



# BIPOLAR ANALOG INTEGRATED CIRCUIT

## $\mu$ PC2745TB, $\mu$ PC2746TB

### 3 V, SUPER MINIMOLD SILICON MMIC WIDEBAND AMPLIFIER FOR MOBILE COMMUNICATIONS

#### DESCRIPTION

The  $\mu$ PC2745TB and  $\mu$ PC2746TB are silicon monolithic integrated circuits designed as buffer amplifier for mobile communications. These low current amplifiers operate on 3.0 V (1.8 V MIN.).

These ICs are manufactured using our 20 GHz fr NESATIII silicon bipolar process. This process uses silicon nitride passivation film and gold electrodes. These materials can protect chip surface from external pollution and prevent corrosion/migration. Thus, these IC have excellent performance, uniformity and reliability.

#### FEATURES

- Supply voltage : Recommended  $V_{CC} = 2.7$  to 3.3 V  
Circuit operation  $V_{CC} = 1.8$  to 3.3 V
- Upper limit operating frequency :  $\mu$ PC2745TB;  $f_u = 2.7$  GHz TYP. @3 dB bandwidth  
 $\mu$ PC2746TB;  $f_u = 1.5$  GHz TYP. @3 dB bandwidth
- High isolation :  $\mu$ PC2745TB; ISL = 38 dB TYP. @f = 500 MHz  
 $\mu$ PC2746TB; ISL = 45 dB TYP. @f = 500 MHz
- Power gain :  $\mu$ PC2745TB;  $G_P = 12$  dB TYP. @f = 500 MHz  
 $\mu$ PC2746TB;  $G_P = 19$  dB TYP. @f = 500 MHz
- Saturated output power :  $\mu$ PC2745TB;  $P_{O(sat)} = -1$  dBm TYP. @f = 500 MHz  
 $\mu$ PC2746TB;  $P_{O(sat)} = 0$  dBm TYP. @f = 500 MHz
- High-density surface mounting : 6-pin super minimold package (2.0 × 1.25 × 0.9 mm)

#### APPLICATIONS

- 1.5 GHz to 2.5 GHz communication system :  $\mu$ PC2745TB
- 800 MHz to 900 MHz communication system :  $\mu$ PC2746TB

#### ORDERING INFORMATION

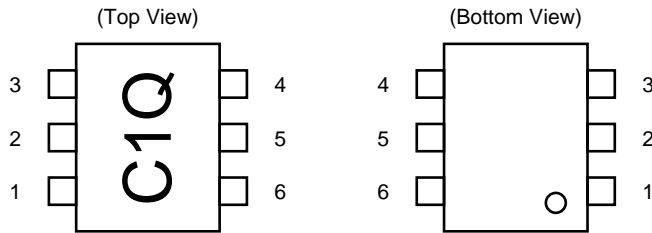
Part Number	Package	Marking	Supplying Form
$\mu$ PC2745TB-E3-A	6-pin super minimold	C1Q	• Embossed tape 8 mm wide • 1, 2, 3 pins face the perforation side of the tape • Qty 3 kpcs/reel
$\mu$ PC2746TB-E3-A		C1R	

**Remark** To order evaluation samples, contact your nearby sales office.  
Part number for sample order:  $\mu$ PC2745TB-A,  $\mu$ PC2746TB-A

**Caution** Observe precautions when handling because these devices are sensitive to electrostatic discharge.

The information in this document is subject to change without notice. Before using this document, please confirm that this is the latest version.

**PIN CONNECTION**



Marking is an example of  $\mu$ PC2745TB

Pin No.	Pin Name
1	INPUT
2	GND
3	GND
4	OUTPUT
5	GND
6	V <sub>CC</sub>

**PRODUCT LINE-UP (T<sub>A</sub> = +25°C, V<sub>CC</sub> = 3.0 V, Z<sub>s</sub> = Z<sub>L</sub> = 50 Ω)**

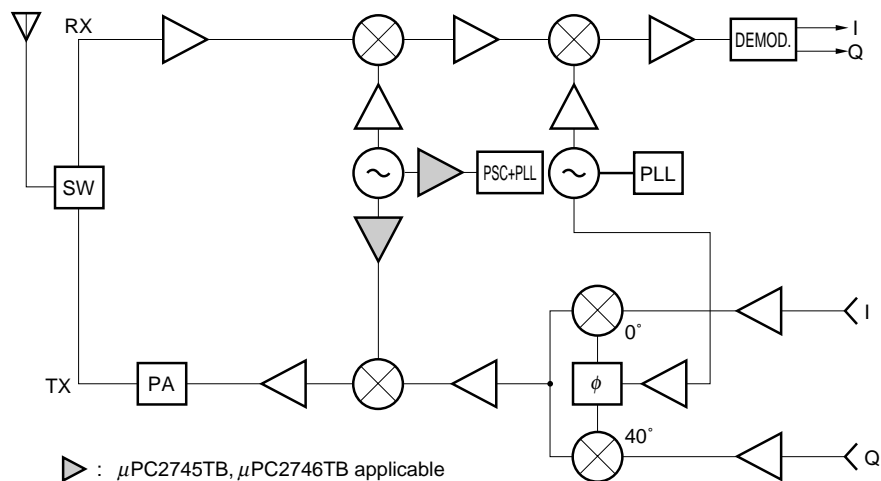
Part No.	f <sub>u</sub> (GHz)	P <sub>O(sat)</sub> (dBm)	G <sub>p</sub> (dB)	NF (dB)	I <sub>CC</sub> (mA)	Package	Making
$\mu$ PC2745T	2.7	-1.0	12	6.0	7.5	6-pin minimold	C1Q
$\mu$ PC2745TB						6-pin super minimold	
$\mu$ PC2746T	1.5	0	19	4.0	7.5	6-pin minimold	C1R
$\mu$ PC2746TB						6-pin super minimold	
$\mu$ PC2747T	1.8	-7.0	12	3.3	5.0	6-pin minimold	C1S
$\mu$ PC2747TB						6-pin super minimold	
$\mu$ PC2748T	0.2 to 1.5	-3.5	19	2.8	6.0	6-pin minimold	C1T
$\mu$ PC2748TB						6-pin super minimold	
$\mu$ PC2749T	2.9	-6.0	16	4.0	6.0	6-pin minimold	C1U
$\mu$ PC2749TB						6-pin super minimold	

