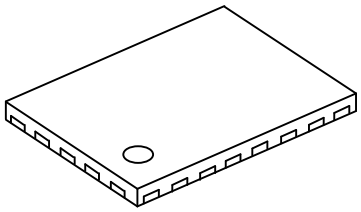
SP10T ANTENNA SWITCH GaAs MMIC

■ GENERAL DESCRIPTION

NJG1686MHH is a GaAs SP10T antenna switch MMIC suitable for LTE/3G+GSM multimode applications. This switch includes on-chip decoder circuits and low pass filters for GSM transmit port. This switch has six transmit/receive ports that provide more efficient band selection for multimode cellular application.

NJG1686MHH offers low insertion loss, high isolation, low harmonics and high linearity. The integrated ESD protection circuits in the switch IC bring excellent ESD performances. In addition, no DC blocking capacitors are required for the RF ports unless DC is biased externally. The small and thin package is adopted.

■ PACKAGE OUTLINE



NJG1686MHH

■ FEATURES

● Low voltage operation	V_{DD}=+2.5V min.
● Low voltage logic control	$V_{CTL(H)}$=+1.8V typ.
● Low insertion loss	0.65dB typ. @ 452~960MHz, TRX1~3,5,6-ANT
	0.30dB typ. @ 452~960MHz, TRX4-ANT
	0.75dB typ. @ 1710~2170MHz, TRX1~3,5,6-ANT
	0.45dB typ. @ 1710~2170MHz, TRX4-ANT
	1.10dB typ. @ 2300~2690MHz, TRX1~3,5,6-ANT
	0.45dB typ. @ 2300~2690MHz, TRX4-ANT
	1.05dB typ. @ GSM850/900, TX1-ANT
	1.20dB typ. @ GSM1800/1900, TX2-ANT
● High isolation	38dB typ. @GSM850/900, TX1-TRX1~3,5,6
	34dB typ. @GSM1800/1900, TX2-TRX 1~3,5,6
	25dB typ. @f=452~2690MHz, TRX1-TRX3, TRX4-TRX6
	36dB typ. @f=1805~1990MHz, ANT-RX1,2,
	33dB typ. @f=452~2690MHz, opposed TRX ports
● High linearity	2^{nd} harmonics=-80dBm typ. @f=786.5MHz
	IIP2=+95.5dBm min. @CDMA2000(AWS, PCS)
	IIP2=+102dBm min. @UMTS
● Less external parts	No DC blocking capacitor unless DC is biased externally
● Small package size	EQFN26-HH (Package size: 2.6 x 3.4 x 0.7 mm typ.)

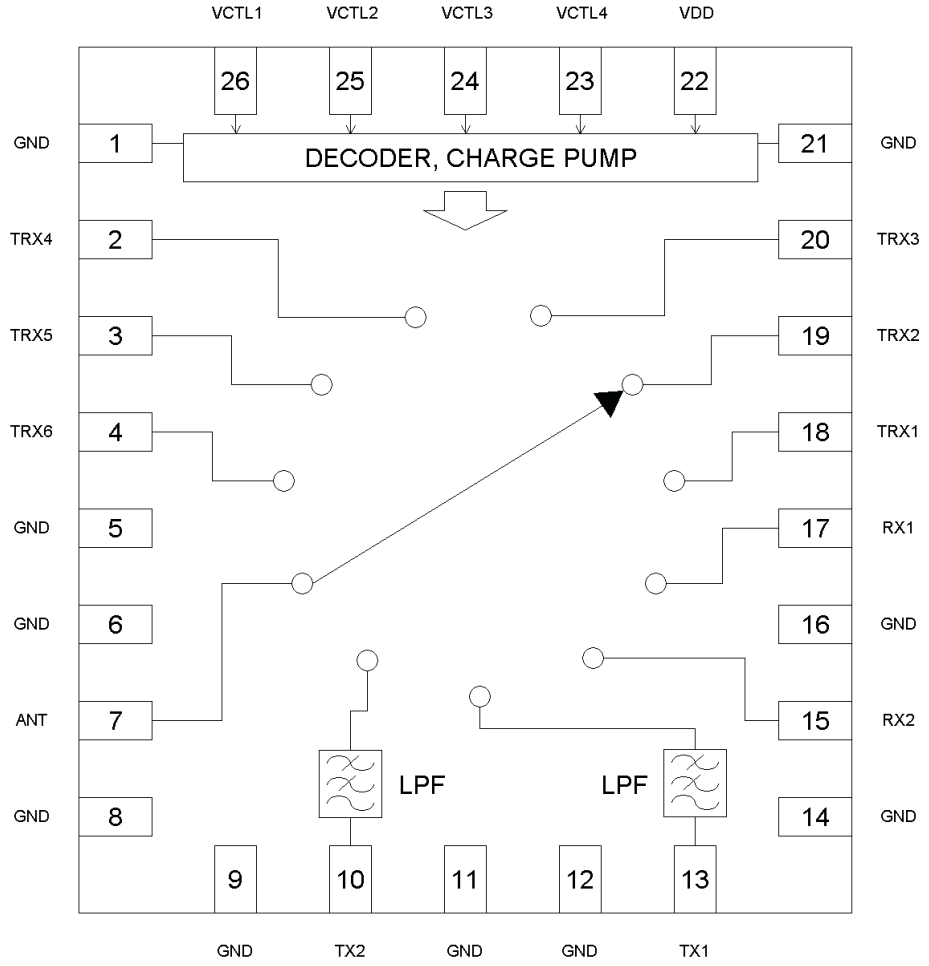
● RoHS compliant and Pb free, Halogen Free

● MSL 1

NOTE: The information in this document is subject to change without notice.

