

# Spread Spectrum Clock Generator

## MB88156

### ■ DESCRIPTION

MB88156 is a clock generator for EMI (Electro Magnetic Interference) reduction. The peak of unnecessary radiation noise (EMI) can be attenuated by making the oscillation frequency slightly modulate periodically with the internal modulator. The modulation corresponds to the center spread and down spread. The multiplication ratio can be changed by the pin setting.

Also, the pin can be set whether the modulation is changed. For no modulation, it has the center-non-spread to fix to the output frequency conforming to the multiplication setting and down-non-spread to fix the output frequency to center frequency of the down spread.

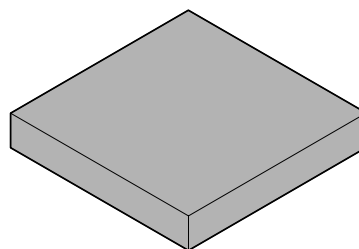
### ■ FEATURES

- Input frequency :  
12.5 MHz to 50 MHz (multiplied by 1)  
12.5 MHz to 25 MHz (multiplied by 2)  
12.5 MHz to 20 MHz (multiplied by 4)
- Output frequency :  
CKOUT 12.5 MHz to 80 MHz  
REFOUT the same as input frequency (not multiplied)

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### ■ PACKAGE

16-pin plastic BCC



(LCC-16P-M09)

# MB88156

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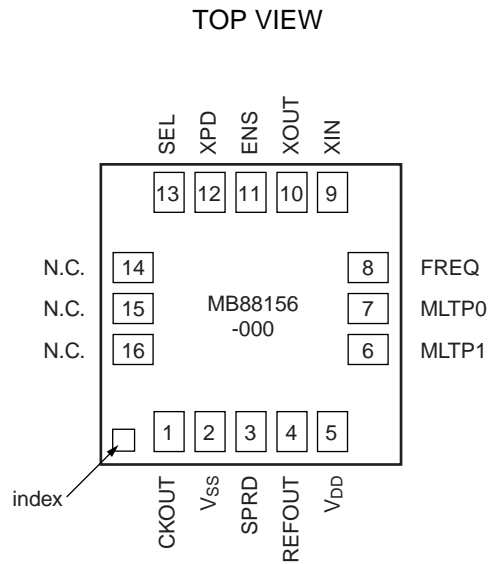
- Modulation rate :  $\pm 0.5\%$ ,  $\pm 1.0\%$  (center spread) ,  $-1.0\%$ ,  $-2.0\%$  (down spread)
- Frequency down function :  $-0.5\%$ ,  $-1.0\%$  (for down-non-spread)
- Equipped with oscillation circuit : Oscillation range 12.5 MHz to 40 MHz (Fundamental oscillation mode)  
40 MHz to 48 MHz (At 3rd over tone)
- Modulation clock output Duty : 40% to 60%
- Modulation clock Cycle-Cycle Jitter : Multiplied by 1 (input) 12.5 MHz to 20 MHz less than 150 ps  
Multiplied by 1 (input) 20.0 MHz to 50 MHz less than 100 ps  
Multiplied by 2 (input) 12.5 MHz to 25 MHz less than 200 ps  
Multiplied by 4 (input) 12.5 MHz to 20 MHz less than 200 ps
- Low current consumption by CMOS process : 5 mA (24 MHz : Typ-sample, no load)
- Power supply voltage :  $3.3\text{ V} \pm 0.3\text{ V}$
- Operating temperature :  $-40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$
- Package : BCC 16-pin

## ■ PRODUCT LINEUP

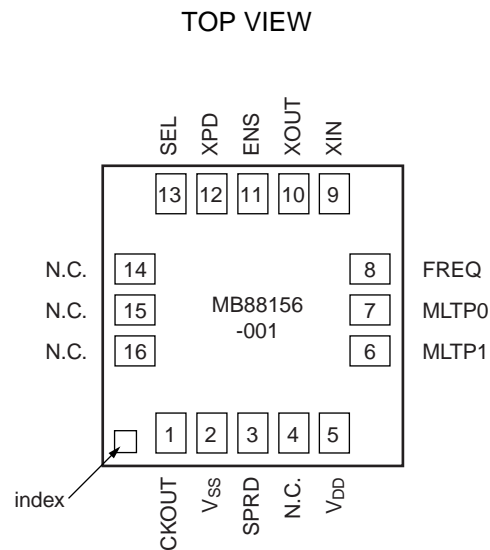
Product	Function
MB88156-000	With REFOUT
MB88156-001	Without REFOUT

## ■ PIN ASSIGNMENT

- MB88156-000



- MB88156-001



LCC-16P-M09

## ■ PIN DESCRIPTION

Pin no.	Pin name	I/O	Description
1	CKOUT	O	Modulated clock output pin Output "L" at power-down
2	V <sub>SS</sub>	—	GND pin
3	SPRD	I	Modulation type setting pin/frequency down setting SPRD = "L" : Down spread/down-non-spread SPRD = "H" : Center spread/center-non-spread For details, see "Setting of ENS, SPRD, and SEL".
4	REFOUT/N.C.	O	Non modulation clock output pin (output "L" at power-down) /non connection pin
5	V <sub>DD</sub>	—	Power supply voltage pin
6	MLTP1	I	Multiplication rate setting pin For details, see "Setting of MLTP1, MLTP0, and FREQ".
7	MLTP0	I	
8	FREQ	I	Frequency setting pin For details, see "Setting of MLTP1, MLTP0, and FREQ".
9	XIN	I	Pin for the connection of resonator/clock input
10	XOUT	O	Connecting pin of resonator
11	ENS	I	Modulation enable setting pin ENS = "L" : Non modulation ENS = "H" : Modulation
12	XPD	I	Power down pin XPD = "L" : Power down XPD = "H" : Normal operation
13	SEL	I	Modulation rate setting pin/frequency falling width setting pin For details, see "Setting of ENS, SPRD, and SEL".
14	N.C.	—	Non connection pin
15	N.C.	—	Non connection pin
16	N.C.	—	Non connection pin

### • Setting of MLTP1, MLTP0, and FREQ (Setting of multiplication rate and input frequency)

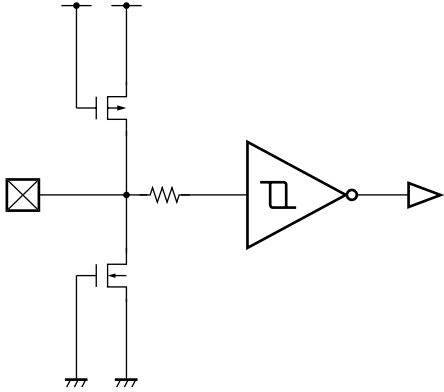
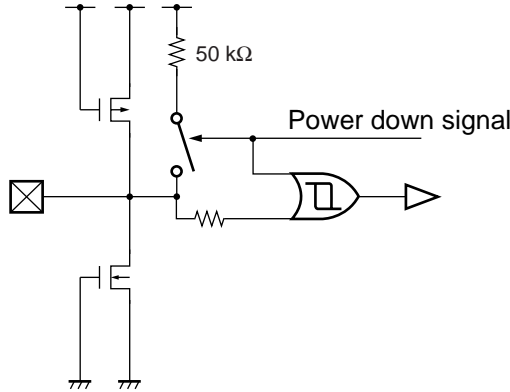
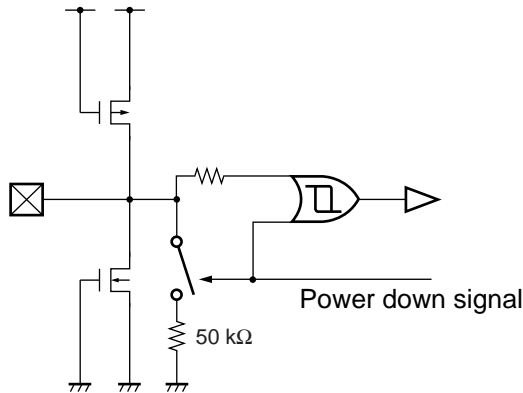
Input frequency	Output frequency	FREQ	Multiplication rate	MLTP1	MLTP0
12.5 MHz to 25 MHz	12.5 MHz to 25.0 MHz	L	Multiplied by 1	L	L
25.0 MHz to 50 MHz	25.0 MHz to 50.0 MHz	H			
12.5 MHz to 25 MHz	25.0 MHz to 50.0 MHz	L	Multiplied by 2	H	L
12.5 MHz to 20 MHz	50.0 MHz to 80.0 MHz	L	Multiplied by 4	H	H

Note : Setting other than above is disabled.

