MOTOROLA RF LDMOS TECHNOLOGY

Move Up to the Next Generation

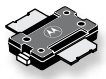
IN 2000 AND BEYOND

4th GENERATION

Enhanced Performance, Improved Thermal Ratings for Increased Power

Used in - 3G Base Stations

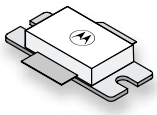
MRF376, MRF9085, MRF9180, MRF9045, MRF9045M, MRF19045, MRF19085, MRF19125, MRF21180, MRF21125



Increased Gain, Linearity, Power Density and Reliability

Used in - W-CDMA & UMTS Base Stations, Multi Carrier PCS CDMA Amplifiers and GSM-EDGE

MRF18060A/B, MRF18090A/B, MRF19030, MRF19060, MRF19090, MRF19120 MRF21030, MRF21060, MRF21090, MRF21120



MRF9482T1

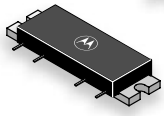
BEGINNING 1998

3rd GENERATION

Transistion to State of the Art Wafer Processing Increases Efficiency and Allows Operation Above 2 GHz

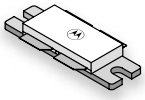
Used in - PCS CDMA Base Stations, DAB and 1800 MHz GSM Base Stations

MRF1511T1, MRF1513T1, MRF1518T1, MRF1517T1, MRF372, MHVIC910L, MHL19336, MRF6522-70, MHL19338, MHL21336



MRF286
MRF9382T1
MHL9838, MHL9318, MHW1810

MRF281S, MRF282S
MHL9236



MRF284

BEGINNING 1996

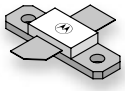
2nd GENERATION

Process Refinement Increases Gain, Linearity and Power Density

Used in - Paging Base Stations, Multi Carrier Linear Amplifiers and GSM Handsets

MRF374

MRF373
Mid-Voltage Discretes



MRF6522-5, MRF6522-10
MRF187
MRF186

MRF184

Low-Voltage Discretes

BEGINNING 1994

1st GENERATION

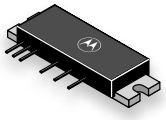
RF LDMOS Pushes Silicon FET Technology to 1 GHz

Used in - Cellular Base Stations, Land Mobile Radios & Base Stations and TV Transmitters

MRF181S, MRF181Z

MRF185

MRF182, MRF183



LDMOS Power Modules

BEGINNING 1993

EXCITING NEW BREAKTHROUGHS IN RF LDMOS TECHNOLOGY

New Motorola RF LDMOS Devices Set Benchmark for 3G, 2.2 GHz Market

TEMPE, ARIZONA, FEBRUARY 23, 2000...
The MRF21125 is the highest single-ended device (125 watts) and the MRF21180 is the highest push-pull device (160 watts) now available in the 2.2 GHz band for W-CDMA applications.

New Motorola RF LDMOS Family Optimized for GSM Base Station Applications

TEMPE, ARIZONA, NOVEMBER 15, 1999...
The introduction of a GSM specific family of products continues Motorola's strategy to penetrate its HV4 generation RF LDMOS into all major markets. The first product to be unveiled in the MRF18000 line-up, the MRF18060A/ MRF18060AS, is a 60-watt device operating up to 2.0 GHz.

Motorola Receives JEDEC Approval on Two RF Power Plastic Packages for Wireless Applications

TEMPE, ARIZONA, OCTOBER 16, 1999...
TO-270 and TO-272 are the first JEDEC approved plastic packages for high power RF LDMOS discrete transistors capable of handling up to 65 watts.

MOTOROLA

Motorola RF LDMOS Product Family

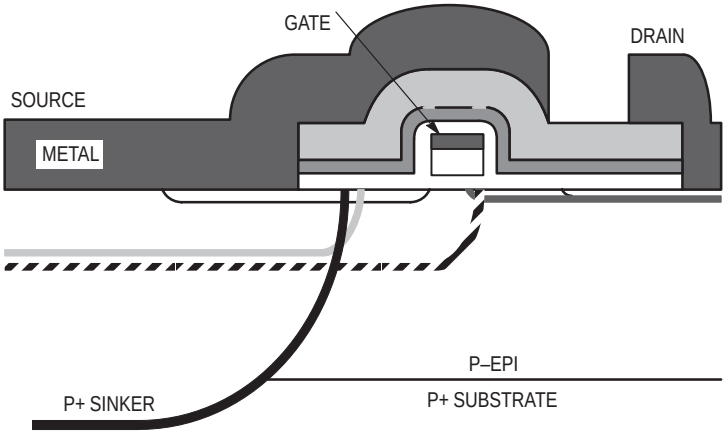
As digital standards increasingly dominate the wireless communication market, Motorola's RF LDMOS technology has become the industry's technology of choice due to its superior linearity, gain and efficiency characteristics. Motorola's LDMOS technology is used in making high power, high frequency RF amplifier designs simpler, easier, and more cost effective, thus enabling our customers to compete in today's competitive wireless markets.