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

**Caution** The package size distinguish between minimold and super minimold.

**SYSTEM APPLICATION EXAMPLE**

**DIGITAL CELLULAR SYSTEM BLOCK DIAGRAM**



**PIN EXPLANATION**

Pin No.	Pin Name	Applied Voltage (V)	Pin Voltage (V) <small>Note</small>	Function and Applications	Internal Equivalent Circuit
1	INPUT	—	0.87 ----- 0.82	Signal input pin. A internal matching circuit, configured with resistors, enables 50 $\Omega$ connection over a wide band. this pin must be coupled to signal source with capacitor for DC cut.	
2 3 5	GND	0	—	Ground pin. This pin should be connected to system ground with minimum inductance. Ground pattern on the board should be formed as wide as possible. All the ground pins must be connected together with wide ground pattern to decrease impedance difference.	
4	OUTPUT	—	1.95 ----- 2.54	Signal output pin. A internal matching circuit, configured with resistors, enables 50 $\Omega$ connection over a wide band. This pin must be coupled to next stage with capacitor for DC cut.	
6	V <sub>CC</sub>	2.7 to 3.3	—	Power supply pin. This pin should be externally equipped with bypass capacity to minimize ground impedance.	

**Note** Pin voltage is measured at V<sub>CC</sub> = 3.0 V. Above:  $\mu$ PC2745TB, Below:  $\mu$ PC2746TB

**ABSOLUTE MAXIMUM RATINGS**

Parameter	Symbol	Conditions	Ratings	Unit
Supply Voltage	V <sub>CC</sub>	T <sub>A</sub> = +25°C	4.0	V
Circuit Current	I <sub>CC</sub>	T <sub>A</sub> = +25°C	16	mA
Power Dissipation	P <sub>D</sub>	T <sub>A</sub> = +85°C <b>Note</b>	270	mW
Operating Ambient Temperature	T <sub>A</sub>		-40 to +85	°C
Storage Temperature	T <sub>stg</sub>		-55 to +150	°C
Input Power	P <sub>in</sub>	T <sub>A</sub> = +25°C	0	dBm

**Note** Mounted on double-sided copper-clad 50 × 50 × 1.6 mm epoxy glass PWB

**RECOMMENDED OPERATING RANGE**

Parameter	Symbol	MIN.	TYP.	MAX.	Unit
Supply Voltage	V <sub>CC</sub>	2.7	3.0	3.3	V

**ELECTRICAL CHARACTERISTICS**

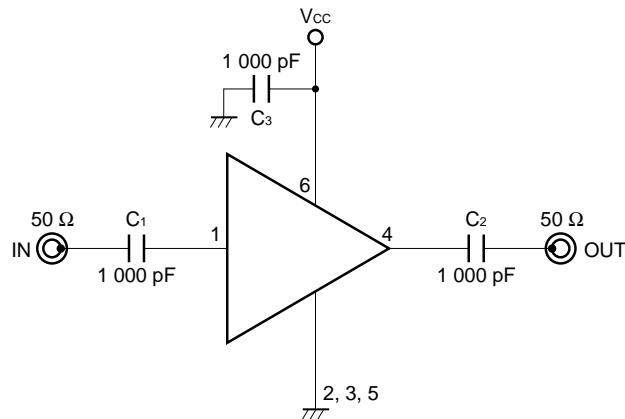
(T<sub>A</sub> = +25°C, V<sub>CC</sub> = 3.0 V, Z<sub>s</sub> = Z<sub>L</sub> = 50 Ω, unless otherwise specified)

Parameter	Symbol	Test Conditions	$\mu$ PC2745TB			$\mu$ PC2746TB			Unit
			MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Circuit Current	I <sub>CC</sub>	No signal	5.0	7.5	10.0	5.0	7.5	10.0	mA
Power Gain	G <sub>P</sub>	f = 500 MHz	9	12	14	16	19	21	dB
Noise Figure	NF	f = 500 MHz	—	6.0	7.5	—	4.0	5.5	dB
Upper Limit Operating Frequency	f <sub>u</sub>	3 dB down below from gain at f = 0.1 GHz	2.3	2.7	—	1.1	1.5	—	GHz
Isolation	ISL	f = 500 MHz	33	38	—	40	45	—	dB
Input Return Loss	RL <sub>in</sub>	f = 500 MHz	8	11	—	10	13	—	dB
Output Return Loss	RL <sub>out</sub>	f = 500 MHz	2.5	5.5	—	5.5	8.5	—	dB
Saturated Output Power	P <sub>O(sat)</sub>	f = 500 MHz, P <sub>in</sub> = -6 dBm	-4.0	-1.0	—	-3.0	0	—	dBm

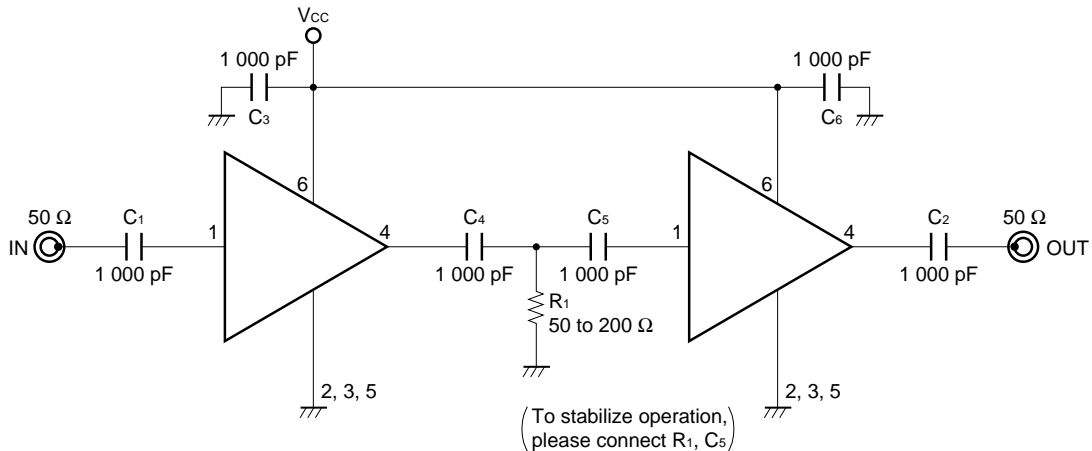
STANDARD CHARACTERISTICS FOR REFERENCE ( $T_A = +25^\circ\text{C}$ ,  $V_{CC} = 3.0\text{ V}$ ,  $Z_s = Z_L = 50\ \Omega$ )