- Setting of ENS, SPRD, and SEL (setting of output frequency)

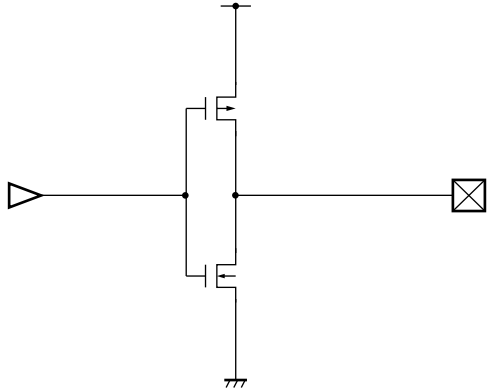
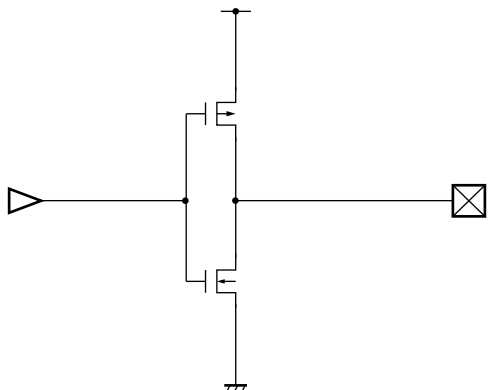
Setting pin			Output status			
ENS	SPRD	SEL	Modulation	Modulation type	Modulation rate	Falling width
L	L	L	None	Down-non-spread	—	-0.5%
		H			—	-1.0%
	H	L		Center-non-spread	—	0.0%
		H			—	0.0%
H	L	L	Provided	Down spread	-1.0%	—
		H			-2.0%	—
	H	L		Center spread	±0.5%	—
		H			± 1.0%	—

## ■ I/O CIRCUIT TYPE

Pin	Circuit type	Remarks
SEL, XPD		<ul style="list-style-type: none"> <li>• CMOS hysteresis input</li> </ul>
ENS, SPRD		<ul style="list-style-type: none"> <li>• CMOS hysteresis input with pull-up resistor 50 kΩ (Typ)</li> <li>• At power-down, pull-up resistance is shut off.</li> </ul>
FREQ, MLTP1, MLTP0		<ul style="list-style-type: none"> <li>• CMOS hysteresis input with pull-down resistor 50 kΩ (Typ)</li> <li>• At power-down, pull-down resistance is shut off.</li> </ul>

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Pin	Circuit type	Remarks
REFOUT		<ul style="list-style-type: none"> <li>• CMOS output</li> <li>• <math>I_{OL} = 3 \text{ mA}</math></li> <li>• Output "L" at power-down</li> </ul>
CKOUT		<ul style="list-style-type: none"> <li>• CMOS output</li> <li>• <math>I_{OL} = 4 \text{ mA}</math></li> <li>• Output "L" at power-down</li> </ul>

Note : For XIN and XOUT pins, see "■ OSCILLATION CIRCUIT".

## ■ HANDLING DEVICES

### Preventing Latchup

A latchup can occur if, on this device, (a) a voltage higher than  $V_{DD}$  or a voltage lower than  $V_{SS}$  is applied to an input or output pin or (b) a voltage higher than the rating is applied between  $V_{DD}$  and  $V_{SS}$ . The latchup, if it occurs, significantly increases the power supply current and may cause thermal destruction of an element. When you use this device, be very careful not to exceed the maximum rating.

### Handling unused pins

Do not leave an unused input pin open, since it may cause a malfunction. Handle by, using a pull-up or pull-down resistor.

Unused output pin should be opened.

### The attention when the external clock is used

Input the clock to XIN pin, and XOUT pin should be opened when you use the external clock. Please pay attention so that an overshoot and an undershoot do not occur to an input clock of XIN pin.

### Power supply pins

Please design connecting the power supply pin of this device by as low impedance as possible from the current supply source.

We recommend connecting electrolytic capacitor (about 10  $\mu\text{F}$ ) and the ceramic capacitor (about 0.01  $\mu\text{F}$ ) in parallel between  $V_{SS}$  and  $V_{DD}$  near the device, as a bypass capacitor.

### Oscillation circuit

Noise near the XIN and XOUT pins may cause the device to malfunction. Design printed circuit boards so that electric wiring of XIN or XOUT pin and the resonator do not intersect other wiring.

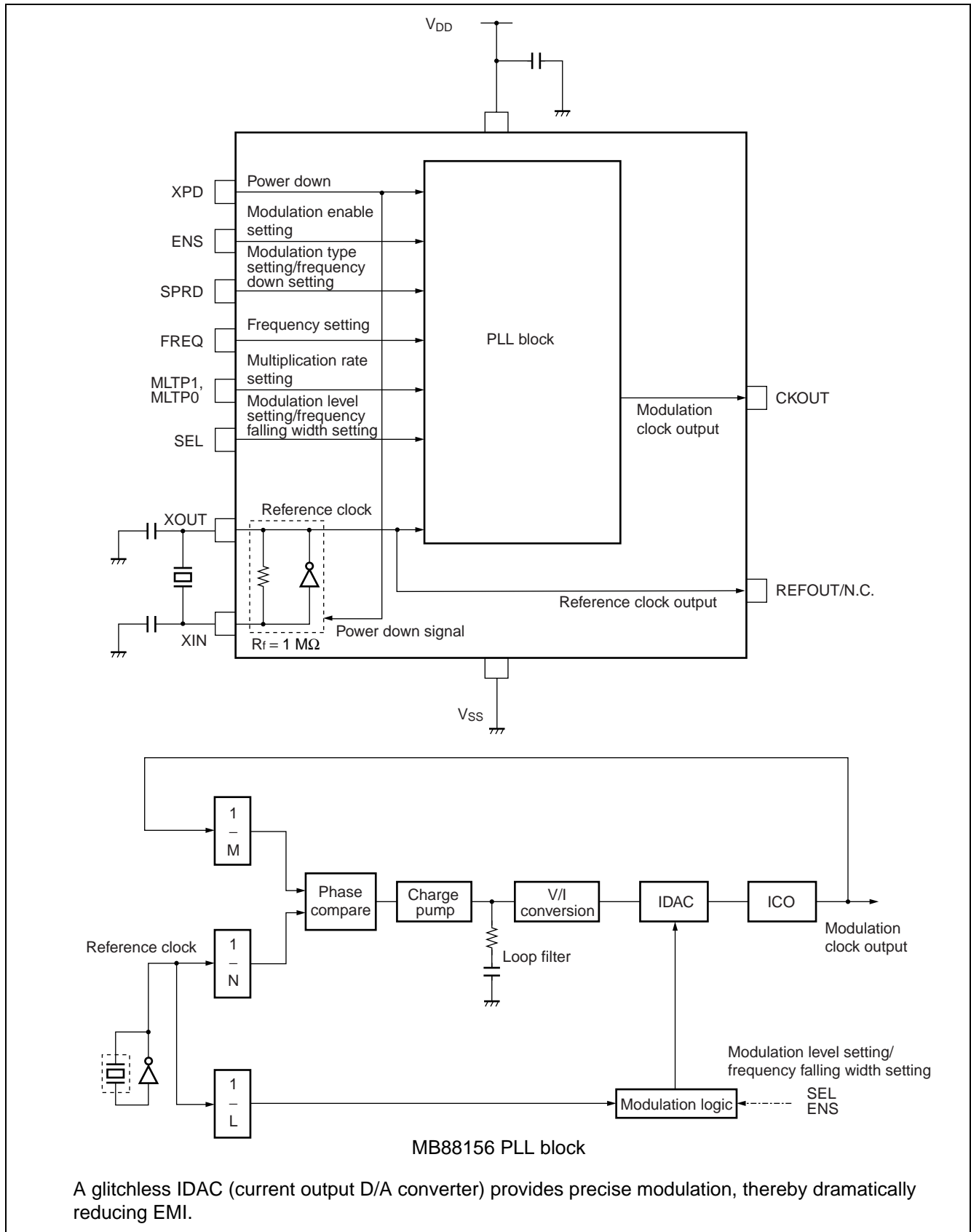
Design the printed circuit board that surrounds the XIN and XOUT pins with ground.

### Handling N.C. pin

Be sure to open the N.C. pin when it is used.



## ■ BLOCK DIAGRAM



## ■ PIN SETTING

After the pin setting is changed, the stabilization wait time of the modulation clock is required. The stabilization wait time of the modulation clock takes the maximum value of Lock-Up time in “AC Characteristics” in

### ■ ELECTRICAL CHARACTERISTICS.

#### ENS modulation enable/disable setting

ENS	Modulation
L	No modulation
H	Modulation

Spectrum does not spread when “L” is set to ENS pin.

#### XPD power down

XPD	Status
L	Power down status
H	Operating status

When setting “L” to XPD pin, it becomes power down mode (low power consumption mode) .  
Both of CKOUT and REFOUT for the output pin fixes to “L” output during the power down.

