

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)

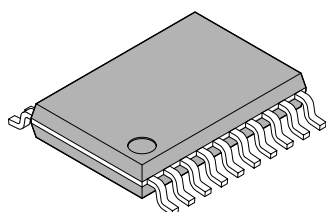
■ FEATURES

- 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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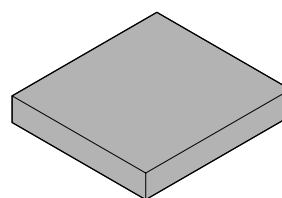
■ PACKAGES

20-pin plastic SSOP



(FPT-20P-M03)

16-pad plastic BCC



(LCC-16P-M04)

MB54608L/MB54608B

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- 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 _{cc}	16.5 mA	19.0 mA	22.5 mA	25.0 mA
	P _{out} (V _{BB} =1.0 V _{p-p})	−4 dBm	−2 dBm	−4 dBm	−2 dBm
Power down	I _{ps}	0.22 mA		0.44 mA	

Note: Typical values

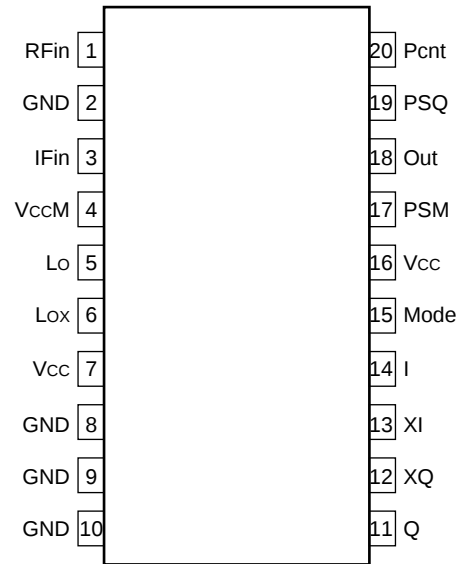
Further increase of the output power is possible by attaching a resistor at P_{cnt} pin.

- Operating temperature range: T_a = −20 to +75°C

PIN ASSIGNMENTS

• MB54608L (SSOP-20)

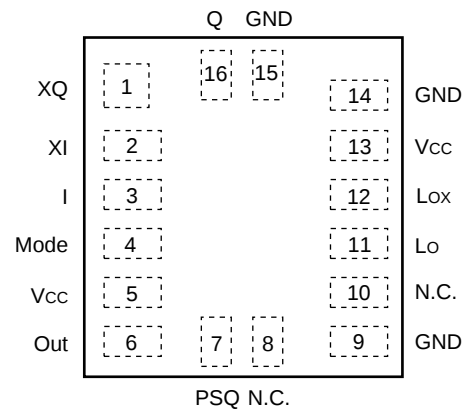
(TOP VIEW)



(FPT-20P-M03)

• MB54608B (BBC-16)

(TOP VIEW)



(LCC-16P-M04)

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

MB54608L/MB54608B

■ PIN DESCRIPTIONS

• MB54608L (SSOP-20)

