

# BIPOLAR ANALOG INTEGRATED CIRCUIT

# $\mu$ PC8105GR

## 400 MHz QUADRATURE MODULATOR FOR DIGITAL MOBILE COMMUNICATION

### DESCRIPTION

The  $\mu$ PC8105GR is a silicon monolithic integrated circuit designed as quadrature modulator for digital mobile communication systems. This modulator housed in a 16 pin plastic SSOP that is easy to install and contributes to miniaturizing the system.

The device has power save function and can operate 2.7 to 5.5 V supply voltage to realize low power consumption.

### FEATURES

- Internal 90° phase shifter is accurate over an IF range from 100 MHz to 400 MHz.
- Wide supply voltage range:  $V_{CC} = 2.7$  to 5.5 V.
- Low operation current:  $I_{CC} = 16$  mA (typ.).
- 16 pin plastic SSOP suitable for high density surface mounting.
- Low current in sleep mode

### APPLICATION

- IF modulator for Digital cellular phone (PDC, IS-54, GSM etc..)
- IF modulator for Digital cordless phone (PHS, PCS etc..)

### ORDERING INFORMATION

PART NUMBER	PACKAGE	SUPPLYING FORM
$\mu$ PC8105GR-E1	16 pin plastic SSOP (225 mil)	Carrier tape width 12 mm. Q'ty 2.5 kp/Reel Pin 1 indicated pull-out direction of tape.

To order evaluation samples, please contact your local NEC sales office. (Part number for sample order:  $\mu$ PC8105GR)

**Caution electro-static sensitive device**

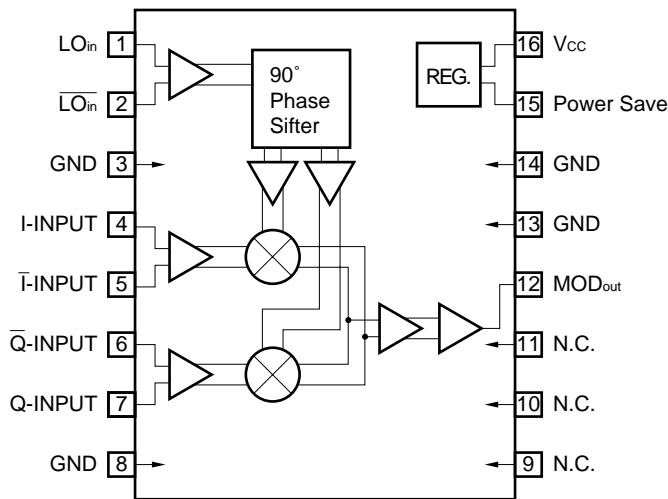
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Not all devices/types available in every country. Please check with local NEC representative for availability and additional information.

**SERIES PRODUCTS**

SERIES TYPE	PART NUMBER	f LO1 in (MHz)	f MODout (MHz)	f I/Q (MHz)	Up-Converter f RFout (MHz)	APPLICATIONS
150 MHz Quadrature MOD	$\mu$ PC8101GR	100 to 300	50 to 150	DC to 0.5	External	CT2, Digital Comm.
Up-Con + Quadrature MOD	$\mu$ PC8104GR	100 to 400		DC to 10	800 to 1900	Digital Comm.
400 MHz Quadrature MOD	$\mu$ PC8105GR	100 to 400		DC to 10	External	Digital Comm.

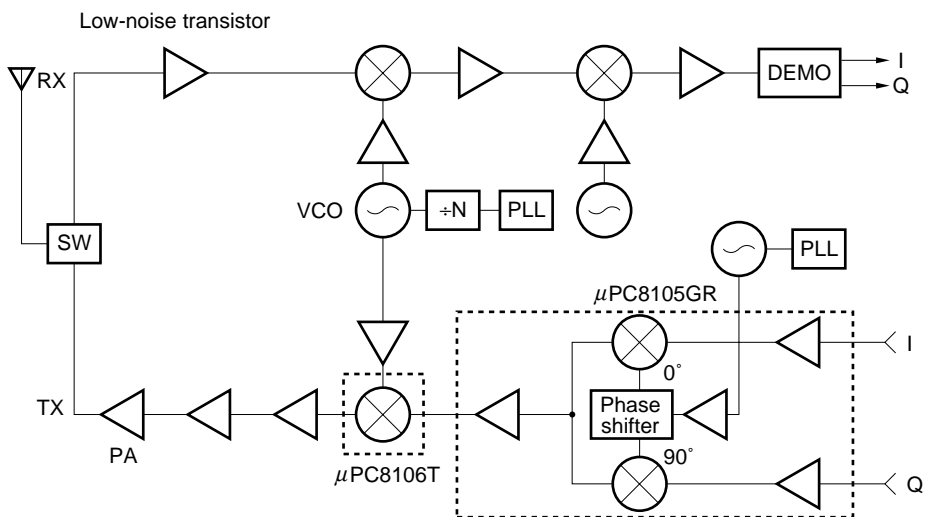
**Remark:** As for detail information of series products, please refer to each data sheet.

