DESCRIPTION
The RA30H4452M1 is a 30W RF MOSFET Amplifier Module for 12.5V mobile radios that operate in the 440 to 520MHz 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 ($P_{out}=30W$) 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).

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.

FEATURES
• Enhancement-Mode MOSFET Transistors ($I_{DD}=0$ @ $V_{DD}=12.5V$, $V_{GG}=0V$)
• $P_{out}>30W$, $\eta>42\%$ @ $V_{DD}=12.5V$, $V_{GG}=5V$, $P_{m}=50mW$
• Broadband Frequency Range: 440-520MHz
• Metal shield structure that makes the improvements of spurious radiation simple
• 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
• RA30H4452M1 is a RoHS compliant product.
• 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:

<table>
<thead>
<tr>
<th>ORDER NUMBER</th>
<th>SUPPLY FORM</th>
</tr>
</thead>
<tbody>
<tr>
<td>RA30H4452M1-501</td>
<td>Antistatic tray,</td>
</tr>
<tr>
<td></td>
<td>10 modules/tray</td>
</tr>
</tbody>
</table>

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MAXIMUM RATINGS  \( T_{\text{case}}=+25^\circ \text{C}, \ Z_0=Z_L=50\Omega, \) unless otherwise specified

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>PARAMETER</th>
<th>CONDITIONS</th>
<th>RATING</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{DD} )</td>
<td>Drain DC Supply Voltage</td>
<td>( V_{GG}=0\text{V}, \ P_{in}=0\text{W} )</td>
<td>17</td>
<td>V</td>
</tr>
<tr>
<td>( V_{GG} )</td>
<td>Gate DC Supply Voltage</td>
<td>( V_{DD} \leq 12.5\text{V}, \ P_{in}=50\text{mW} )</td>
<td>6</td>
<td>V</td>
</tr>
<tr>
<td>( I_{DD} )</td>
<td>Total Current</td>
<td>-</td>
<td>10</td>
<td>A</td>
</tr>
<tr>
<td>( P_{in} )</td>
<td>Input Power</td>
<td>( f=440-520\text{MHz}, \ V_{GG} \leq 5\text{V} )</td>
<td>100</td>
<td>mW</td>
</tr>
<tr>
<td>( P_{out} )</td>
<td>Output Power</td>
<td>Ditto</td>
<td>45</td>
<td>W</td>
</tr>
<tr>
<td>( T_{\text{case(OP)}} )</td>
<td>Operation Case Temperature Range</td>
<td>Ditto</td>
<td>-30 to +100</td>
<td>°C</td>
</tr>
<tr>
<td>( T_{\text{stg}} )</td>
<td>Storage Temperature Range</td>
<td>-</td>
<td>-40 to +110</td>
<td>°C</td>
</tr>
</tbody>
</table>

The above parameters are independently guaranteed.

ELECTRICAL CHARACTERISTICS  \( T_{\text{case}}=+25^\circ \text{C}, \ Z_0=Z_L=50\Omega, \) unless otherwise specified

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>PARAMETER</th>
<th>CONDITIONS</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>( f )</td>
<td>Frequency Range</td>
<td>-</td>
<td>440</td>
<td>-</td>
<td>520</td>
<td>MHz</td>
</tr>
<tr>
<td>( P_{out} )</td>
<td>Total Efficiency</td>
<td>( V_{DD}=12.5\text{V}, \ V_{GG}=5\text{V}, \ P_{in}=50\text{mW} )</td>
<td>30</td>
<td>-</td>
<td>-</td>
<td>W</td>
</tr>
<tr>
<td>( \eta_T )</td>
<td>2\text{nd} Harmonic</td>
<td>( V_{DD}=12.5\text{V}, \ V_{GG}=5\text{V}, \ P_{in}=50\text{mW} )</td>
<td>42</td>
<td>-</td>
<td>-</td>
<td>%</td>
</tr>
<tr>
<td>( \eta_T )</td>
<td>3\text{rd} Harmonic</td>
<td>-</td>
<td>-</td>
<td>-40</td>
<td>dBc</td>
<td></td>
</tr>
<tr>
<td>( \rho_{in} )</td>
<td>Input VSWR</td>
<td>-</td>
<td>-</td>
<td>-50</td>
<td>dBc</td>
<td></td>
</tr>
<tr>
<td>( I_{DD} )</td>
<td>Leakage Current</td>
<td>( V_{DD}=17\text{V}, \ V_{GG}=0\text{V}, \ P_{in}=0\text{W} )</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>mA</td>
</tr>
<tr>
<td>( - )</td>
<td>Load VSWR Tolerance</td>
<td>( V_{DD}=15.2\text{V}, \ P_{in}=50\text{mW}, \ P_{out}=30\text{W} \ (V_{GG} \text{ adj.}), \ Load \ VSWR=20:1 \ (\text{All phase}) )</td>
<td>No degradation or destroy</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( - )</td>
<td>Stability</td>
<td>( V_{DD}=10/12.5/15.2\text{V}, \ P_{in}=25/50/70\text{mW}, \ P_{out} \leq 40\text{W} \ (V_{GG} \text{ control}), \ Load \ VSWR=3:1 \ (\text{All phase}) )</td>
<td>No parasitic oscillation more than -60dBc</td>
<td>-</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

All parameters, conditions, ratings, and limits are subject to change without notice.
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TYPICAL PERFORMANCE  \( T_{\text{case}}=+25^\circ \text{C}, \ Z_0=Z_L=50\Omega, \) unless otherwise specified
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TYPICAL PERFORMANCE  \( (T_{\text{case}}=+25^\circ\text{C}, Z_0=Z_L=50\Omega, \text{unless otherwise specified}) \)