■ PIN CONFIGURATION

(TOP VIEW)



1. GND
2. TRX4
3. TRX5
4. TRX6
5. GND
6. GND
7. ANT
8. GND
9. GND
10. TX2
11. GND
12. GND
13. TX1
14. GND
15. RX2
16. GND
17. RX1
18. TRX1
19. TRX2
20. TRX3
21. GND
22. VDD
23. VCTL4
24. VCTL3
25. VCTL2
26. VCTL1

■ TRUTH TABLE

"H"=$V_{CTL(H)}$, "L"=$V_{CTL(L)}$

On Path	VCTL1	VCTL2	VCTL3	VCTL4
TX1-ANT	H	H	L	L
TX2-ANT	H	L	L	L
ANT-RX1	L	H	H	L
ANT-RX2	L	H	L	L
ANT-TRX1	L	L	H	L
ANT-TRX2	H	L	H	L
ANT-TRX3	H	H	H	L
ANT-TRX4	H	L	H	H
ANT-TRX5	H	H	H	H
ANT-TRX6	H	L	L	H

■ ABSOLUTE MAXIMUM RATINGS

(T_a=+25°C, Z_s=Z_l=50Ω)

PARAMETER	SYMBOL	CONDITIONS	Duty cycle	RATINGS	UNITS
RF Input Power	Pin	GSM LB TX1 port	4:8	36	dBm
		GSM HB TX2 port	4:8	34	dBm
		TRX ports	CW	32	dBm
		RX ports	CW	28	dBm
Supply Voltage	V_{DD}	VDD terminal		5.0	V
Control Voltage	V_{CTL}	VCTL terminal		5.0	V
Power dissipation	P_D	Four-layer FR4 PCB with through-hole (101.5mmx114.5mm), Tj=150°C		2200	mW
Operating Temperature	T_{opr}			-40~+90	°C
Storage Temperature	T_{stg}			-65~+150	°C

■ ELECTRICAL CHARACTERISTICS 1 (DC)

(General conditions: T_a=+25°C, Z_s=Z_l=50Ω, V_{DD}=2.7V, $V_{CTL(L)}$=0V, $V_{CTL(H)}$=1.8V, with application circuit)

PARAMETER	SYMBOL	CONDITIONS	Target SPEC.			UNITS
			MIN	TYP	MAX	
Supply Voltage	V_{DD}		2.5	2.7	5.0	V
Operating Current	I_{DD}		-	0.40	0.65	mA
Control Current	I_{CTL}	$V_{CTL(H)}$=1.8V/1Port	-	4	10	μA
Control Voltage	$V_{CTL(H)}$		1.35	1.8	5.0	V
	$V_{CTL(L)}$		0	-	0.45	V

■ **ELECTRICAL CHARACTERISTICS 2 (RF)**

(General conditions: T_a=+25°C, Z_s=Z_l=50Ω, V_{DD}=2.7V, $V_{CTL(L)}$=0V, $V_{CTL(H)}$=1.8V, with application circuit)

PARAMETER	SYMBOL	CONDITIONS	Target SPEC.			UNITS
			MIN	TYP	MAX	
Insertion Loss 1 (1) TRX1	LOSS1(1)TRX1	TRX1 - ANT, 452MHz~960MHz, Pin=26dBm	-	0.65	0.8	dB
Insertion Loss 1 (1) TRX2	LOSS1(1)TRX2	TRX2 - ANT, 452MHz~960MHz, Pin=26dBm	-	0.65	0.8	dB
Insertion Loss 1 (1) TRX3	LOSS1(1)TRX3	TRX3 - ANT, 452MHz~960MHz, Pin=26dBm	-	0.65	0.8	dB
Insertion Loss 1 (1) TRX4	LOSS1(1)TRX4	TRX4 - ANT, 452MHz~960MHz, Pin=26dBm	-	0.3	0.45	dB
Insertion Loss 1 (1) TRX5	LOSS1(1)TRX5	TRX5 - ANT, 452MHz~960MHz, Pin=26dBm	-	0.65	0.8	dB
Insertion Loss 1 (1) TRX6	LOSS1(1)TRX6	TRX6 - ANT, 452MHz~960MHz, Pin=26dBm	-	0.65	0.8	dB
Insertion Loss 1 (2) TRX1	LOSS1(2)TRX1	TRX1 - ANT, 1710MHz~2170MHz, Pin=26dBm	-	0.75	0.95	dB
Insertion Loss 1 (2) TRX2	LOSS1(2)TRX2	TRX2 - ANT, 1710MHz~2170MHz, Pin=26dBm	-	0.9	1.1	dB
Insertion Loss 1 (2) TRX3	LOSS1(2)TRX3	TRX3 - ANT, 1710MHz~2170MHz, Pin=26dBm	-	0.85	1.05	dB
Insertion Loss 1 (2) TRX4	LOSS1(2)TRX4	TRX4 - ANT, 1710MHz~2170MHz, Pin=26dBm	-	0.45	0.65	dB
Insertion Loss 1 (2) TRX5	LOSS1(2)TRX5	TRX5 - ANT, 1710MHz~2170MHz, Pin=26dBm	-	0.85	1.05	dB
Insertion Loss 1 (2) TRX6	LOSS1(2)TRX6	TRX6 - ANT, 1710MHz~2170MHz, Pin=26dBm	-	0.75	0.95	dB
Insertion Loss 1 (3) TRX1	LOSS1(3)TRX1	TRX1 - ANT, 2300MHz~2690MHz, Pin=26dBm	-	1.1	1.4	dB
Insertion Loss 1 (3) TRX2	LOSS1(3)TRX2	TRX2 - ANT, 2300MHz~2690MHz, Pin=26dBm	-	1.25	1.55	dB
Insertion Loss 1 (3) TRX3	LOSS1(3)TRX3	TRX3 - ANT, 2300MHz~2690MHz, Pin=26dBm	-	1.15	1.45	dB
Insertion Loss 1 (3) TRX4	LOSS1(3)TRX4	TRX4 - ANT, 2300MHz~2690MHz, Pin=26dBm	-	0.45	0.75	dB
Insertion Loss 1 (3) TRX5	LOSS1(3)TRX5	TRX5 - ANT, 2300MHz~2690MHz, Pin=26dBm	-	1.1	1.4	dB
Insertion Loss 1 (3) TRX6	LOSS1(3)TRX6	TRX6 - ANT, 2300MHz~2690MHz, Pin=26dBm	-	1.1	1.4	dB
Insertion Loss 2	LOSS2	TRX4 – ANT, 704MHz~787MHz (Band13, Band17), Pin=26dBm	-	0.25	0.4	dB
Insertion Loss 3	LOSS3	TX1 – ANT, 824MHz~915MHz, Pin=35dBm	-	1.05	1.3	dB
Insertion Loss 4	LOSS4	TX2 – ANT, 1710MHz~1910MHz, Pin=32dBm	-	1.2	1.4	dB
Insertion Loss 5(1)	LOSS5(1)	RX1,2 – ANT, 869MHz~960MHz, Pin=10dBm	-	0.9	1.1	dB
Insertion Loss 5(2)	LOSS5(2)	RX1,2 – ANT, 1805MHz~1990MHz, Pin=10dBm	-	1.0	1.2	dB

