

### 3 V-BIAS, L-BAND SILICON DOWNCONVERTER IC FOR GPS RECEIVER AND WIRELESS COMMUNICATIONS

#### DESCRIPTION

$\mu$ PC2756T is a silicon monolithic integrated circuit designed as L-band downconverter. This L-band downconverter IC is suitable for GPS receiver and wireless communication systems. This IC consumes 6 mA from 3 V and is packaged in a 6 pin mini-mold. Thus, this IC contributes to make the system lower-consumption and physically-smaller.

The  $\mu$ PC2756T is manufactured using NEC's 20 GHz fr NESAT™ III silicon bipolar process. This process uses silicon nitride passivation film and gold electrodes. These materials can protect the chip surface from external pollution and prevent corrosion/migration. Thus, this product has excellent performance, uniformity and reliability.

#### FEATURES

- Wide band operation:  $f_{RF} = 0.1$  GHz to 2.0 GHz
- High-density surface mounting: 6 pin mini-mold
- Low Power-consumption: 3 V, 6 mA
- Suppressed spurious signals: double balanced mixer
- Equable output-impedance: single-end push-pull IF amplifier
- Equable temperature-drift oscillator: differential amplifier type oscillator

#### TYPICAL APPLICATIONS

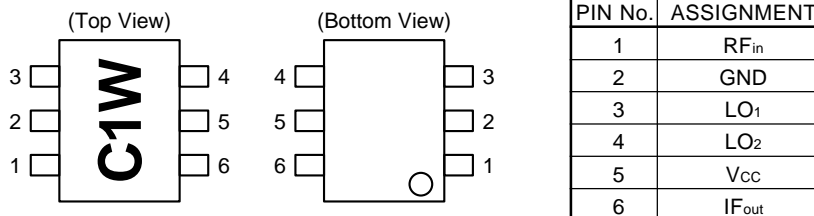
- GPS receiver
- Data carrier
- Wireless LAN

#### ORDERING INFORMATION

PART NUMBER	PACKAGE	SUPPLYING FORM	MARKING
$\mu$ PC2756T-E3	6 pin mini-mold	Embossed tape 8 mm wide. Pin 1, 2, 3 face to perforation side of the tape. QTY 3 kp/Reel.	C1W

\* To order evaluation samples, please contact local NEC sales office. (Order number:  $\mu$ PC2756T)

#### PIN CONNECTIONS



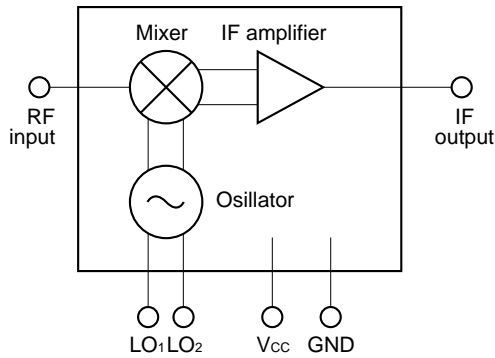
**Caution: Electro-static sensitive devices**

**SELECTOR GUIDE (T<sub>A</sub> = +25 °C, V<sub>CC</sub> = 3.0 V, Z<sub>L</sub> = Z<sub>s</sub> = 50  $\Omega$ )**

MAIN FEATURES		DEVICE NUMBER	V <sub>CC</sub> (V)	I <sub>CC</sub> (mA)	CG (dB)	NF (dB)	f <sub>RF</sub> (GHz)	P <sub>O(sat)</sub> (dBm)
DOWNCONVERTER BUILT-IN Tr for VCO	5 V-bias type	$\mu$ PC2721GR	4.5 to 5.5	38	21	9	0.9 to 2.0	7
	3 V-bias type	$\mu$ PC2756T	2.7 to 3.3	6	14	10	0.1 to 2.0	-8

\* Typical performance. Please refer to ELECTRICAL CHARACTERISTICS in detail.

