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April 1st, 2010
Renesas Electronics Corporation

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DATA SHEET

NEC

GaAs INTEGRATED CIRCUIT

μPG2193T6E

GaAs MMIC SP8T SWITCH FOR MOBILE COMMUNICATIONS

DESCRIPTION

The μPG2193T6E is a GaAs MMIC SP8T switch with SPI control function, which is developed for GSM triple band and W-CDMA triple band applications.

The μPG2193T6E can operate with voltage from 2.5 to 3.0 V, with low insertion loss, high isolation, and high linearity.

This device is housed in a 20-pin plastic TQFN (Thin Quad Flat Non-leaded) package, and is suitable for high-density surface mounting.

FEATURES

- Supply Voltage : V_{DD} = 2.5 to 3.0 V (2.775V TYP.)
- Serial Peripheral Interface SPI Supply Voltage
  : AUX SPI_VDD (H) = 1.5 to 3.0 V (1.8 V TYP.)
  : AUX SPI_VDD (L) = –0.3 to 0.3 V (0 V TYP.)
- Low Insertion Loss : L_{ins} = 0.4 dB TYP. @ GSM_LB_TX
  : L_{ins} = 0.6 dB TYP. @ GSM_HB_TX
- Harmonics : 2f0 = –80 dBc TYP. @ GSM_LB/HB_TX, 50 Ω
  : 3f0 = –80 dBc TYP. @ GSM_LB/HB_TX, 50 Ω
  : 2f0 = –70 dBc TYP. @ GSM_LB_TX, 34.5 dBm, VSWR = 4:1
  : 3f0 = –70 dBc TYP. @ GSM_LB_TX, 34.5 dBm, VSWR = 4:1
- High-density surface mounting : 20-pin TQFN package (3.5 × 3.5 × 0.6 mm)

APPLICATIONS

- Antenna switch for Mobile Communications

ORDERING INFORMATION

Part Number	Order Number	Package	Marking	Supplying Form
μPG2193T6E-E2	μPG2193T6E-E2-A	20-pin plastic TQFN (Pb-Free)	G2193	• Embossed tape 12 mm wide • Pin 16 to 20 face the perforation side of the tape • Qty 5 kpcs/reel

Remark To order evaluation samples, please contact your nearby sales office.
Part number for sample order: μPG2193T6E-A

Caution Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) can damage this device. This device must be protected at all times from ESD. Static charges may easily produce potentials of several kilovolts on the human body or equipment, which can discharge without detection. Industry-standard ESD precautions must be employed at all times.

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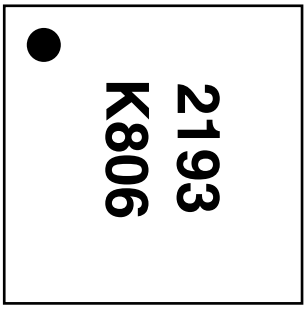
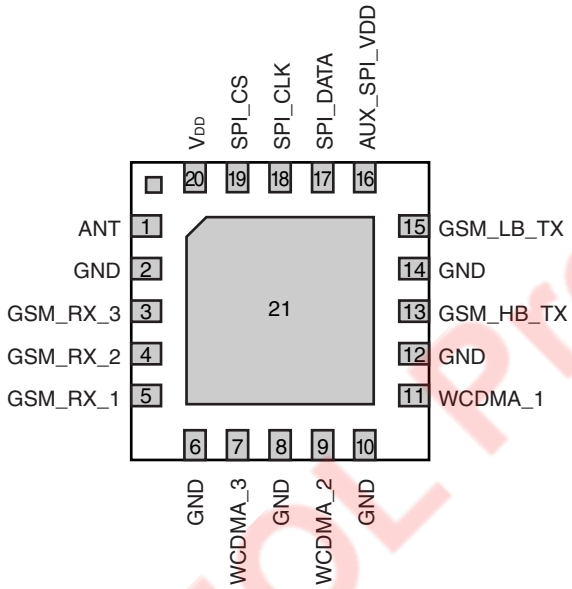
PIN CONNECTIONS

(Top View)



(Bottom View)



