

# MB15ExxSL Series

## Single PLL Frequency Synthesizers with On-Chip Prescalers

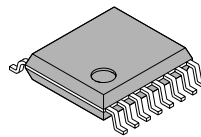
### Description

The Fujitsu ExxSL series single PLLs are serial input frequency synthesizers operating up to 2.5 GHz. They have built-in dual-modulus prescalers enabling pulse swallow operation. The latest advanced BiCMOS technology is used resulting in a super low supply current. A refined charge pump design (Fujitsu's Super Charger) provides fast tuning along with low spurious noise and phase noise characteristics. The E-series is ideally suited for digital mobile communications, including GSM, DCS1800, PCS1900, IS-136, IS-95 and ISM applications.

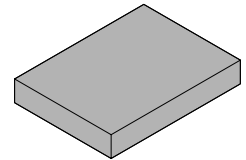
### Features

- Very low spurious and phase noise characteristics
- Excellent lock-up time performance
- Low operating voltage: 2.4 to 3.6 volts
- Super low operating current: 2.5 to 4.0 mA (typical)
- Power-saving current: 0.1 $\mu$ A (typical)
- Selectable charge pump current ( $\pm 1.5$  or  $\pm 6.0$  mA)
- Wide operating temperature:  $-40$  to  $+85^{\circ}\text{C}$
- Plastic 16-pin SSOP and 16-pin BCC packages
- Reference counter:
  - 14-bit programmable divider: 3 to 16383
- 18-bit programmable divider:
  - Binary 7-bit swallow counter: 0 to 127
  - Binary 11-bit programmable counter: 3 to 2047
- Evaluation kits available

### Packages



16-pin plastic SSOP,  
FPT-16P-M05



16-pin plastic BCC,  
LCC-16P-M06

Parameter	MB15E03SL	MB15E05SL	MB15E07SL
RF Frequency of Operation	1.2 GHz	2.0 GHz	2.5 GHz
Low Power Supply Voltage	2.7V	2.7V	2.7V
Low Power Supply Current	2.0 mA	3.0 mA	3.5 mA
Prescaler Divide Ratios	64/65 or 128/129		32/33 or 64/65
Power-Saving Function	0.1 $\mu$ A typ.		

## Table of Contents

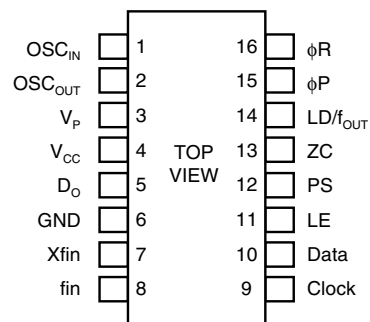
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# Single PLL Frequency Synthesizers with On-Chip Prescalers

## Pin Descriptions

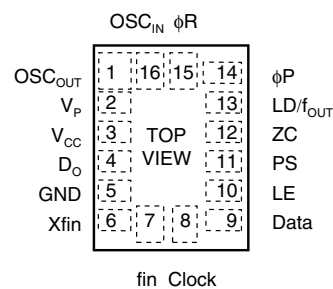
Pin No.		Pin Name	I/O	Descriptions
SSOP	BCC			
1	16	OSC <sub>IN</sub>	I	Programmable reference divider input Oscillator input connection to a TCXO
2	1	OSC <sub>OUT</sub>	O	Oscillator output
3	2	V <sub>P</sub>	—	Power supply voltage input for the charge pump
4	3	V <sub>CC</sub>	—	Power supply voltage input
5	4	D <sub>O</sub>	O	Charge pump output Phase of the charge pump can be selected via programming of the FC bit.
6	5	GND	—	Ground
7	6	Xfin	I	Prescaler complementary input which should be grounded via a capacitor.
8	7	fin	I	Prescaler input Connection to an external VCO should be done via AC coupling.
9	8	Clock	I	Clock input for 19-bit shift register Data is shifted into shift register on rising edge of the clock. (Open is prohibited.)
10	9	Data	I	Serial data input using binary code Last bit of data is a control bit. (Open is prohibited.)
11	10	LE	I	Load enable signal input. (Open is prohibited.) When LE is set high, data in the shift register is transferred to a latch according to control bit in the serial data.
12	11	PS	I	Power-saving mode control. Pin must be set at "L" at Power-ON. (Open is prohibited.) PS = "H" sets normal mode. PS = "L" sets power-saving mode.
13	12	ZC	I	Forced high-impedance control for the charge pump (with internal pull up resistor) ZC = "H" sets normal D <sub>O</sub> output. ZC = "L"; D <sub>O</sub> becomes high impedance.
14	13	LD/f <sub>OUT</sub>	O	Lock detect signal output (LD)/phase comparator monitoring output (f <sub>OUT</sub> ) The output signal is selected via programming of the LDS bit. LDS = "H" outputs f <sub>OUT</sub> (fr/fp monitoring output). LDS = "L" outputs LD ("H" = locked state, "L" = unlocked state).
15	14	φP	O	Phase comparator N-channel open drain output for an external charge pump. Phase can be selected via programming of the FC bit.
16	15	φR	O	Phase comparator CMOS output for an external charge pump. Phase can be selected via programming of the FC bit.

16-pin SSOP



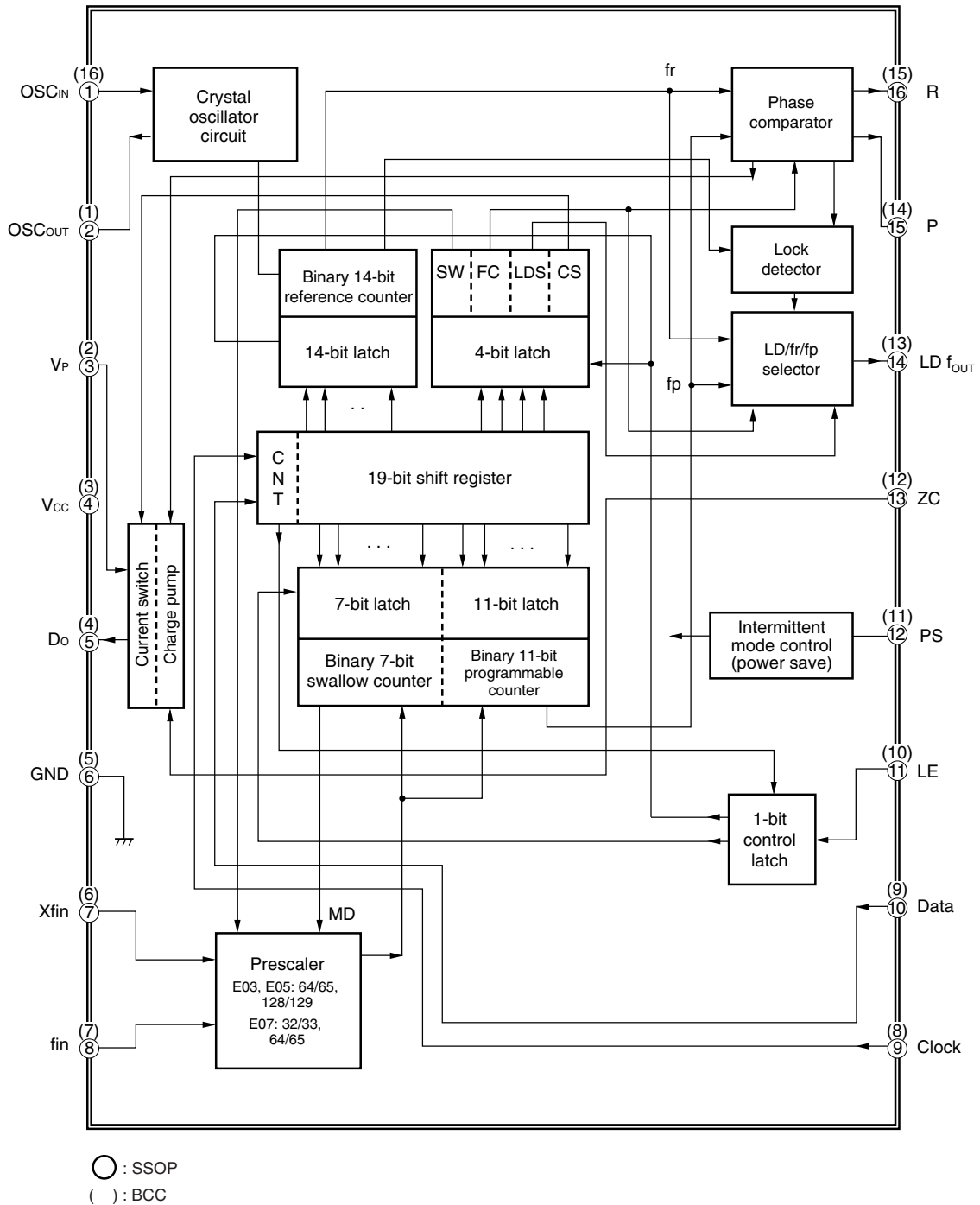
FPT-16P-M05

16-pad BCC



LCC-16P-M06

## Block Diagram



# Single PLL Frequency Synthesizers with On-Chip Prescalers

## Absolute Maximum Ratings

Parameter	Symbol	Condition	Rating		Unit	Remark
			Min.	Max.		
Power supply voltage	$V_{CC}$	–	–0.5	4.0	V	
	$V_P$	–	$V_{CC}$	6.0	V	
Input voltage	$V_I$	–	–0.5	$V_{CC} + 0.5$	V	
Output voltage	$V_O$	Except Do	GND	$V_{CC}$	V	
	$V_O$	Do	GND	$V_P$	V	
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	Remark
		Min.	Typ.	Max.		
Power supply voltage	$V_{CC}$	2.4	3.0	3.6	V	
	$V_P$	$V_{CC}$	–	5.5	V	
Input voltage	$V_I$	GND	–	$V_{CC}$	V	
Operating temperature	$T_a$	–40	–	+85	°C	

WARNING: Recommended operating conditions are normal operating ranges for the semiconductor device. All the device's electrical characteristics are warranted when operated within these ranges. Always use semiconductor devices within the recommended operating conditions. 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 representative beforehand.

## Handling Precautions

- This device should be transported and stored in anti-static containers.
- This is a static-sensitive device; take proper anti-ESD precautions. Ensure that personnel and equipment are properly grounded. Cover workbenches with grounded conductive mats.
- Always turn the power supply off before inserting or removing the device from its socket.
- Protect leads with a conductive sheet when handling or transporting PC boards with devices.

