FUJITSU SEMICONDUCTOR
DATA SHEET

DS06-80106-2E

SEMICUSTOM

Built-in IF Band Voltage Controlled Oscillator Mask ROM Frequency Synthesizer

MB15C700 series

■ DESCRIPTION

MB15C700 series is a Phase Locked Loop (PLL) frequency synthesizer of pulse swallow operation with built-in VCO suitable for Intermediate Frequency band synthesizer of mobile phones.
The VCO can operate option oscillation frequency by an external inductance and capacitor. The PLL reference divider ratio and comparison divider ratio are fixed , so that it is not required to set the divider ratios by a microcontroller externally. BCC-20 plastic package is miniaturized the device and makes it easier to design.
It operates with a supply voltage of 2.5 V typ. (PLLVDD, VCOVDD) and low power consumption current 4.5 mA typ. (PLL + VCO at 400 MHz) is realized by pure- CMOS technology.

■ FEATURES

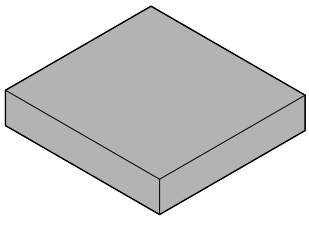
<<PLL>>

- Pulse swallow function
- 400 MHz High-speed Prescaler : 8/9, 16/17, 32/33
- MASK ROM optinal the comparison and reference dividers :
  Comparison counter : Main counter : 5 to 4095, Swallow counter : 0 to 31
  Reference counter : 5 to 4095 (up to 26 MHz)
- Lock detector circuit: Digital lock detector circuit which is “H” level when PLL is locked.

(Continued)

■ PACKAGE

20-pad, plastic BCC



LCC-20P-M04

(Continued)

- Charge pump options :
  H type: Super charger circuit for high speed tuning. (I_{OH} = –4.5 mA, I_{OL} = 4.5 mA at PLLVDD = 2.5 V)
  L type : Low sensitivity charge pump for direct modulation. (I_{OH} = –1.125 mA, I_{OL} = 1.125 mA at PLLVDD = 2.5 V)

<<VCO>>

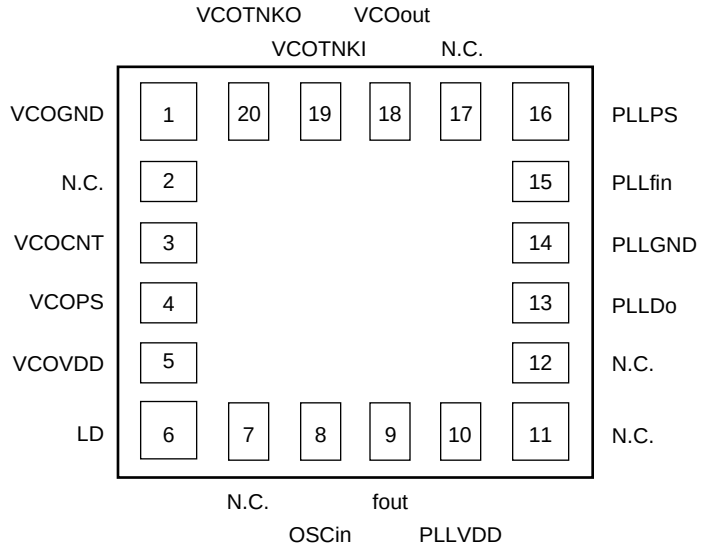
- Integrates vari-cap for VCO
- Operating frequency can be arranged by the number of the external inductor and capacitor connected TANK circuit

<<COMMON>>

- Low power supply voltage : 2.3 V to 2.7 V
- Low power supply current : 4.5 mA typ. (PLLVDD = VCOVDD = 2.5 V, fvco = 400 MHz)
- Operating temperature : –20 °C to +85 °C

■ PIN ASSIGNMENT

(Top View)

