

ASSP

# 1.0 GHz band Low Power I/Q Modulator For Direct Conversion

## MB54608L/MB54608B

### ■ DESCRIPTION

The MB54608L/B is an I/Q Modulator for direct conversion method, and is used for up to 1.0 GHz band digital cellular phones such as GSM, PDC and so on.

MB54608L consists of a frequency doubler, a Flip-flop type quadrature phase shifter, I/Q modulator and a mixer for frequency offset with a separate power supply.

Fujitsu's advanced Bipolar process has realized very low current operation( $I_{CC} = 16.5 \text{ mA}$  @3 V).

SSOP-20 and BCC-16 package are available.(MB54608L: SSOP-20, MB54608B: BCC-16)

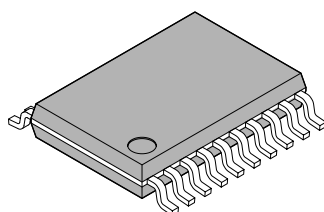
### ■ FEATURES

- Supporting GSM frequency band  
Output frequency: 1.0 GHz (max.)    Output power: -4 dBm(Typical,  $V_{BB} = 1.0 \text{ Vp-p}$  input)
- Low voltage operation:  $V_{CC} = 2.6 \text{ V}$  to 3.8 V

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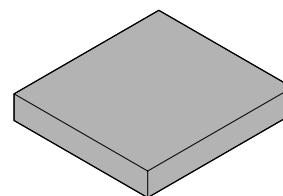
### ■ PACKAGES

20-pin plastic SSOP



(FPT-20P-M03)

16-pad plastic BCC



(LCC-16P-M04)

# MB54608L/MB54608B

(Continued)

- Low current: Please refer to below table.
- Offset mixer on-chip: The separate power supply control is possible. (only MB54608L)
- Output power level switch (Mode) enables high power mode

|                  |   | Offset Mixer not used |            | Offset Mixer used |            |
|------------------|---|-----------------------|------------|-------------------|------------|
|                  |   | Mode = Open           | Mode = GND | Mode = Open       | Mode = GND |
| Normal operation | I <sub>cc</sub>   | 16.5 mA               | 19.0 mA    | 22.5 mA           | 25.0 mA    |
|                  | P <sub>out</sub> (V <sub>BB</sub> =1.0 V <sub>p-p</sub> ) | −4 dBm                | −2 dBm     | −4 dBm            | −2 dBm     |
| Power down       | I <sub>ps</sub>   | 0.22 mA               |            | 0.44 mA           |            |

Note: Typical values

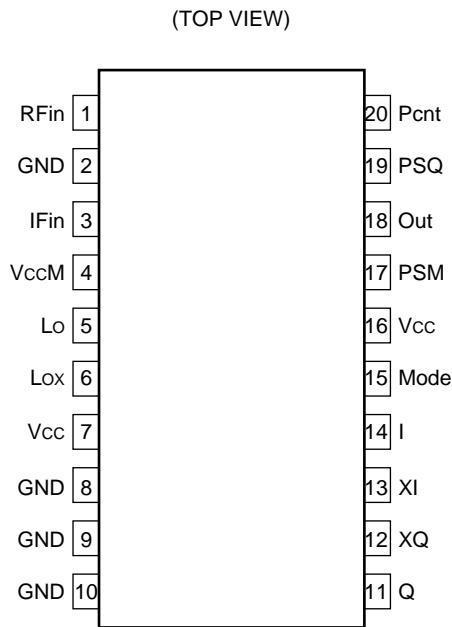
Further increase of the output power is possible by attaching a resistor at P<sub>cnt</sub> pin.

- Operating temperature range: T<sub>a</sub> = −20 to +75°C

# MB54608L/MB54608B

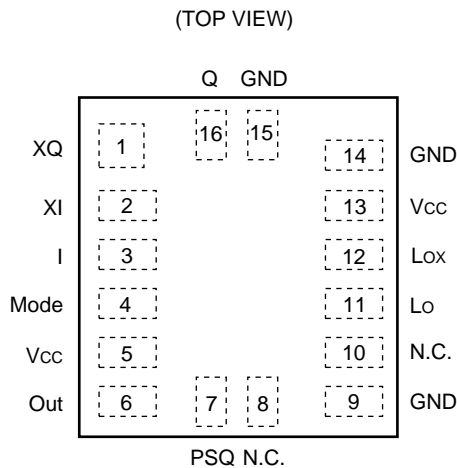
## PIN ASSIGNMENTS

• MB54608L (SSOP-20)



(FPT-20P-M03)

• MB54608B (BBC-16)



(LCC-16P-M04)

Note: MB54608B doesn't have the off-set Mixer and Pcnt pin.