## Electrical Characteristics

### Device Specifications

$V_{CC} = 2.4$  to  $3.6$  V,  $T_a = -40$  to  $+85^\circ\text{C}$

Parameter	Symbol	MB15E03SL	MB15E05SL	MB15E07SL
Power supply current	$I_{CCRF}^{*1}$	2.0 mA	3.0 mA	3.5 mA
Power-saving current	$I_{PSRF}^{*2}$	0.1 $\mu\text{A}$	0.1 $\mu\text{A}$	0.1 $\mu\text{A}$
Operating frequency	$f_{inRF}$	0.1 - 1.2 GHz	0.1 - 2.0 GHz	0.1 - 2.5 GHz
	$OSC_{in}^{*3}$	3 - 40 MHz	3 - 40 MHz	3 - 40 MHz

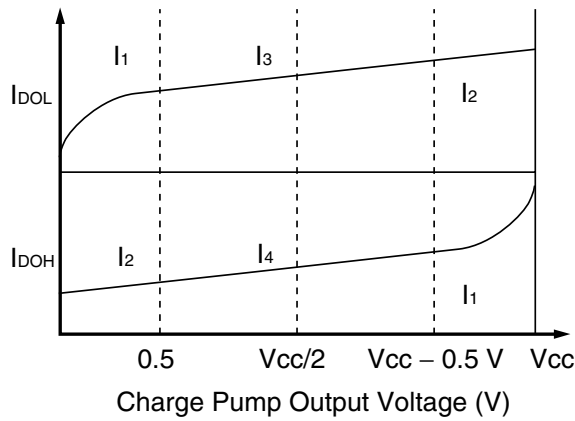
### General Specifications

Parameter	Symbol	Condition	Value			Unit		
			Min.	Typ.	Max.			
Input sensitivity	$f_{inRF}$	$P_{inRF}$	50 $\Omega$ load system (Refer to measurement circuit.)	-15	-	+2	dBm	
	$OSC_{in}$	$V_{OSC}$	-	0.5	-	$V_{CC}$	Vp-p	
Input voltage	Data, Clock, LE, PS, ZC	$V_{IH}$	-	$V_{CC} \times 0.7$	-	-	V	
		$V_{IL}$	-	-	-	$V_{CC} \times 0.3$	V	
Input current	Data, Clock, LE, PS	$I_{IH}^{*4}$	-	-1.0	-	1.0	$\mu\text{A}$	
		$I_{IL}^{*4}$	-	-1.0	-	1.0	$\mu\text{A}$	
	$OSC_{in}$	$I_{IH}$	-	0	-	100	$\mu\text{A}$	
		$I_{IL}^{*4}$	-	-100	-	0	$\mu\text{A}$	
	ZC	$I_{IH}$	-	-1.0	-	1.0	$\mu\text{A}$	
Output voltage	$\phi P$	$V_{OL}$	Open drain output	-	-	0.4	V	
	$\phi R, LD/f_{OUT}$	$V_{OH}$	$V_{CC} = V_P = 3.0\text{V}, I_{OH} = -1\text{ mA}$	$V_{CC} - 0.4$	-	-	V	
		$V_{OL}$	$V_{CC} = V_P = 3.0\text{V}, I_{OL} = 1\text{ mA}$	-	-	0.4	V	
	Do	$V_{DOH}$	$V_{CC} = V_P = 3.0\text{V}, I_{OH} = -0.5\text{ mA}$	$V_{CC} - 0.4$	-	-	V	
$V_{DOL}$		$V_{CC} = V_P = 3.0\text{V}, I_{OL} = 0.5\text{ mA}$	-	-	0.4	V		
High impedance cutoff current	Do	$I_{OFF}$	$V_{CC} = V_P = 3.0\text{V}$ $V_{OFF} = .5\text{V to } V_P - 0.5\text{V}$	-	-	2.5	nA	
Output current	$\phi P$	$I_{OL}$	Open drain output	1.0	-	-1.0	mA	
	$\phi R, LD/f_{OUT}$	$I_{OH}^{*4}$	$V_{CC} = 3.0\text{V}$	-	-	-	mA	
		$I_{OL}$	$V_{CC} = 3.0\text{V}$	1.0	-	-	mA	
	Do	$I_{DOH}^{*4}$	$V_{CC} = V_P = 3.0, V_{DOH} = V_P/2, T_a = +25^\circ\text{C}$	CS bit = "H"	-	-6.0	-	mA
				CS bit = "L"	-	-1.5	-	mA
		$I_{DOL}$	$V_{CC} = V_P = 3.0\text{V}, V_{DOL} = V_P/2, T_a = +25^\circ\text{C}$	CS bit = "H"	-	6.0	-	mA
CS bit = "L"				-	1.5	-	mA	
Charge pump current characteristics	$I_{DOL}/I_{DOH}$	$I_{DOMT}^{*5}$	$V_{DO} = V_{CC}/2$	-	3	-	%	
	vs $V_{DO}$	$I_{DOVD}^{*6}$	$0.5\text{V} \leq V_{DO} \leq V_{CC} - 0.5\text{V}$	-	10	-	%	
	vs $T_a$	$I_{DOTA}^{*7}$	$-40^\circ\text{C} \leq T_a \leq +85^\circ\text{C}, V_{DO} = V_{CC}/2$	-	10	-	%	

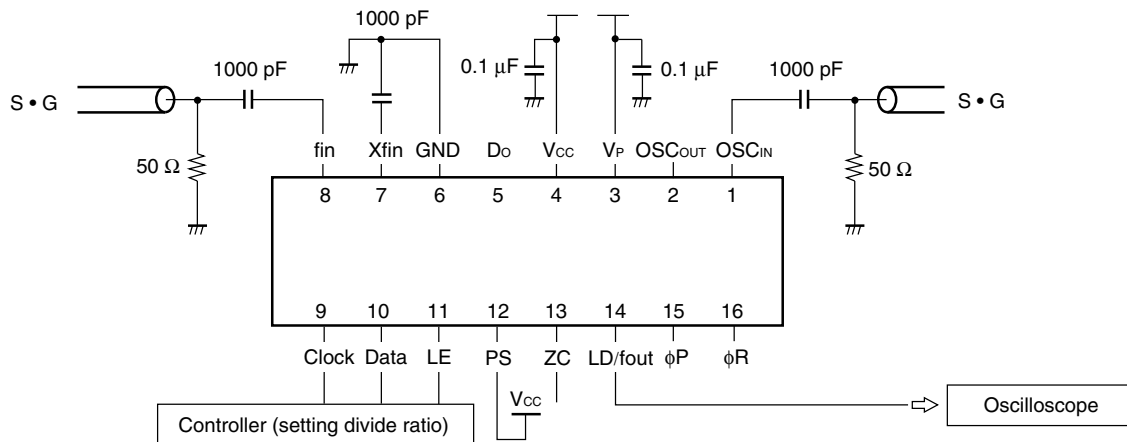
Note: See footnotes on next page.

# Single PLL Frequency Synthesizers with On-Chip Prescalers

- \*1 Conditions:  $f_{osc} = 12 \text{ MHz}$ ,  $T_a = +25^\circ\text{C}$  in locking state,  $V_{CC} = 2.7 \text{ V}$
- \*2  $V_{CCIF} = V_{CCRF} = 3.0 \text{ V}$ ,  $f_{osc} = 12.8 \text{ MHz}$ ,  $Z_c = \text{"H"}$  or open,  $T_a = +25^\circ\text{C}$  in power-saving mode
- \*3 AC coupling. 1000pF capacitor is connected under the condition of minimum operating frequency.
- \*4 The symbol "-" (minus) means direction of current flow.
- \*5  $V_{CC} = 3.0 \text{ V}$ ,  $T_a = +25^\circ\text{C}$   $(|I_3| - |I_4|)/(|I_3| + |I_4|)/2 \times 100(\%)$
- \*6  $V_{CC} = 3.0 \text{ V}$ ,  $T_a = +25^\circ\text{C}$   $(|I_2| - |I_1|)/2 / (|I_1| + |I_2|)/2 \times 100(\%)$  (Applied to each  $I_{DOL}$ ,  $I_{DOH}$ )
- \*7  $V_{CC} = 3.0 \text{ V}$ ,  $(|I_{DO}(85^\circ\text{C}) - I_{DO}(-40^\circ\text{C})|/2) / (|I_{DO}(85^\circ\text{C}) + I_{DO}(-40^\circ\text{C})|/2) \times 100(\%)$  (applied to each  $I_{DOL}$ ,  $I_{DOH}$ )



## Measurement Circuit (For Measuring Input Sensitivity of $f_{in}$ and $OSC_{IN}$ )

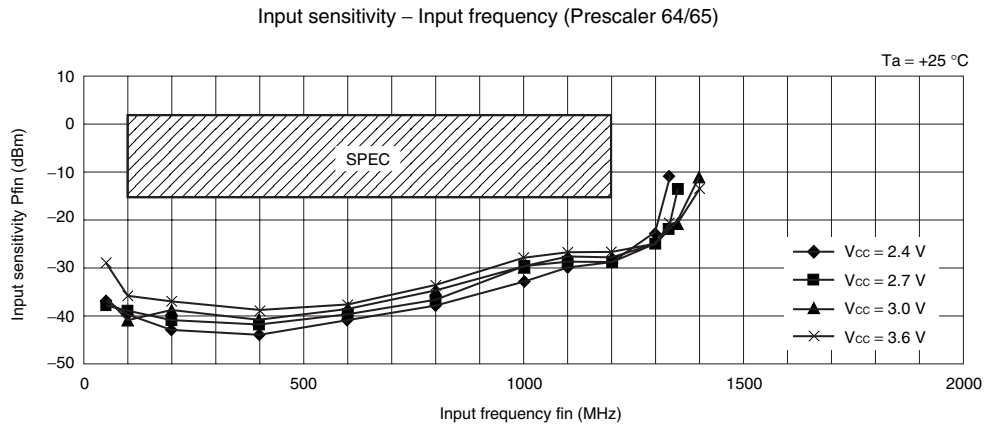


Note: 16-pin SSOP

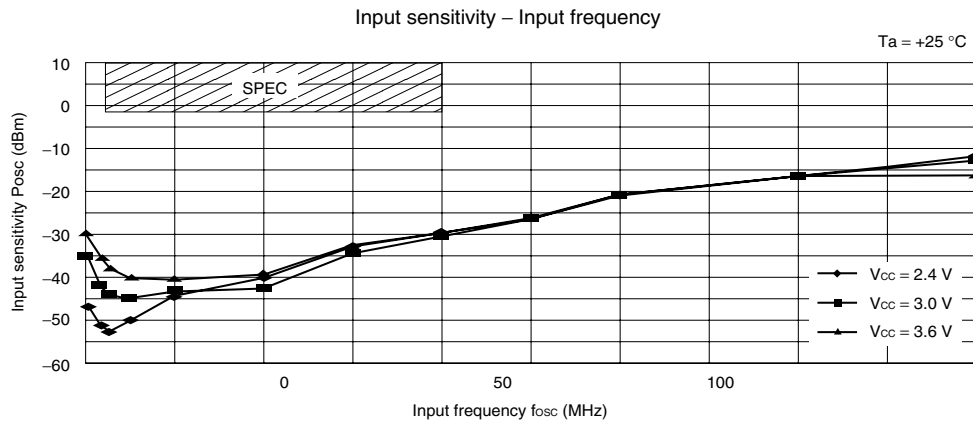
# Single PLL Frequency Synthesizers with On-Chip Prescalers

