BB601M

Build in Biasing Circuit MOS FET IC
UHF RF Amplifier

HITACHI

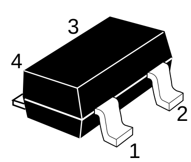
ADE-208-702C (Z)
4th. Edition
Nov. 1998

Features

- Build in Biasing Circuit; To reduce using parts cost & PC board space.
- High gain;
  PG = 21.5 dB typ. at f = 900 MHz
- Low noise;
  NF = 1.85 dB typ. at f = 900 MHz
- 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-143mod)

Outline

MPAK-4R



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

Notes: 1. Marking is "AT–".
2. BB601M is individual type number of HITACHI BBFET.

Hitachi semiconductor

Absolute Maximum Ratings (Ta = 25°C)

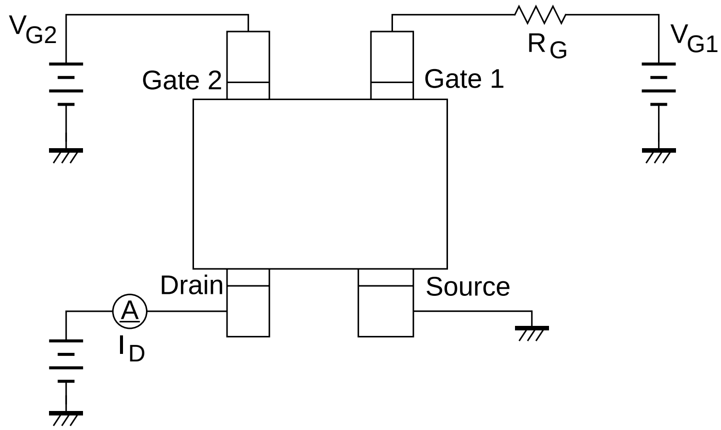
Item	Symbol	Ratings	Unit
Drain to source voltage	V_{DS}	6	V
Gate1 to source voltage	V_{G1S}	+6 – 0	V
Gate2 to source voltage	V_{G2S}	+6 – 0	V
Drain current	I_D	20	mA
Channel power dissipation	Pch	150	mW
Channel temperature	Tch	150	°C
Storage temperature	Tstg	–55 to +150	°C

Electrical Characteristics (Ta = 25°C)

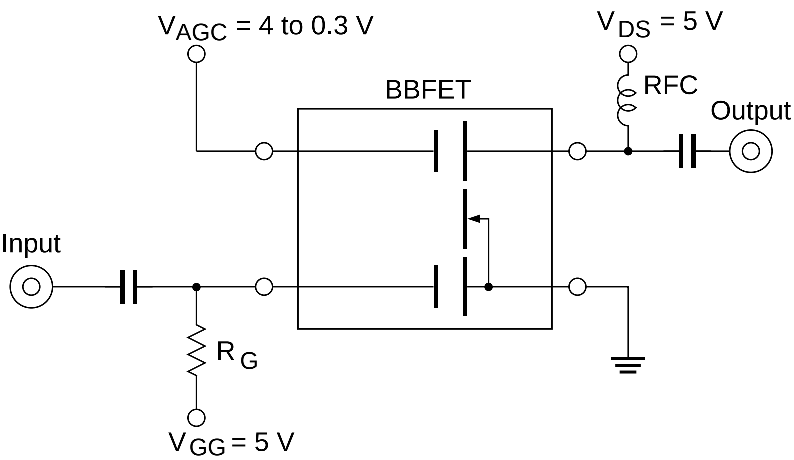
Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Drain to source breakdown voltage	$V_{(BR)DSS}$	6	—	—	V	I_D = 200µA V_{G1S} = V_{G2S} = 0
Gate1 to source breakdown voltage	$V_{(BR)G1SS}$	+6	—	—	V	I_{G1} = +10µA V_{G2S} = V_{DS} = 0
Gate2 to source breakdown voltage	$V_{(BR)G2SS}$	+6	—	—	V	I_{G2} = +10µA V_{G1S} = V_{DS} = 0
Gate1 to source cutoff current	I_{G1SS}	—	—	+100	nA	V_{G1S} = +5V V_{G2S} = V_{DS} = 0
Gate2 to source cutoff current	I_{G2SS}	—	—	+100	nA	V_{G2S} = +5V V_{G1S} = V_{DS} = 0
Gate1 to source cutoff voltage	$V_{G1S(off)}$	0.5	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
Drain current	$I_{D(op)}$	7	10	13	mA	V_{DS} = 5V, V_{G1} = 5V V_{G2S} = 4V, R_G = 47kΩ
Forward transfer admittance	$\|y_{fs}\|$	19	24	29	mS	V_{DS} = 5V, V_{G1} = 5V V_{G2S} =4V R_G = 47kΩ, f = 1kHz
Input capacitance	c_{iss}	1.4	1.7	2.0	pF	V_{DS} = 5V, V_{G1} = 5V
Output capacitance	c_{oss}	0.7	1.1	1.5	pF	V_{G2S} =4V, R_G = 47kΩ
Reverse transfer capacitance	c_{rss}	—	0.019	0.04	pF	f = 1MHz
Power gain	PG	17	21.5	—	dB	V_{DS} = 5V, V_{G1} = 5V V_{G2S} =4V, R_G = 47kΩ
Noise figure	NF	—	1.85	2.4	dB	f = 900MHz