- **OUTPUT POWER, DRAIN CURRENT versus DRAIN VOLTAGE**
- **OUTPUT POWER, DRAIN CURRENT versus DRAIN VOLTAGE**
- **OUTPUT POWER versus DRAIN VOLTAGE**

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

1. INPUT TERMINAL (Pin)
2. GATE BIAS DC SUPPLY TERMINAL (VGG)
3. DRAIN BIAS DC SUPPLY TERMINAL (VD)
4. OUTPUT TERMINAL (Pout)
5. FIN (GND)

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TEST BLOCK DIAGRAM

C1, C2: 4700pF, 22uF in parallel

EQUIVALENT CIRCUIT

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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) 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 $P_{out}=30W, V_{DD}=12.5V$ and $P_{in}=50mW$ each stage transistor operating conditions are:

<table>
<thead>
<tr>
<th>Stage</th>
<th>$P_{in}$ (W)</th>
<th>$P_{out}$ (W)</th>
<th>$R_{th(ch-case)}$ (°C/W)</th>
<th>$I_{DD} \cdot \eta=42%$ (A)</th>
<th>$V_{DD}$ (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>0.05</td>
<td>3.0</td>
<td>2.57</td>
<td>1.5</td>
<td>12.5</td>
</tr>
<tr>
<td>2nd</td>
<td>3.0</td>
<td>30.0</td>
<td>1.0</td>
<td>4.2</td>
<td></td>
</tr>
</tbody>
</table>

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

- $T_{ch1} = T_{case} + (12.5V \cdot 1.5A - 3.0W + 0.05W) \times 2.57°C/W = T_{case} + 40.6°C$
- $T_{ch2} = T_{case} + (12.5V \cdot 4.2A - 30.0W + 3.0W) \times 1.0°C/W = T_{case} + 25.5°C$

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 $P_{out}=30W$, the required thermal resistance $R_{th(case-air)} = (T_{case} - T_{air}) / (P_{out} / \eta_I - P_{out} + P_{in})$ of the heat sink, including the contact resistance, is:

- $R_{th(case-air)} = (90°C - 60°C) / (30W/42% - 30W + 0.05W) = 0.72°C/W$

When mounting the module with the thermal resistance of 0.72 °C/W, the channel temperature of each stage transistor is:

- $T_{ch1} = T_{air} + 70.6°C$
- $T_{ch2} = T_{air} + 55.5°C$

The 175°C maximum rating for the channel temperature ensures application under derated conditions.
PRECAUTIONS FOR THE USE OF MITSUBISHI SILICON RF POWER DEVICES:

1. The specifications of mention are not guarantee values in this data sheet. Please confirm additional details regarding operation of these products from the formal specification sheet. For copies of the formal specification sheets, please contact one of our sales offices.

2. RA series products (RF power amplifier modules) and RD series products (RF power transistors) are designed for consumer mobile communication terminals and were not specifically designed for use in other applications. In particular, while these products are highly reliable for their designed purpose, they are not manufactured under a quality assurance testing protocol that is sufficient to guarantee the level of reliability typically deemed necessary for critical communications elements and in the application, which is base station applications and fixed station applications that operate with long term continuous transmission and a higher on-off frequency during transmitting, please consider the derating, the redundancy system, appropriate setting of the maintain period and others as needed. For the reliability report which is described about predicted operating life time of Mitsubishi Silicon RF Products, please contact Mitsubishi Electric Corporation or an authorized Mitsubishi Semiconductor product distributor.

3. RD series products use MOSFET semiconductor technology. They are sensitive to ESD voltage therefore appropriate ESD precautions are required.

4. In the case of use in below than recommended frequency, there is possibility to occur that the device is deteriorated or destroyed due to the RF-swing exceed the breakdown voltage.

5. In order to maximize reliability of the equipment, it is better to keep the devices temperature low. It is recommended to utilize a sufficient sized heat-sink in conjunction with other cooling methods as needed (fan, etc.) to keep the channel temperature for RD series products lower than 120deg/C (in case of Tchmax=150deg/C), 140deg/C (in case of Tchmax=175deg/C) under standard conditions.

6. Do not use the device at the exceeded the maximum rating condition. In case of plastic molded devices, the exceeded maximum rating condition may cause blowout, smoldering or catch fire of the molding resin due to extreme short current flow between the drain and the source of the device. These results causes in fire or injury.

7. For specific precautions regarding assembly of these products into the equipment, please refer to the supplementary items in the specification sheet.

8. Warranty for the product is void if the products protective cap (lid) is removed or if the product is modified in any way from it’s original form.

9. For additional "Safety first" in your circuit design and notes regarding the materials, please refer the last page of this data sheet.

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10. Design and use environment:
Please avoid use in the place where water or organic solvents can adhere directly to the product and the environments with the possibility of salt air, caustic gas (hydrogen sulfide H_{2}S, sulfurous gas SO_{2}, chlorine gas Cl_{2}, nitrogen dioxide NO_{2}, ozone O_{3}, etc), dust, salinity, etc. Reliability could be markedly decreased and also there is a possibility failures could result causing a serious accident. Likewise, there is a possibility of causing a serious accident if used in an explosive gas environment. Please allow for adequate safety margin in your designs.

11. Please refer to the additional precautions in the formal specification sheet.

Keep safety first in your circuit designs!
Mitsubishi Electric Corporation puts the maximum effort into making semiconductor products better and more reliable, but there is always the possibility that trouble may occur with them. Trouble with semiconductors may lead to personal injury, fire or property damage. Remember to give due consideration to safety when making your circuit designs, with appropriate measures such as (i) placement of substitutive, auxiliary circuits, (ii) use of non-flammable material or (iii) prevention against any malfunction or mishap.

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