RENESAS CONFIDENTIAL **Preliminary**

RPF08155B

MOS FET Power Amplifier Module
for GSM 850/900 and DCS1800/1900 Quad Band Cellular Phone

REJxxxxxxx-xxxxZ
Rev.0.7
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Application

- Quad band amplifier for
  US/E-GSM (824 to 849MHz, 880 to 915 MHz),
  DCS1800/1900 (1710 to 1785 MHz, 1850 to 1910 MHz).
- For 3.5 V nominal operation

Features

- Built-in closed loop APC circuit with power detector performs stable power control accuracy under varied supply voltage and temperature.
- The smallest size : 6.0 × 6.0 × 1.2mm typ. (1.3 mm t Max.) as APC integrated PA module.
- High Gain 3-stage amplifier: 3 dBm typical Input power.
- Superb forward isolation level: -47dBm Typical at 6dBm input power.
- Lead free soldering process available
- GPRS Class 12 compatible

Easy power control design

1. Pre-charge procedure from outside is not necessary.

2. Wide power control dynamic range is obtained. Thus, power deviation is narrow distribution at MP.

3. High efficiency (GSM900_55%, DCS1800_50%)

Absolute Maximum Ratings (Tc = 25°C)

Item	Symbol	Rating	Unit	Remark
Supply voltage	Vdd	6.0	V	within 1sec at no-operation
		5.0	V	at operation (50 Ω load)
Supply current	Idd $_{GSM}$	3.5	A	
	Idd $_{DCS}$	2	A	
Txon voltage	Vtxb	3	V	
Band select voltage	Vband	3	V	
Power control voltage	Vramp	2.2	V	
Input power	Pin	10	dBm	
Operating case temperature	Tc (op)	–30 to +100	°C	
Storage temperature	Tstg	–30 to +100	°C	
Output power	Pout $_{GSM}$	5	W	
	Pout $_{DCS}$	3	W	

Note: The maximum ratings shall be valid over both the GSM850/900-band (824 to 849 MHz , 880 to 915 MHz), and the DCS1800/1900-band (1710 to 1785 MHz, 1850 to 1910 MHz).

Electrical Characteristics for DC (Tc = 25°C)

Item	Symbol	Min	Typ	Max	Unit	Test Condition
Drain cutoff current	Ids	—	0.2	20	μA	Vdd = 4.6V, Vramp = 0.2V, Vband = 0.2V, Vtxb=0.2V
Vtxb voltage range (Hi)	Vtxb(Hi)	1.6	1.8	3.0	V	Tx pulse signal required
Vtxb voltage range (Lo)	Vtxb(Lo)	0	0.2	0.5	V	
Vtxb control current	Itxb	—	25	100	μA	Vtxb = 3.0V
Band select range (Hi)	Vband(Hi)	1.6	1.8	3.0	V	Hi : DCS/PCS
Band select range (Lo)	Vband(Lo)	0	0.2	0.5		Lo : GSM,
Band select current	Iband	—	25	100	μA	Vband = 3.0V
Control voltage range	Vramp	0.2	—	2.0	V	
Vramp control current	Iramp	—	15	25	μA	Vramp = 2V

Electrical Characteristics for GSM850 (Tc = 25°C)

Test conditions unless otherwise noted:

f =824 to 849 MHz, Vdd1 =Vdd2 =Vdd_IC=3.5 V, Pin=3dBm, Vband = 0.2V, Vtxb=1.8V,Rg = Rl =50 Ω, Tc = 25°C,

Pulse operation for Vramp and Vtxb with pulse width 1154 μs and duty cycle 2:8 shall be used.

