ELECTROSTATIC SENSITIVE DEVICE
OBSERVE HANDLING PRECAUTIONS

RA60H3847M1

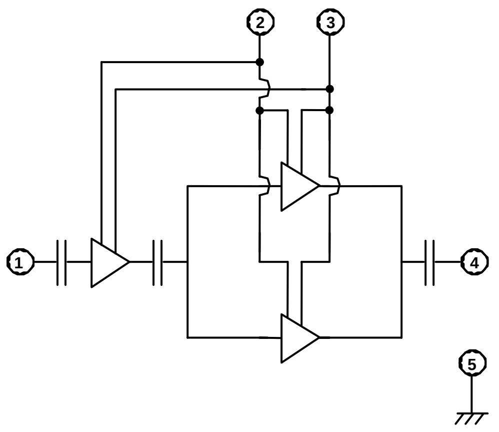
RoHS Compliance, 378-470MHz 60W 12.5V, 2 Stage Amp. For MOBILE RADIO

DESCRIPTION

The RA60H3847M1 is a 60-watt RF MOSFET Amplifier Module for 12.5-volt mobile radios that operate in the 378- to 470-MHz range.

The battery can be connected directly to the drain of the enhancement-mode MOSFET transistors. Without the gate voltage (V_{GG}=0V), only a small leakage current flows into the drain and the nominal output signal (P_{out}=60W) attenuates up to 60 dB. The output power and the drain current increase as the gate voltage increases. The output power and the drain current increase substantially with the gate voltage around 0V(minimum). The nominal output power becomes available at the state that V_{GG} is 4V (typical) and 5V (maximum).
At V_{GG}=5V, the typical gate currents are 5mA.This module is designed for non-linear FM modulation, but may also be used for linear modulation by setting the drain quiescent current with the gate voltage and controlling the output power with the input power.

BLOCK DIAGRAM



1. RF Input (P_{in})
2. Gate Voltage (V_{GG}), Power Control
3. Drain Voltage (V_{DD}), Battery
4. RF Output (P_{out})
5. RF Ground (Case)

PACKAGE CODE: H2M

FEATURES

- Enhancement-Mode MOSFET Transistors ($I_{DD}\cong 0$ @ V_{DD}=12.5V, V_{GG}=0V)
- P_{out}>60W, η_T>40% @ V_{DD}=12.5V, V_{GG}=5V, P_{in}=50mW
- Broadband Frequency Range: 378-470MHz
- Metal shield structure that makes the improvements of spurious radiation simple
- Low-Power Control Current I_{GG}=5mA (typ) @ V_{GG}=5V
- Module Size: 67 x 19.4 x 9.9 mm
- Linear operation is possible by setting the quiescent drain current with the gate voltages and controlling the output power with the input power.

RoHS COMPLIANCE

- RA60H3847M1 is a RoHS compliant product.
- RoHS compliance is indicate by the letter “G” after the Lot Marking.
- This product include the lead in the Glass of electronic parts and the lead in electronic Ceramic parts.

However, it is applicable to the following exceptions of RoHS Directions.

1. Lead in the Glass of a cathode-ray tube, electronic parts, and fluorescent tubes.
2. Lead in electronic Ceramic parts.

ORDERING INFORMATION:

ORDER NUMBER	SUPPLY FORM
RA60H3847M1-101	Antistatic tray, 10 modules/tray

MAXIMUM RATINGS (T_{case}=+25°C, Z_G=Z_L=50Ω, unless otherwise specified)

SYMBOL	PARAMETER	CONDITIONS	RATING	UNIT
V_{DD}	Drain Voltage	V_{GG}<5V, P_{in}=0W	17	V
V_{GG}	Gate Voltage	V_{DD}<12.5V, P_{in}=50mW	6	V
P_{in}	Input Power	f=378-470MHz, $V_{GG}\leqq$5V	100	mW
P_{out}	Output Power		80	W
$T_{case(OP)}$	Operation Case Temperature Range		-30 to +100	°C
T_{stg}	Storage Temperature Range		-40 to +110	°C

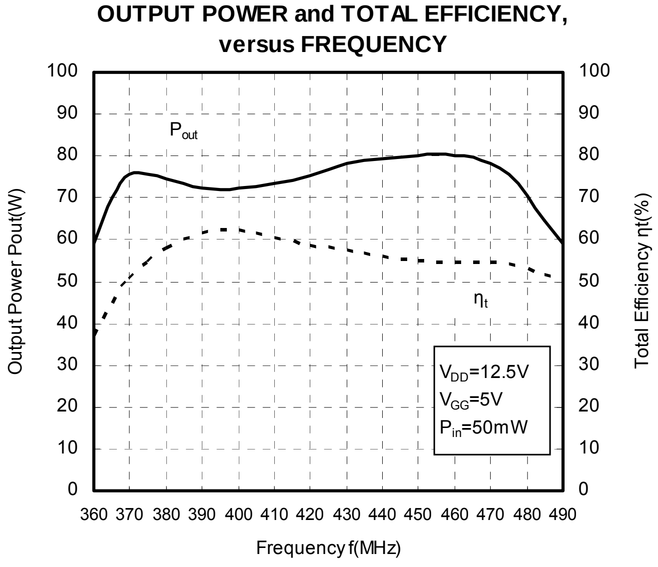
The above parameters are independently guaranteed.