Main Characteristics

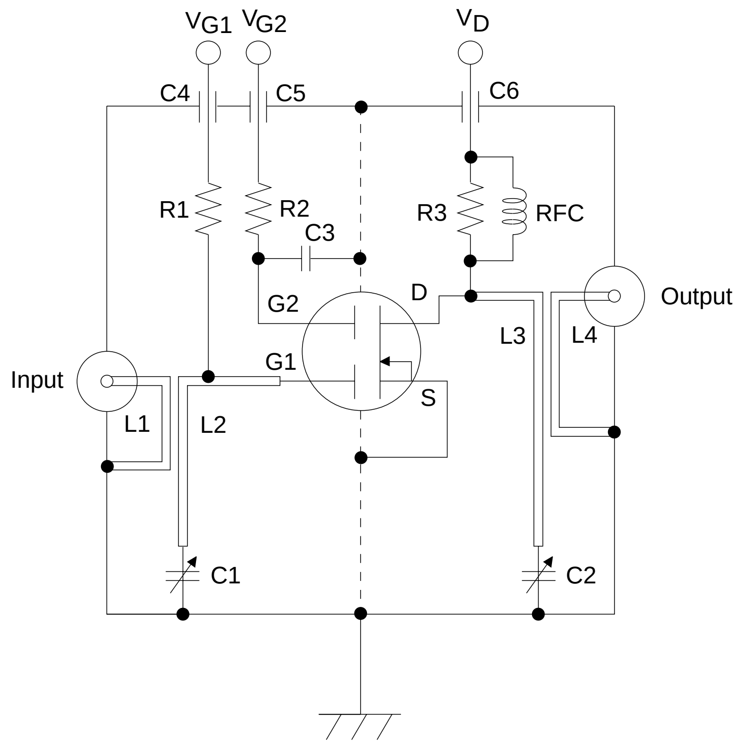
Test Circuit for Operating Items ($I_{D(op)}$, |yfs|, Ciss, Coss, Crss, NF, PG)



Application Circuit

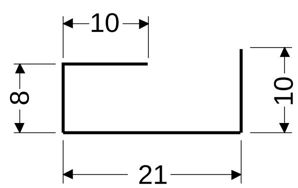


900MHz Power Gain, Noise Test Circuit

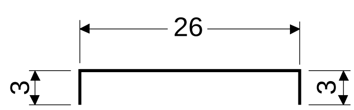


C1, C2 :	Variable Capacitor (10pF MAX)
C3 :	Disk Capacitor (1000pF)
C4 — C6 :	Air Capacitor (1000pF)
R1 :	47 kΩ
R2 :	47 kΩ
R3 :	4.7 kΩ

L1:

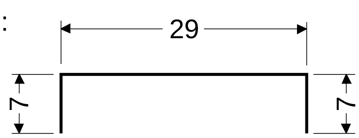


L2:

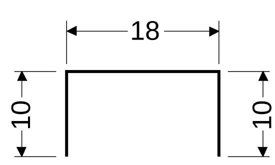


(ϕ1mm Copper wire)
Unit: mm

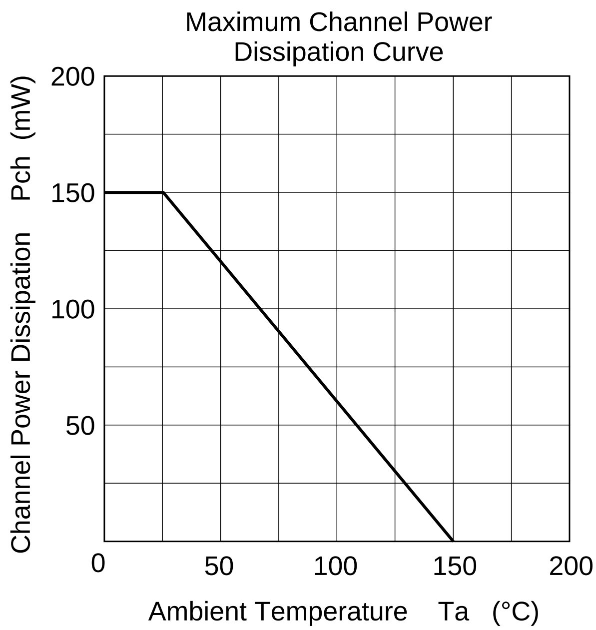
L3:

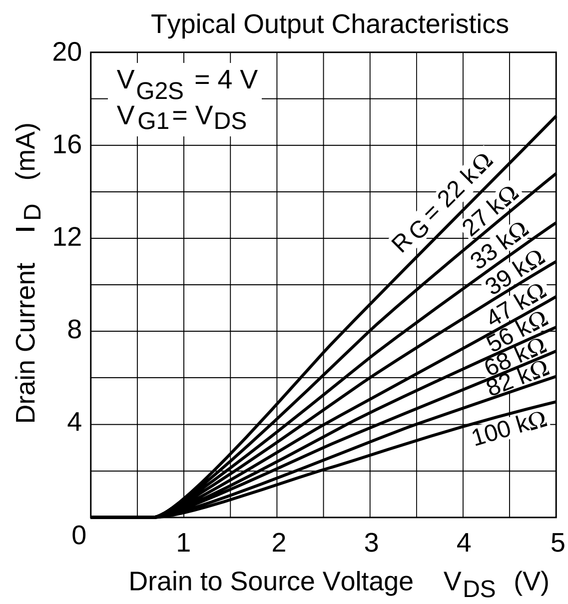


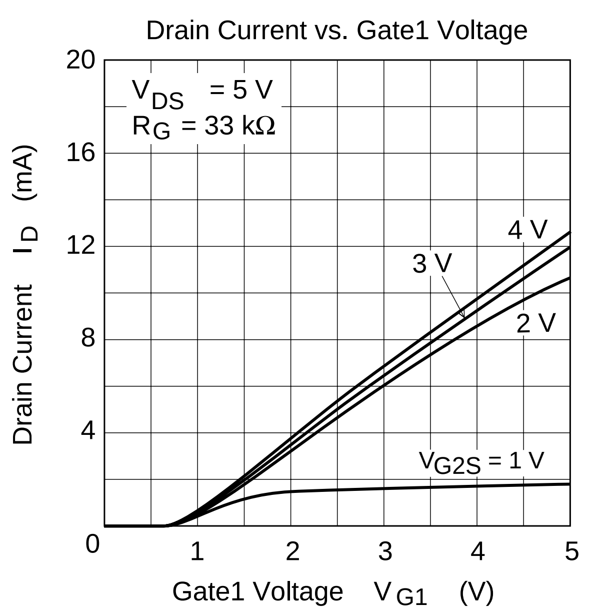
L4:

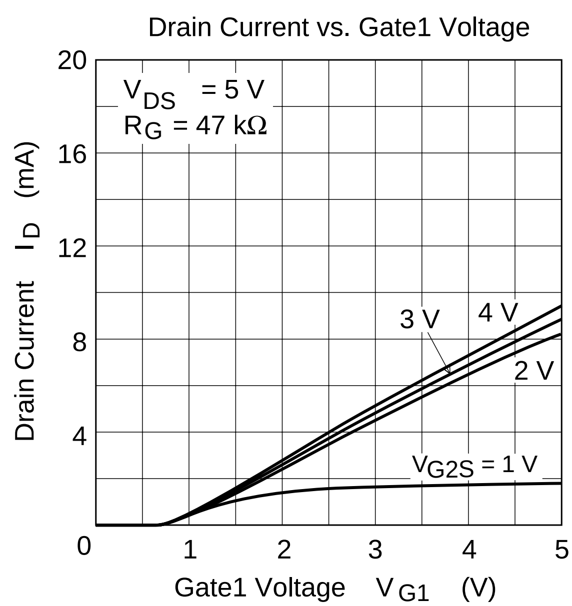


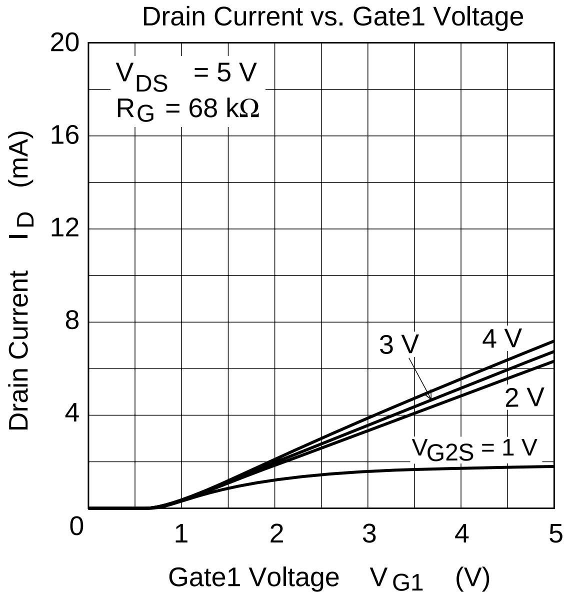
RFC: ϕ1mm Copper wire with enamel 4turns inside dia 6mm

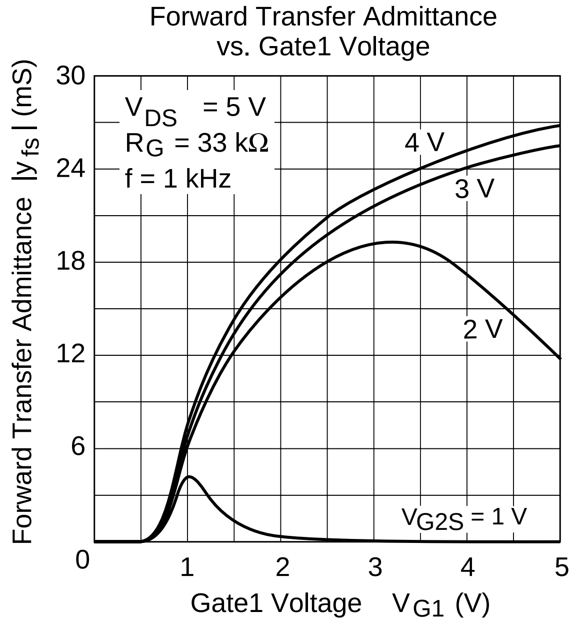

Maximum Channel Power Dissipation Curve
Channel Power Dissipation Pch (mW)
200
150
100
50
0
50
100
150
200
Ambient Temperature Ta (°C)