# MB54608L/MB54608B

## ■ PIN DESCRIPTIONS

### • MB54608L (SSOP-20)

| Pin no. | Symbol | I/O | Descriptions   |
|---------|--------|-----|--|
| 1       | RFin   | I   | RF input for the offset mixer. When the offset mixer is not used, this pin should be opened.   |
| 2       | GND    | —   | Ground.  |
| 3       | IFin   | I   | IF input for the offset mixer. When the offset mixer is not used, this pin should be opened.   |
| 4       | VccM   | —   | Power supply for the offset mixer. Power-on/off is possible indepently to the modulator. When the offset mixer is not used, this pin should be switched OFF.                               |
| 5       | Lo     | I/O | Lo input for the I/Q modulator (Output for the offset mixer.)  |
| 6       | Lox    | I/O | Lo complementary input for the I/Q modulator (Complementary output for the offset mixer.)  |
| 7       | Vcc    | —   | Power supply for the I/Q modulator.  |
| 8       | GND    | —   | Ground.  |
| 9       | GND    | —   | Ground.  |
| 10      | GND    | —   | Ground.  |
| 11      | Q      | I   | Q signal input for the I/Q modulator.  |
| 12      | XQ     | I   | Q signal complementary input for the I/Q modulator.  |
| 13      | XI     | I   | I signal complementary input for the I/Q modulator.  |
| 14      | I      | I   | I signal input for the I/Q modulator.  |
| 15      | Mode   | —   | Output mode switch. Mode = Open: Low power mode.<br>Mode = GND: High power mode.<br>This pin should be connected to ground or left open.   |
| 16      | Vcc    | —   | Power supply for the I/Q modulator.  |
| 17      | PSM    | I   | Power saving control for the offset mixer. When PSM = L(GND), power down mode is selected. When the offset mixer is not used, this pin should be connected to Vcc voltage level or ground. |
| 18      | Out    | O   | Output for the I/Q modulator. (Open collector)<br>Open is prohibited when power is supplied to Vcc pin.  |
| 19      | PSQ    | I   | Power saving control for the I/Q modulator. When PSQ = L(GND), power down mode is selected.  |
| 20      | Pcnt   | —   | Further, increasing the output power level is possible by attaching a resistor between Pcnt pin and ground externally.   |