Item	Symbol	Min	Typ	Max	Unit	Test Condition
Frequency range	F	824	—	849	MHz	
Band select (GSM active)	Vband	0	0.2	0.5	V	
Input power	Pin	0	3	6	dBm	
Vtxb voltage range	Vtxb	1.6	1.8	3.0	V	Tx pulse signal is required.
Supply voltage	Vdd	3.1	3.5	4.6	V	
Total efficiency	η_T	45	50	—	%	Max. efficiency point, Pout>= 34.5dBm
2nd harmonic distortion	2nd H.D.	—	–15	-10	dBm	Pout $_{GSM}$ = 6 to 34.5 dBm
3rd harmonic distortion	3rd H.D.	—	–20	–15	dBm	Vramp = controlled
4 to 8th harmonic distortion	4 to 8th H.D.	—	–30	–15	dBm	
Input VSWR	VSWR (in)	—	1.5	3	—	
Output power (1)	Pout (1)	34.5	—	—	dBm	Vramp = 2.0 V
Output power (2)	Pout (2)	33.0	—	—	dBm	Vdd = 3.1 V, Vramp = 2.0 V, Tc = +85°C
Isolation(1)	Piso(1)	—	–47	–37	dBm	Pin = 6 dBm, Vtxb = 0.2 V
Isolation(2)	Piso(2)	—	–35	-5	dBm	Vramp = 0.15 V (TBD), Vtxb = 1.8 V
Isolation at DCS RF-output when GSM is active	—	—	–25	–18	dBm	Pout $_{GSM}$ = 34.5 dBm, Measured at f = 1648 to 1698 MHz
Stability	—	No parasitic oscillation			—	Vdd = 3.1 to 4.6 V, Pout $_{GSM}$ ≤ 34.5 dBm, Vramp ≤2.0 V, Rg = 50 Ω, Output VSWR = 6 : 1 All phases
Load VSWR tolerance	—	No degradation			—	Vdd = 3.1 to 4.6 V, Pout $_{GSM}$ ≤ 34.5 dBm, Vramp ≤2.0 V, Rg = 50 Ω, t = 20 sec. , Output VSWR = 10 : 1 All phases, Tc ≤ 85°C
Turn On/Off Time	Tr, Tf	—	—	8	μS	Pout = 6 to 34.5 dBm
Power control slope	Slope	—	150	220	dB/V	Pout = 6 to 34.5 dBm
AM output	AM/AM	—	4	8	%	Added 4% AM to Pin,Pout=6 to 34.5dBm

Power Control Stability

Pout ,Vramp adjusted to (at Pin=3dBm, Tc =25°C,f=836.5MHz,Vdd=3.5V)	6 to 14	14 to 32.5	32.5 to 34.0	dBm
Pout Variation (at f=824 to 849MHz,Pin=0 to 6dBm, Tc=25°C, Vdd=3.1 to 3.9V)	±3.5	±1.8	±1.0	dB
Pout ,Vramp adjusted to (at Pin=3dBm, Tc =25°C,f=836.5MHz,Vdd=3.5V)	6 to 14	14 to 32.5	32.5 to 33	dBm
Pout Variation (at f=824 to 849MHz,Pin==0 to 6dBm, Tc=-20 to 85°C, Vdd=3.1 to 4.6V)	-5/+4.5	±2.7	±1.3	dB

Electrical Characteristics for GSM900 (Tc = 25°C)

Test conditions unless otherwise noted:

f =880 to 915 MHz, Vdd1 =Vdd2 =Vdd_IC=3.5 V, Pin=3dBm, Vband = 0.2V, Vtxb=1.8V,Rg = Rl =50 Ω, Tc = 25°C,

Pulse operation for Vramp and Vtxb with pulse width 1154 µs and duty cycle 2:8 shall be used.

Item	Symbol	Min	Typ	Max	Unit	Test Condition
Frequency range	F	880	—	915	MHz	
Band select (GSM active)	Vband	0	0.2	0.5	V	
Input power	Pin	0	3	6	dBm	
Vtxb voltage range	Vtxb	1.6	1.8	3.0	V	Tx pulse signal is required.
Supply voltage	Vdd	3.1	3.5	4.6	V	
Total efficiency	η_T	50	55	—	%	Max efficiency point, Pout>= 34.5dBm
2nd harmonic distortion	2nd H.D.	—	–15	-10	dBm	Pout $_{GSM}$ = 6 to 34.5 dBm
3rd harmonic distortion	3rd H.D.	—	–20	–15	dBm	Vramp = controlled
4 to 8th harmonic distortion	4 to 8th H.D.	—	–30	–15	dBm	
Input VSWR	VSWR (in)	—	1.5	3	—	
Output power (1)	Pout (1)	34.5	—	—	dBm	Vramp = 2.0 V
Output power (2)	Pout (2)	33.0	—	—	dBm	Vdd = 3.1 V, Vramp = 2.0 V, Tc = +85°C
Isolation(1)	Piso(1)	—	–47	–37	dBm	Pin = 6 dBm, Vtxb = 0.2 V
Isolation(2)	Piso(2)	—	–35	-5	dBm	Vramp = 0.15 V (TBD), Vtxb = 1.8 V
Isolation at DCS RF-output when GSM is active	—	—	–25	–18	dBm	Pout $_{GSM}$ = 34.5 dBm, Measured at f = 1760 to 1830 MHz
Stability	—	No parasitic oscillation			—	Vdd = 3.1 to 4.6 V, Pout $_{GSM} \leq$ 34.5 dBm, Vramp ≤2.0 V, Rg = 50 Ω, Output VSWR = 6 : 1 All phases
Load VSWR tolerance	—	No degradation			—	Vdd = 3.1 to 4.6 V, Pout $_{GSM} \leq$ 34.5 dBm, Vramp ≤2.0 V, Rg = 50 Ω, t = 20 sec. , Output VSWR = 10 : 1 All phases, Tc ≤ 85°C
Turn On/Off Time	Tr, Tf	—	—	8	µS	Pout=6 to 34.5 dBm
Power control slope	Slope	—	150	220	dB/V	Pout = 6 to 34.5 dBm
AM output	AM/AM	—	4	8	%	Added 4% AM to Pin,Pout=6 to 34.5dBm