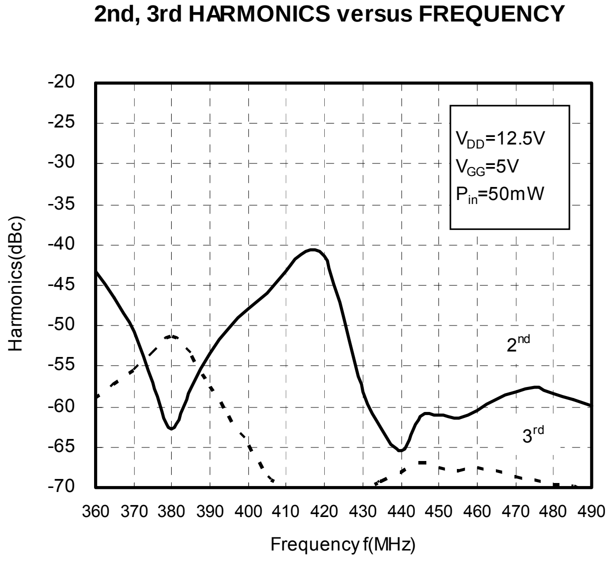
ELECTRICAL CHARACTERISTICS (T_{case}=+25°C, Z_G=Z_L=50Ω, unless otherwise specified)

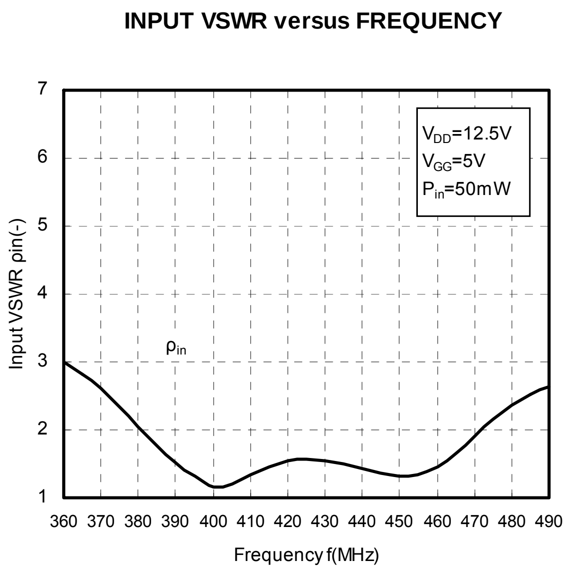
SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
F	Frequency Range		378	-	470	MHz
P_{out}	Output Power	V_{DD}=12.5V V_{GG}=5V P_{in}=50mW	60	-	-	W
ηT	Total Efficiency		40	-	-	%
$2f_o$	2nd Harmonic		-	-	-35	dBc
$3f_o$	3rd Harmonic		-	-	-40	dBc
ρ_{in}	Input VSWR		-	-	3:1	—
I_{GG}	Gate Current	V_{DD}=0V, V_{GG}=5V, P_{in}=0W	-	5	6	mA
I_{DD}	Leakage Current	V_{DD}=17V, V_{GG}=0V, P_{in}=0W	-	-	1	mA
—	Stability	V_{DD}=10.0-15.2V, P_{in}=25-70mW, 5<P_{out}<65W (V_{GG} control), Load VSWR=3:1	No parasitic oscillation more than -65dBc			—
—	Load VSWR Tolerance	V_{DD}=15.2V, P_{in}=50mW, P_{out}=60W (V_{GG} control), Load VSWR=20:1	No degradation or destroy			—

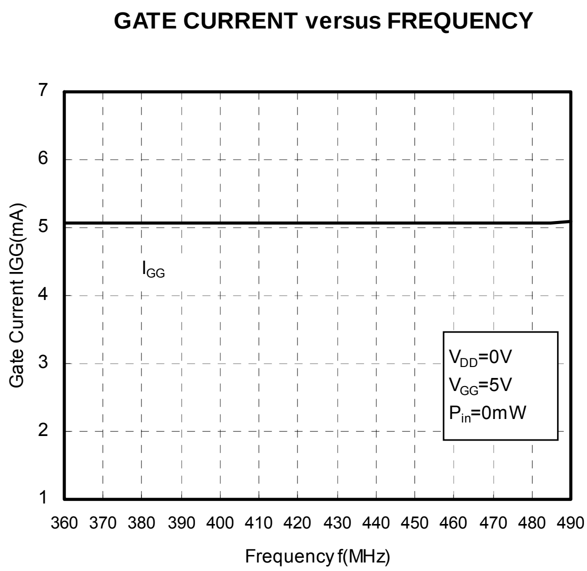
All parameters, conditions, ratings, and limits are subject to change without notice.