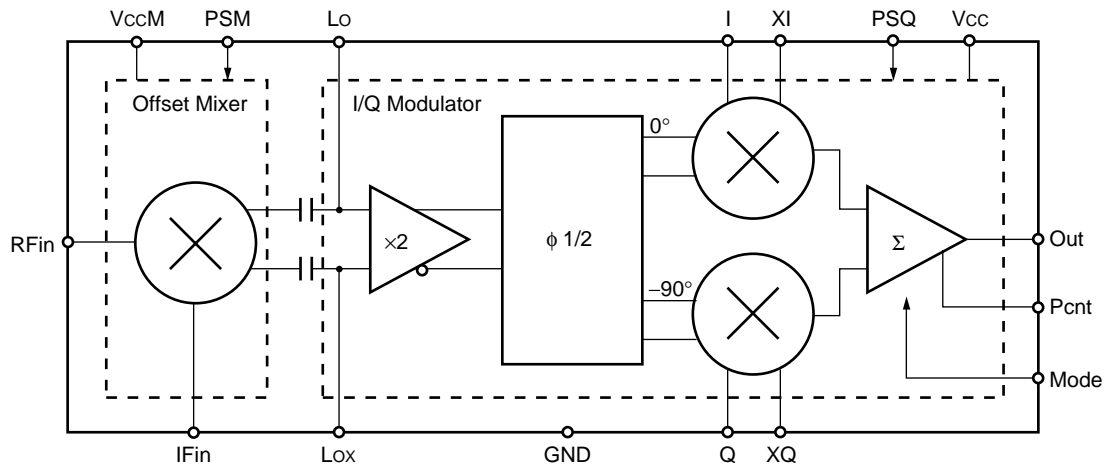
# MB54608L/MB54608B

## • MB54608B (BCC-16)

| Pin no. | Pin name | I/O | Descriptions   |
|---------|----------|-----|--|
| 1       | XQ       | I   | Q signal complementary input for the I/Q modulator.  |
| 2       | XI       | I   | I signal complementary input for the I/Q modulator.  |
| 3       | I        | I   | I signal input for the I/Q modulator.  |
| 4       | Mode     | —   | Output mode switch. Mode=Open: Low power mode.<br>Mode=GND: High power mode.<br>This pin should be connected to ground or left open. |
| 5       | Vcc      | —   | Power supply for the I/Q modulator.  |
| 6       | Out      | O   | Output for the I/Q modulator. (Open collector)<br>Open is prohibited when power is supplied to Vcc pin.                              |
| 7       | PSQ      | I   | Power saving control for the I/Q modulator. When PSQ = L(GND), power down mode is selected.  |
| 8       | N.C.     | —   | No connection.   |
| 9       | GND      | —   | Ground.  |
| 10      | N.C.     | —   | No connection.   |
| 11      | Lo       | I/O | Lo input for the I/Q modulator (Output for the offset mixer.)  |
| 12      | Lox      | I/O | Lo complementary input for the I/Q modulator (Complementary output for the offset mixer.)  |
| 13      | Vcc      | —   | Power supply for the I/Q modulator.  |
| 14      | GND      | —   | Ground.  |
| 15      | GND      | —   | Ground.  |
| 16      | Q        | I   | Q signal input for the I/Q modulator.  |

# MB54608L/MB54608B

## ■ BLOCK DIAGRAM



Note: MB54608B doesn't have VccM, PSM, RFin, IFin and Pcnt pins.

# MB54608L/MB54608B

## ■ ABSOLUTE MAXIMUM RATINGS

| Parameter                                 | Symbol    | Rating                |                       | Unit | Remarks                      |
|---|-----------|-----------------------|-----------------------|------|------------------------------|
|   |           | Min.                  | Max.                  |      |                              |
| Power supply voltage                      | $V_{CC}$  | -0.5                  | +5.0                  | V    |                              |
| Output voltage                            | $V_O$     | -0.5                  | $V_{CC} + 0.5$ (<5.0) | V    |                              |
| Input voltage                             | $V_I$     | -0.5                  | $V_{CC} + 0.5$ (<5.0) | V    |                              |
| Allowed voltage on the open collector pin | $V_{OC}$  | $V_{CC} - 0.3$ (-0.5) | $V_{CC} + 0.3$ (5.0)  | V    | Out pin, Open is prohibited. |
| Output current                            | $I_O$     | 0                     | +10                   | mA   |                              |
| Storage temperature                       | $T_{stg}$ | -55                   | +125                  | °C   |                              |

**WARNING:** Semiconductor devices can be permanently damaged by application of stress (voltage, current, temperature, etc.) in excess of absolute maximum ratings. Do not exceed these ratings.

## ■ RECOMMENDED OPERATING CONDITIONS

| Parameter                                 | Symbol   | Value          |      |                | Unit | Remarks                      |
|---|----------|----------------|------|----------------|------|------------------------------|
|   |          | Min.           | Typ. | Max.           |      |                              |
| Power supply voltage                      | $V_{CC}$ | 2.6            | 3.0  | 3.8            | V    |                              |
| Input voltage                             | $V_I$    | GND            | —    | $V_{CC}$       | V    |                              |
| Allowed voltage on the open collector pin | $V_{OC}$ | $V_{CC} - 0.2$ | —    | $V_{CC} + 0.2$ | V    | Out pin. Open is prohibited. |
| Operating temperature                     | $T_a$    | -20            | —    | +75            | V    | Ambient temperature.         |

**WARNING:** The recommended operating conditions are required in order to ensure the normal operation of the semiconductor device. All of the device's electrical characteristics are warranted when the device is operated within these ranges.

Always use semiconductor devices within their recommended operating condition ranges. Operation outside these ranges may adversely affect reliability and could result in device failure.

No warranty is made with respect to uses, operating conditions, or combinations not represented on the data sheet. Users considering application outside the listed conditions are advised to contact their FUJITSU representatives beforehand.