Parameter	Symbol	Test Conditions	Reference Value		Unit
			$\mu$ PC2745TB	$\mu$ PC2746TB	
Circuit Current	$I_{CC}$	$V_{CC} = 1.8\text{ V}$ , No signal	4.5	4.5	mA
Power Gain	$G_P$	$V_{CC} = 3.0\text{ V}$ , $f = 1.0\text{ GHz}$	12.0	18.5	dB
		$V_{CC} = 3.0\text{ V}$ , $f = 2.0\text{ GHz}$	11.0	—	
		$V_{CC} = 1.8\text{ V}$ , $f = 0.5\text{ GHz}$	7.0	14.0	
Noise Figure	NF	$V_{CC} = 3.0\text{ V}$ , $f = 1.0\text{ GHz}$	5.5	4.2	dB
		$V_{CC} = 3.0\text{ V}$ , $f = 2.0\text{ GHz}$	5.7	—	
		$V_{CC} = 1.8\text{ V}$ , $f = 0.5\text{ GHz}$	8.0	5.0	
Upper Limit Operating Frequency	$f_u$	$V_{CC} = 1.8\text{ V}$ , 3 dB down below from gain at $f = 0.1\text{ GHz}$	1.8	1.1	GHz
Isolation	ISL	$V_{CC} = 3.0\text{ V}$ , $f = 1.0\text{ GHz}$	33	38	dB
		$V_{CC} = 3.0\text{ V}$ , $f = 2.0\text{ GHz}$	30	—	
		$V_{CC} = 1.8\text{ V}$ , $f = 0.5\text{ GHz}$	35	37	
Input Return Loss	$RL_{in}$	$V_{CC} = 3.0\text{ V}$ , $f = 1.0\text{ GHz}$	13.0	10.0	dB
		$V_{CC} = 3.0\text{ V}$ , $f = 2.0\text{ GHz}$	14.0	—	
		$V_{CC} = 1.8\text{ V}$ , $f = 0.5\text{ GHz}$	6.5	10.0	
Output Return Loss	$RL_{out}$	$V_{CC} = 3.0\text{ V}$ , $f = 1.0\text{ GHz}$	6.5	8.5	dB
		$V_{CC} = 3.0\text{ V}$ , $f = 2.0\text{ GHz}$	8.5	—	
		$V_{CC} = 1.8\text{ V}$ , $f = 0.5\text{ GHz}$	6.0	9.5	
Saturated Output Power	$P_{O(sat)}$	$V_{CC} = 3.0\text{ V}$ , $f = 1.0\text{ GHz}$ , $P_{in} = -6\text{ dBm}$	-2.5	-1.0	dBm
		$V_{CC} = 3.0\text{ V}$ , $f = 2.0\text{ GHz}$ , $P_{in} = -6\text{ dBm}$	-3.5	—	
		$V_{CC} = 1.8\text{ V}$ , $f = 0.5\text{ GHz}$ , $P_{in} = -10\text{ dBm}$	-11.0	-8.0	
★ 3rd Order Intermodulation Distortion	$IM_3$	$V_{CC} = 3.0\text{ V}$ , $P_{out} = -10\text{ dBm}$ , $f_1 = 500\text{ MHz}$ , $f_2 = 502\text{ MHz}$	-30.0	-26.0	dBc
		$V_{CC} = 1.8\text{ V}$ , $P_{out} = -20\text{ dBm}$ , $f_1 = 500\text{ MHz}$ , $f_2 = 502\text{ MHz}$	-31.0	-37.0	
		$V_{CC} = 3.0\text{ V}$ , $P_{out} = -10\text{ dBm}$ , $f_1 = 1\ 000\text{ MHz}$ , $f_2 = 1\ 002\text{ MHz}$	-26.0	—	

**TEST CIRCUIT**



**EXAMPLE OF APPLICATION CIRCUIT**



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

**CAPACITORS FOR THE V<sub>CC</sub>, INPUT, AND OUTPUT PINS**

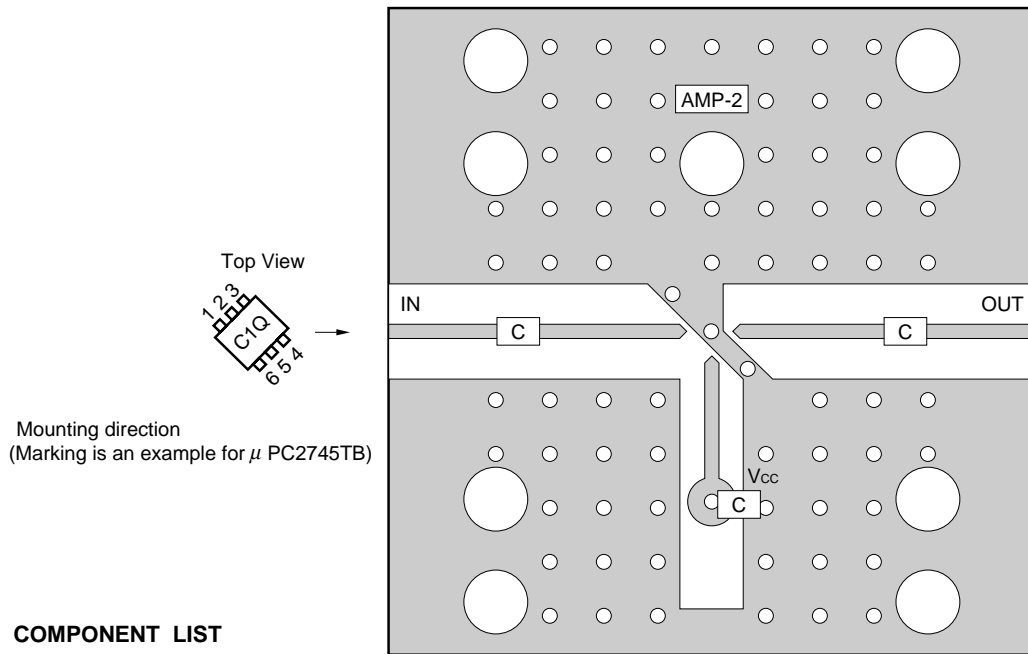
Capacitors of 1 000 pF are recommendable as the bypass capacitor for the V<sub>CC</sub> pin and the coupling capacitors for the input and output pins.

The bypass capacitor connected to the V<sub>CC</sub> pin is used to minimize ground impedance of V<sub>CC</sub> pin. So, stable bias can be supplied against V<sub>CC</sub> fluctuation.