TYPICAL PERFORMANCE (T_{case}=+25°C, Z_G=Z_L=50Ω, unless otherwise specified)



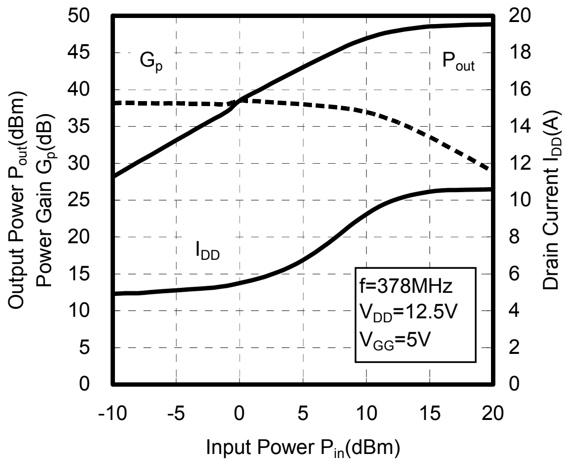






TYPICAL PERFORMANCE (T_{case}=+25°C, Z_G=Z_L=50Ω, unless otherwise specified)

OUTPUTPOWER, POWER GAIN and DRAIN CURRENT versus INPUT POWER



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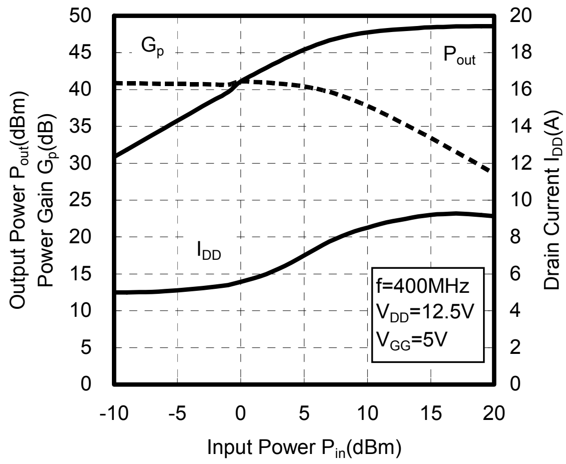

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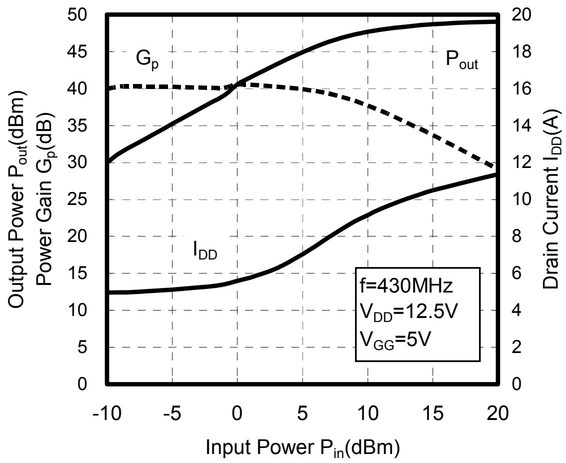

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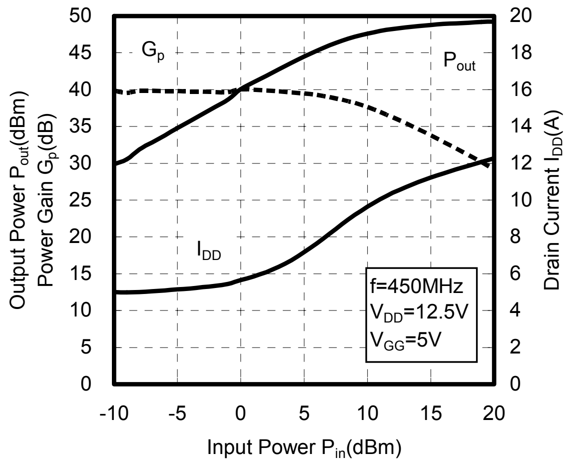

