# BB504M

## Built in Biasing Circuit MOS FET IC
## VHF&UHF RF Amplifier

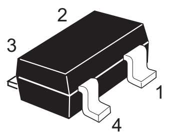
REJ03G0837-0700
(Previous ADE-208-982E)
Rev.7.00
Aug.10.2005

## Features

- Built in Biasing Circuit; To reduce using parts cost & PC board space.
- Low noise; NF = 1.0 dB typ. at f = 200 MHz, NF = 1.75 dB typ. at f =900 MHz
- High gain; PG = 30 dB typ. at f = 200 MHz, PG = 22 dB typ. at f = 900 MHz
- Withstanding to ESD;
  Built in ESD absorbing diode. Withstand up to 200 V at C = 200 pF, Rs = 0 conditions.
- Provide mini mold packages; MPAK-4 (SOT-143Rmod)

## Outline

RENESAS Package code: PLSP0004ZA-A
(Package name: MPAK-4)




1. Source
2. Gate1
3. Gate2
4. Drain

Notes: 1. Marking is “DS–”.
2. BB504M is individual type number of RENESAS BBFET.

## Absolute Maximum Ratings

(Ta = 25°C)

| Item | Symbol | Ratings | Unit |
|---|---|---|---|
| Drain to source voltage | $V_{DS}$ | 6 | V |
| Gate1 to source voltage | $V_{G1S}$ | +6<br>–0 | V |
| Gate2 to source voltage | $V_{G2S}$ | +6<br>–0 | V |
| Drain current | $I_D$ | 30 | mA |
| Channel power dissipation | Pch | 150 | mW |
| Channel temperature | Tch | 150 | °C |
| Storage temperature | Tstg | –55 to +150 | °C |

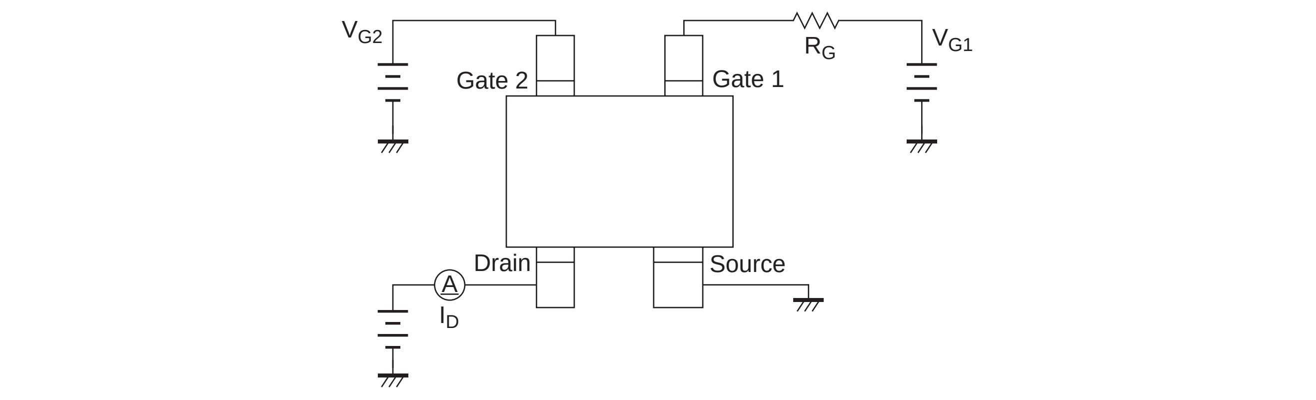
## Electrical Characteristics

(Ta = 25°C)

