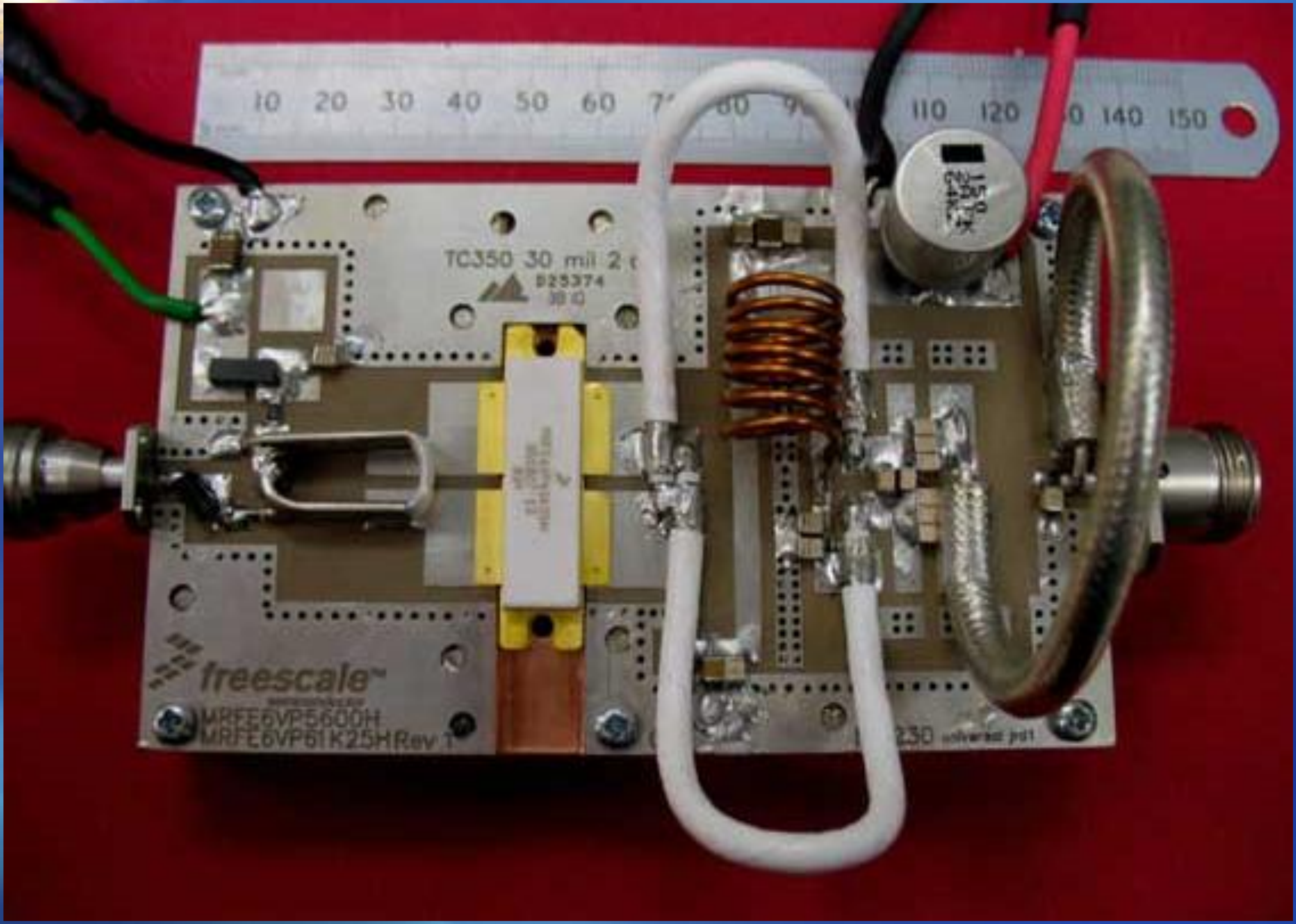


- MRFE6VP61K25H
- 1.8-600 MHz
- 1250 W Output
- 24 dB Gain @ 230 MHz
- 74 % Efficiency
- 50 Volt Supply
- Hardened Version Available Now

Solid State Replacements for 2 x 4CX250Bs !

- 144 MHz PA Article by F1JRD in DUBUS Magazine Issue 4 / 2010
- 3 W in 1250 W output
- Kit of PC Board & Hard to Get Parts available from “RF Ham” for ~ $100
- Similar Transistor (BLF578) Available from NXP (old Philips)