#### SPRD modulation type setting/frequency down setting

SPRD	Status
L	Down spread/down-non-spread
H	Center spread/center-non-spread

#### SEL modulation level setting/frequency falling width setting

SEL	Status
L	$\pm 0.5\%$ (at center spread) / $\pm 0.0\%$ (at center-non-spread)
	$-1.0\%$ (at down spread) / $-0.5\%$ (at down-non-spread)
H	$\pm 1.0\%$ (at center spread) / $\pm 0.0\%$ (at center-non-spread)
	$-2.0\%$ (at down spread) / $-1.0\%$ (at down-non-spread)

#### MLTP1, MLTP0 multiplication rate setting

MLTP1	MLTP0	Multiplication rate
L	L	Multiplied by 1
H	L	Multiplied by 2
H	H	Multiplied by 4

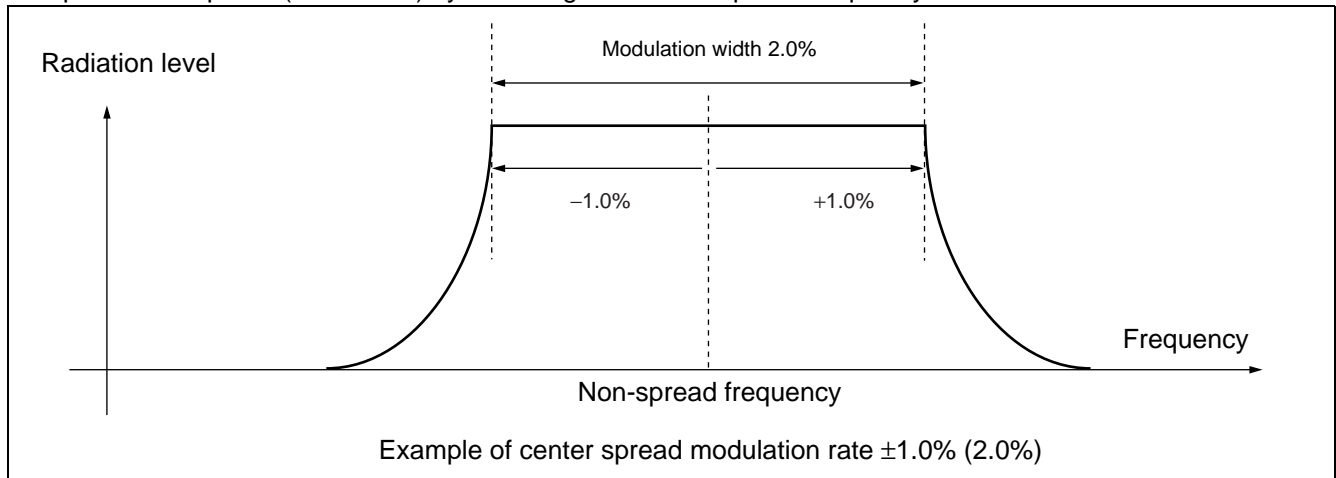
Note : REFOUT is not multiplied.

#### FREQ frequency setting

FREQ	Input frequency
L	12.5 MHz to 25 MHz (Multiplied by 1, 2) / 12.5 MHz to 20 MHz (Multiplied by 4)
H	25 MHz to 50 MHz (Multiplied by 1)

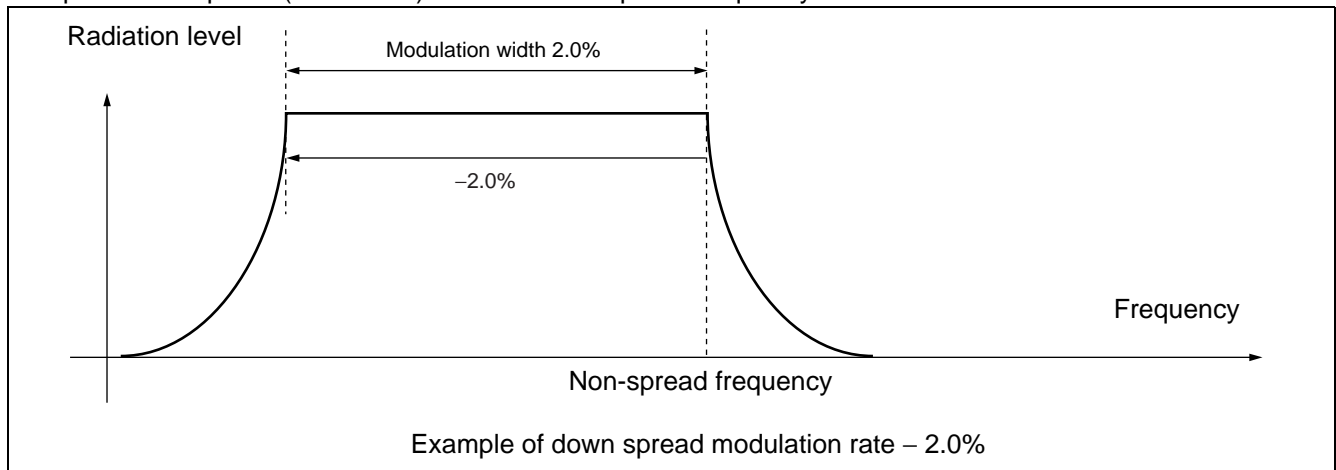
- Center spread

Spectrum is spread (modulated) by centering on the non-spread frequency.



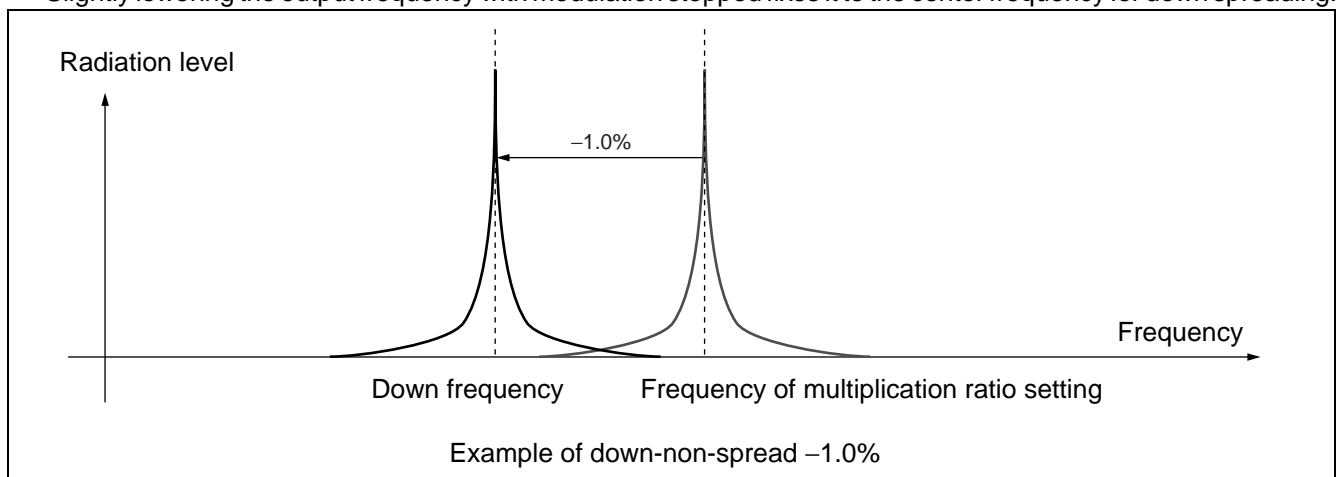
- Down spread

Spectrum is spread (modulated) below the non-spread frequency.



- Down-non-spread

Slightly lowering the output frequency with modulation stopped fixes it to the center frequency for down spreading.