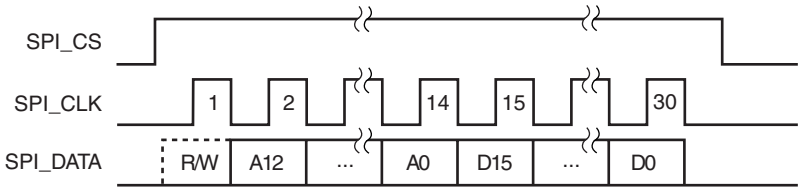
Pin No.	Pin Name
1	ANT
2	GND
3	GSM_RX_3
4	GSM_RX_2
5	GSM_RX_1
6	GND
7	WCDMA_3
8	GND
9	WCDMA_2
10	GND
11	WCDMA_1
12	GND
13	GSM_HB_TX
14	GND
15	GSM_LB_TX
16	AUX_SPI_VDD
17	SPI_DATA
18	SPI_CLK
19	SPI_CS
20	VDD

Remark Exposed pad (Pin No. 21): GND

TRUTH TABLE

Bit	Function	Set	Description
29	Read/Write mode	1	Not used for front end switch
		0	Write to the switch
28	Address	0	001 used for front end switches
27	(Slave Type)	0	
26		1	
25	Address	0	00000 = FE switch module for single antenna radios
24	(Slave Identifier)	0	
23		0	
22		0	
21		0	
20	Address	0	Only one SPI register will be used on the front end switch
19	(Slave SPI register)	0	
18		0	
17		0	
16		0	
15	DCDC converter enable	1/0	A logic high enables the DCDC converter (if applicable)
14	FE Select 4 = MSB	0000	Switch Disabled (low current mode)
13	FE Select 3	0001	GSM_HB_TX enable
12	FE Select 2	0010	GSM_LB_TX enable
11	FE Select 1 = LSB	0011	Not Used/Reserved
		0100	GSM_RX_1 enable
		0101	GSM_RX_2 enable
		0110	GSM_RX_3 enable
		0111	Not Used / Reserved
		1000	WCDMA_1 enable
		1001	WCDMA_2 enable
		1010	WCDMA_3 enable
		1011 to 1111	Not used/Reserved
10	Not used	X	Not used/Reserved
9	Not used	X	Not used/Reserved
8	Not used	X	Not used/Reserved
7	Not used	X	Not used/Reserved
6	Not used	X	Not used/Reserved
5	Not used	X	Not used/Reserved
4	Not used	X	Not used/Reserved
3	Not used	X	Not used/Reserved
2	Not used	X	Not used/Reserved
1	Not used	X	Not used/Reserved
0	Not used	X	Not used/Reserved

Timing Chart (SPI Control)



On a write command to the device with address bots A12 through A0 set to all 1's, the device shall revert to the default state. The default state of this device is the deep sleep mode.

Bit	Function	Set	Description
29	Read/Write mode	0	Logic low command puts device in read mode
28	Address (Slave Type)	1	111 used for global write
27		1	
26		1	
25	Address (Slave Identifier)	1	11111 used for global write
24		1	
23		1	
22		1	
21		1	
20	Command	1/0	A transmission of "11111" must put the switch into standby mode
19		1/0	
18		1/0	
17		1/0	
16		1/0	
15	DCDC converter enable	1/0	A logic high enables the DCDC converter (if applicable)
14	Not used	X	Data bit must be ignored during Global Command Write
13	Not used	X	Data bit must be ignored during Global Command Write
12	Not used	X	Data bit must be ignored during Global Command Write
11	Not used	X	Data bit must be ignored during Global Command Write
10	Not used	X	Data bit must be ignored during Global Command Write
9	Not used	X	Data bit must be ignored during Global Command Write
8	Not used	X	Data bit must be ignored during Global Command Write
7	Not used	X	Data bit must be ignored during Global Command Write
6	Not used	X	Data bit must be ignored during Global Command Write
5	Not used	X	Data bit must be ignored during Global Command Write
4	Not used	X	Data bit must be ignored during Global Command Write
3	Not used	X	Data bit must be ignored during Global Command Write
2	Not used	X	Data bit must be ignored during Global Command Write
1	Not used	X	Data bit must be ignored during Global Command Write
0	Not used	X	Data bit must be ignored during Global Command Write

DISABLING THE SWITCH: The switch can be disabled in two ways. Either the appropriate SPI command can be sent, or AUX_SPI_VDD can be sent low.