## Typical Electrical Characteristics: MB15E03SL

### Input Sensivity of $f_{IN}$ Versus Input Frequency

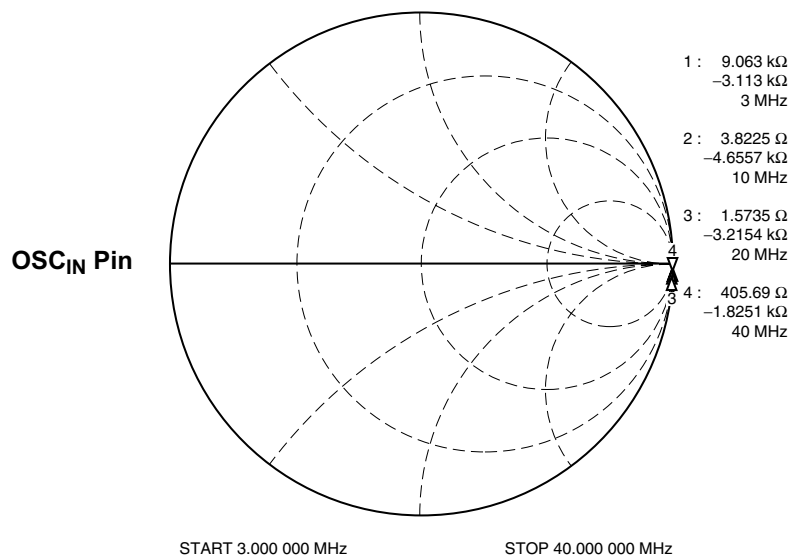
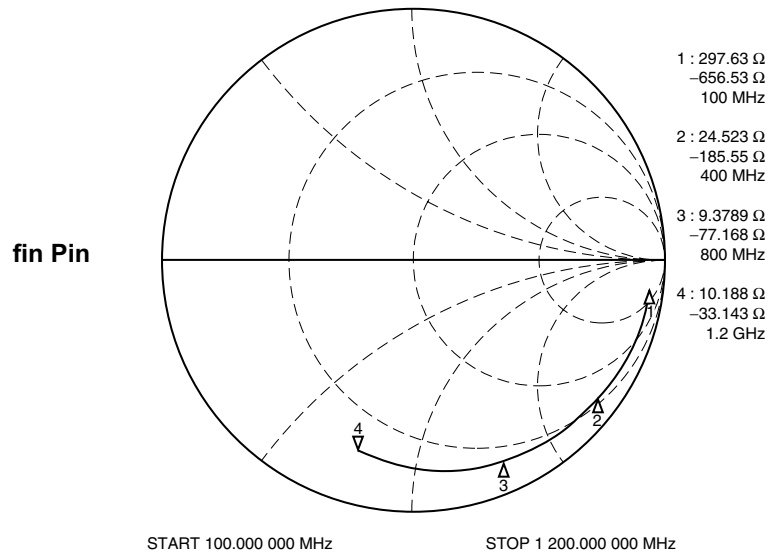


### Input Sensivity of OSC<sub>IN</sub> versus Input Frequency



## Typical Electrical Characteristics: MB15E03SL

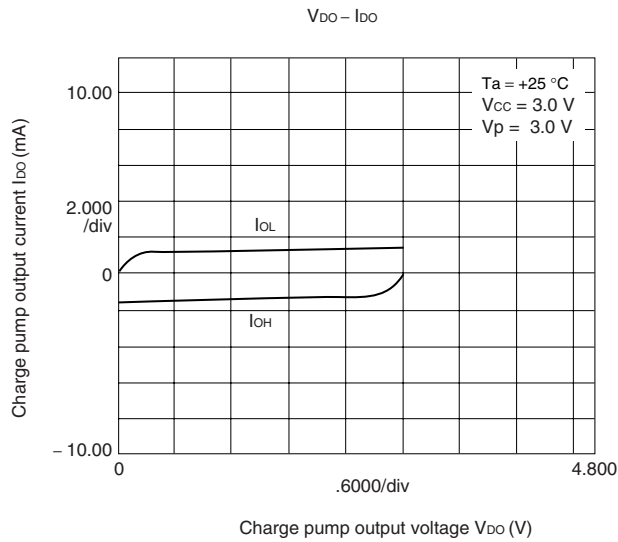
### Input Impedance



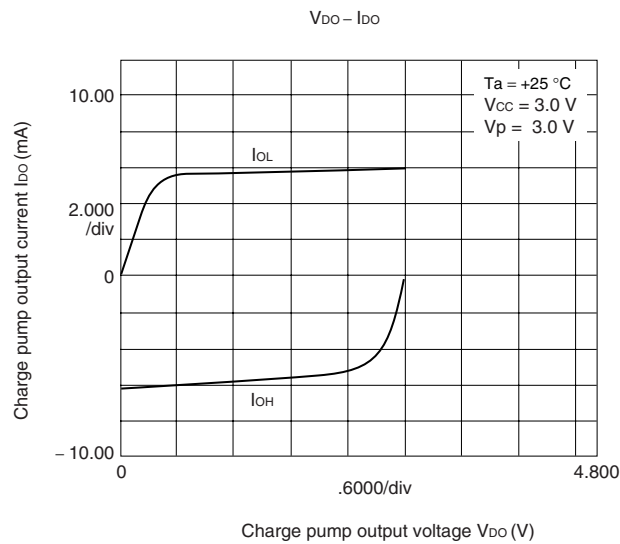
# Single PLL Frequency Synthesizers with On-Chip Prescalers

## Typical Electrical Characteristics: MB15E03SL

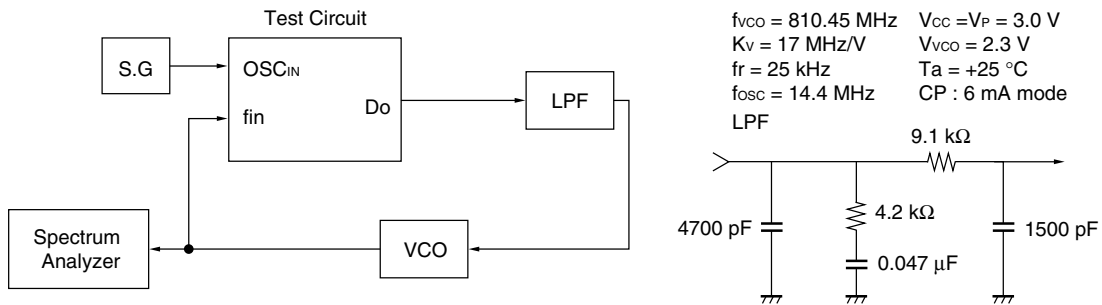
Do ouput current: 1.5 mA mode



Do ouput current: 6.0 mA mode

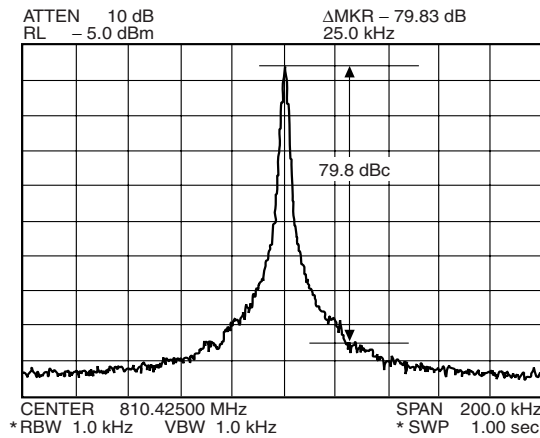


## Reference Information: MB15E03SL

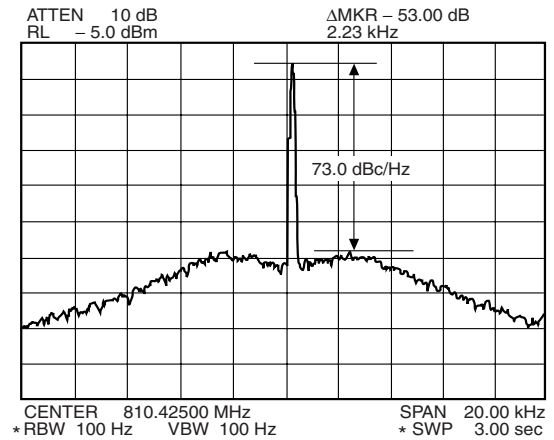


Typical plots measured with the test circuit are shown below. The plots show lock up time, phase noise and reference leakage.

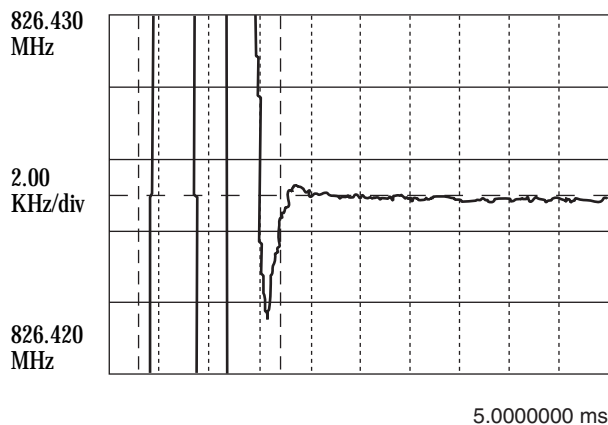
**PLL Reference Leakage**  
@ 25 kHz offset = -79.8 dBc



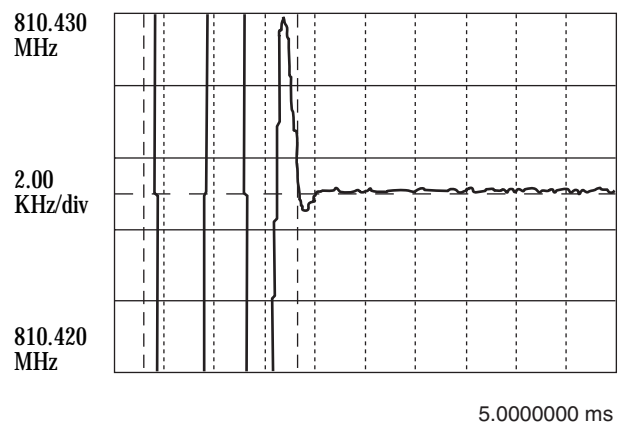
**PLL Phase Noise**  
@ max within loop band = -73.0 dBc/Hz