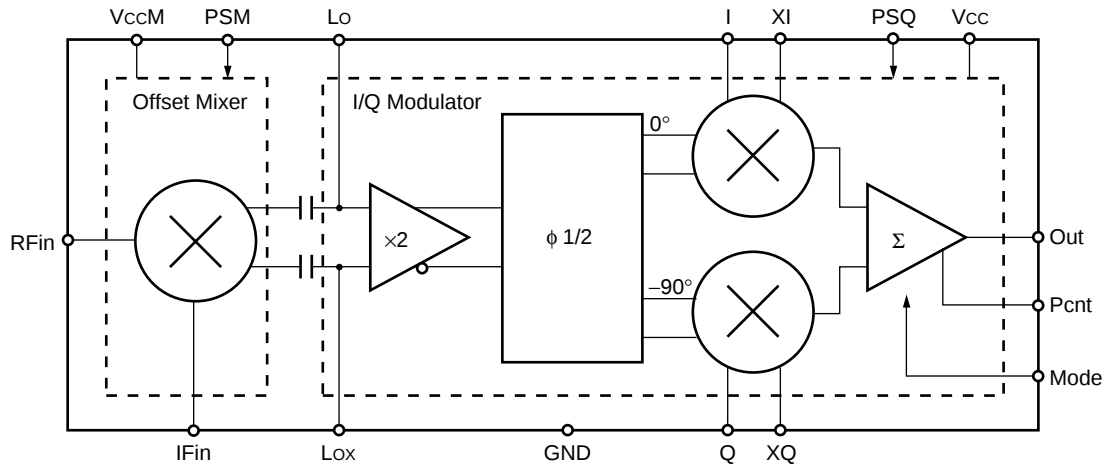
Pin no.	Symbol	I/O	Descriptions
1	RFin	I	RF input for the offset mixer. When the offset mixer is not used, this pin should be opened.
2	GND	—	Ground.
3	IFin	I	IF input for the offset mixer. When the offset mixer is not used, this pin should be opened.
4	VccM	—	Power supply for the offset mixer. Power-on/off 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. Mode = GND: High power mode. 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) 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.

• 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. Mode=GND: High power mode. 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) 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.

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■ BLOCK DIAGRAM



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

■ 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_{CC} = 3.0 V)

Parameter	Symbol	Value			Unit	Remarks		
		Min.	Typ.	Max.				
Power supply current	I _{CC}					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 _{PS}	—	220	310	μA	Not used	Don't care	
		—	440	620	μA	Used		
Power down pin input voltage	V _{IHPS}	V _{CC} × 0.7	—	—	V			
	V _{ILPS}	—	—	V _{CC} × 0.3	V			
Power down pin input current	I _{IHPS}	—	—	5.0	μA	V _{IH} = V _{CC}		PSM, PSQ Value
	I _{ILPS}	−50	—	—	μA	V _{IL} = GND		
Pcnt pin load resistance	R _{cnt}	50	—	—	Ω			

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

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 _{BB}	DC	—	10	MHz		
	Input amplitude	V _{BB}	0.3	1.0	1.3	Vp-p	Single ended input	
	Offset voltage	V _{OS}	1.4	1.5	1.6	V	External offset voltage	
	Offset current	I _{OS}	—	3.0	4.0	μA		
Offset Mixer	Operating band	f _{RF}	—	1078.5	1100	MHz		
		f _{IF}	—	130.5	500	MHz		
		f _{LO}	800	948	1000	MHz	Output	
	Input power level	P _{RF}	−15	−10	0	dBm		
		P _{IF}	−15	−10	0	dBm		
RF output	Operating band	f _{OUT}	800	948	1000	MHz		
	SSB output power level	P _{OUT}	−8	−4	—	dBm	Mode pin is opened	V _{BB} = 1.0 Vp-p (single ended input) f _{RF} = 1078.5 MHz P _{RF} = −10 dBm f _{IF} = 130.5 MHz P _{IF} = −10 dBm f _{OUT} = 948 MHz
			−6	−2	—	dBm	Mode pin is grounded	
Modulation accuracy	Amplitude error	A _{ERR}	—	2.0	3.0	%	RMS value	
	Phase error	P _{ERR}	—	1.5	2.0	deg.	RMS value	
	Vector error	V _{ERR}	—	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		