Power Control Stability

Pout ,Vramp adjusted to (at Pin=3dBm, Tc =25°C,f=897.5MHz,Vdd=3.5V)	6 to 14	14 to 32.5	32.5 to 34.0	dBm
Pout Variation (at f=880 to 915MHz,Pin=0 to 6dBm, Tc=25°C, Vdd=3.1 to 3.9V)	±3.5	±1.8	±1.0	dB
Pout ,Vramp adjusted to (at Pin=3dBm, Tc =25°C,f=897.5MHz,Vdd=3.5V)	6 to 14	14 to 32.5	32.5 to 33	dBm
Pout Variation (at f=880 to 915MHz,Pin=0 to 6dBm, Tc=-20 to 85°C, Vdd=3.1 to 4.6V)	-5/+4.5	±2.7	±1.3	dB

Electrical Characteristics for DCS1800 (Tc = 25°C)

Test conditions unless otherwise noted:

f =1710 to 1785 MHz, Vdd1 =Vdd2 =Vdd_IC=3.5 V, Pin=3dBm, Vband = 1.8V, Vtxb=1.8V,Rg = Rl =50 Ω, Tc = 25°C,

Pulse operation for Vramp and Vtxb with pulse width 1154 μs and duty cycle 2:8 shall be used.

Item	Symbol	Min	Typ	Max	Unit	Test Condition
Frequency range	F	1710	—	1785	MHz	
Band select (DCS active)	Vband	1.6	1.8	3.0	V	
Input power	Pin	0	3	6	dBm	
Vtxb voltage range	Vtxb	1.6	1.8	3.0	V	Tx pulse signal is required.
Supply voltage	Vdd	3.1	3.5	4.6	V	
Total efficiency	η_T	43	50	—	%	Max. efficiency point, Pout>= 32dBm
2nd harmonic distortion	2nd H.D.	—	–15	-10	dBm	Pout $_{DCS}$ = 2 to 32 dBm
3rd harmonic distortion	3rd H.D.	—	–20	–15	dBm	Vramp = controlled
4 to 8th harmonic distortion	4 to 8th H.D.	—	–25	–15	dBm	
Input VSWR	VSWR (in)	—	1.5	3	—	
Output power (1)	Pout (1)	32.0	—	—	dBm	Vramp = 2.0 V
Output power (2)	Pout (2)	30.5	—	—	dBm	Vdd = 3.1 V, Vramp = 2.0 V, Tc = +85°C
Isolation(1)	Piso(1)	—	–38	–35	dBm	Pin = 6 dBm, Vtxb = 0.2 V
Isolation(2)	Piso(2)	—	–35	-5	dBm	Vramp = 0.15 V (TBD), Vtxb = 1.8 V
Stability	—	No parasitic oscillation			—	Vdd = 3.1 to 4.6 V, Pout ≤ 32 dBm, Vramp ≤2.0 V, Rg = 50 Ω, Output VSWR = 6 : 1 All phases
Load VSWR tolerance	—	No degradation			—	Vdd = 3.1 to 4.6 V, Pout ≤ 32 dBm, Vramp ≤2.0 V, Rg = 50 Ω, t = 20 sec. , Output VSWR = 10 : 1 All phases, Tc ≤ 85°C
Turn On/Off Time	Tr, Tf	—	—	8	μS	Pout=2 to 32 dBm
Power control slope	Slope	—	180	220	dB/V	Pout = 2 to 32 dBm
AM output	AM/AM	—	4	8	%	Added 4% AM to Pin,Pout=2 to 32 dBm

