

SEMI CUSTOM IF Band PLL Frequency Synthesizer

MB15C100 Series

■ DESCRIPTION

The Fujitsu MB15C100 series is an exclusive Intermediate Frequency (IF) band Phase Locked Loop (PLL) frequency synthesizer with pulse swallow operation. It can operate maximum at 500 MHz.

The reference divider and comparison divider have fixed divide ratios, so that it is not required to set the divide ratios by a μ controller externally. Because the dividers are designed by means of **MASK ROM** method, a customer can chose them optionally. SSOP-8 and BCC-16 plastic packages are available.

All of the above features help a system designer for **easier** as well as **compact** layout work.

It operates with a supply voltage of 3.0 V typ. and dissipates 1.2 mA typ. (@ 300 MHz) of current realized through the use of CMOS technology.

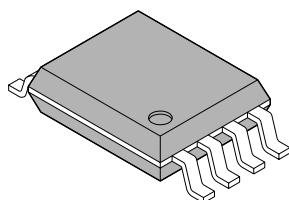
■ FEATURES

- Operating frequency : 500 MHz max.
- Low power supply current: I_{CC} (total) = 1.2 mA typ. (V_{CC} = 3V, 300 MHz)
- Pulse swallow function;
500 MHz Prescaler: 8/9, 16/17, 32/33
- MASK ROM optional the comparison and reference dividers:
 - Main counter ; 5 to 4,095
 - Swallow counter ; 0 to 31
 - Reference counter ; 5 to 4,095

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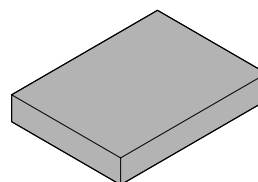
■ PACKAGES

8-pin plastic SSOP



(FPT-8P-M03)

16-pad plastic BCC



(LCC-16P-M06)

MB15C100 Series

(Continued)

- Charge pump options:
 - L type ; Low sensitivity charge pump for direct modulation. (IOH/IOL = 1.5 mA @ $V_{CC} = 3.0$ V)
 - H type ; Super charger circuit for High speed tuning. (IOH/IOL = 6.0 mA @ $V_{CC} = 3.0$ V)
- Low power supply voltage: $V_{CC} = 2.4$ V min.
- Wide operating temperature: $T_a = -40$ to $+85^{\circ}\text{C}$
- Selectable A or B type

A: Div type

Two different frequencies can be selected by Div input "H" or "L".

B: PS type

Power saving control

PS	OSC	R	N. A. P
H	Active	Active	Active
L	Stop	Stop	Stop

PS = "L" → Do = "Z", LD = "H"

- Plastic BCC-16 and 8-pin SSOP packages

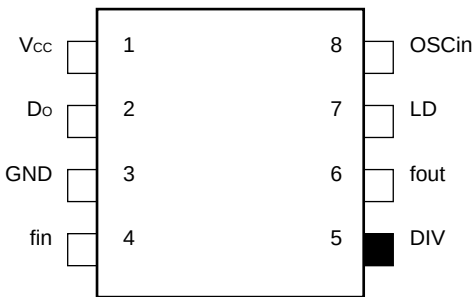
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PIN ASSIGNMENT

<A type>

Divide ratio switching type (DIV)

(TOP VIEW)

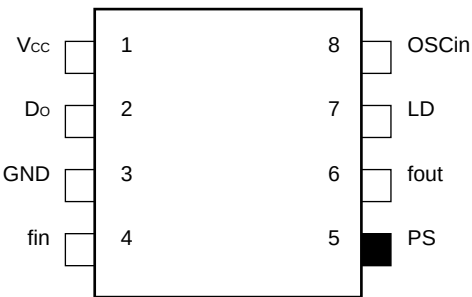


(FPT-8P-M03)

<B type>

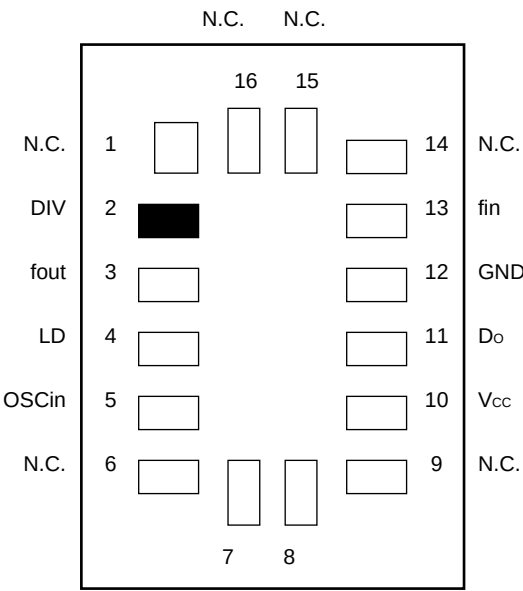
Power saving function type (PS)

(TOP VIEW)



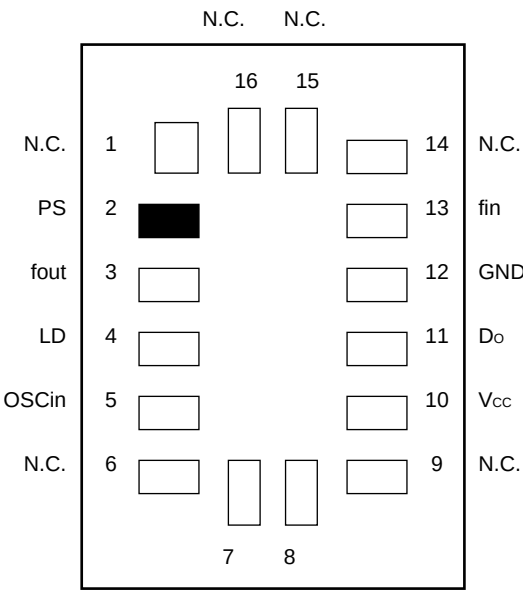
(FPT-8P-M03)

(TOP VIEW)



(LCC-16P-M06)

(TOP VIEW)



(LCC-16P-M06)

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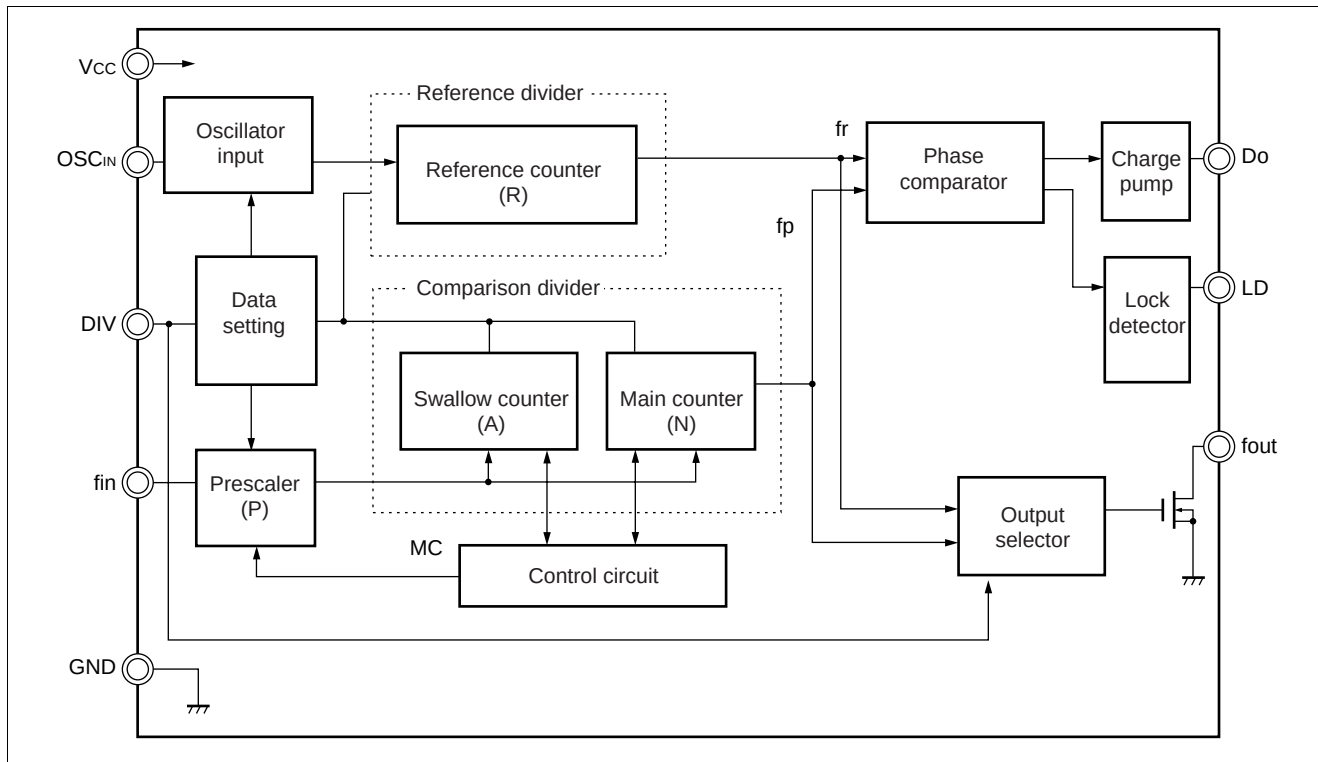
■ PIN DESCRIPTIONS

Pin No.		Pin name	Description												
SSOP	BCC														
1	10	V _{CC}	Power supply voltage input.												
2	11	Do	Charge pump output.												
3	12	GND	Ground.												
4	13	fin	Prescaler input. Connection should be with AC coupling.												
5	2	Div (A type)	Divide ratio switching input. Two kinds of divide ratios are selectable by Div input "H" or "L".												
		PS (B type)	Power saving mode control												
			<table><tr><th>PS</th><th>OSC</th><th>R</th><th>N. A. P</th></tr><tr><td>H</td><td>Active</td><td>Active</td><td>Active</td></tr><tr><td>L</td><td>Stop</td><td>Stop</td><td>Stop</td></tr></table>	PS	OSC	R	N. A. P	H	Active	Active	Active	L	Stop	Stop	Stop
			PS	OSC	R	N. A. P									
H	Active	Active	Active												
L	Stop	Stop	Stop												
	PS = "L" → Do = "Z", LD = "H"														
6	3	fout	Test purpose output. This pin is an open drain output so that should be left open usually.												
7	4	LD	Lock detector output. LD = H: Locking state, Power saving state, LD = L: Unlocking state.												
8	5	OSCin	Reference counter input. Connection should be with AC coupling.												
—	1,6,7, 8,9,14, 15,16	N.C.	No connection												