We are enhancing our RF portfolio by combining world leadership in submicron VLSI MOS technology with high volume manufacturing. The result: An even wider breadth of RF products, including discrete medium and high power devices, power modules, ICs and Class A, ultra–linear amplifiers.

Motorola continues to develop and improve its patented RF LDMOS design and has recently extended performance on new 4th generation RF LDMOS products. The newest product introductions incorporate the latest process improvements. Take advantage of the increased ease of use and improved performance as highlighted below.

Advantages of RF LDMOS transistors for new designs:

- Higher Gain . . . . . Reliable processing creates higher performance
- Higher Efficiency . . . . . Increased power density allows for higher power
- Better Thermal Performance . . . . . Higher average power is achieved
- Higher Reliability . . . . . Double layer metal increases MTBF
- Ease of Use . . . . . Addition of die level ESD protection diodes decreases handling concerns



LDMOS Vertical Cross Section

Access LDMOS Models, Test Fixtures and Reference Designs On–line!

Visit our web pages for distribution of our NEW electro–thermal models for RF LDMOS transistors.

The url is: **http://www.motorola.com/semiconductors/rf/models/**

The new Motorola Electro Thermal (MET) model for RF LDMOS transistors is a nonlinear model that for the first time examines both electrical and thermal phenomena and can account for dynamic self–heating effects of device performance. It is specifically tailored to model high power RF LDMOS transistors used in base station, HDTV digital broadcast, and land mobile radio applications. Implemented in the Agilent–EEsof's® Libra® (V6.1 and V6.6) and Advanced Design System (ADS V1.3) harmonic balance simulators, the MET LDMOS model is capable of performing small–signal, large–signal, harmonic–balance, noise and transient simulations. Because of its ability to simulate self–heating effects, the MET model is more accurate than existing models, enabling circuit designers to predict prototype performance more accurately and reduce cycle time.

The model is available as a compiled code for all major computer platforms including Microsoft® Windows® 95, 98 and Windows NT® 4.0, Solaris® 2.6 and HP–UX® 10.2. The object code can easily be linked with Agilent–EEsof's Libra and ADS harmonic balance simulators.

Subscribe to our LDMOS Models mail list to get the latest news on the availability of newly released RF LDMOS Transistor Models. To subscribe, just fill out the RF LDMOS Transistor Model Subscription form on–line at http://www.motorola.com/semiconductors/rf/models/ and you will receive notification of new models as they are posted.

AND, visit our web pages for distribution of Test Fixtures and Reference Designs.

The url is: **http://www.motorola.com/semiconductors/rf/designtds/designtd.html**

The Test Fixture library contains application specific solutions for select Motorola parts. Access the Test Fixture library to determine which test fixture is most suitable for your application.

The Reference Design library contains easy–to–copy, fully functional amplifier designs. They consist of "no tune" distributed element matching circuits designed to be as small as possible, include temperature compensated bias circuitry, and are designed to be used as "building blocks" for our customers.

Test fixtures and functional Reference Design test units can be purchased for a nominal fee. Contact your local Motorola Distributor for additional information.

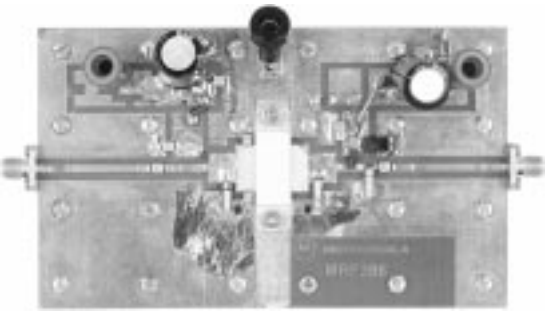


Figure 1. Test Fixture Example

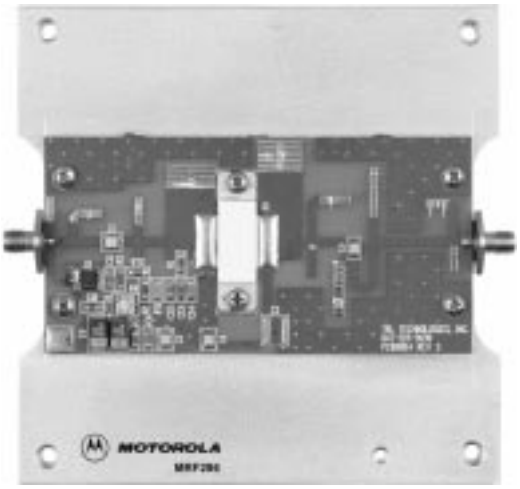


Figure 2. Reference Design Example

RF High Power Transistors

Our LDMOS technology is ideally suited for RF power amplifier applications. Several families of products have been targeted for specific markets including VHF and UHF portable, 900 MHz linear cellular, GSM, TDMA and CDMA, Digital Television, GSM–Edge, PCS, UMTS, and W–CDMA.