■ **ELECTRICAL CHARACTERISTICS 3 (RF)**

(General conditions: T_a=+25°C, Z_s=Z_l=50Ω, V_{DD}=2.7V, $V_{CTL(L)}$=0V, $V_{CTL(H)}$=1.8V, with application circuit)

PARAMETER	SYMBOL	CONDITIONS	Target SPEC.			UNITS
			MIN	TYP	MAX	
Isolation 1(1)	ISL1(1)	TX1-TRX1~3,TRX5,6,RX1 (TX1 ON) f=824MHz~915MHz	35	38	-	dB
Isolation 1(2)	ISL1(2)	TX1-TRX4,RX2 (TX1 ON) f=824MHz~915MHz	33	35	-	dB
Isolation 2(1)	ISL2(1)	TX2-TRX1~3, TRX5,6, RX1,2 (TX2 ON) f=1710MHz~1910MHz	32	35	-	dB
Isolation 2(2)	ISL2(2)	TX2-TRX4 (TX2 ON) f=1710MHz~1910MHz	31	34	-	dB
Isolation 3	ISL3	TRX1 – TRX3, TRX4 – TRX6, 452MHz~2690MHz	23	25	-	dB
Isolation 4	ISL4	TRX1 – TRX2, TRX2 – TRX3, TRX4 – TRX5, TRX5 – TRX6, 452MHz~2690MHz	17	20	-	dB
Isolation 5	ISL5	ANT – RX1 (RX2 ON), ANT – RX2 (RX1 ON), 1805MHz~1990MHz	33	36	-	dB
Isolation 6(1)	ISL6(1)	TRX1~3 – TRX4~6 (TRX1~3 ON), 452MHz~2690MHz	25	27	-	dB
Isolation 6(2)	ISL6(2)	TRX1~3 – TRX4~6 (TRX4~6 ON), 452MHz~2690MHz	31	33	-	dB
VSWR (1)	VSWR (1)	TX1 ON 824MHz~915MHz	-	-	1.5	-
VSWR (2)	VSWR (2)	TX2 ON 1710MHz~1910MHz	-	-	1.6	-
VSWR (3)	VSWR (3)	TRX1-TRX6 452MHz~2170MHz	-	-	1.6	-
VSWR (4)	VSWR (4)	TRX1-TRX6 452MHz~2690MHz	-	-	1.8	-
VSWR (5)	VSWR (5)	RX1~2 869MHz~1990MHz	-	-	1.5	-
Switching Speed	TSW	50% $V_{CTL(H)}$ to 10/90% RF	-	3	5	μs

■ **ELECTRICAL CHARACTERISTICS 4 (RF)**

(General conditions: T_a=+25°C, Z_s=Z_l=50Ω, V_{DD}=2.7V, $V_{CTL(L)}$=0V, $V_{CTL(H)}$=1.8V, with application circuit)