**PLL Lock Up Time = 1.4 ms**  
(810.425 MHz → 826.425 MHz, within  $\pm 1 \text{ kHz}$ )



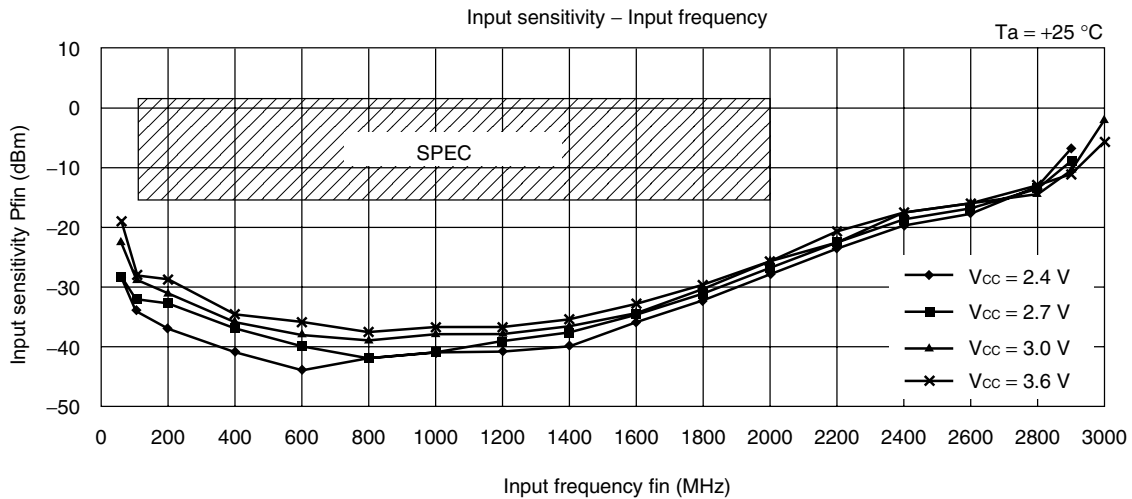
**PLL Lock Up Time = 1.52 ms**  
(826.425 MHz → 810.425 MHz, within  $\pm 1 \text{ kHz}$ )



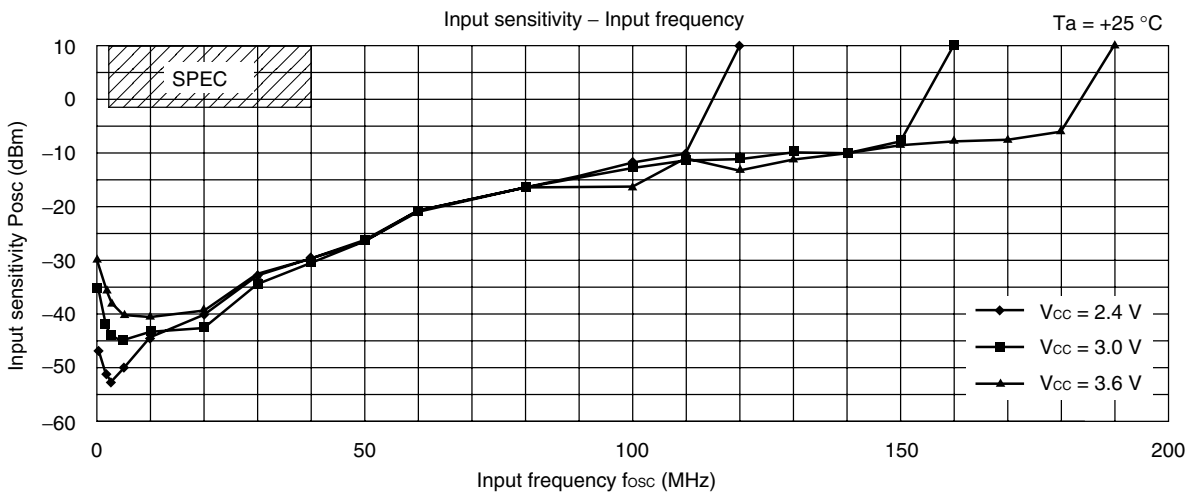
# Single PLL Frequency Synthesizers with On-Chip Prescalers

## Typical Electrical Characteristics: MB15E05SL

### Input Sensivity of $f_{IN}$ Versus Input Frequency

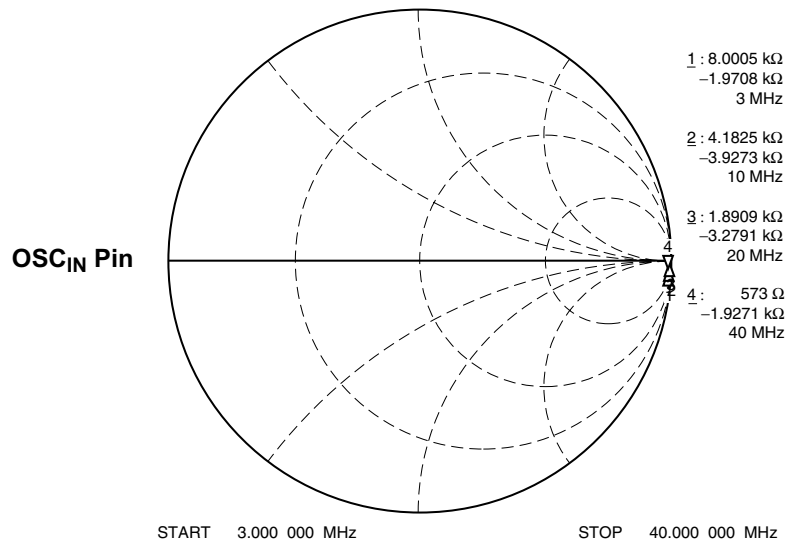
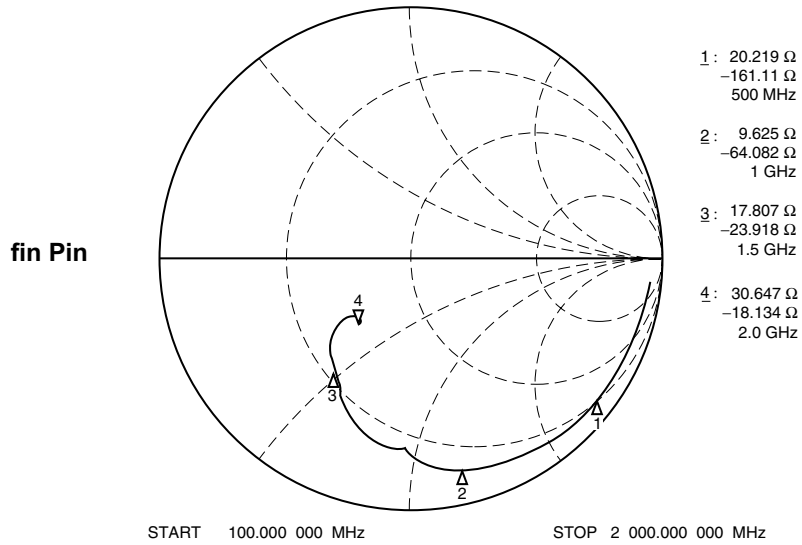


### Input Sensivity of $OSC_{IN}$ Versus Input Frequency



## Typical Electrical Characteristics: MB15E05SL

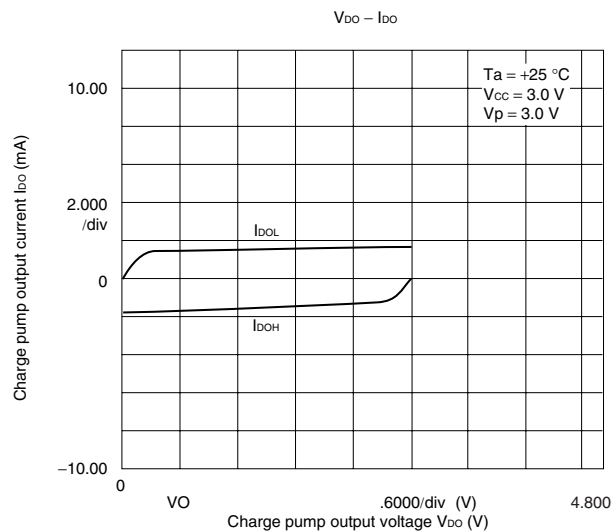
### Input Impedance



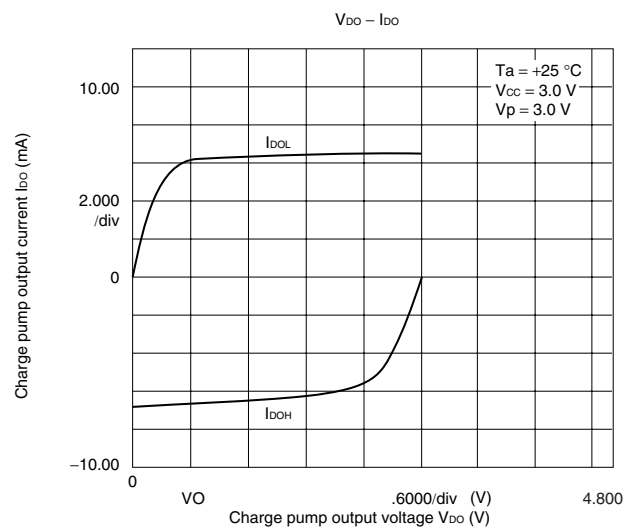
# Single PLL Frequency Synthesizers with On-Chip Prescalers

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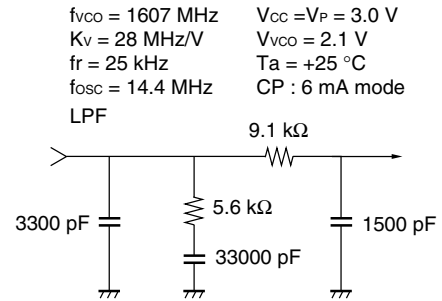
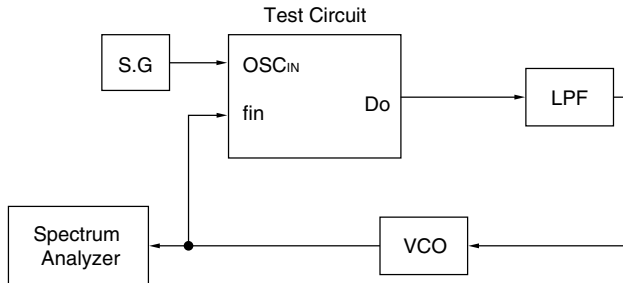
Do ouput current: 1.5 mA mode



Do ouput current: 6.0 mA mode



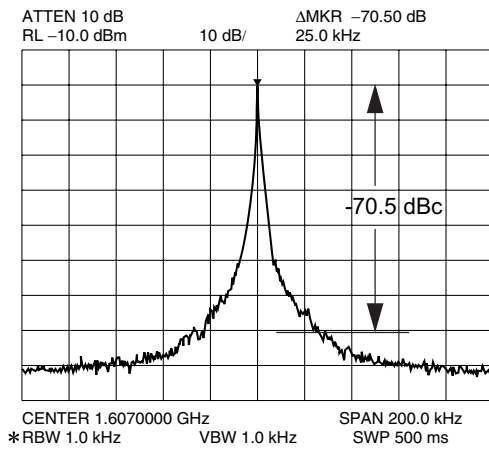
## Reference Information: MB15E05SL



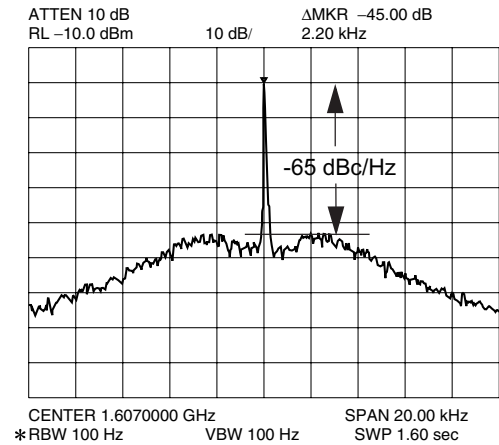
$f_{VCO} = 1607 \text{ MHz}$      $V_{CC} = V_P = 3.0 \text{ V}$   
 $K_V = 28 \text{ MHz/V}$      $V_{VCO} = 2.1 \text{ V}$   
 $f_r = 25 \text{ kHz}$      $T_a = +25 \text{ }^\circ\text{C}$   
 $f_{osc} = 14.4 \text{ MHz}$      $CP : 6 \text{ mA mode}$   
 LPF

Typical plots measured with the test circuit are shown below. The plots show lock up time, phase noise and reference leakage.

