BB404M

Build in Biasing Circuit MOS FET IC
UHF/VHF RF Amplifier

HITACHI

ADE-208-717A (Z)
2nd. Edition
Dec. 1998

Features

- Build in Biasing Circuit; To reduce using parts cost & PC board space.
- High gain;
  (PG = 29 dB typ. at f = 200 MHz)
- Low noise characteristics;
  (NF = 1.2 dB typ. at f = 200 MHz)
- Wide supply voltage range;
  Applicable with 5V to 9V supply voltage.
- Withstanding to ESD;
  Build in ESD absorbing diode. Withstand up to 200V at C=200pF, Rs=0 conditions.
- Provide mini mold packages; MPAK-4R(SOT-143 var.)

Outline

MPAK-4R

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

Notes: 1. Marking is “DX–”.
2. BB404M is individual type number of HITACHI BBFET.

Hitachi semiconductor

Absolute Maximum Ratings (Ta = 25°C)

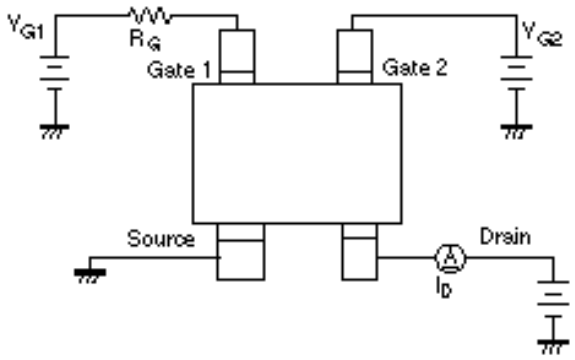
Item	Symbol	Ratings	Unit
Drain to source voltage	V_{DS}	12	V
Gate1 to source voltage	V_{G1S}	±10 – 0	V
Gate2 to source voltage	V_{G2S}	±10	V
Drain current	I_D	25	mA
Channel power dissipation	Pch	150	mW
Channel temperature	Tch	150	°C
Storage temperature	Tstg	–55 to +150	°C

Electrical Characteristics (Ta = 25°C)