PARAMETER	SYMBOL	CONDITIONS	Target SPEC.			UNITS
			MIN	TYP	MAX	
Triple Beat Ratio	TBR	TRX1~6 ON, 650 ~ 900 MHz 1710 ~ 2155 MHz	-	80	-	dBc
2nd Harmonics 1	2fo(1)	TRX1~6 ON, 452 ~ 1980 MHz, Pin=26dBm	-	-	-62	dBc
2nd Harmonics 2	2fo(2)	TX1 ON, 824 ~ 915 MHz Pin=35dBm	-	-	-70	dBc
2nd Harmonics 3	2fo(3)	TX2 ON, 1710 ~ 1910 MHz Pin=32dBm	-	-	-67	dBc
2nd Harmonics 4	2fo(4)	TRX4 ON, 786.5MHz (Band13), Pin=25dBm	-	-80	-	dBm
3rd Harmonics 1	3fo(1)	TRX1~6 ON, 452 ~ 1980 MHz, Pin=26dBm	-	-	-62	dBc
3rd Harmonics 2	3fo(2)	TX1 ON, 824 ~ 915 MHz Pin=35dBm	-	-	-70	dBc
3rd Harmonics 3	3fo(3)	TX2 ON, 1710 ~ 1910 MHz Pin=32dBm	-	-	-67	dBc
GSM Tx Attenuation 1	ATT(1)	TX1 ON, 2fo, 3fo	25	-	-	dB
GSM Tx Attenuation 2	ATT(2)	TX1 ON, Past 3f to 12.75 GHz	16	-	-	dB
GSM Tx Attenuation 3	ATT(3)	TX2 ON, 2f, 3f	25	-	-	dB
GSM Tx Attenuation 4	ATT(4)	TX2 ON, Past 6.84 to 12.75 GHz	14	-	-	dB

■ **ELECTRICAL CHARACTERISTICS 5 (RF)**

(General conditions: T_a=+25°C, Z_s=Z_l=50Ω, V_{DD}=2.7V, $V_{CTL(L)}$=0V, $V_{CTL(H)}$=1.8V, with application circuit)

PARAMETER	SYMBOL	CONDITIONS	Target SPEC.			UNITS
			MIN	TYP	MAX	
IIP3(1) – UMTS mode (2600)	IIP3(1)	*Table 1, TRX1~6 ON	+60	-	-	dBm
IIP3(2) – UMTS mode (IMT)	IIP3(2)	*Table 1, TRX1~6 ON	+60	-	-	dBm
IIP3(3) – UMTS mode (PCS)	IIP3(3)	*Table 1, TRX1~6 ON	+61	-	-	dBm
IIP3(4) – UMTS mode (DCS)	IIP3(4)	*Table 1, TRX1~6 ON	+61	-	-	dBm
IIP3(5) – UMTS mode (PDC)	IIP3(5)	*Table 1, TRX1~6 ON	+61	-	-	dBm
IIP3(6) – UMTS mode (900)	IIP3(6)	*Table 1, TRX1~6 ON	+61	-	-	dBm
IIP3(7) – UMTS mode (US cell)	IIP3(7)	*Table 1, TRX1~6 ON	+61	-	-	dBm
IIP2(1) – UMTS mode (2600)	IIP2(1)	*Table 1, TRX1~6 ON	+102	-	-	dBm
IIP2(2) – UMTS mode (IMT)	IIP2(2)	*Table 1, TRX1~6 ON	+102	-	-	dBm
IIP2(3) – UMTS mode (PCS)	IIP2(3)	*Table 1, TRX1~6 ON	+102	-	-	dBm
IIP2(4) – UMTS mode (DCS)	IIP2(4)	*Table 1, TRX1~6 ON	+102	-	-	dBm
IIP2(5) – UMTS mode (PDC)	IIP2(5)	*Table 1, TRX1~6 ON	+102	-	-	dBm
IIP2(6) – UMTS mode (900)	IIP2(6)	*Table 1, TRX1~6 ON	+102	-	-	dBm
IIP2(7) – UMTS mode (US cell)	IIP2(7)	*Table 1, TRX1~6 ON	+102	-	-	dBm
IIP2(8) – C2K mode (AWS)	IIP2(8)	*Table 2, TRX1~6 ON	+95.5	-	-	dBm
IIP2(9) – C2K mode (PCS)	IIP2(9)	*Table 2, TRX1~6 ON	+95.5	-	-	dBm
IIP2(10) – C2K mode (cell)	IIP2(10)	*Table 2, TRX1~6 ON	+111.5	-	-	dBm

Table 1 IIP2/IIP3 UMTS Mode

	Band	CW tone 1 (MHz)	CW tone 1 (dBm)	CW tone 2 (MHz)	CW tone 2 (dBm)	Min IIP 2 (dBm)
IIP2	2600	2535	20	120	-15	+102
	IMT	1950	20	190	-15	+102
	PCS	1880	20	80	-15	+102
	DCS	1745	20	95	-15	+102
	PDC	1440	20	48	-15	+102
	900	892	20	45	-15	+102
	US cell	835	20	45	-15	+102
IIP3	2600	2535	20	2415	-15	+60
	IMT	1950	20	1760	-15	+60
	PCS	1880	20	1800	-15	+61
	DCS	1745	20	1650	-15	+61
	PDC	1440	20	1392	-15	+61
	900	892	20	847	-15	+61
	US cell	835	20	790	-15	+61