**INTERNAL BLOCK DIAGRAM AND PIN CONNECTIONS (Top View)**



**APPLICATION EXAMPLE**

[Digital cellular hand-held phone]



**ABSOLUTE MAXIMUM RATINGS**

PARAMETER	SYMBOL	RATING	UNIT	TEST CONDITIONS
Supply Voltage	V <sub>CC</sub>	6.0	V	T <sub>A</sub> = +25 °C
Power Save Voltage	V <sub>PS</sub>	6.0	V	T <sub>A</sub> = +25 °C
Power Dissipation	P <sub>D</sub>	310	mW	T <sub>A</sub> = +85 °C <sup>*1</sup>
Operating Temperature	T <sub>op</sub>	-40 to +85	°C	
Storage Temperature	T <sub>stg</sub>	-55 to +150	°C	

\*1: Mounted on 50 × 50 × 1.6 mm double copper clad epoxy glass board

**RECOMMENDED OPERATING CONDITIONS**

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Supply Voltage	V <sub>CC</sub>	2.7	3.0	5.5	V	
Operating Temperature	T <sub>A</sub>	-40	+25	+85	°C	
Modulator Output Frequency	f <sub>MODout</sub>	100		400	MHz	
LO1 Input Frequency	f <sub>LO1in</sub>					P <sub>LOin</sub> = -10 dBm
I/Q Input Frequency	f <sub>I/Qin</sub>	DC		10	MHz	P <sub>I/Qin</sub> = 600 mV <sub>p-p</sub> MAX (Single ended)

**ELECTRICAL CHARACTERISTICS (T<sub>A</sub> = +25 °C, V<sub>CC</sub> = 3.0 V, Unless Otherwise Specified V<sub>PS</sub> ≥ 1.8 V)**

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Circuit Current	I <sub>CC</sub>	10	16	21	mA	No input signal
Circuit Current at Power Save Mode	I <sub>CC(PS)</sub>		0.1	5	μA	V <sub>PS</sub> ≤ 1.0 V
Output Power	P <sub>MODout</sub>	-21.0	-16.5	-12.0	dBm	I/Q DC = 1.5 V
LO Carrier Leak	LOL		-40	-30	dBc	P <sub>I/Qin</sub> = 500 mV <sub>p-p</sub> (Single ended)
Image Rejection (Side Band Leak)	ImR		-40	-30	dBc	

**STANDARD CHARACTERISTICS FOR REFERENCE**

(T<sub>A</sub> = +25 °C, V<sub>CC</sub> = 3.0 V, Unless Otherwise Specified V<sub>PS</sub> ≥ 1.8 V)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
I/Q 3rd Order Intermodulation Distortion	IM <sub>3I/Q</sub>		-50	-30	dBc	I/Q DC = 1.5 V P <sub>I/Qin</sub> = 500 mV <sub>p-p</sub> (Single ended)
I/Q Input Impedance	Z <sub>I/Q</sub>		20		kΩ	I/Q DC = 1.5 V P <sub>I/Qin</sub> = 500 mV <sub>p-p</sub> (Single ended) (I → I, Q → Q)
I/Q Bias Current	I <sub>I/Q</sub>		5		μA	
LO1 Input VSWR	Z <sub>LO</sub>		1.2:1		-	
Power Save Rise Time	T <sub>PS(RISE)</sub>		2	5	μs	V <sub>PS(OFF)</sub> → V <sub>PS(ON)</sub>
Power Save Fall Time	T <sub>PS(FALL)</sub>		2	5	μs	V <sub>PS(ON)</sub> → V <sub>PS(OFF)</sub>

PIN EXPLANATION

PIN NO.	ASSIGNMENT	SUPPLY VOL. (V)	PIN VOL.(V)	FUNCTION AND APPLICATION	EQUIPMENT CIRCUIT								
1	LOin	–	0	LO input for phase shifter. This input impedance is 50 Ω matched internally.									
2	$\overline{\text{LOin}}$	–	2.4	Bypass of LO input. This pin is grounded through internal capacitor. Open in case of single ended.									
3	GND	0	–	Connect to the ground with minimum inductance. Track length should be kept as short as possible.									
8													
4	I	$V_{cc}/2$	–	Input for I signal. This in put impedance is larger than 20 kΩ. Relations between amplitude and $V_{cc}/2$ bias of input signal are following. <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th><math>V_{cc}/2</math> (v)</th> <th>Amp. (mV<sub>p-p</sub>) *1</th> </tr> </thead> <tbody> <tr> <td>≥ 1.35</td> <td>400</td> </tr> <tr> <td>≥ 1.5</td> <td>600</td> </tr> <tr> <td>≥ 1.75</td> <td>1000</td> </tr> </tbody> </table>	$V_{cc}/2$ (v)	Amp. (mV <sub>p-p</sub> ) *1	≥ 1.35	400	≥ 1.5	600	≥ 1.75	1000	
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≥ 1.35	400												
≥ 1.5	600												
≥ 1.75	1000												
5	$\overline{\text{I}}$	$V_{cc}/2$	–	Input for I signal. This in put impedance is larger than 20 kΩ. $V_{cc}/2$ biased DC signal should be input.									
6	$\overline{\text{Q}}$	$V_{cc}/2$	–	Input for Q signal. This in put impedance is larger than 20 kΩ. $V_{cc}/2$ biased DC signal should be input.									
7	Q	$V_{cc}/2$	–	Input for Q signal. This in put impedance is larger than 20 kΩ. Relations between amplitude and $V_{cc}/2$ bias of input signal are following. <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th><math>V_{cc}/2</math> (v)</th> <th>Amp. (mV<sub>p-p</sub>) *1</th> </tr> </thead> <tbody> <tr> <td>≥ 1.35</td> <td>400</td> </tr> <tr> <td>≥ 1.5</td> <td>600</td> </tr> <tr> <td>≥ 1.75</td> <td>1000</td> </tr> </tbody> </table>		$V_{cc}/2$ (v)	Amp. (mV <sub>p-p</sub> ) *1	≥ 1.35	400	≥ 1.5	600	≥ 1.75	1000
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≥ 1.35	400												
≥ 1.5	600												
≥ 1.75	1000												
12	MODout	–	1.5	Output from modulator. This is emitter follower output.									