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

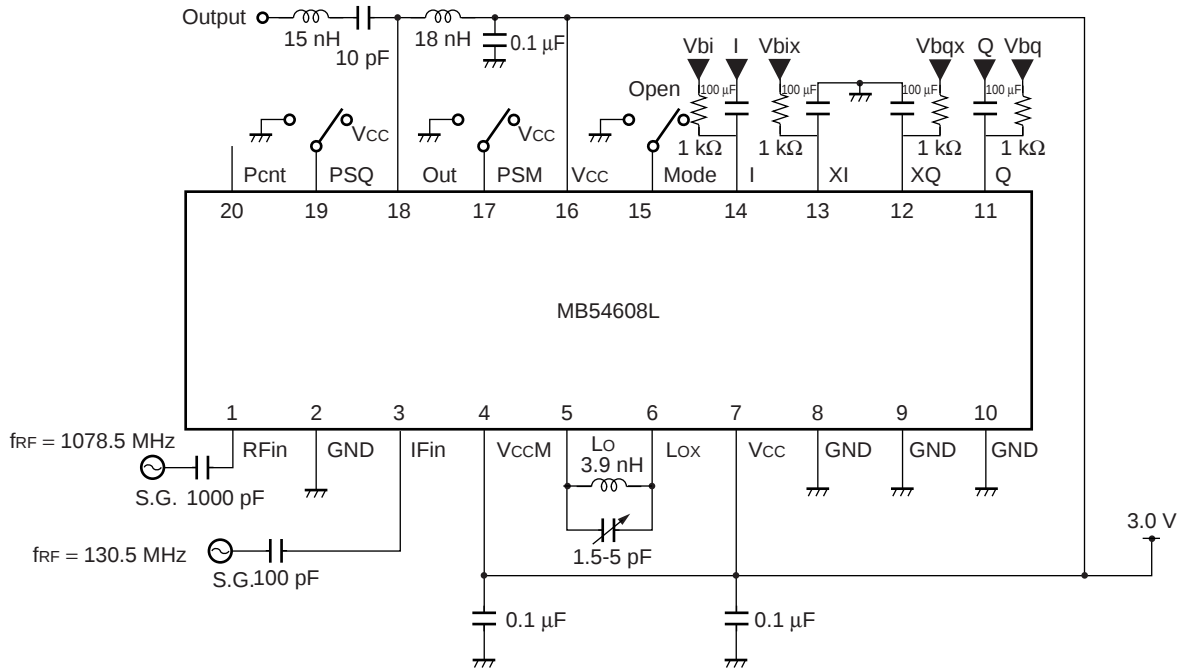
(Ta = +25°C, Vcc = 3.0 V)

Parameter		Symbol	Value			Unit	Remarks	
			Min.	Typ.	Max.			
Baseband input	Operating band	f _{BB}	DC	—	10	MHz		
	Input amplitude	V _{BB}	0.3	1.0	1.3	Vp-p	Single ended input	
	Offset voltage	V _{OS}	1.4	1.5	1.6	V	External offset voltage	
	Offset current	I _{OS}	—	3.0	4.0	μA		
Lo input	Operating band	f _{LO}	800	948	1000	MHz	Differential input with balun.	
	Input power	P _{LO}	−15	−10	0	dBm		
RF output	Operating band	f _{OUT}	800	948	1000	MHz		
	SSB output power level	P _{OUT}	−8	−4	—	dBm	Mode pin is opened	V _{BB} = 1.0 Vp-p (single ended input) f _{LO} = 948 MHz P _{LO} = −10 dBm (Differential input with balun).
			−6	−2	—	dBm	Mode pin is grounded	
Modulation accuracy	Amplitude error	A _{ERR}	—	2.0	3.0	%	RMS value	
	Phase error	P _{ERR}	—	1.5	2.0	deg.	RMS value	
	Vector error	V _{ERR}	—	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	