POWER ON RESET: Assuming the 2.775 V supply is already on when AUX_SPI_VDD is powered up, the switch should revert to the default state, which is the deep sleep mode. If the deep sleep mode corresponds to a port being connected to the antenna, it should be Rx1. If a DCDC converter is used, it should be shut off. If AUX_SPI_VDD comes up before the 2.775 V supply, the POR should occur as soon as both signals are high. In any case, where the AUX_SPI_VDD is low, the chip should be powered off.

Remark “Deep sleep mode”, “powered off”, “low current mode”, and “standby mode” all mean the same thing.

ABSOLUTE MAXIMUM RATINGS (T_A = +25°C, unless otherwise specified)

Parameter	Symbol	Ratings	Unit
Supply Voltage	V_{DD}	3.2	V
Switch Control Voltage	AUX_SPI_VDD VC	3.2	V
Input Power 1	Pin TX	+36	dBm
Input Power 2	Pin RX	+26	
Operating Ambient Temperature	T_A	−30 to +85	°C
Storage Temperature	T_{stg}	−55 to +150	°C

RECOMMENDED OPERATING RANGE (T_A = +25°C, unless otherwise specified)

Parameter	Pin	Symbol	MIN.	TYP.	MAX.	Unit
Switch Supply Voltage	V_{DD}	V_{DD}	2.5	2.775	3.0	V
SPI Supply Voltage (High)	AUX_SPI_VDD	AUX_SPI_VDD	1.5	1.8	3.0	V
SPI Supply Voltage (Low)			−0.3	0	0.3	V
SPI Control Input Voltage (High)	SPI_CS SPI_CLK SPI_DATA	VC_HI	AUX_SPI_VDD × 80%	1.8	AUX_SPI_VDD +0.3	V
SPI Control Input Voltage (Low)		VC_LO	−0.3	0	AUX_SPI_VDD × 20%	V
SPI Control Enable	AUX_SPI_VDD	SPI_en	150	–	–	μs
CLK frequency	SPI_CLK	–	10	–	26	MHz

ELECTRICAL CHARACTERISTICS 1

(T_A = +25°C, V_{DD} = 2.5 to 3.0 V, Z_0 = 50 Ω, DC blocking capacitors = 22 pF, with ESD protection circuit, unless otherwise specified)

Parameter	Symbol	Frequency (MHz)	P_{in} (dBm)	Measured Path	MAX.	Unit
Insertion Loss	L_{ins} GSM_LB_TX	824 to 915	+35	GSM_LB_TX (Pin 15) to ANT (Pin 1)	0.60	dB
	L_{ins} GSM_HB_TX	1 710 to 1 910	+33	GSM_HB_TX (Pin 13) to ANT (Pin 1)	0.70	
	L_{ins}	824 to 960	+25.5	WCDMA_1 (Pin 11) or	0.55	
	WCDMA_1	1 710 to 1 910		WCDMA_2 (Pin 9) or	0.70	
	WCDMA_2 WCDMA_3	1 920 to 2 170		WCDMA_3 (Pin 7) to ANT (Pin 1)	0.85	
	L_{ins} GSM_RX1	869 to 960	−15	GSM_RX1 (Pin 5) or GSM_RX2 (Pin 4) or GSM_RX3 (Pin 3) to ANT (Pin 1)	0.90	
	GSM_RX2	1 805 to 1 990		GSM_RX1 (Pin 5) to ANT (Pin 1)	1.10	
	GSM_RX3			GSM_RX2 (Pin 4) to ANT (Pin 1)	1.05	
				GSM_RX3 (Pin 3) to ANT (Pin 1)	1.15	

ELECTRICAL CHARACTERISTICS 2

(T_A = –30 to +85°C, V_{DD} = 2.5 to 3.0 V, Z_0 = 50 Ω, DC blocking capacitors = 22 pF, with ESD protection circuit, unless otherwise specified)