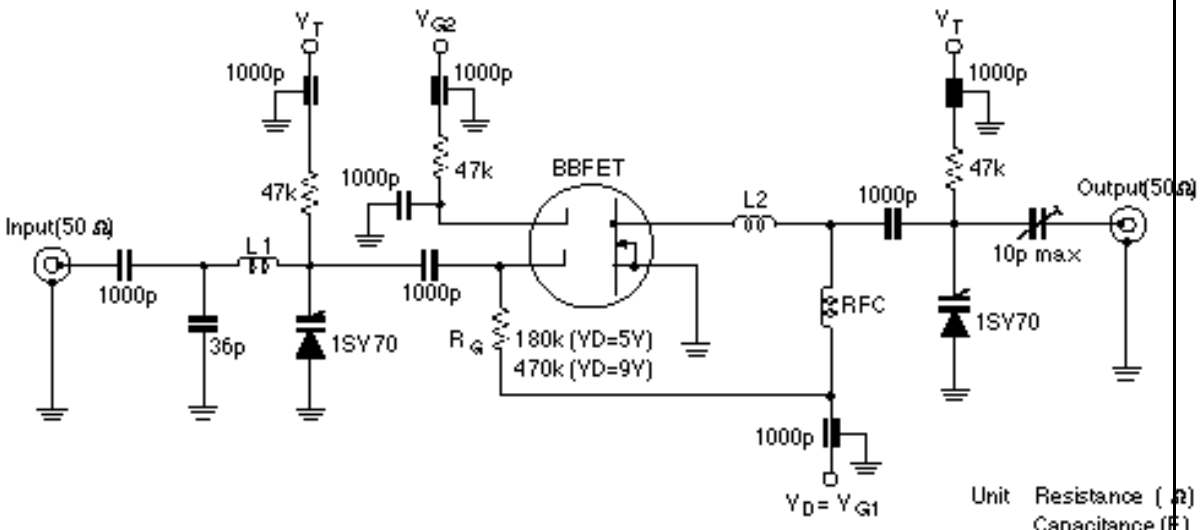
Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Drain to source breakdown voltage	$V_{(BR)DSS}$	12	—	—	V	I_D = 200µA, V_{G1S} = V_{G2S} = 0
Gate1 to source breakdown voltage	$V_{(BR)G1SS}$	+10	—	—	V	I_{G1} = +10µA, V_{G2S} = V_{DS} = 0
Gate2 to source breakdown voltage	$V_{(BR)G2SS}$	±10	—	—	V	I_{G2} = ±10µA, V_{G1S} = V_{DS} = 0
Gate1 to source cutoff current	I_{G1SS}	—	—	+100	nA	V_{G1S} = +9V, V_{G2S} = V_{DS} = 0
Gate2 to source cutoff current	I_{G2SS}	—	—	±100	nA	V_{G2S} = ±9V, V_{G1S} = V_{DS} = 0
Gate1 to source cutoff voltage	$V_{G1S(off)}$	0.4	0.7	1.0	V	V_{DS} = 5V, V_{G2S} = 4V, I_D = 100µA
Gate2 to source cutoff voltage	$V_{G2S(off)}$	0.5	0.7	1.0	V	V_{DS} = 5V, V_{G1S} = 5V, I_D = 100µA
Input capacitance	c_{iss}	2.3	2.8	3.6	pF	V_{DS} = 5V, V_{G1} = 5V
Output capacitance	c_{oss}	0.9	1.3	2.0	pF	V_{G2S} =4V, R_G = 180kΩ
Reverse transfer capacitance	c_{rss}	0.003	0.02	0.05	pF	f = 1MHz
Drain current	$I_{D(op)}$ 1	9	15	19	mA	V_{DS} = 5V, V_{G1} = 5V V_{G2S} = 4V, R_G = 180kΩ
	$I_{D(op)}$ 2	—	13	—	mA	V_{DS} = 9V, V_{G1} = 9V V_{G2S} =6V, R_G = 470kΩ
Forward transfer admittance	$|y_{fs}|$1	22	27	34	mS	V_{DS} = 5V, V_{G1} = 5V, V_{G2S} =4V R_G = 180kΩ, f = 1kHz
	$|y_{fs}|$2	—	27	—	mS	V_{DS} = 9V, V_{G1} = 9V, V_{G2S} =6V R_G = 470kΩ, f = 1kHz
Power gain	PG1	24	29	32	dB	V_{DS} = 5V, V_{G1} = 5V, V_{G2S} =4V R_G = 180kΩ, f = 200MHz
	PG2	—	29	—	dB	V_{DS} = 9V, V_{G1} = 9V, V_{G2S} =6V R_G = 470kΩ, f = 200MHz
Noise figure	NF1	—	1.2	1.9	dB	V_{DS} = 5V, V_{G1} = 5V, V_{G2S} =4V R_G = 180kΩ, f = 200MHz
	NF2	—	1.2	—	dB	V_{DS} = 9V, V_{G1} = 9V, V_{G2S} =6V R_G = 470kΩ, f = 200MHz