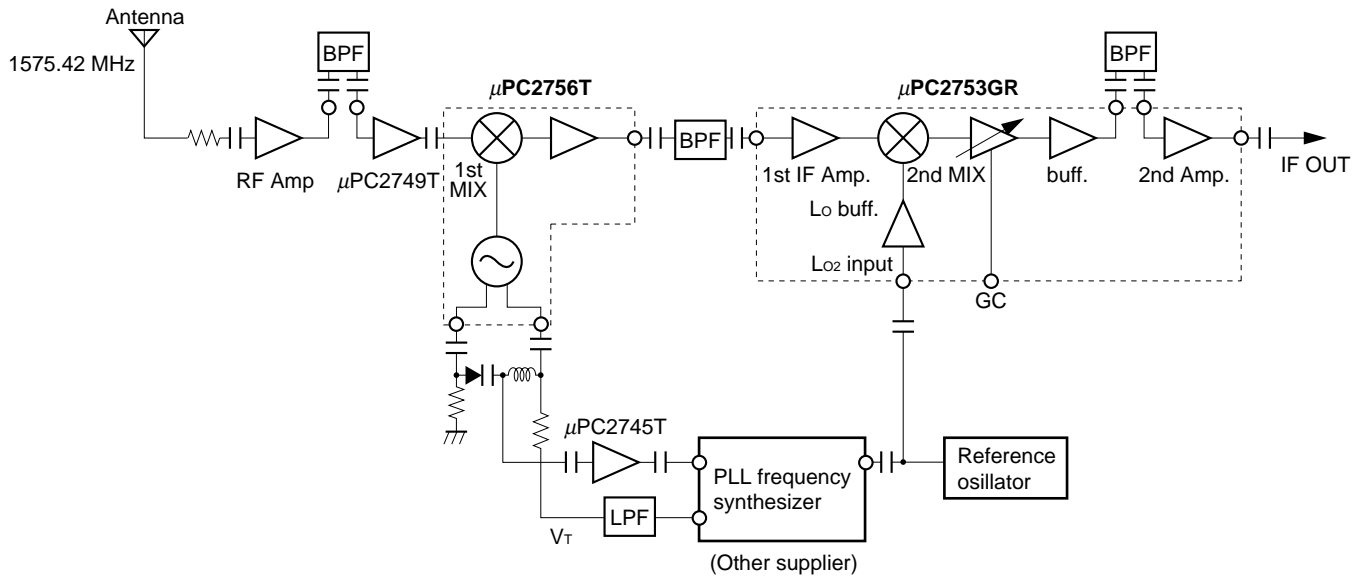
**INTERNAL BLOCK DIAGRAM**



**Note** Oscillator tank circuit must be externally attached to LO1 and LO2 pins.

**TYPICAL APPLICATION EXAMPLE**

— GPS receiver application —



**Note** This application example is intended to show only the product line-up schematically, not to present the application circuit in detail.

To know the detail in associated products, please refer to their latest data sheets.

**PIN EXPLANATION**

PIN NO.	SYMBOL	ASSIGNMENT	PIN VOLTAGE (V)	APPLIED VOLTAGE (V)	FUNCTION AND APPLICATION	EQUIVALENT CIRCUIT
1	RF <sub>in</sub>	RF input	–	1.2	<p>This pin is RF input for mixer designed as double balance type.</p> <p>This circuit contributes to suppress spurious signal with minimum LO and bias power consumption.</p> <p>Also this symmetrical circuit can keep specified performance insensitive to process-condition distribution.</p> <p>This pin must be externally coupled with capacitor for DC cut.</p>	
2	GND	Ground	0	–	<p>Must be connected to the system ground with minimum inductance. Ground pattern on the board should be formed as wide as possible.</p> <p>(Track length should be kept as short as possible.)</p>	
3	LO <sub>1</sub>	Local oscillator base collector	–	1.2	<p>These pins are both base-collector of oscillator. This oscillator is designed as differential amplifier type.</p> <p>3 pin and 4 pin should be externally equipped with tank resonator circuit in order to oscillate with feedback loop.</p> <p>Also this symmetrical circuit can keep specified performance insensitive to process-condition distribution.</p> <p>Each pin must be externally coupled with capacitor for DC cut.</p>	
4	LO <sub>2</sub>	Local oscillator base collector	–	1.2		
5	V <sub>cc</sub>	Power supply	2.7 to 3.3	–	<p>Supply voltage 3.0 ± 0.3 V for operation. Must be connected bypass capacitor (e.g. 1 000 pF) to minimize ground impedance.</p>	
6	IF out	IF output	–	1.7	<p>This pin is output from IF buffer amplifier designed as single-ended push-pull type.</p> <p>This pin is assigned for emitter follower output with Low-impedance.</p> <p>This pin must be externally coupled with capacitor for DC cut.</p>	

**ABSOLUTE MAXIMUM RATINGS**

PARAMETER	SYMBOL	RATING	UNIT	CONDITIONS
Supply voltage	V <sub>CC</sub>	5.5	V	T <sub>A</sub> = +25 °C
Power Dissipation	P <sub>D</sub>	280	mW	Mounted on 50 × 50 × 1.6 mm double copper clad epoxy glass board at T <sub>A</sub> = +85 °C
Operating temperature	T <sub>opt</sub>	-40 to +85	°C	
Storage temperature	T <sub>stg</sub>	-55 to +150	°C	

**RECOMMENDED OPERATING RANGE**

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply voltage	V <sub>CC</sub>	2.7	3.0	3.3	V
Operating temperature	T <sub>opt</sub>	-40	+25	+85	°C

**ELECTRICAL CHARACTERISTICS (T<sub>A</sub> = +25 °C, V<sub>CC</sub> = 3.0 V, Z<sub>L</sub> = Z<sub>s</sub> = 50 Ω, Test circuit)**

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT	CONDITIONS
Circuit Current	I <sub>CC</sub>	3.5	6.0	8.0	mA	No input signals
RF Frequency Response	f <sub>RF</sub>	0.1	-	2.0	GHz	CG ≥ (CG1 -3 dB) f <sub>IF</sub> = 150 MHz constant
IF Frequency Response	f <sub>IF</sub>	10	-	300	MHz	CG ≥ (CG1 -3 dB) f <sub>RF</sub> = 0.9 GHz constant
Conversion Gain 1	CG1	11	14	17	dB	f <sub>RF</sub> = 0.9 GHz, f <sub>IF</sub> = 150 MHz P <sub>RFIn</sub> = -40 dBm
Conversion Gain 2	CG2	11	14	17	dB	f <sub>RF</sub> = 1.6 GHz, f <sub>IF</sub> = 20 MHz P <sub>RFIn</sub> = -40 dBm
Single sideband Noise Figure 1	NF1	-	10	13	dB	f <sub>RF</sub> = 0.9 GHz, f <sub>IF</sub> = 150 MHz
Single sideband Noise Figure 2	NF2	-	13	16	dB	f <sub>RF</sub> = 1.6 GHz, f <sub>IF</sub> = 20 MHz
Maximum IF Output Level 1	P <sub>O(SAT)1</sub>	-11	-8	-	dBm	f <sub>RF</sub> = 0.9 GHz, f <sub>IF</sub> = 150 MHz P <sub>RFIn</sub> = -10 dBm
Maximum IF Output Level 2	P <sub>O(SAT)2</sub>	-15	-12	-	dBm	f <sub>RF</sub> = 1.6 GHz, f <sub>IF</sub> = 20 MHz P <sub>RFIn</sub> = -10 dBm