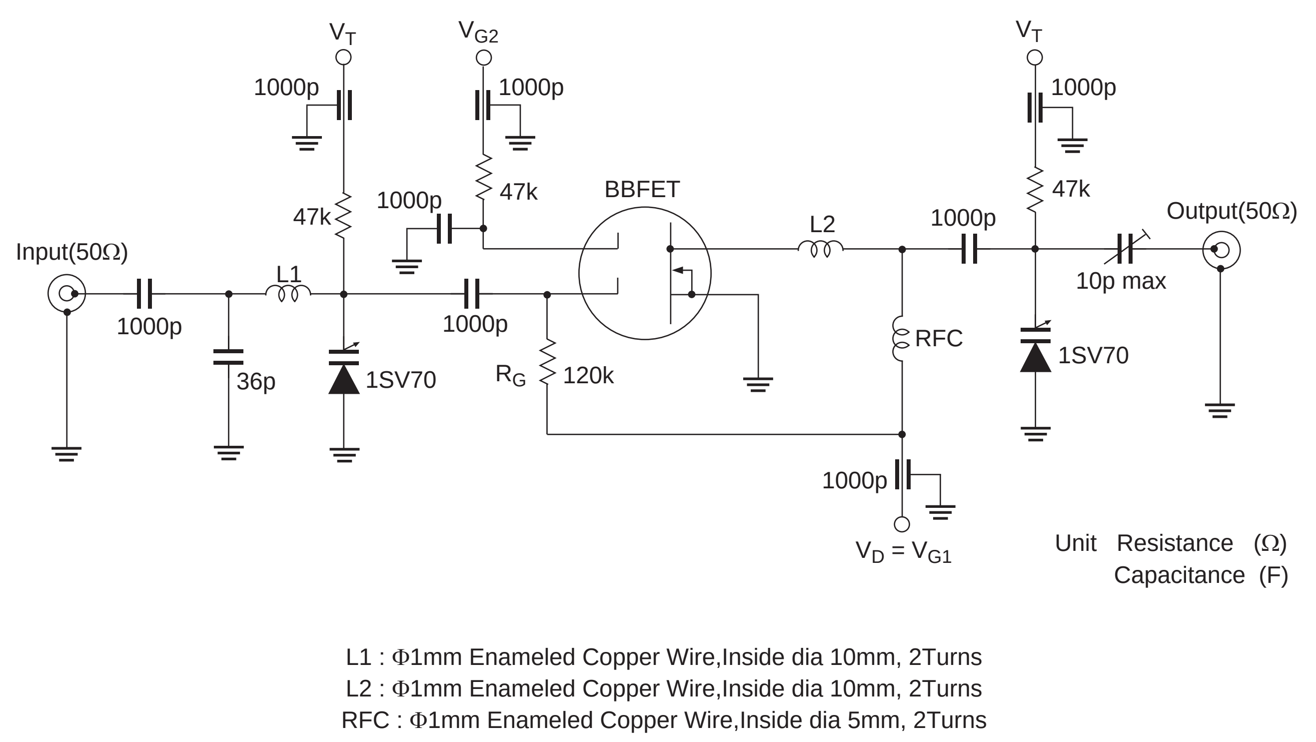
| Item | Symbol | Min | Typ | Max | Unit | Test conditions |
|---|---|---|---|---|---|---|
| Drain to source breakdown voltage | $V_{(BR)DSS}$ | 6 | — | — | V | $I_D$ = 200 μA, $V_{G1S}$ = $V_{G2S}$ = 0 |
| Gate1 to source breakdown voltage | $V_{(BR)G1SS}$ | +6 | — | — | V | $I_{G1}$ = +10 μA, $V_{G2S}$ = $V_{DS}$ = 0 |
| Gate2 to source breakdown voltage | $V_{(BR)G2SS}$ | +6 | — | — | V | $I_{G2}$ = +10 μA, $V_{G1S}$ = $V_{DS}$ = 0 |
| Gate1 to source cutoff current | $I_{G1SS}$ | — | — | +100 | nA | $V_{G1S}$ = +5 V, $V_{G2S}$ = $V_{DS}$ = 0 |
| Gate2 to source cutoff current | $I_{G2SS}$ | — | — | +100 | nA | $V_{G2S}$ = +5 V, $V_{G1S}$ = $V_{DS}$ = 0 |
| Gate1 to source cutoff voltage | $V_{G1S(off)}$ | 0.6 | 0.85 | 1.1 | V | $V_{DS}$ = 5 V, $V_{G2S}$ = 4 V<br>$I_D$ = 100 μA |
| Gate2 to source cutoff voltage | $V_{G2S(off)}$ | 0.6 | 0.85 | 1.1 | V | $V_{DS}$ = 5 V, $V_{G1S}$ = 5 V<br>$I_D$ = 100 μA |
| Drain current | $I_{D(op)}$ | 13 | 16 | 19 | mA | $V_{DS}$ = 5 V, $V_{G1}$ = 5 V<br>$V_{G2S}$ = 4 V, $R_G$ = 120 kΩ |
| Forward transfer admittance | $\|y_{fs}\|$ | 24 | 29 | 34 | mS | $V_{DS}$ = 5 V, $V_{G1}$ = 5 V, $V_{G2S}$ = 4 V<br>$R_G$ = 120 kΩ, f = 1 kHz |
| Input capacitance | $c_{iss}$ | 1.7 | 2.1 | 2.5 | pF | $V_{DS}$ = 5 V, $V_{G1}$ = 5 V<br>$V_{G2S}$ = 4 V, $R_G$ = 120 kΩ<br>f = 1 MHz |
| Output capacitance | $c_{oss}$ | 1.0 | 1.4 | 1.8 | pF | |
| Reverse transfer capacitance | $c_{rss}$ | — | 0.027 | 0.05 | pF | |
| Power gain (1) | PG | 25 | 30 | — | dB | $V_{DS}$ = 5 V, $V_{G1}$ = 5 V<br>$V_{G2S}$ = 4 V, $R_G$ = 120 kΩ<br>f = 200 MHz |
| Noise figure (1) | NF | — | 1.0 | 1.8 | dB | |
| Power gain (2) | PG | 17 | 22 | — | dB | $V_{DS}$ = 5 V, $V_{G1}$ = 5 V<br>$V_{G2S}$ = 4 V, $R_G$ = 120 kΩ<br>f = 900 MHz |
| Noise figure (2) | NF | — | 1.75 | 2.3 | dB | |