The coupling capacitors, connected to the input and output pins, are used to cut the DC and minimize RF serial impedance. Their capacitance are therefore selected as lower impedance against a 50 Ω load. The capacitors thus perform as high pass filters, suppressing low frequencies to DC.

To obtain a flat gain from 100 MHz upwards, 1 000 pF capacitors are used in the test circuit. In the case of under 10 MHz operation, increase the value of coupling capacitor such as 10 000 pF. Because the coupling capacitors are determined by equation,  $f_c = 1/(2\pi RC)$ .

ILLUSTRATION OF THE TEST CIRCUIT ASSEMBLED ON EVALUATION BOARD



Mounting direction  
(Marking is an example for  $\mu$  PC2745TB)

COMPONENT LIST

	Value
C	1 000 pF

Notes

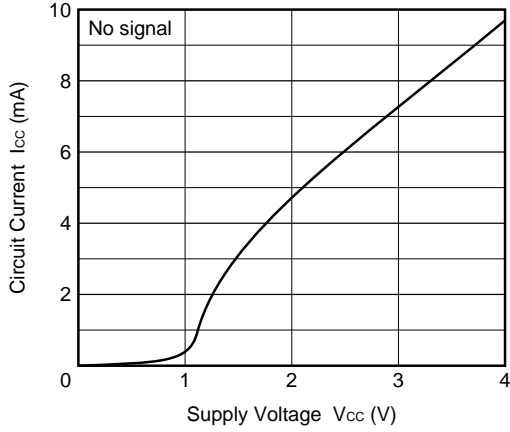
1. 30 × 30 × 0.4 mm double sided copper clad polyimide board.
2. Back side: GND pattern
3. Solder plated on pattern
4.  $\oplus \oplus \oplus$ : Through holes

For more information on the use of this IC, refer to the following application note: **USAGE AND APPLICATIONS OF 6-PIN MINI-MOLD, 6-PIN SUPER MINI-MOLD SILICON HIGH-FREQUENCY WIDEBAND AMPLIFIER MMIC (P11976E).**

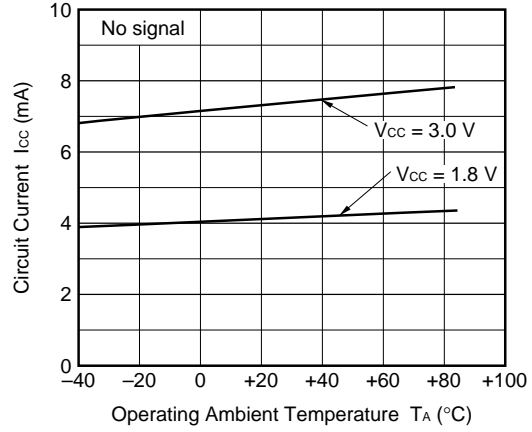
**TYPICAL CHARACTERISTICS ( $T_A = +25^\circ\text{C}$ , unless otherwise specified)**

—  $\mu$ PC2745TB —

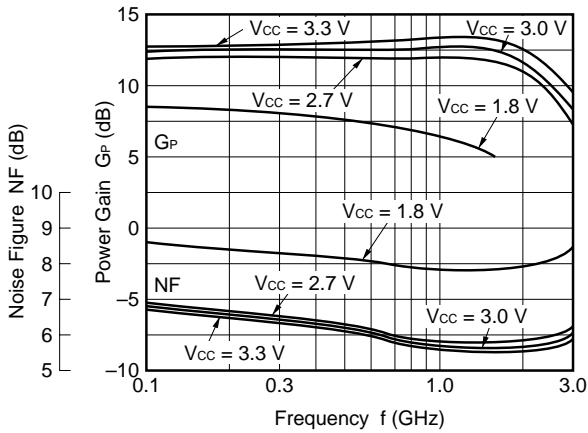
**CIRCUIT CURRENT vs. SUPPLY VOLTAGE**



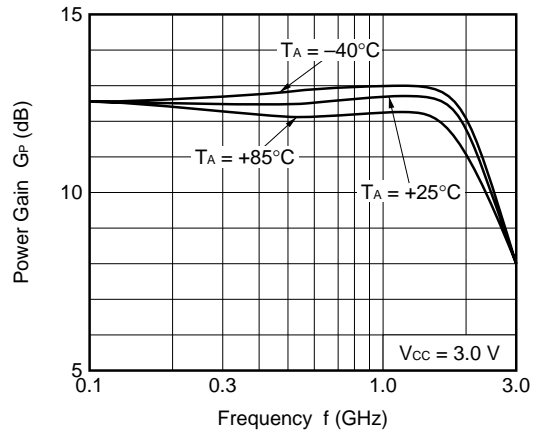
**CIRCUIT CURRENT vs. OPERATING AMBIENT TEMPERATURE**



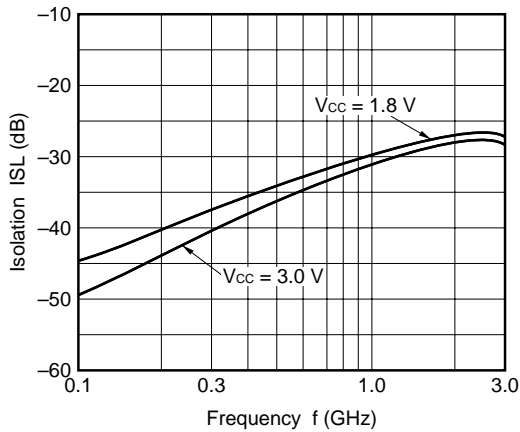
**NOISE FIGURE, POWER GAIN vs. FREQUENCY**



