

NEC**BIPOLAR ANALOG INTEGRATED CIRCUIT**
 μ PC8126K**900 MHz BAND DIRECT QUADRATURE MODULATOR IC
FOR DIGITAL MOBILE COMMUNICATION SYSTEMS****DESCRIPTION**

The μ PC8126K is a silicon monolithic integrated circuit designed as quadrature modulator for digital mobile communication systems. This IC integrates a pre-mixer for local signals plus a quadrature modulator operating from 889 MHz to 960 MHz. The chip which has been conventionally packaged in 20-pin SSOP is packaged in 28-pin QFN and therefore is suitable for higher density mounting. In addition, the IC has power save function and can operate 2.7 to 3.6 V supply voltage. Consequently the μ PC8126K can contribute to make RF blocks smaller size, higher performance and lower power consumption.

FEATURES

- Directly modulate in 889 MHz to 960 MHz
- Built-in pre-mixer for local signals
- External IF filter can be applied between modulator output and pre-mixer input terminal.
- Current consumption $I_{CC} = 35$ mA TYP. @ $V_{CC} = 3.0$ V
- Equipped with power save function.
- 28-pin QFN suitable for higher density mounting.

APPLICATIONS

- Digital cellular phones: PDC800M

ORDERING INFORMATION

| Part Number | Package | Supplying Form |
|------------------|--|---|
| μ PC8126K-E1 | 28-pin plastic QFN (5.1 × 5.5 × 0.95 mm) | Embossed tape 12 mm wide. QTY 2.5 kp/reel. Pins 1 through 10 are in pull-out direction. |

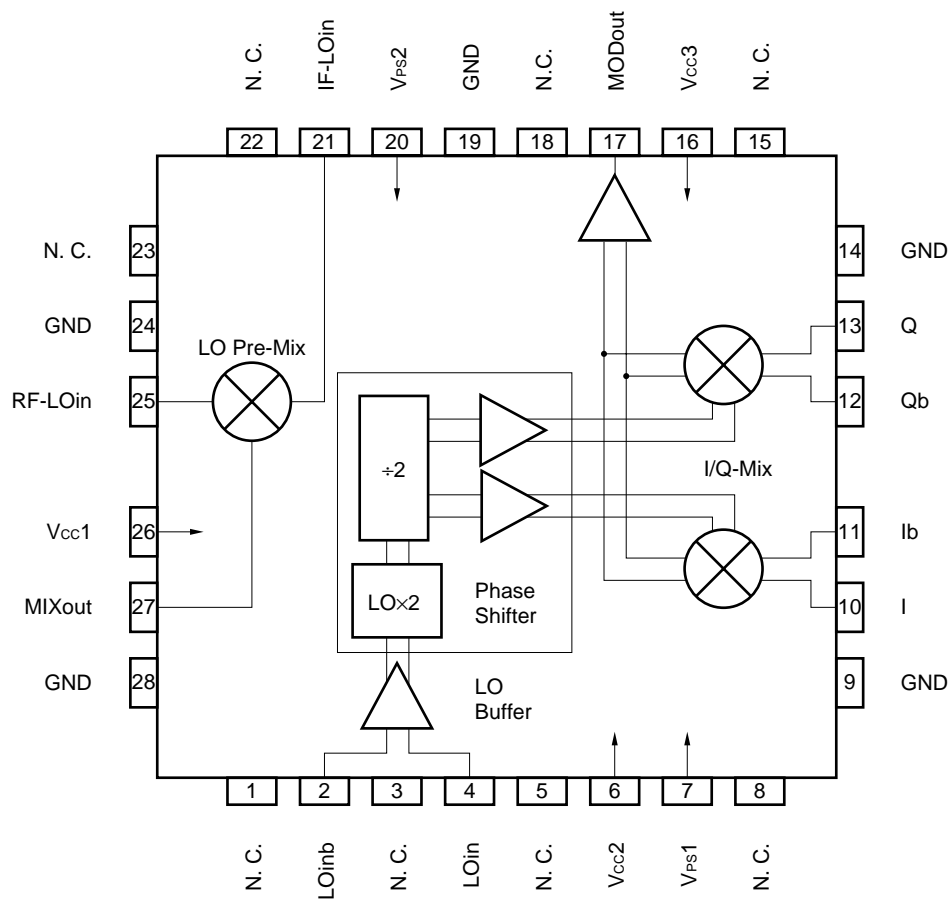
Remark To order evaluation samples, please contact your local NEC sales office .
(Part number for sample order: μ PC8126K)

Caution Electro-static sensitive device

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



INTERNAL BLOCK DIAGRAM AND PIN CONNECTIONS (Top View)