Parameter	Symbol	Frequency (MHz)	P_{in} (dBm)	Measured Path	MAX.	Unit
Insertion Loss	L_{ins} GSM_LB_TX	824 to 915	+35	GSM_LB_TX (Pin 15) to ANT (Pin 1)	0.65	dB
	L_{ins} GSM_HB_TX	1 710 to 1 910	+33	GSM_HB_TX (Pin 13) to ANT (Pin 1)	0.75	
	L_{ins}	824 to 960	+25.5	WCDMA_1 (Pin 11) or	0.60	
	WCDMA_1	1 710 to 1 910		WCDMA_2 (Pin 9) or	0.80	
	WCDMA_2 WCDMA_3	1 920 to 2 170		WCDMA_3 (Pin 7) to ANT (Pin 1)	0.95	
	L_{ins} GSM_RX1	869 to 960	−15	GSM_RX1 (Pin 5) or GSM_RX2 (Pin 4) or GSM_RX3 (Pin 3) to ANT (Pin 1)	0.90	
	GSM_RX2	1 805 to 1 990		GSM_RX1 (Pin 5) to ANT (Pin 1)	1.25	
	GSM_RX3			GSM_RX2 (Pin 4) to ANT (Pin 1)	1.20	
				GSM_RX3 (Pin 3) to ANT (Pin 1)	1.30	

ELECTRICAL CHARACTERISTICS 3

(T_A = +25°C, DC blocking capacitors = 22 pF, with ESD protection circuit, unless otherwise specified)

Parameter	Symbol	Conditions	P_{in} (dBm)	Measured Path	MIN.	Unit
Harmonics (50 Ω)	nf0 WCDMA_1, 2, 3	f = 824 to 1 980 MHz, V_{DD} = 2.775 V	+25.5	WCDMA_1 (Pin 11) or WCDMA_2 (Pin 9) or WCDMA_3 (Pin 7) to ANT (Pin 1)	69	dBc
	3f0 WCDMA_1, 2, 3	f = 824 to 833 MHz, V_{DD} = 2.775 V			74	
	nf0 GSM_HB_TX	f = 1710 to 1910 MHz, V_{DD} = 2.691 V	+32.5	GSM_HB_TX (Pin 13) to ANT (Pin 1)	70	
	nf0 GSM_LB_TX	f = 824 to 915 MHz, V_{DD} = 2.691 V	+34.5	GSM_LB_TX (Pin 15) to ANT (Pin 1)	72	
	3f0 GSM_LB_TX	f = 824 to 833 MHz, V_{DD} = 2.691 V				
Harmonics (VSWR = 4:1 on ANT port)	nf0 WCDMA_1, 2, 3	f = 824 to 1 980 MHz, V_{DD} = 2.775 V	+25.5	WCDMA_1 (Pin 11) or WCDMA_2 (Pin 9) or WCDMA_3 (Pin 7) to ANT (Pin 1)	65	dBc
	3f0 WCDMA_1, 2, 3	f = 824 to 833 MHz, V_{DD} = 2.775 V			70	
	nf0 GSM_HB_TX	f = 1710 to 1910 MHz, V_{DD} = 2.691 V	+32.5	GSM_HB_TX (Pin 13) to ANT (Pin 1)	68	
	nf0 GSM_LB_TX	f = 824 to 915 MHz, V_{DD} = 2.691 V	+34.5	GSM_LB_TX (Pin 15) to ANT (Pin 1)	70	
Transient Harmonics (50 Ω)	nf0 GSM_HB_TX	f = 1710 to 1910 MHz, V_{DD} = 2.691 V	0	GSM_HB_TX (Pin 13) to ANT (Pin 1)	38	dBc
	nf0 GSM_LB_TX	f = 824 to 915 MHz, V_{DD} = 2.691 V		GSM_LB_TX (Pin 15) to ANT (Pin 1)	39	
	3f0 GSM_LB_TX	f = 824 to 833 MHz, V_{DD} = 2.691 V			44	

ELECTRICAL CHARACTERISTICS 4

(T_A = –30 to +85°C, V_{DD} = 2.5 to 3.0 V, Z_0 = 50 Ω, DC blocking capacitors = 22 pF, with ESD protection circuit, unless otherwise specified)