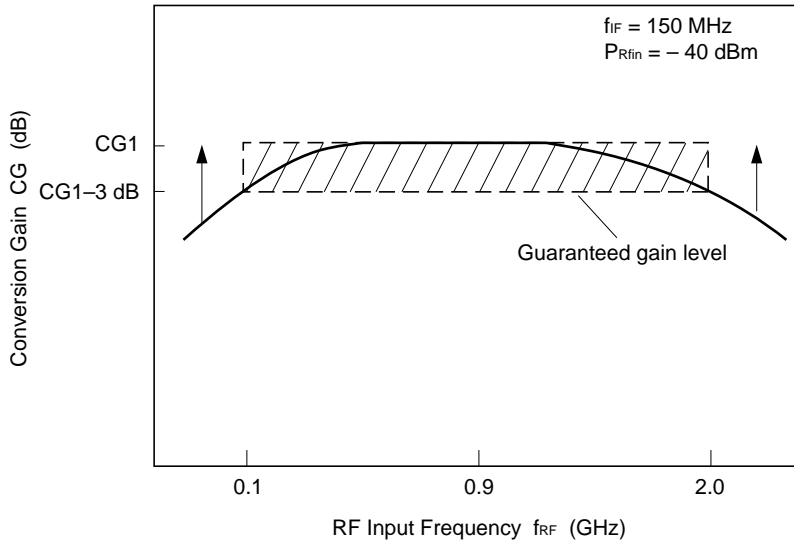
**STANDARD CHARACTERISTICS FOR REFERENCE (Unless otherwise specified; T<sub>A</sub> = +25 °C, V<sub>CC</sub> = 3.0 V, Z<sub>L</sub> = Z<sub>s</sub> = 50 Ω)**

PARAMETER	SYMBOL	REFERENCE	UNIT	CONDITIONS
Output 3rd order intercept point	OIP <sub>3</sub>	+4	dBm	f <sub>RF</sub> = 0.8 to 2.0 GHz, f <sub>IF</sub> = 0.1 GHz, Cross point IP.
Phase Noise	PN	-68	dBc/Hz	f <sub>OSC</sub> = 1.9 GHz*
LO leakage at RF pin	LO <sub>rf</sub>	-35	dB	f <sub>RF</sub> = 0.8 to 2.0 GHz
LO leakage at IF pin	LO <sub>if</sub>	-23	dB	f <sub>RF</sub> = 0.8 to 2.0 GHz
Maximum oscillating frequency	f <sub>OSCMAX</sub>	2.2	GHz	VaractorDi : 1SV210, L : 7 nH*

\* Application circuit example (refer to page 7)