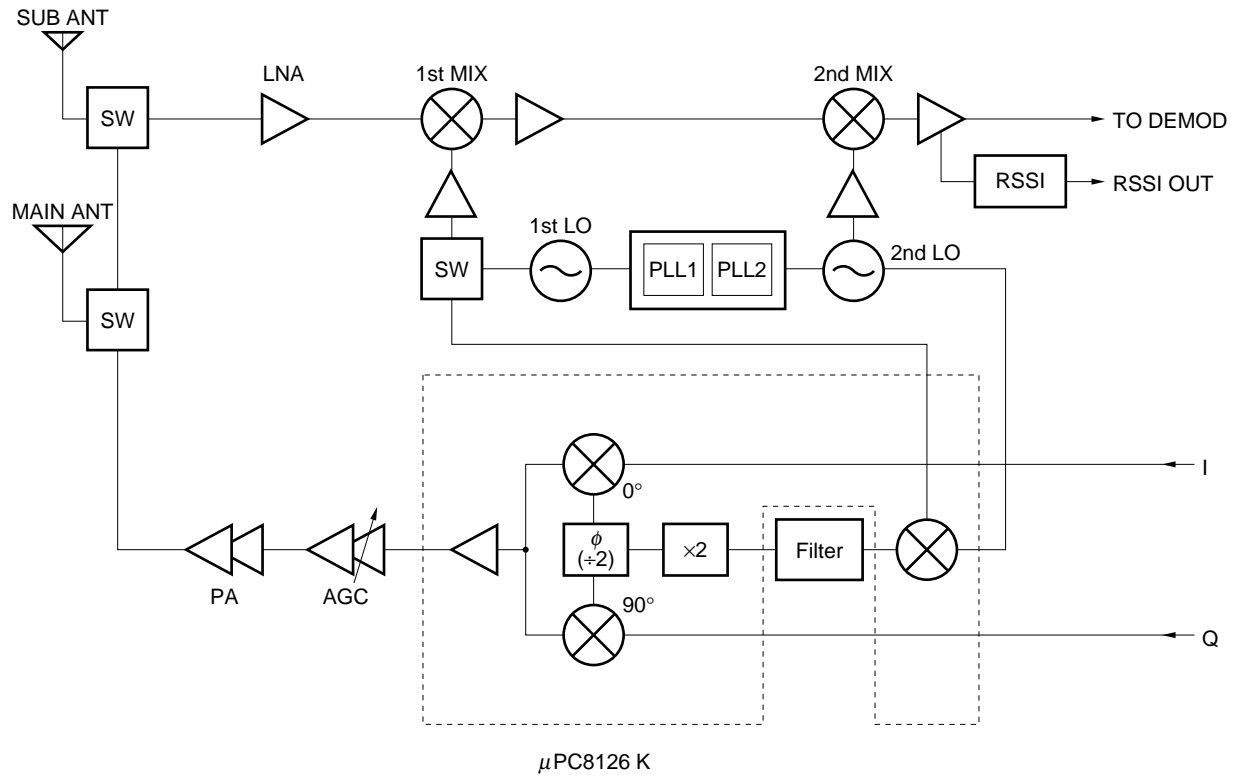
QUADRATURE MODULATOR SERIES PRODUCT

| Part Number | Functions | I _{CC} (mA) | f _{LO1in} (MHz) | f _{MODout} (MHz) | Up-Converter f _{RFout} (MHz) | Phase Shifter | Package | Application |
|---------------|--|--------------------------------|-----------------------------|------------------------------|--|------------------|---------------------------|-----------------------|
| μPC8101GR | 150 MHz Quad.Mod | 15/@2.7 V | 100 to 300 | 50 to 150 | External | F/F | 20-pin SSOP (225 mil) | CT-2 etc. |
| μPC8104GR | RF Up-Converter + IF Quad.Mod | 28/@3.0 V | 100 to 400 | | 900 to 1 900 | Doubler + F/F | 20-pin SSOP (225 mil) | Digital Comm. |
| μPC8105GR | 400 MHz Quad.Mod | 16/@3.0 V | 100 to 400 | | External | | | |
| μPC8110GR | 1 GHz Direct Quad.Mod | 24/@3.0 V | 800 to 1 000 | | Direct | | 20-pin SSOP (225 mil) | PDC800 MHz, etc. |
| μPC8125GR | RF Up-Converter + IF Quad.Mod + AGC | 36/@3.0 V | 220 to 270 | | 1 800 to 2 000 | | | PHS |
| μPC8126GR | 900 MHz Direct Quad.Mod with Offset-Mixer | 35/@3.0 V | 915 to 960 | | 915 to 960 (LO pre-mixer) | | | PDC800 MHz |
| μPC8126K | | | 889 to 960 | | 889 to 960 | | 28-pin QFN | |
| μPC8129GR | ×2LO IF Quad. Mod+RF Up-Converter | 28/@3.0 V | 200 to 800 | 100 to 400 | 800 to 1 900 | F/F | 20-pin SSOP (225 mil) | GSM, DCS1800, etc. |
| μPC8139GR-7JH | Transceiver IC (1.9 GHz Indirect Quad. Mod + RX-IF + IF VCO) | TX: 32.5 RX: 4.8 /@3.0 V | 220 to 270 | | 1 800 to 2 000 | CR | 30-pin TSSOP (225 mil) | PHS |
| μPC8158K | RF Up-Converter + IF Quad.Mod + AGC | 28/@3.0 V | 100 to 300 | | 800 to 1 500 | | 28-pin QFN | PDC800 M/1.5 G |

Remark For outline of the quadrature modulator series, please refer to the application note **Usage of μPC8101, 8104, 8105, 8125, 8129 (Document No. P13251E)** and so on.

APPLICATION EXAMPLE

[PDC800 MHz]



This block diagram presents the IC's location example applied in the system. The system block construction herein is an example.

ABSOLUTE MAXIMUM RATINGS

| Parameter | Symbol | Test Conditions | Rating | Unit |
|-------------------------------|------------------|---|-------------|------|
| Supply Voltage | V _{CC} | T _A = +25 °C | 4.0 | V |
| Power Save Control Voltage | V _{PS} | T _A = +25 °C | 4.0 | V |
| Power Dissipation | P _D | T _A = +85 °C ^{Note} | 430 | mW |
| Operating Ambient Temperature | T _A | | –40 to +85 | °C |
| Storage Temperature | T _{stg} | | –55 to +150 | °C |

Note Mounted on a 50 × 50 × 1.6 mm double sided copper clad epoxy glass PWB.