Thanks to unique LDMOS characteristics, these parts offer superior thermal performance. This is due to the simplified package design, which offers excellent Class AB intermodulation performance under medium peak–to–average ratios which makes for a fine device choice for advanced digital modulations formats or high gain applications.

RF LDMOS High Power Transistors

Mobile – To 520 MHz

Device	P_{out} Output Power Watts	Gain (Typ)/Freq. dB/MHz	η Eff. (Typ) %	θ_{JC} °C/W	Package/Style
VHF & UHF, V_{DD} = 7.5 Volts, Class AB, Land Mobile Radio					
MRF1511T1(18f,46a)	8	11.5/175	55	2.0	466/1
MRF1517T1(18f,46a)	8	11/520	55	2.0	466/1
VHF & UHF, V_{DD} = 7.5/12.5 Volts, Class AB, Land Mobile Radio					
MRF1513T1(18f,46a)	3	11/520	55	2.0	466/1
VHF & UHF, V_{DD} = 12.5 Volts, Class AB, Land Mobile Radio					
MRF1518T1(18f,46a)	8	11/520	55	2.0	466/1

Broadcast – To 1.0 GHz – Lateral MOSFETs

Device	P_{out} Output Power Watts	Gain (Typ)/Freq. dB/MHz	η Eff. (Typ) %	θ_{JC} °C/W	IMD dBc	Package/Style
470 – 1000 MHz, V_{DD} = 28 Volts, Class AB						
MRF373	60	14.7/860	54	1.0	—	360B/1
MRF373S	60	14.7/860	54	0.75	—	360C/1
MRF372(9)	180 PEP	14.0/860	35	0.4	–30	375B/2
MRF374	100 PEP	13.5/860	36	0.5	–31	375F/2
470 – 1000 MHz, V_{DD} = 50 Volts, Class AB						
MRF376(9)	240	14/860	55	0.3	—	375B/2

Cellular – To 1.0 GHz – Lateral MOSFETs

Device	P_{out} Output Power Watts	Gain (Typ)/Freq. dB/MHz	η Eff. (Typ) %	θ_{JC} °C/W	Package/Style
800 – 1.0 GHz, V_{DD} = 26 Volts, Class AB					
MRF6522–5R1(18a,46a)	5 CW	18/960	53	15	458A/1
MRF6522–10R1(18a,46a)	10 CW	17.5/960	55	6.0	458A/1
MRF6522–70(18i)★	70 CW	16/921–960	58	1.1	465D/1
MRF187	85 PEP	13/880	33	0.7	465/1
MRF187S	85 PEP	13/880	33	0.7	465A/1
MRF9085(46a)	85 PEP	17/880	38	0.7	465/1
MRF9085S(46a)	85 PEP	17/880	38	0.7	465A/1
MRF9180(46a)	180 PEP	17/880	38	0.4	375D/2

RF LDMOS High Power Transistor (continued)

Cellular – To 1.0 GHz – Lateral MOSFETs (continued)

Device	P_{out} Output Power Watts	Gain (Typ)/Freq. dB/MHz	η Eff. (Typ) %	θ_{JC} °C/W	Package/Style
800 – 1.0 GHz, V_{DD} = 28 Volts, Class AB					
MRF181SR1(18a,46a)	8 PEP	17/945	35	3.6	458/1
MRF181ZR1(18a,46a)	8 PEP	17/945	35	3.6	458A/1
MRF182	30 CW	14/945	58	1.75	360B/1
MRF182S(18a)	30 CW	14/945	58	1.75	360C/1
MRF183	45 PEP	13.5/945	38	1.5	360B/1
MRF183S(18a)	45 PEP	13.5/945	38	1.5	360C/1
MRF9045(46a)	45 PEP	18/945	42	1.3	360B/1
MRF9045S(46a)	45 PEP	18/945	42	1.3	360C/1
MRF9045M(46a)	45 PEP	16/945	40	TBD	1265/–
MRF184	60 CW	13.5/945	60	1.1	360B/1
MRF184S(18a)	60 CW	13.5/945	60	1.1	360C/1
MRF185(3)	85 CW	14/960	53	0.7	375B/2
MRF186(3)	120 PEP	12/945	35	0.6	375B/2