# MB54608L/MB54608B

## ■ ELECTRICAL CHARACTERISTICS

### 1. DC CHARACTERISTICS (MB54608L, MB54608B)

(Ta = +25°C, V<sub>CC</sub> = 3.0 V)

| Parameter                    | Symbol            | Value                 |      |                       | Unit | Remarks                           |            |                         |                |
|------------------------------|-------------------|-----------------------|------|-----------------------|------|-----------------------------------|------------|-------------------------|----------------|
|                              |                   | Min.                  | Typ. | Max.                  |      |                                   |            |                         |                |
| Power supply current         | I <sub>CC</sub>   |                       |      |                       |      | Offset mix.                       | Mode pin   | DC. No AC signal input. |                |
|                              |                   | 12.0                  | 16.5 | 24.5                  | mA   | Not used                          | Open       |                         |                |
|                              |                   | 13.5                  | 19.0 | 28.0                  | mA   | Not used                          | GND        |                         |                |
|                              |                   | 16.0                  | 22.5 | 33.5                  | mA   | Used                              | Open       |                         |                |
|                              |                   | 18.0                  | 25.0 | 37.0                  | mA   | Used                              | GND        |                         |                |
| Power down current           | I <sub>PS</sub>   | —                     | 220  | 310                   | μA   | Not used                          | Don't care |                         |                |
|                              |                   | —                     | 440  | 620                   | μA   | Used                              |            |                         |                |
| Power down pin input voltage | V <sub>IHPS</sub> | V <sub>CC</sub> × 0.7 | —    | —                     | V    |                                   |            |                         |                |
|                              | V <sub>ILPS</sub> | —                     | —    | V <sub>CC</sub> × 0.3 | V    |                                   |            |                         |                |
| Power down pin input current | I <sub>IHPS</sub> | —                     | —    | 5.0                   | μA   | V <sub>IH</sub> = V <sub>CC</sub> |            |                         | PSM, PSQ Value |
|                              | I <sub>ILPS</sub> | −50                   | —    | —                     | μA   | V <sub>IL</sub> = GND             |            |                         |                |
| Pcnt pin load resistance     | R <sub>cnt</sub>  | 50                    | —    | —                     | Ω    |                                   |            |                         |                |

Note: MB54608B doesn't have Offset mix., so please refer to "offset mix. = Not used" column in regard to power supply current.

# MB54608L/MB54608B

## 2. AC CHARACTERISTICS

- A case of the offset mixer is used. (only MB54608L)

(Ta = +25°C, Vcc = 3.0 V)

| Parameter              |                        | Symbol           | Value |        |      | Unit | Remarks                                |  |
|------------------------|------------------------|------------------|-------|--------|------|------|--|--|
|                        |                        |                  | Min.  | Typ.   | Max. |      |  |  |
| Baseband input         | Operating band         | f <sub>BB</sub>  | DC    | —      | 10   | MHz  |  |  |
|                        | Input amplitude        | V <sub>BB</sub>  | 0.3   | 1.0    | 1.3  | Vp-p | Single ended input                     |  |
|                        | Offset voltage         | V <sub>OS</sub>  | 1.4   | 1.5    | 1.6  | V    | External offset voltage                |  |
|                        | Offset current         | I <sub>OS</sub>  | —     | 3.0    | 4.0  | μA   |  |  |
| Offset Mixer           | Operating band         | f <sub>RF</sub>  | —     | 1078.5 | 1100 | MHz  |  |  |
|                        |                        | f <sub>IF</sub>  | —     | 130.5  | 500  | MHz  |  |  |
|                        |                        | f <sub>LO</sub>  | 800   | 948    | 1000 | MHz  | Output                                 |  |
|                        | Input power level      | P <sub>RF</sub>  | −15   | −10    | 0    | dBm  |  |  |
|                        |                        | P <sub>IF</sub>  | −15   | −10    | 0    | dBm  |  |  |
| RF output              | Operating band         | f <sub>OUT</sub> | 800   | 948    | 1000 | MHz  |  |  |
|                        | SSB output power level | P <sub>OUT</sub> | −8    | −4     | −    | dBm  | Mode pin is opened                     | V <sub>BB</sub> = 1.0 Vp-p (single ended input)<br>f <sub>RF</sub> = 1078.5 MHz<br>P <sub>RF</sub> = −10 dBm<br>f <sub>IF</sub> = 130.5 MHz<br>P <sub>IF</sub> = −10 dBm<br>f <sub>OUT</sub> = 948 MHz |
|                        |                        |                  | −6    | −2     | −    | dBm  | Mode pin is grounded                   |  |
| Modulation accuracy    | Amplitude error        | A <sub>ERR</sub> | —     | 2.0    | 3.0  | %    | RMS value                              |  |
|                        | Phase error            | P <sub>ERR</sub> | —     | 1.5    | 2.0  | deg. | RMS value                              |  |
|                        | Vector error           | V <sub>ERR</sub> | —     | 3.0    | 4.0  | %    | RMS value                              |  |
| Carrier suppression    |                        | CS               | —     | −35    | −27  | dBc  | External offset. No offset adjustment. |  |
| Image rejection        |                        | IR               | —     | −40    | −28  | dBc  |  |  |
| Adjucent channel power |                        | ACP              | —     | −65    | −60  | dB   | Δf = 50 kHz                            |  |
| IF × 7 spurious        |                        | IF × 7           | —     | −65    | −60  | dBc  |  |  |