RECOMMENDED OPERATING CONDITIONS

| Parameter | Symbol | Test Conditions | MIN. | TYP. | MAX. | Unit |
|--|---|-----------------------------------|-------|-------|-------|-------------------|
| Supply Voltage | V _{CC} | | 2.7 | 3.0 | 3.6 | V |
| Operating Ambient Temperature | T _A | | –25 | +25 | +75 | °C |
| Pre-Mix. RF Input Frequency | f _{RFin} | | 689 | – | 1 200 | MHz |
| Pre-Mix. RF Input Power | P _{RFin} | | –13 | –11 | –9 | dBm |
| Pre-Mix. IF Input Frequency | f _{IFin} | P (f _{IF} × 7) ≤ –65 dBc | 120 | 135 | 270 | MHz |
| Pre-Mix. IF Input Power | P _{IFin} | | –14 | –12 | –10 | dBm |
| Pre-Mix. Output Frequency (Modulator Output Frequency, Modulator LO Input Frequency) | f _{MIXout} (f _{MODout} , f _{LOin}) | f _{IFin} = 200 MHz | 889 | – | 898 | MHz |
| | | f _{IFin} = 135 MHz | 915 | – | 960 | MHz |
| Modulator LO Input Power | P _{LOin} | | –21.5 | –18.5 | –15.5 | dBm |
| I/Q Input Frequency | f _{I/Qin} | | DC | – | 10 | MHz |
| I/Q Input Amplitude | V _{I/Qin} | Single ended Input | – | – | 500 | mV _{P-P} |
| | | Differential Input | – | – | 250 | |

ELECTRICAL CHARACTERISTICS

(T_A = +25°C, V_{cc1} = V_{cc2} = V_{cc3} = 3.0 V, V_{ps1}, V_{ps2} ≥ 2.2 V unless otherwise specified)

| Parameter | | Symbol | Test Conditions | MIN. | TYP. | MAX. | Unit |
|---|-----------|---------------------------|---|------|------|------|------|
| MODULATOR + PRE-MIXER TOTAL (TEST CIRCUIT 1 unless otherwise specified) | | | | | | | |
| Total Circuit Current | | I _{cc} (TOTAL) | No Input Signals | 24 | 35 | 44 | mA |
| Total Circuit Current at Sleep Mode | | I _{cc(PS)} TOTAL | V _{PS} ≤ 0.5 V (Low), No Input Signals | – | 0 | 15 | μA |
| Modulator Output Power | | P _{MODout} | f _{IFin} = 135 MHz, P _{IFin} = –12 dBm f _{RFin} = 813 MHz, P _{RFin} = –11 dBm | –12 | –9 | –6 | dBm |
| Local Oscillator Leakage | | LOL ^{Note} | f _{MODout} = 948 MHz + f _{I/Q} f _{I/Qin} = 2.625 kHz | – | –35 | –30 | dBc |
| Image Rejection | | ImR | V _{I/Qin} = 500 mV _{P-P} (Single ended) I/Q (DC) = I _b /Q _b (DC) = V _{cc} /2 | – | –40 | –30 | dBc |
| I/Q 3rd Order Intermodulation | | IM _{3(I/Q)} | Data Rate: 42 kbps, RNYQ: α = 0.5 | – | –45 | –30 | dBc |
| f _{IF-LO} × 7 Harmonics | | P (f _{IF} × 7) | MOD Pattern: All Zero | – | – | –65 | dBc |
| Power Save Response Time | Rise Time | T _{PS} (RISE) | V _{PS} : Low to High, TEST CIRCUIT 2 | – | 3 | 5 | μs |
| | Fall Time | T _{PS} (FALL) | V _{PS} : High to Low, TEST CIRCUIT 2 | – | 3 | 5 | μs |
| Error Vector Magnitude | | EVM | f _{IFin} = 135 MHz, P _{IFin} = –12 dBm f _{RFin} = 813 MHz, P _{RFin} = –11 dBm f _{MODout} = 948 MHz + f _{I/Q} f _{I/Qin} = 2.625 kHz V _{I/Qin} = 500 mV _{P-P} (Single ended) | – | 1.6 | 3.5 | %rms |
| Adjacent Channel Power | | ACP (Δf = ±50 kHz) | I/Q (DC) = I _b /Q _b (DC) = V _{cc} /2 Data Rate: 42 kbps, RNYQ: α = 0.5 MOD Pattern: PN9 (Pseudo-random pattern) | – | –65 | –60 | dBc |
| Port Current-7 pin | | I _{PS} (7 pin) | No Input Signals | – | – | 620 | μA |
| Port Current-17 pin | | I _{PS} (17 pin) | No Input Signals | – | – | 400 | μA |

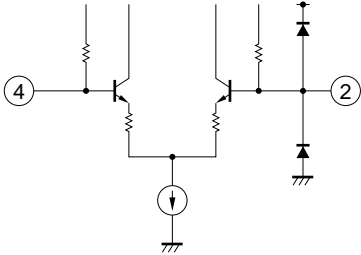

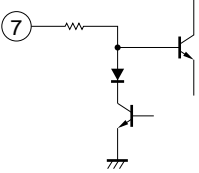

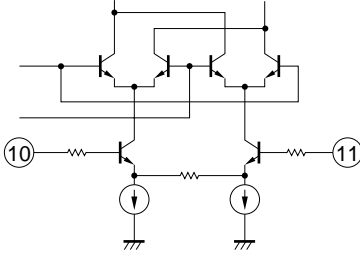
Note f_{LOL} = f_{IFin} + f_{RFin}

STANDARD CHARACTERISTICS FOR REFERENCE

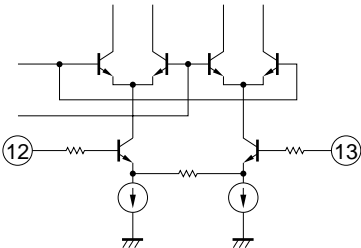


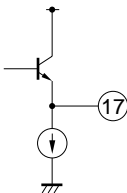

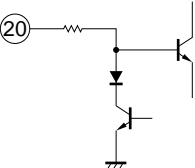
(T_A = +25°C, V_{cc1} = V_{cc2} = V_{cc3} = 3.0 V, V_{PS1}, V_{PS2} ≥ 2.2 V unless otherwise specified)