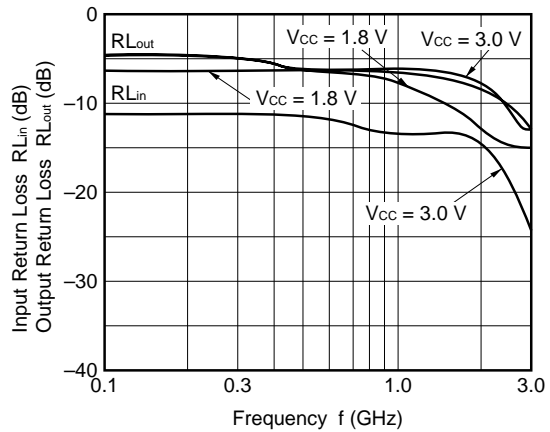
**POWER GAIN vs. FREQUENCY**



**ISOLATION vs. FREQUENCY**



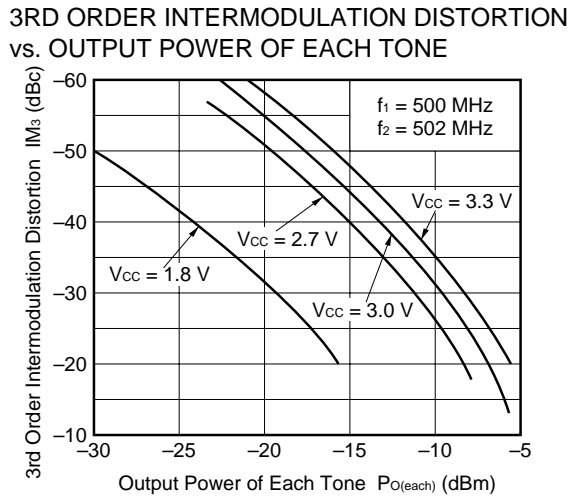
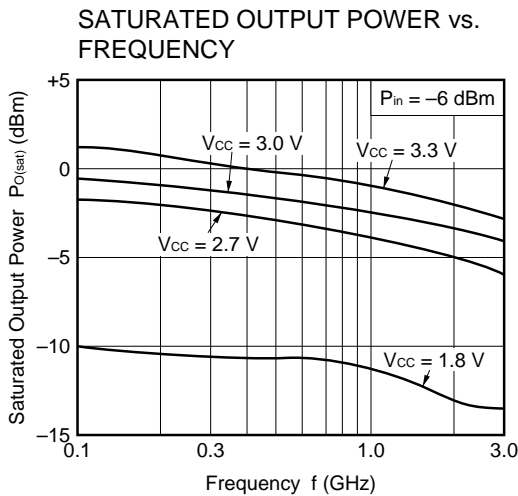
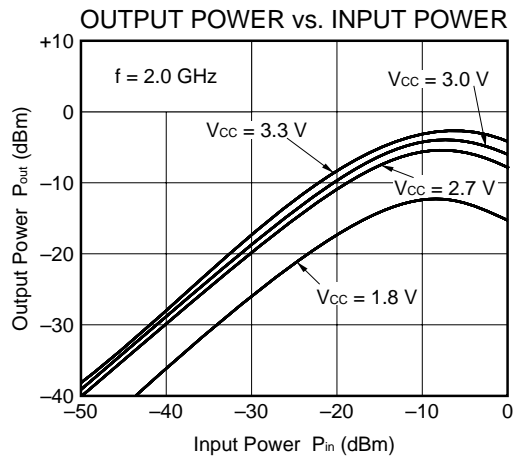
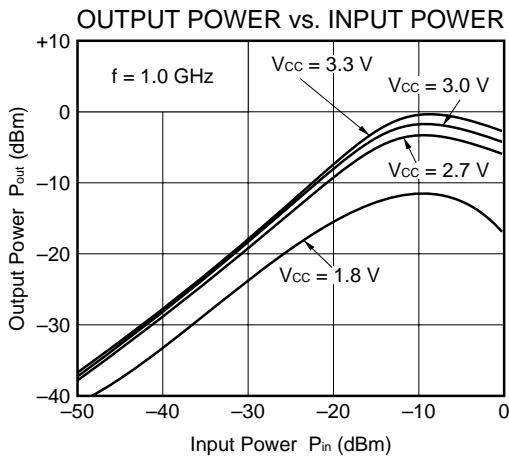
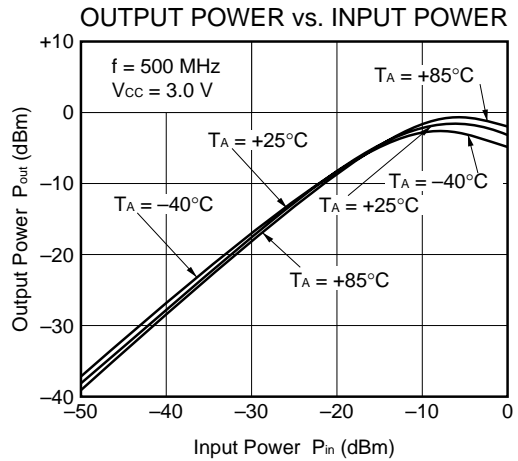
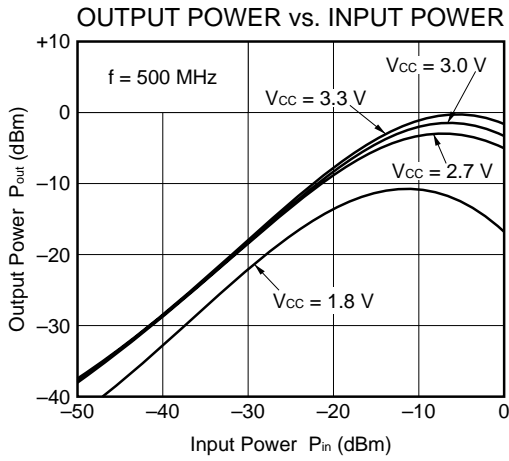
**INPUT RETURN LOSS, OUTPUT RETURN LOSS vs. FREQUENCY**