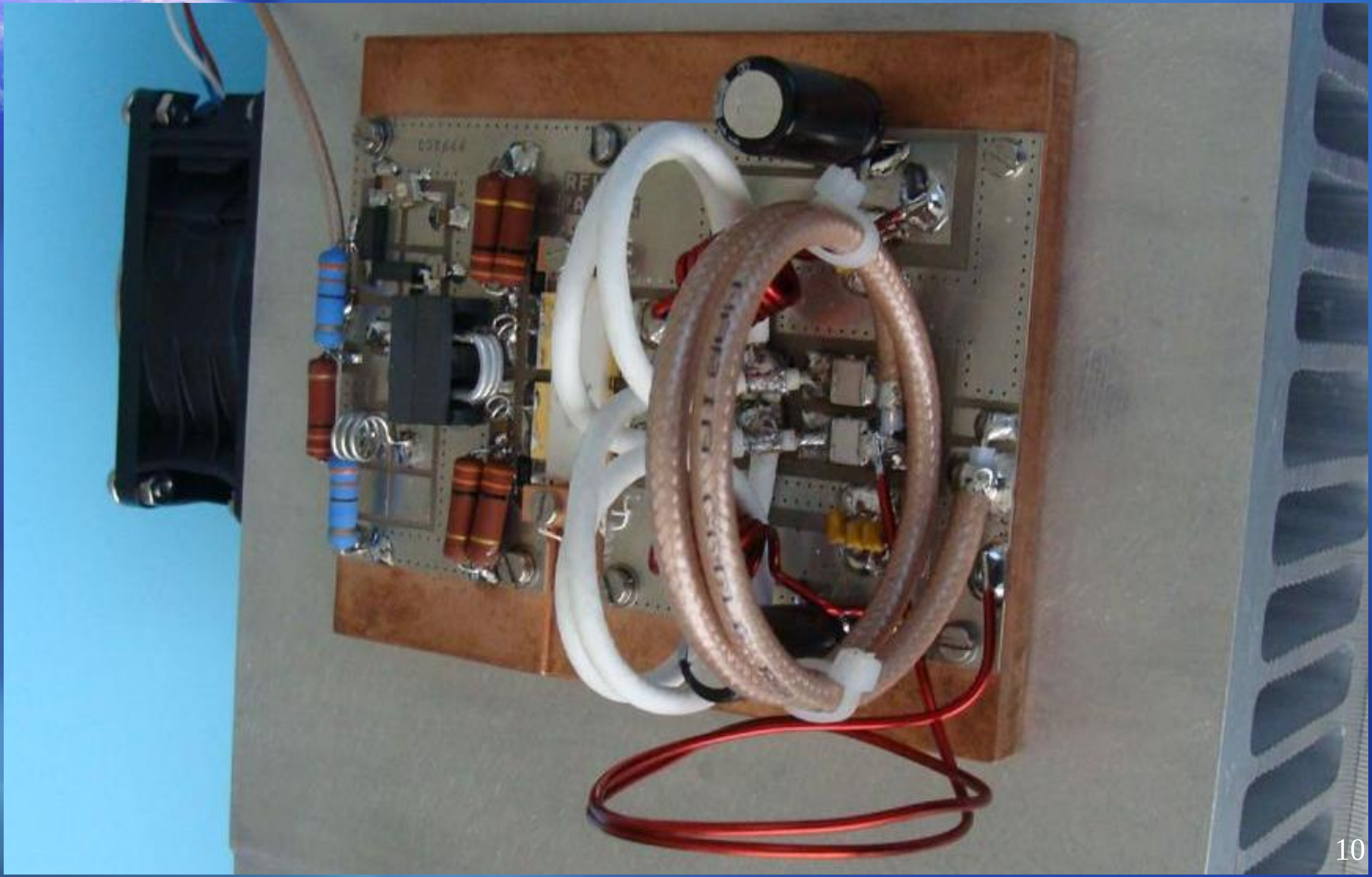
Solid State Replacements for 2 x 4CX250Bs !



Solid State Replacements for 2 x 4CX250Bs !

- Design Reproduced by Many and in Production Amplifiers by M^2 & Others
- Modified by W6PQL for 222 MHz with Good Results
- 50 MHz Version Described in DUBUS Magazine Issue 4 / 2011
- Kit of PC Board & Hard to Get Parts available from “RF Ham” for ~ $100

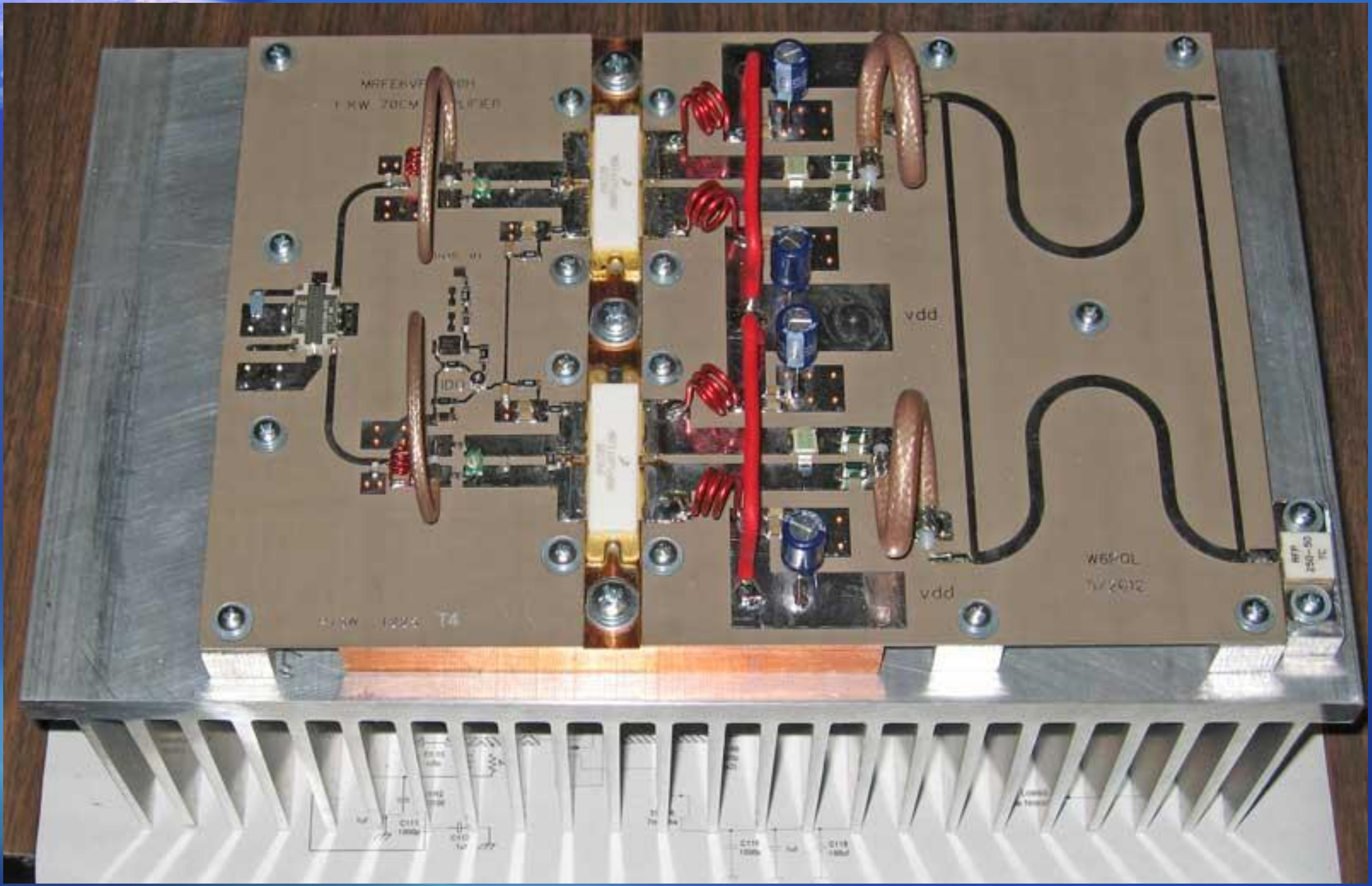
Solid State Replacements for 2 x 4CX250Bs on 50 MHz !