| Parameter | Symbol | Test Conditions | MIN. | TYP. | MAX. | Unit |
|---|----------------------------|--|------|-------|------|------|
| MODULATOR (TEST CIRCUIT 3) | | | | | | |
| Modulator Circuit Current | I _{CC} (MOD) | No Input Signals | – | 27.5 | 34 | mA |
| Modulator Circuit Current at Sleep Mode | I _{CC (PS)} (MOD) | V _{PS} ≤ 0.5 V (Low), No Input Signals | – | 0 | 10 | μA |
| Input Impedance I and Q Port | Z _{I/Qin} | f _{I/Q} = DC to 10 MHz | 90 | 180 | – | kΩ |
| Modulator Output Port VSWR | VSWR (MOD) | f _{MODout} = 948 MHz | – | 1.5:1 | – | – |
| PRE-MIXER (TEST CIRCUIT 4) | | | | | | |
| Pre-Mixer Circuit Current | I _{CC} (MIX) | No Input Signals | – | 7.5 | 10 | mA |
| Pre-Mixer Circuit Current at Sleep Mode | I _{CC (PS)} (MIX) | V _{PS} ≤ 0.5 V (Low), No Input Signals | – | 0 | 5 | μA |
| Pre-Mixer Conversion Gain | CG (MIX) | f _{RFin} = 813 MHz, P _{RFin} = –11 dBm f _{IFin} = 135 MHz, P _{IFin} = –12 dBm | –5 | –3 | –1 | dB |
| Pre-Mixer Output Power | P _{out} (MIX) | f _{MIXout} = 948 MHz | –17 | –15 | –13 | dBm |

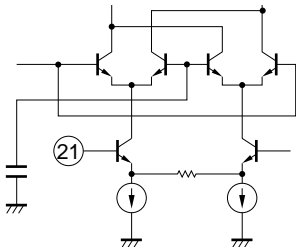

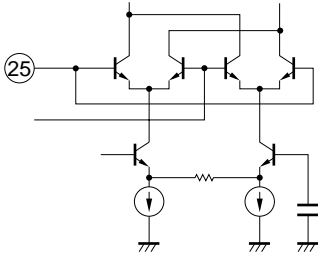

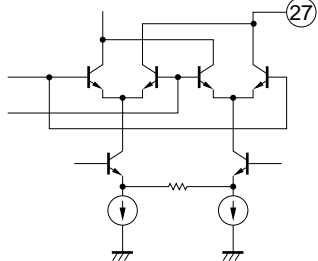


PIN EXPLANATIONS

| Pin No. | Symbol | Supply Voltage (V) | Pin Voltage (V) @3 V | Description | Equivalent Circuit | | | | | | |
|------------|------------------|--------------------|----------------------|---|---|-------|------------|------------------|----------|------------------|--|
| 2 | LOinb | — | 2.6 | Bypass of LO input for modulator. This pin should be externally grounded through around 33 pF capacitor. |  | | | | | | |
| 4 | LOin | — | 2.6 | LO input for the phase shifter. Connect around 300 Ω between pin 4 and 5 to match to 50 Ω by LC. | | | | | | | |
| 6 | Vcc2 | 2.7 to 3.6 | — | Supply voltage pin for the phase shifter and IQ Mixer. An internal regulator helps keep the device stable against temperature or Vcc variation. |  | | | | | | |
| 7 | Vps1 (Modulator) | Vps | — | Power save control pin for the modulator can control On/Sleep state with bias as follows. <table border="1" data-bbox="573 1039 924 1173"><thead><tr><th>Vps (V)</th><th>State</th></tr></thead><tbody><tr><td>2.2 to 3.6</td><td>ON (Active Mode)</td></tr><tr><td>0 to 0.5</td><td>OFF (Sleep Mode)</td></tr></tbody></table> | Vps (V) | State | 2.2 to 3.6 | ON (Active Mode) | 0 to 0.5 | OFF (Sleep Mode) |  |
| Vps (V) | State | | | | | | | | | | |
| 2.2 to 3.6 | ON (Active Mode) | | | | | | | | | | |
| 0 to 0.5 | OFF (Sleep Mode) | | | | | | | | | | |
| 9 | GND (Modulator) | 0 | — | Ground pin for the modulator. Connect to the ground with minimum inductance. Track length should be kept as short as possible. |  | | | | | | |
| 10 | I | Vcc/2 | — | Input for I signal. This input impedance is 180 kΩ. In case of that I/Q input signals are single ended, amplitude of the signal is 500 mV _{P-P} max. Note |  | | | | | | |
| 11 | Ib | Vcc/2 | — | Input for I signal. This input impedance is 180 kΩ. In case of that I/Q input signals are single ended, Vcc/2 biased DC signal should be input. In case of that I/Q input signals are differential, amplitude of the signal is 250 mV _{P-P} max. Note | | | | | | | |

Note Relations between amplitude and V_{cc}/2 bias of input signal are following.