**Remark** The graphs indicate nominal characteristics.



—  $\mu$ PC2745TB —

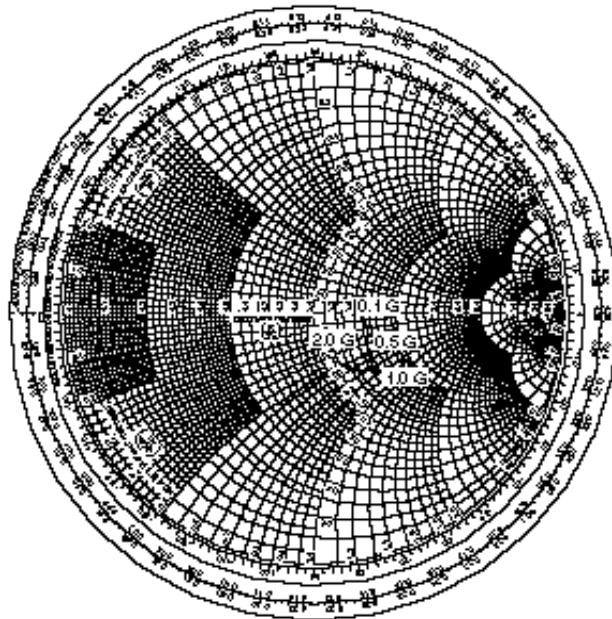


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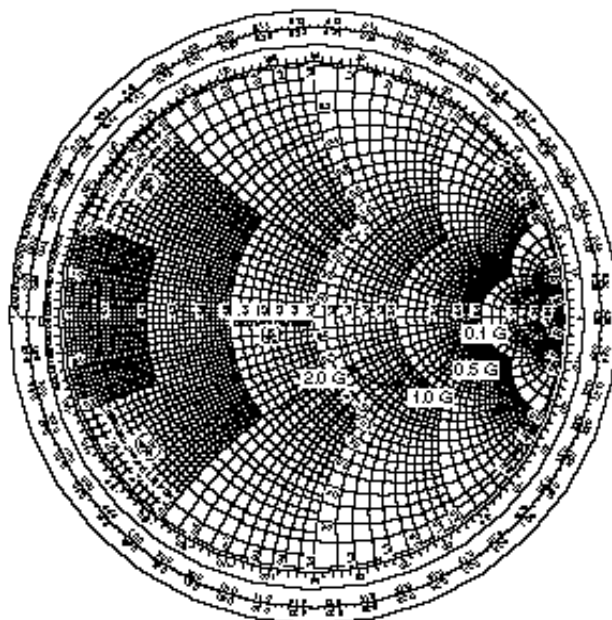
SMITH CHART ( $T_A = +25^\circ\text{C}$ ,  $V_{CC} = 3.0\text{ V}$ )

—  $\mu$ PC2745TB —

S<sub>11</sub>-FREQUENCY



S<sub>22</sub>-FREQUENCY



**S-PARAMETERS**

S-parameters/Noise parameters are provided on the NEC Compound Semiconductor Devices Web site in a form (S2P) that enables direct import to a microwave circuit simulator without keyboard input.

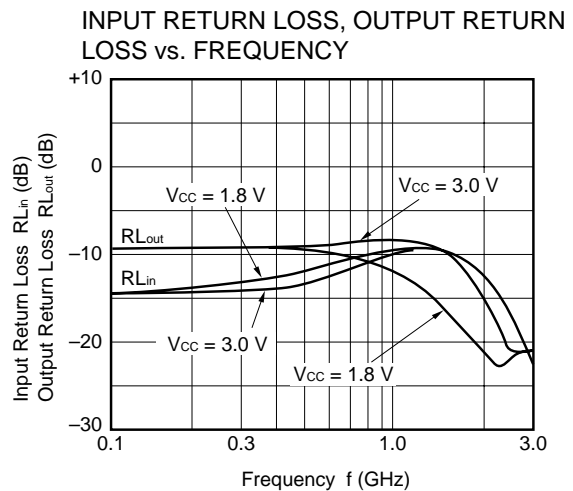
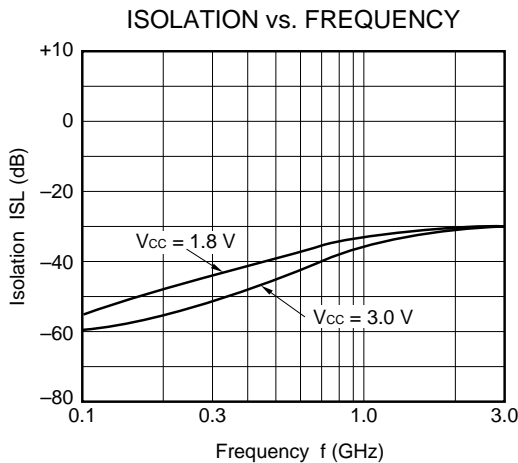
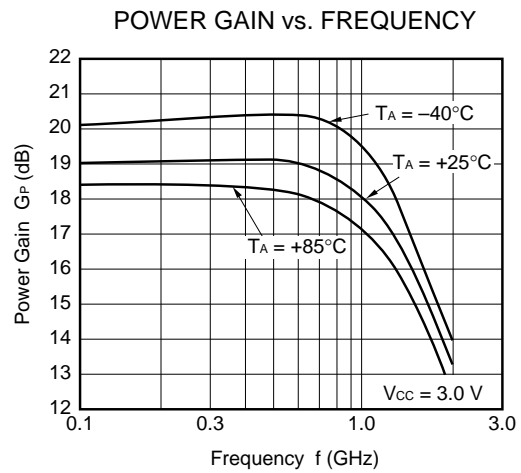
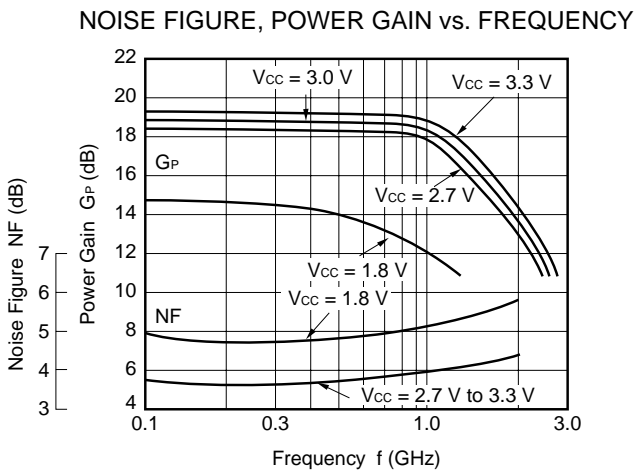
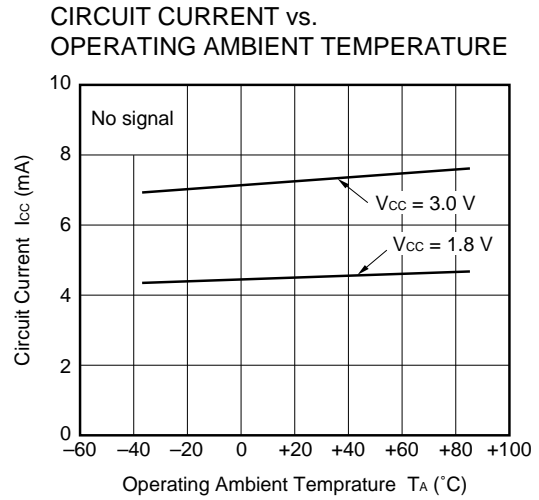
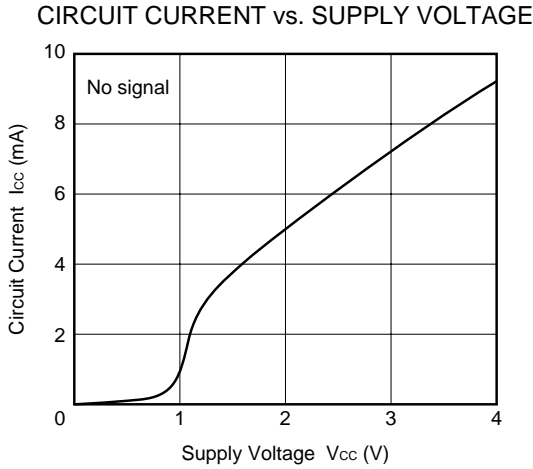
Click here to download S-parameters.