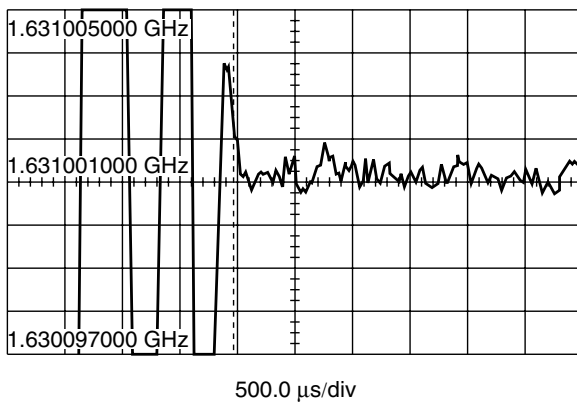
**RF PLL Reference Leakage**  
@ 25 kHz offset = -70.5 dBc



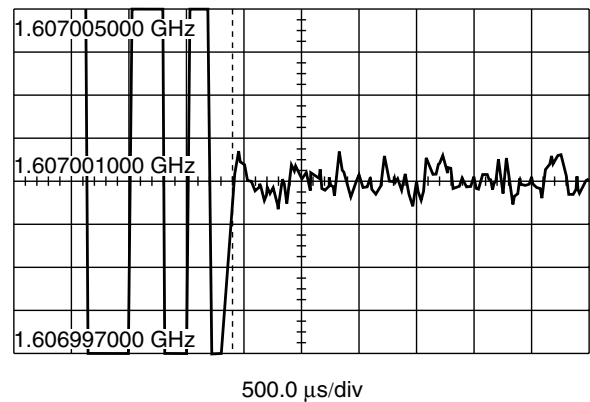
**RF PLL Phase Noise**  
@ max within loop band = -65 dBc/Hz



**RF PLL Lock Up Time = 1.46 ms**  
(1607.000 MHz → 1631.000 MHz, within ± 1kHz)



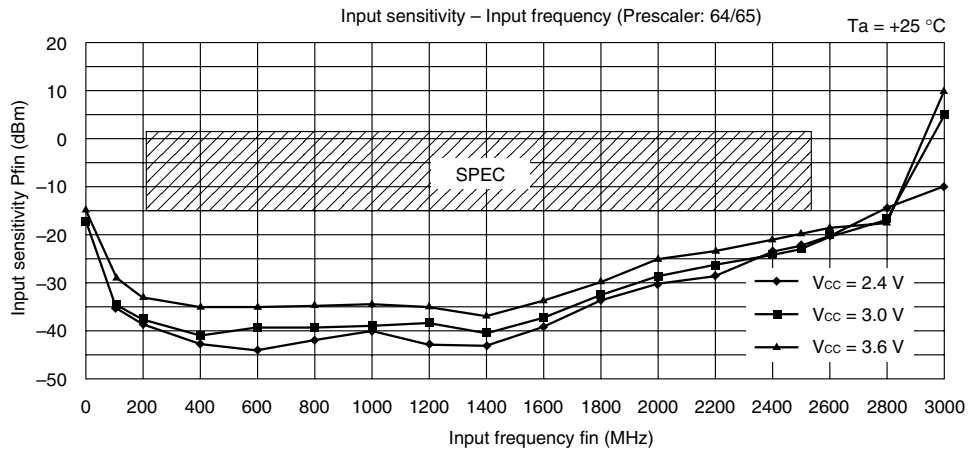
**RF PLL Lock Up Time = 1.37 ms**  
(1631.000 MHz → 1607.000 MHz, within ± 1kHz)



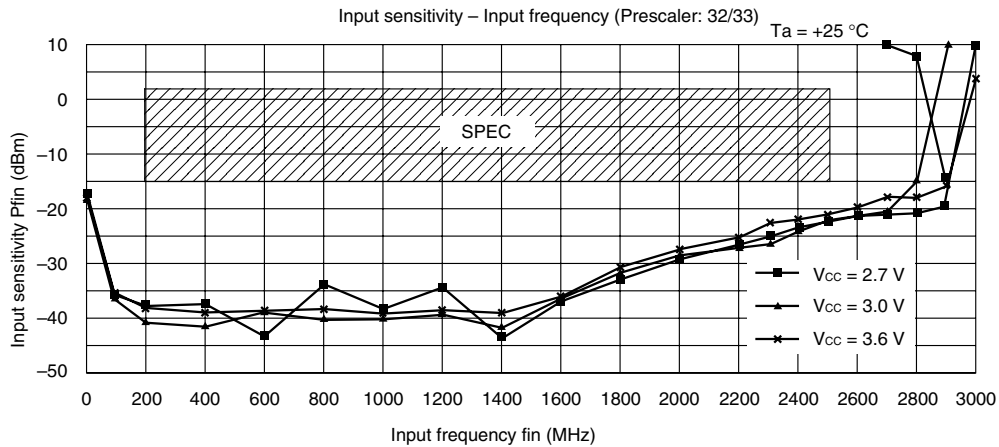
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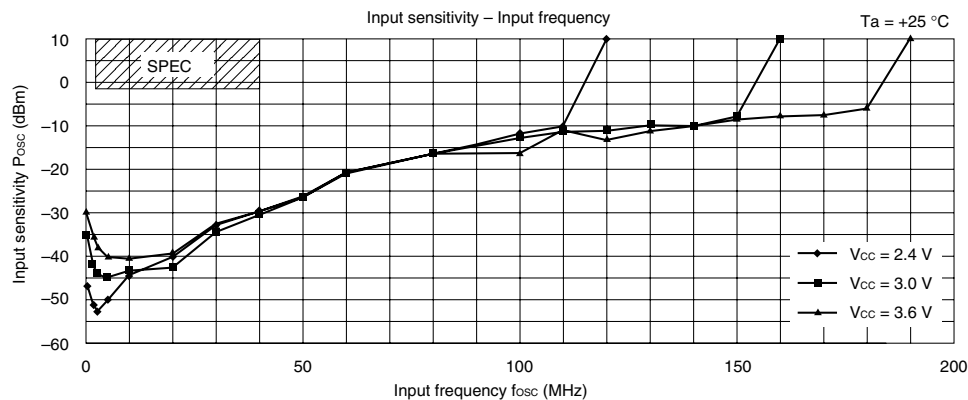
### Input Sensivity of $f_{IN}$ Versus Input Frequency