| Pin No. | Symbol | Supply Voltage (V) | Pin Voltage (V) @3 V | Description | Equivalent Circuit | | | | | | |
|---------------------|-----------------------------|--------------------|----------------------|--|---|-------|------------|------------------|----------|------------------|---|
| 12 | Qb | V _{cc} /2 | — | Input for Q signal. This input impedance is 180 kΩ. In case of that I/Q input signals are single ended, V _{cc} /2 biased DC signal should be input. In case of that I/Q input signals are differential, amplitude of the signal is 250 mV _{P-P} max. Note |  | | | | | | |
| 13 | Q | V _{cc} /2 | — | Input for Q signal. This input impedance is 180 kΩ. In case of that I/Q input signals are single ended, amplitude of the signal is 500 mV _{P-P} max. Note | | | | | | | |
| 14 | GND (Modulator) | 0 | — | Ground pin for the modulator. Connect to the ground with minimum inductance. Track length should be kept as short as possible. |  | | | | | | |
| 16 | V _{cc} 3 | 2.7 to 3.6 | — | Supply voltage pin for the output buffer amplifier of modulator. An internal regulator helps keep the device stable against temperature or V _{cc} variation. |  | | | | | | |
| 17 | MODout | — | 1.6 | Output pin from the modulator. This is emitter follower output. So this output impedance is low. |  | | | | | | |
| 19 | GND (Modulator) | 0 | — | Ground pin for the modulator. Connect to the ground with minimum inductance. Track length should be kept as short as possible. |  | | | | | | |
| 20 | V _{PS} 2 (Pre-Mix) | V _{PS} | — | Power save control pin can control the On/Sleep state with bias as follows. <table border="1" data-bbox="651 1682 1002 1822"><tr><th>V_{PS} (V)</th><th>State</th></tr><tr><td>2.2 to 3.6</td><td>ON (Active Mode)</td></tr><tr><td>0 to 0.5</td><td>OFF (Sleep Mode)</td></tr></table> | V _{PS} (V) | State | 2.2 to 3.6 | ON (Active Mode) | 0 to 0.5 | OFF (Sleep Mode) |  |
| V _{PS} (V) | State | | | | | | | | | | |
| 2.2 to 3.6 | ON (Active Mode) | | | | | | | | | | |
| 0 to 0.5 | OFF (Sleep Mode) | | | | | | | | | | |

Note Relations between amplitude and $V_{CC}/2$ bias of input signal are following.

| Pin No. | Symbol | Supply Voltage (V) | Pin Voltage (V) @3 V | Description | Equivalent Circuit |
|----------------------------|-----------------------------|--------------------|----------------------|---|---|
| 21 | IF-LOin | — | 1.3 | IF input pin for the Pre-Mixer. This pin is biased internally. Capacitor should be connected in series, and grounded through 51 Ω . |  |
| 24 | GND (Pre-Mix) | 0 | — | Ground pin for Pre-Mixer. Connect to the ground with minimum inductance. Track length should be kept as short as possible. |  |
| 25 | RF-LOin | — | 2.3 | RF input pin for the Pre-Mixer. This pin is biased internally. Capacitor should be connected in series, and grounded through 51 Ω . |  |
| 26 | V _{CC} 1 (Pre-Mix) | 2.7 to 3.6 | — | Supply voltage pin for the Pre-Mixer. An internal regulator helps keep the device stable against temperature or V _{CC} variation. |  |
| 27 | Pre-Mixout | 2.7 to 3.6 | — | Output from the Pre-Mixer. This pin is designed as open collector. Due to the high impedance output, this pin should be externally equipped with LC matching circuit to next stage. |  |
| 28 | GND (Modulator) | 0 | — | Ground pin for the modulator. Connect to the ground with minimum inductance. Track length should be kept as short as possible. |  |
| 1, 3, 5, 8, 15, 18, 22, 23 | N.C. | — | — | Non connection pins. |  |