PCS and 3G – To 2.1 GHz – Lateral MOSFETs

Device	P_{out} Output Power Watts	Class	Gain (Typ)/Freq. dB/MHz	η Eff. (Typ) %	θ_{JC} °C/W	Package/Style
1805 – 1990 MHz, V_{DD} = 26 Volts (GSM1800, GSM1900 and PCS TDMA)						
MRF18060A★	60 CW	AB	13/1805–1880	45	0.97	465/1
MRF18060AS★	60 CW	AB	13/1805–1880	45	0.97	465A/1
MRF18060B★	60 CW	AB	13/1930–1990	45	0.97	465/1
MRF18060BS★	60 CW	AB	13/1930–1990	45	0.97	465A/1
MRF18090A★	90 CW	AB	13.5/1805–1880	52	0.7	465B/1
MRF18090AS★	90 CW	AB	13.5/1805–1880	52	0.7	465C/1
MRF18090B★	90 CW	AB	13.5/1930–1990	45	0.7	465B/1
MRF18090BS★	90 CW	AB	13.5/1930–1990	45	0.7	465C/1
1.9 GHz, V_{DD} = 26 Volts (PCS CDMA)						
MRF19030(46a)	30 PEP	AB	13/1990	36	1.2	465E/1
MRF19030S(46a)	30 PEP	AB	13/1990	36	1.2	465F/1
MRF19045(46a)	45 PEP	AB	14/1990	37	0.84	465E/1
MRF19045S(46a)	45 PEP	AB	14/1990	37	0.84	465F/1
MRF19060★	60 PEP	AB	12.5/1990	36	0.97	465/1
MRF19060S★	60 PEP	AB	12.5/1990	36	0.97	465A/1
MRF19090★	90 PEP	AB	11.5/1990	35	0.65	465B/1
MRF19090S(18a)★	90 PEP	AB	11.5/1990	35	0.65	465C/1
MRF19085(46a)	90 PEP	AB	12.5/1990	37	0.64	465/1
MRF19085S(46a)	90 PEP	AB	12.5/1990	37	0.64	465A/1
MRF19120(3,46a)	120 PEP	AB	11.8/1990	34.5	0.45	375D/2
MRF19120S(3,46a)	120 PEP	AB	11.8/1990	34.5	0.45	375E/2
MRF19125(46a)	125 PEP	AB	12.5/1990	35	0.53	465B/1
MRF19125S(46a)	125 PEP	AB	12.5/1990	35	0.53	465C/1
2.0 GHz, V_{DD} = 26 Volts						
MRF281SR1(18a,46a)	4 PEP	A, AB	13.6/2000	41	8.75	458/1
MRF281ZR1(18a,46a)	4 PEP	A, AB	13.6/2000	41	8.75	458A/1
MRF282SR1(18a,46a)	10 PEP	A, AB	12.5/2000	34	2.9	458/1
MRF282ZR1(18a,46a)	10 PEP	A, AB	12.5/2000	34	2.9	458A/1
MRF284	30 PEP	A, AB	10.5/2000	35	2.0	360B/1
MRF284SR1(18a)	30 PEP	A, AB	10.5/2000	35	2.0	360C/1
MRF286(46a)	60 PEP	A, AB	10.5/2000	31	0.73	465/1
MRF286S(46a)	60 PEP	A, AB	10.5/2000	31	0.73	465A/1

RF LDMOS High Power Transistor (continued)

PCS and 3G – To 2.1 GHz – Lateral MOSFETs (continued)

2.1 GHz, V_{DD} = 28 Volts (W–CDMA, UMTS)

Device	P_{out} Output Power Watts	Class	Gain (Typ)/Freq. dB/MHz	η Eff. (Typ) %	θ_{JC} °C/W	Package/Style
MRF21030(46a)	30 PEP	AB	13.5/2170	33	1.2	465E/1
MRF21030S(46a)	30 PEP	AB	13.5/2170	33	1.2	465F/1
MRF21060★	60 PEP	AB	12.5/2170	34	1.02	465/1
MRF21060S★	60 PEP	AB	12.5/2170	34	1.02	465A/1
MRF21090(46a)	90 PEP	AB	11.7/2170	33	0.65	465B/1
MRF21090S(46a)	90 PEP	AB	11.7/2170	33	0.65	465C/1
MRF21120(3,46a)	120 PEP	AB	11.3/2170	35	0.45	375D/2
MRF21120S(3,46a)	120 PEP	AB	11.3/2170	35	0.45	375E/2
MRF21125(26)★	125 PEP	AB	12/2170	34	0.53	465B/1
MRF21125S(26)★	125 PEP	AB	12/2170	34	0.53	465C/1
MRF21180(3,46a)	160 PEP	AB	11.3/2170	33	0.39	375D/2
MRF21180S(3,46a)	160 PEP	AB	11.3/2170	33	0.39	375E/2