## Test Circuits

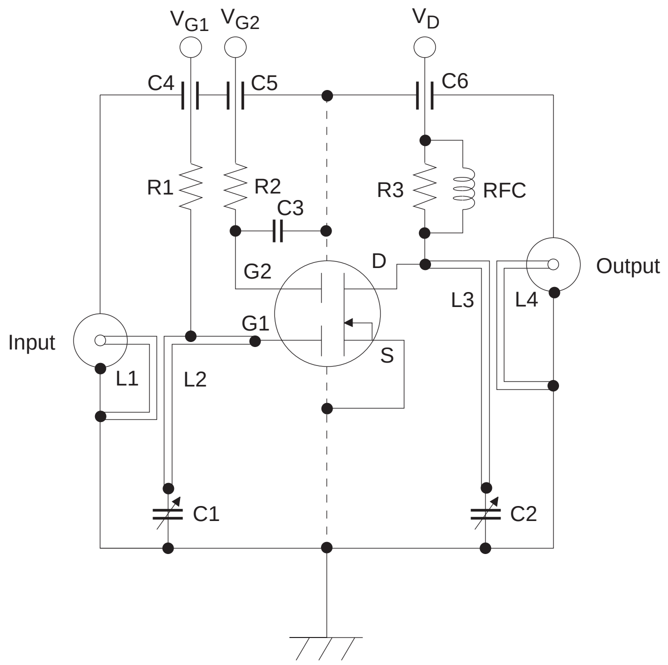
- **DC Biasing Circuit for Operating Characteristics Items** ($I_{D(op)}$, |yfs|, Ciss, Coss, Crss, NF, PG)




- **200 MHz Power Gain, Noise Figure Test Circuit**

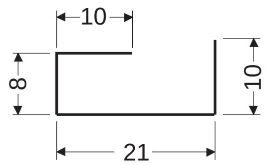


- **900 MHz Power Gain, Noise Figure Test Circuit**

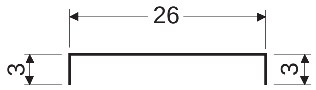



| | | |
|---|---|---|
| C1, C2 | : | Variable Capacitor (10pF MAX) |
| C3 | : | Disk Capacitor (1000pF) |
| C4 to C6 | : | Air Capacitor (1000pF) |
| R1 | : | 120 kΩ |
| R2 | : | 47 kΩ |
| R3 | : | 4.7 kΩ |

L1:

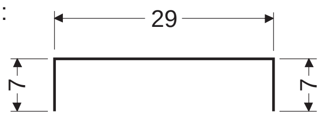



L2:

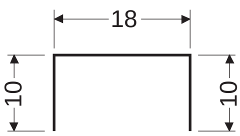



(Φ1mm Copper wire)
Unit:mm

L3:



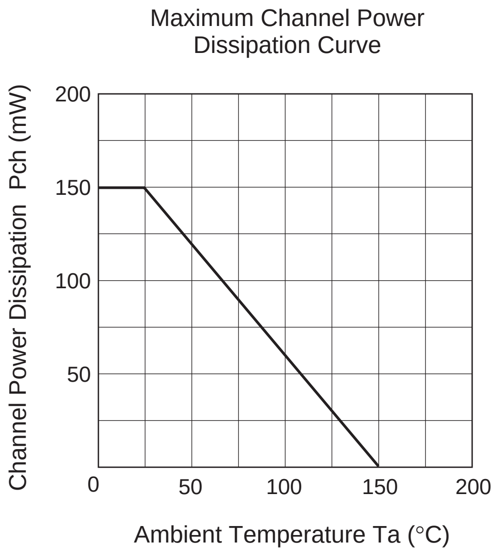

L4:

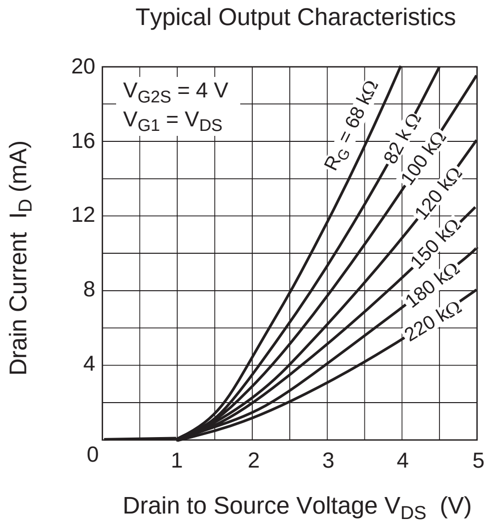


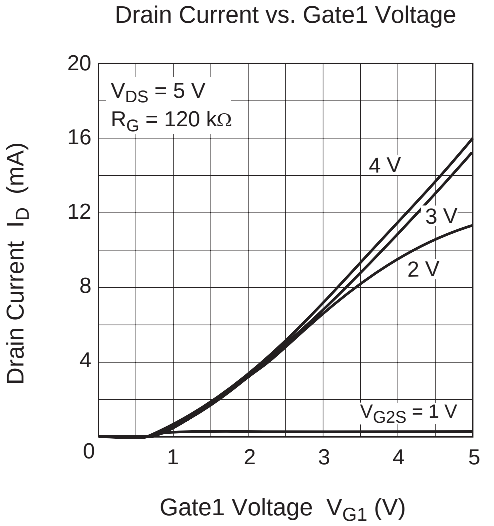

RFC : Φ1mm Copper wire with enamel 4turns inside dia 6mm

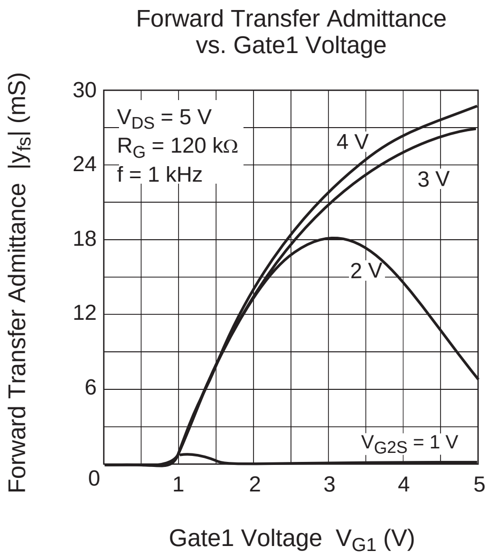


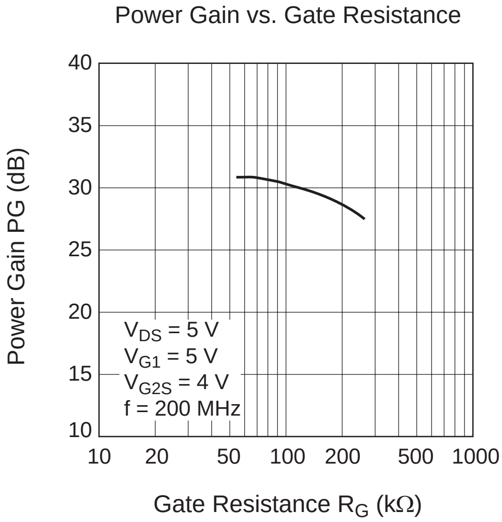
RENESAS

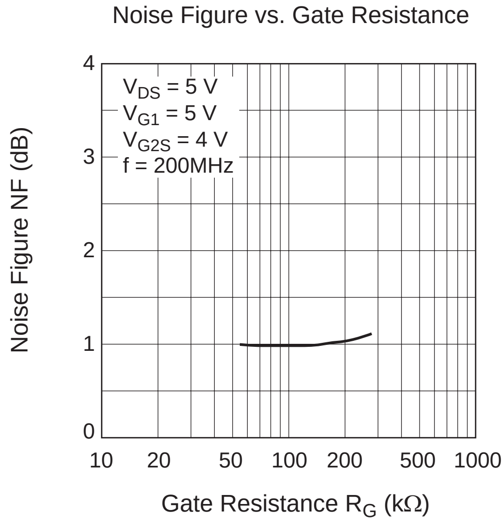

Maximum Channel Power Dissipation Curve
Channel Power Dissipation Pch (mW)
200
150
100
50
0
50
100
150
200
Ambient Temperature Ta (°C)