\*1: In case of that I/Q input signals are single ended.

Of course, I/Q signal inputs can be used either single endedly or differentially with proper terminations.

**PIN EXPLANATION**

PIN NO.	ASSIGNMENT	SUPPLY VOL. (V)	PIN VOL.(V)	FUNCTION AND APPLICATION	EQUIPMENT CIRCUIT						
13	GND	0	-	Connect to the ground with minimum inductance. Track length should be kept as short as possible.							
14											
15	Power Save	VP/S	-	Power save control pin can be controlled ON/SLEEP state with bias as follows; <table border="1" style="margin: 5px auto;"> <tr> <td>VP/S (v)</td> <td>STATE</td> </tr> <tr> <td>1.8 to 5.5</td> <td>ON</td> </tr> <tr> <td>0 to 1.0</td> <td>SLEEP</td> </tr> </table>	VP/S (v)	STATE	1.8 to 5.5	ON	0 to 1.0	SLEEP	
VP/S (v)	STATE										
1.8 to 5.5	ON										
0 to 1.0	SLEEP										
16	Vcc	2.7 to 5.5	-	Supply voltage pin for modulator. Internal regulator can be kept stable condition of supply bias against the variable temperature or Vcc.							

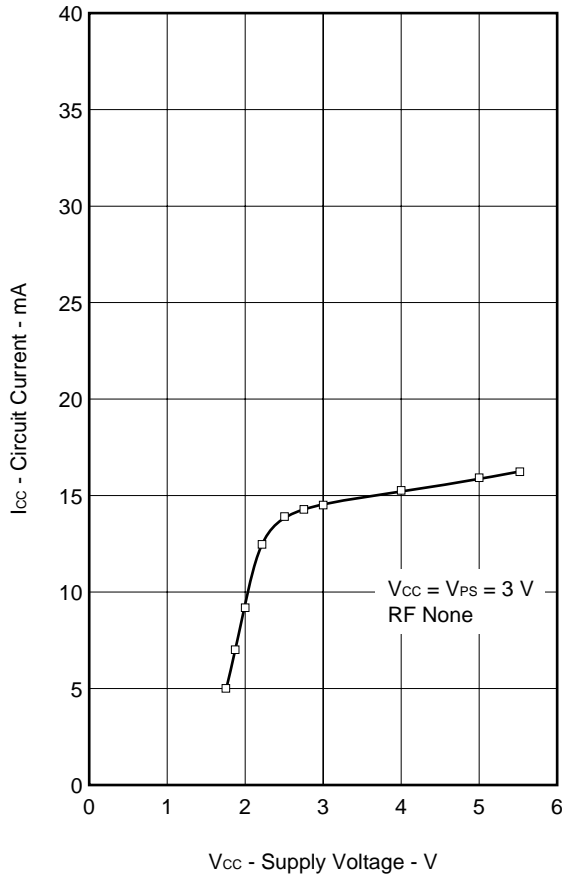
**EXPLANATION OF INTERNAL FUNCTION**

BLOCK	FUNCTION/OPERATION	BLOCK DIAGRAM
90° PHASE SHIFTER	Input signal from LO is send to digital circuit of T-type flip-flop through frequency doubler. Output signal from T-type F/F is changed to same frequency as LO input and that have quadrature phase shift, 0°, 90°, 180°, 270°. These circuits have function of self phase correction to make correctly quadrature signals.	
BUFFER AMP.	Buffer amplifiers for each phase signals to send to each mixers.	
MIXER	Each signals from buffer amp. are quadrature modulated with two double-balanced mixers. High accurate phase and amplitude inputs are realized to good performance for image rejection.	
ADDER	Output signals from each mixers are added with adder and send to final amplifier.	