[RF and Microwave] → [Device Parameters]

URL <http://www.ncsd.necel.com/>

TYPICAL CHARACTERISTICS (T<sub>A</sub> = +25°C, unless otherwise specified)

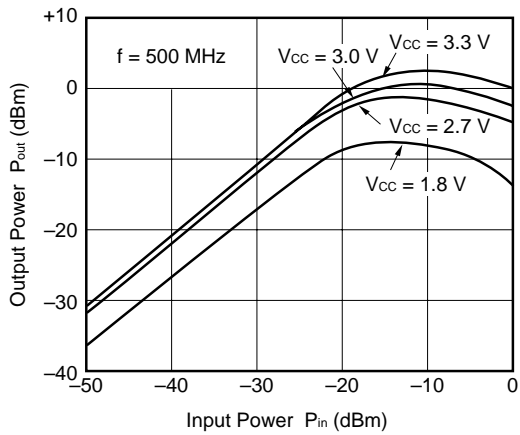
—  $\mu$ PC2746TB —



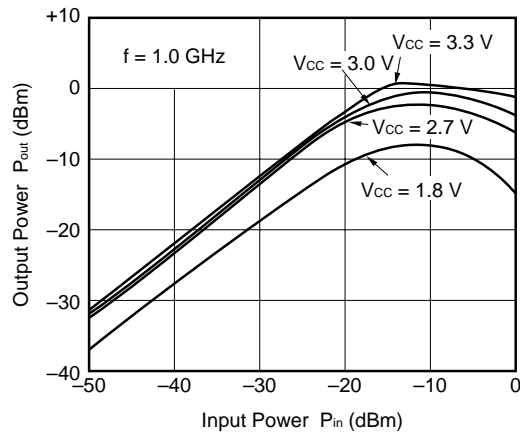
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—  $\mu$ PC2746TB —