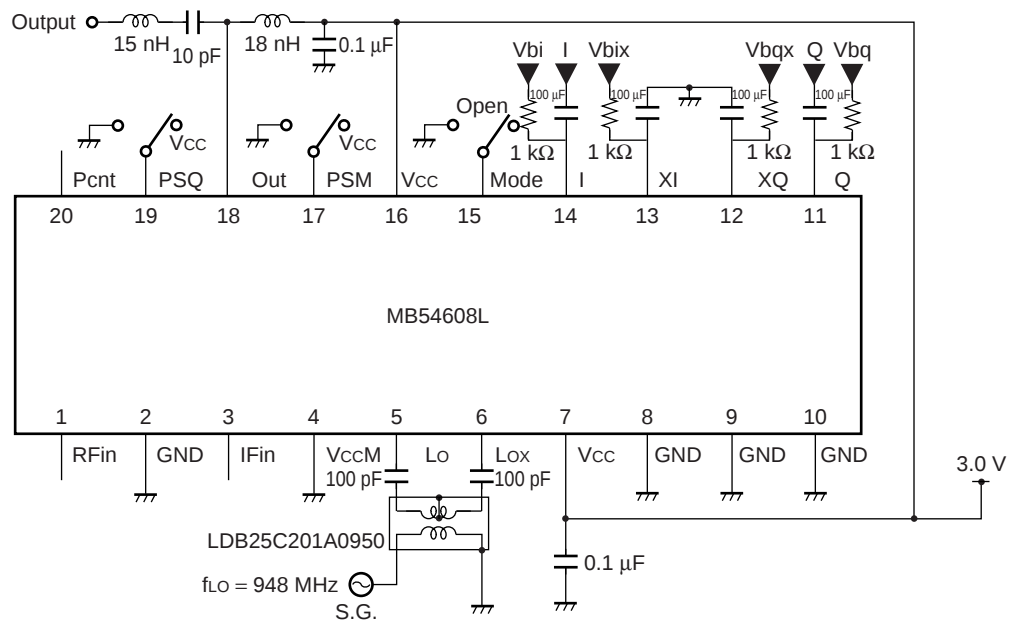
- Notes:
- Spec. of MB54608B is identical with MB54608L.
 - When the offset mixer is not used, using a differential balun is recommended for input. (When the balun is not used, the changing carrier suppression may happen depending on the timing of powering up.)

■ APPLICATION EXAMPLE (MB54608L)

1) A case of the offset mixer is used.



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



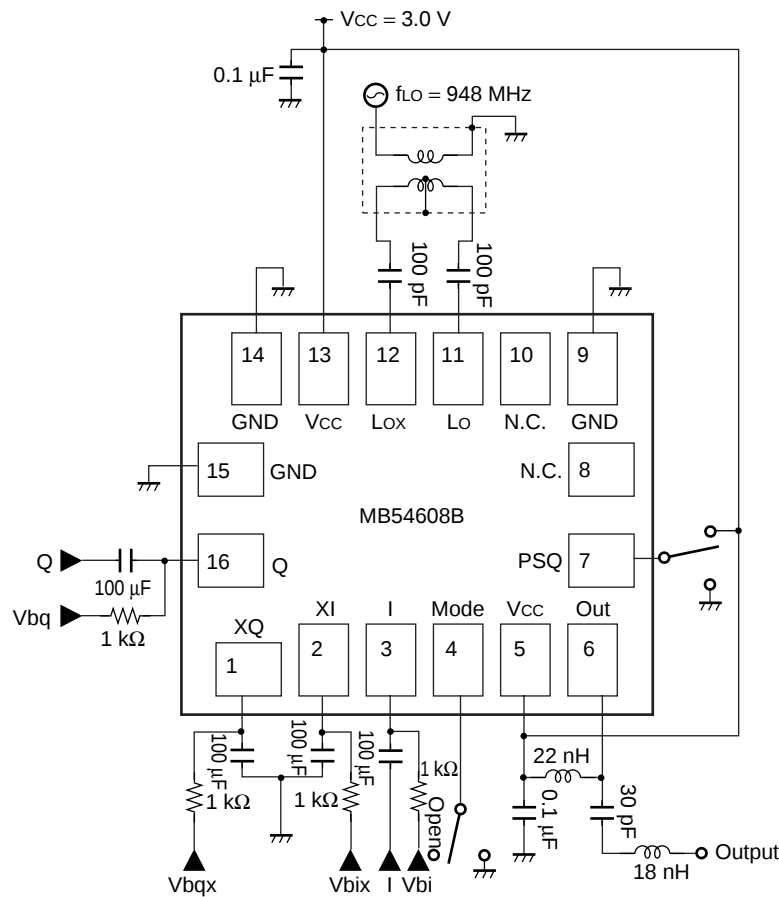
Note: LDB25C201A0950: Murata Mfg. Co., Ltd.