Typical Output Characteristics
$V_{G2S}$ = 4 V
$V_{G1}$ = $V_{DS}$
$R_G$ = 68 kΩ
82 kΩ
100 kΩ
120 kΩ
150 kΩ
180 kΩ
220 kΩ
Drain Current $I_D$ (mA)
20
16
12
8
4
0
1
2
3
4
5
Drain to Source Voltage $V_{DS}$ (V)

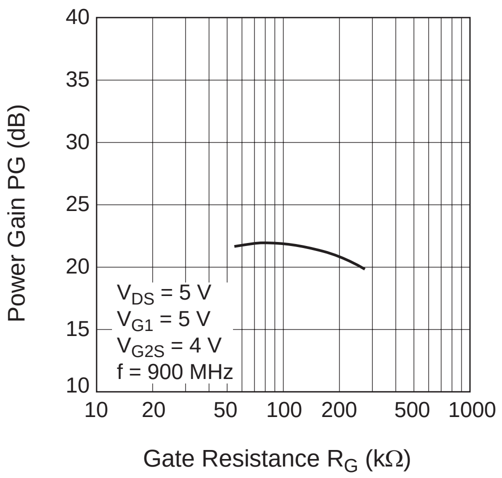

Drain Current vs. Gate1 Voltage
$V_{DS}$ = 5 V
$R_G$ = 120 kΩ
4 V
3 V
2 V
$V_{G2S}$ = 1 V
Drain Current $I_D$ (mA)
20
16
12
8
4
0
1
2
3
4
5
Gate1 Voltage $V_{G1}$ (V)


Forward Transfer Admittance vs. Gate1 Voltage
$V_{DS}$ = 5 V
$R_G$ = 120 kΩ
f = 1 kHz
4 V
3 V
2 V
$V_{G2S}$ = 1 V
Forward Transfer Admittance |$y_{fs}$| (mS)
30
24
18
12
6
0
1
2
3
4
5
Gate1 Voltage $V_{G1}$ (V)

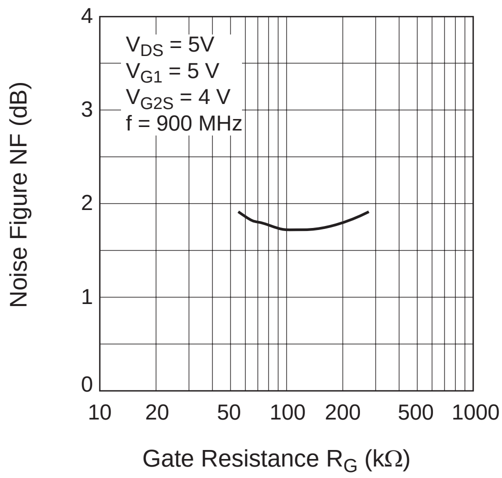

Power Gain vs. Gate Resistance
$V_{DS}$ = 5 V
$V_{G1}$ = 5 V
$V_{G2S}$ = 4 V
f = 200 MHz
Power Gain PG (dB)
40
35
30
25
20
15
10
10
20
50
100
200
500
1000
Gate Resistance $R_G$ (kΩ)


Noise Figure vs. Gate Resistance
$V_{DS}$ = 5 V
$V_{G1}$ = 5 V
$V_{G2S}$ = 4 V
f = 200MHz
Noise Figure NF (dB)
4
3
2
1
0
10
20
50
100
200
500
1000
Gate Resistance $R_G$ (kΩ)