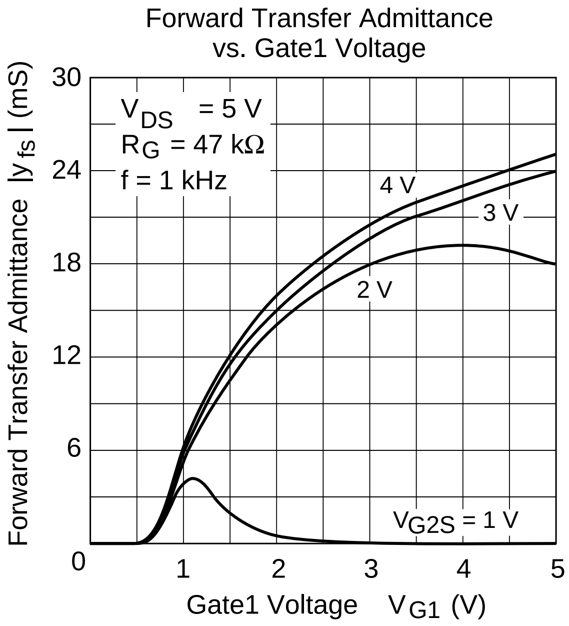

Typical Output Characteristics
V G2S = 4 V
V G1 = V DS
RG = 22 kΩ
27 kΩ
33 kΩ
39 kΩ
47 kΩ
56 kΩ
68 kΩ
82 kΩ
100 kΩ
Drain Current I D (mA)
20
16
12
8
4
0
1
2
3
4
5
Drain to Source Voltage V DS (V)

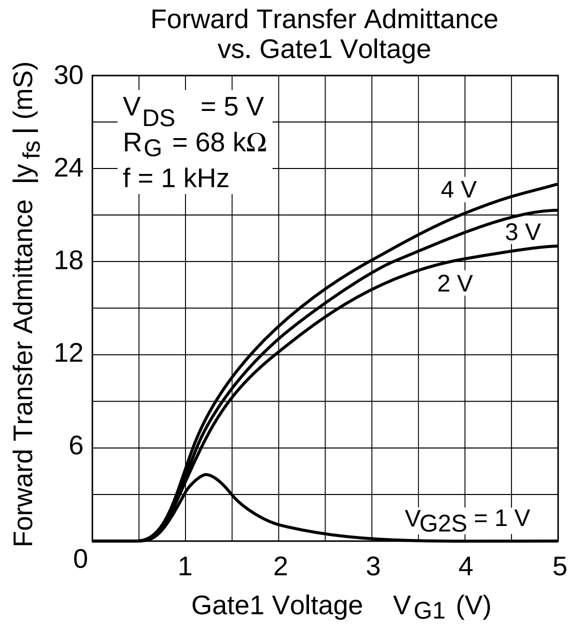

Drain Current vs. Gate1 Voltage
V DS = 5 V
R G = 33 kΩ
4 V
3 V
2 V
V G2S = 1 V
Drain Current I D (mA)
20
16
12
8
4
0
1
2
3
4
5
Gate1 Voltage V G1 (V)

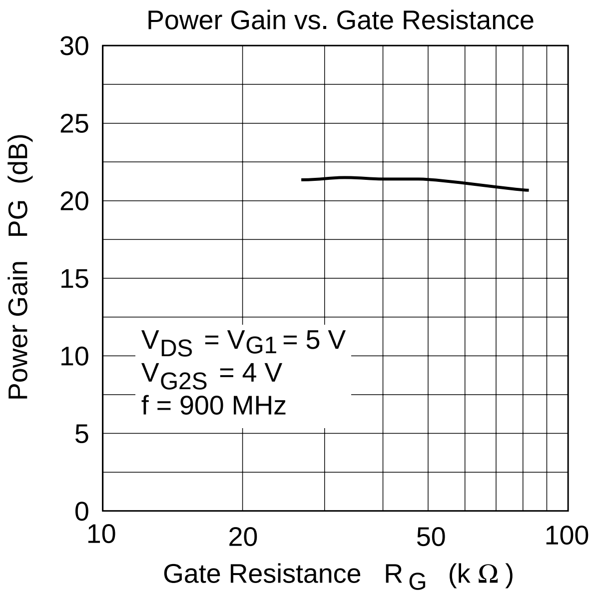

Drain Current vs. Gate1 Voltage
V DS = 5 V
R G = 47 kΩ
3 V
4 V
2 V
V G2S = 1 V
Drain Current I D (mA)
20
16
12
8
4
0
1
2
3
4
5
Gate1 Voltage V G1 (V)