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MB54608L/MB54608B

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(MB54608L)



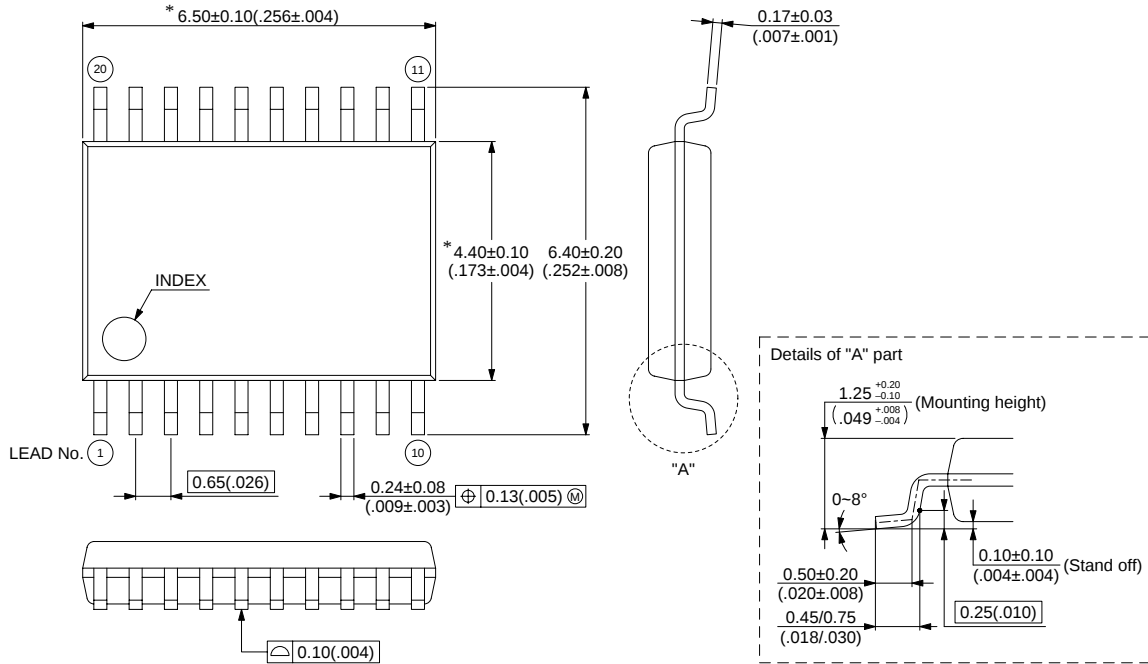
ORDERING INFORMATION

Part number	Package	Remarks
MB54608L PFV	20-pin, Plastic SSOP (FPT-20P-M03)	MB54608L
MB54608L PV1	16-pad, Plastic BCC (LCC-16P-M04)	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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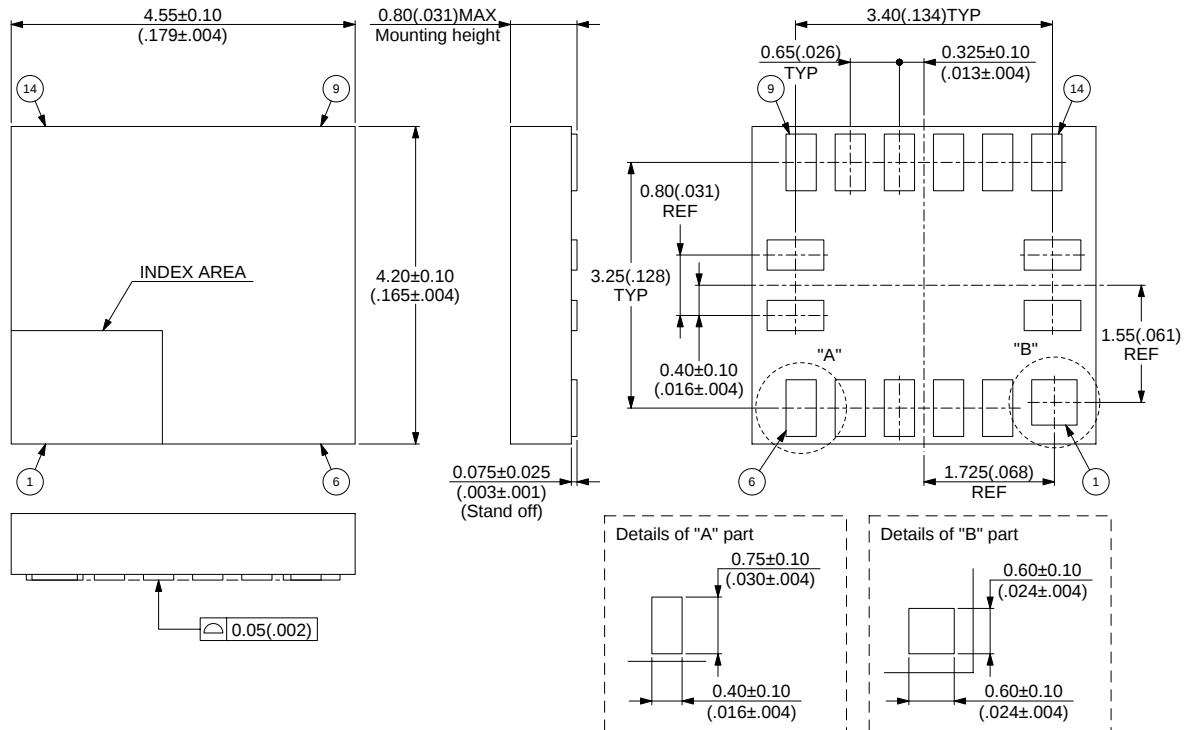
Dimensions in mm (inches)

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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)

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For further information please contact:

Japan

FUJITSU LIMITED
Corporate Global Business Support Division
Electronic Devices
KAWASAKI PLANT, 4-1-1, Kamikodanaka,
Nakahara-ku, Kawasaki-shi,
Kanagawa 211-8588, Japan
Tel: +81-44-754-3763
Fax: +81-44-754-3329

<http://www.fujitsu.co.jp/>

North and South America

FUJITSU MICROELECTRONICS, INC.
3545 North First Street,
San Jose, CA 95134-1804, USA
Tel: +1-408-922-9000
Fax: +1-408-922-9179

Customer Response Center
Mon. - Fri.: 7 am - 5 pm (PST)
Tel: +1-800-866-8608
Fax: +1-408-922-9179

<http://www.fujitsumicro.com/>

Europe

FUJITSU MICROELECTRONICS EUROPE GmbH
Am Siebenstein 6-10,
D-63303 Dreieich-Buchschlag,
Germany
Tel: +49-6103-690-0
Fax: +49-6103-690-122

<http://www.fujitsu-fme.com/>

Asia Pacific

FUJITSU MICROELECTRONICS ASIA PTE LTD
#05-08, 151 Lorong Chuan,
New Tech Park,
Singapore 556741
Tel: +65-281-0770
Fax: +65-281-0220

<http://www.fmap.com.sg/>

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