**SCHEMATIC SUPPLEMENT FOR RF, IF SPECIFICATIONS**

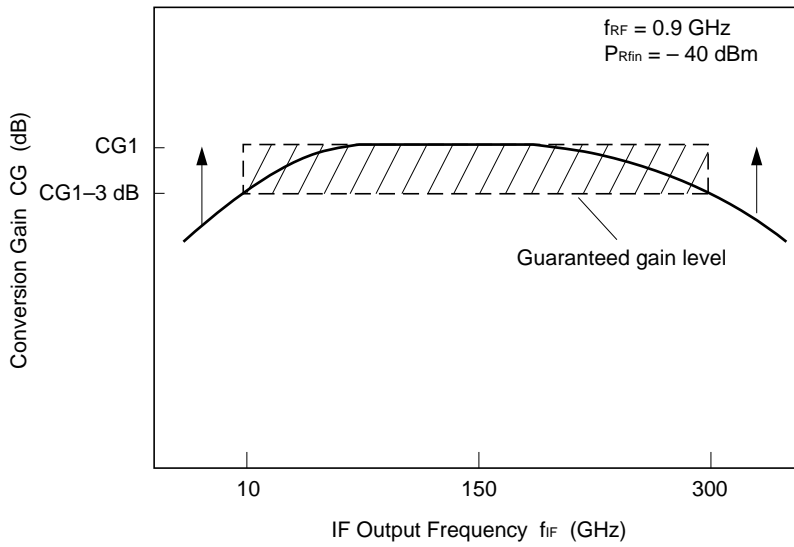
RF Frequency Response



**Note:**

	MIN.	TYP.	MAX.	UNIT
CG1	11	14	17	dB
CG1 - 3 dB	8	11	14	dB

IF Frequency Response



TEST CIRCUIT

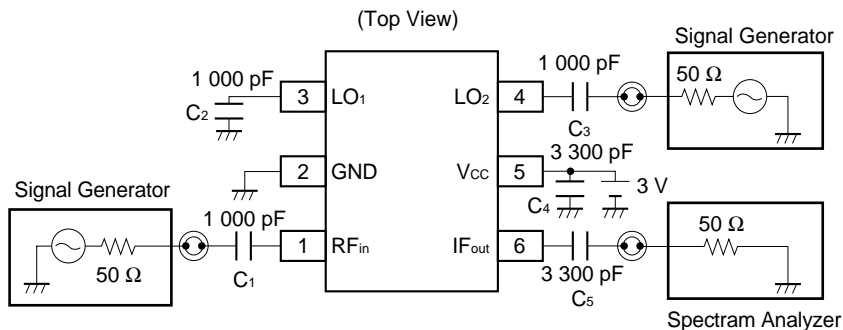
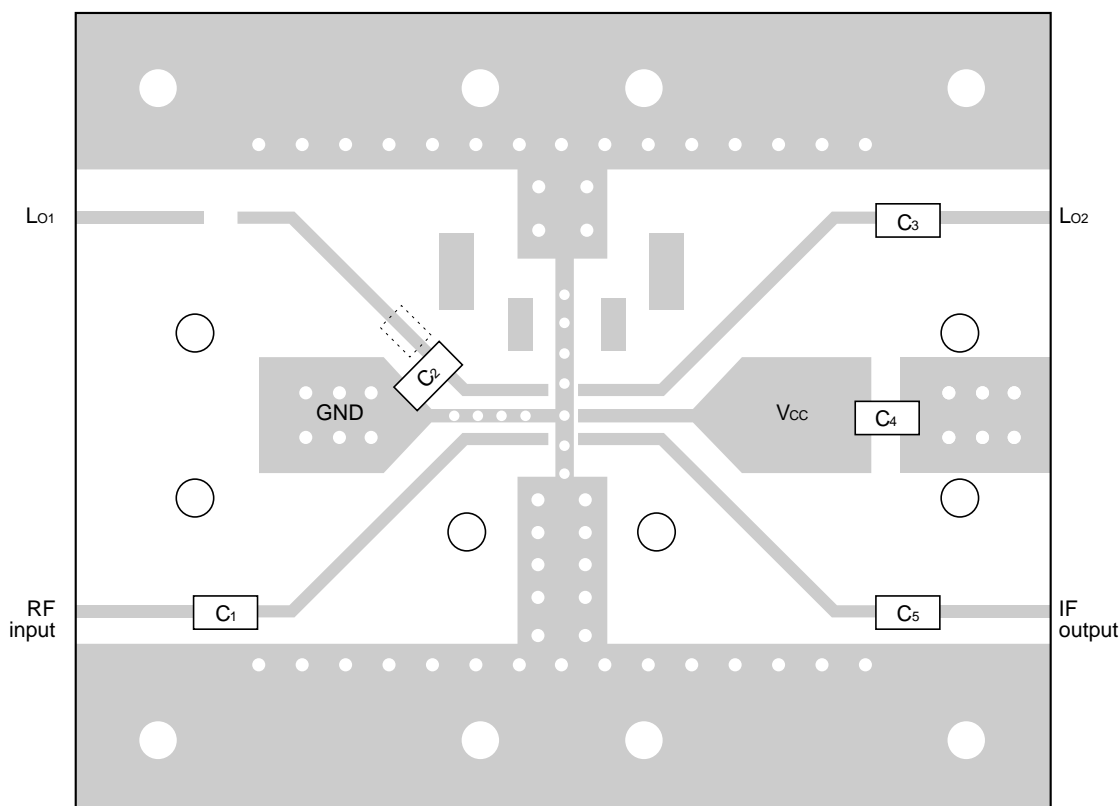


ILLUSTRATION OF THE TEST CIRCUIT ASSEMBLED ON EVALUATION BOARD



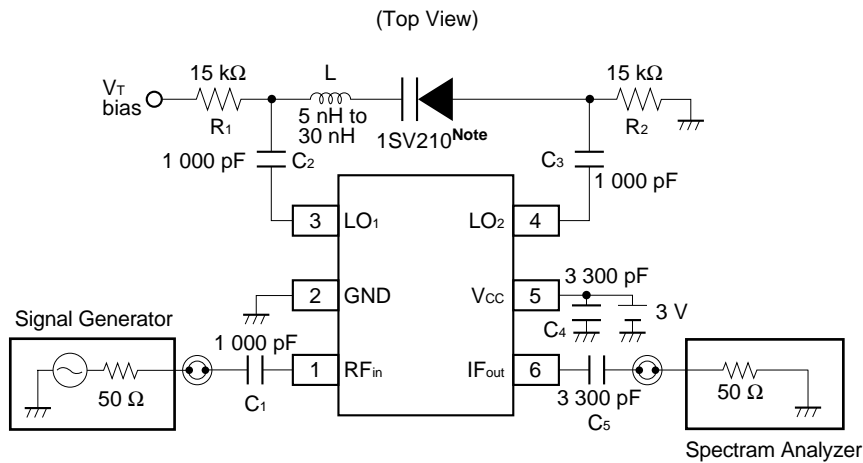
COMPONENT LIST

No.	Value
C1 to 3	1 000 pF
C4 to 5	3 300 pF

Note

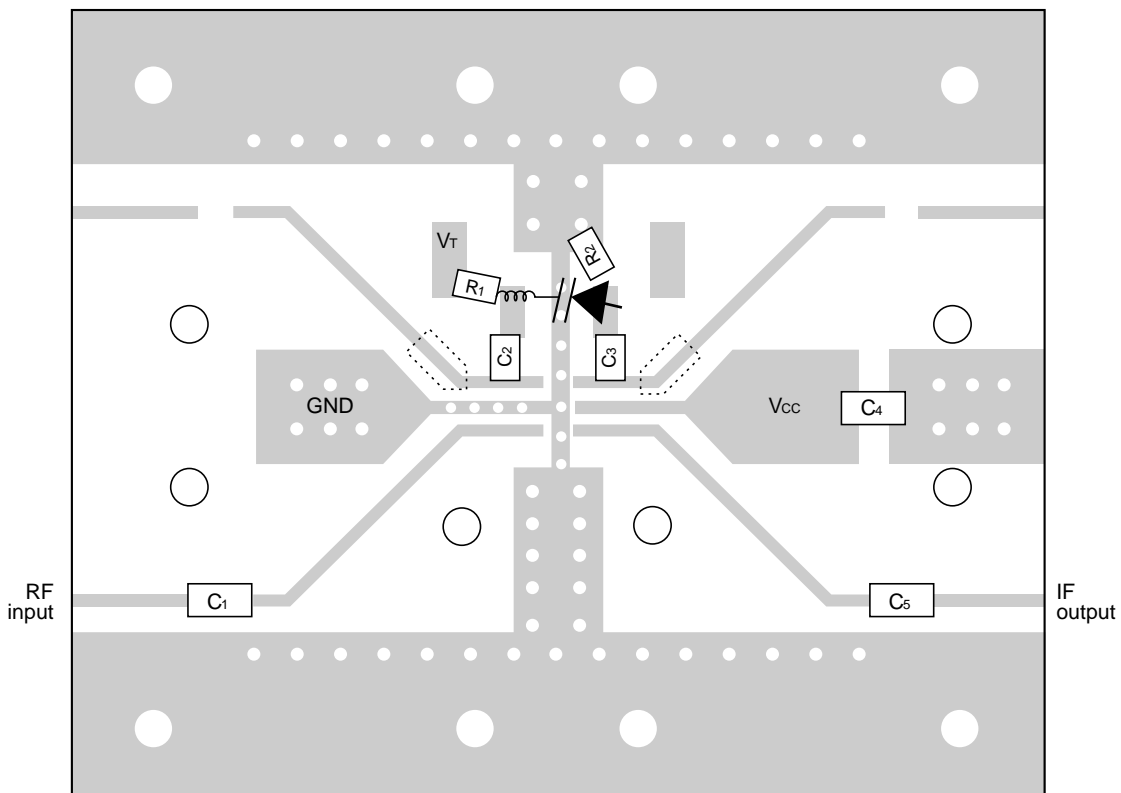
- (1) 35 × 42 × 0.4 mm double copper clad polyimide board.
- (2) Back side: GND pattern
- (3) Solder plated on pattern
- (4) ○ : Through holes
- (5) [dashed box] pattern should be removed on this testing.