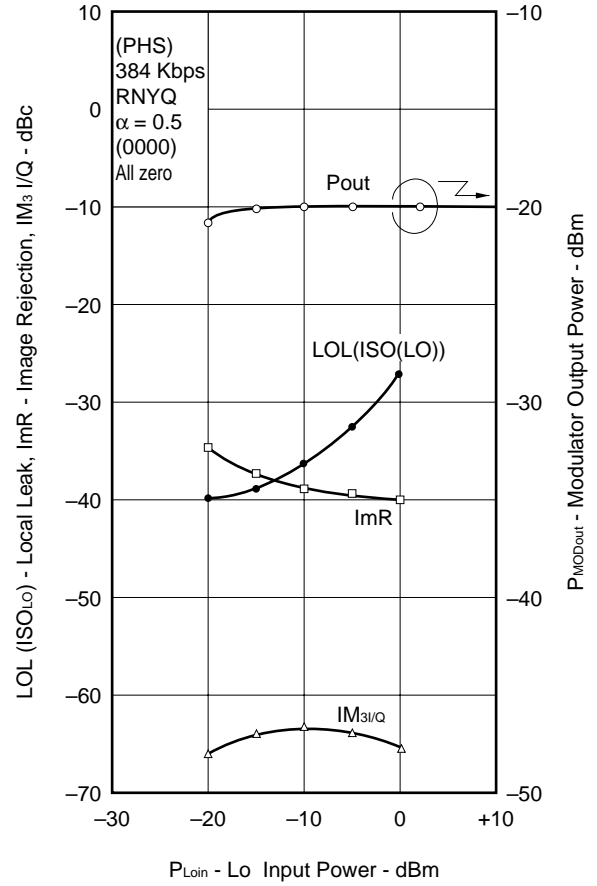
**TYPICAL CHARACTERISTICS (TA = +25 °C)**

Unless otherwise specified  $V_{CC} = V_{PS} = 3\text{ V}$ , I/Q DC offset =  $\overline{\text{I/Q}}$  DC offset = 1.5 V, I/Q Input Signal = 500 mV<sub>p-p</sub> (single ended), P<sub>LoIn</sub> = -10 dBm, (continuous wave)

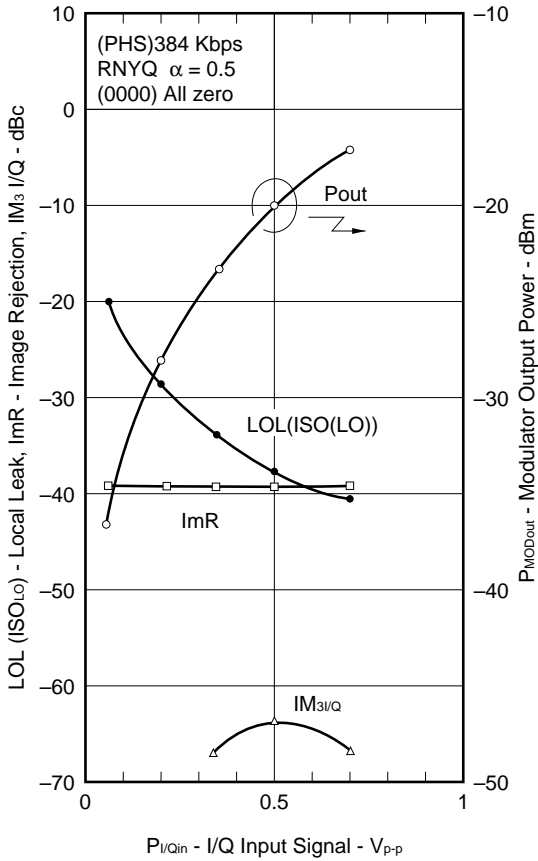
SUPPLY VOLTAGE vs CIRCUIT CURRENT



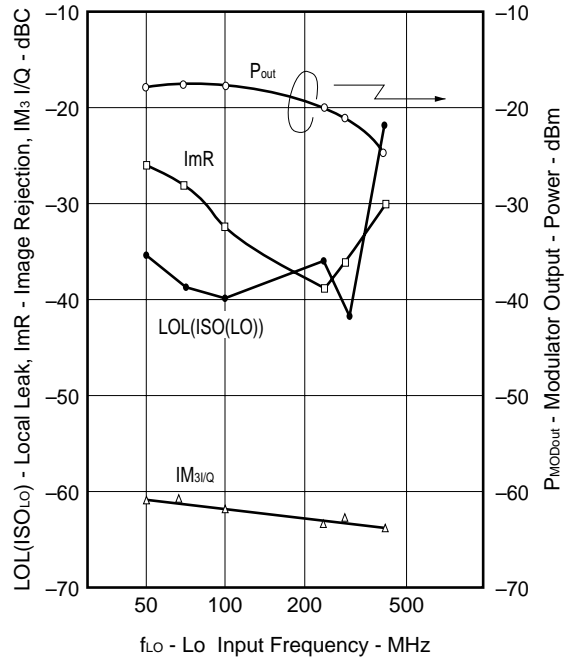
Lo INPUT POWER vs OUTPUT POWER, LOCAL LEAK, IMAGE REJECTION, I/Q 3RD ORDER INTERMODULATION DISTORTION