Power Control Stability

Pout ,Vramp adjusted to (at Pin=3dBm,Tc=25°C,f=1747.5MHz,Vdd=3.5V)	2 to 4	4 to 14	14 to 30	30 to 31.5	dBm
Pout Variation (at f=1710 to 1785MHz,Pin=0 to 6dBm, Tc=25°C, Vdd=3.1 to 3.9V)	±3.8	±2.8	±1.8	±1.0	dB
Pout ,Vramp adjusted to (at Pin=3dBm, Tc=25°C,f=1747.5MHz,Vdd=3.5V)	2 to 4	4 to 14	14 to 30	30 to 30.5	dBm
Pout Variation (at f=1710 to 1785MHz,Pin=0 to 6dBm, Tc=-20 to 85°C, Vdd=3.1 to 4.6V)	-5/+4.8	±3.8	±2.8	±1.3	dB

Electrical Characteristics for PCS1900 (Tc = 25°C)

Test conditions unless otherwise noted:

f =1850 to 1910 MHz, Vdd1 =Vdd2 =Vdd_IC=3.5 V, Pin=3dBm, Vband = 1.8V, Vtxb=1.8V,Rg = Rl =50 Ω, Tc = 25°C,

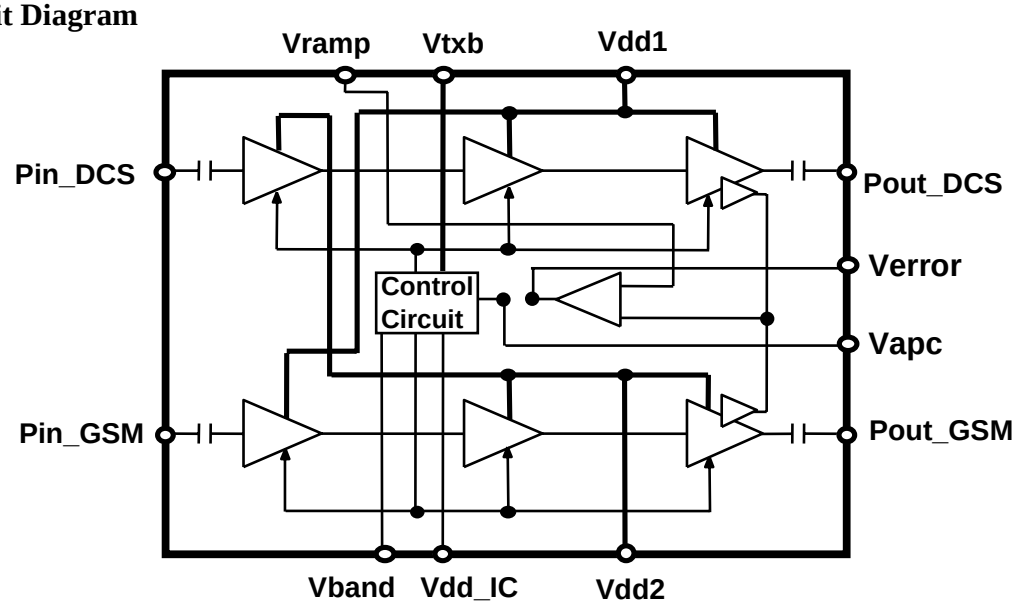
Pulse operation for Vramp and Vtxb with pulse width 1154 μs and duty cycle 2:8 shall be used.

Item	Symbol	Min	Typ	Max	Unit	Test Condition
Frequency range	F	1850	—	1910	MHz	
Band select (DCS active)	Vband	1.6	1.8	3.0	V	
Input power	Pin	0	3	6	dBm	
Vtxb voltage range	Vtxb	1.6	1.8	3.0	V	Tx pulse signal is required.
Supply voltage	Vdd	3.1	3.5	4.6	V	
Total efficiency	η_T	42	50	—	%	Max. efficiency point, Pout>= 32dBm
2nd harmonic distortion	2nd H.D.	—	–15	-10	dBm	Pout $_{DCS}$ = 2 to 32 dBm
3rd harmonic distortion	3rd H.D.	—	–20	–15	dBm	Vramp = controlled
4 to 8th harmonic distortion	4 to 8th H.D.	—	–25	–15	dBm	
Input VSWR	VSWR (in)	—	1.5	3	—	
Output power (1)	Pout (1)	32	—	—	dBm	Vramp = 2.0 V
Output power (2)	Pout (2)	30.5	—	—	dBm	Vdd = 3.1 V, Vramp = 2.0 V, Tc = +85°C
Isolation(1)	Piso(1)	—	–39	–35	dBm	Pin = 6 dBm, Vtxb = 0.2 V
Isolation(2)	Piso(2)	—	–35	-5	dBm	Vramp = 0.15 V (TBD), Vtxb = 1.8 V
Stability	—	No parasitic oscillation			—	Vdd = 3.1 to 4.6 V, Pout ≤ 32 dBm, Vramp ≤2.0 V, Rg = 50 Ω, Output VSWR = 6 : 1 All phases
Load VSWR tolerance	—	No degradation			—	Vdd = 3.1 to 4.6 V, Pout ≤ 32 dBm, Vramp ≤2.0 V, Rg = 50 Ω, t = 20 sec. , Output VSWR = 10 : 1 All phases, Tc ≤ 85°C
Turn On/Off Time	Tr, Tf	—	—	8	μS	Pout=2 to 32 dBm
Power control slope	Slope	—	180	220	dB/V	Pout = 2 to 32 dBm
AM output	AM/AM	—	4	8	%	Added 4% AM to Pin,Pout=2 to 32 dBm