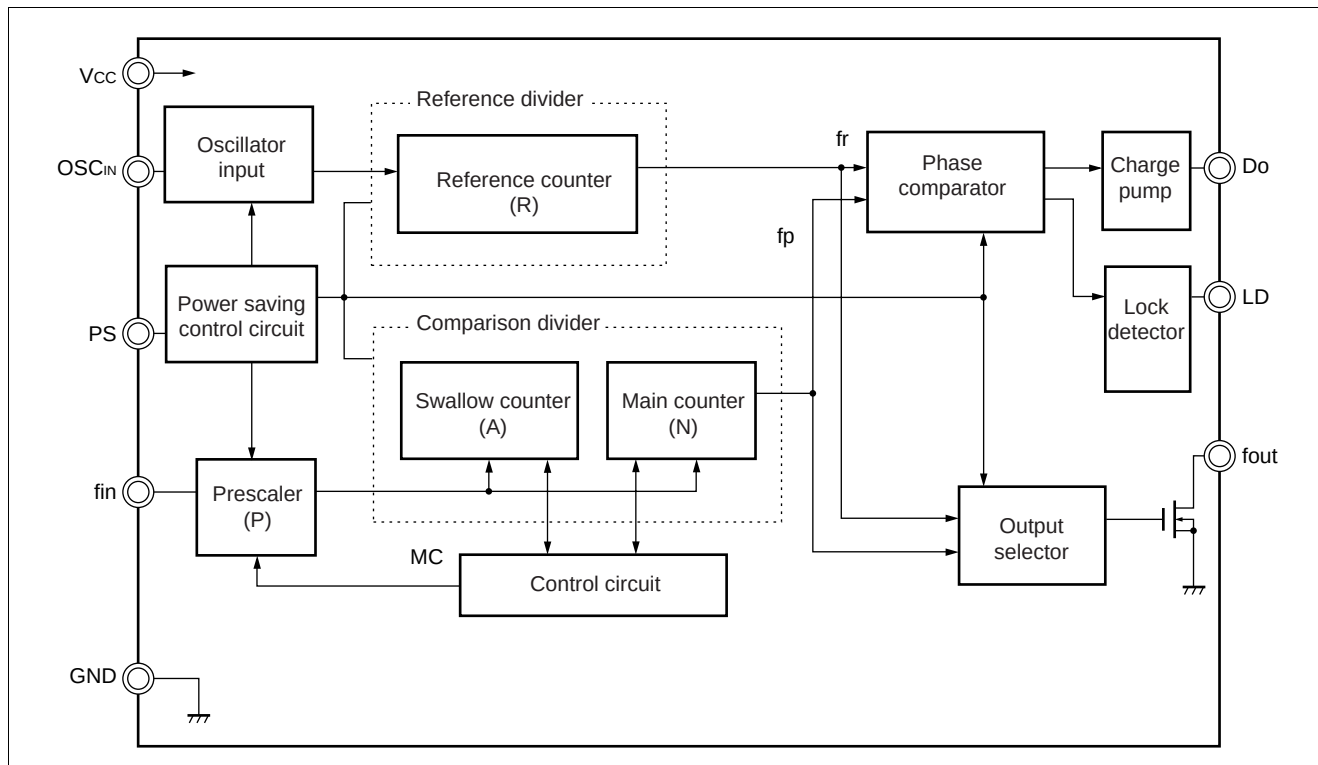
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■ BLOCK DIAGRAM

<A type>



<B type>



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■ ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Rating		Unit
		Min.	Max.	
Power supply voltage	V_{CC}	-0.5	+ 4.0	V
Input voltage	V_I	-0.5	$V_{CC} + 0.5$	V
Output voltage	V_O	-0.5	$V_{CC} + 0.5$	V
Output current	I_{OUT}	0	5	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	Note
		Min.	Typ.	Max.		
Power supply voltage	V_{CC}	2.4	3.0	3.6	V	
Input voltage	V_{IN}	GND	—	V_{CC}	V	
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.

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■ ELECTRICAL CHARACTERISTICS

(Recommended operating conditions unless otherwise noted.)

Parameter (Symbol)	Condition	Condition 1: $f_{in} \leq 300$ MHz			Condition 2: $f_{in} \leq 380$ MHz			Condition 3: $f_{in} \leq 500$ MHz			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Operating frequency (f_{in})	AC coupling by 1000 pF capacitor	50	—	300	30	—	380	30	—	500	MHz
Power supply voltage (V_{CC})	—	2.4	3.0	3.6	2.4	2.7	3.0	2.4	3.0	3.6	V
Input sensitivity (P_{fin})	AC coupling by 1000 pF capacitor	-10	—	+2	-10	—	+2	-5	—	+2	dBm
Power supply current (I_{CC})	PLL is locked at f_{in} max.	0.1	1.2* ¹	2.4	0.1	1.4* ²	1.7	0.1	1.2* ³	2.4	mA

*1: $V_{CC} = 3.0$ V, $T_a = +25^\circ\text{C}$, $f_{in} = 300$ MHz, $V_{in} = -10$ dBm, $OSC_{in} = 19.2$ MHz, $V_{OSC} = -2$ dBm*2: $V_{CC} = 3.0$ V, $T_a = +25^\circ\text{C}$, $f_{in} = 380$ MHz, $V_{in} = -10$ dBm, $OSC_{in} = 19.2$ MHz, $V_{OSC} = -2$ dBm*3: $V_{CC} = 3.0$ V, $T_a = +25^\circ\text{C}$, $f_{in} = 500$ MHz, $V_{in} = -5$ dBm, $OSC_{in} = 19.2$ MHz, $V_{OSC} = -2$ dBm

(Recommended operating conditions unless otherwise noted.)

Parameter	Symbol	Condition	Value			Unit
			Min.	Typ.*	Max.	
Power saving current (B type)	I_{PS}	$P_S = "L"$	—	—	+10	μA
Oscillator input frequency	f_{osc}	AC coupling by 1000pF capacitor	3	12	23	MHz
Oscillator input sensitivity	V_{osc}	AC coupling by 1000pF capacitor	0.5	—	—	V _{pp}
Input voltage (Div)	V_{IH}	—	$V_{CC} \times 0.7$	—	—	V
	V_{IL}	—	—	—	$V_{CC} \times 0.3$	V
Input current (Div)	I_{IH}	—	—	—	1.0	μA
	I_{IL}	—	-1.0	—	—	μA
Input current (OSC_{in})	I_{OSC}	—	-100	—	100	μA
Output voltage (LD)	V_{OH}	$I_{OH} = -1.0$ mA	$V_{CC} - 0.8$	—	—	V
	V_{OL}	$I_{OL} = 1.0$ mA	—	—	0.4	V
Output voltage (Do) Charge pump type: H Charge pump type: L	V_{OH}	$V_{CC} = 3.0$ V, $I_{OH} = -0.3$ mA	2.6	—	—	V
	V_{OL}	$V_{CC} = 3.0$ V, $I_{OL} = 0.3$ mA	—	—	0.4	V

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Parameter	Symbol	Condition	Value			Unit
			Min.	Typ.*	Max.	
Output current (Do) (Charge pump type: H)	I _{OH}	V _{CC} = 3 V, V _{OH} = 2 V, Ta = +25°C	—	−6.0	—	mA
	I _{OL}	V _{CC} = 3 V, V _{OL} = 1 V, Ta = +25°C	—	6.0	—	
Output current (Do) (Charge pump type: L)	I _{OH}	V _{CC} = 3 V, V _{OH} = 2 V, Ta = +25°C	—	−1.5	—	mA
	I _{OL}	V _{CC} = 3 V, V _{OL} = 1 V, Ta = +25°C	—	1.5	—	
High impedance cut off current (Do)	I _{OFF}	0V ≤ V _{DO} ≤ V _{CC}	—	—	3	nA

* : V_{CC} = 3.0, Ta = +25°C

■ FUNCTIONAL DESCRIPTIONS

<A type>

Divide ratios of the internal counters can be set optionally according to customer requirements. Two different frequencies can be selected by Div input "H" or "L".

The divide ratio can be calculated using the following equation:

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

f_{VCO}: Output frequency of external voltage controlled oscillator (VCO: up to 500 MHz)

P: Preset divide ratio of dual modulus prescaler (8/9, 16/17, 32/33)

N: Divide ratio of the main counter (5 to 4,095)

A: Divide ratio of the swallow counter (0 to 31)

f_{osc}: Reference oscillation frequency (up to 26 MHz)

R: Divide ratio of the reference counter (5 to 4,095)

<B type>

Power saving control (PS)

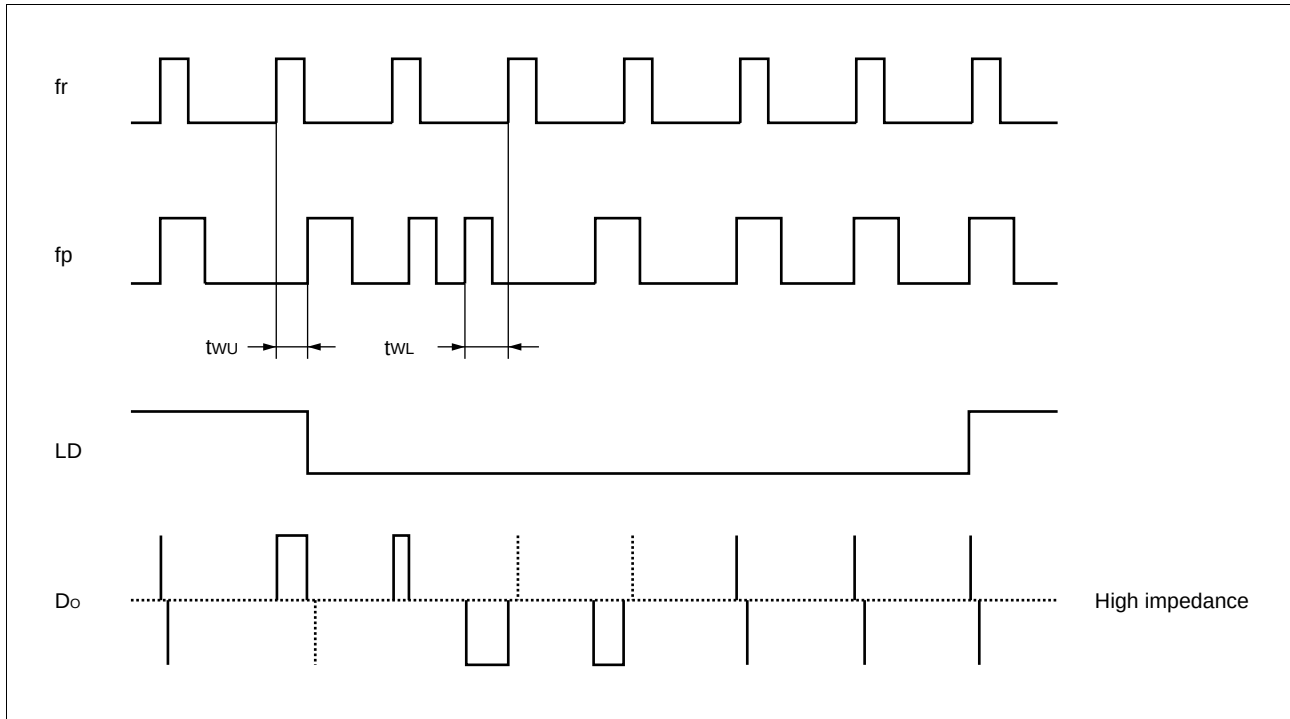
PS	OSC	R	N.A.P
H	Active	Active	Active
L	Stop	Stop	Stop