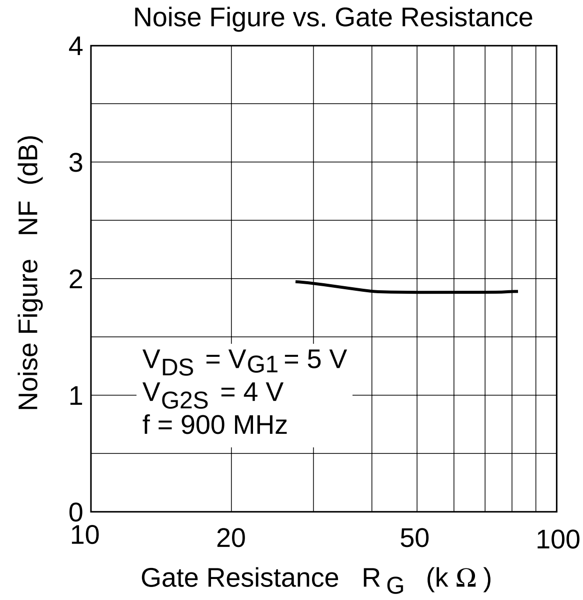

Drain Current vs. Gate1 Voltage
VDS = 5 V
RG = 68 kΩ
3 V
4 V
2 V
VG2S = 1 V
Drain Current ID (mA)
Gate1 Voltage VG1 (V)

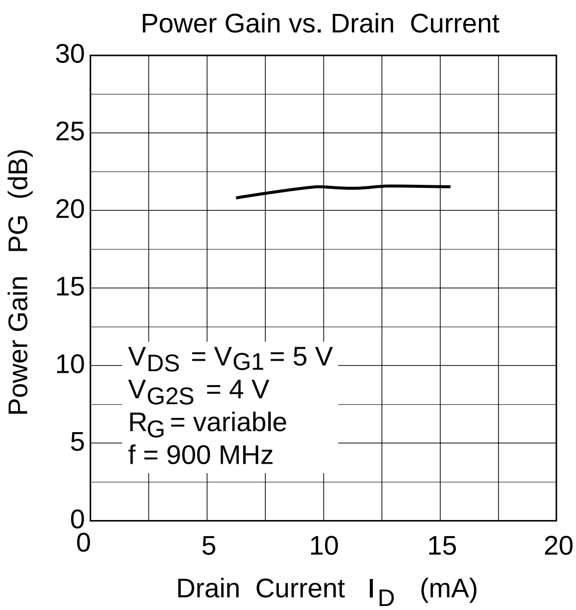

Forward Transfer Admittance vs. Gate1 Voltage
VDS = 5 V
RG = 33 kΩ
f = 1 kHz
4 V
3 V
2 V
VG2S = 1 V
Forward Transfer Admittance |yfs| (mS)
Gate1 Voltage VG1 (V)

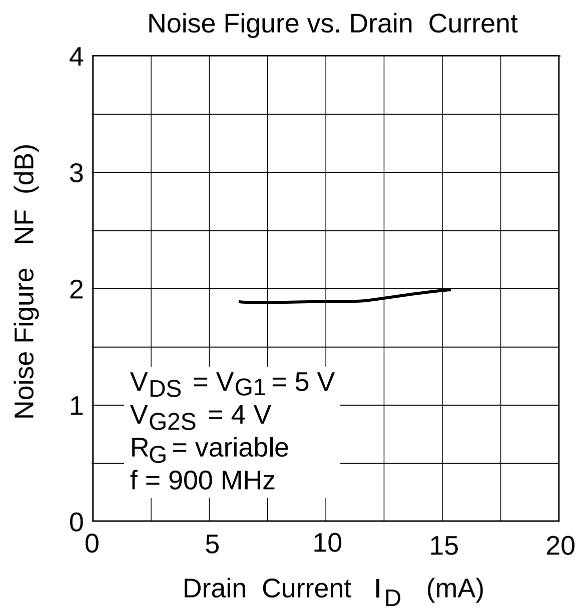

Forward Transfer Admittance vs. Gate1 Voltage
VDS = 5 V
RG = 47 kΩ
f = 1 kHz
4 V
3 V
2 V
VG2S = 1 V
Forward Transfer Admittance |yfs| (mS)
Gate1 Voltage VG1 (V)