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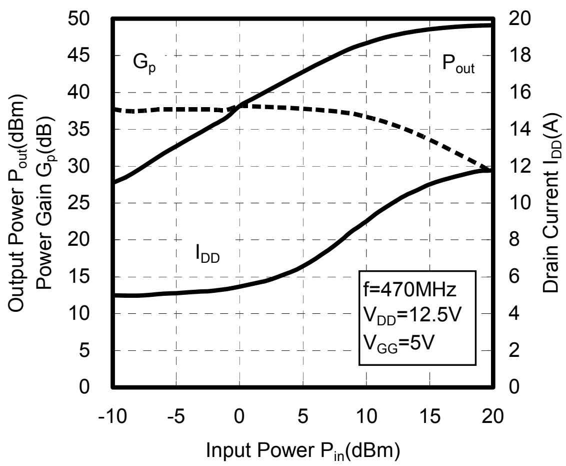
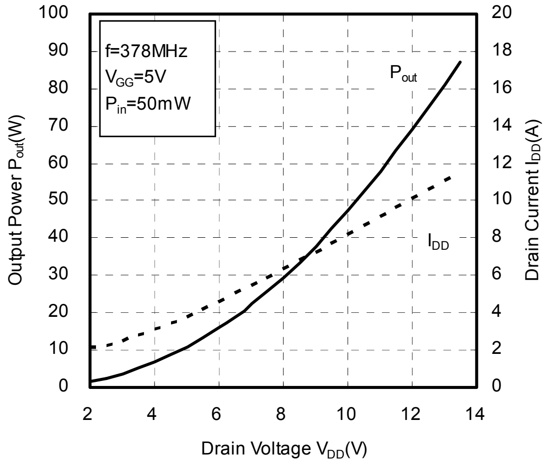
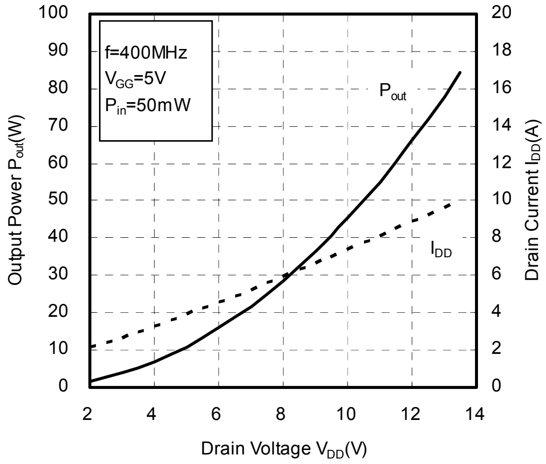


TYPICAL PERFORMANCE (T_{case}=+25°C, Z_G=Z_L=50Ω, unless otherwise specified)

OUTPUTPOWER and DRAIN CURRENT versus DRAIN VOLTAGE



OUTPUTPOWER and DRAIN CURRENT versus DRAIN VOLTAGE



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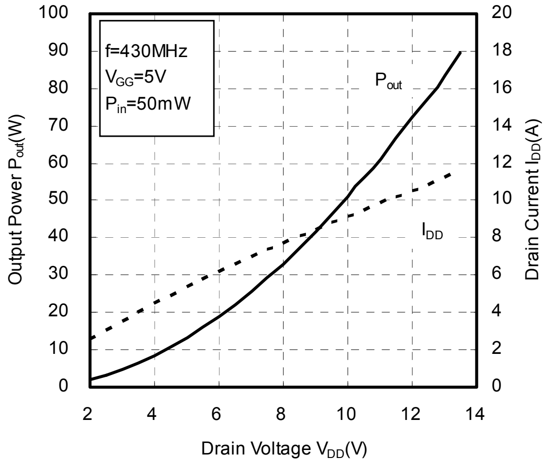