RELATION BETWEEN I/Q PIN INPUT DC VOLTAGE AND AMPLITUDE

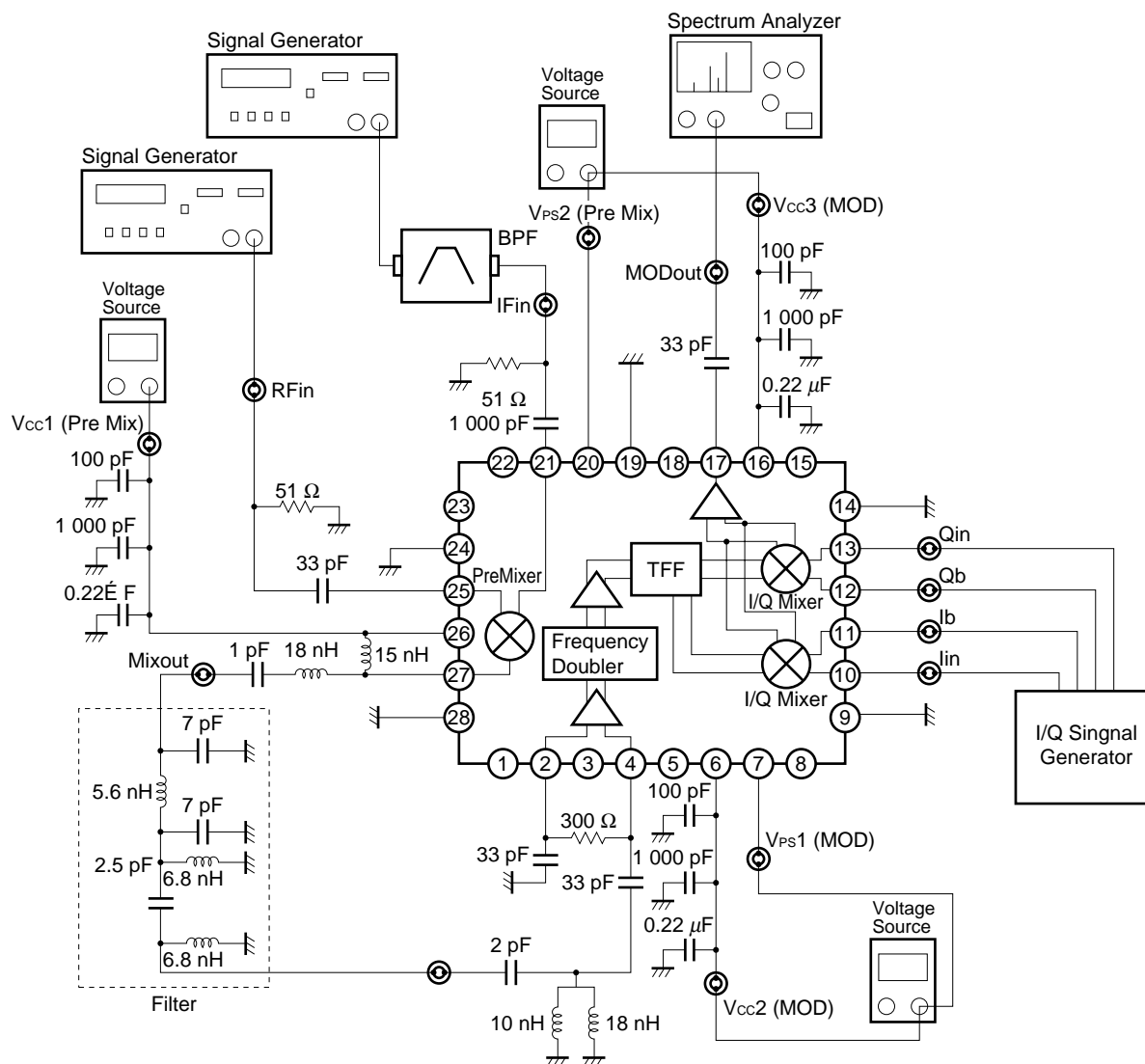
| Supply Voltage (V) V_{CC} | I/Q DC Voltage (V) $V_{CC}/2 = I = Ib = Q = Qb$ | I/Q input signal (mV _{P-P}) | |
|--------------------------------|--|---------------------------------------|---|
| | | Single ended input $I = Q$ | Differential input $I = Ib = Q = Qb$ |
| 2.7 to 3.6 | 1.35 to 1.8 | ≤ 500 | ≤ 250 |

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. | <p>The block diagram illustrates the internal signal processing. It begins with an input 'from LOin' which passes through a frequency doubler block labeled 'x2'. The output of the doubler then goes through a divider block labeled '÷2F/F'. This signal is then split into two paths, each passing through a buffer amplifier (represented by a triangle). The outputs of these buffer amplifiers are fed into two mixers, represented by circles with an 'X'. The first mixer has inputs 'I' and 'Ib', and the second mixer has inputs 'Qb' and 'Q'. The outputs of the mixers are then combined in an adder block (represented by a triangle) to produce the final output, labeled 'to MODout'.</p> |
| 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. | |