* : Power saving current : ~ 10 μA

* : PS = "L" → Do = "Z"
LD = "H"

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■ PHASE DETECTOR TIME CHART

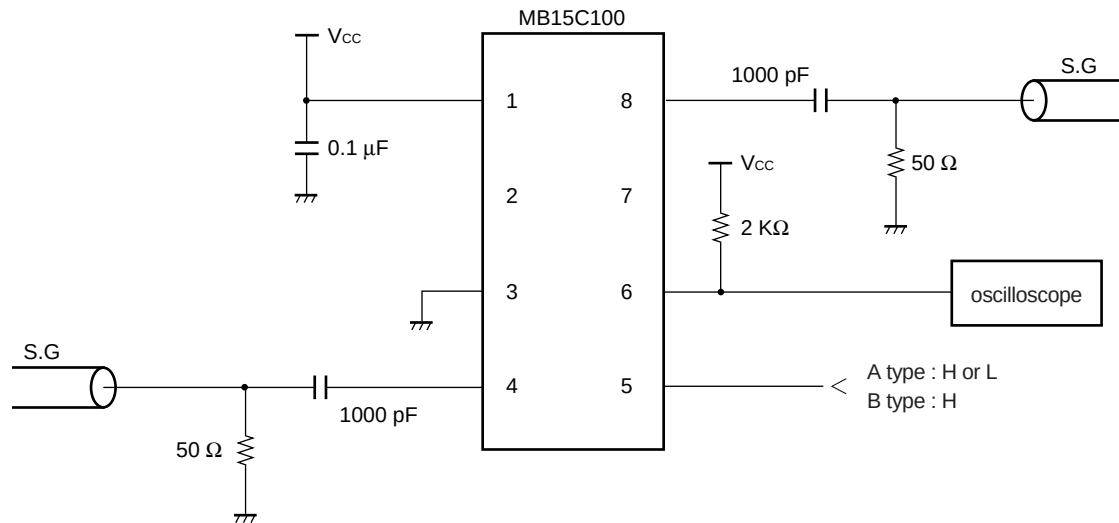


- Note:
- Phase difference detection range = -2π to $+2\pi$
 - Spikes on Do pulse during locking state are output to prevent dead zone.
 - LD output becomes low when phase difference is t_{WU} or more.
 - LD output becomes high when phase difference is t_{WL} or less and continues to be so for three cycles or more.
 - t_{WU} and t_{WL} depend on OSCin input frequency
 - $t_{WU} \geq 8/f_{osc}$: i.e. $t_{WU} \geq 625$ ns, $f_{osc} = 12.8$ MHz
 - $t_{WL} \leq 16/f_{osc}$: i.e. $t_{WL} \leq 1250$ ns, $f_{osc} = 12.8$ MHz

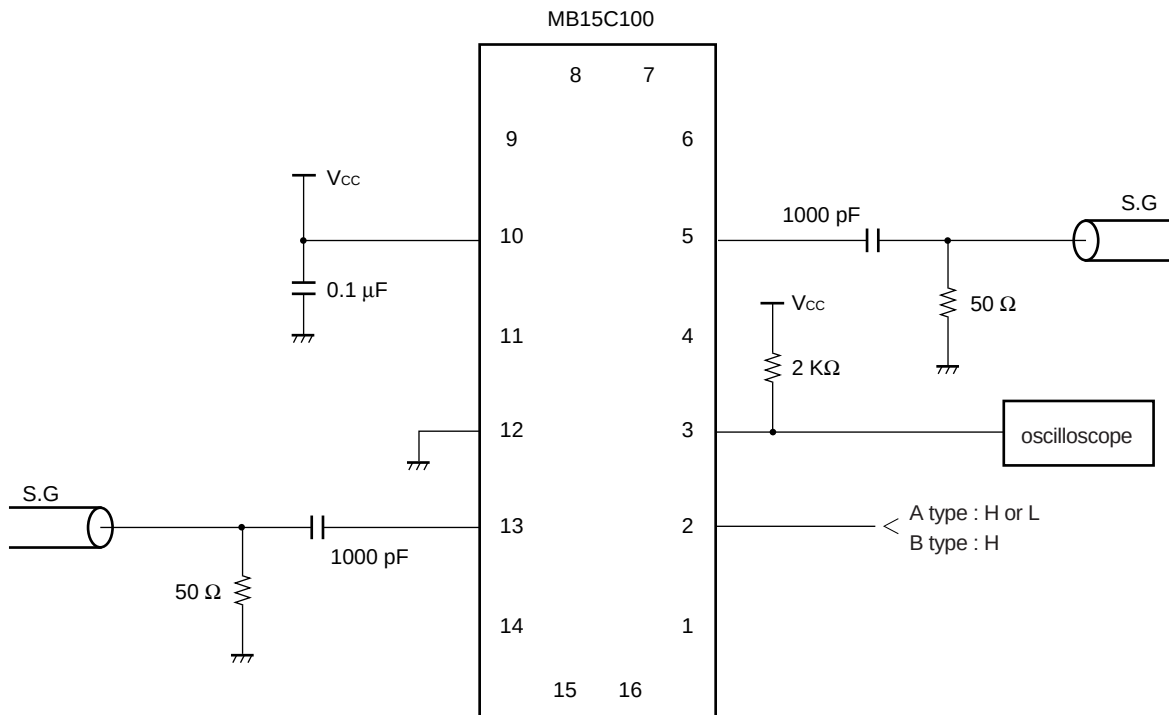
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MEASUREMENT CIRCUIT (fin, OSCin Input Sensitivity)

<8-pin, SSOP>



<16-pin, BCC>

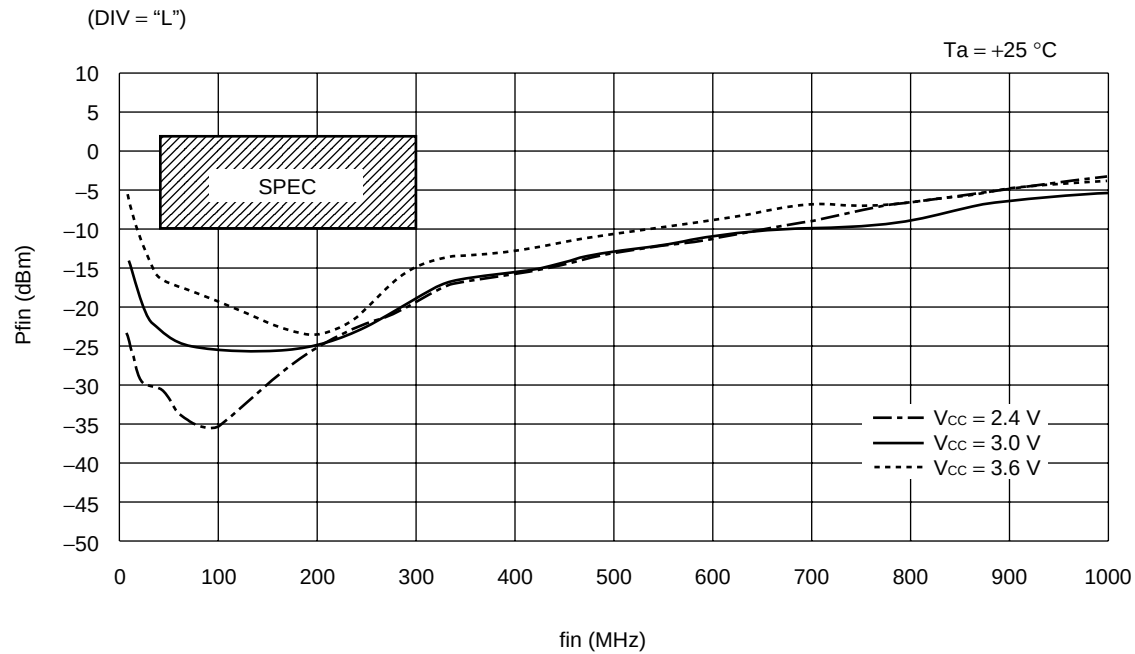


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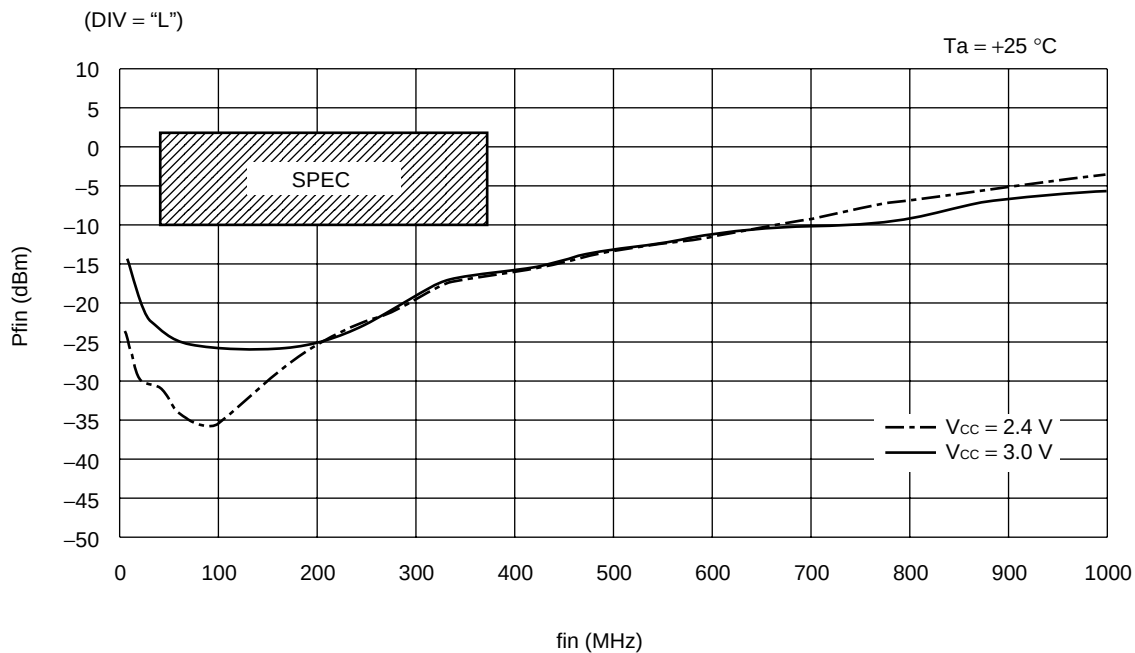
■ TYPICAL CHARACTERISTICS