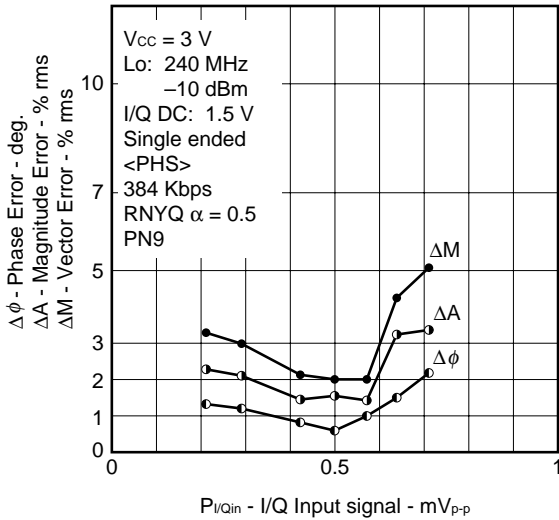
I/Q INPUT SIGNAL vs OUTPUT POWER, LOCAL LEAK, IMAGE REJECTION, I/Q 3RD ORDER INTERMODULATION DISTORTION



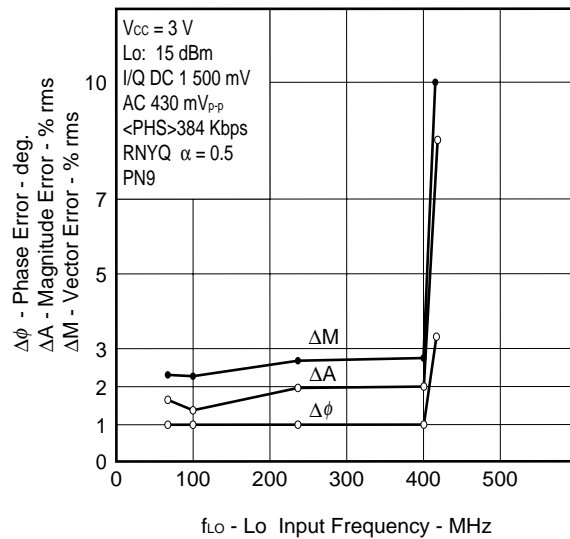
Lo INPUT FREQUENCY vs OUTPUT POWER, LOCAL LEAK, IMAGE REJECTION, I/Q 3RD ORDER INTERMODULATION DISTORTION



I/Q INPUT SIGNAL vs PHASE ERROR, MAGNITUDE ERROR, VECTOR ERROR

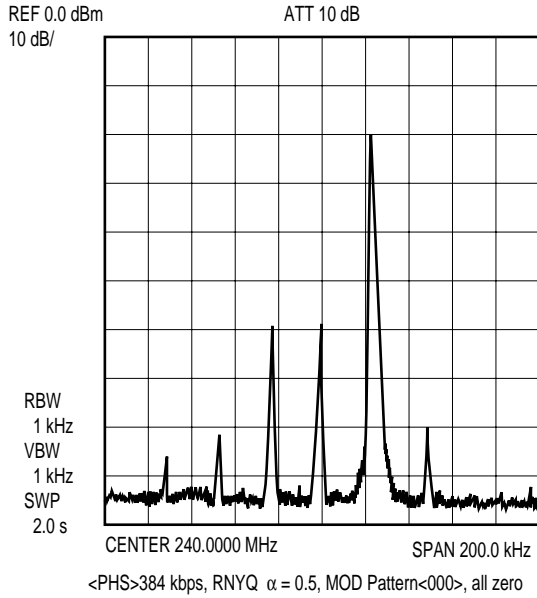


Lo INPUT FREQUENCY vs VECTOR ERROR, MAGNITUDE ERROR, PHASE ERROR

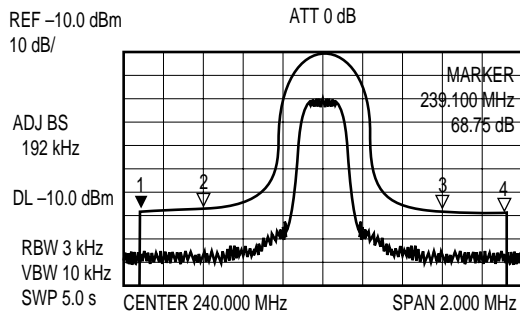




TYPICAL SINE WAVE MODULATION  
OUTPUT SPECTRUM

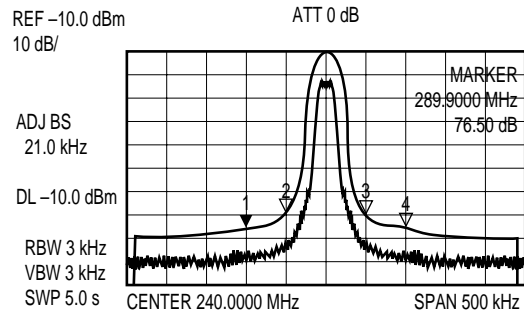


TYPICAL  $\pi/4$  DQPSK MODULATION OUTPUT SPECTRUM  
<PHS>384 kbps, RNYQ  $\alpha = 0.5$ , MOD Pattern (PN9)