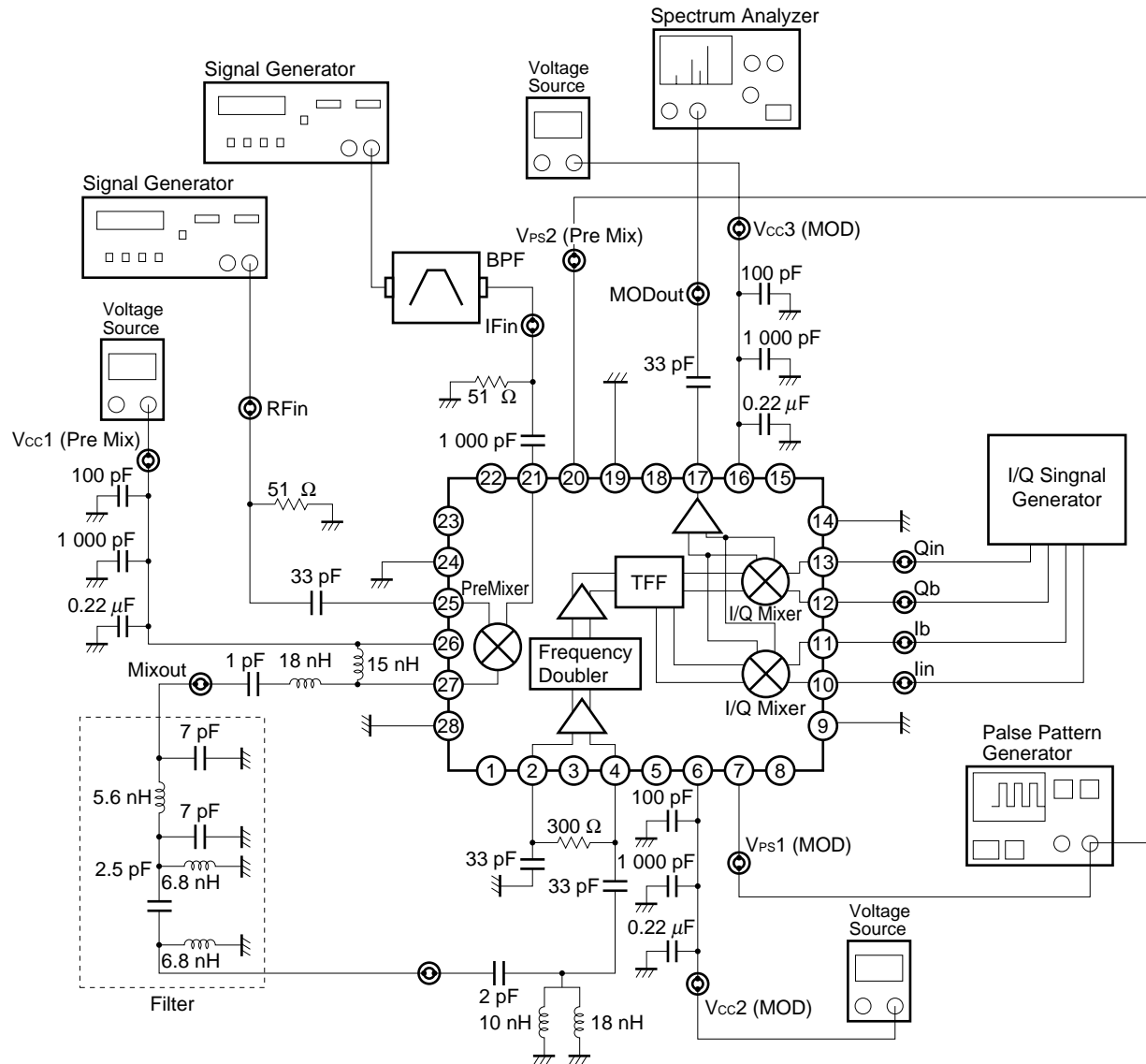
TEST CIRCUIT 1

Pre-mixer + Quadrature modulator (except Power save response time)



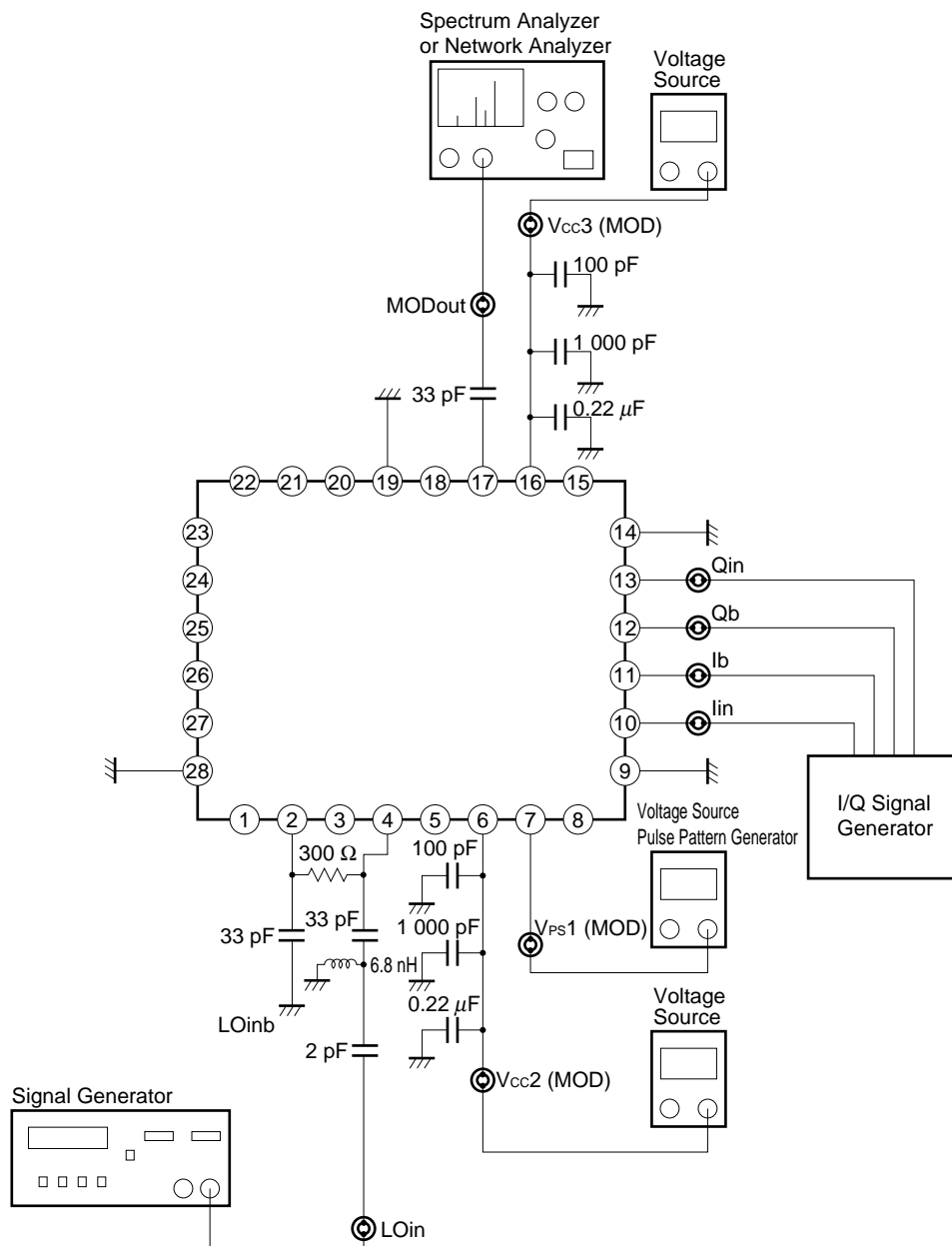
TEST CIRCUIT 2

Pre-mixer + Quadrature modulator (for Power save response time)