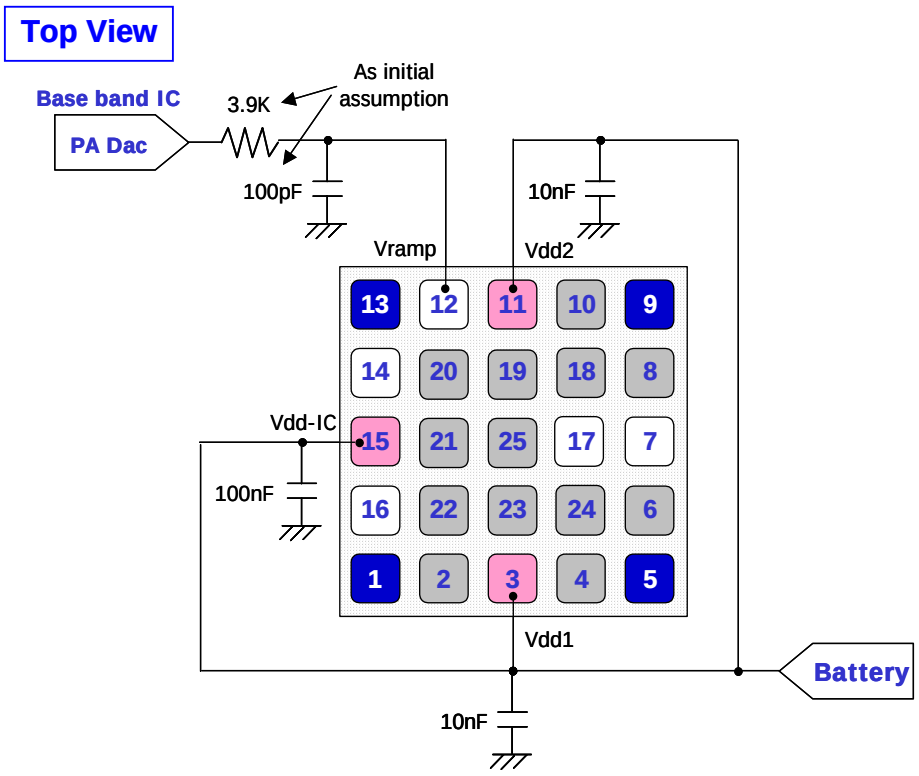
Power Control Stability

Pout ,Vramp adjusted to (at Pin=3dBm,Tc=25°C,f=1880MHz,Vdd=3.5V)	2 to 4	4 to 14	14 to 30	30 to 31.5	dBm
Pout Variation (at f=1850 to 1910MHz,Pin=0 to 6dBm, Tc=25°C, Vdd=3.1 to 3.9V)	±3.8	±2.8	±1.8	±1.0	dB
Pout ,Vramp adjusted to (at Pin=3dBm, Tc=25°C,f=1880MHz,Vdd=3.5V)	2 to 4	4 to 14	14 to 30	30 to 30.5	dBm
Pout Variation (at f=1850 to 1910MHz,Pin=0 to 6dBm, Tc=-20 to 85°C, Vdd=3.1 to 4.6V)	-5/+4.8	±3.8	±2.8	±1.3	dB

Circuit Diagram



Interface with Battery & B/B IC



Pin assignment

1: Pin_GSM850/900
2:GND
3: Vdd1
4:GND
5: Pout_GSM850/900
6:GND
7: Vapc
8:GND
9: Pout_DCS/PCS
10:GND
11: Vdd2
12: Vramp
13: Pin_DCS/PCS
14: Vtxb
15: Vdd_IC
16: Vband
17.Verror
18 to 25:GND