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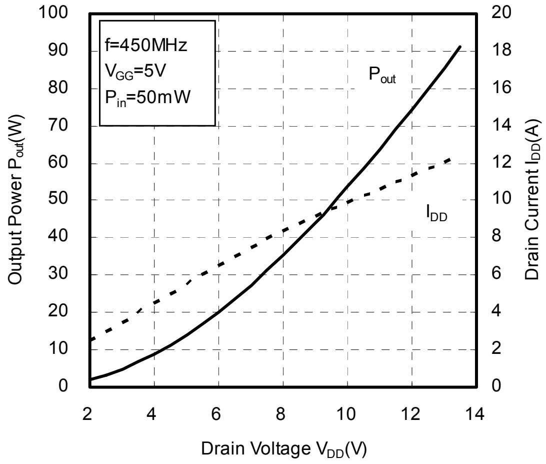
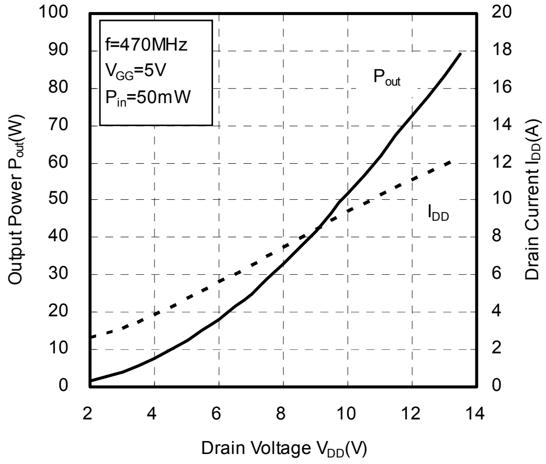
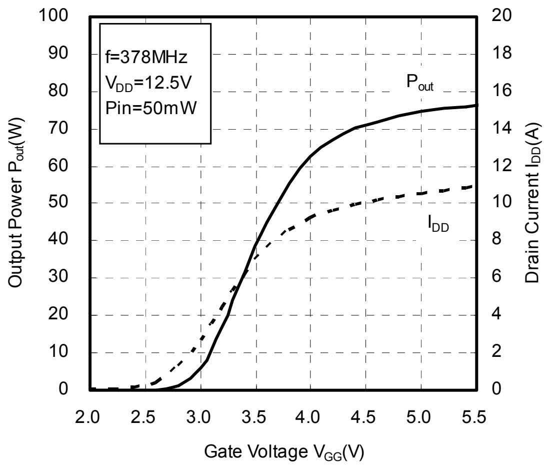


OUTPUTPOWER and DRAIN CURRENT versus DRAIN VOLTAGE

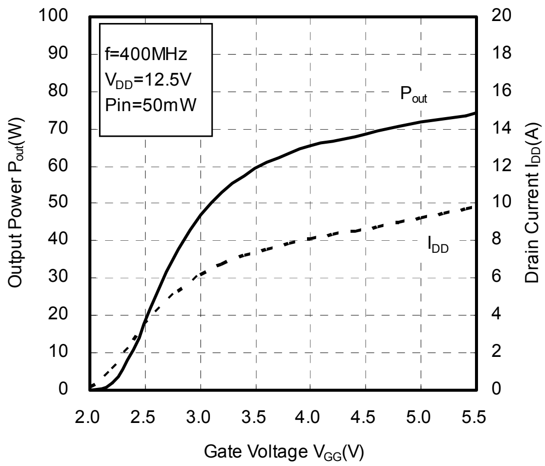


TYPICAL PERFORMANCE (T$_{case}$=+25°C, Z$_G$=Z$_L$=50Ω, unless otherwise specified)

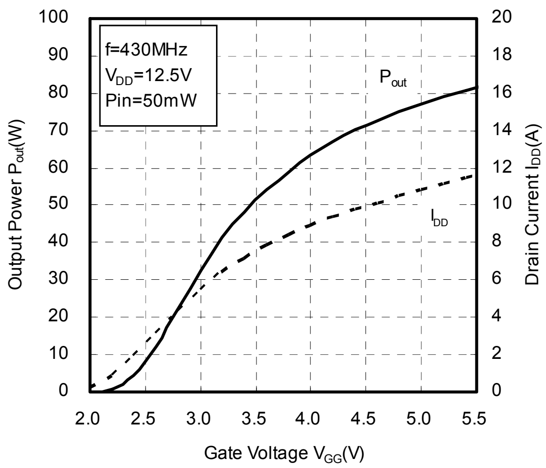
OUTPUTPOWER and DRAIN CURRENT versus GATE VOLTAGE