Parameter	Symbol	Frequency (MHz)	P_{in} (dBm)	ON Path	Measured Path	MIN.	Unit
Forward Isolation	Forward Isolation GSM_LB_TX	824 to 833	+35	Any RF port except GSM_LB_TX	GSM_LB_TX (Pin 15) to ANT (Pin 1)	20	dB
	Forward Isolation GSM_HB_TX	1 710 to 1 910	+33	Any RF port except GSM_HB_TX	GSM_HB_TX (Pin 13) to ANT (Pin 1)	19.5	
Pin to Pin Isolation	Pin to Pin Isolation WCDMA_1, 2, 3	824 to 960	+25.5	WCDMA_1 or 2 or 3 to ANT (Pin1)	WCDMA_1 or 2 or 3 to Any RX port	29	dB
		960 to 1 980				25	
	Pin to Pin Isolation GSM_HB_TX	1 710 to 1 910	+33	GSM_HB_TX (Pin 13) to ANT (Pin1)	GSM_HB_TX to Any RX port	30	
					GSM_HB_TX to WCDMA_1	27	
					GSM_HB_TX to WCDMA_2	27	
					GSM_HB_TX to WCDMA_3	28	
	Pin to Pin Isolation GSM_LB_TX	824 to 915	+35	GSM_LB_TX (Pin15) to ANT (Pin1)	GSM_LB_TX to Any RX port	30	
					GSM_LB_TX to Any WCDMA port	30	
	Pin to Pin Isolation WCDMA_1	824 to 960	+25.5	WCDMA_1 to ANT (Pin 1)	WCDMA_1 to WCDMA_2	29	
		960 to 1 980			WCDMA_1 to WCDMA_3	27	
	Pin to Pin Isolation WCDMA_2	824 to 960		WCDMA_2 to ANT (Pin 1)	WCDMA_2 to WCDMA_3	29	
		960 to 1 980			WCDMA_2 to WCDMA_1	26.5	
	Pin to Pin Isolation WCDMA_3	824 to 960		WCDMA_3 to ANT (Pin 1)	WCDMA_3 to WCDMA_1	29	
		960 to 1 980			WCDMA_3 to WCDMA_2	26.5	

ELECTRICAL CHARACTERISTICS 5

(T_A = –30 to +85°C, V_{DD} = 2.5 to 3.0 V, Z_0 = 50 Ω, DC blocking capacitors = 22 pF, with ESD protection circuit, unless otherwise specified)

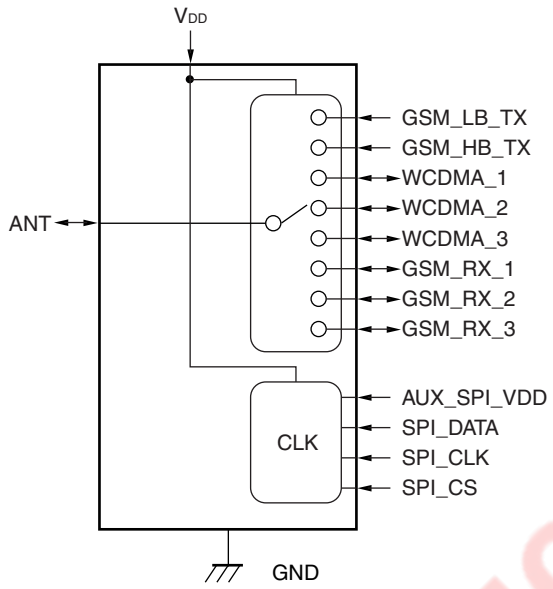
Parameter	Symbol	Frequency (MHz)	P_{in} (dBm)	ON Path	Measured Path	MIN.	Unit
Return Loss	Return Loss ANT to any port	824 to 2 170	−15	ANT (Pin1) to any port		9.5	dB
	Return Loss WCDMA_1, 2, 3 to ANT		+25.5	WCDMA_1 or WCDMA_2 or WCDMA_3 to ANT (Pin 2)		12.5	
	Return Loss GSM_HB_TX to ANT	1 710 to 1 910	+33	GSM_HB_TX (Pin 13) to ANT (Pin 1)		15.0	
	Return Loss GSM_LB_TX to ANT	824 to 915	+35	GSM_LB_TX (Pin15) to ANT (Pin1)		15.0	
	Return Loss ANT to any GSM_RX	869 to 1 990	−15	ANT (Pin1) to any GSM_RX		11.5	

ELECTRICAL CHARACTERISTICS 6

(T_A = –30 to +85°C, V_{DD} = 2.5 to 3.0 V, Z_0 = 50 Ω, DC blocking capacitors = 22 pF, with ESD protection circuit, unless otherwise specified)