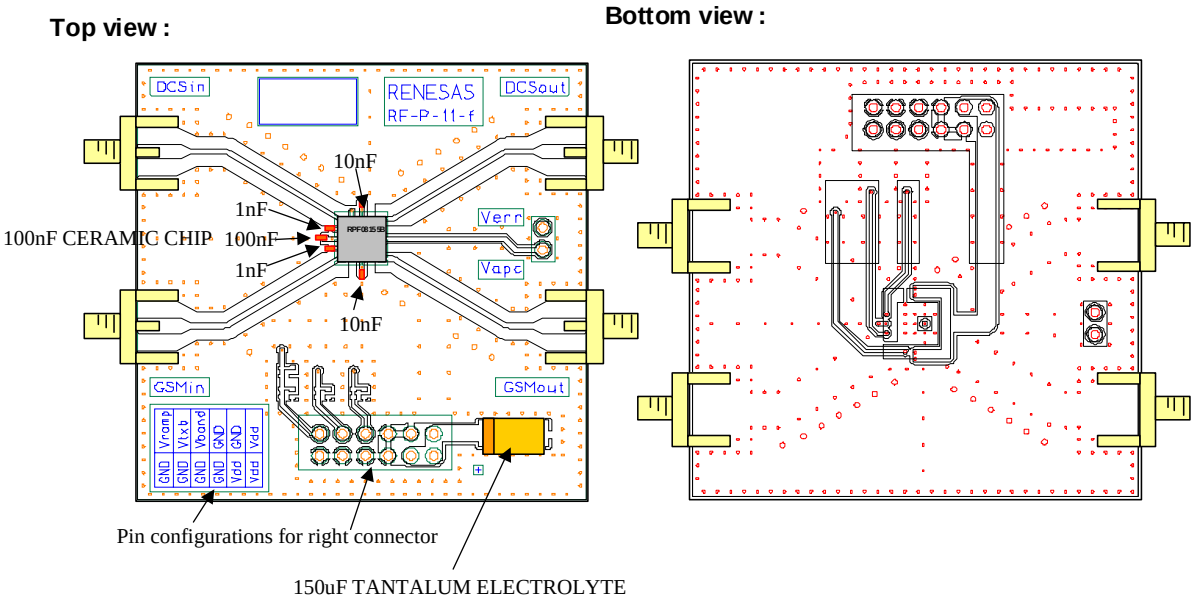
Pin descriptions

Pin #	Name	Function and Description
1	Pin_GSM850/900	RF input for GSM band through 50 Ω transmission line.
2	GND	
3	Vdd1	Biasing pin to supply battery voltage (Vdd) to RF MOSFET's 1.
4	GND	
5	Pout_GSM850/900	RF output for GSM band to 50 Ω load.
6	GND	
7	Vapc	Vapc input from APC IC (internal one or external APC IC). This pin is next to Verror to connect by phone board pattern layout.
8	GND	
9	Pout_DCS/PCS	RF output for DCS/PCS Band to 50 Ω load.
10	GND	
11	Vdd2	Biasing pin to supply battery voltage (Vdd) to RF MOSFET's 2.
12	Vramp	Power control bias voltage as ramping signal from DAC. A peripheral simple R/C filter is assumed. Don't control to high impedance.
13	Pin_DCS/PCS	RF input to DCS/PCS band through 50 Ω transmission line.
14	Vtxb	Switch on / Shut down signal for CMOS APC circuit.
15	Vdd_IC	Biasing pin to supply battery voltage (Vdd) to CMOS APC IC.
16	Vband	Band select logic pin. Low : GSM active, High : DCS/PCS active.
17	Verror	Output pin of error amp to create APC IC loop. This pin is next to Vapc to connect by phone board pattern layout.
18 to 25	GND	

Test fixture

Top view :

Bottom view :



Grass Epoxy Double sided PCB (t = 0.8mm, er = 4.8)

The coefficient of output power losses in the PCB output line are shown as follows;