Solid State Replacements for 2 x 4CX250Bs on 432 MHz!

- Very Low Impedances using 6, 2 & 222 Transistor on 432…Caps can’t handle RF current!
- New Design using 2 x MRF6VP5600 for 1 kW by F5FLN in DUBUS Magazine Issue 1 / 2012
- Smaller and Cheaper Devices, but need external Combiners for 2 boards (Kits Available from RF Ham for ~ $100 each (2 needed))
- W6PQL is producing Amps & Kits with 500 W + or 1 kW + with Combiners on the Board.

Solid State Replacements for 2 x 4CX250Bs on 432 MHz!



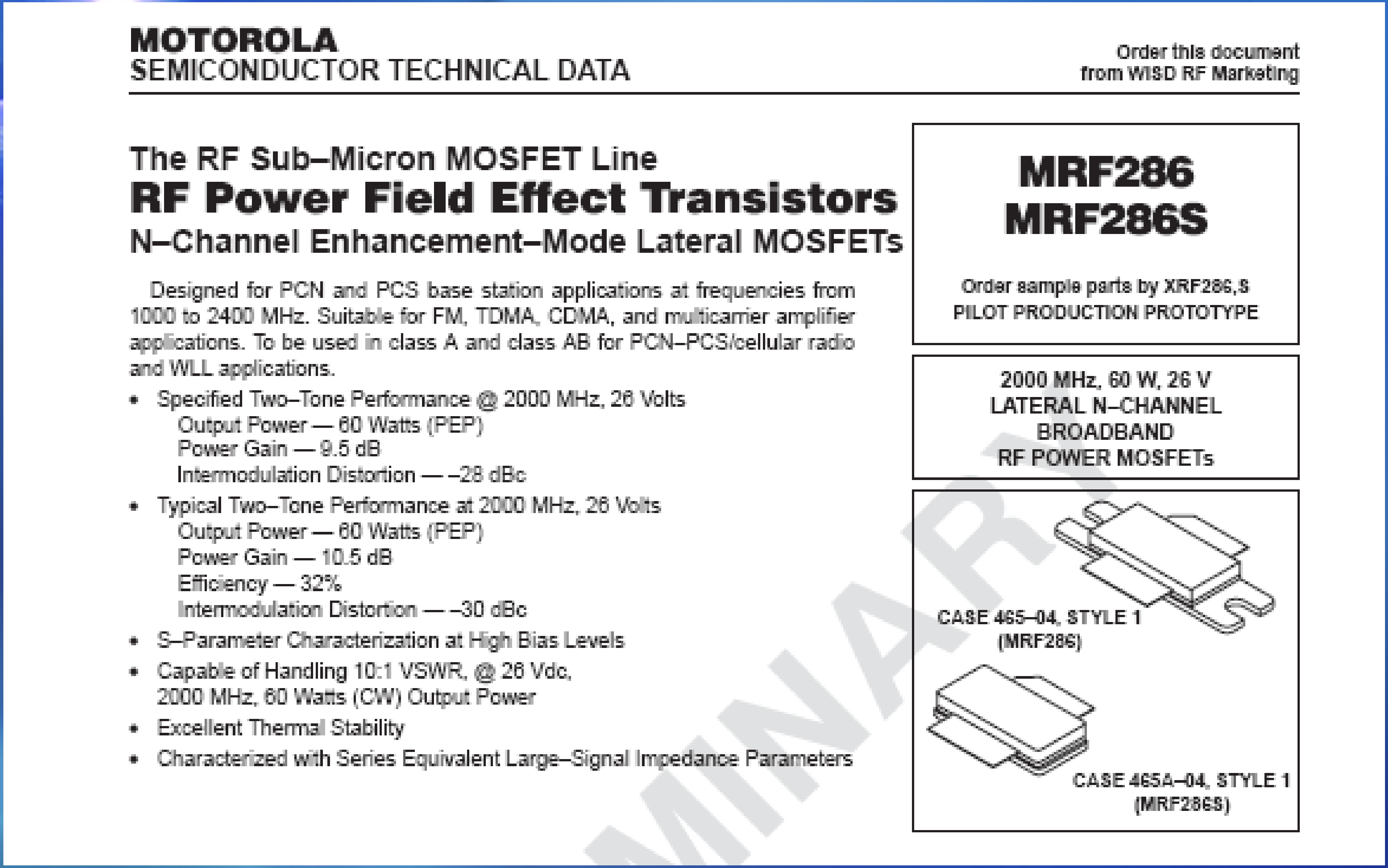
Solid State Replacements for 2 x 4CX250Bs!