# MB54608L/MB54608B

- A case of the offset mixer is not used. (MB54608L, MB54608B)

(Ta = +25°C, Vcc = 3.0 V)

| Parameter              |                        | Symbol           | Value |      |      | Unit | Remarks                                |  |
|------------------------|------------------------|------------------|-------|------|------|------|--|--|
|                        |                        |                  | Min.  | Typ. | Max. |      |  |  |
| Baseband input         | Operating band         | f <sub>BB</sub>  | DC    | —    | 10   | MHz  |  |  |
|                        | Input amplitude        | V <sub>BB</sub>  | 0.3   | 1.0  | 1.3  | Vp-p | Single ended input                     |  |
|                        | Offset voltage         | V <sub>OS</sub>  | 1.4   | 1.5  | 1.6  | V    | External offset voltage                |  |
|                        | Offset current         | I <sub>OS</sub>  | —     | 3.0  | 4.0  | μA   |  |  |
| Lo input               | Operating band         | f <sub>LO</sub>  | 800   | 948  | 1000 | MHz  | Differential input with balun.         |  |
|                        | Input power            | P <sub>LO</sub>  | −15   | −10  | 0    | dBm  |  |  |
| RF output              | Operating band         | f <sub>OUT</sub> | 800   | 948  | 1000 | MHz  |  |  |
|                        | SSB output power level | P <sub>OUT</sub> | −8    | −4   | —    | dBm  | Mode pin is opened                     | V <sub>BB</sub> = 1.0 Vp-p (single ended input)<br>f <sub>LO</sub> = 948 MHz<br>P <sub>LO</sub> = −10 dBm (Differential input with balun). |
|                        |                        |                  | −6    | −2   | —    | dBm  | Mode pin is grounded                   |  |
| Modulation accuracy    | Amplitude error        | A <sub>ERR</sub> | —     | 2.0  | 3.0  | %    | RMS value                              |  |
|                        | Phase error            | P <sub>ERR</sub> | —     | 1.5  | 2.0  | deg. | RMS value                              |  |
|                        | Vector error           | V <sub>ERR</sub> | —     | 3.0  | 4.0  | %    | RMS value                              |  |
| Carrier suppression    |                        | CS               | —     | −35  | −27  | dBc  | External offset. No offset adjustment. |  |
| Image rejection        |                        | IR               | —     | −40  | −28  | dBc  |  |  |
| Adjucent channel power |                        | ACP              | —     | −65  | −60  | dB   | Δf = 50 kHz                            |  |