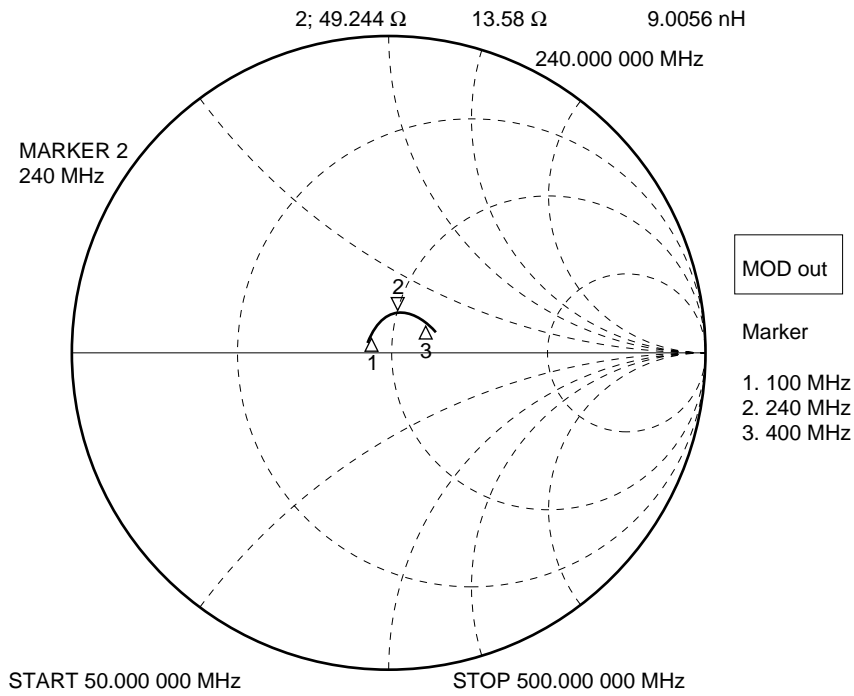
- \*\*\* Multi Marker List \*\*\*
- No.1: 239.100 MHz -68.75 dB
  - No.2: 239.400 MHz -68.25 dB
  - No.3: 240.600 MHz -68.25 dB
  - No.4: 240.900 MHz -69.00 dB

TYPICAL  $\pi/4$  DQPSK MODULATION OUTPUT SPECTRUM  
<PDC>42 kbps, RNYQ  $\alpha = 0.5$ , MOD Pattern<PN9>

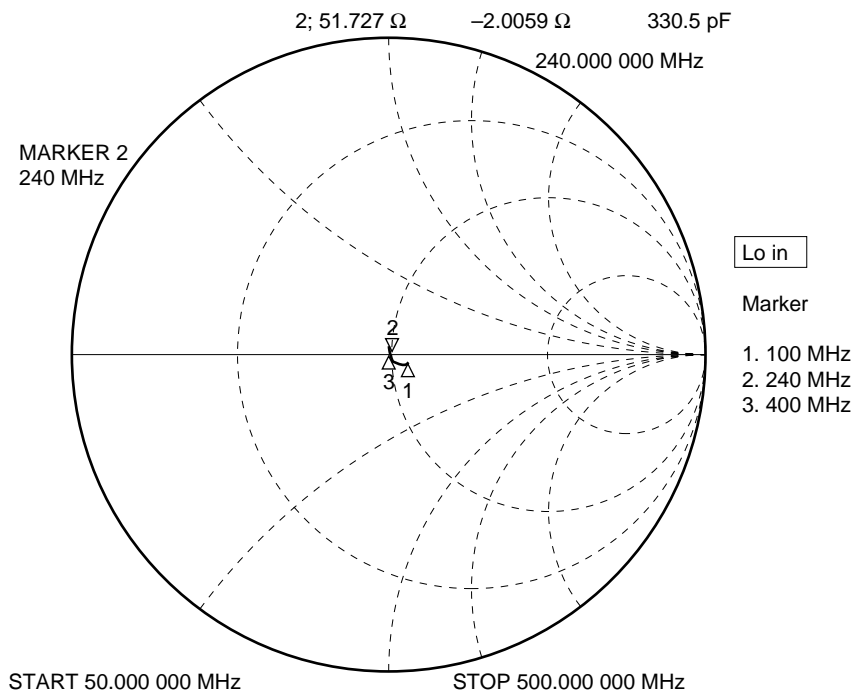


- \*\*\* Multi Marker List \*\*\*
- No.1: 239.9000 MHz -76.50 dB
  - No.2: 239.9500 MHz -70.50 dB
  - No.3: 240.0500 MHz -71.00 dB
  - No.4: 240.1000 MHz -75.75 dB