1. Input Sensitivity (fin Pin)

- $f_{in} \leq 300$ MHz, $V_{CC} = 2.4$ to 3.6 V



- $f_{in} \leq 380$ MHz, $V_{CC} = 2.4$ to 3.0 V

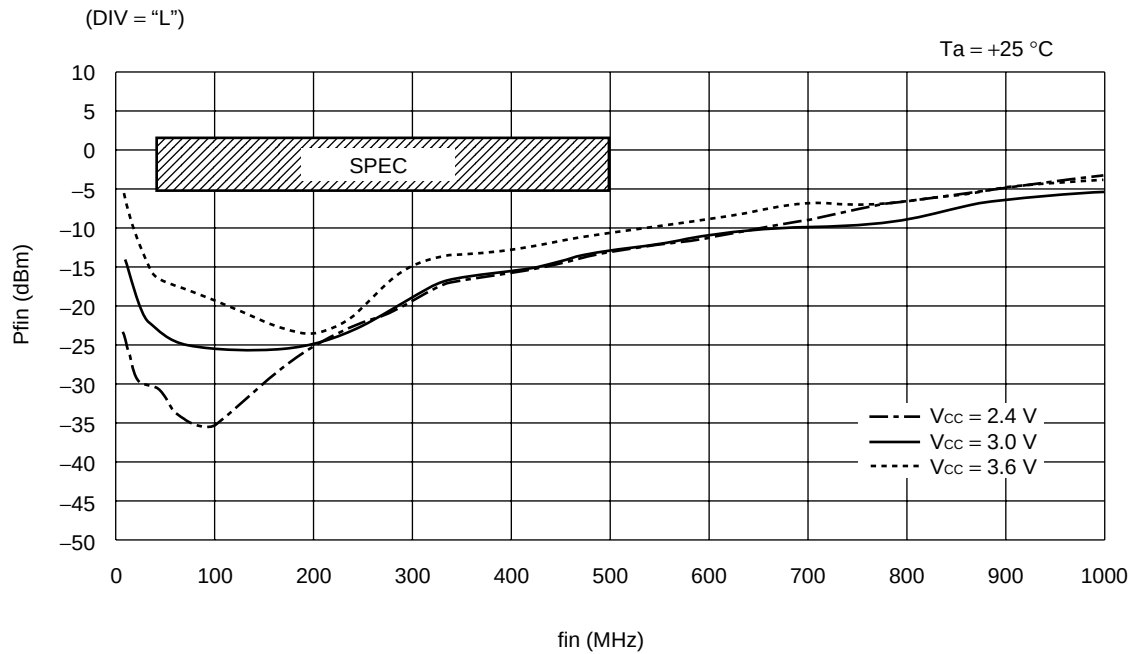


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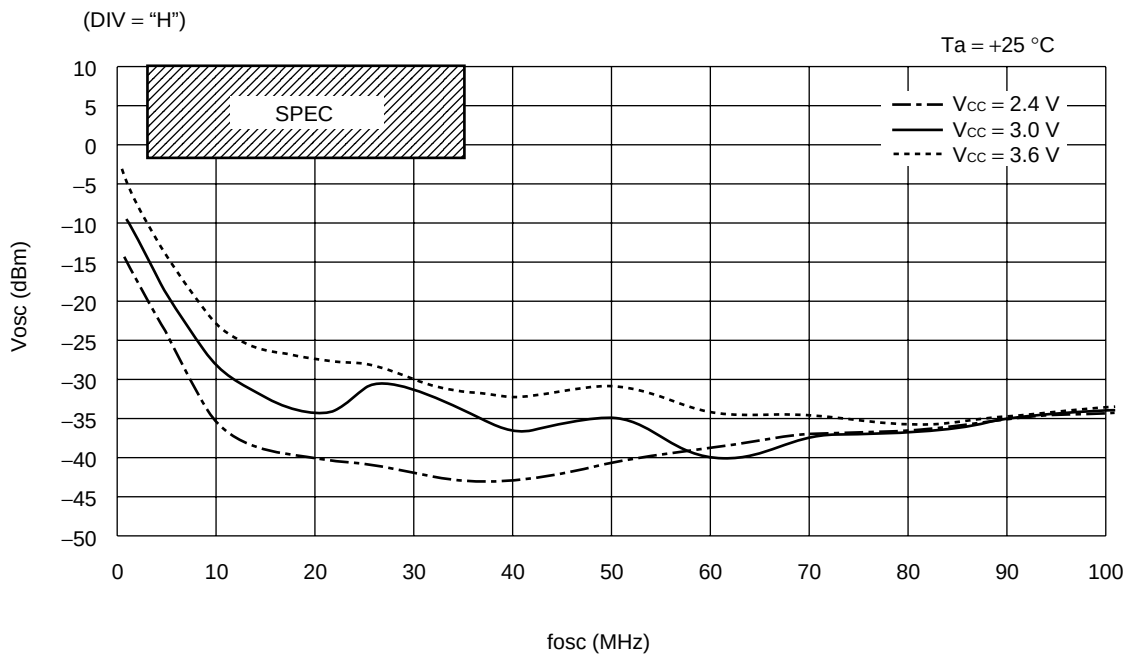
MB15C100 Series

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- $f_{in} \leq 500$ MHz, $V_{CC} = 2.4$ to 3.6 V