OUTPUTPOWER and DRAIN CURRENT versus GATE VOLTAGE



OUTPUTPOWER and DRAIN CURRENT versus GATE VOLTAGE



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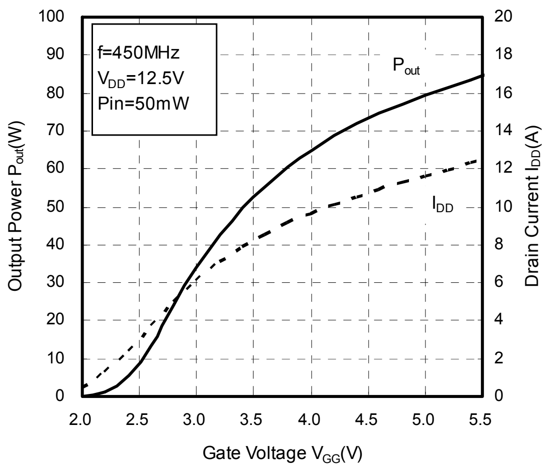
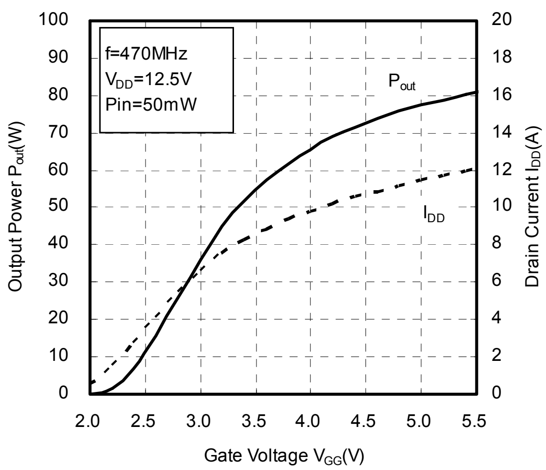
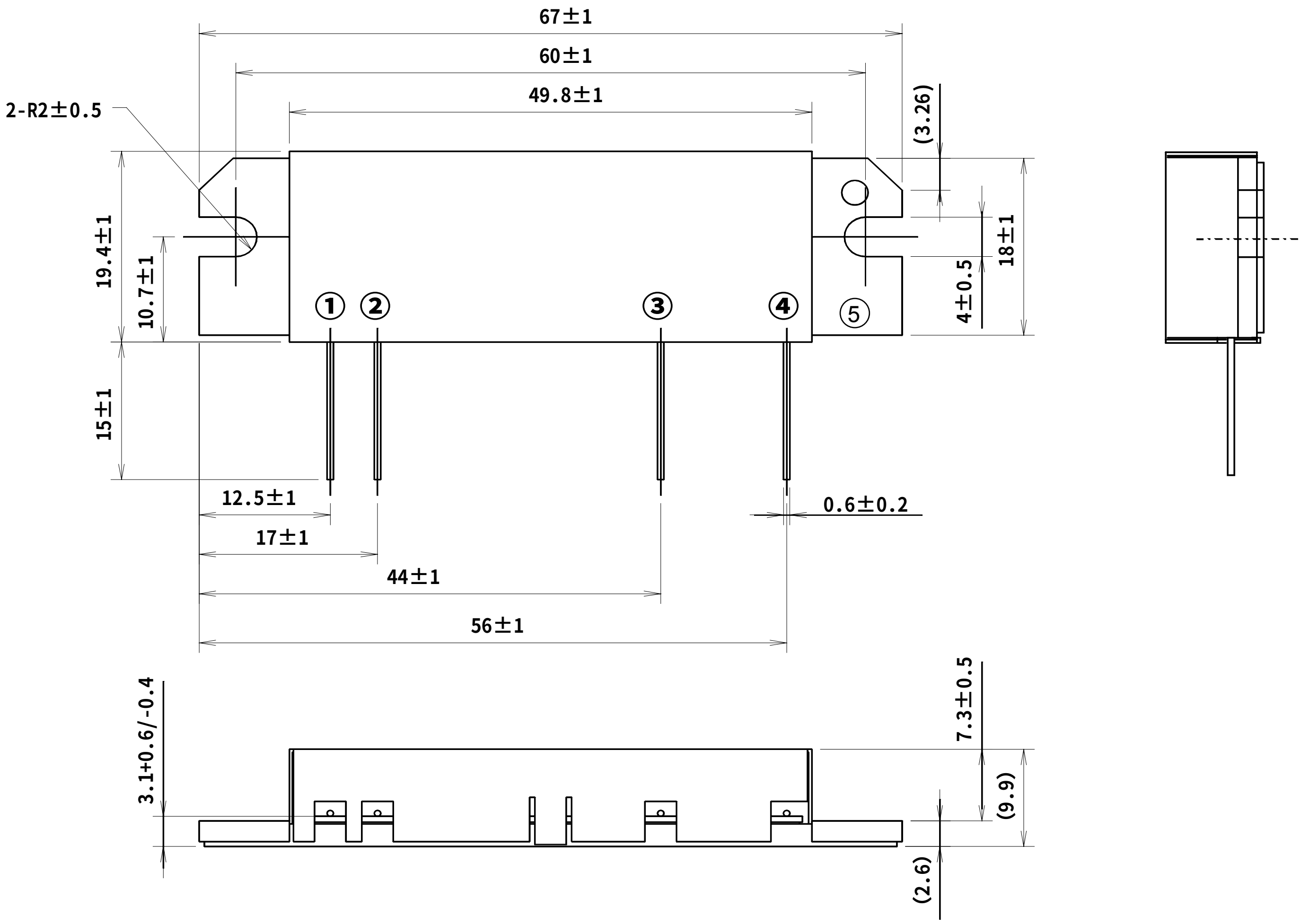