TEST CIRCUIT 3

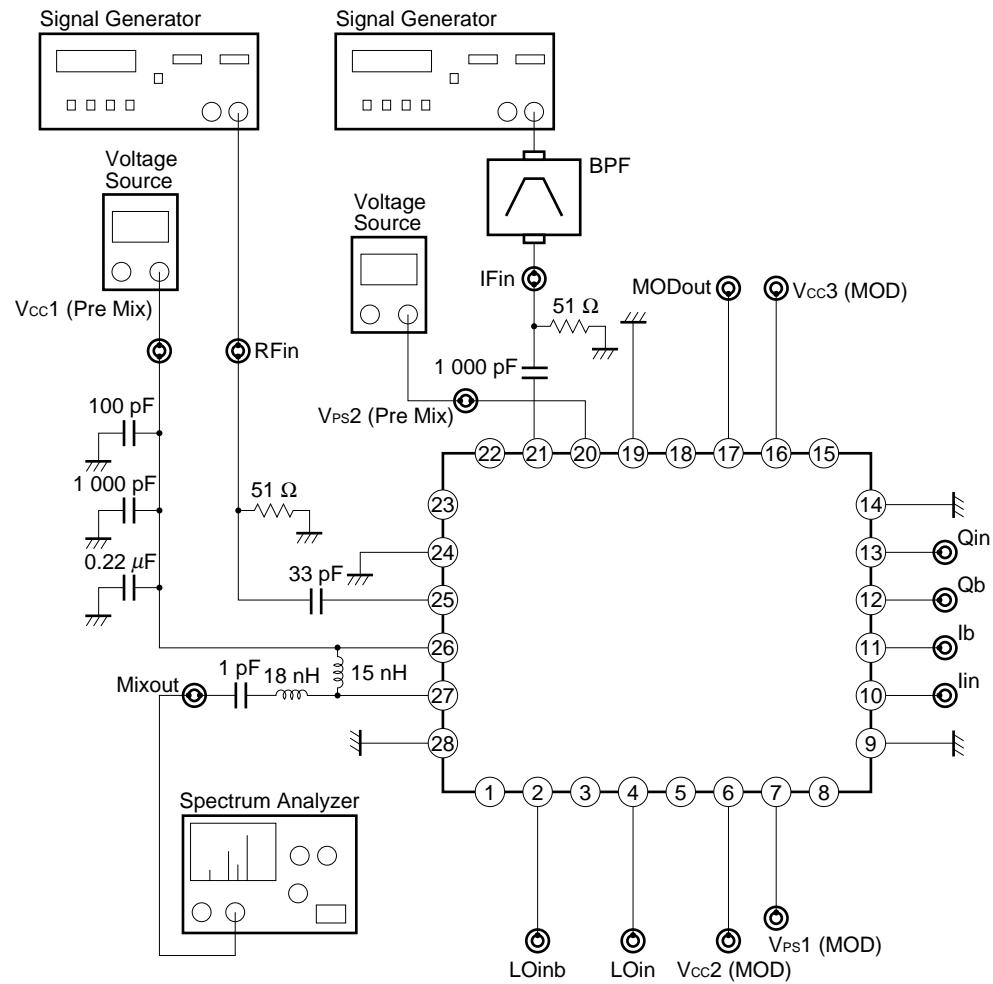
Quadrature modulator block



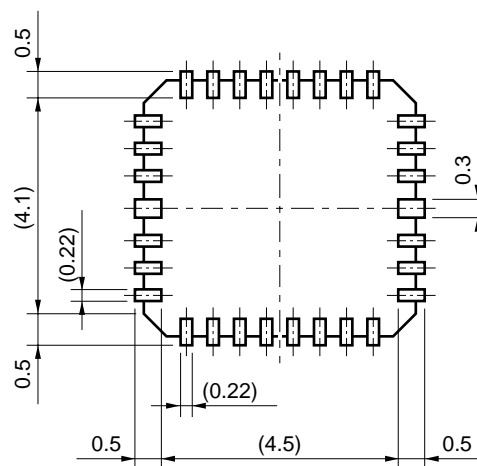
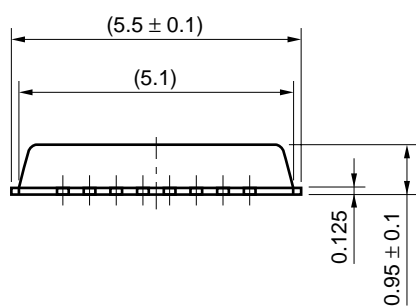
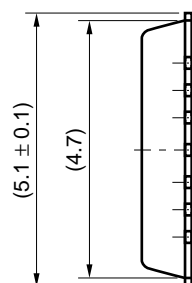
In this case, pin 20 to 27 should be opened or grounded.

TEST CIRCUIT 4

Pre-mixer block



28 pin plastic QFN (UNIT: mm)



Bottom View

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 operation).
- (3) Keep the track length between the ground pins as short as possible.
- (4) Connect a bypass capacitor (example 1 000 pF) to the V_{CC} pin.

RECOMMENDED SOLDERING CONDITIONS

This product should be soldered under the following recommended condition. For soldering methods and conditions other than those recommended below, contact your NEC sales representative.

| Soldering Method | Soldering Conditions | Recommended Condition Symbol |
|------------------|--|------------------------------|
| Infrared Reflow | Package peak temperature: 235°C or below Time: 30 seconds or less (at 210°C) Count: 2, Exposure limit ^{Note} : None | IR35-00-2 |
| Partial Heating | Pin temperature: 300°C Time: 3 seconds or less (per side of device) Exposure limit ^{Note} : None | — |

Note After opening the dry pack, keep it in a place below 25°C and 65% RH for the allowable storage period.

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

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

[MEMO]

[MEMO]

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

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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.

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Anti-radioactive design is not implemented in this product.