Main Characteristics

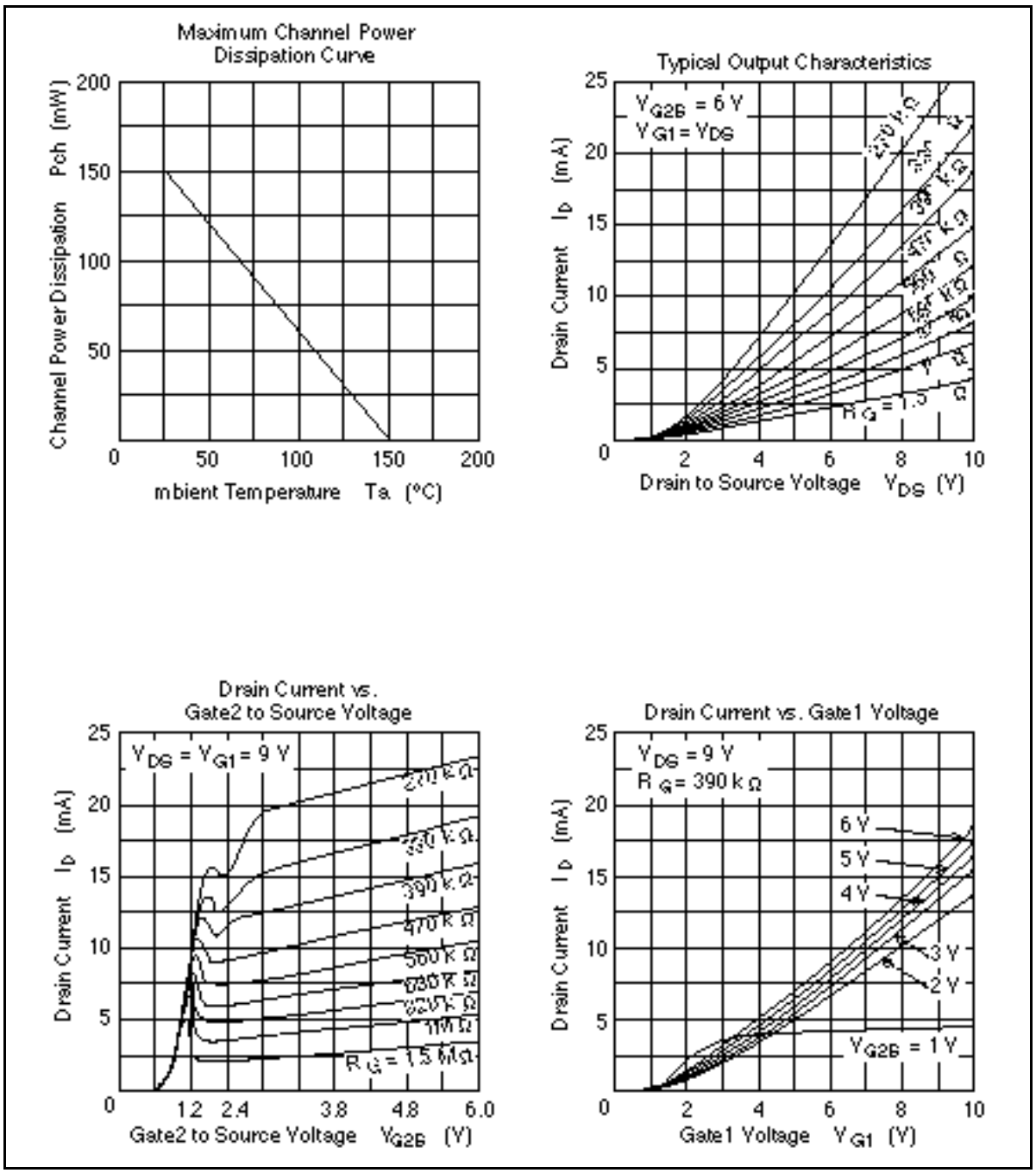
Test Circuit for Operating Items ($I_{D(op)}$, |yfs|, Ciss, Coss, Crss, NF, PG)