(3)Internal Impedance Matched Push-Pull Transistors

(9)In Development

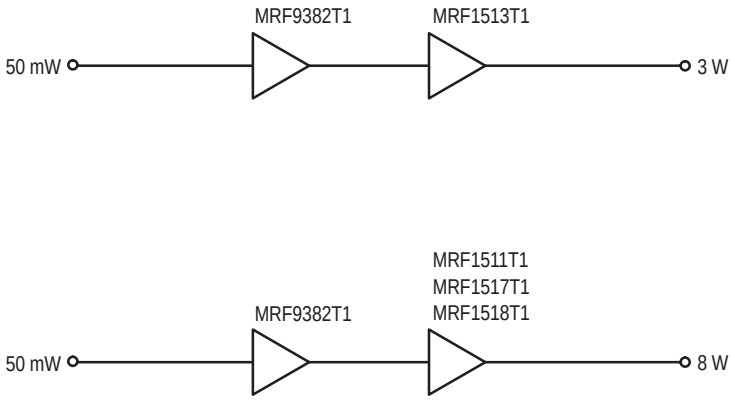
(18)Tape and Reel Packaging Option Available by adding suffix: a) R1 = 500 units; b) R2 = 2,500 units; c) T1 = 3,000 units; d) T3 = 10,000 units; e) R2 = 1,500 units; f) T1 = 1,000 units; g) R2 = 4,000 units; h) R1 = 1,000 units; i) R3 = 250 units.

(26)W–CDMA = 20 W P_{out}, 13 dB Gain, 18% Efficiency, 2.1125–2.1675 GHz.

(46)To be introduced: a) 1Q00; b) 2Q00; c) 3Q00

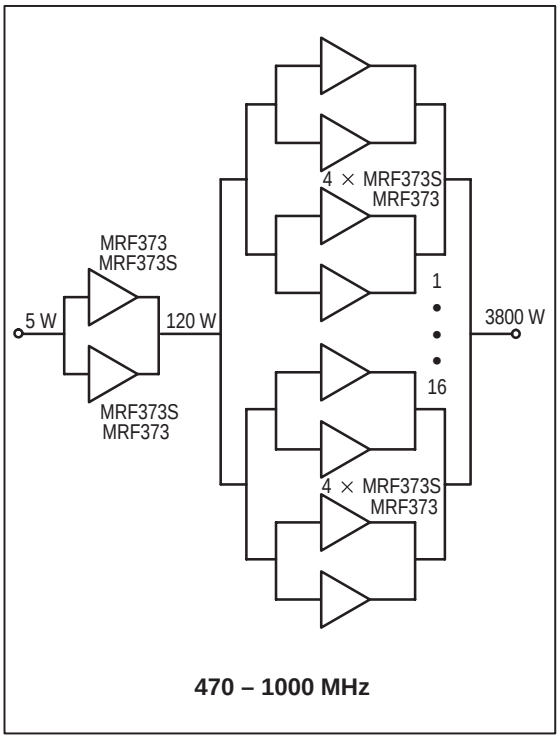
★New Product

RF LDMOS High Power Transistor Amplifier Line–ups

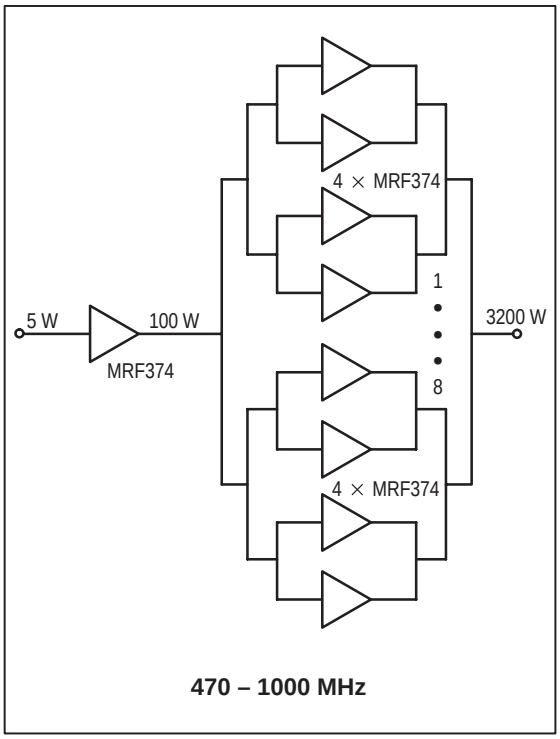


VHF – UHF

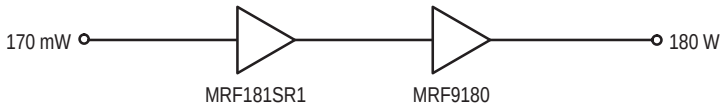
RF LDMOS High Power Transistor Amplifier Line–ups