- New Transistors are Rugged against 50:1 VSWR…..but NOT Forgiving of Input Overdrive !
- Very High gains from delicate Gate structure …..like a good Tube !
- Needs FAST Overdrive protection ~10 mS
- Comprehensive VSWR and Input Protection is a Good Practice if Not Essential !

23 cm Power Amplifiers

- Recall the W6PQL 23 cm Single and Dual Transistor Power Amplifiers
- Single Transistor produced 75 W and the Dual Amplifier 150 W
- Nice Boards and Kits Were Available, Results as Claimed on 4 – 2 x MRF286 PA with 600 W Output.

MRF 286 2 GHz FET



MOTOROLA
SEMICONDUCTOR TECHNICAL DATA

Order this document
from WISD RF Marketing

The RF Sub–Micron MOSFET Line
RF Power Field Effect Transistors
N–Channel Enhancement–Mode Lateral MOSFETs

Designed for PCN and PCS base station applications at frequencies from 1000 to 2400 MHz. Suitable for FM, TDMA, CDMA, and multicarrier amplifier applications. To be used in class A and class AB for PCN–PCS/cellular radio and WLL applications.

- Specified Two–Tone Performance @ 2000 MHz, 26 Volts
  Output Power — 60 Watts (PEP)
  Power Gain — 9.5 dB
  Intermodulation Distortion — –28 dBc
- Typical Two–Tone Performance at 2000 MHz, 26 Volts
  Output Power — 60 Watts (PEP)
  Power Gain — 10.5 dB
  Efficiency — 32%
  Intermodulation Distortion — –30 dBc
- S–Parameter Characterization at High Bias Levels
- Capable of Handling 10:1 VSWR, @ 26 Vdc, 2000 MHz, 60 Watts (CW) Output Power
- Excellent Thermal Stability
- Characterized with Series Equivalent Large–Signal Impedance Parameters

MRF286
MRF286S

Order sample parts by XRF286,S
PILOT PRODUCTION PROTOTYPE

2000 MHz, 60 W, 26 V
LATERAL N–CHANNEL
BROADBAND
RF POWER MOSFETs

CASE 465–04, STYLE 1
(MRF286)

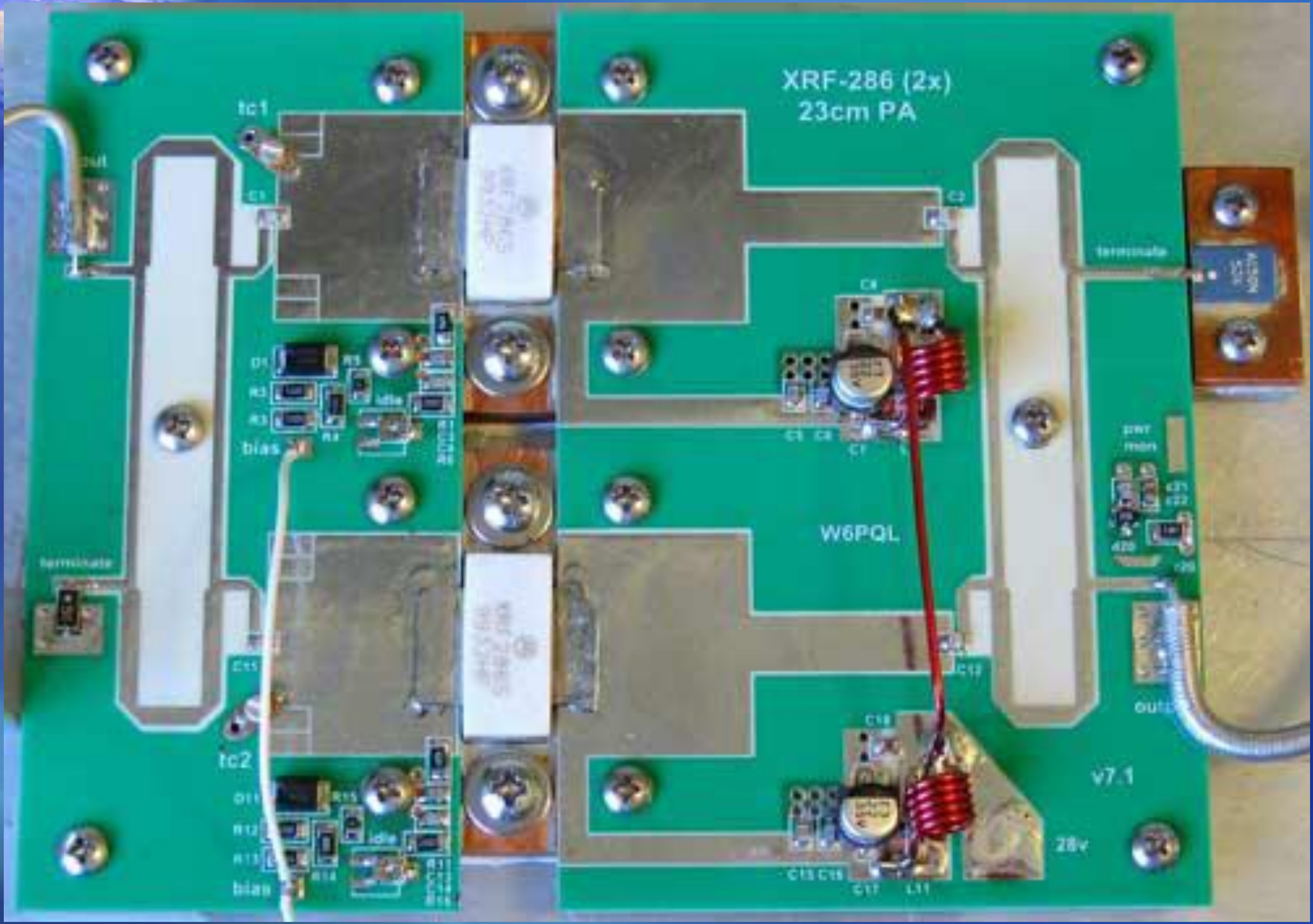
CASE 465A–04, STYLE 1
(MRF286S)