Parameter	Symbol	Frequency (MHz)	P_{in} (dBm)	ON Path	Measured Path	MIN.	TYP.	MAX.	Unit
IIP_2 IMD2_out	IIP_2 WCDMA_1, 2, 3	Refer to **FREQUENCY CONDITIONS FOR IMD TESTING**	P_{tx} = +20 P_{int} = –15	WCDMA_1 or WCDMA_2 or WCDMA_3	to ANT (Pin 1)	108	–	–	dBm
	IMD_2 WCDMA_1, 2, 3					–	–	–104	
IIP_3 IMD3_out	IIP_3 WCDMA_1, 2, 3					65.25	–	–	
	IMD_3 WCDMA_1, 2, 3					–	–	–106.5	
Spectrum Emissions	Spectrum Emissions WCDMA_1, 2, 3	824 to 1 980	+25.5 (CW)	WCDMA_1 or WCDMA_2 or WCDMA_3 to ANT (Pin1)		–	–	83	dBc
		869 to 2 170	RBW = 3.84 MHz	ANT to WCDMA_1 or WCDMA_2 or WCDMA_3		–	–	–114	dBm
	Spectrum Emissions GSM_HB_TX	1710 to 1 910	+33	GSM_HB_TX to ANT		–	–	83	dBc
	Spectrum Emissions GSM_LB_TX	824 to 915	+35	GSM_LB_TX to ANT		–	–	83	
	Spectrum Emissions GSM_RX	869 to 1 990	RBW = 180 kHz	ANT to any GSM_RX		–	–	–132.5	dBm
Switching Speed	tsw	Any path transition Time from SPI frame low to RF turn on				–	1	5.0	μs
Turn on time	Turn on time	Any path From 10% to 90% of full DC/DC converter voltage				–	–	100	μs
Supply Current	IDD1	Active mode, DC/DC converter on				–	–	850	μA
	IDD2	Active mode, DC/DC converter off				–	–	650	
Standby Current	IDD_stb	Standby mode				–	–	30	μA
SPI Control Current	SPI_IDD	During SPI read (V_{DD} < 2.1V)				–	–	400	μA
		During SPI read (2.1 ≤ V_{DD} ≤3.0 V)				–	–	650	
SPI Line Capacitance	SPI_C	Capacitance on SPI data line				–	–	5	pF

FUNCTIONAL BLOCK DIAGRAM



The application circuits and their parameters are for reference only and are not intended for use in actual design-ins.