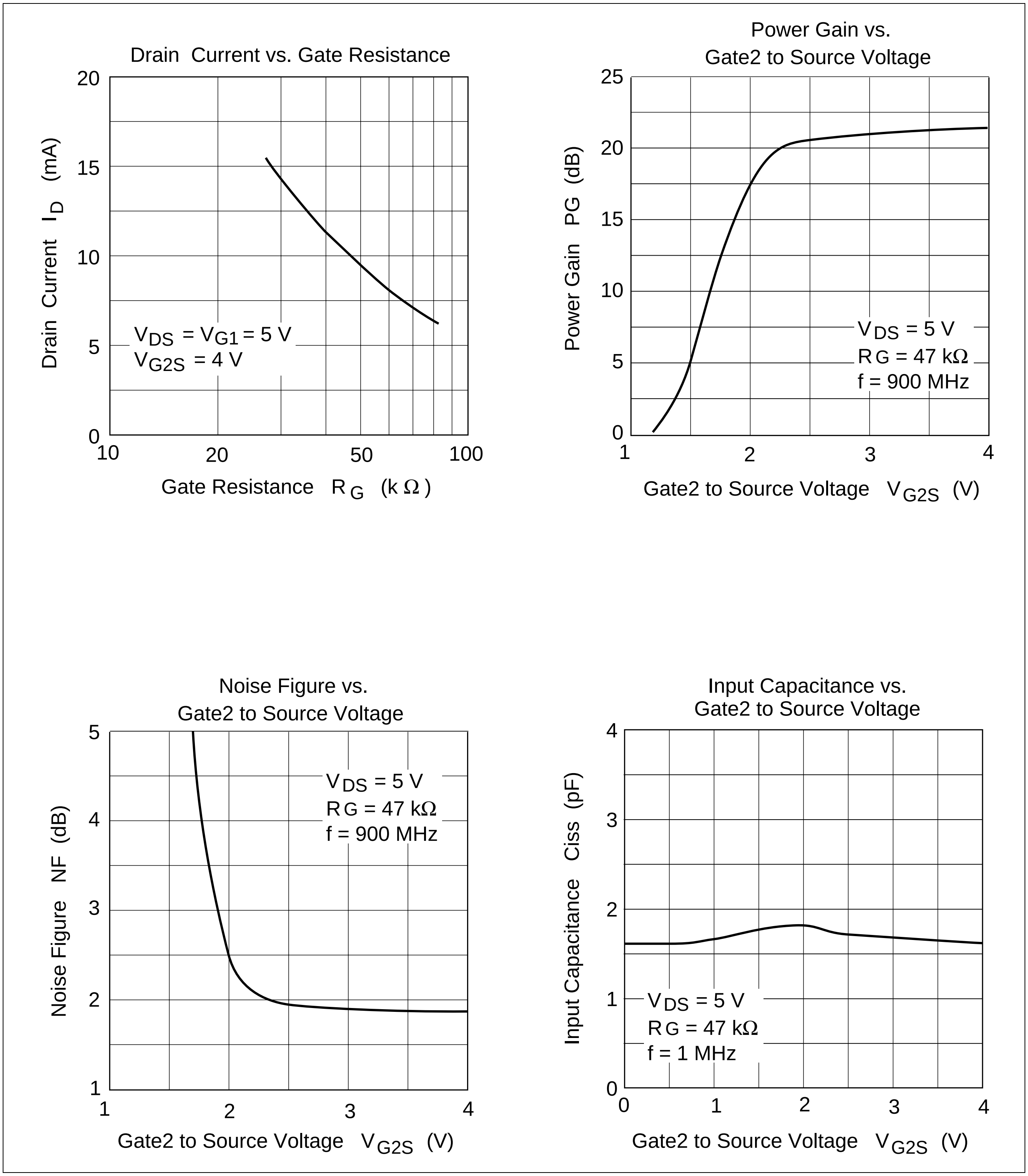

Forward Transfer Admittance vs. Gate1 Voltage
VDS = 5 V
RG = 68 kΩ
f = 1 kHz
4 V
3 V
2 V
VG2S = 1 V
Forward Transfer Admittance |yfs| (mS)
Gate1 Voltage VG1 (V)

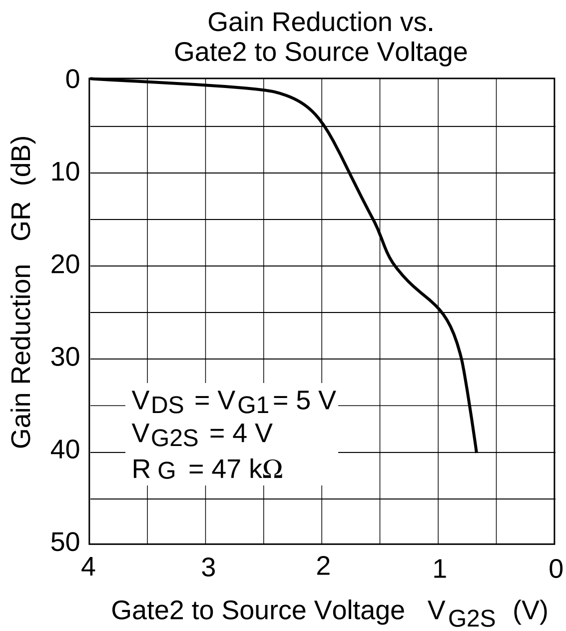

Power Gain vs. Gate Resistance
Power Gain PG (dB)
30
25
20
15
10
5
0
10
20
50
100
Gate Resistance R G (k Ω)
VDS = VG1 = 5 V
VG2S = 4 V
f = 900 MHz


Noise Figure vs. Gate Resistance
Noise Figure NF (dB)
4
3
2
1
0
10
20
50
100
Gate Resistance R G (k Ω)
VDS = VG1 = 5 V
VG2S = 4 V
f = 900 MHz

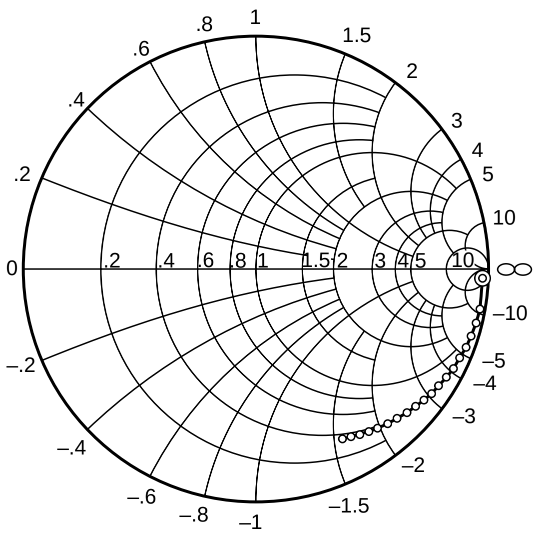

Power Gain vs. Drain Current
Power Gain PG (dB)
30
25
20
15
10
5
0
0
5
10
15
20
Drain Current I D (mA)
VDS = VG1 = 5 V
VG2S = 4 V
RG = variable
f = 900 MHz