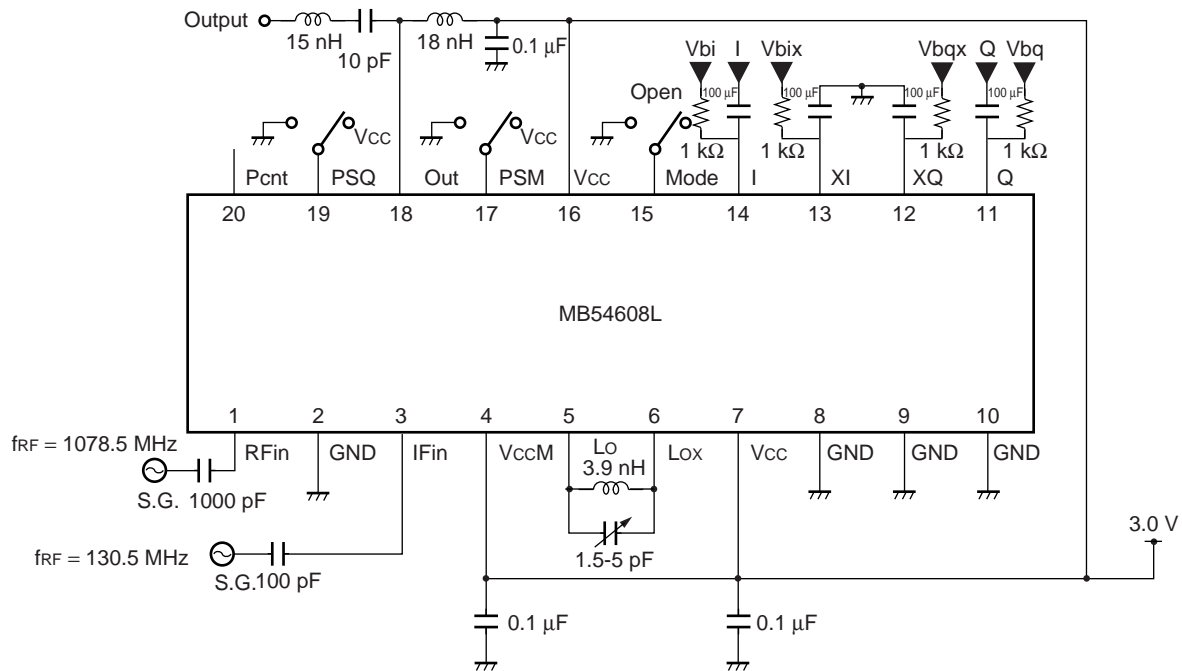
Notes: • Spec. of MB54608B is identical with MB54608L.

- When the offset mixer is not used, using a differential balun is recommended for input. (When the balun is not used, the changing carrier suppression may happen depending on the timing of powering up.)