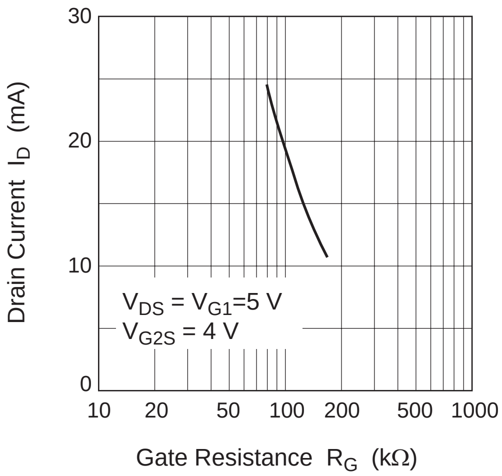
Power Gain vs. Gate Resistance



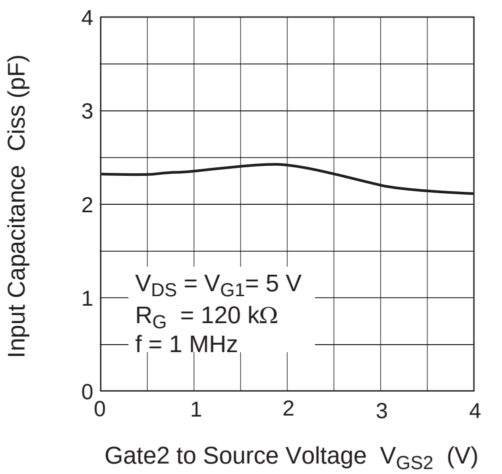

Noise Figure vs. Gate Resistance



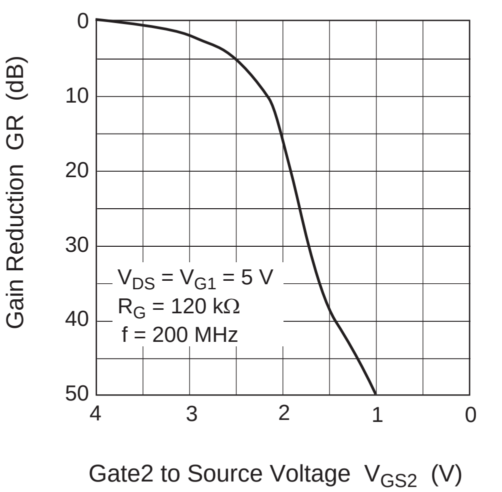

Drain Current vs. Gate Resistance



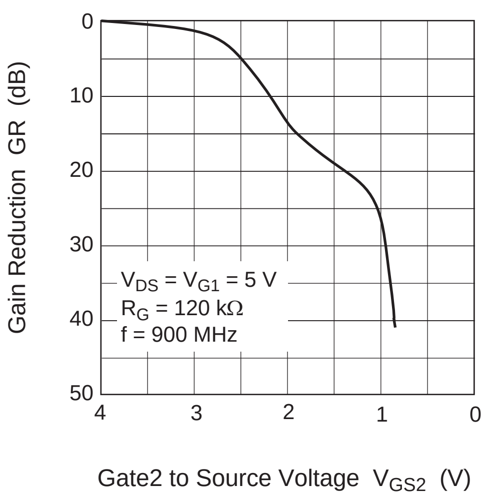

Input Capacitance vs.
Gate2 to Source Voltage



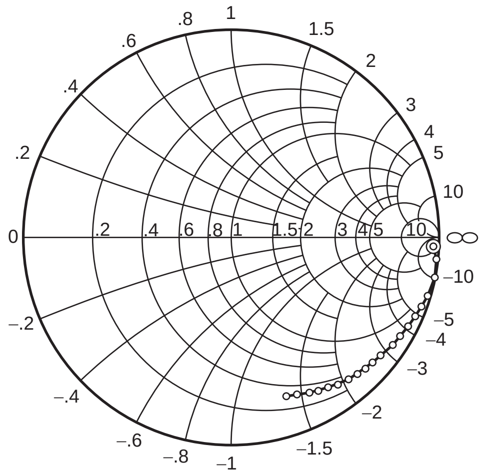

Gain Reduction vs.
Gate2 acto Source Voltage




Gain Reduction vs.
Gate2 acto Source Voltage

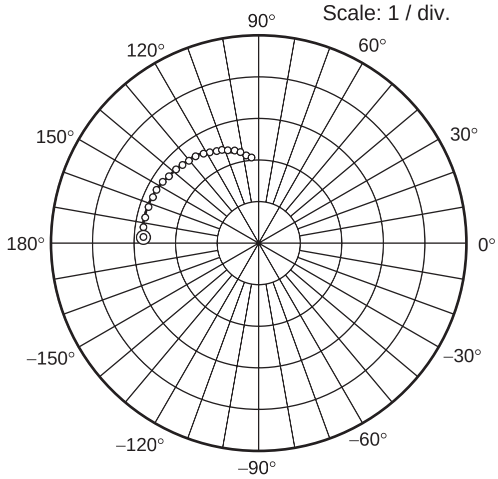


S11 Parameter vs. Frequency



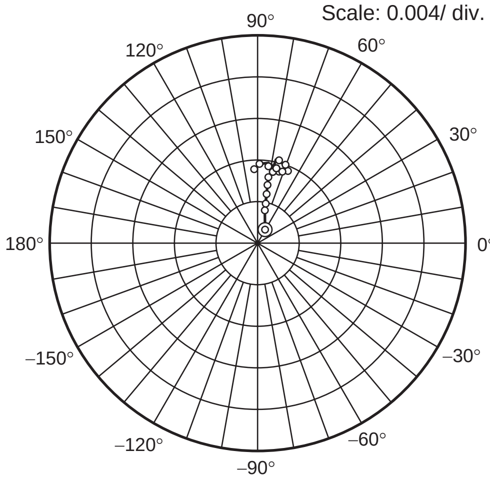

Test Condition: $V_{DS}$ = 5 V, $V_{G1}$ = 5 V
$V_{G2S}$ = 4 V, $R_G$ = 120 kΩ ,
Zo = 50Ω
50 to 1000 MHz (50 MHz step)