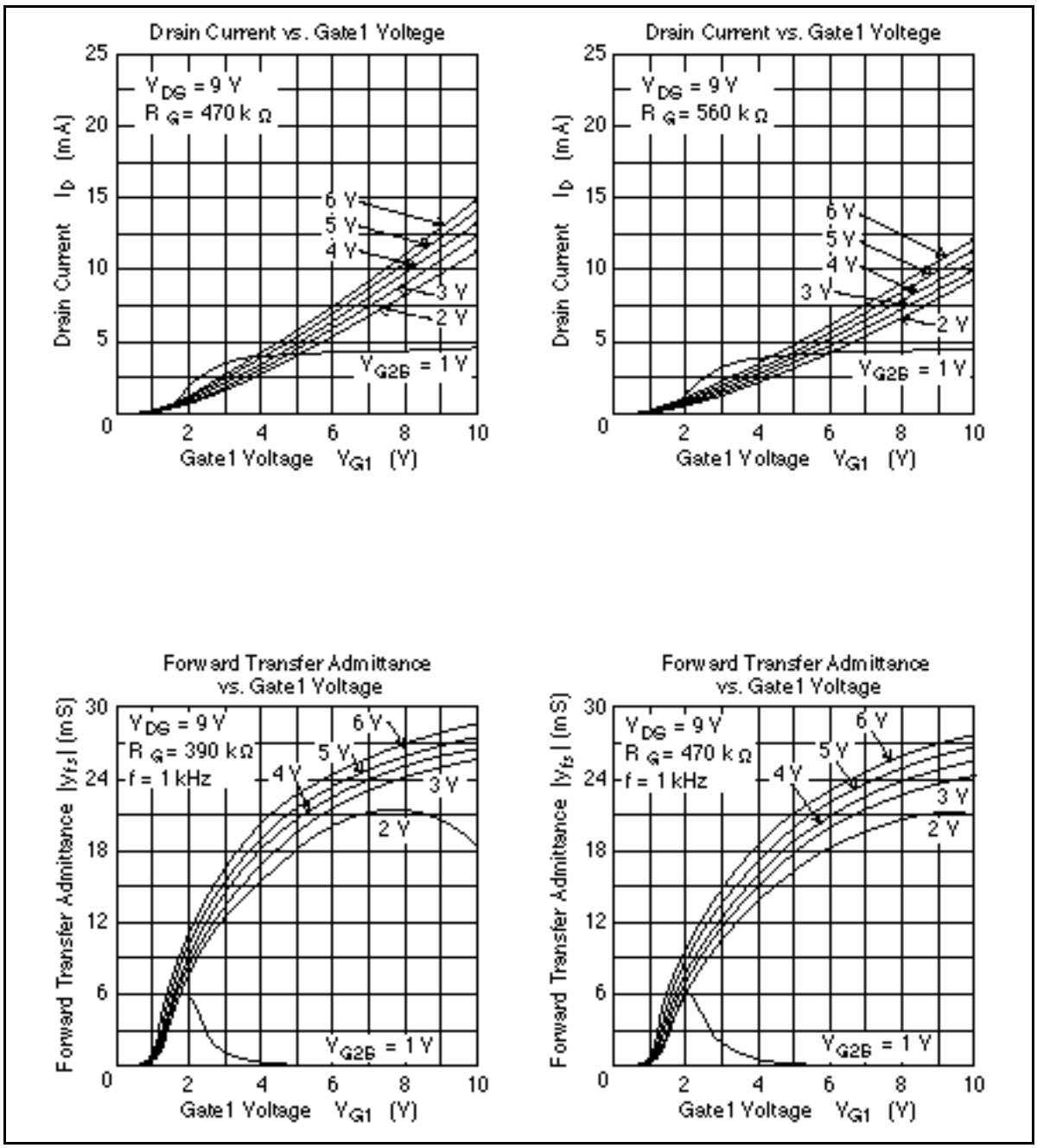


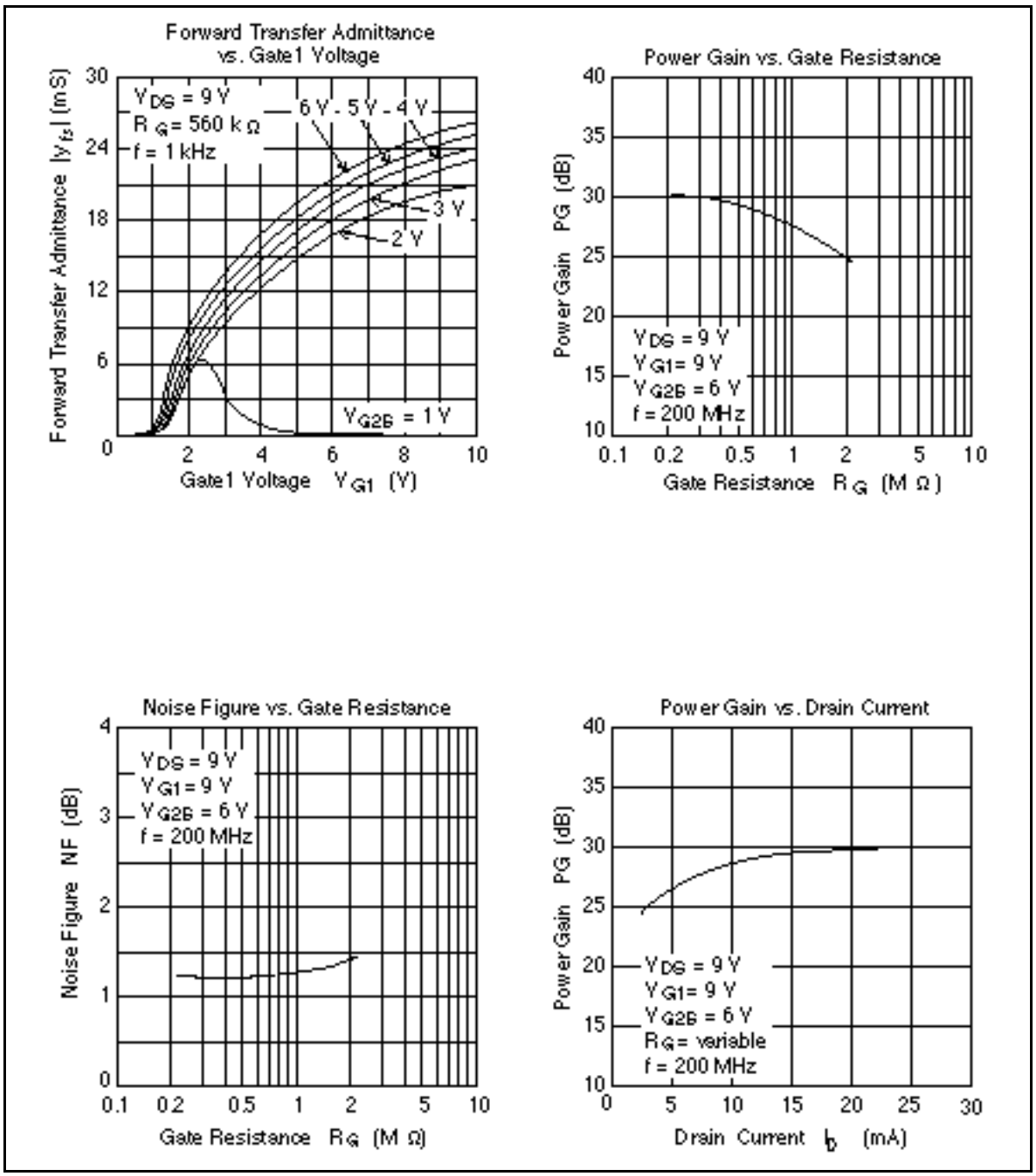
Power Gain, Noise Figure Test Circuit

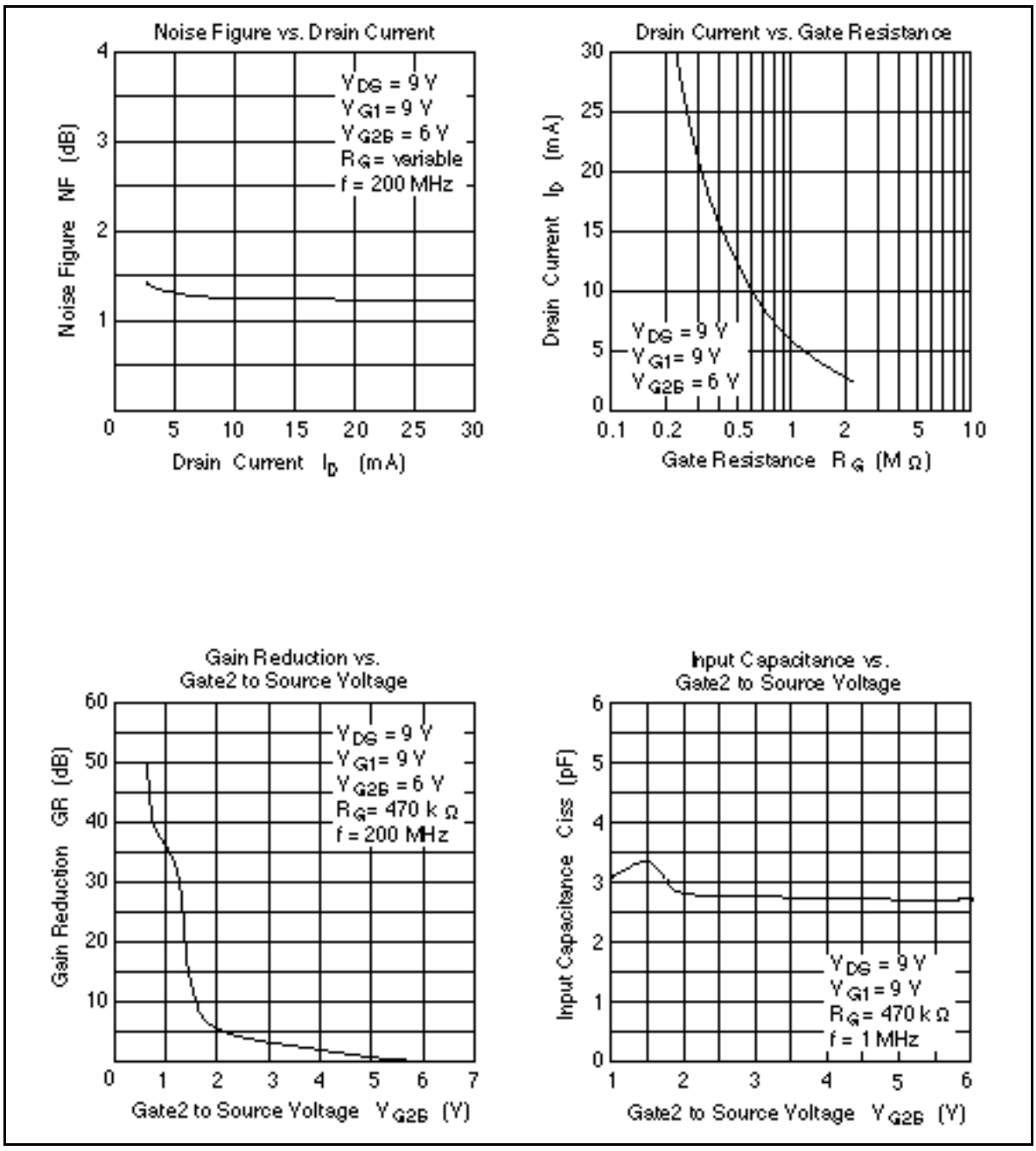


L1 : ϕ 1mm Enameled Copper Wire, Inside dia. 10mm, 2Turns
L2 : ϕ 1mm Enameled Copper Wire, Inside dia. 10mm, 2Turns
RFC : ϕ 1mm Enameled Copper Wire, Inside dia. 5mm, 2Turns

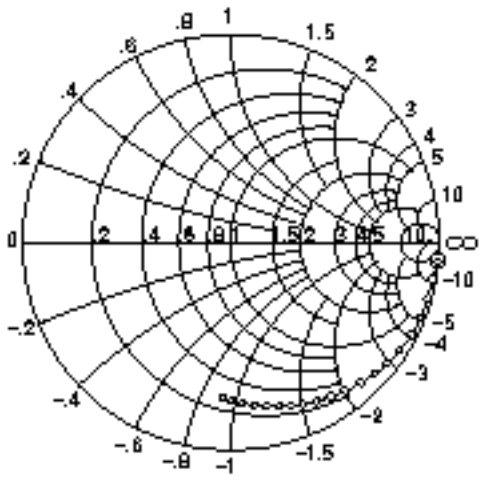

Maximum Channel Power Dissipation Curve
Channel Power Dissipation Pch (mW)
200
150
100
50
0
50
100
150
200
Ambient Temperature Ta (°C)
Typical Output Characteristics
V_{G2B} = 6 V
V_{G1} = V_{DS}
Drain Current I_D (mA)
25
20
15
10
5
0
2
4
6
8
10
Drain to Source Voltage V_{DS} (V)
Drain Current vs. Gate2 to Source Voltage