APPLICATION CIRCUIT EXAMPLE



**Note** Our varactor diodes will be discontinued. For varactor diode, contact other supplier.

ILLUSTRATION OF THE APPLICATION CIRCUIT ASSEMBLED ON EVALUATION BOARD



COMPONENT LIST

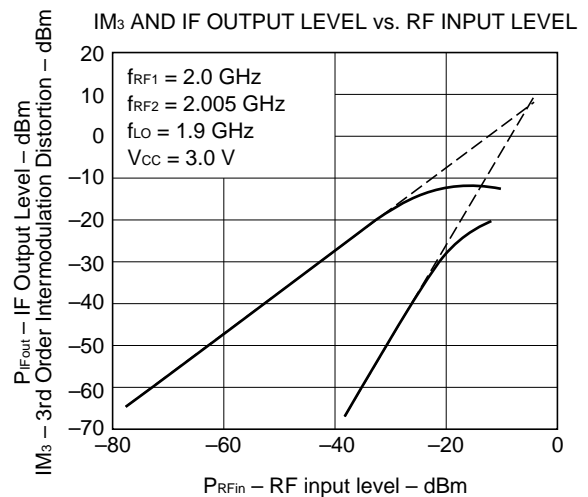
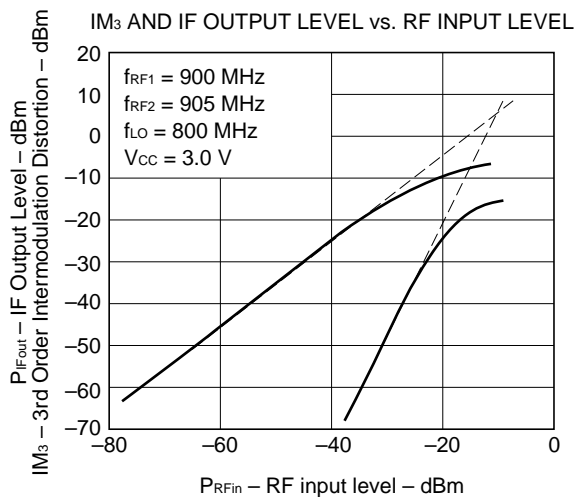
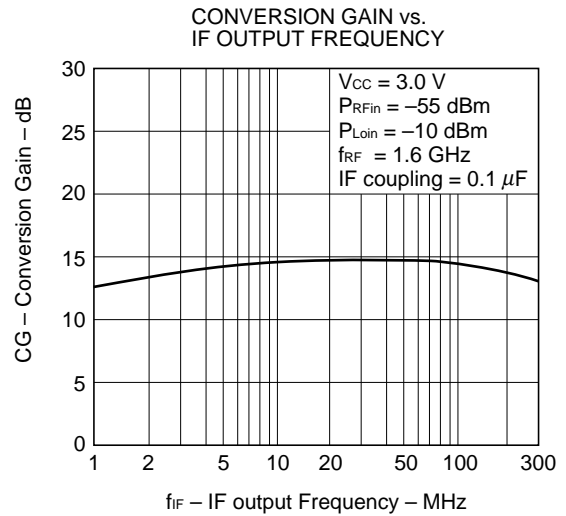
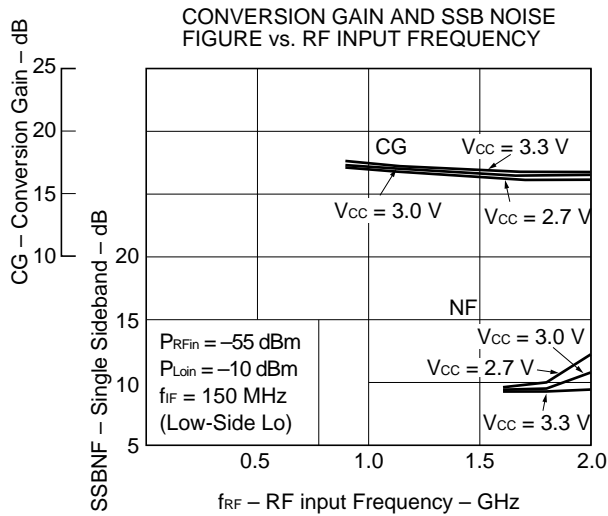
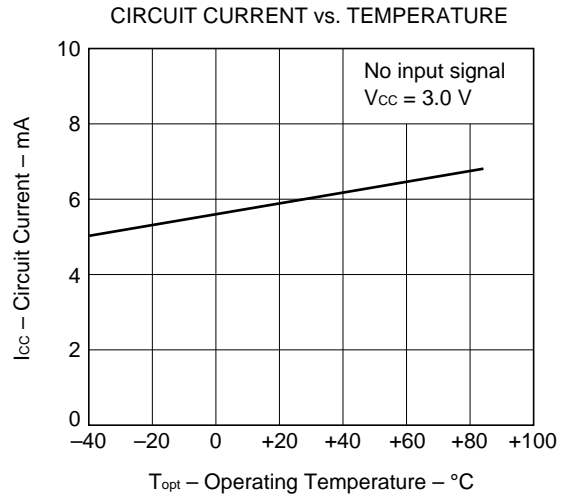
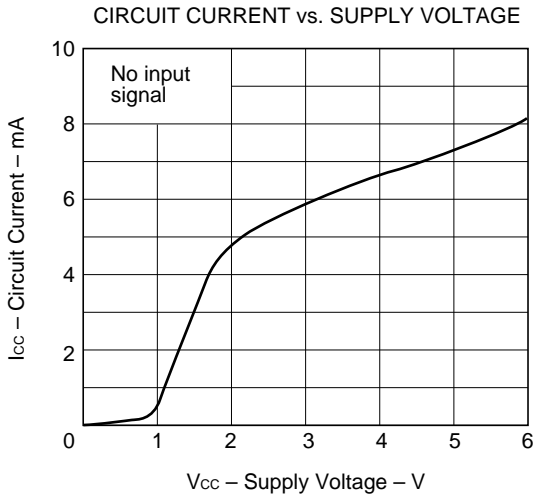
No.	Value
C <sub>1</sub> to 3	1 000 pF
C <sub>4</sub> to 5	3 300 pF
R <sub>1</sub> to 2	15 kΩ
L	5 nH to 30 nH
1SV210	—