Noise Figure vs. Drain Current
Noise Figure NF (dB)
4
3
2
1
0
0
5
10
15
20
Drain Current I D (mA)
VDS = VG1 = 5 V
VG2S = 4 V
RG = variable
f = 900 MHz


Drain Current vs. Gate Resistance
Drain Current I D (mA)
Gate Resistance R G (k Ω)
VDS = VG1 = 5 V
VG2S = 4 V
Power Gain vs.
Gate2 to Source Voltage
Power Gain PG (dB)
Gate2 to Source Voltage VG2S (V)
VDS = 5 V
RG = 47 kΩ
f = 900 MHz
Noise Figure vs.
Gate2 to Source Voltage
Noise Figure NF (dB)
Gate2 to Source Voltage VG2S (V)
VDS = 5 V
RG = 47 kΩ
f = 900 MHz
Input Capacitance vs.
Gate2 to Source Voltage
Input Capacitance Ciss (pF)
Gate2 to Source Voltage VG2S (V)
VDS = 5 V
RG = 47 kΩ
f = 1 MHz


Gain Reduction vs.
Gate2 to Source Voltage
Gain Reduction GR (dB)
0
10
20
30
40
50
4
3
2
1
0
Gate2 to Source Voltage V_{G2S} (V)
$V_{DS} = V_{G1} = 5$ V
$V_{G2S} = 4$ V
$R_G = 47$ kΩ

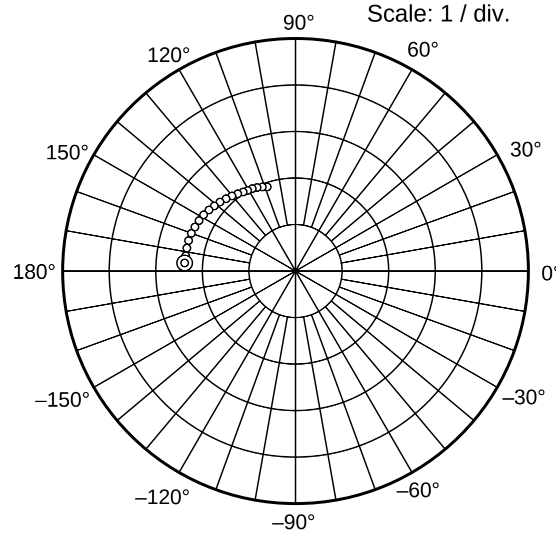
S11 Parameter vs. Frequency



Test Condition: V_{DS} = 5 V , V_{G1} = 5 V
V_{G2S} = 4 V , R_G = 47 k Ω ,
Zo = 50 Ω

50 — 1000 MHz (50 MHz step)

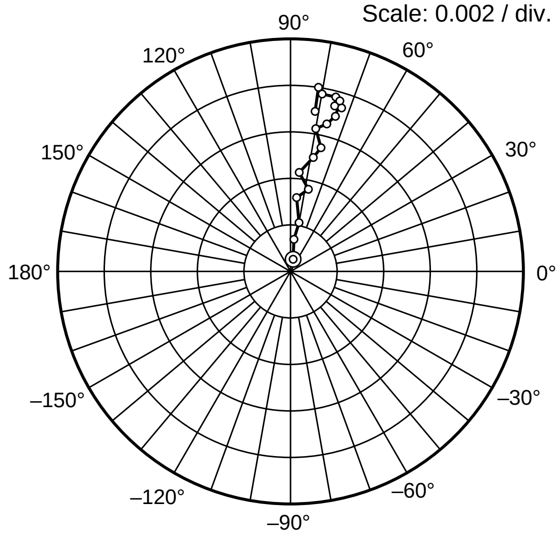
S21 Parameter vs. Frequency



Test Condition: V_{DS} = 5 V , V_{G1} = 5 V
V_{G2S} = 4 V , R_G = 47 k Ω ,
Zo = 50 Ω

50 — 1000 MHz (50 MHz step)

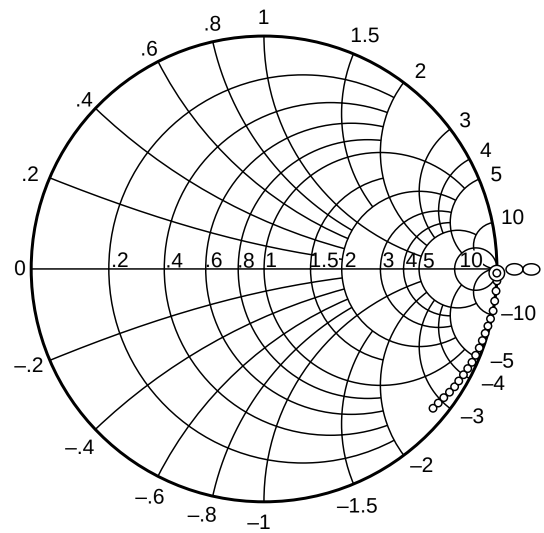
S12 Parameter vs. Frequency



Test Condition: V_{DS} = 5 V , V_{G1} = 5 V
V_{G2S} = 4 V , R_G = 47 k Ω ,
Zo = 50 Ω