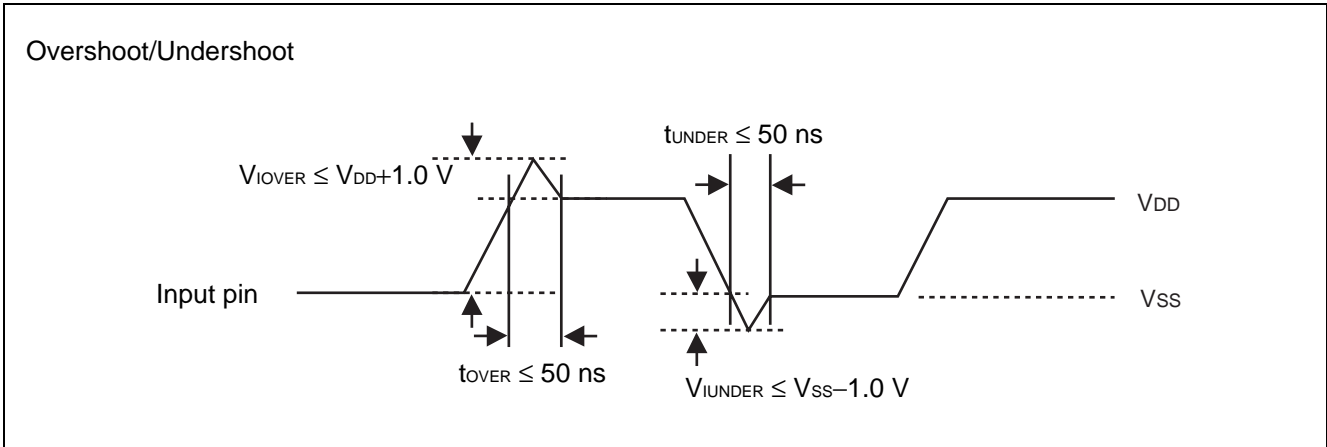


## ■ ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Rating		Unit
		Min	Max	
Power supply voltage*	$V_{DD}$	- 0.5	+4.0	V
Input voltage*	$V_I$	$V_{SS} - 0.5$	$V_{DD} + 0.5$	V
Output voltage*	$V_O$	$V_{SS} - 0.5$	$V_{DD} + 0.5$	V
Storage temperature	$T_{ST}$	- 55	+125	°C
Operation junction temperature	$T_J$	- 40	+125	°C
Output current	$I_O$	- 14	+14	mA
Overshoot	$V_{IOVER}$	—	$V_{DD} + 1.0$ ( $t_{OVER} \leq 50$ ns)	V
Undershoot	$V_{IUNDER}$	$V_{SS} - 1.0$ ( $t_{UNDER} \leq 50$ ns)	—	V

\*: The parameter is based on  $V_{SS} = 0.0$  V.

**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

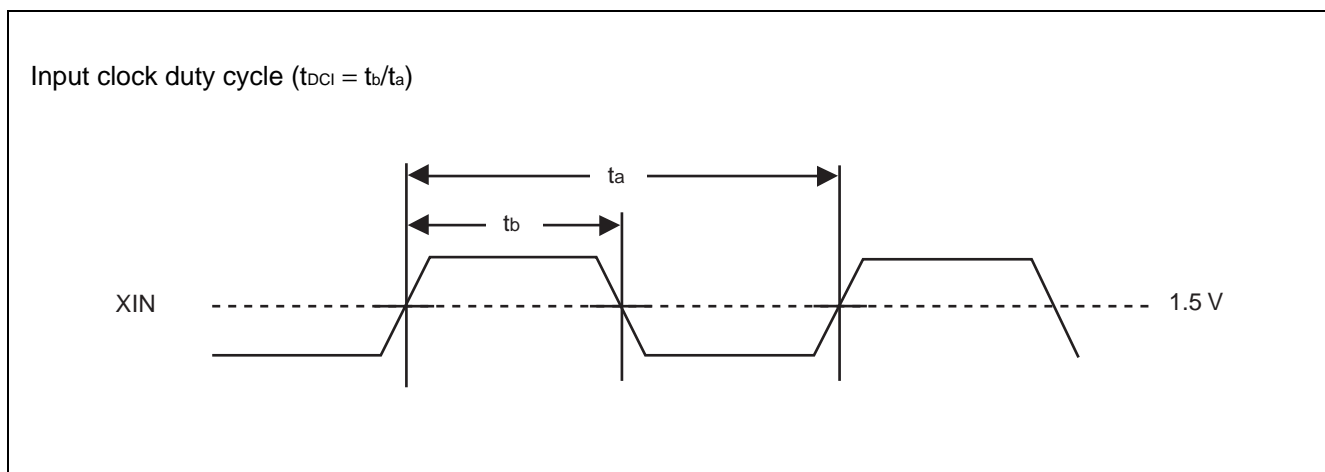
( $V_{SS} = 0.0\text{ V}$ )

Parameter	Symbol	Pin	Conditions	Value			Unit
				Min	Typ	Max	
Power supply voltage	$V_{DD}$	$V_{DD}$	—	3.0	3.3	3.6	V
“H” level input voltage	$V_{IH}$	XIN, SEL, ENS, FREQ, MLTP1, MLTP0, SPRD, XPD	—	$V_{DD} \times 0.8$	—	$V_{DD} + 0.3$	V
“L” level input voltage	$V_{IL}$	XIN, SEL, ENS, FREQ, MLTP1, MLTP0, SPRD, XPD	—	$V_{SS}$	—	$V_{DD} \times 0.2$	V
Input clock duty cycle	$t_{DCI}$	XIN	12.5 MHz to 50 MHz	40	50	60	%
Operating temperature	$T_a$	—	—	-40	—	+85	°C

**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.



# MB88156

## ■ ELECTRICAL CHARACTERISTICS

### • DC Characteristics

( $T_a = -40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$ ,  $V_{DD} = 3.3\text{ V} \pm 0.3\text{ V}$ ,  $V_{SS} = 0.0\text{ V}$ )

Parameter	Symbol	Pin	Conditions	Value			Unit
				Min	Typ	Max	
Power supply current	$I_{CC}$	$V_{DD}$	24 MHz output No load capacitance	—	5.0	7.0	mA
			At power-down	—	10	—	$\mu\text{A}$
Output voltage	$V_{OHC}$	CKOUT	“H” level output $I_{OH} = -4\text{ mA}$	$V_{DD} - 0.5$	—	$V_{DD}$	V
	$V_{OHR}$	REFOUT	“H” level output $I_{OH} = -3\text{ mA}$				
	$V_{OLC}$	CKOUT	“L” level output $I_{OL} = 4\text{ mA}$	$V_{SS}$	—	0.4	V
	$V_{OLR}$	REFOUT	“L” level output $I_{OL} = 3\text{ mA}$				
Output impedance	$Z_{OC}$	CKOUT	12.5 MHz to 80 MHz	—	45	—	$\Omega$
	$Z_{OR}$	REFOUT	12.5 MHz to 50 MHz	—	70	—	
Input capacitance	$C_{IN}$	SEL, ENS, FREQ, MLTP1, MLTP0, SPRD, XPD	$T_a = +25\text{ }^{\circ}\text{C}$ $V_{DD} = V_I = 0.0\text{ V}$ $f = 1\text{ MHz}$	—	—	16	pF
Pull-up resistor	$R_{PU}$	ENS, SPRD	—	25	50	200	$\text{k}\Omega$
Pull-down resistor	$R_{PD}$	FREQ, MLTP1, MLTP0	—	25	50	200	$\text{k}\Omega$
Load capacitance	$C_L$	REFOUT	12.5 MHz to 50 MHz	—	—	15	pF
		CKOUT	12.5 MHz to 50 MHz	—	—	15	
			50 MHz to 80 MHz	—	—	7	

• AC Characteristics

( $T_a = -40\text{ }^\circ\text{C}$  to  $+85\text{ }^\circ\text{C}$ ,  $V_{DD} = 3.3\text{ V} \pm 0.3\text{ V}$ ,  $V_{SS} = 0.0\text{ V}$ )

Parameter	Symbol	Pin	Conditions	Value			Unit	
				Min	Typ	Max		
Oscillation frequency	$f_x$	XIN, XOUT	Fundamental oscillation	12.5	—	40	MHz	
			3rd overtone	40	—	48		
Input frequency	$f_{in}$	XIN	FREQ = 0	Multiplied by 1	12.5	—	25	MHz
				Multiplied by 2	12.5	—	25	
				Multiplied by 4	12.5	—	20	
			FREQ = 1	Multiplied by 1	25	—	50	
Output frequency	$f_{out}$	REFOUT	FREQ = 0	Multiplied by 1	12.5	—	25	MHz
				Multiplied by 2	12.5	—	25	
				Multiplied by 4	12.5	—	20	
			FREQ = 1	Multiplied by 1	25	—	50	
		CKOUT	FREQ = 0	Multiplied by 1	12.5	—	25	
				Multiplied by 2	25	—	50	
				Multiplied by 4	50	—	80	
			FREQ = 1	Multiplied by 1	25	—	50	
Output slew rate	$SR_C$	CKOUT	Load capacitance 15 pF 0.4 to 2.4 V	0.4	—	4.0	V/ns	
	$SR_R$	REFOUT	Load capacitance 15pF 0.4 to 2.4 V	0.3	—	2.0		
Output clock Duty Cycle	$t_{DCC}$	CKOUT	1.5 V reference level	40	—	60	%	
	$t_{DCR}$	REFOUT	1.5 V reference level	$t_{DCI} - 10^{*1}$	—	$t_{DCI} + 10^{*1}$		
Modulation frequency	$f_{MOD}$	CKOUT	Input frequency at 24 MHz	—	32.4	—	kHz	
Lock-Up time <sup>*2</sup>	$t_{LK}$	CKOUT	—	—	2	5	ms	
Cycle-cycle jitter	$t_{JC}$	CKOUT	Multiplied by 1 No load capacitance Standard deviation $\sigma$	Input frequency 12.5 MHz to 20 MHz	—	—	150	ps
				Input frequency 20 MHz to 50 MHz	—	—	100	
			Multiplied by 2 No load capacitance Standard deviation $\sigma$	Input frequency 12.5 MHz to 25 MHz	—	—	200	
				Input frequency 12.5 MHz to 20 MHz	—	—	200	