Table 2 IIP2 C2k Mode

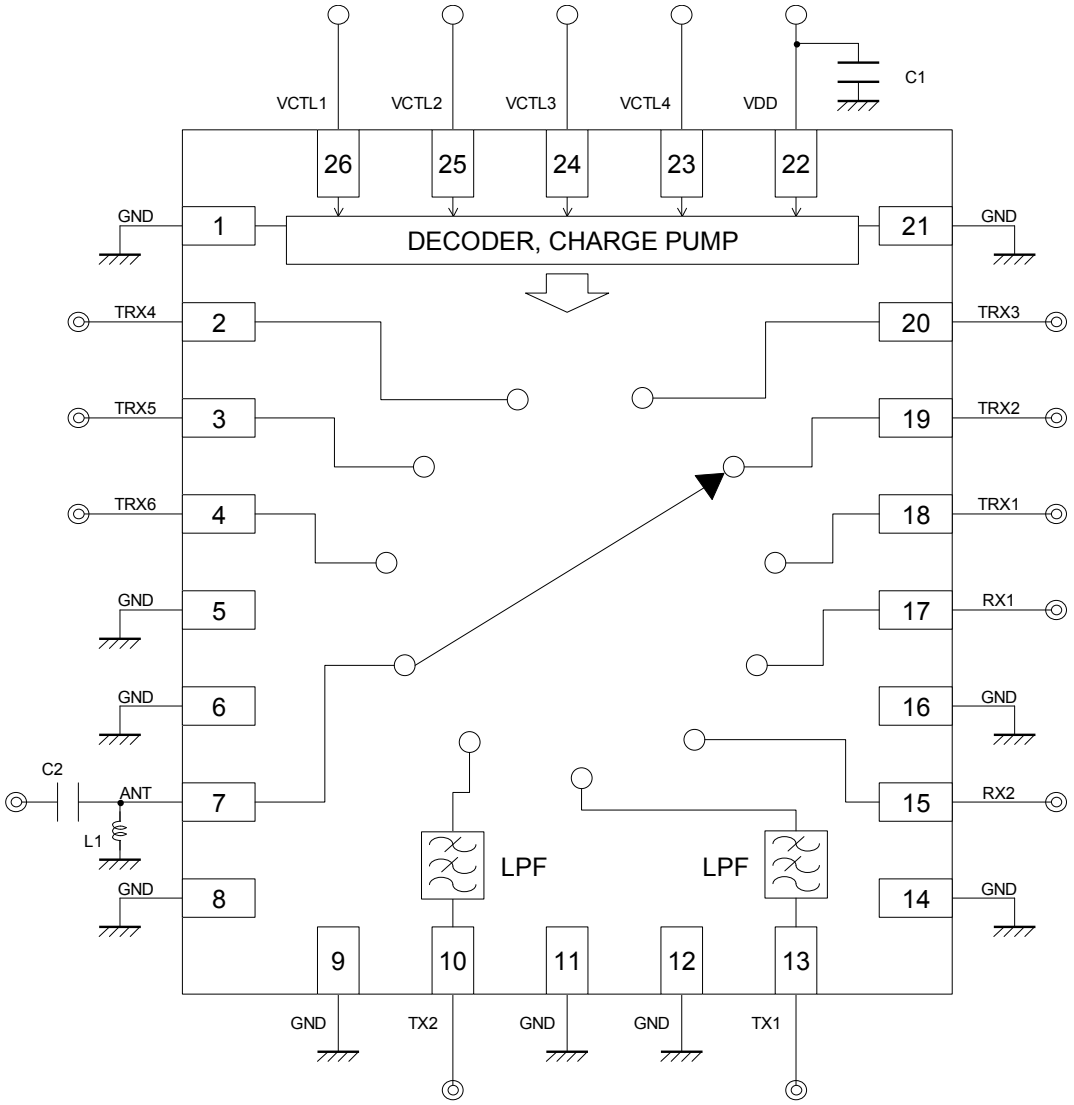
Band	Temp (°C)	In-band Freq (MHz)	CW tone 1 Freq (MHz)	CW tone Power (dBm)	CW tone 2 Freq (MHz)	CW tone 2 Power (dBm)	Min IIP 2 (dBm)
Cell	25	869.28	824.28	26	1693.56	-20	+111.5
	-30, 25, 85	881.61	836.61	26	1718.22	-20	+111.5
	25	893.31	848.31	26	1741.62	-20	+111.5
PCS	25	1930.05	1850.05	26	3780.1	-20	+95.5
	-30, 25, 85	1965	1885	26	3850	-20	+95.5
	25	1989.95	1909.95	26	3899.9	-20	+95.5
AWS	25	2110	1710	26	3820	-20	+95.5
	-30, 25, 85	2132.5	1732.5	26	3865	-20	+95.5
	25	2155	1755	26	3910	-20	+95.5

■ TERMINAL INFORMATION

No.	SYMBOL	DESCRIPTION
1	GND	Ground terminal. Please connect this terminal with ground plane as close as possible for excellent RF performance.
2	TRX4	RF transmitting/receiving port.
3	TRX5	RF transmitting/receiving port.
4	TRX6	RF transmitting/receiving port.
5	GND	Ground terminal. Please connect this terminal with ground plane as close as possible for excellent RF performance.
6	GND	Ground terminal. Please connect this terminal with ground plane as close as possible for excellent RF performance.
7	ANT	RF transmitting/receiving port. Please connect an inductor and capacitor with GND terminal for enhancing ESD protection, keeping zero DC Voltage at RF ports, and good RF characteristics.
8	GND	Ground terminal. Please connect this terminal with ground plane as close as possible for excellent RF performance.
9	GND	Ground terminal. Please connect this terminal with ground plane as close as possible for excellent RF performance.
10	TX2	RF transmitting port. This port is connected the LPF for GSM1800/1900 TX band.
11	GND	Ground terminal. Please connect this terminal with ground plane as close as possible for excellent RF performance.
12	GND	Ground terminal. Please connect this terminal with ground plane as close as possible for excellent RF performance.
13	TX1	RF transmitting port. This port is connected the LPF for GSM850/900 TX Band.
14	GND	Ground terminal. Please connect this terminal with ground plane as close as possible for excellent RF performance.
15	RX2	RF receiving port.
16	GND	Ground terminal. Please connect this terminal with ground plane as close as possible for excellent RF performance.
17	RX1	RF receiving port.
18	TRX1	RF transmitting/receiving port.
19	TRX2	RF transmitting/receiving port.
20	TRX3	RF transmitting/receiving port.
21	GND	Ground terminal. Please connect this terminal with ground plane as close as possible for excellent RF performance.
22	VDD	Positive voltage supply terminal. The positive voltage (+2.5~+5.0V) has to be supplied. Please connect a bypass capacitor with GND terminal for excellent RF performance.
23	VCTL4	Control signal input terminal. This terminal is set to High-Level (+1.35~+5.0V) or Low-Level (0~+0.45V).
24	VCTL3	Control signal input terminal. This terminal is set to High-Level (+1.35~+5.0V) or Low-Level (0~+0.45V).
25	VCTL2	Control signal input terminal. This terminal is set to High-Level (+1.35~+5.0V) or Low-Level (0~+0.45V).
26	VCTL1	Control signal input terminal. This terminal is set to High-Level (+1.35~+5.0V) or Low-Level (0~+0.45V).