W6PQL 23 cm 70WAmplifier

- Nice Design Using MRF286 Devices
- Approx 75 W Output with 3W Input

W6PQL 23 cm 150W Amplifier

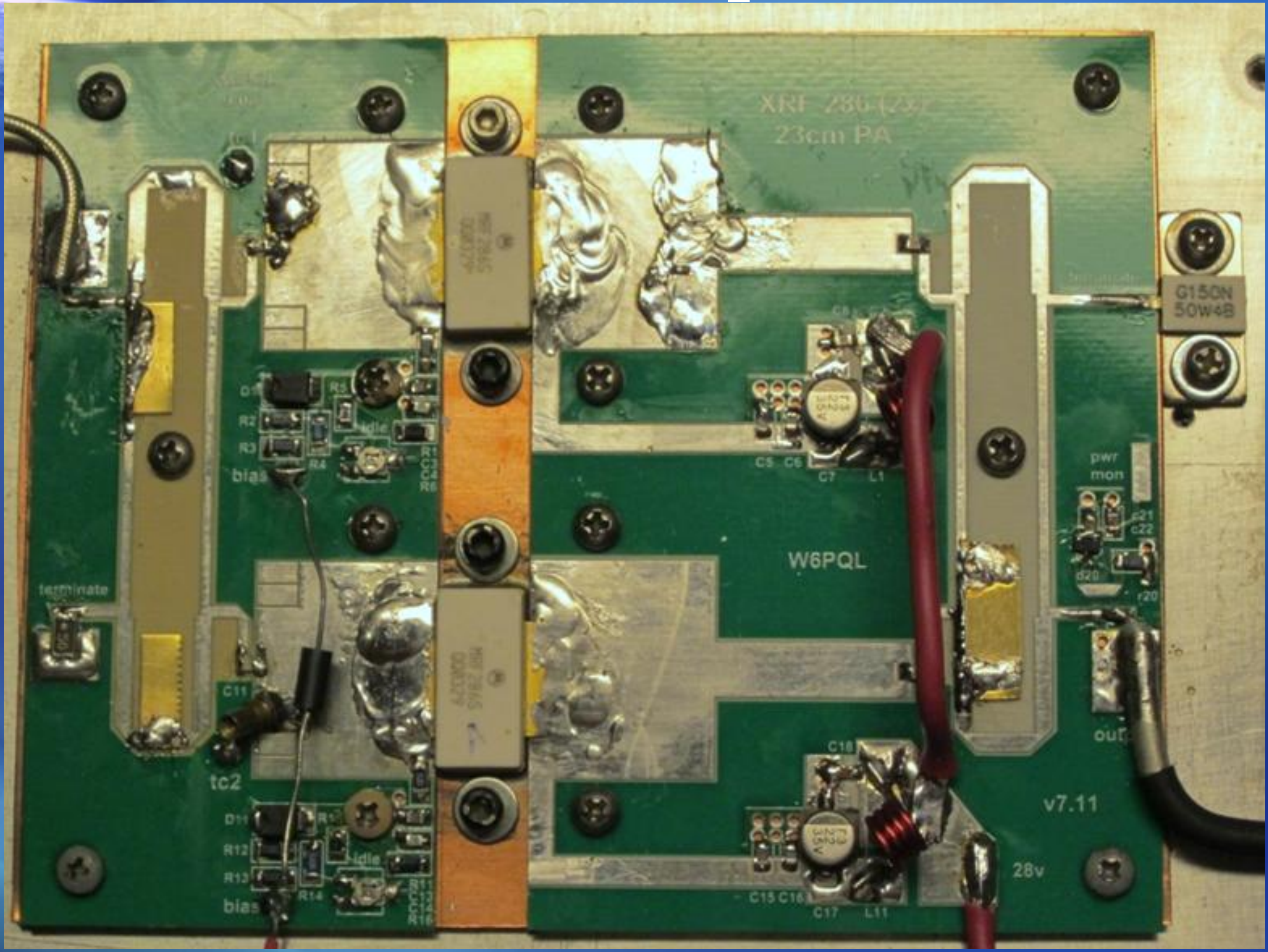
- Approx 150 W Output with 8 W Input



Problems with W6PQL 23 cm Power Amplifiers

- Later production of Boards Resulted in Problems, Confirmed by Practical work of HB9BBD, and Computer Aided Design Review by VE1ALQ
- Although I have 4 of the 2 x MRF 286 amplifiers working exactly as designed
- I built one more 2 x MRF 286 module with same PCB artwork but It needed modification like HB9BBD identified in the Hybrids

Problems with W6PQL 23 cm Power Amplifiers



Problems With 23 cm Power Amplifiers

- Some Speculation that "Chinese Copies" of MRF286's available on Ebay are bad?