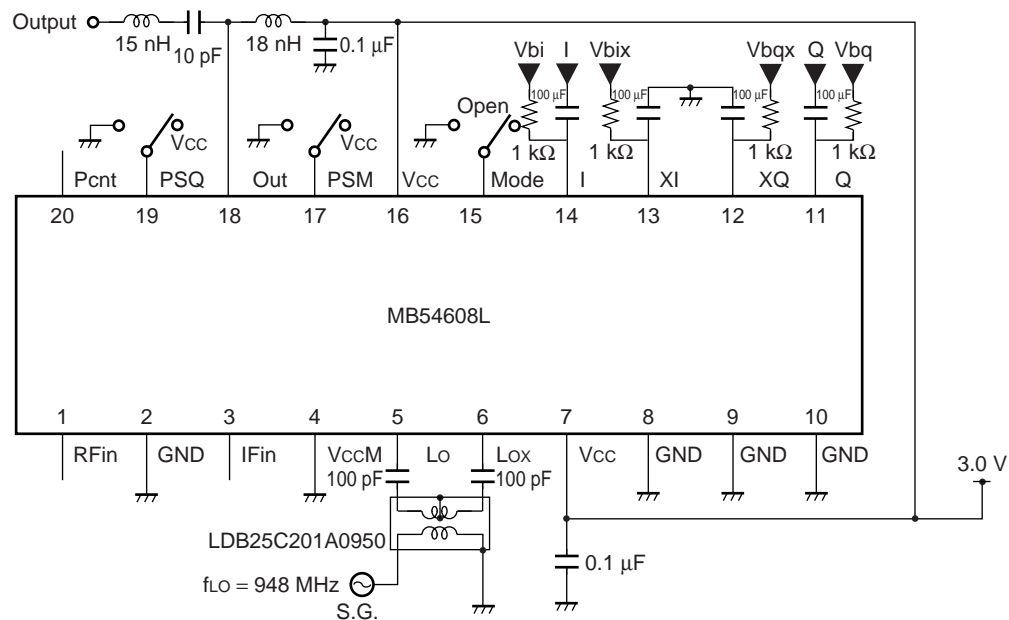
# MB54608L/MB54608B

## ■ APPLICATION EXAMPLE (MB54608L)

### 1) A case of the offset mixer is used.



### 2) A case of the offset mixer is not used.



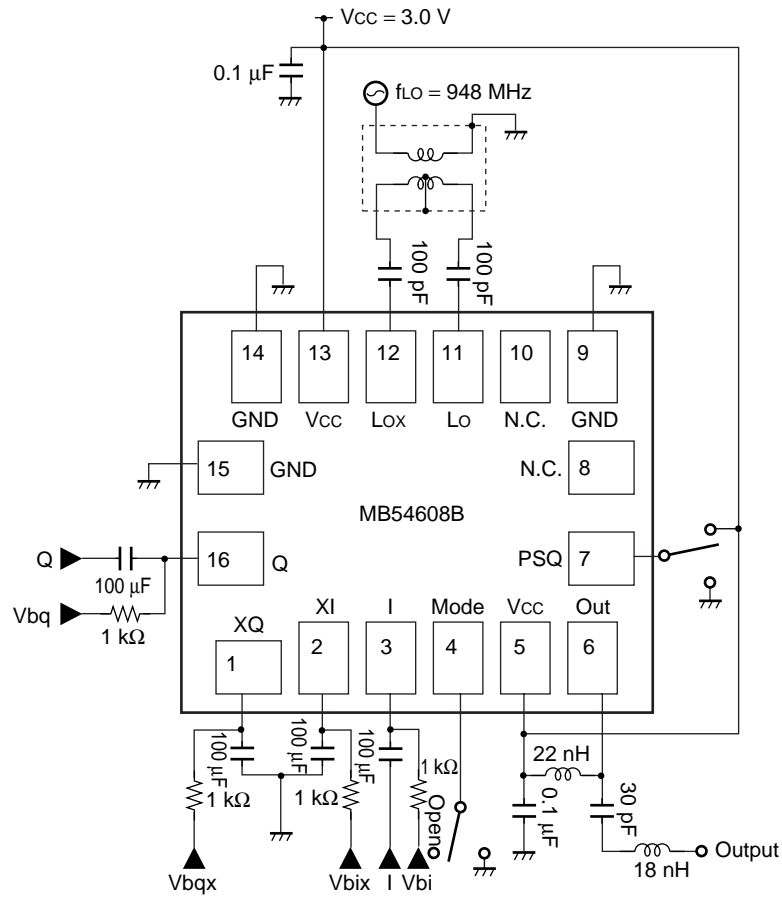
Note: LDB25C201A0950: Murata Mfg. Co., Ltd.

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# MB54608L/MB54608B

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(MB54608L)



## ■ ORDERING INFORMATION

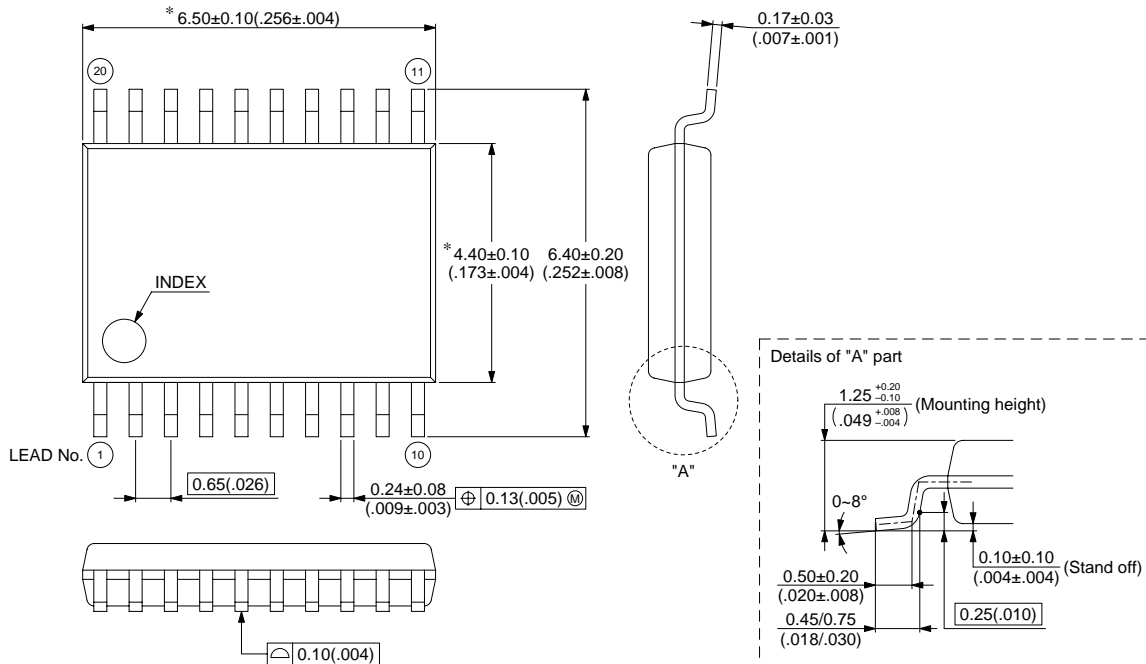
| Part number  | Package                               | Remarks  |
|--------------|---------------------------------------|----------|
| MB54608L PFV | 20-pin, Plastic SSOP<br>(FPT-20P-M03) | MB54608L |
| MB54608L PV1 | 16-pad, Plastic BCC<br>(LCC-16P-M04)  | MB54608B |