### Input Sensivity of $f_{IN}$ Versus Input Frequency

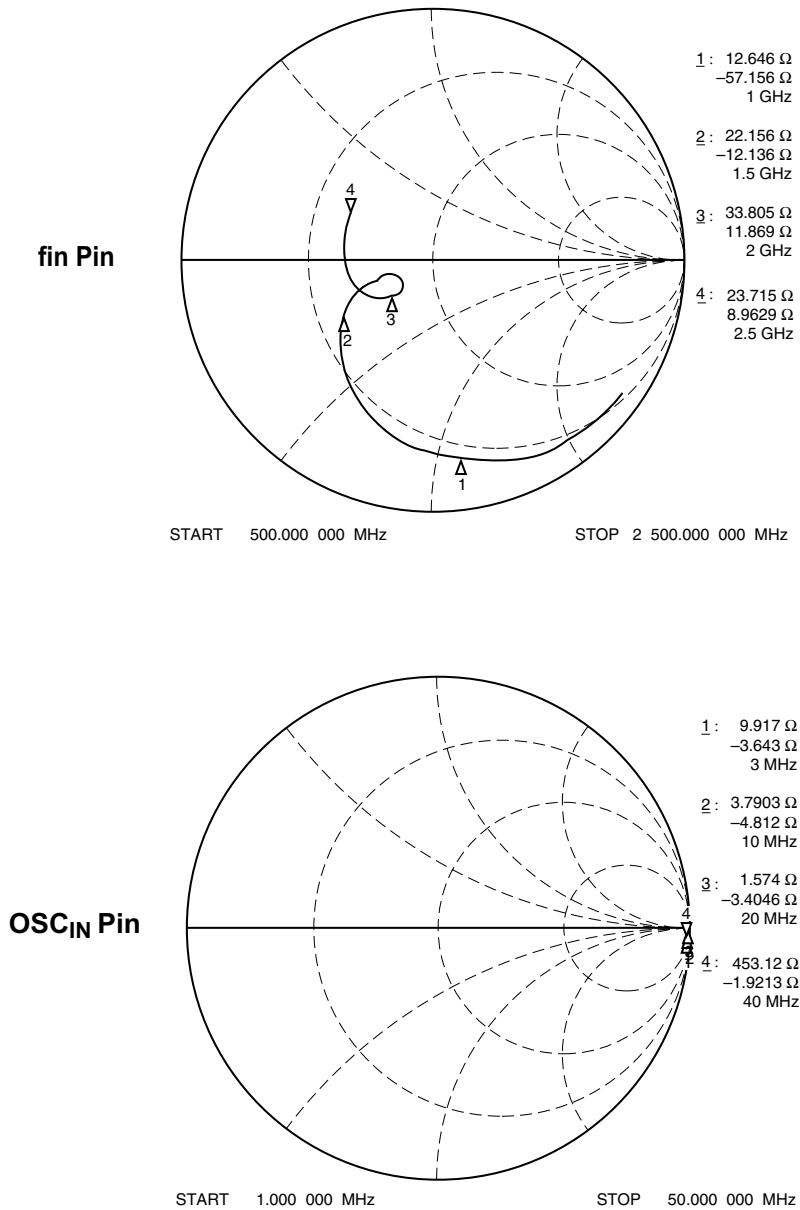


### Input Sensivity of $OSC_{IN}$ Versus Input Frequency



## Typical Electrical Characteristics: MB15E07SL

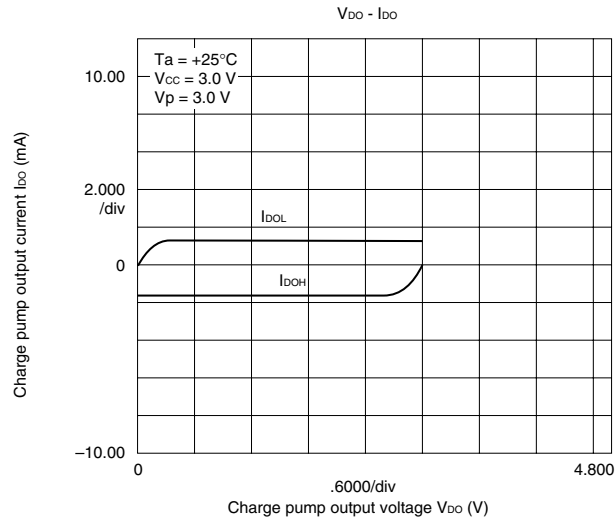
### Input Impedance



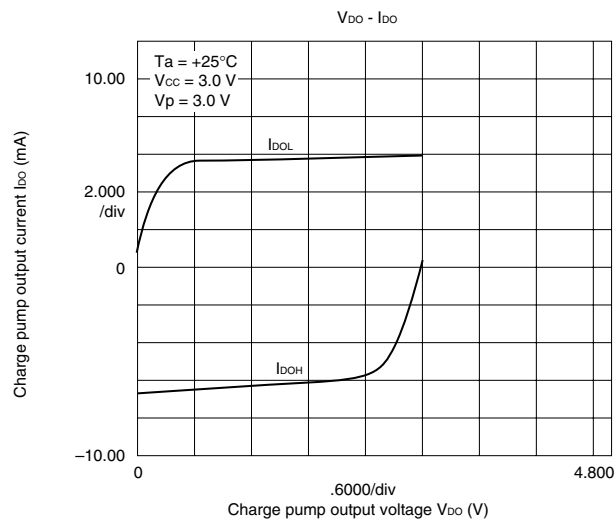
# Single PLL Frequency Synthesizers with On-Chip Prescalers

## Typical Electrical Characteristics: MB15E07SL

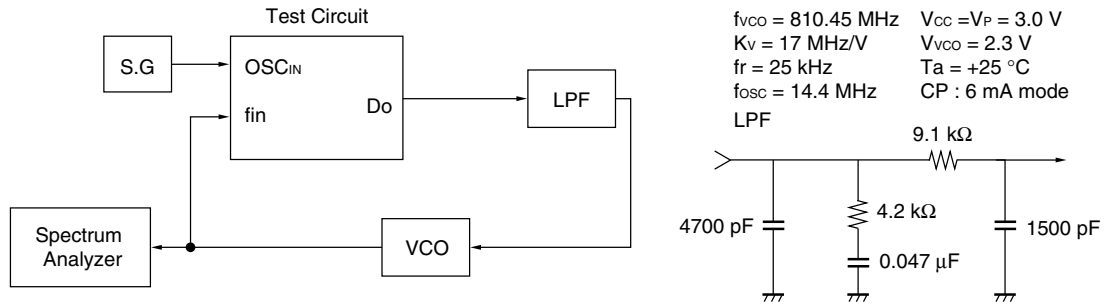
Do output current: 1.5 mA mode



Do output current: 6.0 mA mode

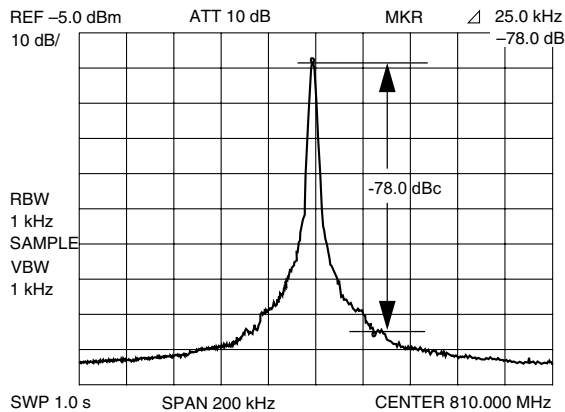


## Reference Information: MB15E07SL

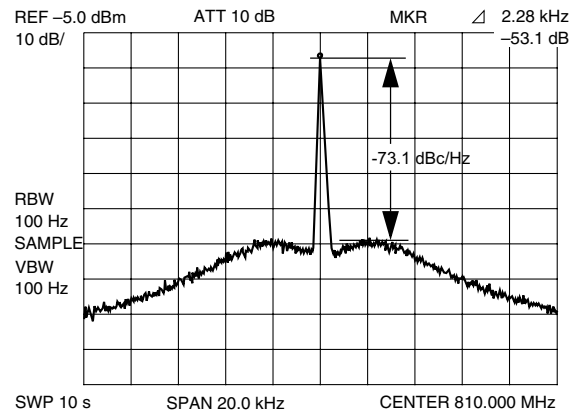


Typical plots measured with the test circuit are shown below. The plots show lock up time, phase noise and reference leakage.

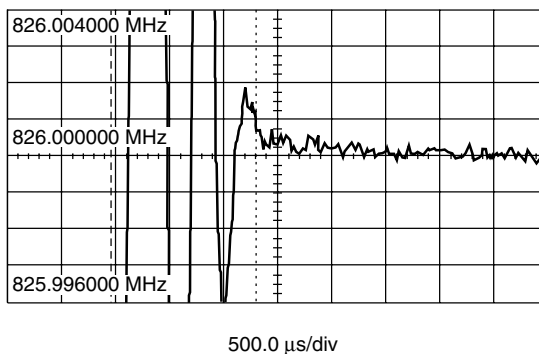
**PLL Reference Leakage**  
@ 25 kHz offset = -78 dBc



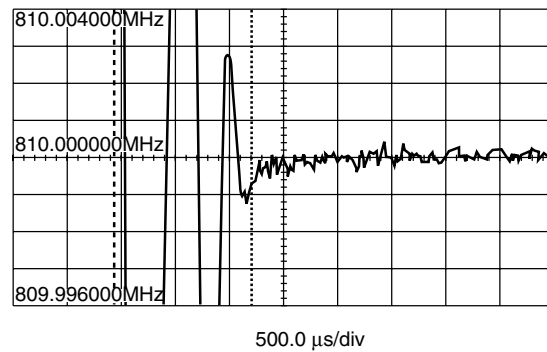
**PLL Phase Noise**  
@ max within loop band = -73.1 dBc/Hz



**PLL Lock Up Time = 1.3 ms**  
(810.000 MHz  $\rightarrow$  826.000 MHz, within  $\pm 1$  kHz)



**PLL Lock Up Time = 1.28 ms**  
(826.000 MHz  $\rightarrow$  810.000 MHz, within  $\pm 1$  kHz)



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## Functional Descriptions

The VCO output frequency can be calculated using the following equation:

$$f_{VCO} = \{(M \times N) + A\} \times f_{OSC} \div R \quad (A < N)$$

- $f_{VCO}$  Output frequency of external voltage controlled oscillator (VCO)
- M Preset divide ratio of dual modulus prescaler (64 or 128 for MB15E03SL, MB15E05SL) (32 or 64 for MB15E07SL)
- N Preset divide ratio of binary 11-bit programmable counter (3 to 2,047)
- A Preset divide ratio of binary 7-bit swallow counter ( $0 \leq A \leq 127$ )
- $f_{OSC}$  Reference oscillation frequency
- R Preset divide ratio of binary 14-bit programmable reference counter (3 to 16,383)

## Serial Data Input

Serial data is entered using the Data, Clock and LE pins. The serial data controls the programmable reference counters and the programmable counters separately.

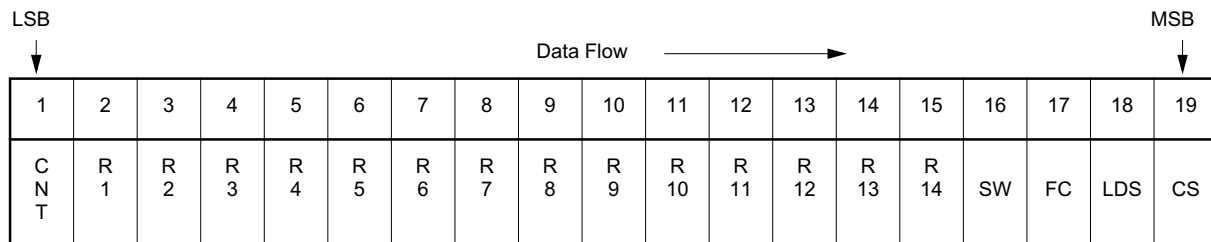
Binary serial data is entered through the Data pin when the LE pin is held low. One bit of data is shifted into the shift register on the rising edge of the Clock. When the LE signal pin is taken high, entered data is latched into the appropriate counters according to the control bit settings as follows:

**Table 1. Control Bits**

Control Bit (CNT)	Destination of Serial Data
H	Programmable reference counter latch
L	Programmable counter latch

## Shift Register Configuration

### Programmable Reference Counter

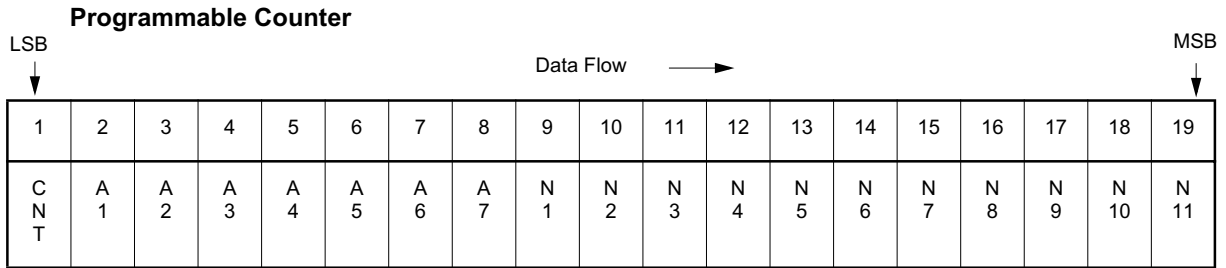


- |           |  |           |
|-----------|--|-----------|
| CNT       | Control bit  | [Table 1] |
| R1 to R14 | Divide ratio setting bits for the programmable reference counter (3 to 16,383) | [Table 2] |
| SW        | Divide ratio setting bit for the prescaler                                     | [Table 5] |
| FC        | Phase control bit for the phase comparator                                     | [Table 6] |
| LDS       | LD/ $f_{OUT}$ signal select bit  | [Table 7] |
| CS        | Charge pump current select bit   | [Table 8] |

Note: Input data with MSB first.

## Functional Descriptions

### Shift Register Configuration



CNT Control bit  
 N1 to N11 Divide ratio setting bits for the programmable counter (3 to 2,047)  
 A1 to A7 Divide ratio setting bits for the swallow counter (0 to 127)

[Table 1]  
 [Table 3]  
 [Table 4]

Note: Input data with MSB first.

**Table 2. Binary 14-Bit Programmable Reference Counter Data Setting**

Divide ratio (R)	R 14	R 13	R 12	R 11	R 10	R 9	R 8	R 7	R 6	R 5	R 4	R 3	R 2	R 1
3	0	0	0	0	0	0	0	0	0	0	0	0	1	1
4	0	0	0	0	0	0	0	0	0	0	0	1	0	0
...	.	.	.	.	.	.	.	.	.	.	.	.	.	.
16383	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Note: Divide ratio less than 3 is prohibited.