S21 Parameter vs. Frequency



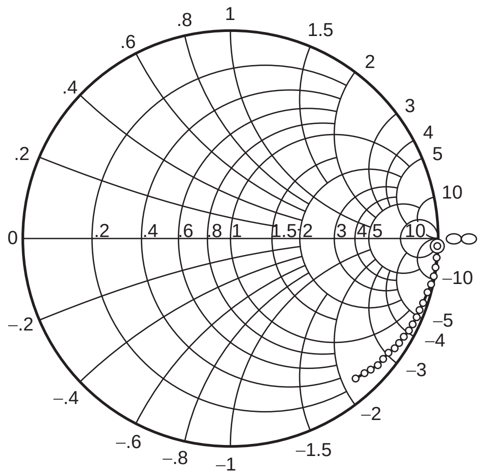

Test Condition: $V_{DS}$ = 5 V, $V_{G1}$ = 5 V
$V_{G2S}$ = 4 V, $R_G$ = 120 kΩ ,
Zo = 50Ω
50 to 1000 MHz (50 MHz step)

S12 Parameter vs. Frequency




Test Condition: $V_{DS}$ = 5 V, $V_{G1}$ = 5 V
$V_{G2S}$ = 4 V, $R_G$ = 120 kΩ ,
Zo = 50Ω
50 to 1000 MHz (50 MHz step)

S22 Parameter vs. Frequency




Test Condition: $V_{DS}$ = 5 V, $V_{G1}$ = 5 V
$V_{G2S}$ = 4 V, $R_G$ = 120 kΩ ,
Zo = 50Ω
50 to 1000 MHz (50 MHz step)

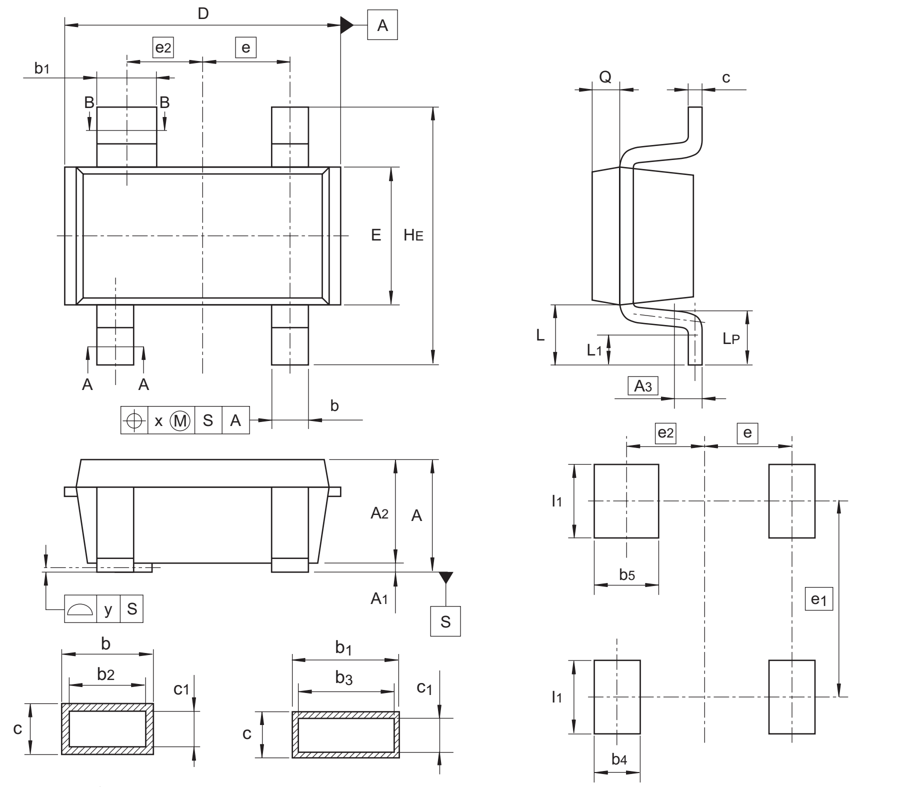
## S Parameter

($V_{DS} = V_{G1} = 5V, V_{G2S} = 4 V, R_G = 120 k\Omega, Zo = 50 \Omega$)