50 — 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 = 47 k Ω ,
Zo = 50 Ω

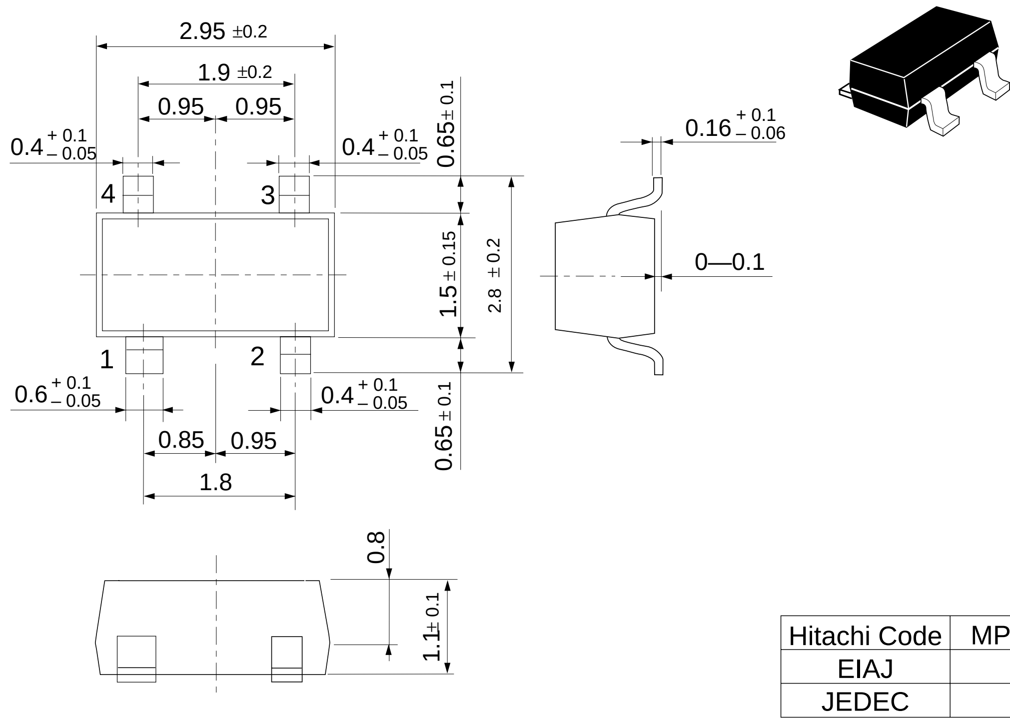
50 — 1000 MHz (50 MHz step)

Sparameter ($V_{DS} = V_{G1}$ = 5V, V_{G2S} = 4V, R_G = 47kΩ, Zo = 50Ω)

	S11		S21		S12		S22	
f (MHz)	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
50	0.974	–2.8	2.40	176.4	0.00057	78.1	0.997	–2.0
100	0.974	–10.0	2.38	172.2	0.00144	82.4	0.998	–4.2
150	0.974	–13.6	2.38	168.4	0.00211	78.7	0.997	–6.0
200	0.965	–16.5	2.37	164.1	0.00316	84.8	0.995	–8.1
250	0.963	–20.0	2.35	160.4	0.00358	76.3	0.994	–10.2
300	0.953	–23.7	2.32	156.8	0.00431	84.0	0.992	–12.2
350	0.947	–26.8	2.30	152.9	0.00503	79.0	0.990	–14.2
400	0.942	–29.6	2.28	148.6	0.00545	76.6	0.987	–16.2
450	0.929	–32.8	2.26	144.9	0.00630	80.3	0.984	–18.1
500	0.923	–35.4	2.21	141.2	0.00646	76.1	0.981	–20.2
550	0.912	–38.5	2.19	137.6	0.00693	73.7	0.977	–22.1
600	0.903	–41.2	2.15	134.2	0.00732	72.9	0.974	–24.1
650	0.886	–44.2	2.12	130.6	0.00729	74.6	0.971	–26.0
700	0.879	–46.8	2.08	127.4	0.00733	72.0	0.967	–27.8
750	0.873	–49.2	2.06	124.3	0.00762	74.5	0.962	–29.7
800	0.859	–52.4	2.03	120.8	0.00756	73.7	0.959	–31.7
850	0.846	–55.4	2.00	117.3	0.00772	75.5	0.955	–33.6
900	0.836	–58.0	1.96	114.3	0.00775	79.6	0.951	–35.5
950	0.827	–60.4	1.93	111.0	0.00801	81.7	0.946	–37.3
1000	0.815	–62.8	1.89	108.0	0.00704	81.0	0.942	–39.4

Package Dimensions

Unit: mm



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JEDEC	—

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