**Table 3. Binary 11-Bit Programmable Counter Data Setting**

Divide ratio (N)	N 11	N 10	N 9	N 8	N 7	N 6	N 5	N 4	N 3	N 2	N 1
3	0	0	0	0	0	0	0	0	0	1	1
4	0	0	0	0	0	0	0	0	1	0	0
...	.	.	.	.	.	.	.	.	.	.	.
2047	1	1	1	1	1	1	1	1	1	1	1

Note: Divide ratio less than 3 is prohibited.

# Single PLL Frequency Synthesizers with On-Chip Prescalers

## Functional Descriptions

**Table 4. Binary 7-Bit Swallow Counter Data Setting**

Divide Ratio (A)	A 7	A 6	A 5	A 4	A 3	A 2	A 1
0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	1
...	...	...	...	...	...	...	...
127	1	1	1	1	1	1	1

Note: Divide ratio (A) range = 0 to 127

**Table 5. Prescaler Data Setting for MB15E03SL, MB15E05SL (SW Bit)**

SW	Prescaler Dived Ratio
H	64/65
L	128/129

### Prescaler Data Setting for MB15E07SL (SW Bit)

SW	Prescaler Dived Ratio
H	32/33
L	64/65

## Relationship Between the FC Input and Phase Characteristics

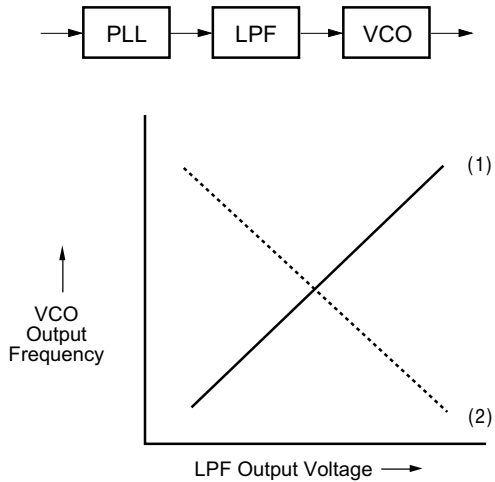
The FC bit changes the phase characteristics of the phase comparator. Both the internal charge pump output level ( $D_O$ ) and the phase comparator output ( $f_r$ ,  $f_p$ ) are reversed according to the FC bit setting. Also, the monitor pin ( $f_{OUT}$ ) output is controlled by the FC bit. The relationship between the FC bit setting and each of  $D_O$ ,  $f_r$ , and  $f_p$  is shown below.

**Table 6. FC Bit Data Setting (LDS = "H")**

	FC = High				FC = Low			
	$D_O$	$f_R$	$f_P$	LD/ $f_{out}$	$D_O$	$f_R$	$f_P$	LD/ $f_{out}$
$f_r > f_p$	H	L	L		L	H	Z*	
$f_r < f_p$	L	H	Z*	$f_{out} = f_r$	H	L	L	$f_{out} = f_p$
$f_r = f_p$	Z*	L	Z*		Z*	L	Z*	

\* High impedance

## Functional Descriptions



- (1) When the LPF and VCO characteristics are similar to (1), set the FC bit high.
- (2) When the VCO characteristics are similar to (2), set the FC bit low.

**Table 7. LD/f<sub>OUT</sub> Output Select Data Setting (LDS Bit)**

LDS	LD/f <sub>OUT</sub> Output Signal
H	f <sub>OUT</sub> signals
L	LD signals

**Table 8. Charge Pump Current Setting (CS Bit)**

CS	Current Value
H	± 6.0 mA
L	± 1.5 mA

**Table 9. Do Output Impedance Pin Setting (ZC Pin)**

CS	Do Output
H	Normal output
L	High impedance

# Single PLL Frequency Synthesizers with On-Chip Prescalers

## Functional Descriptions

### Power-Saving Mode (Intermittent Mode Control)

The Intermittent Mode Control circuit greatly reduces the PLL power consumption by shutting down various internal functions, depending upon the settings of the power-save (PS) pins. (See the Electrical Characteristics chart for the specific value of current when the device is in the power-saving mode.) In this mode, the phase detector output, Do, becomes high impedance.

Setting the PS pin high releases the power-saving mode, returning the selected PLL to normal operation.

When power ( $V_{CC}$ ) is first applied, the device must be in standby mode, PS = Low, for at least 1  $\mu$ s.

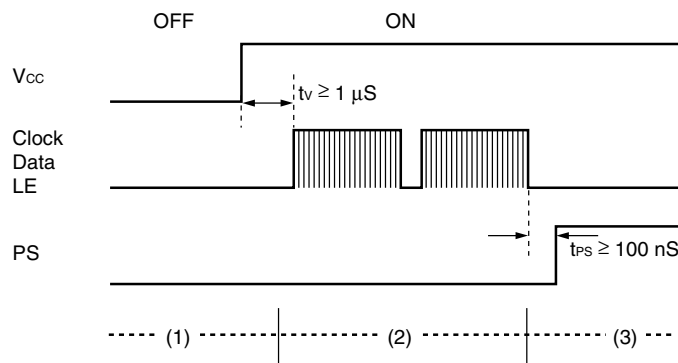
The intermittent mode control circuit also ensures a smooth startup when the device returns to normal operation, at which time the phase comparator output signal is unpredictable due to the unknown relationship between the comparison frequency ( $f_p$ ) and the reference frequency ( $f_r$ ). This can cause a major change in the comparator output, resulting in a VCO frequency jump and an increase in lock-up time.

To prevent this the Intermittent Mode Control circuit limits the magnitude of the error signal from the phase detector when it returns to normal operation.

**Table 10. Power Save Pin Setting (PS Pins)**

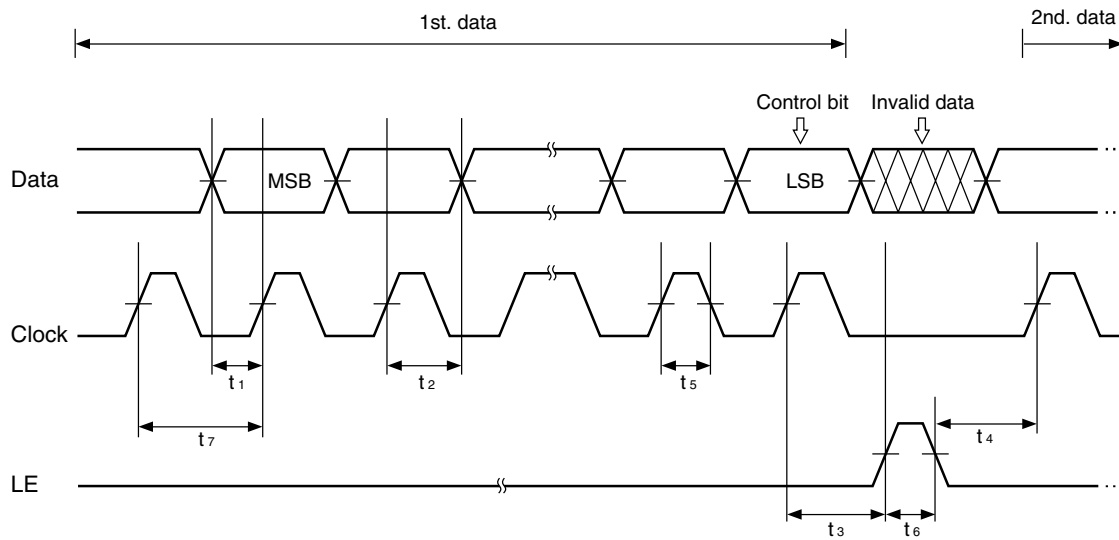
PS Pins	Status
H	Normal mode
L	Power saving mode

### Power-ON Timing



- (1) PS = L (power-saving mode) at Power ON
- (2) Set serial data 1  $\mu$ s later after power supply remains stable ( $V_{CC} \geq 2.2V$ ).
- (3) Release power-saving mode (PS: L  $\rightarrow$  H) 100 ns later after setting serial data.

## Serial Data Input Timing



**Table 11. Timing Parameters**

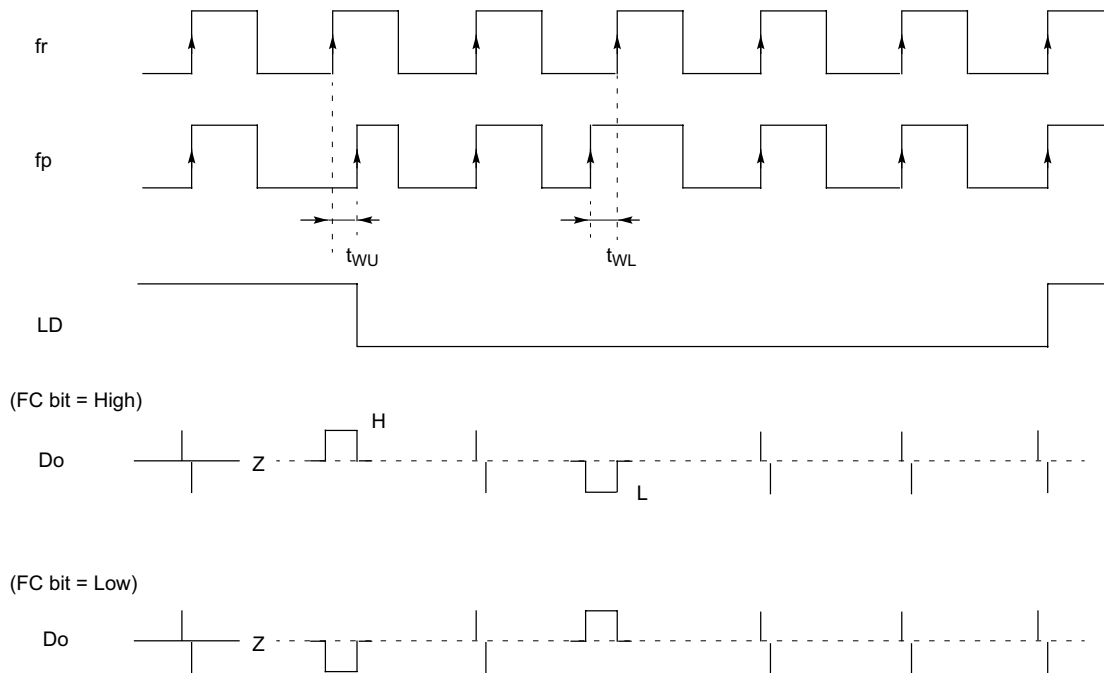
Parameter	Min.	Typ.	Max.	Unit	Parameter	Min.	Typ.	Max.	Unit
t1	20	–	–	ns	t5	100	–	–	ns
t2	20	–	–	ns	t6	20	–	–	ns
t3	30	–	–	ns	t7	100	–	–	ns
t4	30	–	–	ns					

On the rising edge of the clock, one bit of the data is transferred into the shift register.

Note: LE should be "L" when the data is transferred into the shift register.