V_{DS} = V_{G1} = 9 V
Drain Current I_D (mA)
Gate2 to Source Voltage V_{G2B} (V)
1.2
2.4
3.8
4.8
6.0
Drain Current vs. Gate1 Voltage
V_{DS} = 9 V
R_G = 390 kΩ
6 V
5 V
4 V
3 V
2 V
V_{G2B} = 1 V
Gate1 Voltage V_{G1} (V)


Drain Current vs. Gate1 Voltege
V_{DS} = 9 V
R_G = 470 kΩ
6 V
5 V
4 V
3 V
2 V
V_{G2B} = 1 V
Drain Current I_D (mA)
Gate1 Voltage V_{G1} (V)
Drain Current vs. Gate1 Voltege
V_{DS} = 9 V
R_G = 560 kΩ
6 V
5 V
4 V
3 V
2 V
V_{G2B} = 1 V
Drain Current I_D (mA)
Gate1 Voltage V_{G1} (V)
Forward Transfer Admittance
vs. Gate1 Voltage
V_{DS} = 9 V
R_G = 390 kΩ
f = 1 kHz
6 V
5 V
4 V
3 V
2 V
V_{G2B} = 1 V
Forward Transfer Admittance $|y_{fs}|$ (mS)
Gate1 Voltage V_{G1} (V)
Forward Transfer Admittance
vs. Gate1 Voltage
V_{DS} = 9 V
R_G = 470 kΩ
f = 1 kHz
6 V
5 V
4 V
3 V
2 V
V_{G2B} = 1 V
Forward Transfer Admittance $|y_{fs}|$ (mS)
Gate1 Voltage V_{G1} (V)


Forward Transfer Admittance vs. Gate1 Voltage
Forward Transfer Admittance |yfs| (mS)
VDS = 9 V
RG = 560 kΩ
f = 1 kHz
6 V
5 V
4 V
3 V
2 V
VG2B = 1 V
Gate1 Voltage VG1 (V)
Power Gain vs. Gate Resistance
Power Gain PG (dB)
VDS = 9 V
VG1 = 9 V
VG2B = 6 V
f = 200 MHz
Gate Resistance RG (MΩ)
Noise Figure vs. Gate Resistance
Noise Figure NF (dB)
VDS = 9 V
VG1 = 9 V
VG2B = 6 V
f = 200 MHz
Gate Resistance RG (MΩ)
Power Gain vs. Drain Current
Power Gain PG (dB)
VDS = 9 V
VG1 = 9 V
VG2B = 6 V
RG = variable
f = 200 MHz
Drain Current ID (mA)