■ APPLICATION CIRCUIT

(TOP VIEW)



1. GND
2. TRX4
3. TRX5
4. TRX6
5. GND
6. GND
7. ANT
8. GND
9. GND
10. TX2
11. GND
12. GND
13. TX1
14. GND
15. RX2
16. GND
17. RX1
18. TRX1
19. TRX2
20. TRX3
21. GND
22. VDD
23. VCTL4
24. VCTL3
25. VCTL2
26. VCTL1

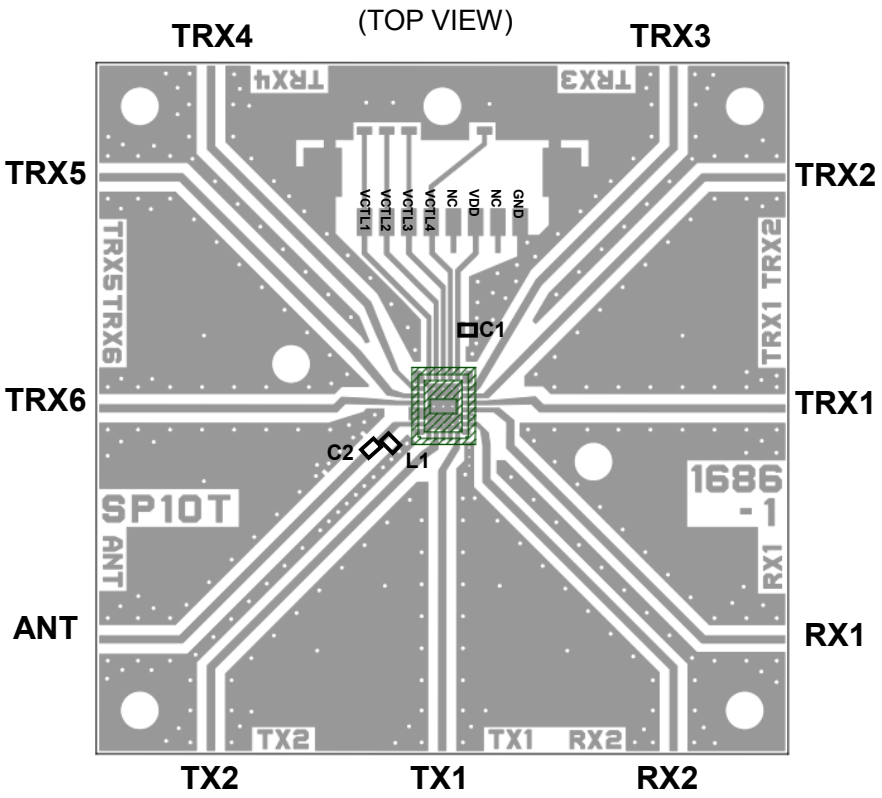
No DC blocking capacitors are required on all RF ports, unless DC is biased externally.

■ PARTS LIST

No.	Parameters	Note
C1	1000 pF	MURATA (GRM15)
C2 *1	47pF	MURATA (GRM15)
L1 *1	56 nH	TDK (MLG1005S)

*1: The use of the inductor L1 and the capacitor C2 are needed in order to keep zero DC Voltage at RF ports, enhancing ESD protection level, and for good RF characteristics.