- I tested one Chinese device and found to be +/- 0.5 dB in Test Amplifier without Retuning.

- I have received several other "Bad" Chinese Transistors from a VK amateur for Test but not completed yet.

Improved 23 cm
Power Amplifiers

- Computer Aided Design Review by VE1ALQ
- All Designs Very Sensitive to Circuit Board Parameters as well as Dimensions
- New Board Layout produced and Tested at > 300 W for 2 transistor board with ~13 dB gain
- Production Boards made in Limited Numbers and But No continuing supply….Others Someday?

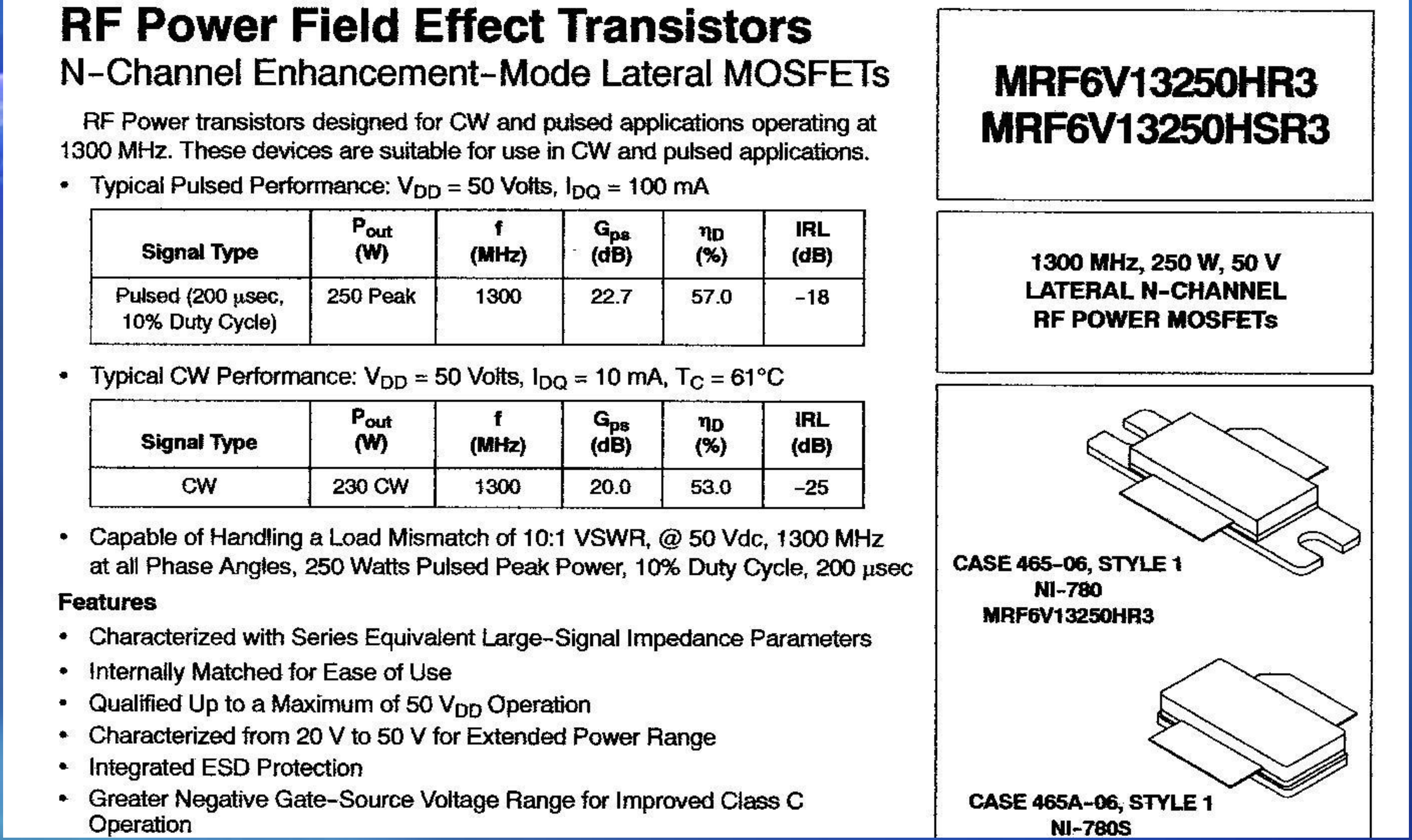
Improved 23 cm Power Amplifiers

- Tests of VE1ALQ Production Boards were Disappointing !
- Others and Myself could not get them to work as Claimed after Many Tries
- I have created Initial Mods to Boards and Get 125 W with Single Transistor, but Input Match Not Right VSWR 1.8 :1
- 57 % Efficiency and 14 dB Gain @ >80 W

Improved 23 cm Power Amplifiers

- Due to Health Problems VE1ALQ is Unable to provide Software support
- Have been reverse engineering MRF286 designs with Computer Smith chart program
- Quite a Variation in “apparent” transistor Input and Output Impedance parameters
- Performed Vector Impedance Measurements and have yet to look at impact of results
- Intend to come out with Final Board Mods

New 1296 MHz Power Transistor !