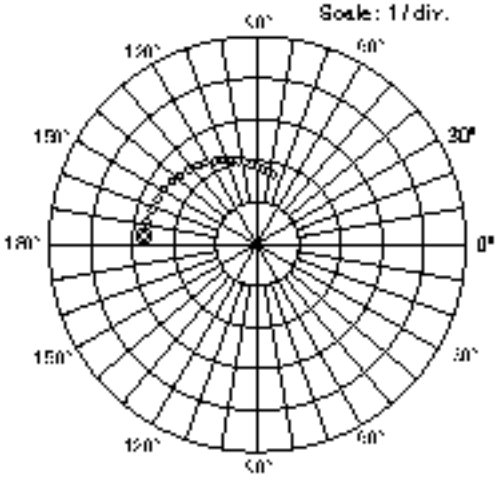

Noise Figure vs. Drain Current
Noise Figure NF (dB)
Drain Current I_D (mA)
V_{DS} = 9 V
V_{G1} = 9 V
V_{G2S} = 6 V
R_G = variable
f = 200 MHz
Drain Current vs. Gate Resistance
Drain Current I_D (mA)
Gate Resistance R_G (M Ω)
V_{DS} = 9 V
V_{G1} = 9 V
V_{G2S} = 6 V
Gain Reduction vs.
Gate2 to Source Voltage
Gain Reduction GR (dB)
Gate2 to Source Voltage V_{G2S} (V)
V_{DS} = 9 V
V_{G1} = 9 V
V_{G2S} = 6 V
R_G = 470 k Ω
f = 200 MHz
Input Capacitance vs.
Gate2 to Source Voltage
Input Capacitance Ciss (pF)
Gate2 to Source Voltage V_{G2S} (V)
V_{DS} = 9 V
V_{G1} = 9 V
R_G = 470 k Ω
f = 1 MHz

S11 Parameter vs. Frequency



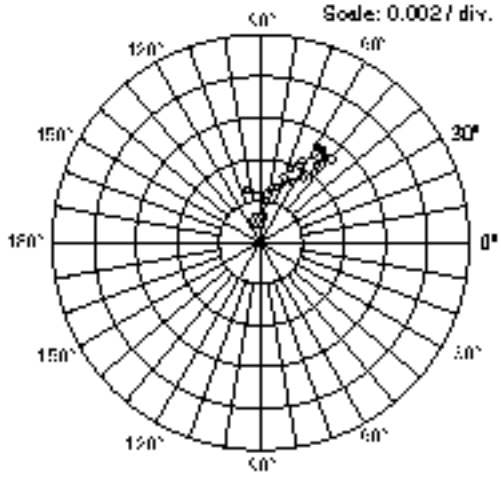
Test Condition : V_{DS}= 9 V, V_{G1}= 9 V
V_{G2S} = 6 V, R_G = 470 kΩ
50 to 1000 MHz (50 MHz step)

S21 Parameter vs. Frequency



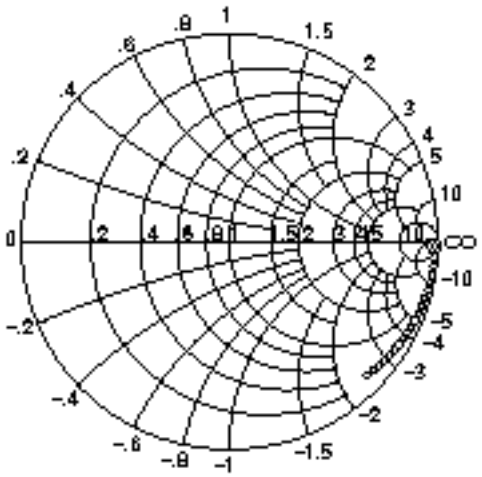
Test Condition : V_{DS}= 9 V, V_{G1}= 9 V
V_{G2S} = 6 V, R_G = 470 kΩ
50 to 1000 MHz (50 MHz step)

S12 Parameter vs. Frequency



Test Condition : V_{DS}= 9 V, V_{G1}= 9 V
V_{G2S} = 6 V, R_G = 470 kΩ
50 to 1000 MHz (50 MHz step)