| f(MHz) | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| | MAG. | ANG. | MAG. | ANG. | MAG. | ANG. | MAG. | ANG. |
| 50 | 1.000 | -3.3 | 2.80 | 175.9 | 0.00106 | 58.8 | 0.990 | -2.4 |
| 100 | 0.993 | -7.2 | 2.78 | 170.9 | 0.00171 | 75.7 | 0.992 | -4.7 |
| 150 | 0.991 | -10.9 | 2.77 | 166.1 | 0.00253 | 75.1 | 0.991 | -7.2 |
| 200 | 0.984 | -15.0 | 2.74 | 161.2 | 0.00356 | 77.4 | 0.987 | -9.6 |
| 250 | 0.978 | -19.0 | 2.72 | 156.5 | 0.00442 | 78.2 | 0.985 | -12.2 |
| 300 | 0.970 | -22.8 | 2.68 | 151.8 | 0.00485 | 80.0 | 0.982 | -14.7 |
| 350 | 0.958 | -26.7 | 2.64 | 147.2 | 0.00576 | 74.7 | 0.978 | -17.1 |
| 400 | 0.954 | -30.3 | 2.60 | 142.7 | 0.00642 | 71.7 | 0.973 | -19.6 |
| 450 | 0.945 | -33.8 | 2.56 | 138.6 | 0.00689 | 73.3 | 0.968 | -22.0 |
| 500 | 0.932 | -37.5 | 2.50 | 134.1 | 0.00712 | 71.8 | 0.963 | -24.2 |
| 550 | 0.920 | -40.6 | 2.46 | 129.8 | 0.00765 | 70.7 | 0.958 | -26.7 |
| 600 | 0.910 | -44.3 | 2.41 | 125.7 | 0.00804 | 69.9 | 0.952 | -28.9 |
| 650 | 0.900 | -47.5 | 2.37 | 121.6 | 0.00798 | 69.1 | 0.947 | -31.3 |
| 700 | 0.887 | -50.9 | 2.31 | 117.8 | 0.00787 | 67.8 | 0.942 | -33.4 |
| 750 | 0.870 | -54.4 | 2.27 | 113.6 | 0.00785 | 70.8 | 0.936 | -35.8 |
| 800 | 0.863 | -57.6 | 2.22 | 110.0 | 0.00758 | 73.3 | 0.929 | -37.9 |
| 850 | 0.853 | -60.9 | 2.18 | 105.8 | 0.00721 | 75.2 | 0.924 | -40.3 |
| 900 | 0.839 | -63.6 | 2.12 | 102.2 | 0.00694 | 75.8 | 0.917 | -42.5 |
| 950 | 0.827 | -66.5 | 2.07 | 98.6 | 0.00716 | 88.1 | 0.912 | -44.5 |
| 1000 | 0.819 | -70.1 | 2.04 | 94.9 | 0.00667 | 92.7 | 0.906 | -46.7 |

## Package Dimensions

| JEITA Package Code | RENESAS Code | Package Name | MASS[Typ.] |
|---|---|---|---|
| SC-61AA | PLSP0004ZA-A | MPAK-4 / MPAK-4V | 0.013g |




| Reference Symbol | Dimension in Millimeters | | |
|---|---|---|---|
| | Min | Nom | Max |
| A | 1.0 | — | 1.3 |
| $A_1$ | 0 | — | 0.1 |
| $A_2$ | 1.0 | 1.1 | 1.2 |
| $A_3$ | — | 0.25 | — |
| b | 0.35 | 0.42 | 0.5 |
| $b_1$ | 0.55 | 0.62 | 0.7 |
| $b_2$ | — | 0.4 | — |
| $b_3$ | — | 0.6 | — |
| c | 0.1 | 0.13 | 0.15 |
| $c_1$ | — | 0.11 | — |
| D | 2.7 | — | 3.1 |
| E | 1.35 | 1.5 | 1.65 |
| e | — | 0.95 | — |
| $e_2$ | — | 0.85 | — |
| $H_E$ | 2.2 | 2.8 | 3.0 |
| L | 0.35 | — | 0.75 |
| $L_1$ | 0.15 | — | 0.55 |
| $L_P$ | 0.25 | — | 0.65 |
| x | — | — | 0.05 |
| y | — | — | 0.05 |
| $b_4$ | — | — | 0.55 |
| $b_5$ | — | — | 0.75 |
| $e_1$ | — | 1.95 | — |
| $l_1$ | — | — | 1.05 |
| Q | — | 0.3 | — |

## Ordering Information

| Part Name | Quantity | Shipping Container |
|---|---|---|
| BB504MDS-TL-E | 3000 | $\phi$ 178 mm Reel, 8 mm Emboss Taping |

Note: For some grades, production may be terminated. Please contact the Renesas sales office to check the state of production before ordering the product.

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1. Renesas Technology Corp. 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.
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Colophon .3.0