RF Power Field Effect Transistors

N-Channel Enhancement-Mode Lateral MOSFETs

RF Power transistors designed for CW and pulsed applications operating at 1300 MHz. These devices are suitable for use in CW and pulsed applications.

- Typical Pulsed Performance: V_{DD} = 50 Volts, I_{DQ} = 100 mA

Signal Type	P_{out} (W)	f (MHz)	G_{ps} (dB)	η_D (%)	IRL (dB)
Pulsed (200 µsec, 10% Duty Cycle)	250 Peak	1300	22.7	57.0	-18

- Typical CW Performance: V_{DD} = 50 Volts, I_{DQ} = 10 mA, T_C = 61°C

Signal Type	P_{out} (W)	f (MHz)	G_{ps} (dB)	η_D (%)	IRL (dB)
CW	230 CW	1300	20.0	53.0	-25

- Capable of Handling a Load Mismatch of 10:1 VSWR, @ 50 Vdc, 1300 MHz at all Phase Angles, 250 Watts Pulsed Peak Power, 10% Duty Cycle, 200 µsec

Features

- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched for Ease of Use
- Qualified Up to a Maximum of 50 V_{DD} Operation
- Characterized from 20 V to 50 V for Extended Power Range
- Integrated ESD Protection
- Greater Negative Gate-Source Voltage Range for Improved Class C Operation

MRF6V13250HR3
MRF6V13250HSR3

1300 MHz, 250 W, 50 V
LATERAL N-CHANNEL
RF POWER MOSFETs

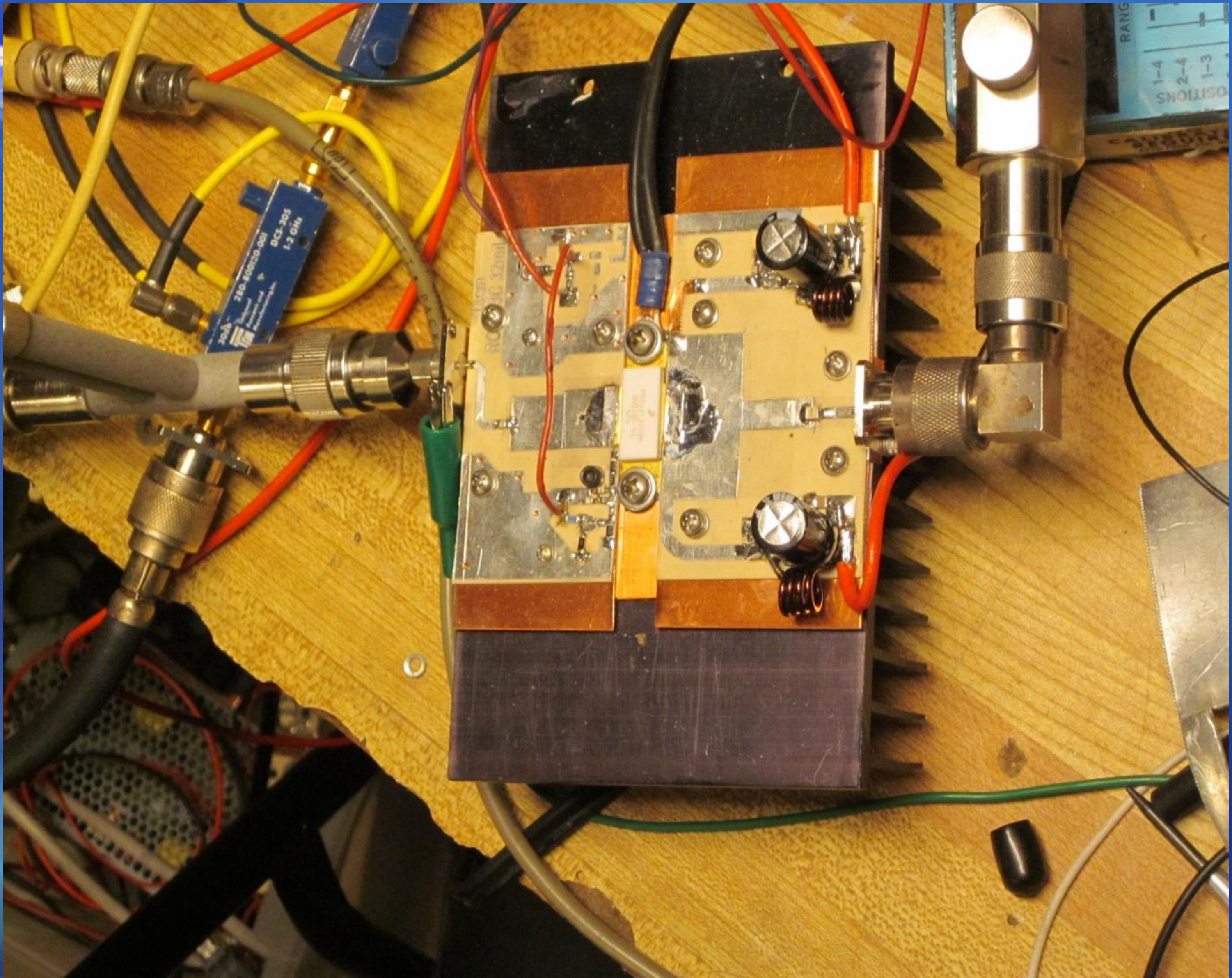
CASE 465-06, STYLE 1
NI-780
MRF6V13250HR3

CASE 465A-06, STYLE 1
NI-780S

New 23 cm Power Transistor Tests

- Impedance Parameters for CW Service Not Available…only Pulse.
- Board Design created from Reverse Engineering of Broadband Test Circuit
- Tests Conducted with two (2) Double Stub tuners resulted in 230W out with 2.5 W of drive at 48 % Efficiency.