S22 Parameter vs. Frequency



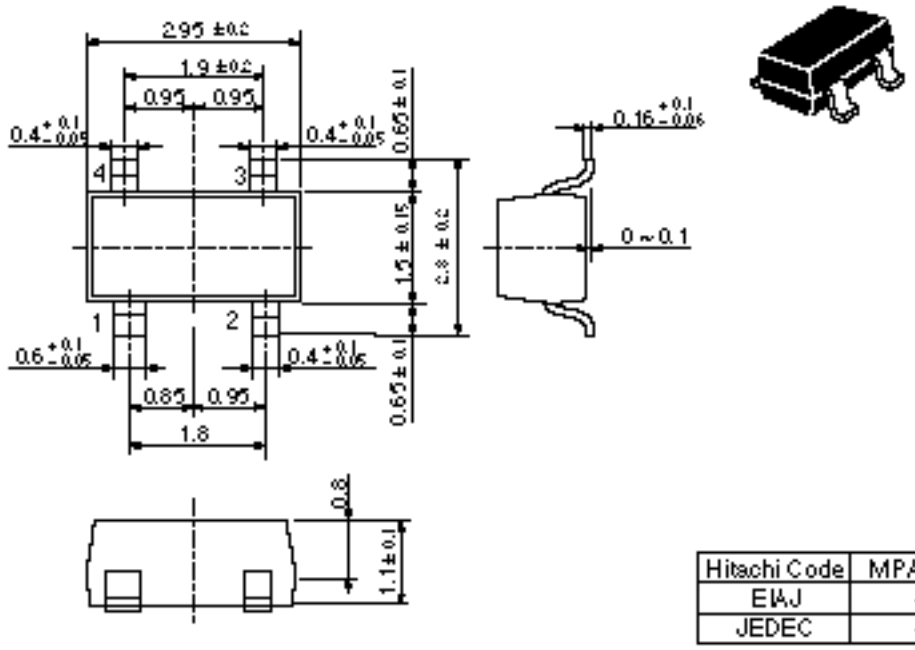
Test Condition : V_{DS}= 9 V, V_{G1}= 9 V
V_{G2S} = 6 V, R_G = 470 kΩ
50 to 1000 MHz (50 MHz step)

Sparameter (V_{DS} = V_{G1} = 9V, V_{G2S} = 6V, R_G = 470kΩ, Zo = 50Ω)

	S11		S21		S12		S22	
f (MHz)	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
50	0.996	–5.3	2.74	174.0	0.00096	98.6	0.985	–1.9
100	0.993	–10.9	2.73	168.0	0.00130	84.4	0.991	–4.5
150	0.987	–16.6	2.68	162.3	0.00203	83.6	0.990	–6.5
200	0.978	–21.9	2.66	156.3	0.00285	72.3	0.988	–9.4
250	0.972	–27.4	2.63	150.4	0.00335	69.7	0.985	–11.6
300	0.954	–33.2	2.57	144.3	0.00385	68.3	0.982	–14.0
350	0.943	–38.2	2.50	138.7	0.00455	63.2	0.979	–16.2
400	0.925	–43.2	2.43	133.3	0.00488	55.4	0.975	–18.4
450	0.910	–48.0	2.37	128.0	0.00526	59.8	0.971	–21.0
500	0.893	–52.5	2.30	122.6	0.00522	56.1	0.967	–23.0
550	0.880	–57.4	2.24	117.5	0.00498	53.2	0.962	–25.2
600	0.861	–62.1	2.17	112.7	0.00512	49.1	0.957	–27.3
650	0.847	–66.1	2.10	108.1	0.00497	53.4	0.952	–29.4
700	0.829	–69.9	2.02	103.6	0.00455	53.6	0.947	–31.6
750	0.816	–74.1	1.96	99.1	0.00418	51.6	0.943	–33.7
800	0.804	–78.2	1.91	94.8	0.00372	55.7	0.937	–35.8
850	0.791	–82.4	1.85	80.4	0.00329	62.4	0.933	–38.0
900	0.779	–86.1	1.79	86.3	0.00275	73.0	0.928	–40.0
950	0.764	–89.5	1.73	82.2	0.00233	82.4	0.921	–42.1
1000	0.753	–92.4	1.68	78.3	0.00258	105.1	0.918	–44.2

Package Dimensions

Unit: mm



Hitachi Code	MPAK-4R
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