FREQUENCY CONDITIONS FOR IMD TESTING

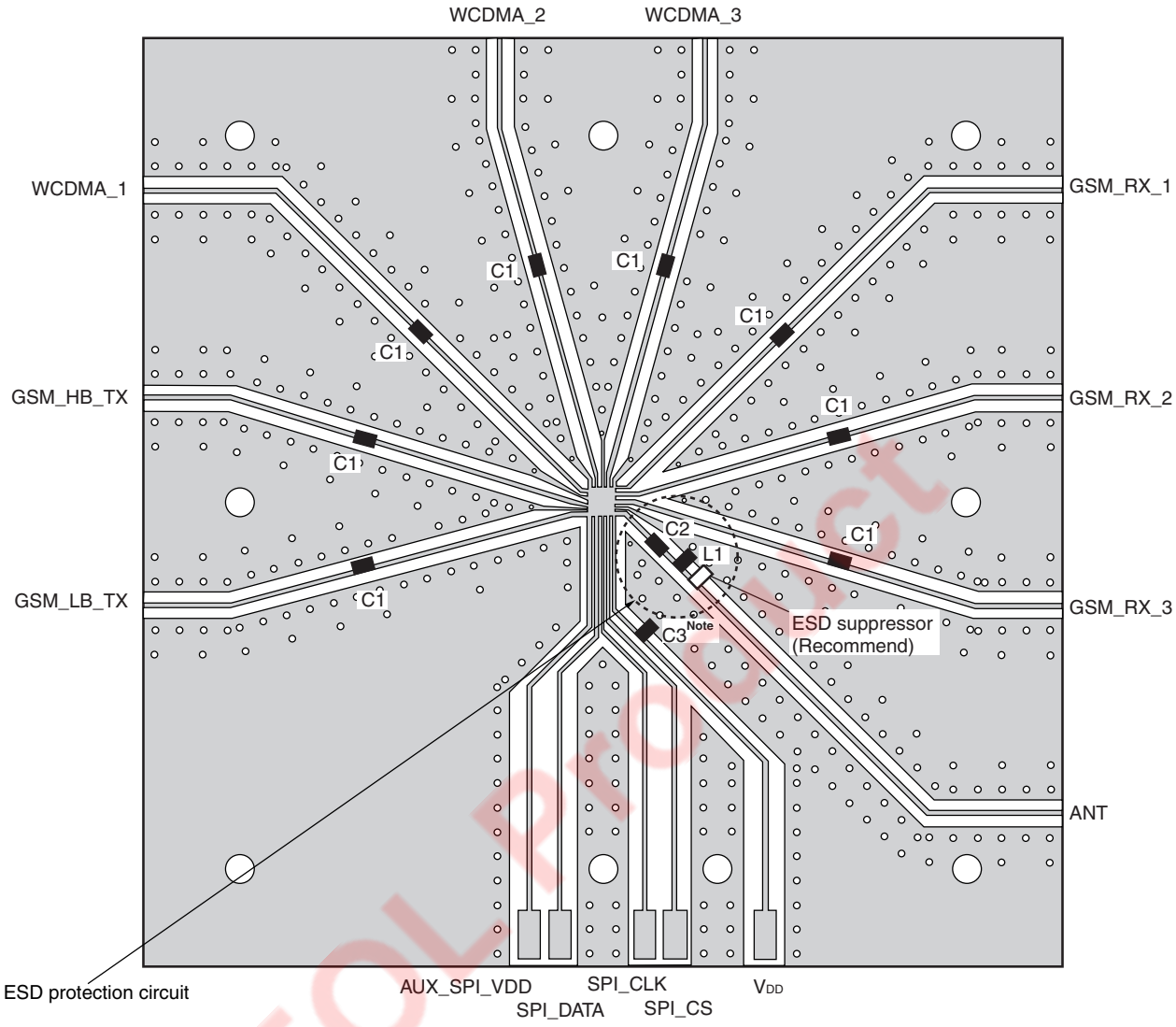
IP2 TEST (Unit: MHz)

	TX		RX		Duplex	RX/2	
BAND	FTX LOW	FTX HIGH	FRX LOW	FRX HIGH	FINT1	FINT2 LOW	FINT2 HIGH
B1	1 920	1 980	2 110	2 170	190	1 055.0	1 085.0
B2	1 850	1 910	1 930	1 990	80	965.0	995.0
B3	1 710	1 785	1 805	1 880	95	902.5	940.0
B5	824	849	869	894	45	434.5	447.0
B8	880	915	925	960	45	462.5	480.0
B10	1 710	1 770	2 110	2 170	400	1 055.0	1 085.0

IP3 TEST (Unit: MHz)

	TX		RX		Duplex		RX/3	
BAND	FTX LOW	FTX HIGH	FRX LOW	FRX HIGH	FINT1 LOW	FINT1 HIGH	FINT2 LOW	FINT2 HIGH
B1	1 920	1 980	2 110	2 170	1 730	1 790	703.33	723.33
B2	1 850	1 910	1 930	1 990	1 770	1 830	643.33	663.33
B3	1 710	1 785	1 805	1 880	1 615	1 690	601.67	626.67
B5	824	849	869	894	779	804	289.67	298.00
B8	880	915	925	960	835	870	308.33	320.00
B10	1 710	1 770	2 110	2 170	1 310	1 370	703.33	723.33