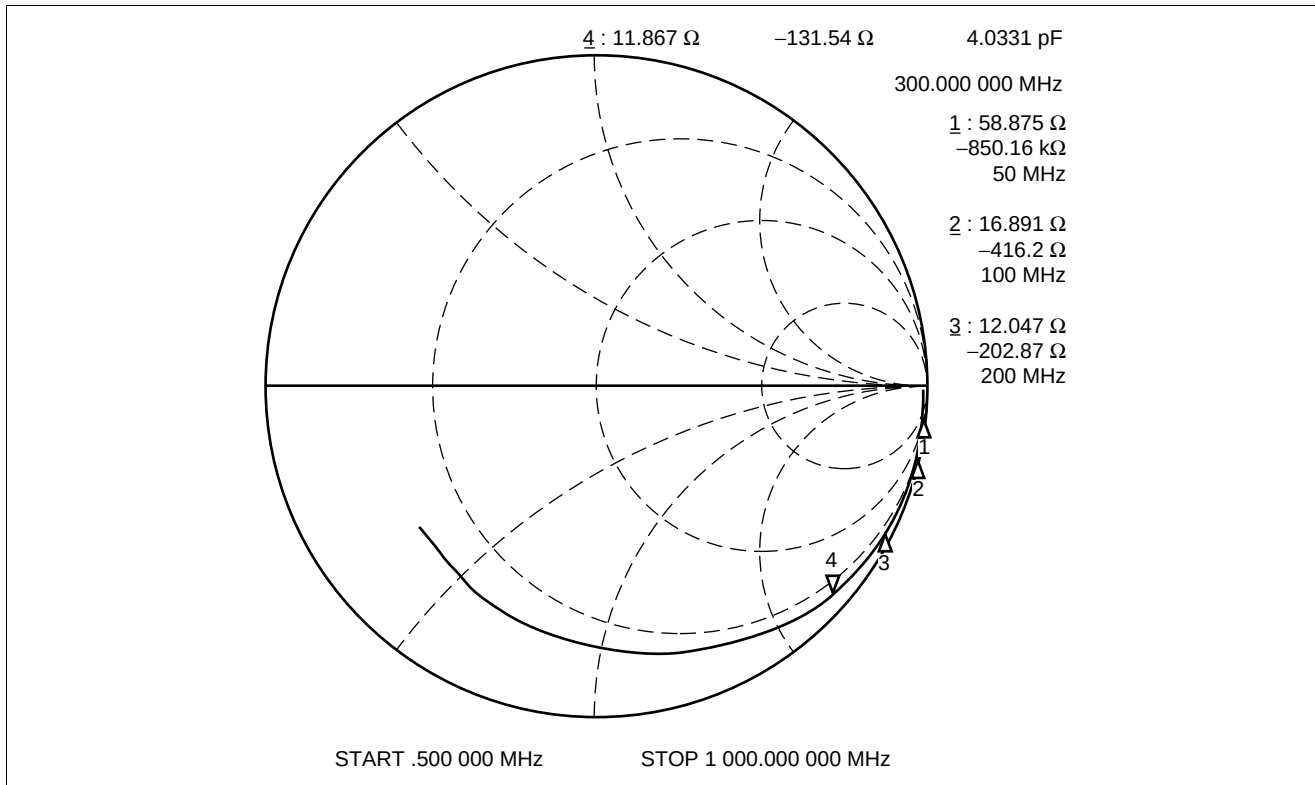


2. Input Sensitivity (OSCin Pin)

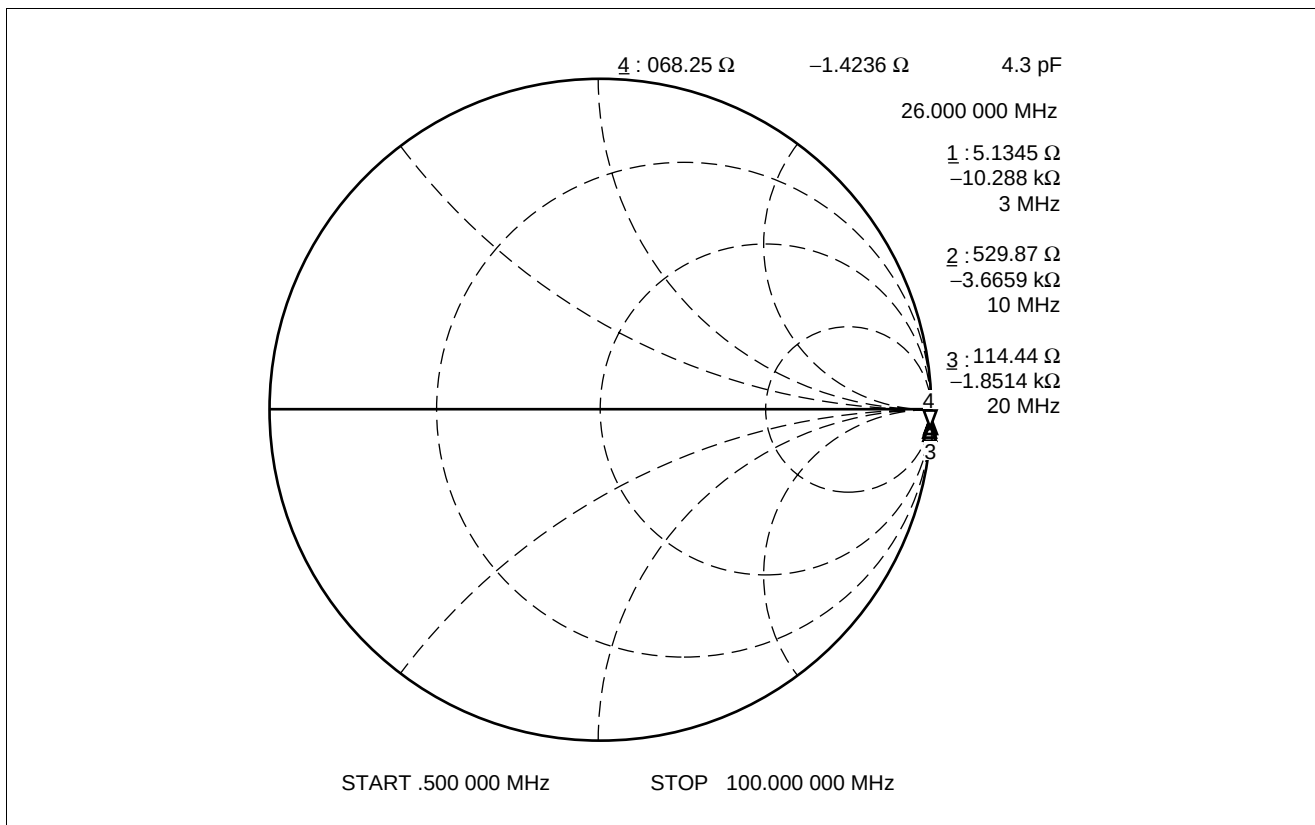


MB15C100 Series

3. Input Impedance (fin Pin)



4. Input Impedance (OSCin Pin)

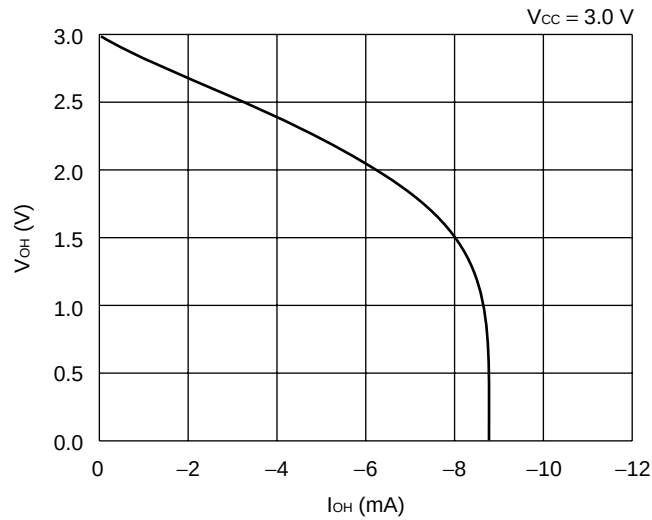


MB15C100 Series

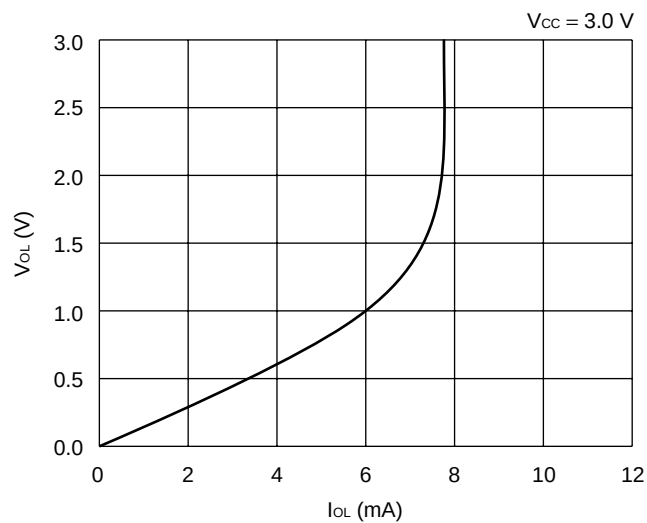
5. Output Current Characteristics

- Charge pump current (H type: high-speed sync charge pump)

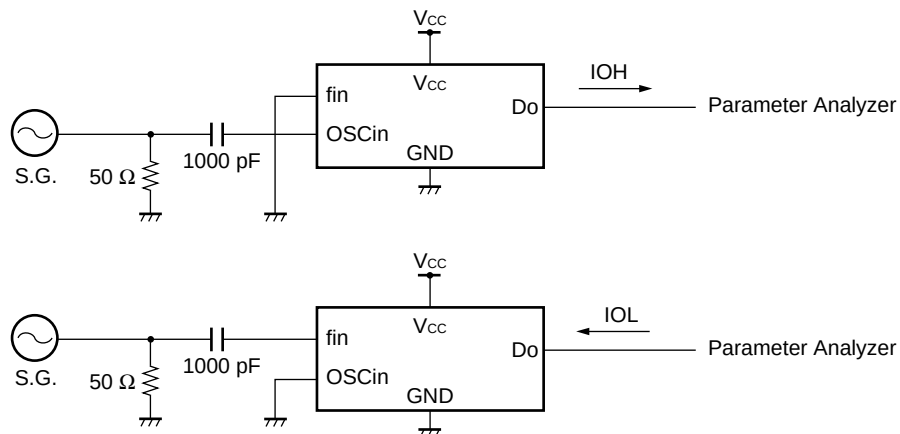
[VOH-IOH]



[VOL-IOL]



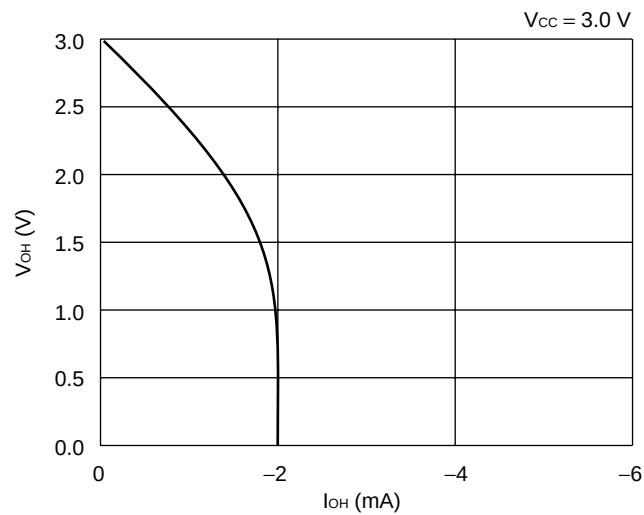
[Measurement circuit]



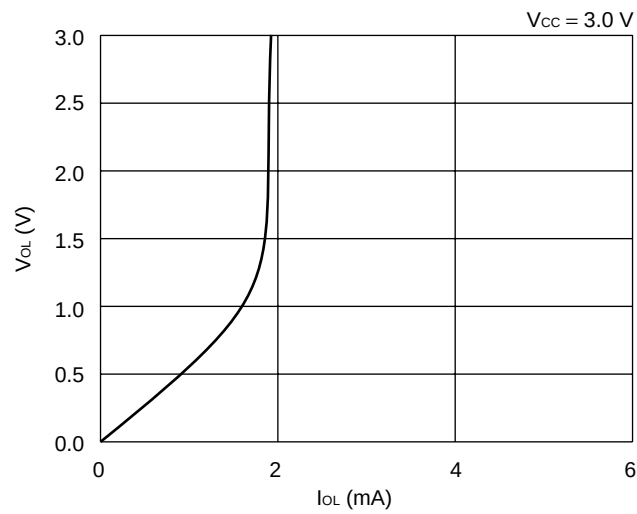
MB15C100 Series

- Charge pump current (L type: low sensitivity charge pump)

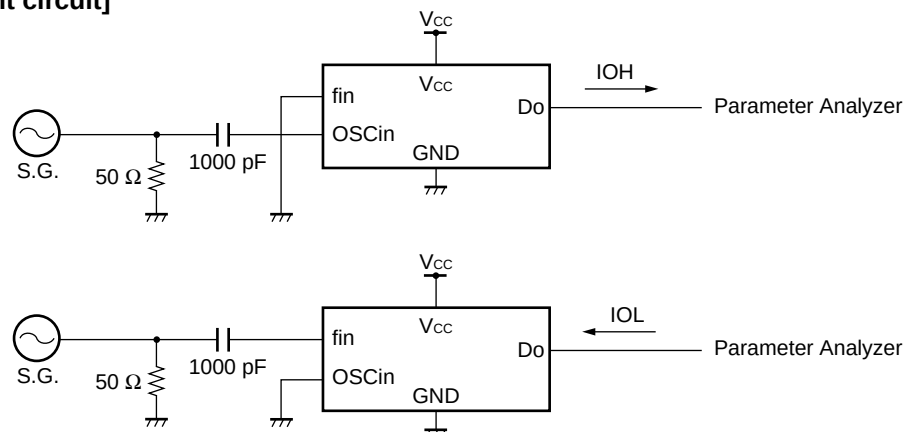
[VOH-IOH]



[VOL-IOL]



[Measurement circuit]