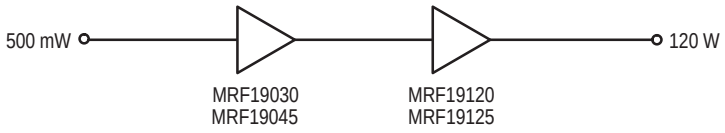
470 – 1000 MHz



470 – 1000 MHz



1.0 GHz

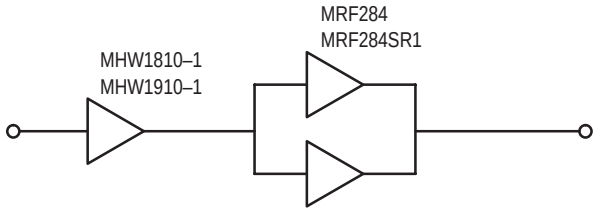


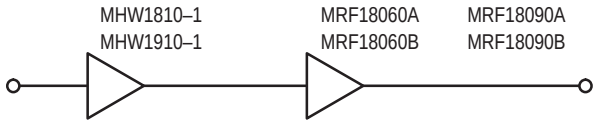
1.9 GHz

2.1 GHz

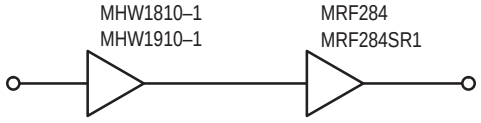
RF LDMOS High Power Transistor Amplifier Line–ups

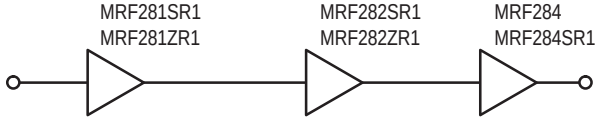
GSM1800/GSM1900 Base Station – Class 1: 20 – 40 Watts, 24 – 26 Volts





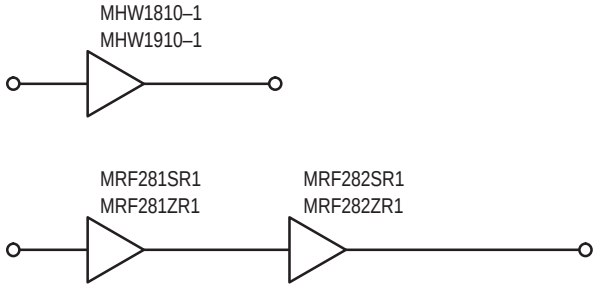
GSM1800/GSM1900 Base Station – Class 2: 10 – 20 Watts, 24 – 26 Volts



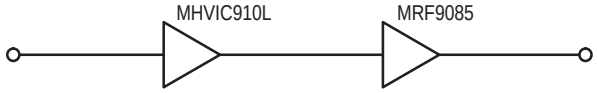


RF LDMOS High Power Transistor Amplifier Line–ups

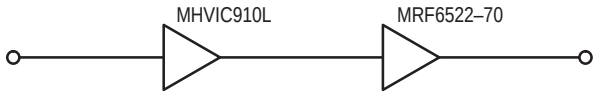
GSM1800/GSM1900 Base Station – Class 3: 5 – 10 Watts, 24 – 26 Volts Microcell