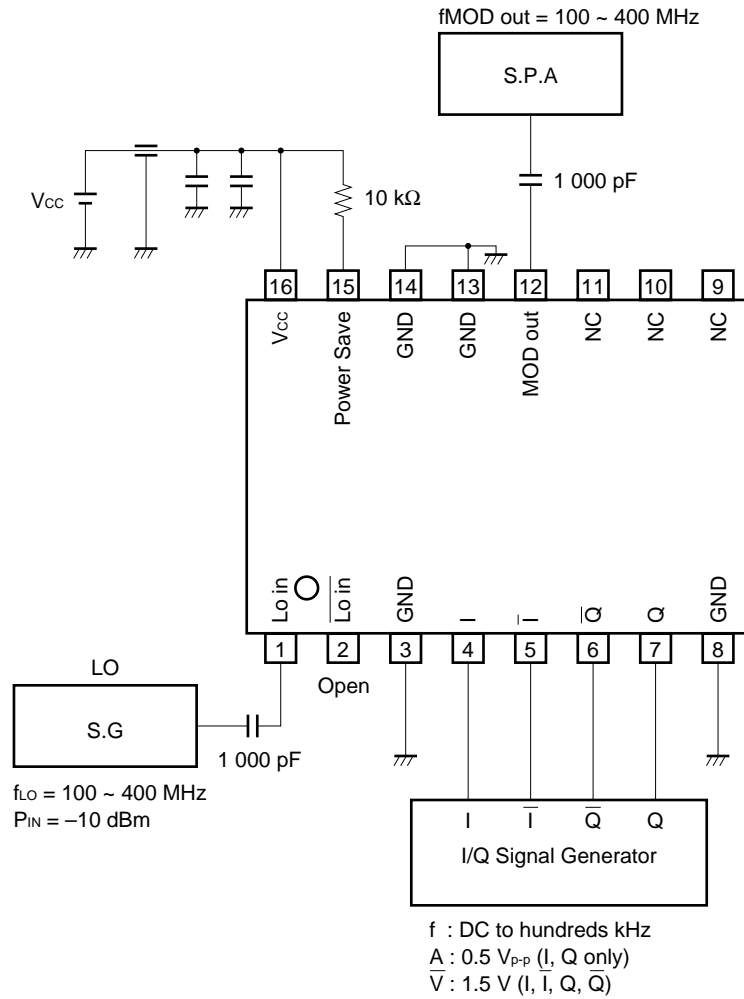
MODout OUTPUT IMPEDANCE



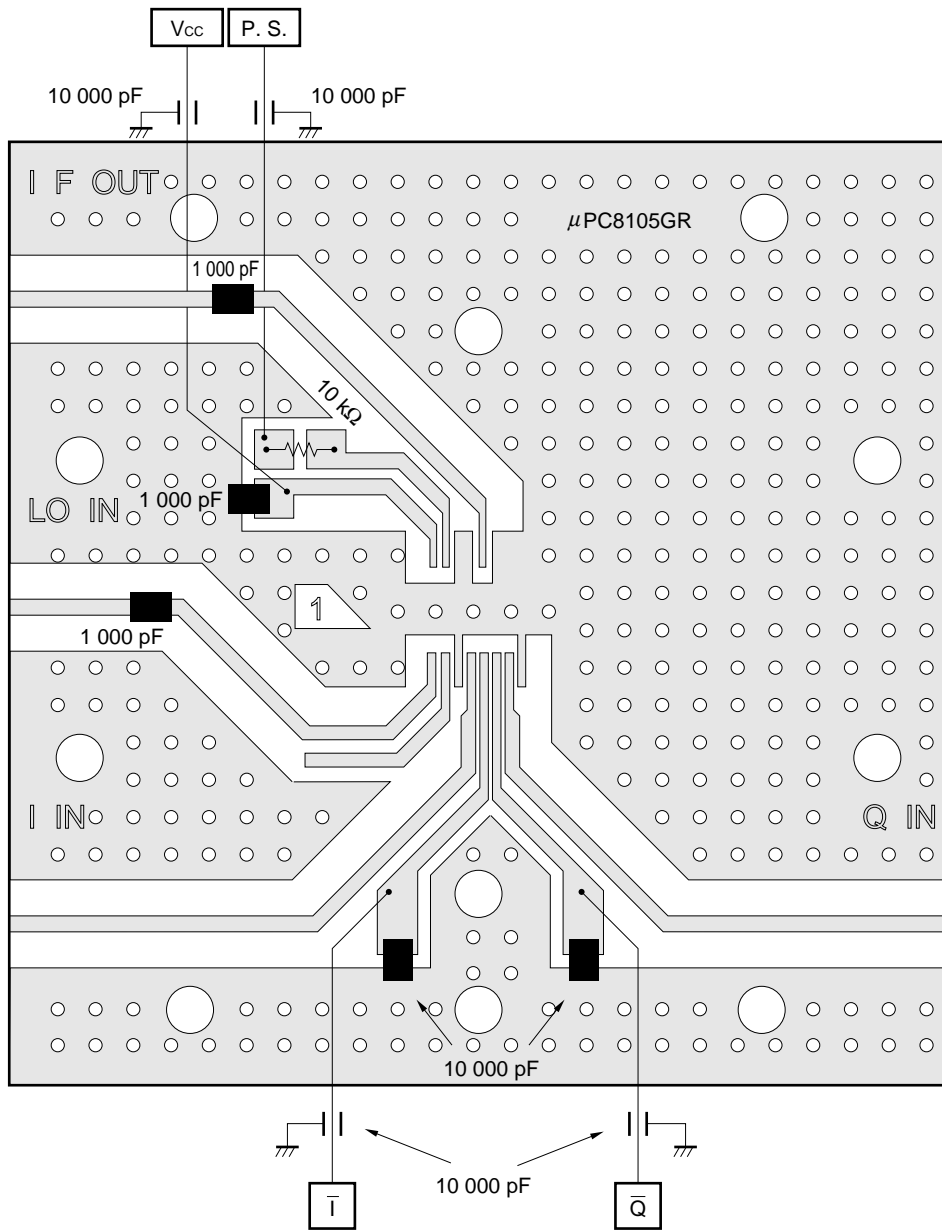
Lo in INPUT IMPEDANCE



TEST CIRCUIT

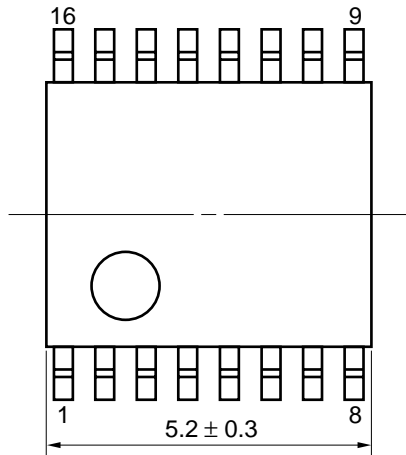


TEST BOARD

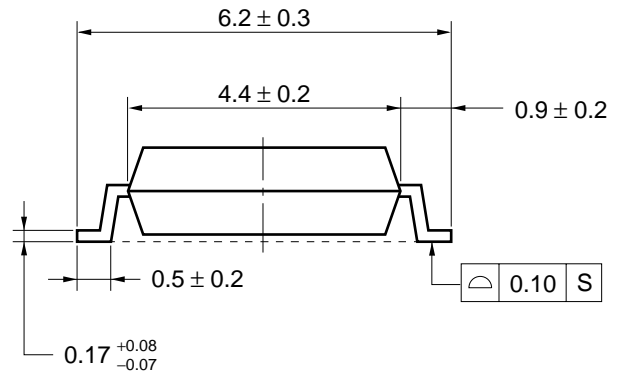
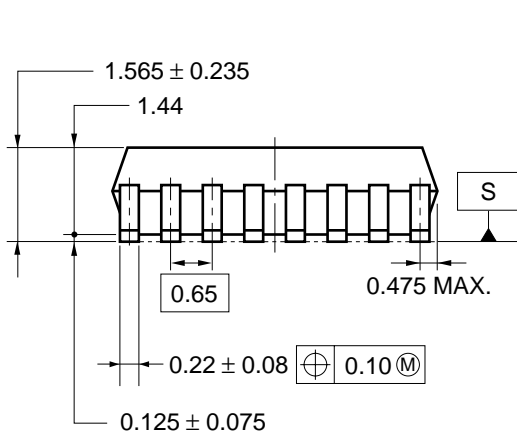
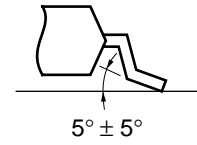


PACKAGE DIMENSIONS

★ 16 PIN PLASTIC SHRINK SOP (225 mil) (UNIT: mm)



detail of lead end



**NOTE** Each lead centerline is located within 0.10 mm of its true position (T.P.) at maximum material condition.

**NOTE ON CORRECT USE**

- (1) Observe precautions for handling because of electrostatic sensitive devices.
- (2) Form a ground pattern as widely as possible to minimize ground impedance (to prevent undesired 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 Vcc pin.
- (5) I, Q DC offset voltage should be same as the I, Q DC offset voltage (to prevent changing the local leak level with power save control.)

**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.

**μPC8105GR**

Soldering process	Soldering Conditions	Symbol
Infrared ray reflow	Peak package's surface temperature: 235 °C or below, Reflow time: 30 seconds or below (210 °C or higher), Number of reflow process: 3, Exposure limit*: None	IR35-00-3
VPS	Peak package's surface temperature: 215 °C or below, Reflow time: 30 seconds or below (200 °C or higher), Number of reflow process: 3, Exposure limit*: None	VP15-00-3
Wave soldering	Solder temperature: 260 °C or below Flow time: 10 seconds or below, Number of reflow process: 1, Exposure limit*: None	WS60-00-1
Partial heating method	Terminal temperature: 300 °C or below Flow time: 3 seconds/pin or below, Exposure limit*: None	

\*: Exposure limit before soldering after dry-pack package is opened.  
Storage conditions: 25 °C and relative humidity at 65 % or less.

**Note:** Apply only a single process at once, except for "Partial heating method".

For details of recommended soldering conditions for surface mounting, refer to information document SEMICONDUCTOR DEVICE MOUNTING TECHNOLOGY MANUAL (C10535E).

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

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    - 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)
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