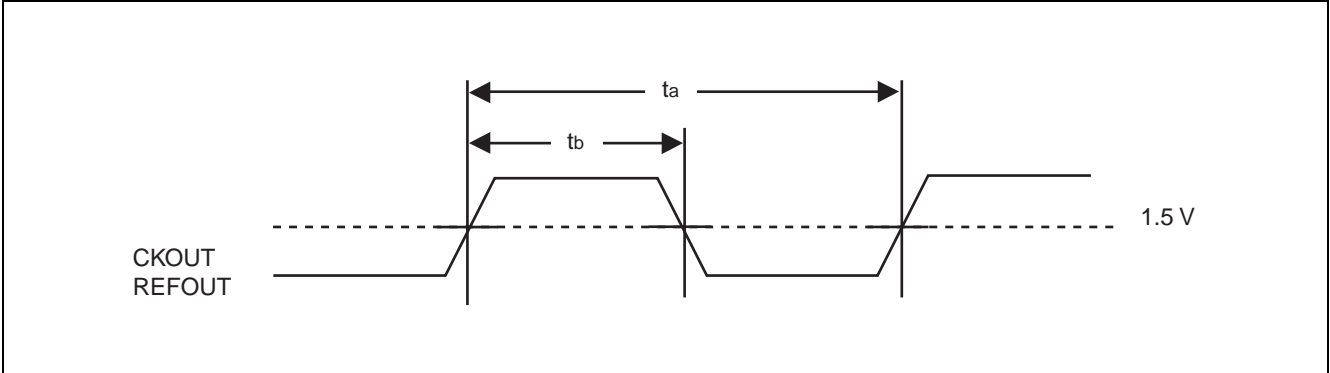
\*1 : Because the duty of REFOUT pin output depends on  $t_{DCI}$  of the input clock duty, it is assured only when either A or B condition is used as follow:

A : Resonator input : When the resonator is connected to the XIN pin and XOUT pin and oscillates normally.

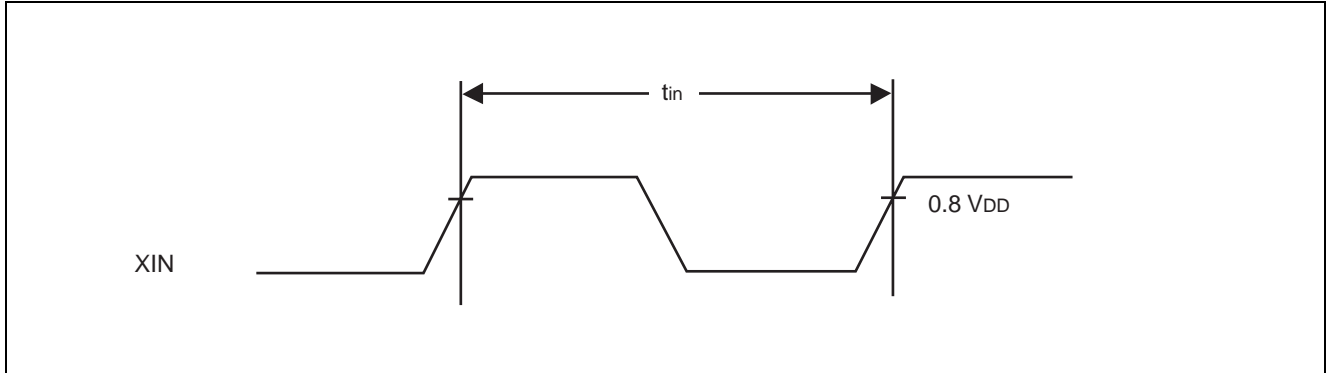
B : External clock input : The input level is full swing ( $V_{SS} - V_{DD}$ ) .

\*2 : After power on and release of power down or changing the pin setting (SEL, ENS, FREQ, MLTP1 and MLTP0, and SPRD) , the stabilization wait time of the modulation clock is required. The stabilization wait time of the modulation clock takes the maximum value of Lock-Up time.

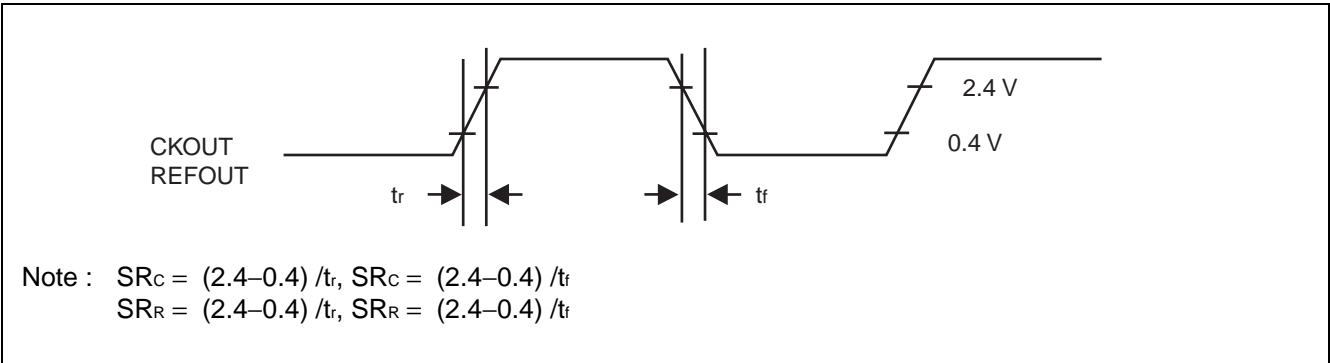
## ■ OUTPUT CLOCK Duty Cycle ( $t_{DCC}$ , $t_{DCR} = t_b/t_a$ )



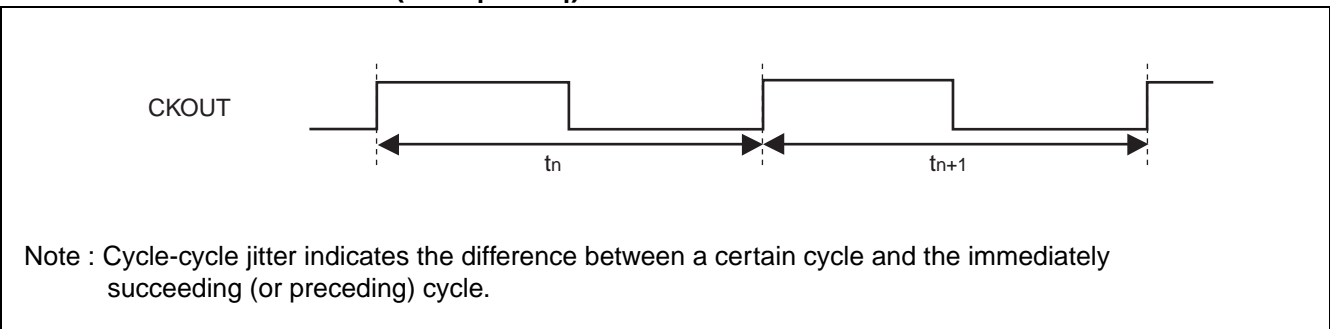
## ■ INPUT FREQUENCY ( $f_{in} = 1/t_{in}$ )



## ■ OUTPUT SLEW RATE ( $SR_C$ , $SR_R$ )



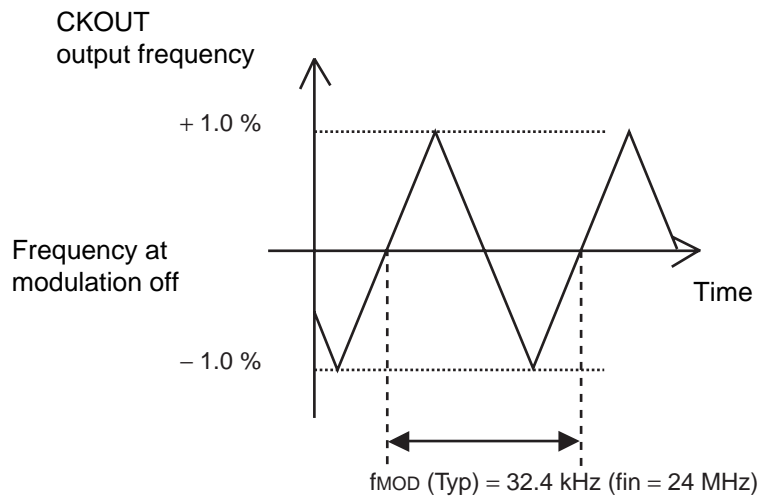
## ■ CYCLE-CYCLE JITTER ( $t_{JC} = |t_n - t_{n+1}|$ )