GSM900 Base Station – Class 4: 40 – 80 Watts, 24 – 26 Volts

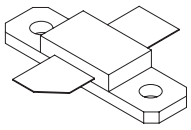


GSM900 Base Station – Class 5: 20 – 40 Watts, 24 – 26 Volts

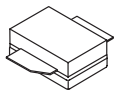


GSM900 Base Station – Class 7: 5 – 10 Watts, 24 – 26 Volts

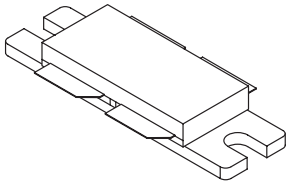
RF High Power Transistor Packages



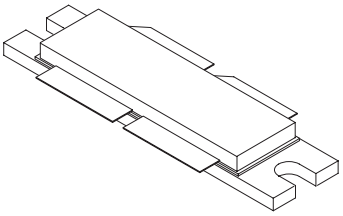
CASE 360B



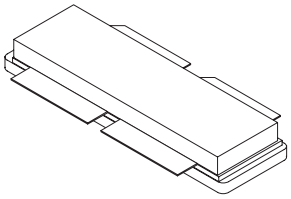
CASE 360C



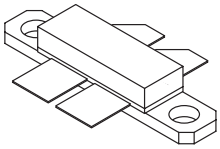
CASE 375B



CASE 375D



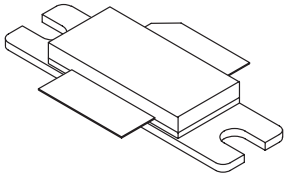
CASE 375E



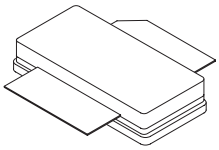
CASE 375F

CASE 458

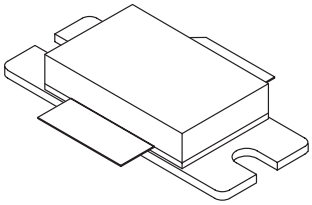
CASE 458A



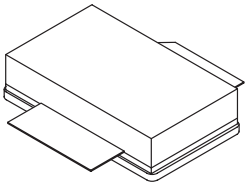
CASE 465



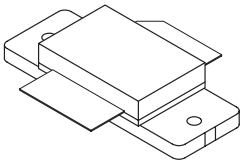
CASE 465A



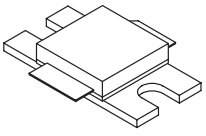
CASE 465B



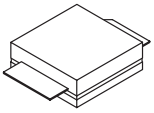
CASE 465C



CASE 465D

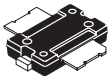


CASE 465E



CASE 465F

CASE 466
PLASTIC



CASE 1265
PLASTIC
(TO–270)

SCALE: 1:1

RF LDMOS for Portable Applications

Motorola's newly introduced family of RF LDMOS medium power discretes is ideally suited for battery operated portable transmitters in the 4.8 and 6 V nominal battery voltage range. In addition, they make excellent driver devices in power amplifiers. These surface mount devices are conducive to cost effective volume manufacturing and are available in tape and reel packaging.

Because of inherent LDMOS characteristics, their small size, high gain, ruggedness, voltage–controlled gates and single supply operation allow usage in almost any portable application such as analog cellular, GSM cellular, PCS, cordless phones, RF modems, cable modems and talkback pagers.

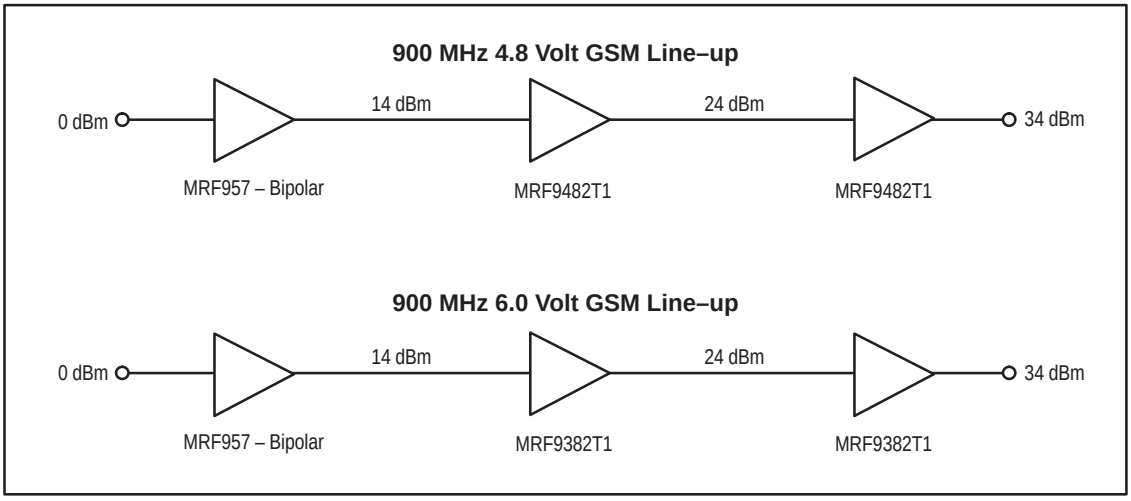
RF LDMOS Medium Power Transistors

Device	Freq. MHz	V_{DD} V	Typical Output Power dBm	Typical Drain Eff. %	Typical Gain dB	Semiconductor Technology	Case No./ Package
MRF9382T1 (18f,46a)	900	6.0	36.5	65	10.5	LDMOS	449/PLD–1
MRF9482T1 (18f,46a)	900	4.8	36.0	65	10	LDMOS	449/PLD–1

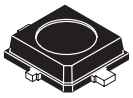
(18)Tape and Reel Packaging Option Available by adding suffix: a) R1 = 500 units; b) R2 = 2,500 units; c) T1 = 3,000 units; d) T3 = 10,000 units; e) R2 = 1,500 units; f) T1 = 1,000 units; g) R2 = 4,000 units; h) R1 = 1,000 units; i) R3 = 250 units.