OUTPUTPOWER and DRAIN CURRENT versus GATE VOLTAGE

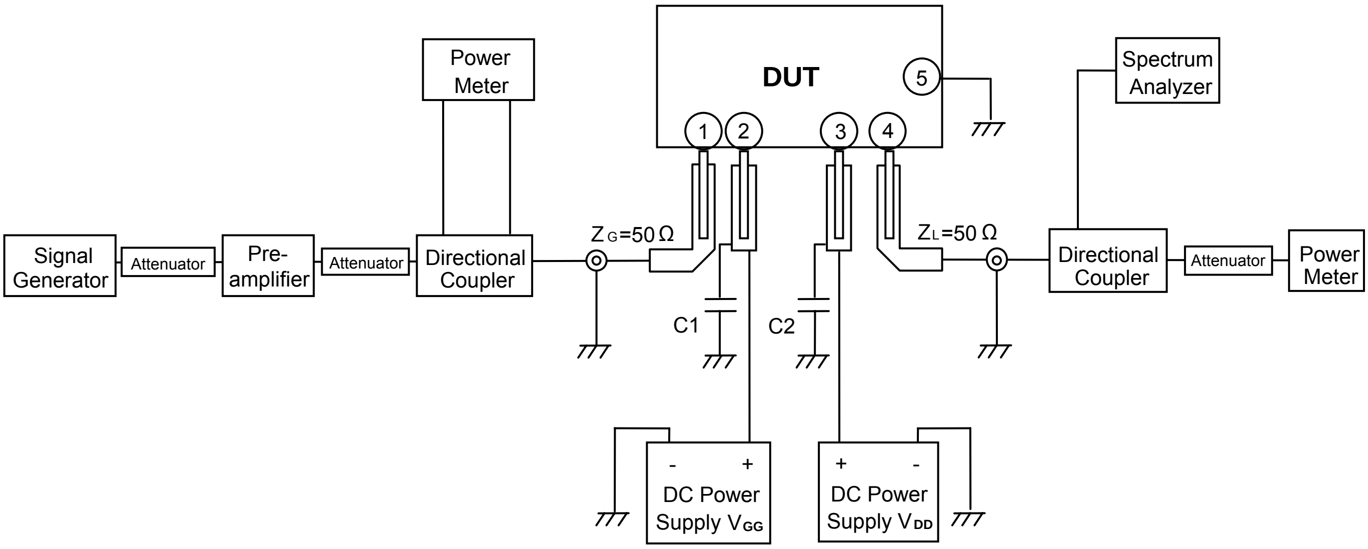


OUTLINE



① RF Input (P_{in})
② Gate Voltage(V_{GG})
③ Drain Voltage (V_{DD})
④ RF Output (P_{out})
⑤ RF Ground (Case)