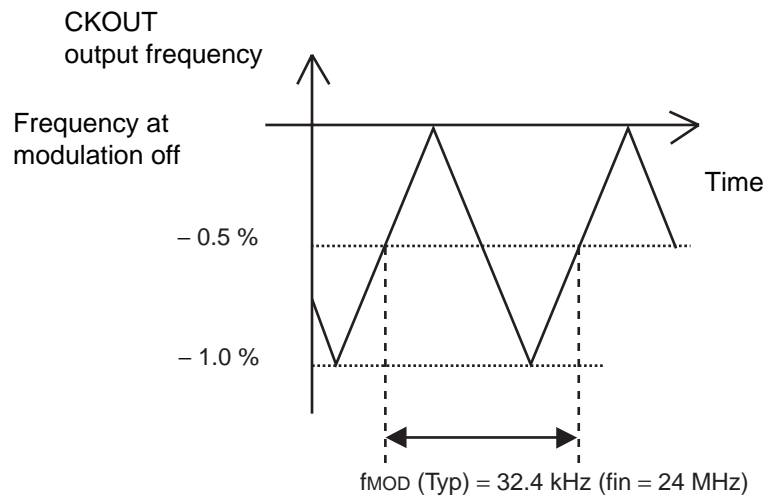


## MODULATION WAVEFORM

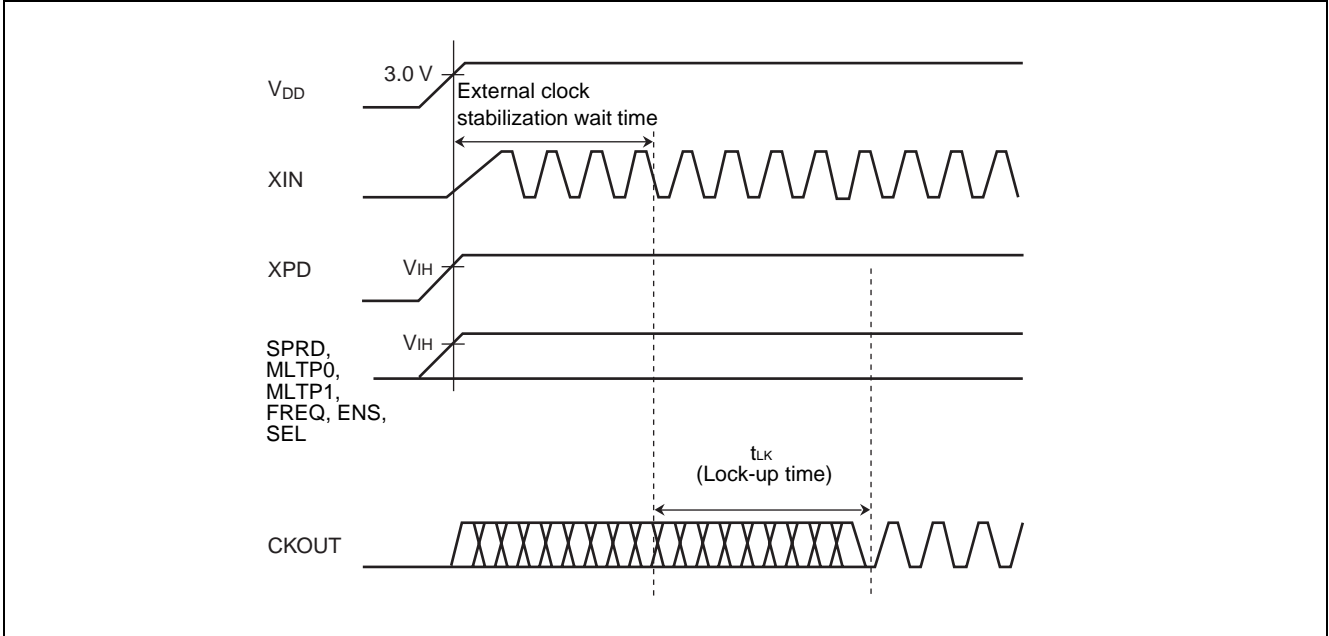
- Modulation rate  $\pm 1.0\%$ , example of center spread



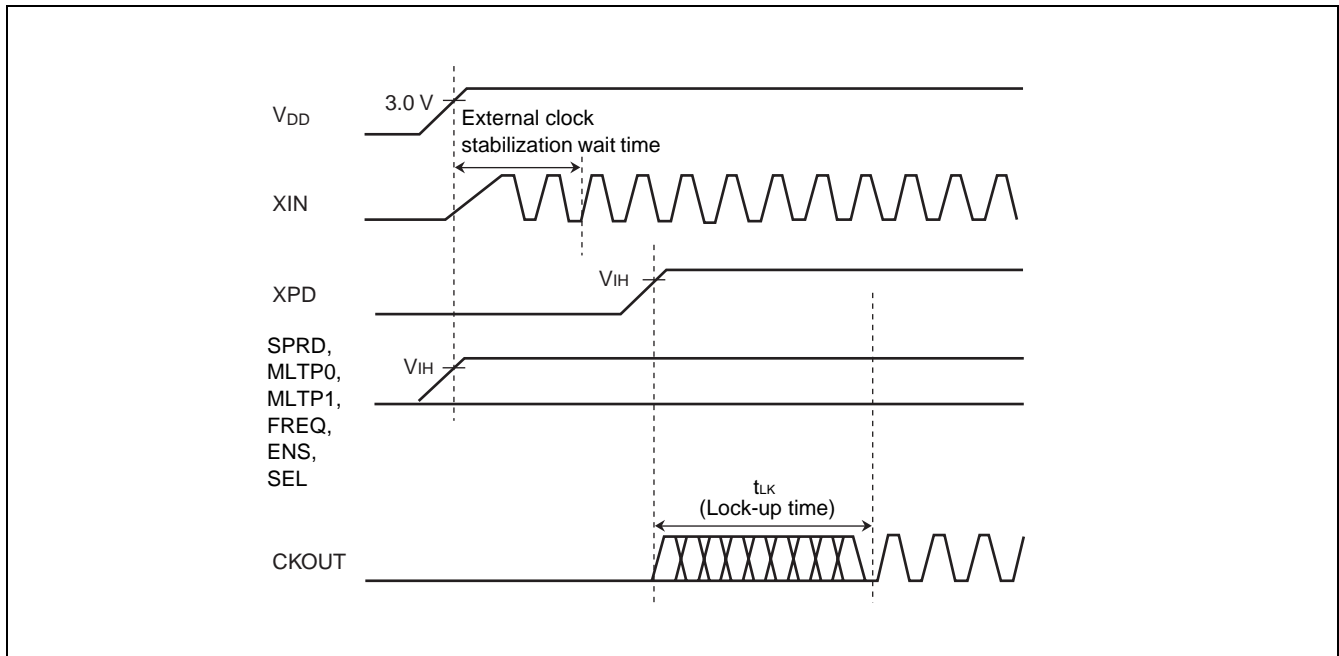
- Modulation rate  $-1.0\%$ , example of down spread



## ■ LOCK-UP TIME



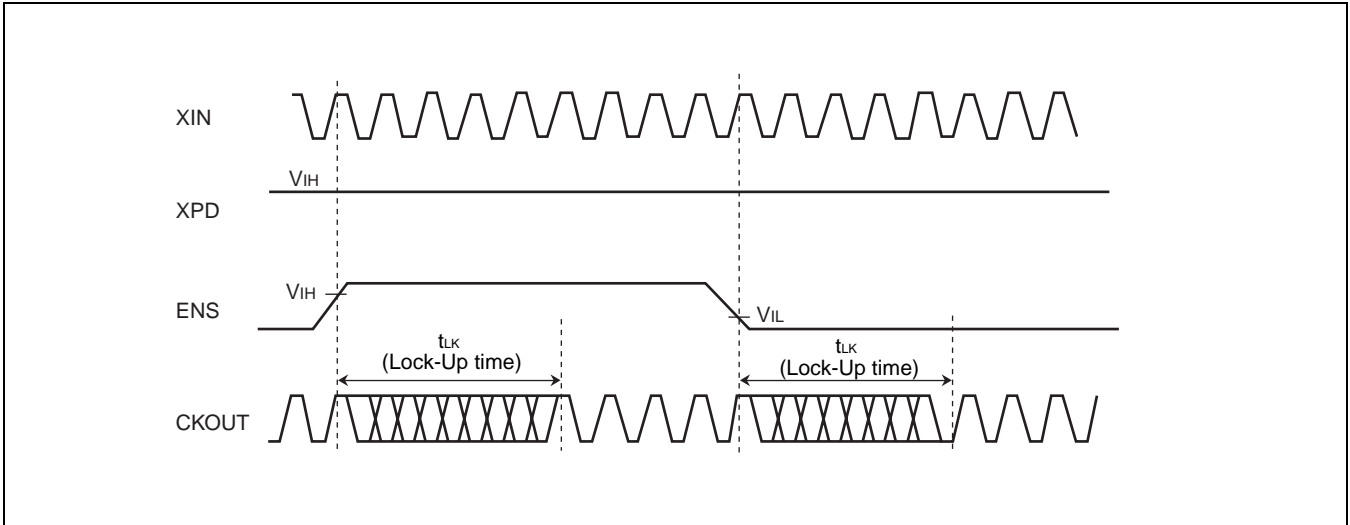
If the XPD pin is fixed at the "H" level, the maximum time after the power is turned on until the set clock signal is output from CKOUT pin is (the stabilization wait time of input clock to XIN pin) + (the lock-up time "t<sub>LK</sub>"). For the input clock stabilization time, check the characteristics of the resonator or oscillator used.