**Note**

- (1) 35 × 42 × 0.4 mm double copper clad polyimide board.
- (2) Back side: GND pattern
- (3) Solder plated on pattern
- (4) ○ : Through holes
- (5) ⬢ pattern should be removed on this application.

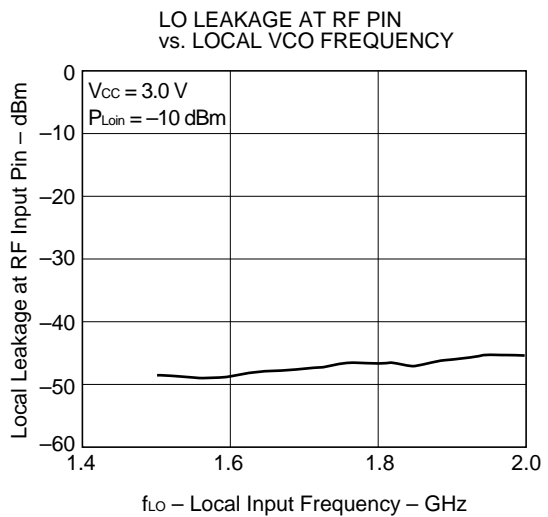
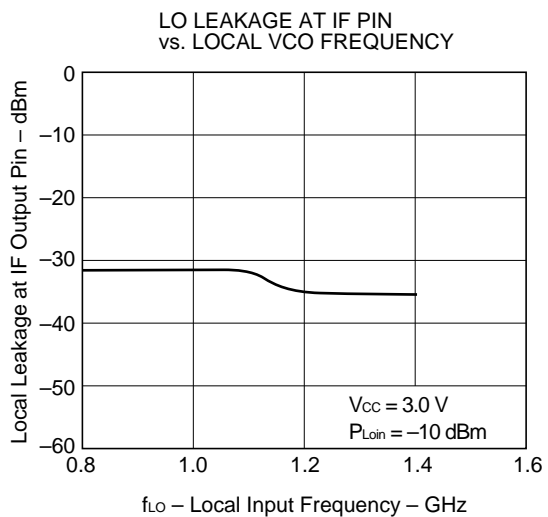
**TYPICAL CHARACTERISTICS (T<sub>A</sub> = +25 °C)**

– ON THE TEST CIRCUIT –



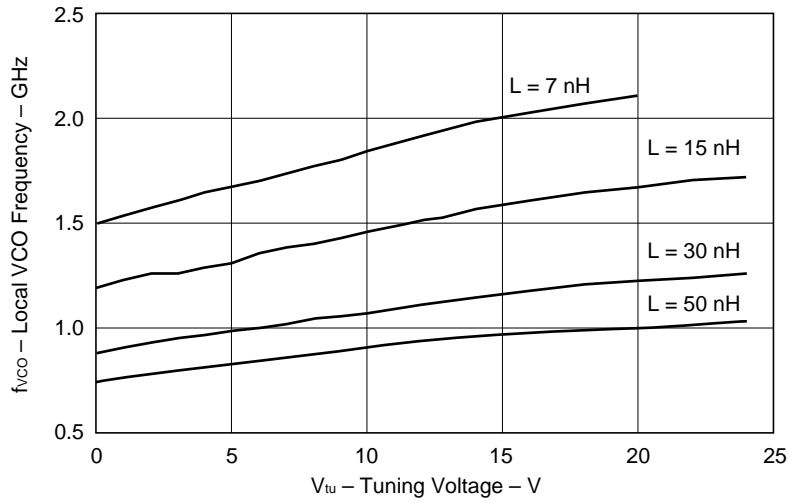


– ON THE TEST CIRCUIT –



– ON THE APPLICATION CIRCUIT –

VCO TUNING VOLTAGE vs. VCO FREQUENCY



VCO PHASE NOISE ( $f_{VCO} = 774.4258$  MHz center)