(46)To be introduced: a) 1Q00; b) 2Q00; c) 3Q00

RF LDMOS Medium Power Transistor Line–ups



RF Medium Power Transistor Plastic Package



PLD–1
PLASTIC

SCALE 2:1

RF Amplifier Modules

Utilizing Motorola's leadership in the integration of LDMOS, new families of smaller, more efficient, and cost effective amplifier modules are available. LDMOS amplifiers provides high stage gain and good linear performance when used in cellular and other wireless applications. They are single supply, fully–matched designs using a silicon based technology.

Current designs cover GSM, CDMA, W–CDMA, TDMA and Analog applications.

RF LDMOS Amplifier Modules/ICs

Base Stations

Device	P_{out} Output Power Watts	P_{in} Input Power Watts	f Frequency MHz	Gain (Min) dB	Supply Voltage Volts	Package/Style
880–960 MHz (for GSM900) — Class AB						
MHVIC910L (46b)	10	0.050	921–960	22	26	978/–
1805–1880 MHz (for GSM1800) — Class AB						
MHW1810–1	10	0.040	1805–1880	24	26	301AW/1
MHW1810–2	10	0.008	1805–1880	32	26	301AW/1
1930–1990 MHz (for GSM1900) — Class AB						
MHW1910–1	10	0.040	1930–1990	24	26	301AW/1

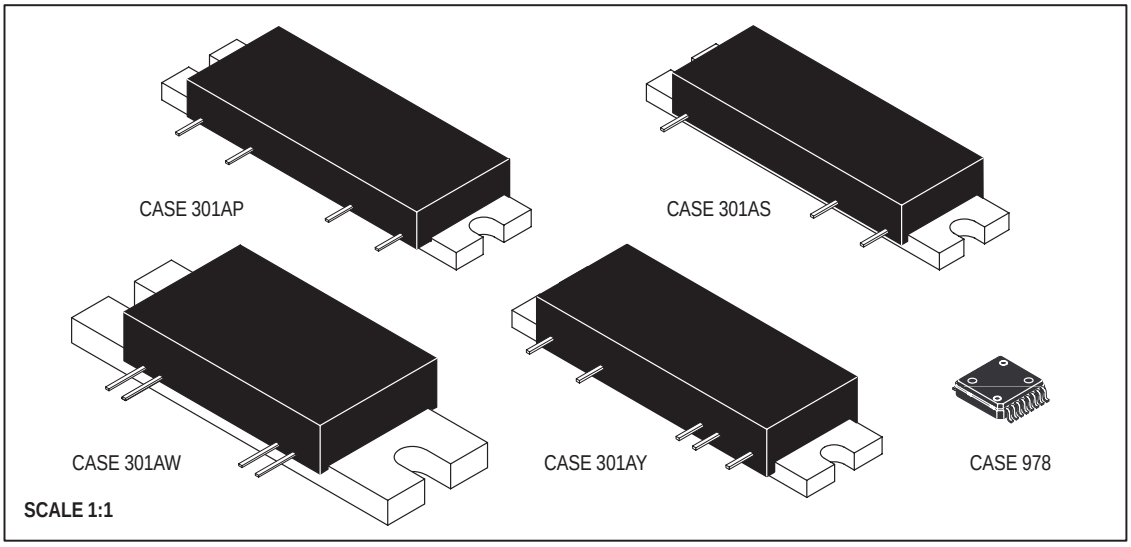
Base Station Drivers

Device	Frequency Band MHz	V_{DD} (Nom.) Volts	I_{DD} (Nom.) mA	Gain (Nom.) dB	Gain Flatness (Typ) ±dB	P_{1dB} (Typ) dBm	3rd Order Intercept (Typ) dBm	NF (Typ) dB	Case/ Style
Ultra–Linear (for CDMA, W–CDMA, TDMA, Analog) – Class A – Lateral MOSFETs									
MHL9838★	800–925	28	770	31	.1	39	50	3.7	301AP/1
MHL9236	800–960	26	550	30.5	.1	34	47	3.5	301AP/1
MHL9236M	800–960	26	550	30.5	.1	34	47	3.5	301AP/2
MHL9318★	860–900	28	500	17.5	.1	35.5	49	3.0	301AS/1
MHL19338★	1900–2000	28	500	30	.1	36	46	4.2	301AP/1
MHL19936 (46b)	1900–2000	28	1400	30	.2	41	51	4.2	301AY/1
MHL21336★	2110–2170	26	500	31	.15	35	45	4.5	301AP/1

(46)To be introduced: a) 1Q00; b) 2Q00; c) 3Q00

★New Product

RF Amplifier Module/IC Packages



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