■ PCB LAYOUT

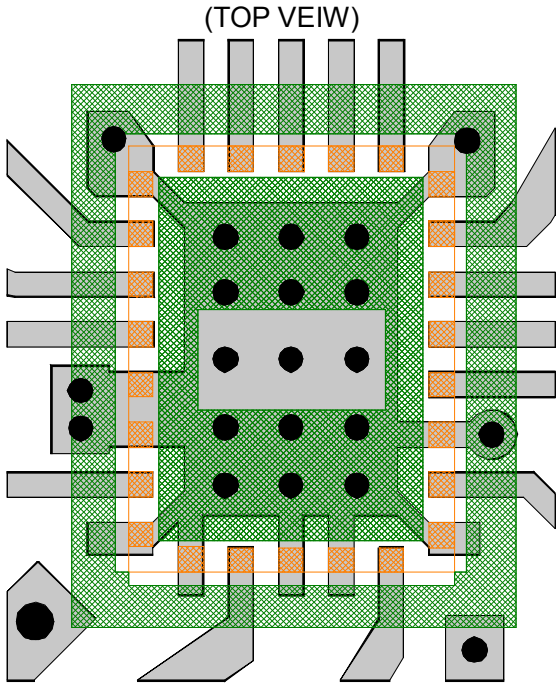


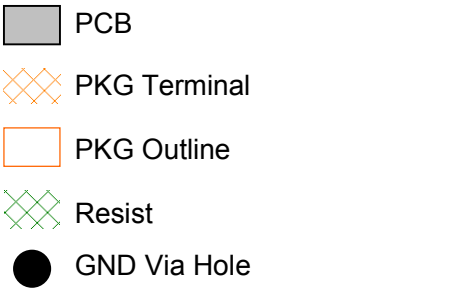
Losses of PCB and connectors, Ta=+25°C

Frequency (MHz)	ANT-TX2,RX1,2, TRX2,3,4,5 Loss (dB)	ANT-TX1, TRX1,6 Loss (dB)
787	0.36	0.34
915	0.38	0.35
960	0.37	0.34
1910	0.58	0.53
2170	0.64	0.57
2690	0.72	0.66

PCB SIZE: 38.9 x 38.9 mm
PCB: FR-4, t=0.2mm
Capacitor size: 1005 [mm]
MICROSTRIP LINE WIDTH: 0.4mm
Areas being hatched are covered with resist.

<PCB LAYOUT GUIDELINE>





■ PRECAUTIONS

[1] No DC block capacitors are required for RF ports unless DC is biased externally.
[2] For avoiding the degradation of RF performance, the bypass capacitor (C1) should be placed as close as possible to VDD terminal
[3] For good RF performance, all GND terminals are must be connected to PCB ground plane of substrate, and through - holes for GND should be placed the IC near.

■ RECOMMENDED FOOTPRINT PATTERN (EQFN26-HH PACKAGE REFERENCE)

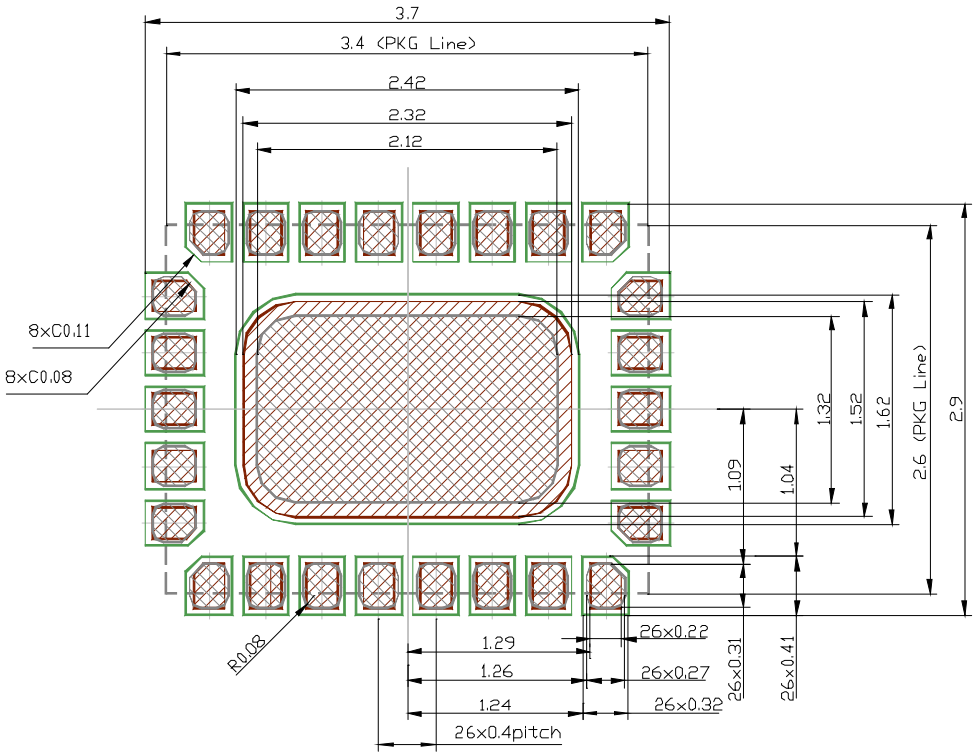
: Land

: Mask (Open area) *Metal mask thickness : 100um

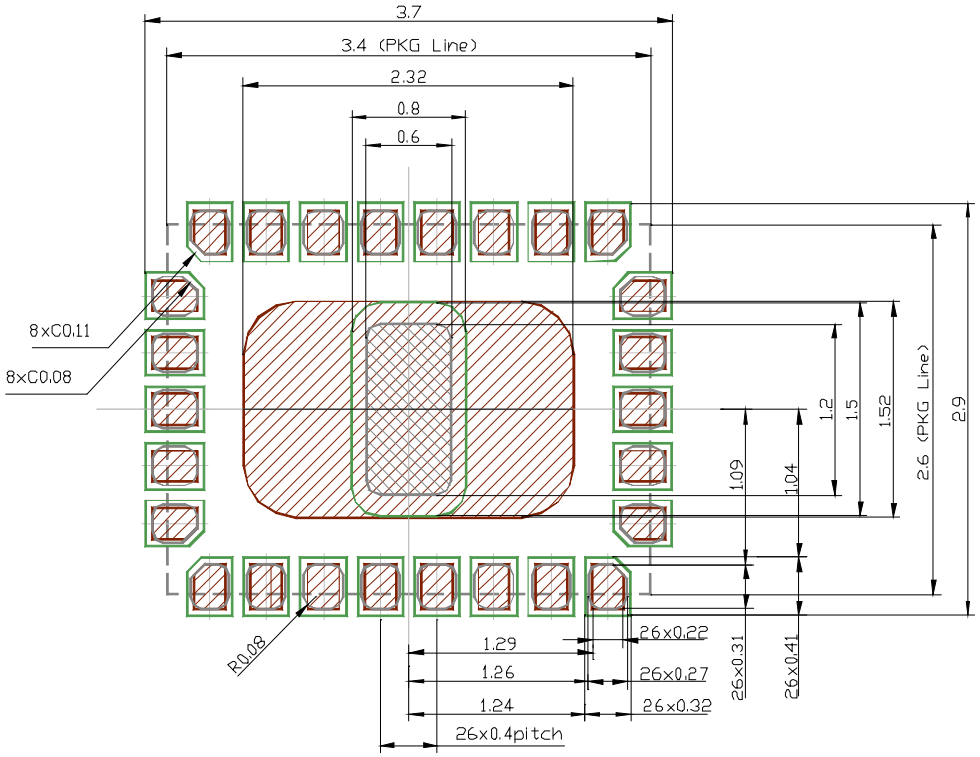
: Resist (Open area)