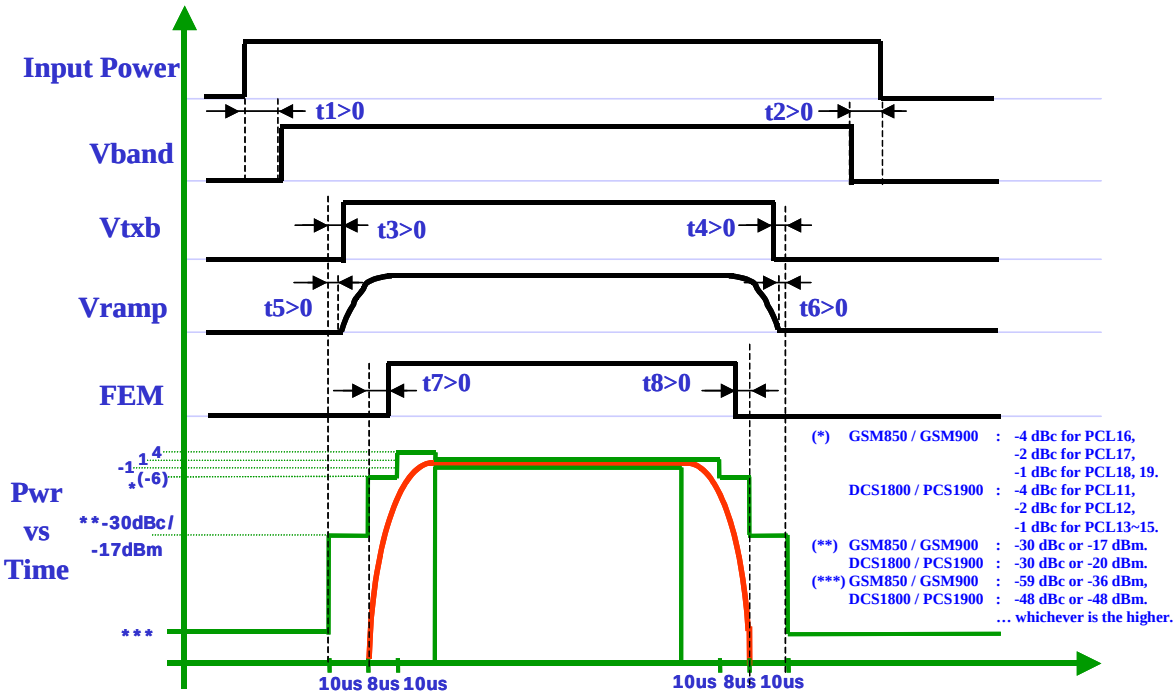
0.14dB ,at GSM850 band,

0.17dB ,at GSM900 band,

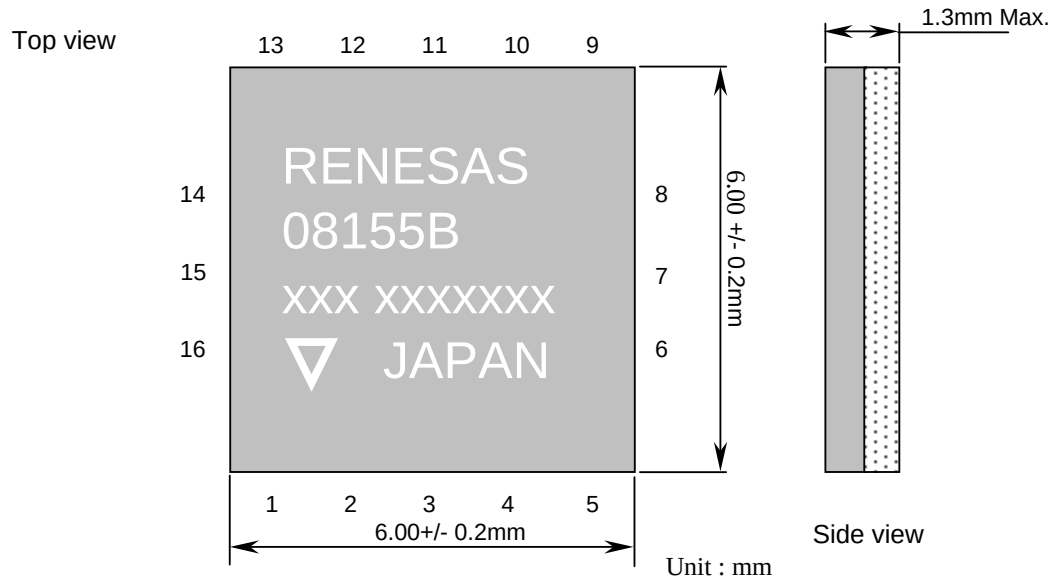
0.24dB ,at DCS1800 band,

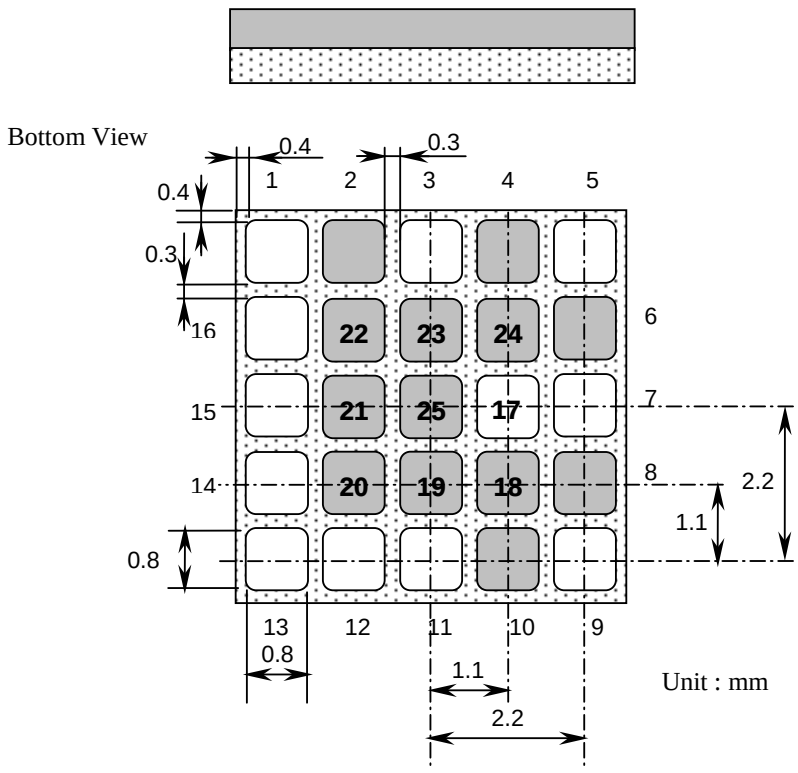
0.30dB ,at PCS1900 band

Recommended timing chart



Package Dimensions

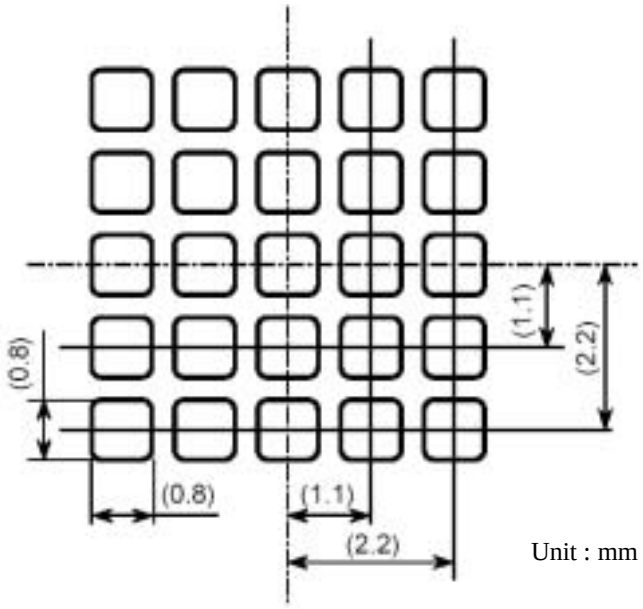




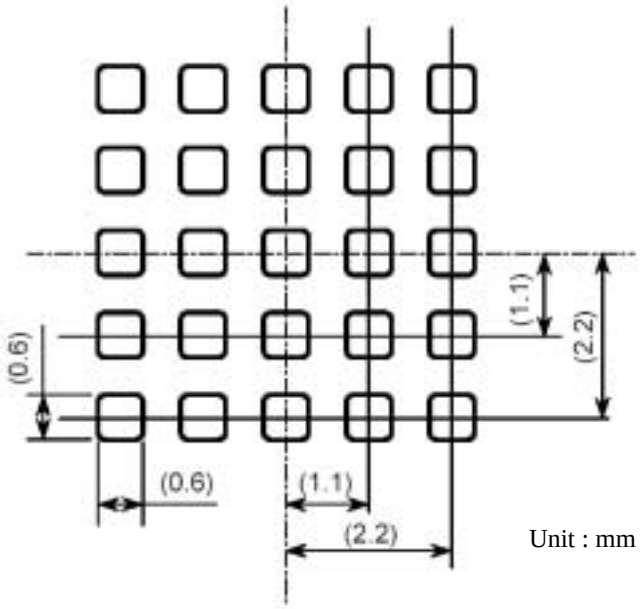
Pin assignment

1: Pin_GSM850/900
2:GND
3: Vdd1
4:GND
5: Pout_GSM850/900
6:GND
7: Vapc
8:GND
9: Pout_DCS/PCS
10:GND
11: Vdd2
12: Vramp
13: Pin_DCS/PCS
14: Vtxb
15: Vdd_IC
16: Vband
17.Verror
18-25:GND

Recommended foot pattern and solder stencil



Recommended foot pattern



Recommended solder stencil

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