# MB54608L/MB54608B

## ■ PACKAGE DIMENSION

20-pin Plastic SSOP  
(FPT-20P-M03)

Note 1) \*:This dimension does not include resin protrusion.  
Note 2) Pins width and pins thickness include plating thickness.



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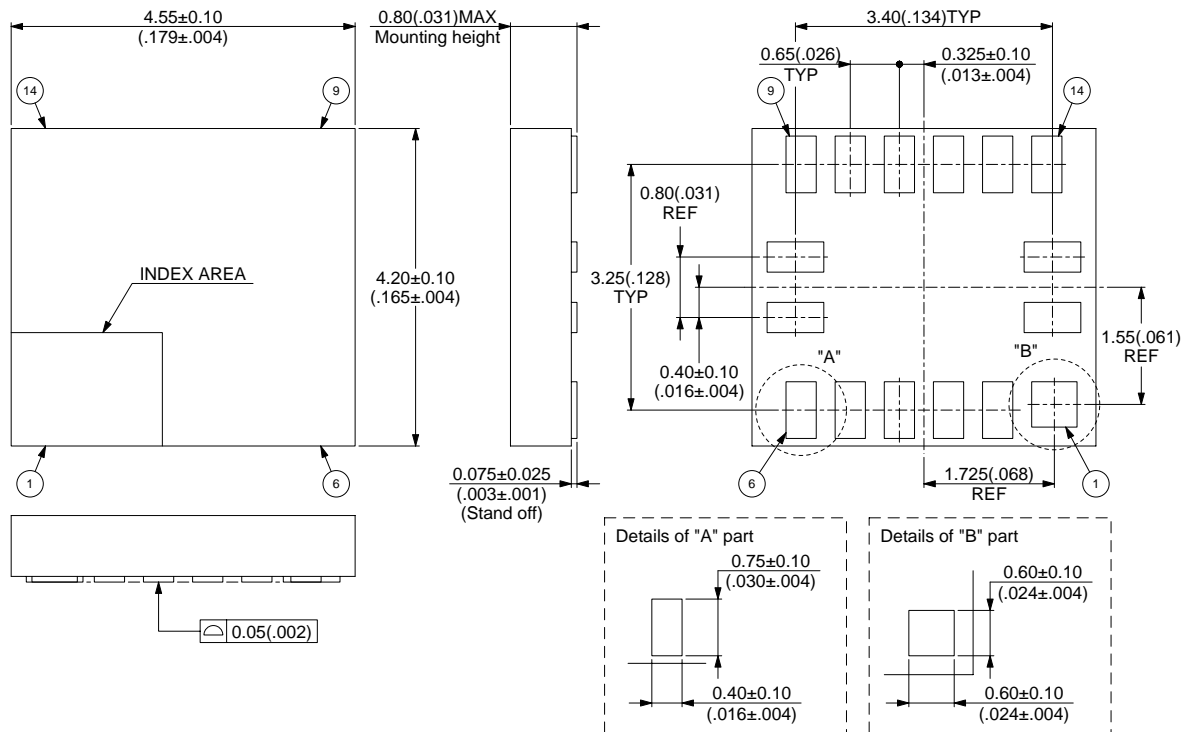
Dimensions in mm (inches)

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# MB54608L/MB54608B

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## 16-pad Plastic BCC (LCC-16P-M04)



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Dimensions in mm (inches)

# MB54608L/MB54608B

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