MB15C100 Series

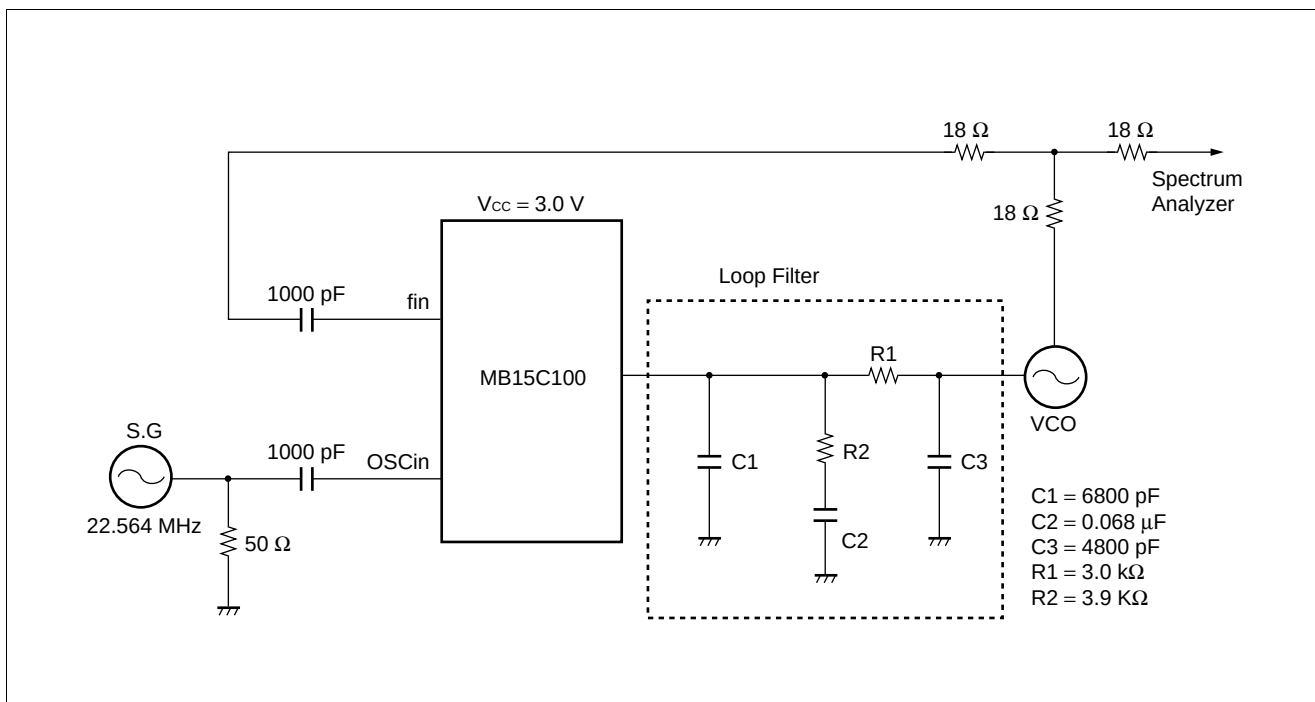
■ REFERENCE INFORMATION

1. Application Measurement (H type: high-speed sync charge pump)

• Measurement results

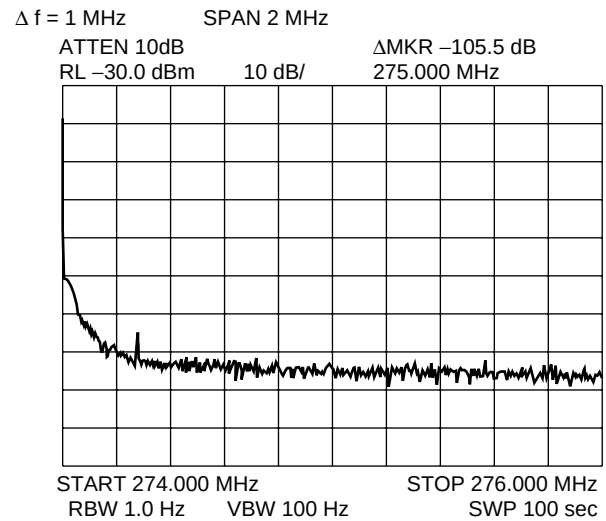
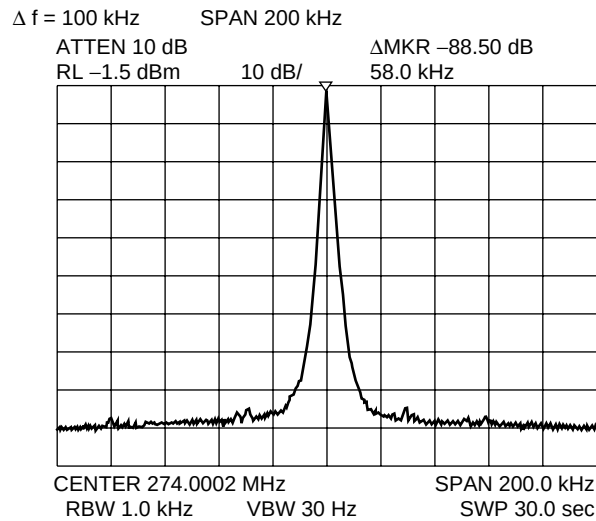
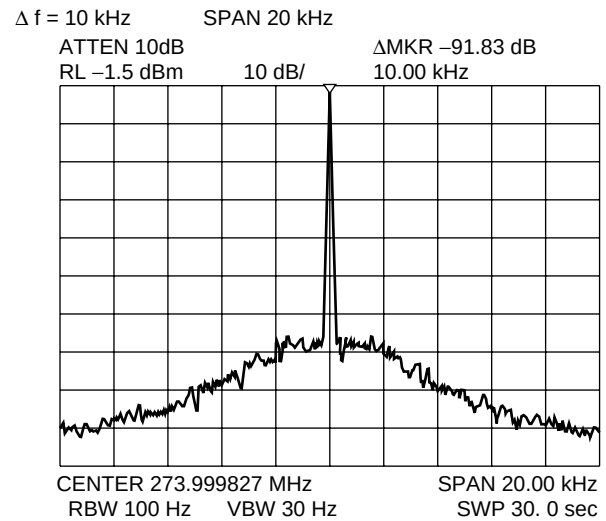
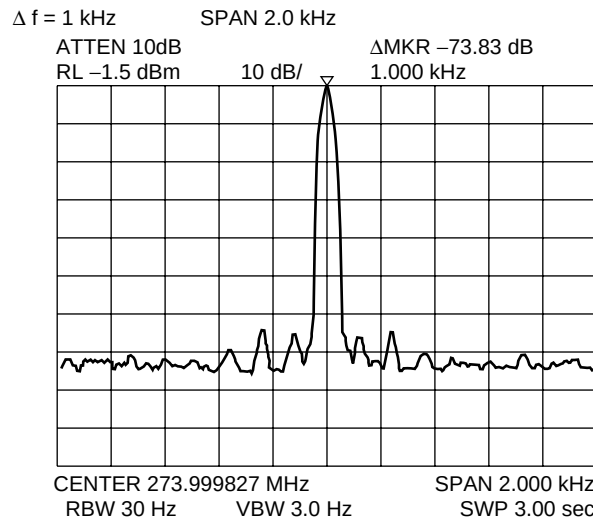
Parameter	Results
Lock up time ± 1 kHz	2.3 ms
Unlock $\rightarrow$ Lock	3.4 ms
Power on $\rightarrow$ Lock	
Reference leakage ($\Delta f = 58$ kHz)	-88.5 dBc
Phase noise ($\Delta f = 1$ kHz)	-88.0 dBc/Hz
($\Delta f = 10$ kHz)	-111.0 dBc/Hz
($\Delta f = 100$ kHz)	-118.0 dBc/Hz
($\Delta f = 1$ MHz)	-134.0 dBc/Hz
V_{CC} (V)	3.0 V
VCO	Discrete VCO ($K_v = 3.5$ MHz/V) Lock frequency = 274.0 MHz ($f_r = 58$ kHz)

• Measurement circuit



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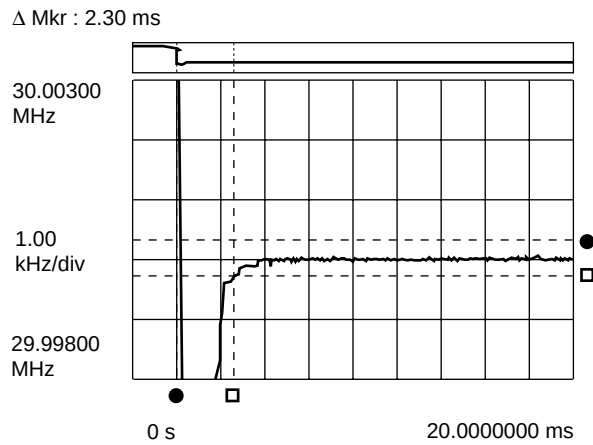
2. Phase Noise (H type: high-speed sync charge pump)



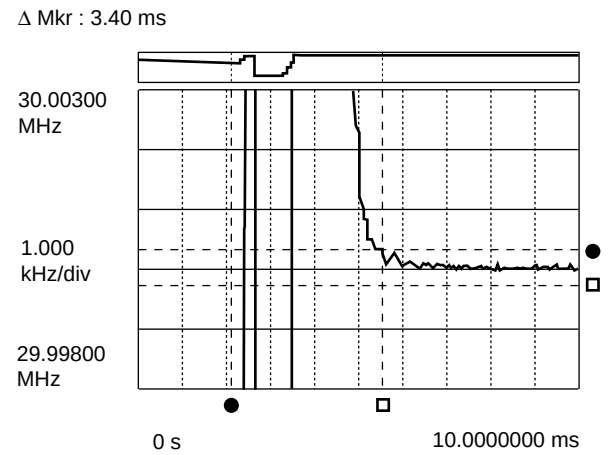
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3. Lock-up Time: Un-Lock → Lock (H type: high-speed sync charge pump)

Un-Lock to Lock: DIV = "L" → "H"



V_{CC} "OFF" to V_{CC} "ON"



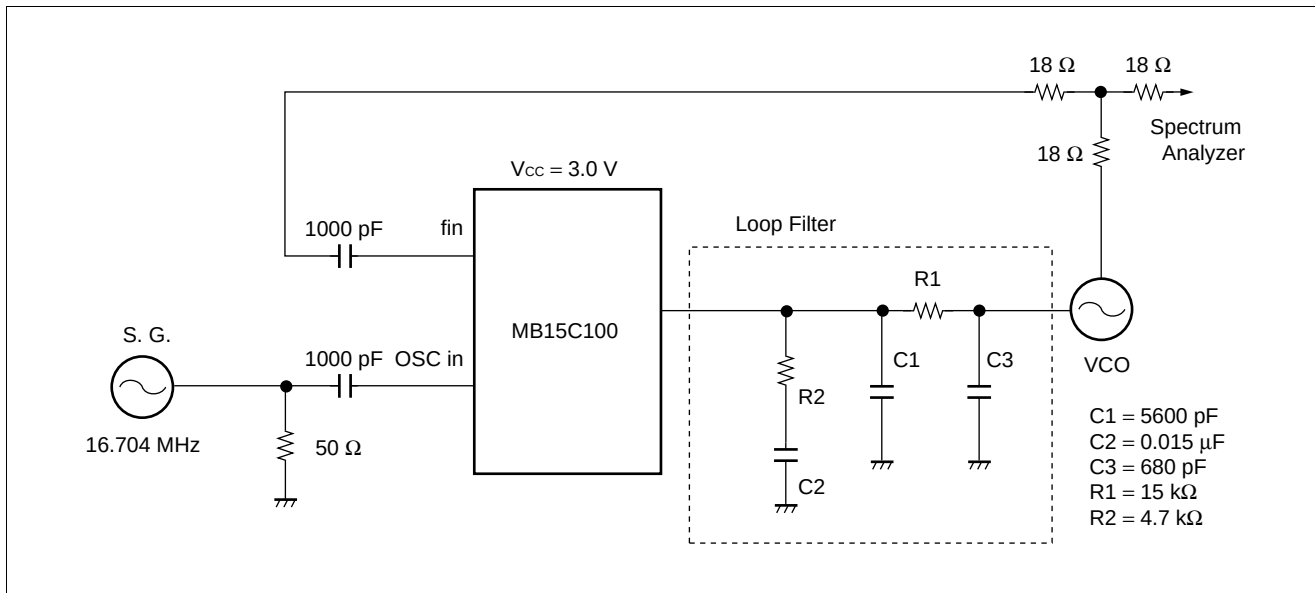
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4. Application Measurement (L type: low sensitivity charge pump)