If the XPD pin is used for power-down control, the set clock signal is output from the CKOUT pin at most the lock-up time "t<sub>LK</sub>" after the XPD pin goes "H" level.

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If the ENS pin is used for modulation enable control during normal operation, the set clock signal is output from the CKOUT pin at most the lock-up time " $t_{LK}$ " after the level at the ENS pin is determined.

Note : The wait time for the clock signal output from the CKOUT pin to become stable is required after the IC is released from power-down mode by the XPD pin or after another pin's setting is changed. During the period until the output clock signal becomes stable, neither of the output frequency, output clock duty cycle, modulation period, and cycle-cycle jitter characteristic cannot be guaranteed. It is therefore advisable to take action, such as cancelling a device reset at the stage after the lock-up time has passed.

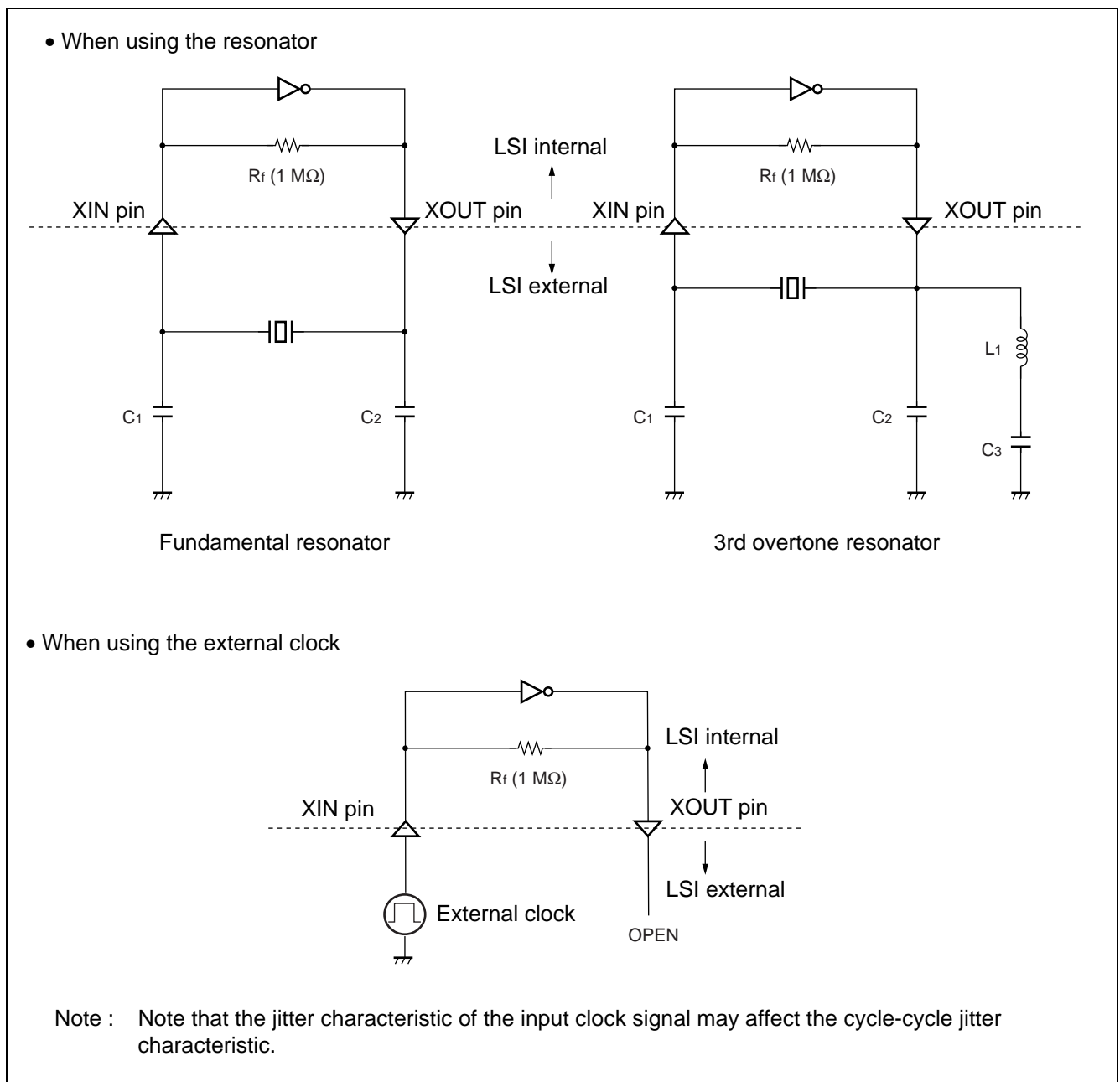
## ■ OSCILLATION CIRCUIT

The following schematic on the left-hand side shows a sample connection of a general resonator. The oscillation circuit contains a feedback resistor ( $1\text{ M}\Omega$ ). The values of capacitors ( $C_1$  and  $C_2$ ) must be adjusted to the optimum constant of the resonator used.

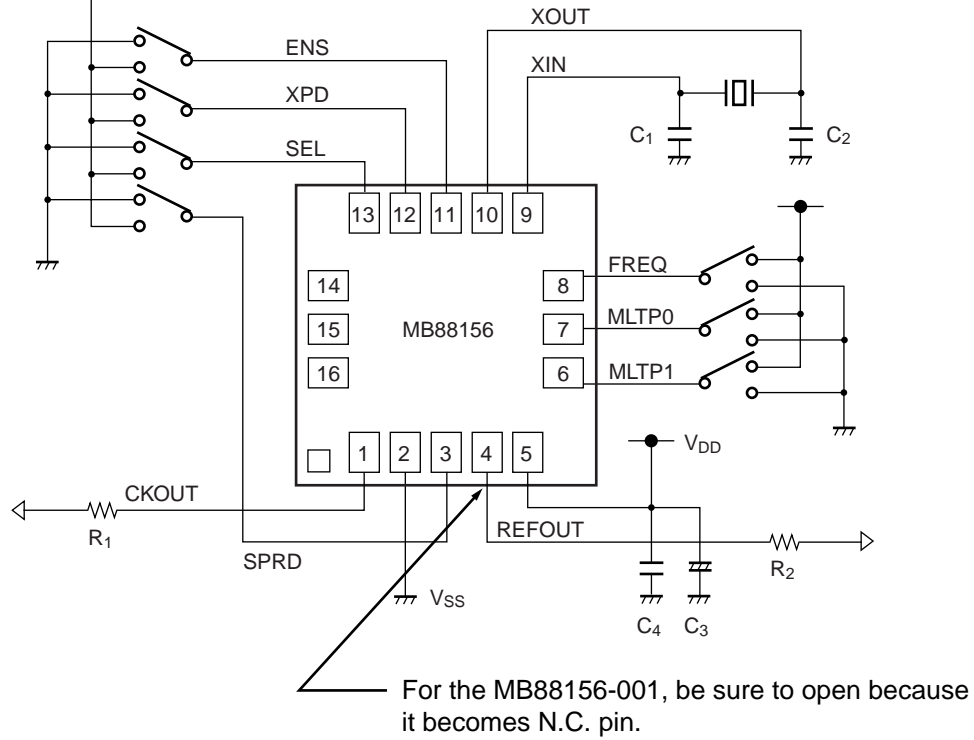
The following schematic on the right-hand side shows a sample connection of a 3rd overtone resonator. The values of capacitors ( $C_1$ ,  $C_2$ , and  $C_3$ ) and inductor ( $L_1$ ) must be adjusted to the optimum constant of the resonator used.

The most suitable value is different by individual resonator. Please refer to the resonator manufacturer which you use for the most suitable value.

To use an external clock signal (without using the resonator), input the clock signal to the XIN pin with the XOUT pin connected to nothing.