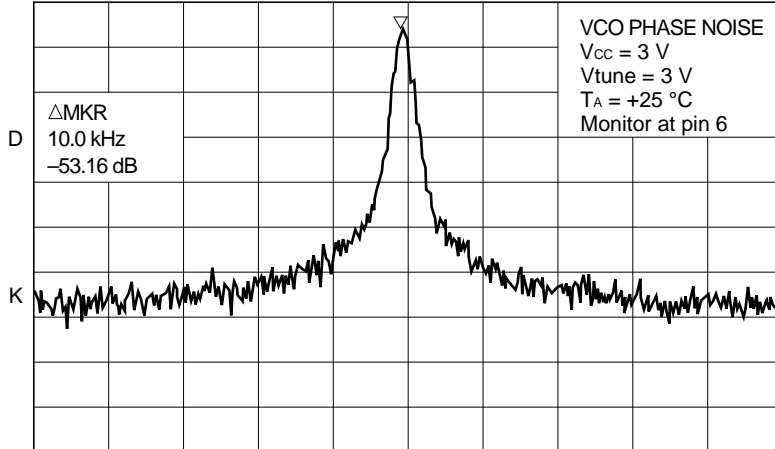
ATTEN 10 dB

RL -40.0 dBm

10 dB /

$\Delta$ MKR -53.16 dB

10.0 kHz



CENTER 774.4258 MHz

RBW 1.0 kHz ++ VBW 100 Hz

SPAN 100.0 kHz

SWP 3.0 s

VCO PHASE NOISE ( $f_{VCO} = 1.6391942$  GHz center)

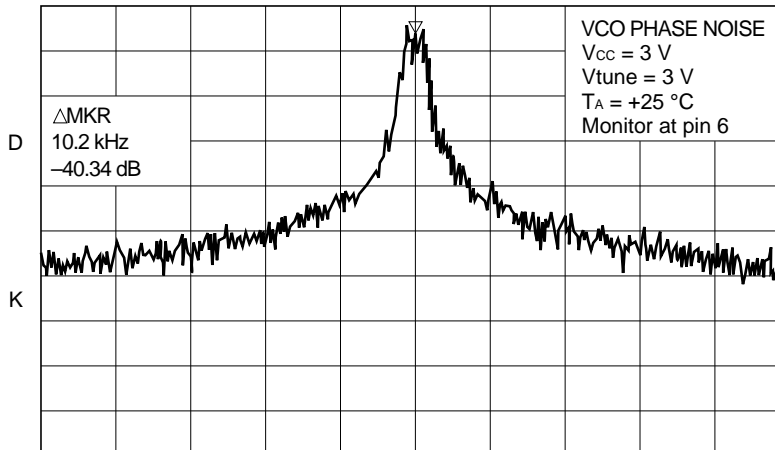
ATTEN 10 dB

RL -40.0 dBm

10 dB /

$\Delta$ MKR -40.34 dB

10.2 kHz



CENTER 1.6391942 GHz

RBW 1.0 kHz ++ VBW 100 Hz

SPAN 100.0 kHz

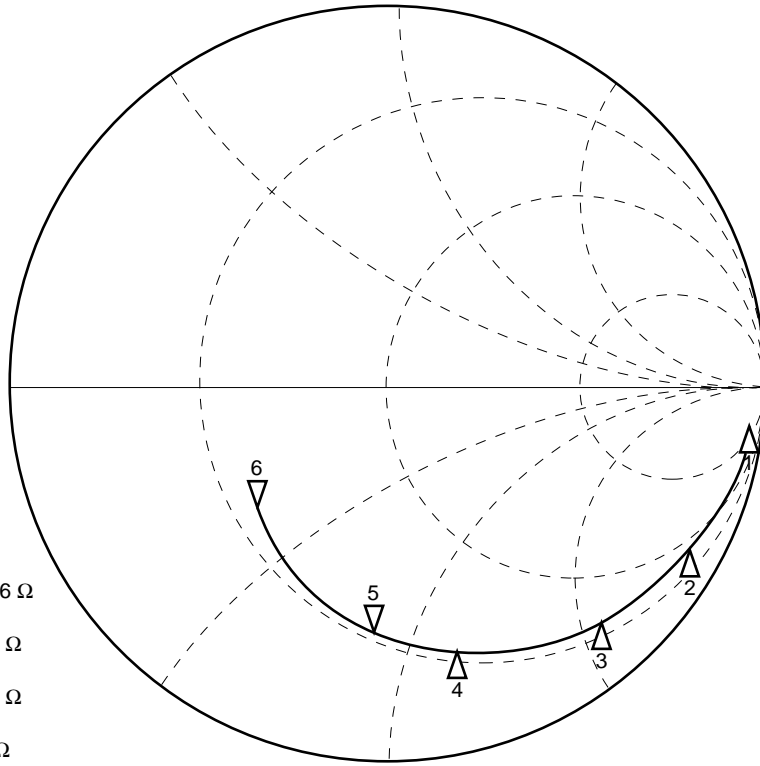
SWP 3.0 s

S PARAMETER – μPC2756T – ON THE PIN OF D.U.T. –

RF port  
V<sub>cc</sub> = 3.0 V

- △ 1 : 100 MHz 330.7 Ω - j 861.6 Ω
- △ 2 : 500 MHz 38.8 Ω - j 194.3 Ω
- △ 3 : 900 MHz 25.5 Ω - j 107.6 Ω
- △ 4 : 1500 MHz 20.5 Ω - j 60.7 Ω
- △ 5 : 1900 MHz 17.9 Ω - j 44.2 Ω
- △ 6 : 3000 MHz 19.5 Ω - j 16.3 Ω