• Test results

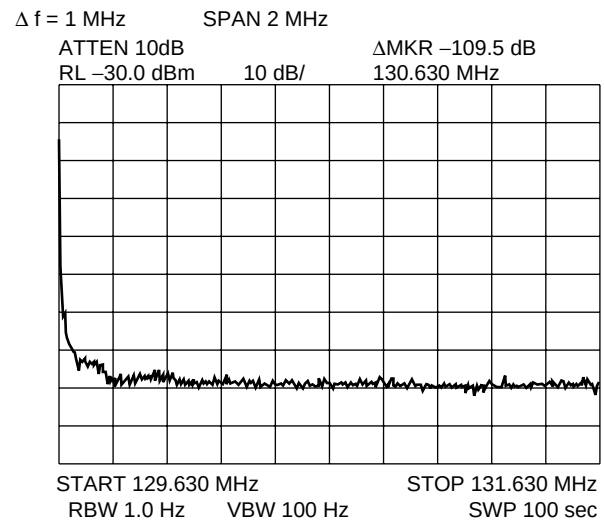
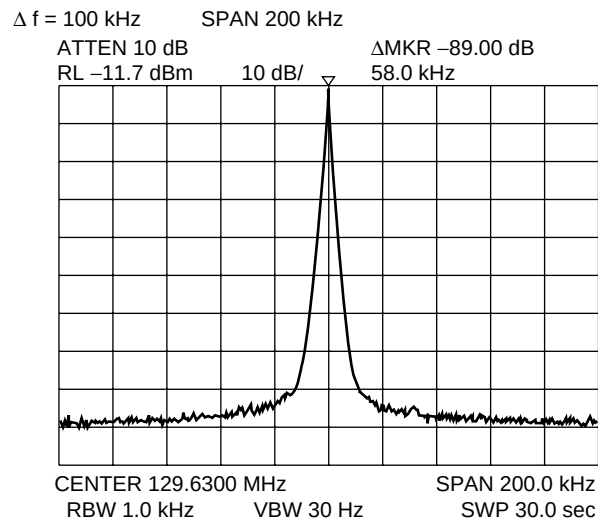
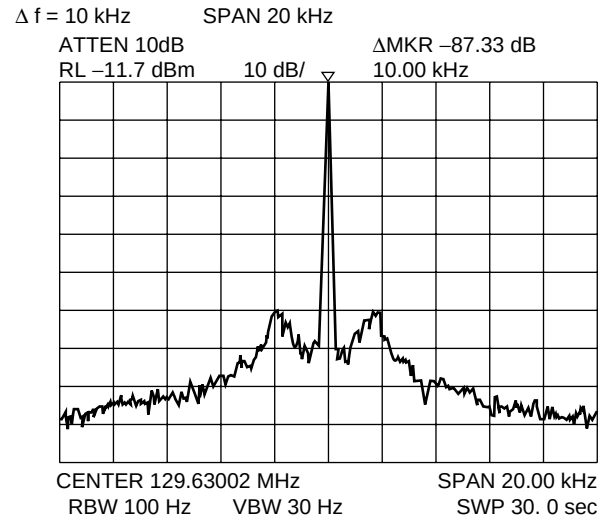
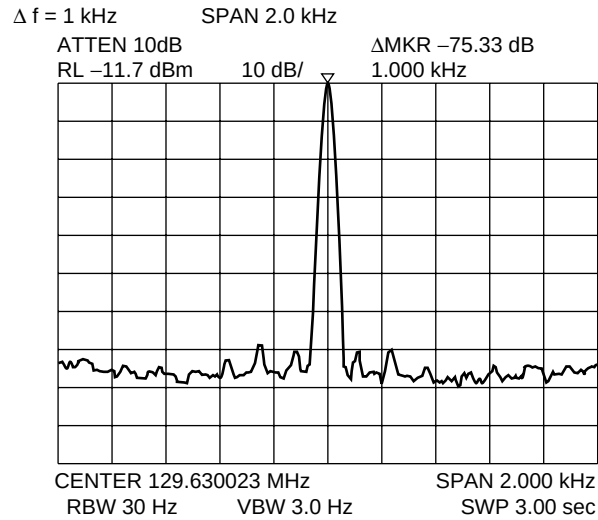
Parameter	Results
Lock-up time ± 1 kHz Unlock $\rightarrow$ Lock Power on $\rightarrow$ Lock	3.4 ms 5.7 ms
Reference leakage ($\Delta f = 58$ kHz)	-88.5 dBc
Phase noise ($\Delta f = 1$ kHz) ($\Delta f = 10$ kHz) ($\Delta f = 100$ kHz) ($\Delta f = 1$ MHz)	-90.1 dBc/Hz -107.3 dBc/Hz -119.0 dBc/Hz -127.8 dBc/Hz
V_{CC} (V)	3.0 v
VCO	Discrete VCO ($K_v = 2.2$ MHz/V) Lock Frequency = 129.63 MHz ($f_r = 58$ kHz)

• Measurement circuit



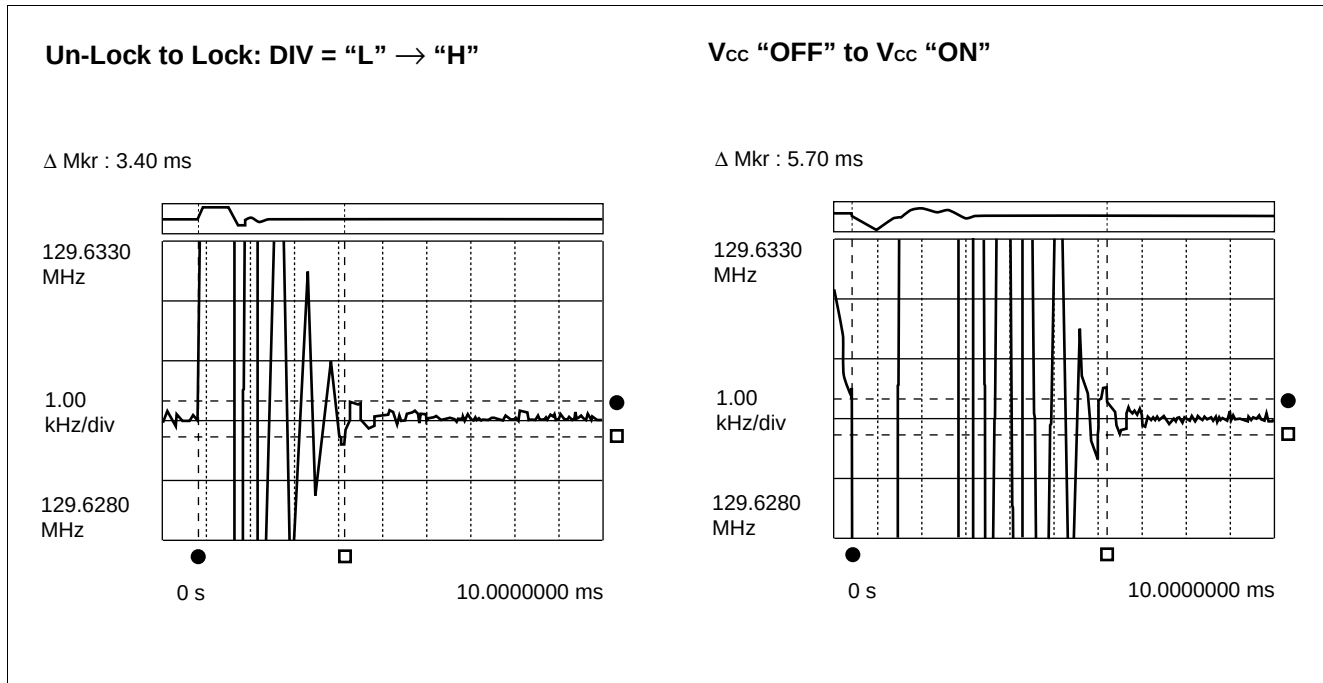
MB15C100 Series

5. Phase Noise (L type: low sensitivity charge pump)



MB15C100 Series

6. Lock-up Time: Un-Lock → Lock (L type : low sensitivity charge pump)

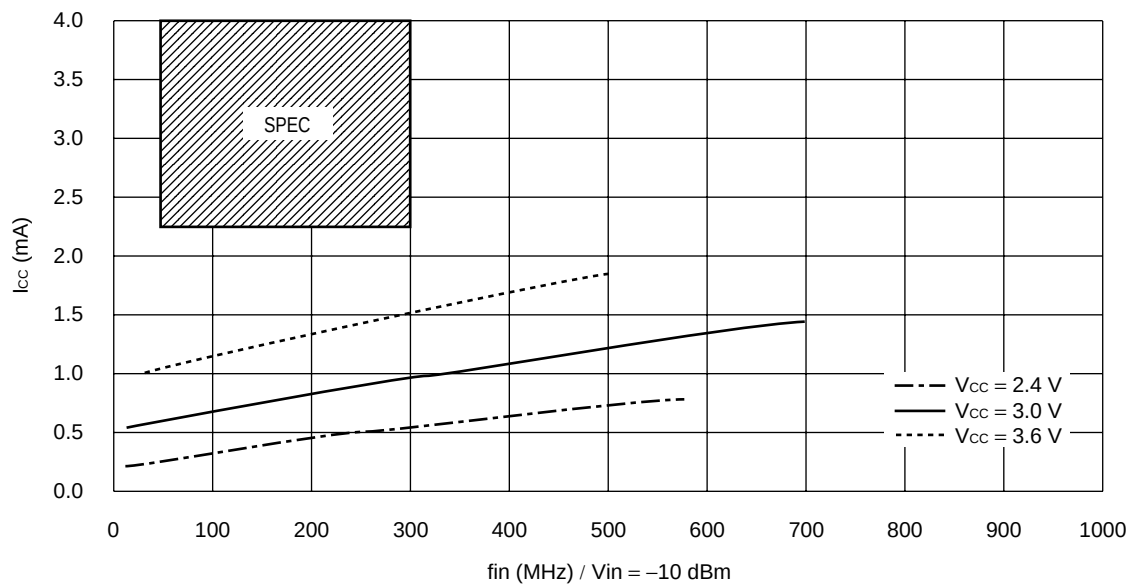


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7. f_{in} - I_{CC} Characteristics

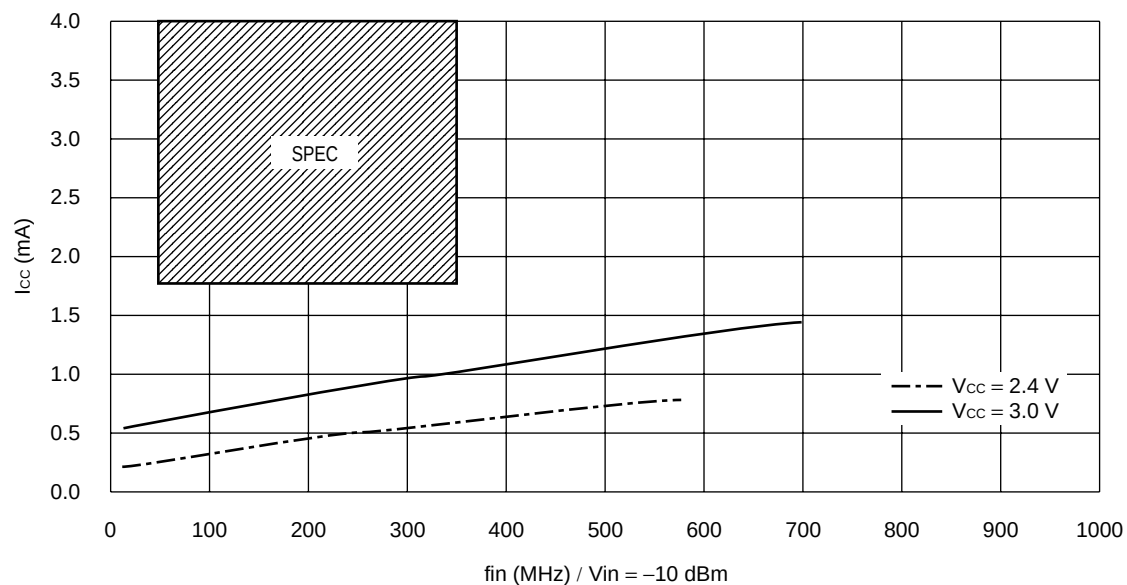
- $f_{in} \leq 300$ MHz, $V_{CC} = 2.4$ to 3.6 V