PKG : 3.4mm x 2.6mm
Pin pitch : 0.4mm

<TYPE 1> *



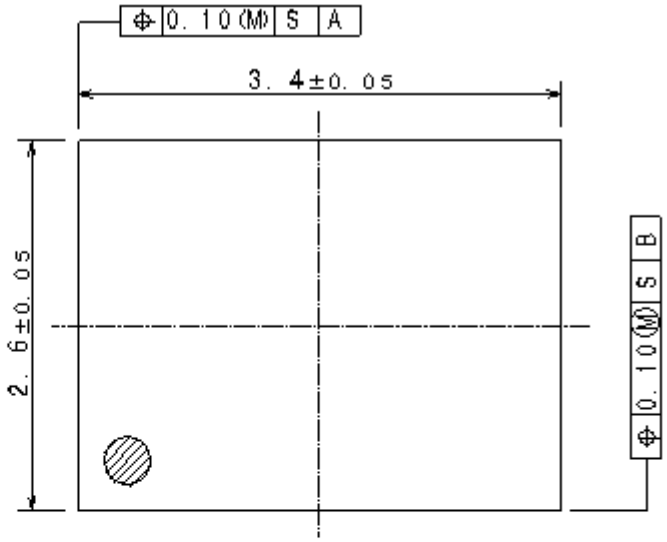
< TYPE 2> *



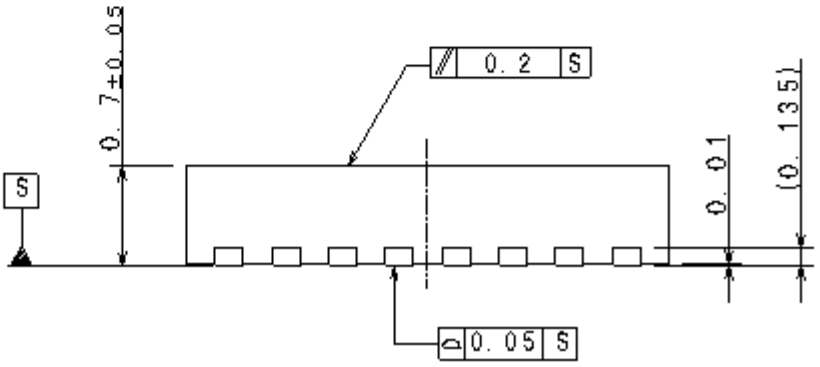
* There is no difference in the characteristics using both of TYPE 1 and TYPE 2.

■ **PACKAGE OUTLINE (EQFN26-HH)**

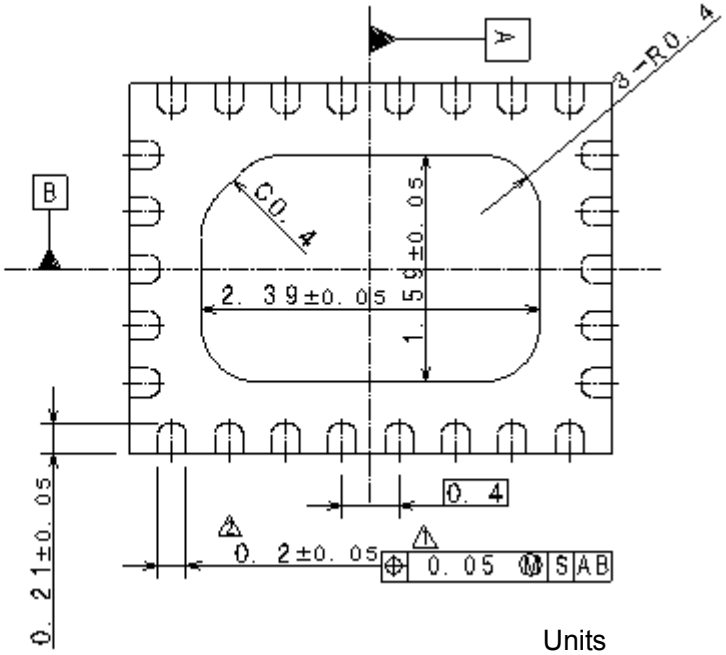
TOP VIEW



SIDE VIEW



BOTTOM VIEW



Units	: mm
Board	: Cu
Terminal treat	: SnBi
Molding material	: Epoxy resin
Weight	: 18mg