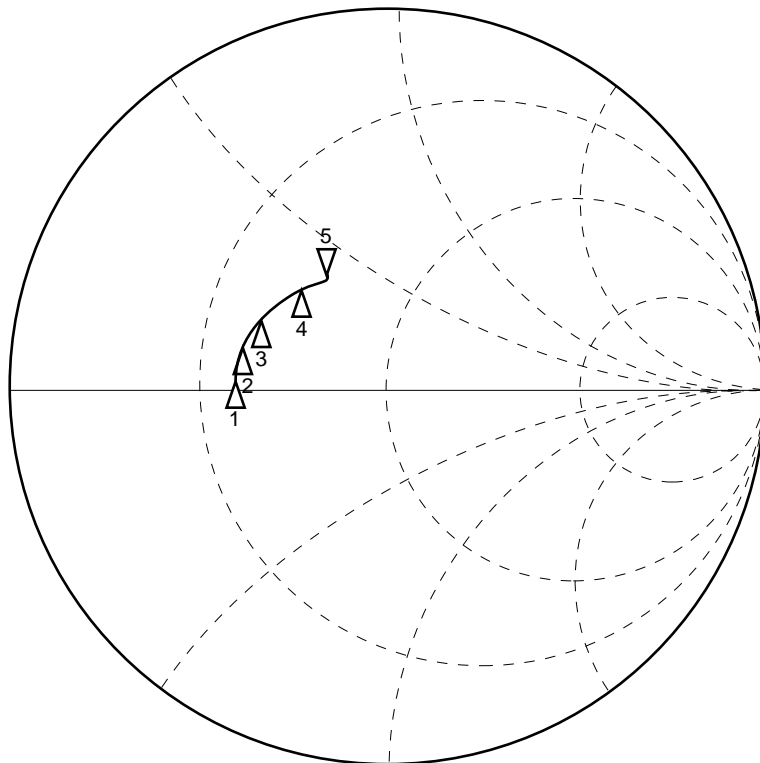
START 0.100000000 GHz  
STOP 3.000000000 GHz



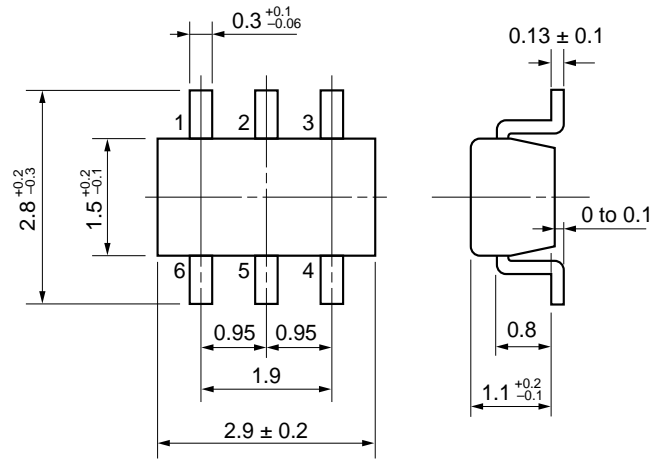
IF port  
V<sub>cc</sub> = 3.0 V

- △ 1 : 50 MHz 21.4 Ω + j 2.4 Ω
- △ 2 : 80 MHz 21.8 Ω + j 5.5 Ω
- △ 3 : 130 MHz 23.1 Ω + j 9.4 Ω
- △ 4 : 240 MHz 27.4 Ω + j 16.3 Ω
- △ 5 : 300 MHz 30.6 Ω + j 19.1 Ω

START 0.050000000 GHz  
STOP 0.300000000 GHz



6 PIN MINI MOLD PACKAGE DIMENSIONS (Unit: mm)



**NOTE ON CORRECT USE**

- (1) Observe precautions for handling because of electro-static sensitive devices.
- (2) Form a ground pattern as wide as possible to minimize ground impedance (to prevent abnormal oscillation).
- (3) Keep the track length of the ground pins as short as possible.
- (4) Connect a bypass capacitor (e.g. 1 000 pF) to the V<sub>CC</sub> pin.
- (5) To construct oscillator, tank circuit must be externally attached to pin 3 and 4.

**RECOMMENDED SOLDERING CONDITIONS**

This product should be soldered in the following recommended conditions. Other soldering methods and conditions than the recommended conditions are to be consulted with our sales representatives.

μPC2756T

Soldering method	Soldering conditions	Recommended condition symbol
Infrared ray reflow	Package peak temperature: 235 °C, Hour: within 30 s. (more than 210 °C), Time: 2 time, Limited days: no.*	IR35-00-2
VPS	Package peak temperature: 215 °C, Hour: within 40 s. (more than 200 °C), Time: 2 time, Limited days: no.*	VP15-00-2
Wave soldering	Soldering tub temperature: less than 260 °C, Hour: within 10 s. Time: 1 time, Limited days: no.	WS60-00-1
Pin part heating	Pin area temperature: less than 300 °C, Hour: within 3 s/pin. Limited days: no.*	

\*: It is the storage days after opening a dry pack, the storage conditions are 25 °C, less than 65 % RH.

**Note 1.** The combined use of soldering method is to be avoided (However, except the pin area heating method).

For details of recommended soldering conditions for surface mounting, refer to information document SEMICONDUCTOR DEVICE MOUNTING TECHNOLOGY MANUAL (IEI-1207).

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NEC devices are classified into the following three quality grades:

“Standard”, “Special”, and “Specific”. The Specific quality grade applies only to devices developed based on a customer designated “quality assurance program” for a specific application. The recommended applications of a device depend on its quality grade, as indicated below. Customers must check the quality grade of each device before using it in a particular application.

Standard: Computers, office equipment, communications equipment, test and measurement equipment, audio and visual equipment, home electronic appliances, machine tools, personal electronic equipment and industrial robots

Special: Transportation equipment (automobiles, trains, ships, etc.), traffic control systems, anti-disaster systems, anti-crime systems, safety equipment and medical equipment (not specifically designed for life support)

Specific: Aircrafts, aerospace equipment, submersible repeaters, nuclear reactor control systems, life support systems or medical equipment for life support, etc.

The quality grade of NEC devices in “Standard” unless otherwise specified in NEC's Data Sheets or Data Books. If customers intend to use NEC devices for applications other than those specified for Standard quality grade, they should contact NEC Sales Representative in advance.

Anti-radioactive design is not implemented in this product.