(DIV = "L", $f_{osc} = 19.2$ MHz / $V_{osc} = -2$ dBm)



- $f_{in} \leq 380$ MHz, $V_{CC} = 2.4$ to 3.0 V

(DIV = "L", $f_{osc} = 19.2$ MHz / $V_{osc} = -2$ dBm)

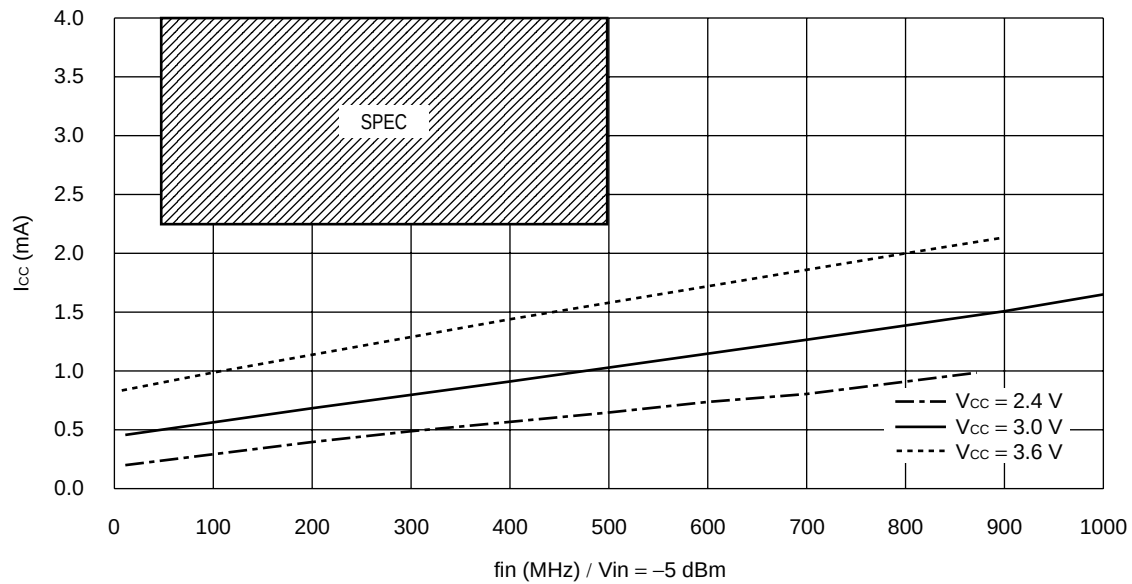


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MB15C100 Series*(Continued)*

- $f_{in} \leq 500$ MHz, $V_{CC} = 2.4$ to 3.6 V

(DIV = "L", $f_{osc} = 19.2$ MHz / $V_{osc} = -2$ dBm)



MB15C100 Series

■ USAGE 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.

■ ORDERING INFORMATION

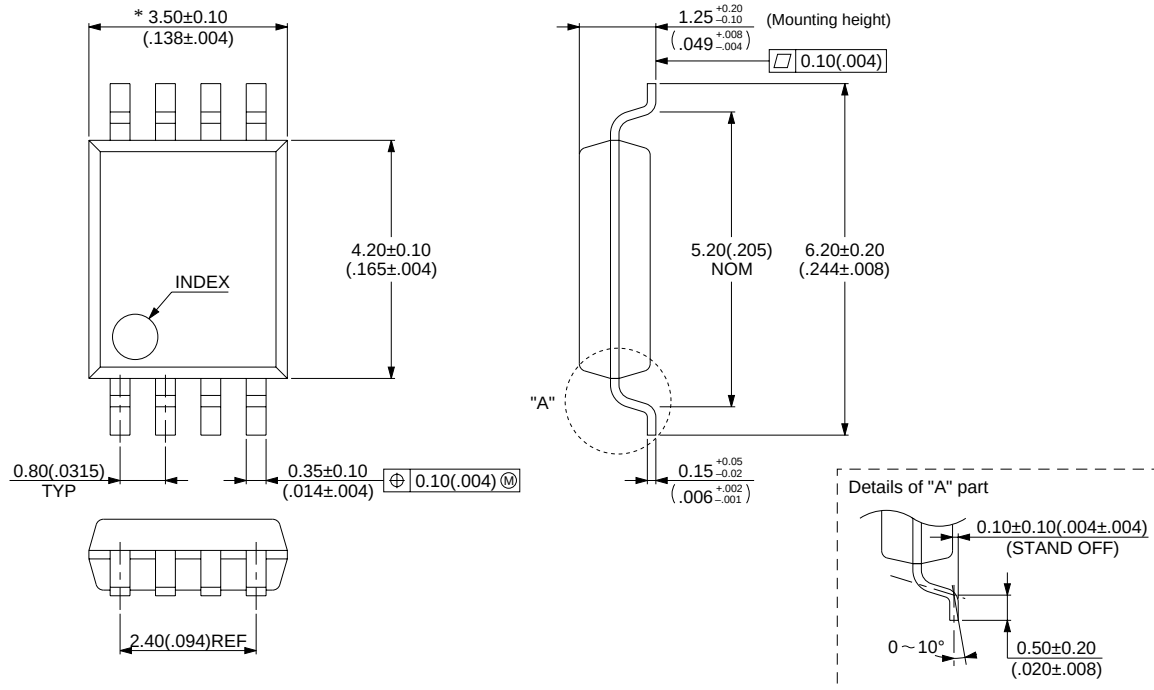
Part number	Package	Remarks
MB15C100PFV	8-pin Plastic SSOP (FPT-8P-M03)	
MB15C100PV1	16-pad Plastic BCC (LCC-16P-M06)	

MB15C100 Series

■ PACKAGE DIMENSIONS

8-pin plastic SSOP
(FPT-8P-M03)

*: This dimension does not include resin protrusion.



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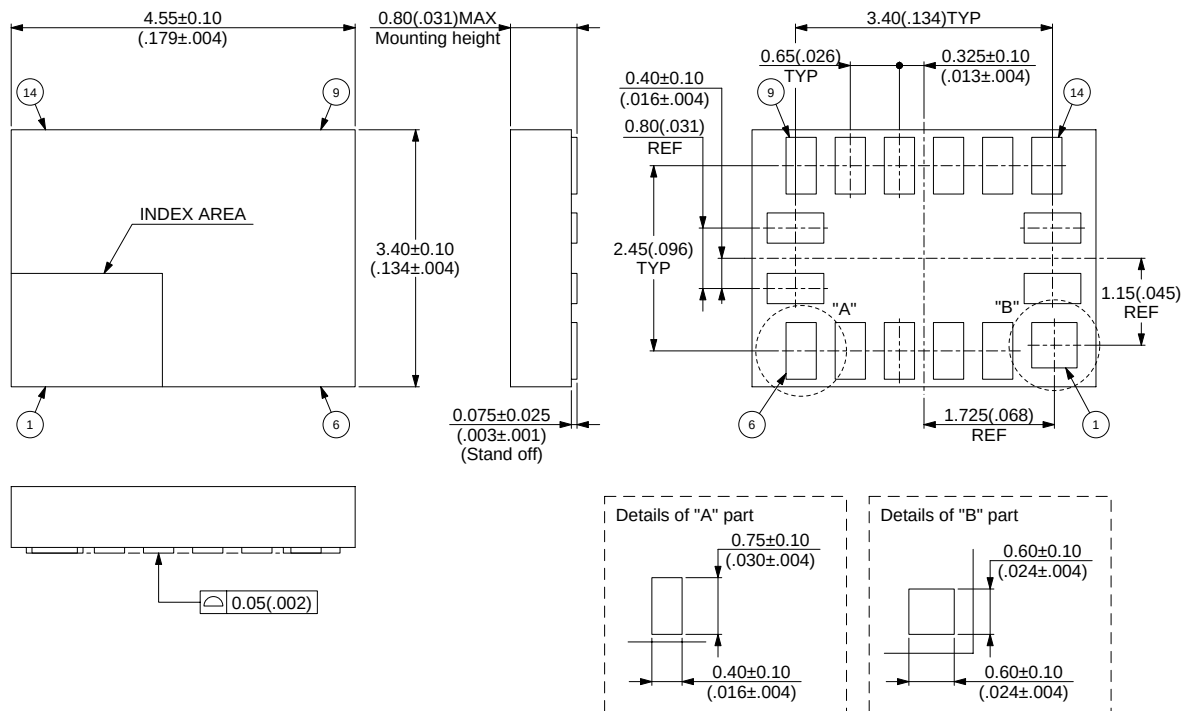
Dimensions in mm (inches)

(Continued)

MB15C100 Series

(Continued)

16-pad plastic BCC (LCC-16P-M06)



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Dimensions in mm (inches)

MB15C100 Series

■ CUSTOMER REQUESTING SPECIFICATIONS

Prameter			Option	Requirements	
f _{vco}		VCO output frequency	50 to 500 MHz (* 30 to 380 MHz: V _{cc} = 2.4 V to 3.0 V) (*30 to 500 MHz: Vin = −5 to +2 dBm) f _{vco} = [(P × N) + A] × fr (N>A, P>A)		
f _{osc}		Reference oscillation frequency	3 to 26 MHz f _{osc} = R × fr		
Power saving function (PS) Div type or PS type			A type (Div) or B type (PS)		
Comparison divider	N	Main counter divide ratio	5 to 4095		
	A	Swallow counter divide ratio	0 to 31		
	P	Prescaler divide ratio	8/9, 16/17 or 32/33		
Reference divider	R	Reference counter divide ratio	5 to 4095		
	fr	Reference frequency	Option		
	CP	Charge pump type	H type (high-speed sync) or L type (Low sensitivity)		
Package type			SSOP-8 or BCC-16		
ES request date/qty.			Typically 4 weeks from spec. fix to the first ES.		
CS request date/qty.			—		
MP request date/qty.			—		
Customer comments					

MB15C100 Series

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