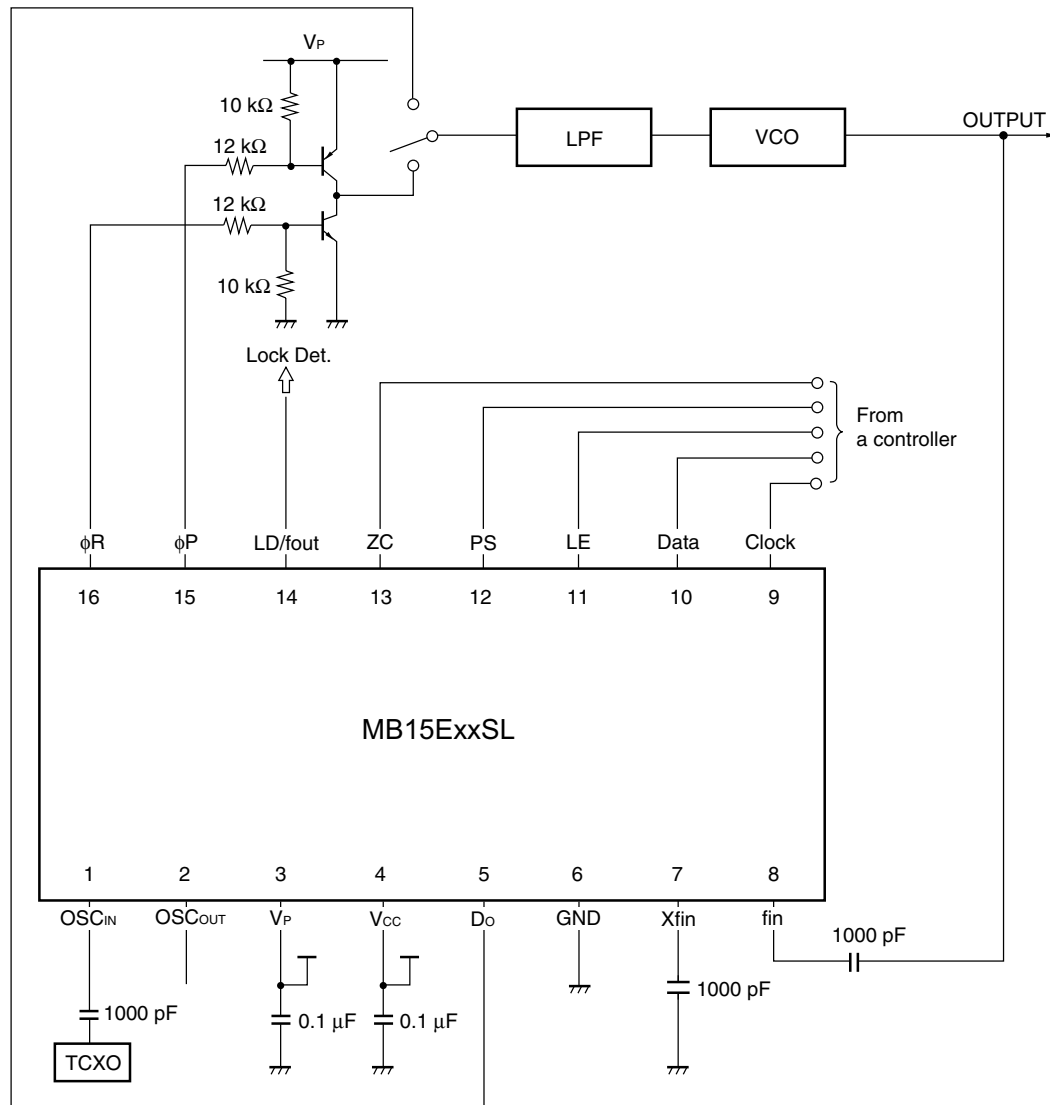
# Single PLL Frequency Synthesizers with On-Chip Prescalers

## Phase Detector Output Waveform



- Notes:
- 1) Phase error detection range:  $-2\pi$  to  $+2\pi$
  - 2) Pulses on Do signal during locked state are output to prevent dead zone.
  - 3) LD output becomes low when phase is  $t_{WU}$  or more. LD output becomes high when phase error is  $t_{WL}$  or less and continues to be so for three cycles or more.
  - 4)  $t_{WU}$  and  $t_{WL}$  depend on  $OSC_{IN}$  input frequency.  
 $t_{WU} \geq 2/f_{osc}$  (s) (e. g.  $t_{WU} \geq 156.3ns$ ,  $f_{osc} = 12.8MHz$ )  
 $t_{WL} \leq 4/f_{osc}$  (s) (e. g.  $t_{WL} \leq 312.5ns$ ,  $f_{osc} = 12.8MHz$ )
  - 5) LD becomes high during the power-saving mode (PS = "L").

## Application Example



$V_P$ : 5.5V Max

- Notes:
- 1) 16-pin SSOP
  - 2) In case of using a crystal resonator, it is necessary to optimize matching between the crystal and this device, and it is advised to perform a detailed system evaluation. It is also recommended to consult with the supplier of the crystal resonator. (The reference oscillator circuit provides its own bias)

# Single PLL Frequency Synthesizers with On-Chip Prescalers

## Usage Precautions

To protect against damage by electrostatic discharge, note the following handling precautions:

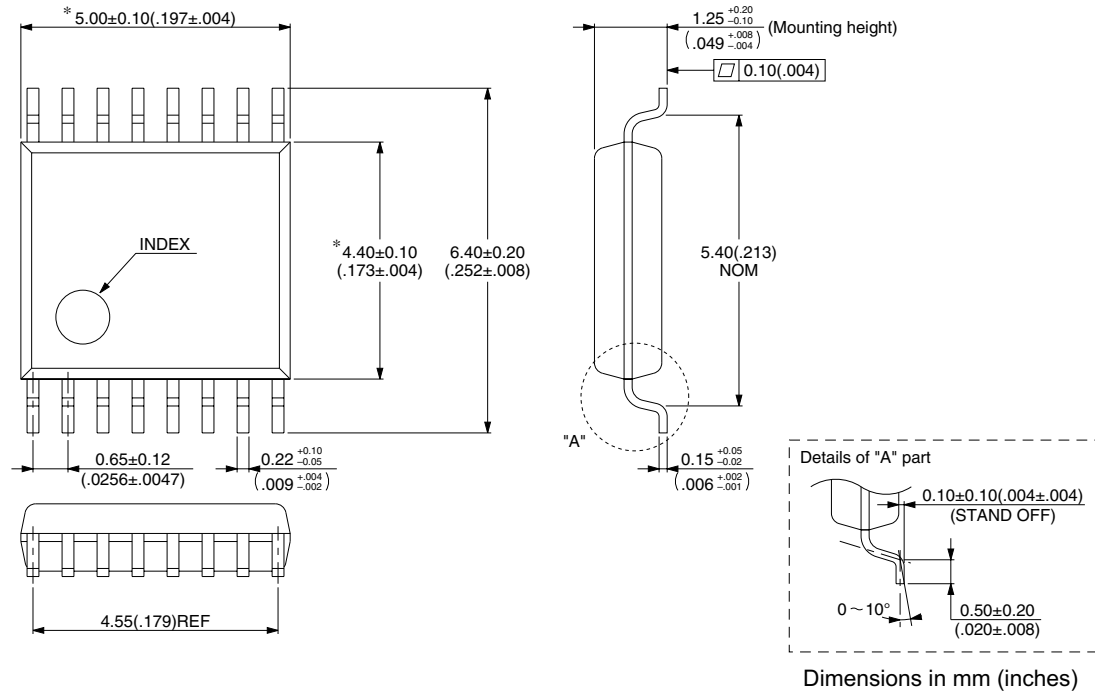
- Store and transport devices in conductive containers.
- Use properly grounded workstations, tools and equipment.
- Turn off power before inserting or removing this device into or from a socket.
- Protect leads with conductive sheet when transporting a board mounted device.

## Ordering Information

Part Number	Package
MB15ExxSLPFV1	16 pin, Plastic SSOP (FPT-16P-M05)
MB15ExxSLPV1	16 pin, Plastic BCC (LCC-16P-M06)

# MB15ExxSL Series

## Package Dimensions

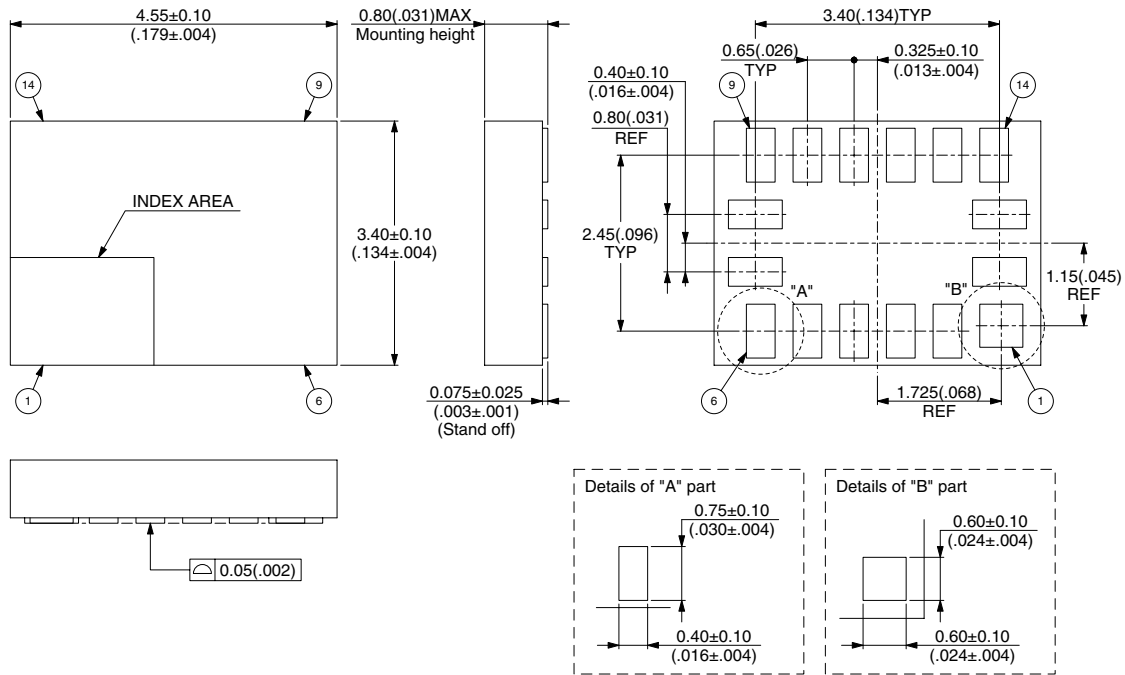


Note: 16-pin, Plastic SSOP (FPT-16P-M05)

\*These dimensions do not include resin protrusion.

# Single PLL Frequency Synthesizers with On-Chip Prescalers

## Package Dimensions



Dimensions in mm (inches)

Note: 16-pad, Plastic BCC (LCC-16P-M06)

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