ILLUSTRATION OF THE TEST CIRCUIT ASSEMBLED ON EVALUATION BOARD



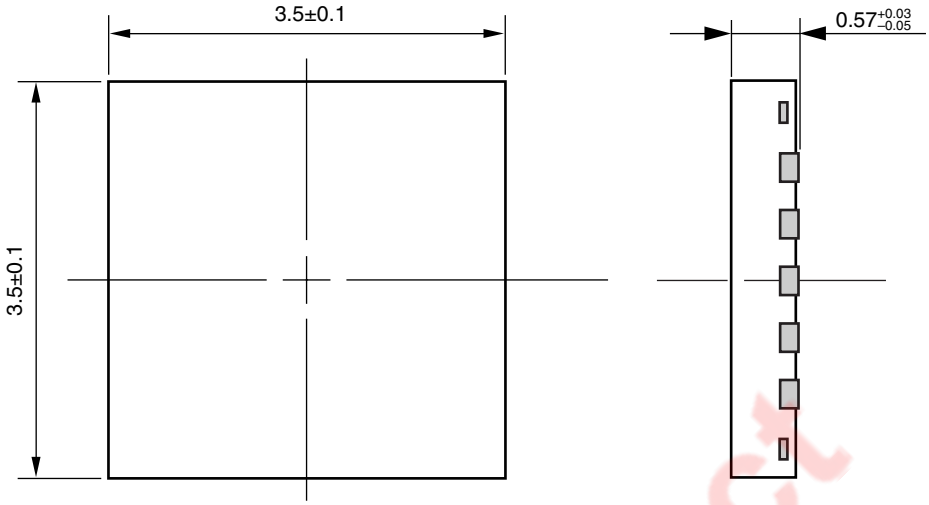
Note 1 000 pF V_{DD} decoupling capacitor to be placed near V_{DD} pin of the antenna switch to improve spurious emissions.

USING THE NEC EVALUATION BOARD

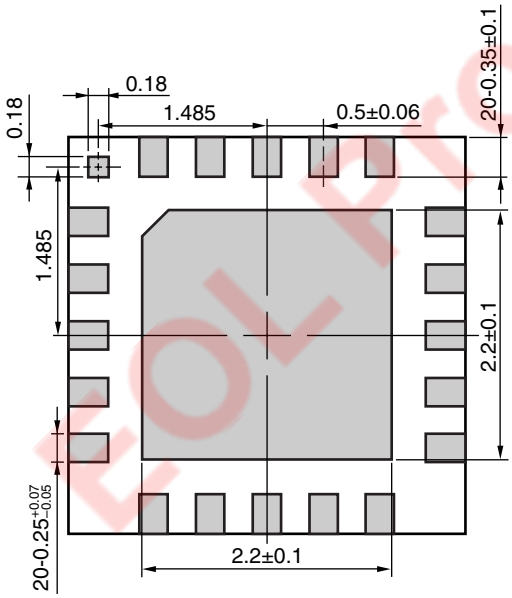
Symbol	Values
C1	22 pF
C2	12 pF
C3	1 000 pF
L1	15 nH

PACKAGE DIMENSIONS

20-PIN PLASTIC TQFN (UNIT: mm)



(Bottom View)



RECOMMENDED SOLDERING CONDITIONS

This product should be soldered and mounted under the following recommended conditions. For soldering methods and conditions other than those recommended below, contact your nearby sales office.

Soldering Method	Soldering Conditions		Condition Symbol
Infrared Reflow	Peak temperature (package surface temperature) Time at peak temperature Time at temperature of 220°C or higher Preheating time at 120 to 180°C Maximum number of reflow processes Maximum chlorine content of rosin flux (% mass)	: 260°C or below : 10 seconds or less : 60 seconds or less : 120±30 seconds : 3 times : 0.2%(Wt.) or below	IR260
Partial Heating	Peak temperature (terminal temperature) Soldering time (per side of device) Maximum chlorine content of rosin flux (% mass)	: 350°C or below : 3 seconds or less : 0.2%(Wt.) or below	HS350

Caution Do not use different soldering methods together (except for partial heating).

- **The information in this document is current as of April, 2009. The information is subject to change without notice. For actual design-in, refer to the latest publications of NEC Electronics data sheets or data books, etc., for the most up-to-date specifications of NEC Electronics products. Not all products and/or types are available in every country. Please check with an NEC Electronics sales representative for availability and additional information.**
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Caution GaAs Products	This product uses gallium arsenide (GaAs). GaAs vapor and powder are hazardous to human health if inhaled or ingested, so please observe the following points. • Follow related laws and ordinances when disposing of the product. If there are no applicable laws and/or ordinances, dispose of the product as recommended below. 1. Commission a disposal company able to (with a license to) collect, transport and dispose of materials that contain arsenic and other such industrial waste materials. 2. Exclude the product from general industrial waste and household garbage, and ensure that the product is controlled (as industrial waste subject to special control) up until final disposal. • Do not burn, destroy, cut, crush, or chemically dissolve the product. • Do not lick the product or in any way allow it to enter the mouth.