New 23 cm Transistor Under Test



New 23 cm Power Transistor Tests

- Impedance Parameters for CW Service Not Available…only Pulse.
- Board Design created from Reverse Engineering of Broadband Test Circuit
- Tests Conducted with two (2) Double Stub tuners resulted in 230W out with 2.5 W of drive at 48 % Efficiency.

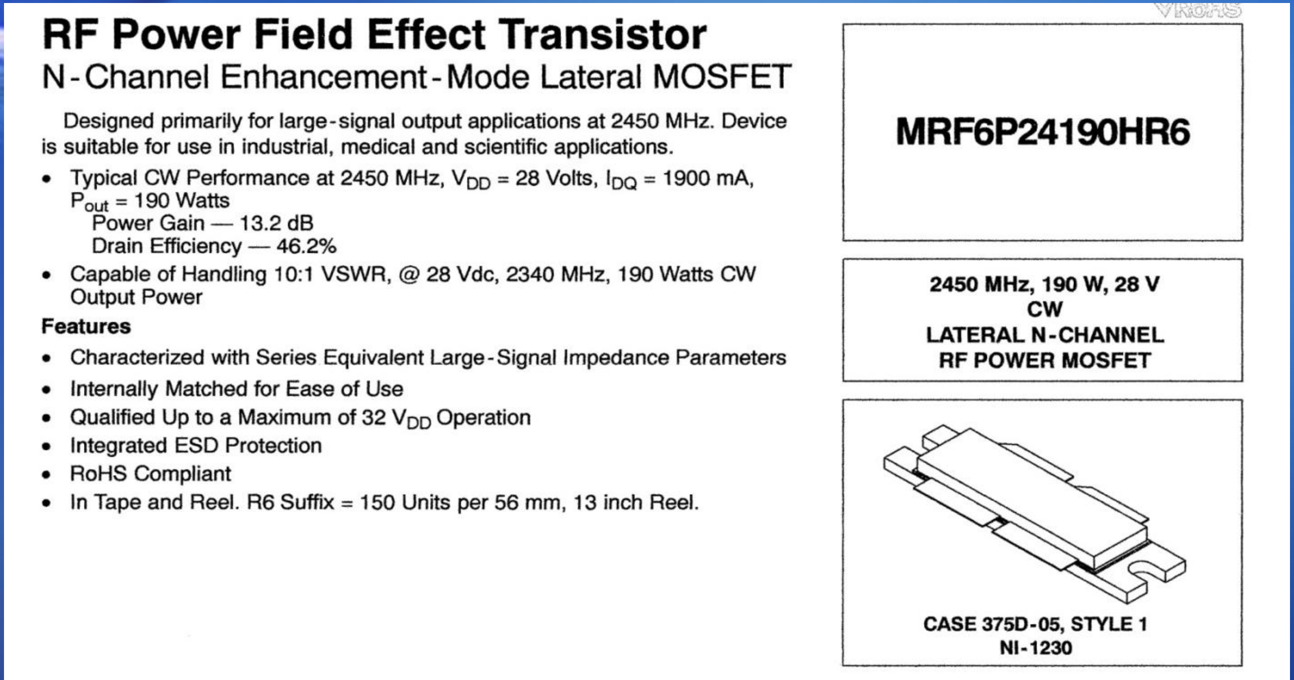
New 23 cm Power Transistor Tests

- Need to do Impedance Measurements and Revise board design.
- NXP has a 250 W CW Rated device BLF6G13L-250P using Push Pull circuitry Similar to VHF amplifiers Described Earlier.
- Goran AD6IW has a 23 cm amplifier using these new devices in DUBUS 3/2012
- Hopefully Someone will Produce a Board or Kit for These devices!

13 cm Power Amplifiers

- Surplus High Power amplifiers very common now
  - Spectrian at 180 W in NA & 250 W 1.9 & 2.1/2.2 GHz Cellular Radio in EU
  - John G4BAO modifications described recently
- Newer Technology High Power Transistors being used in Microwave Ovens by Midea
- Promises of 300 W and 600W power in future

13 cm Power Amplifiers



√RoHS

RF Power Field Effect Transistor

N-Channel Enhancement-Mode Lateral MOSFET

Designed primarily for large-signal output applications at 2450 MHz. Device is suitable for use in industrial, medical and scientific applications.

- Typical CW Performance at 2450 MHz, V_{DD} = 28 Volts, I_{DQ} = 1900 mA, P_{out} = 190 Watts
  Power Gain — 13.2 dB
  Drain Efficiency — 46.2%
- Capable of Handling 10:1 VSWR, @ 28 Vdc, 2340 MHz, 190 Watts CW Output Power

Features

- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched for Ease of Use
- Qualified Up to a Maximum of 32 V_{DD} Operation
- Integrated ESD Protection
- RoHS Compliant
- In Tape and Reel. R6 Suffix = 150 Units per 56 mm, 13 inch Reel.

MRF6P24190HR6

2450 MHz, 190 W, 28 V
CW
LATERAL N-CHANNEL
RF POWER MOSFET

CASE 375D-05, STYLE 1
NI-1230

- 190 W with 13.2 dB gain at 28V on 2.45 GHz
- Older Device ….50 V Part coming?

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Questions?