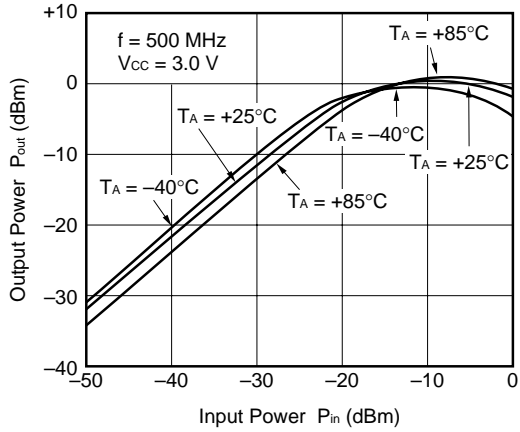
OUTPUT POWER vs. INPUT POWER



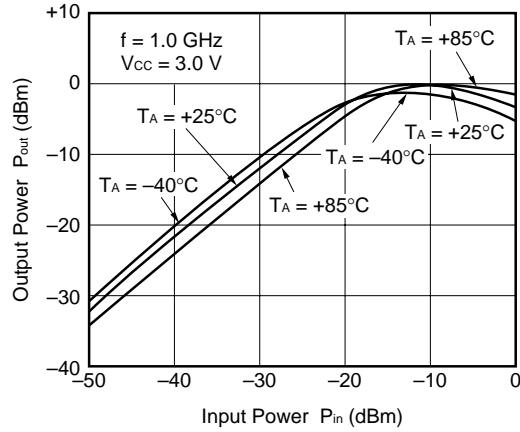
OUTPUT POWER vs. INPUT POWER



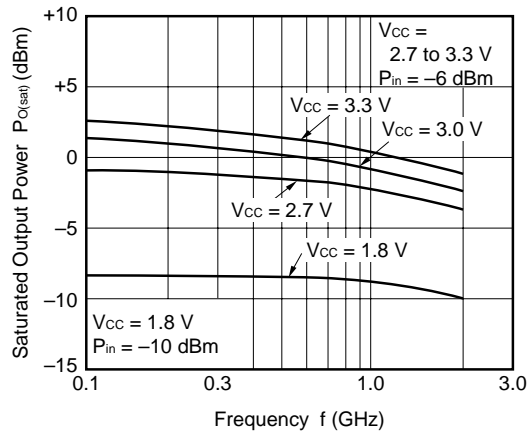
OUTPUT POWER vs. INPUT POWER



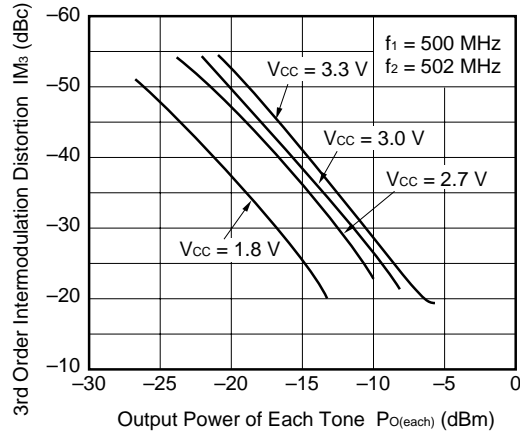
OUTPUT POWER vs. INPUT POWER



SATURATED OUTPUT POWER vs. FREQUENCY



3RD ORDER INTERMODULATION DISTORTION vs. OUTPUT POWER OF EACH TONE

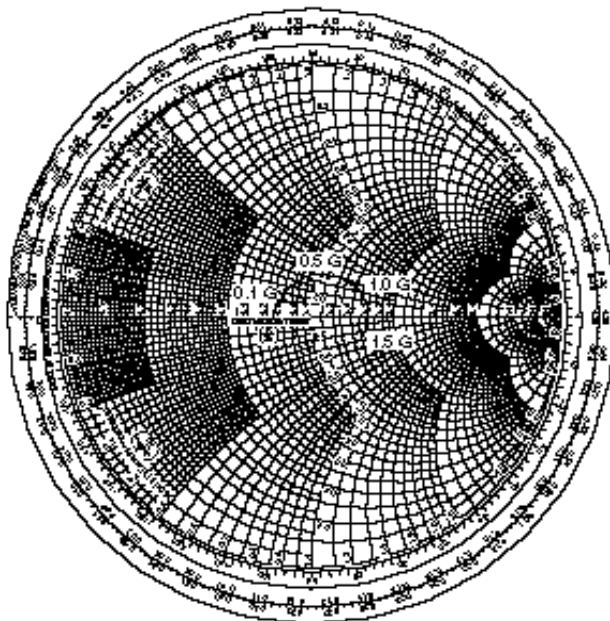


**Remark** The graphs indicate nominal characteristics.

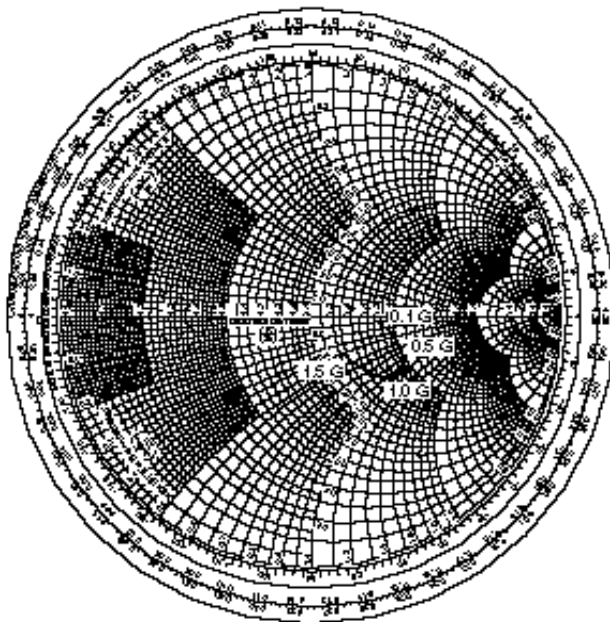
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—  $\mu$ PC2746TB —

$S_{11}$ -FREQUENCY



$S_{22}$ -FREQUENCY



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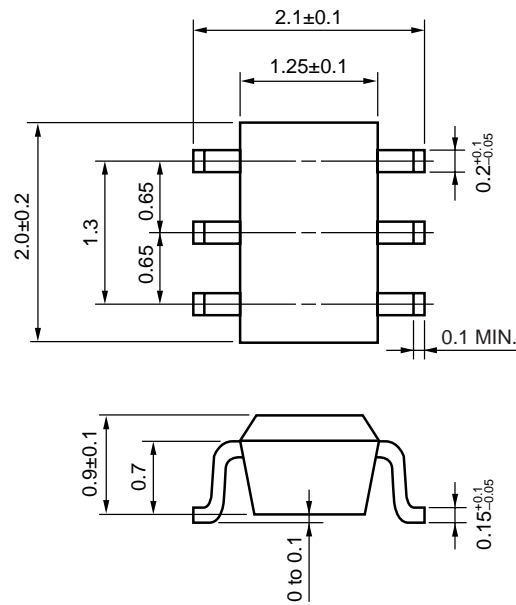
Click here to download S-parameters.

[RF and Microwave] → [Device Parameters]

URL <http://www.ncsd.necel.com/>

PACKAGE DIMENSIONS

6-PIN SUPER MINIMOLD (UNIT: mm)





**NOTES ON CORRECT USE**

- (1) Observe precautions for handling because of electro-static sensitive devices.
- (2) Form a ground pattern as widely as possible to minimize ground impedance (to prevent undesired oscillation).  
All the ground pins must be connected together with wide ground pattern to decrease impedance difference.
- (3) The bypass capacitor should be attached to the V<sub>CC</sub> pin.
- (4) The DC cut capacitor must be attached to input pin and output pin.

**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) : 260°C or below Time at peak temperature : 10 seconds or less Time at temperature of 220°C or higher : 60 seconds or less Preheating time at 120 to 180°C : 120±30 seconds Maximum number of reflow processes : 3 times Maximum chlorine content of rosin flux (% mass) : 0.2%(Wt.) or below	IR260
VPS	Peak temperature (package surface temperature) : 215°C or below Time at temperature of 200°C or higher : 25 to 40 seconds Preheating time at 120 to 150°C : 30 to 60 seconds Maximum number of reflow processes : 3 times Maximum chlorine content of rosin flux (% mass) : 0.2%(Wt.) or below	VP215
Wave Soldering	Peak temperature (molten solder temperature) : 260°C or below Time at peak temperature : 10 seconds or less Preheating temperature (package surface temperature) : 120°C or below Maximum number of flow processes : 1 time Maximum chlorine content of rosin flux (% mass) : 0.2%(Wt.) or below	WS260
Partial Heating	Peak temperature (pin temperature) : 350°C or below Soldering time (per side of device) : 3 seconds or less Maximum chlorine content of rosin flux (% mass) : 0.2%(Wt.) or below	HS350

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

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Subject: Compliance with EU Directives

CEL certifies, to its knowledge, that semiconductor and laser products detailed below are compliant with the requirements of European Union (EU) Directive 2002/95/EC Restriction on Use of Hazardous Substances in electrical and electronic equipment (RoHS) and the requirements of EU Directive 2003/11/EC Restriction on Penta and Octa BDE.

CEL Pb-free products have the same base part number with a suffix added. The suffix –A indicates that the device is Pb-free. The –AZ suffix is used to designate devices containing Pb which are exempted from the requirement of RoHS directive (\*). In all cases the devices have Pb-free terminals. All devices with these suffixes meet the requirements of the RoHS directive.

This status is based on CEL’s understanding of the EU Directives and knowledge of the materials that go into its products as of the date of disclosure of this information.

Restricted Substance per RoHS	Concentration Limit per RoHS (values are not yet fixed)	Concentration contained in CEL devices	
		-A	-AZ
Lead (Pb)	< 1000 PPM	Not Detected	(*)
Mercury	< 1000 PPM	Not Detected	
Cadmium	< 100 PPM	Not Detected	
Hexavalent Chromium	< 1000 PPM	Not Detected	
PBB	< 1000 PPM	Not Detected	
PBDE	< 1000 PPM	Not Detected	

If you should have any additional questions regarding our devices and compliance to environmental standards, please do not hesitate to contact your local representative.

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