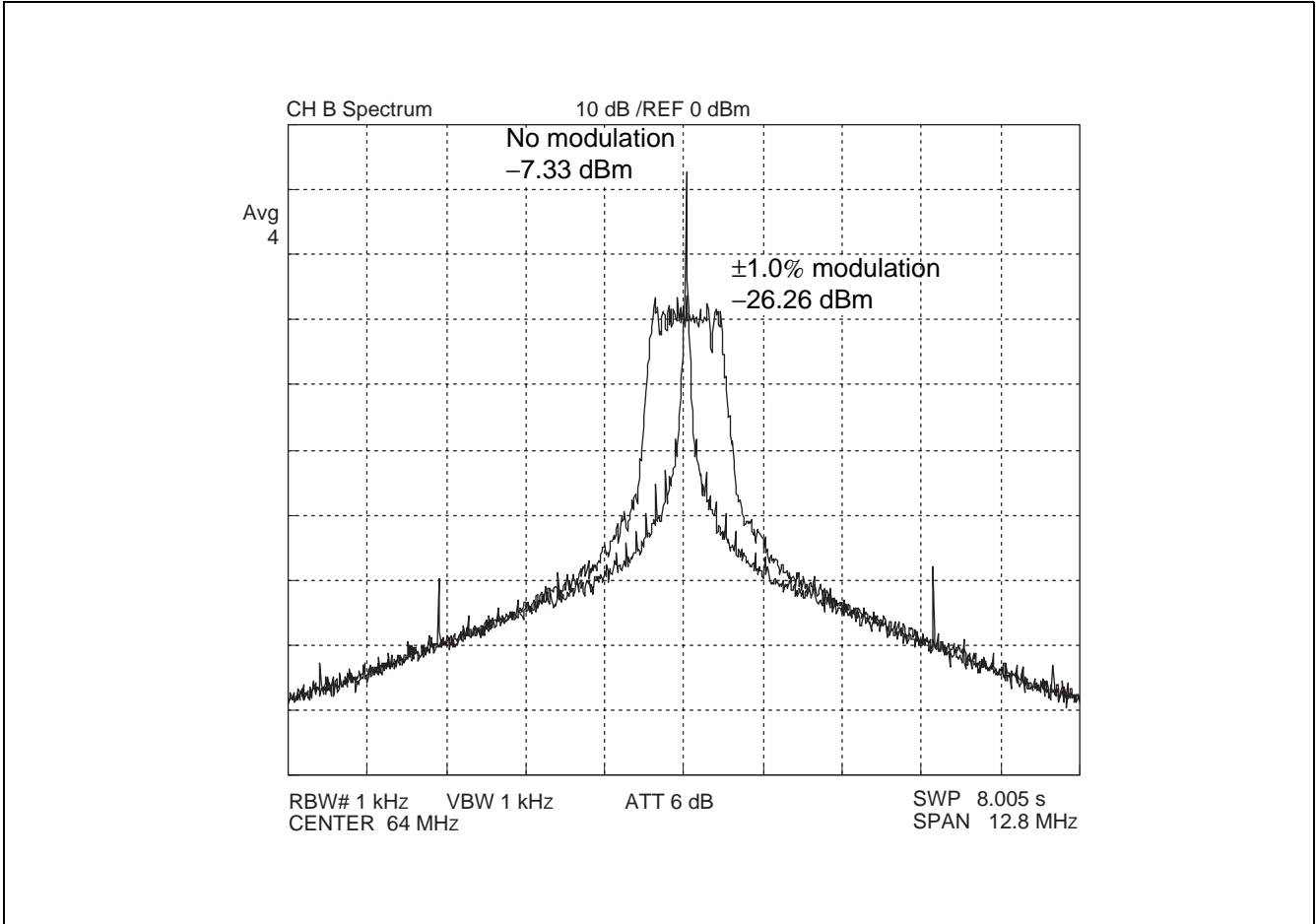
## ■ INTERCONNECTION CIRCUIT EXAMPLE



- C<sub>1</sub>, C<sub>2</sub> : Oscillation stabilization capacitance (see ■ OSCILLATION CIRCUIT)
- C<sub>3</sub> : Capacitor of 10 μF or higher
- C<sub>4</sub> : Capacitor of about 0.01 μF (connect a capacitor of good high frequency property (ex. laminated ceramic capacitor) to close to this device)
- R<sub>1</sub>, R<sub>2</sub> : Impedance matching resistor for board pattern

## ■ SPECTRUM EXAMPLE CHARACTERISTICS

The condition of the examples of the characteristic is shown as follows : Input frequency = 16 MHz (Output frequency = 64 MHz : Using MB88156-001 (Multiplied by 4) )  
Power-supply voltage = 3.3 V, None load capacity. Modulation rate =  $\pm 1.0\%$  (center spread).  
Spectrum analyzer HP4396B is connected with CKOUT. The result of the measurement with RBW = 1 kHz (ATT use for -6 dB) .

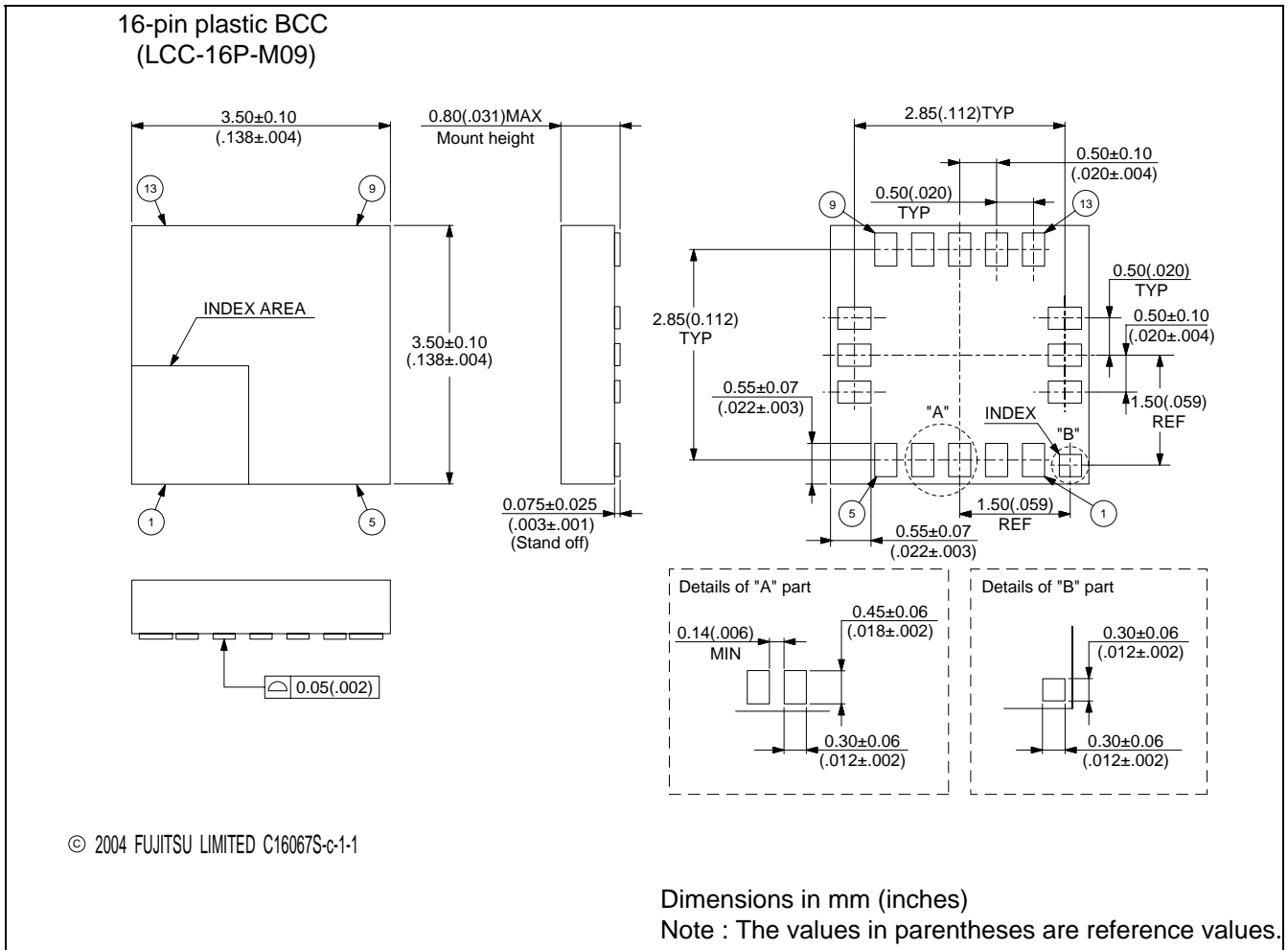


## ■ ORDERING INFORMATION

Part number	REFOUT pin	Package	Emboss taping
MB88156PV-G-000-EFE1	Provided	16-pin plastic BCC (LCC-16P-M09)	EF type
MB88156PV-G-000-ERE1			ER type
MB88156PV-G-001-EFE1	None		EF type
MB88156PV-G-001-ERE1			ER type

# MB88156

## ■ PACKAGE DIMENSION





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