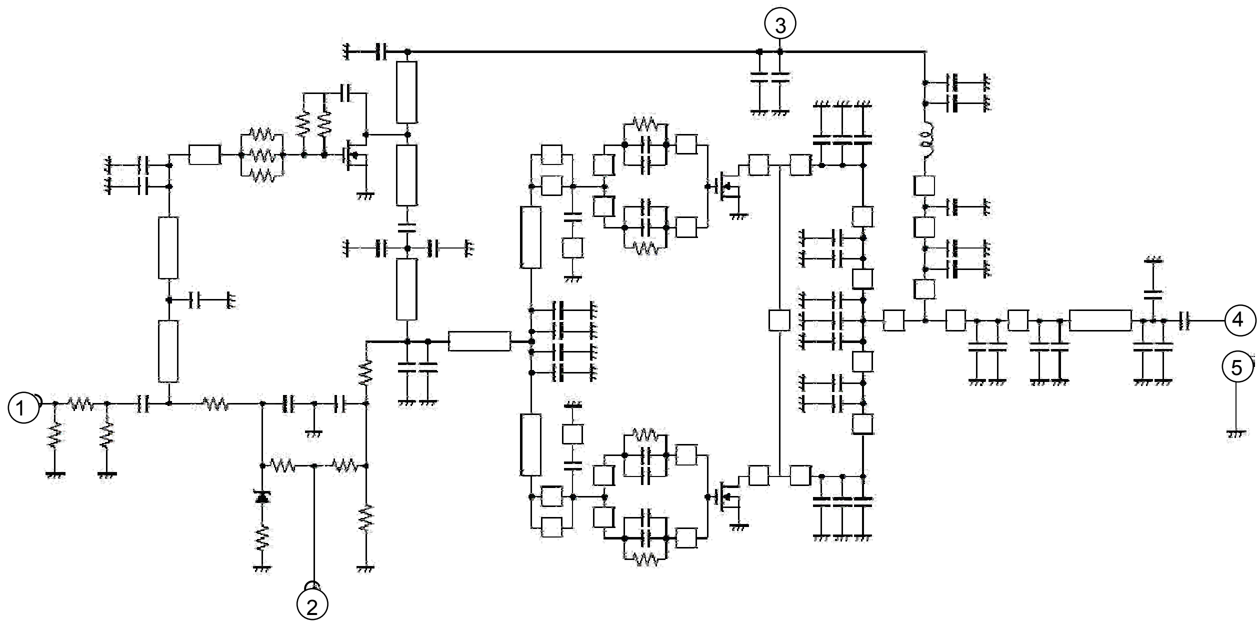
TEST BLOCK DIAGRAM



C1, C2: 4700pF, 22uF in parallel

① RF Input (P_{in})
② Gate Voltage (V_{GG})
③ Drain Voltage (V_{DD})
④ RF Output (P_{out})
⑤ RF Ground (Case)

EQUIVALENT CIRCUIT



RECOMMENDATIONS and APPLICATION INFORMATION:

Construction:

This module consists of a glass-epoxy substrate soldered onto a copper flange. For mechanical protection, a metal cap is attached (which makes the improvement of RF radiation easy). The MOSFET transistor chips are die bonded onto metal, wire bonded to the substrate, and coated with resin. Lines on the substrate (eventually inductors), chip capacitors, and resistors form the bias and matching circuits. Wire leads soldered onto the glass-epoxy substrate provide the DC and RF connection.

Following conditions must be avoided:

a) Bending forces on the glass-epoxy substrate (for example, by driving screws or from fast thermal changes)
b) Mechanical stress on the wire leads (for example, by first soldering then driving screws or by thermal expansion)
c) Defluxing solvents reacting with the resin coating on the MOSFET chips (for example, Trichloroethylene)
d) Frequent on/off switching that causes thermal expansion of the resin
e) ESD, surge, overvoltage in combination with load VSWR, and oscillation

ESD:

This MOSFET module is sensitive to ESD voltages down to 1000V. Appropriate ESD precautions are required.

Mounting:

A thermal compound between module and heat sink is recommended for low thermal contact resistance.
The module must first be screwed to the heat sink, then the leads can be soldered to the printed circuit board.
M3 screws are recommended with a tightening torque of 4.0 to 6.0 kgf-cm.

Soldering and Defluxing:

This module is designed for manual soldering.
The leads must be soldered after the module is screwed onto the heat sink.
The temperature of the lead (terminal) soldering should be lower than 350°C and shorter than 3 second.
Ethyl Alcohol is recommend for removing flux. Trichloroethylene solvents must not be used (they may cause bubbles in the coating of the transistor chips which can lift off the bond wires).

Thermal Design of the Heat Sink:

At P_{out}=60W, V_{DD}=12.5V and P_{in}=50mW each stage transistor operating conditions are:

Stage	P_{in} (W)	P_{out} (W)	$R_{th(ch-case)}$ (°C/W)	I_{DD} @ η_T=40% (A)	V_{DD} (V)
1st	0.05	3.4	2.57	1.5	12.5
2nd	3.4	60.0	0.45	10.5	

The channel temperatures of each stage transistor $T_{ch} = T_{case} + (V_{DD} \times I_{DD} - P_{out} + P_{in}) \times R_{th(ch-case)}$ are:

$T_{ch1} = T_{case}$ + (12.5V x 1.5A – 3.4W + 0.05W) x 2.57°C/W = T_{case} + 39.6 °C
$T_{ch2} = T_{case}$ + (12.5V x 10.5A – 60.0W + 3.4W) x 0.45°C/W = T_{case} + 33.6 °C

For long-term reliability, it is best to keep the module case temperature (T_{case}) below 90°C. For an ambient temperature T_{air}=60°C and P_{out}=60W, the required thermal resistance $R_{th\ (case-air)} = (T_{case} - T_{air}) / ((P_{out} / \eta_T) - P_{out} + P_{in})$ of the heat sink, including the contact resistance, is:

$R_{th(case-air)}$ = (90°C - 60°C) / (60W/40% - 60W + 0.05W) = 0.33 °C/W

When mounting the module with the thermal resistance of 0.33 °C/W, the channel temperature of each stage transistor is:

$T_{ch1} = T_{air}$ + 69.6 °C
$T_{ch2} = T_{air}$ + 63.6 °C

The 175°C maximum rating for the channel temperature ensures application under derated conditions.