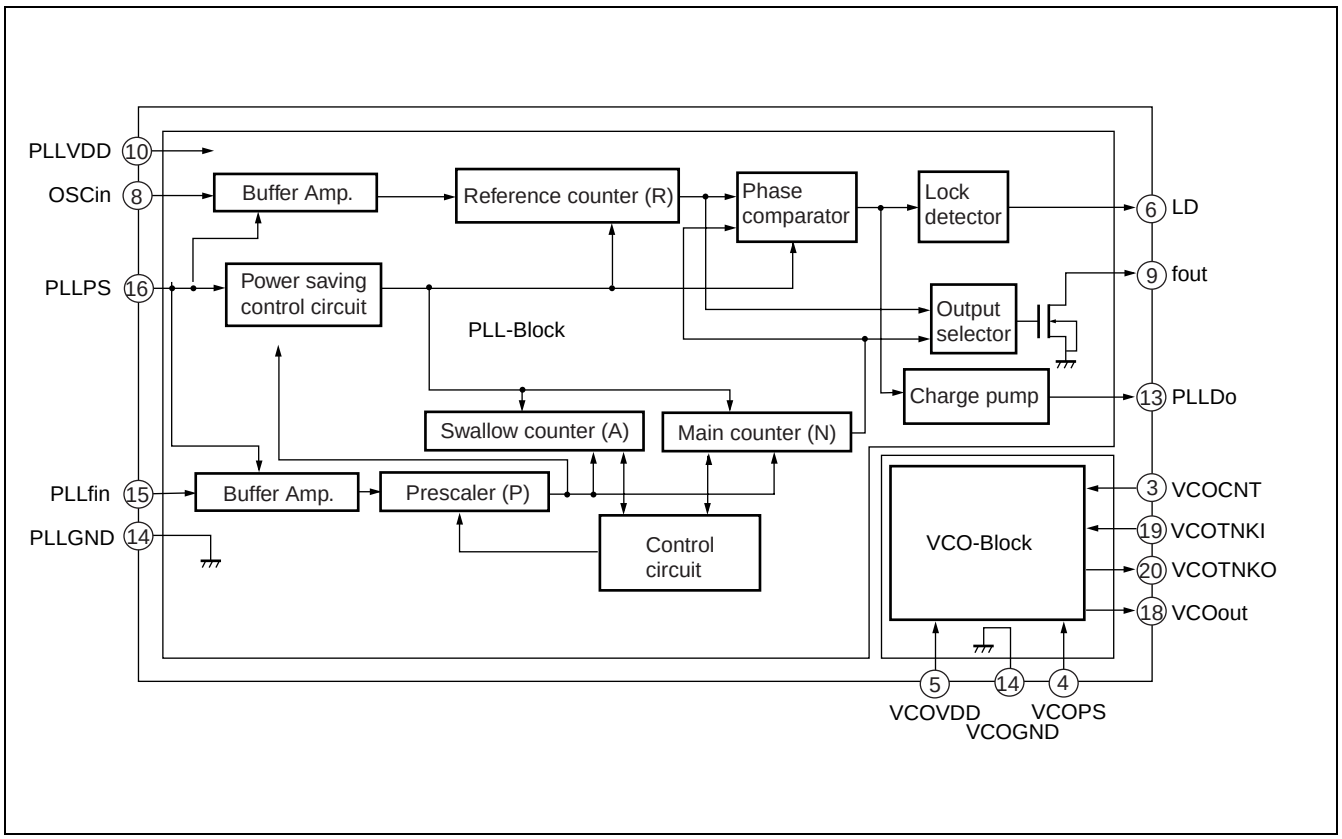


LCC-20P-M04

■ PIN DESCRIPTIONS

Pin No.	Symbol	I/O	Descriptions
1	VCOGND	—	Ground for the VCO.
2	N.C.	—	No connection.
3	VCOCNT	I	VCO control voltage input. Connection to PLLDo terminal via LPF.
4	VCOPS	I	Power saving control for the VCO. (Open is prohibited.) “H” : Normal mode “L” : Power saving mode
5	VCOVDD	—	Power supply voltage input for VCO. Connect to capacitor between GND.
6	LD	O	Lock detector signal output. LD = “H” : Locking mode or power saving mode LD = “L” : Unlocking mode.
7	N.C.	—	No connection.
8	OSCin	I	The reference counter input. Connect with a AC coupling capacitor.
9	fout	O	Test purpose output. This pin is an open drain output.
10	PLLVDD	—	Power supply voltage input for the PLL. Connect to capacitor between GND
11	N.C.	—	No connection
12	N.C.	—	No connection.
13	PLLDo	O	PLL charge pump output. Connect to VCOCNT pin via LPF.
14	PLLGND	—	Ground for the PLL.
15	PLLfin	I	Prescaler input. Connect with an AC coupling capacitor.
16	PLLPS	I	Power saving control for the PLL. (Open is prohibited.) “H”: Normal mode “L”: Power saving mode
17	N.C.	—	No connection.
18	VCOout	O	VCO output.
19	VCOTNKI	I	VCOTANK circuit input. Connect to VCOTNKO pin with inductance and resistance. Connect to capacitor between GND.
20	VCOTNKO	O	VCOTANK circuit output. Connect to VCOTNKI terminal with inductance and resistance. Connect to capacitor between GND. (max.2.0 pF)

■ BLOCK DIAGRAM



■ FUNCTIONAL DESCRIPTIONS

Divide ratios of the internal counters can be set optionally according to customer requirements.

The divide ratio can be calculated using the following equation.

$$fvco = [(P \times N + A)] \times fosc / R$$

Note: N > A, P > A

fvco : Output frequency of Voltage Controlled Oscillator (VCOout up to 400 MHz)
fosc : Reference oscillation frequency (up to 26 MHz)
N : Divide ratio of the main counter (5 to 4095)
A : Divide ratio of the swallow counter (0 to 31)
P : Preset divide ratio of dual modulus prescaler (8/9, 16/17, 32/33)
R : Divide ratio of the reference counter (5 to 4095)

■ ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol		Rating		Unit
			Min.	Max.	
Power supply voltage	V_{DD}	PLLVDD	–0.5	4.0	V
		VCOVDD			
Output voltage	V_O		–0.5	V_{DD}+0.5	V
Input voltage	V_I		–0.5	V_{DD}+0.5	V
Output current	I_O		0	+5.0	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
			Min.	Typ.	Max.	
Power supply voltage	V_{DD}	PLLVDD	2.3	2.5	2.7	V
		VCOVDD				
Input voltage	V_{IN}		GND	—	V_{DD}	V
Operating temperature	Ta		–20	—	+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.

■ ELECTRICAL CHARACTERISTICS

(Recommended operating conditions unless otherwise noted.)

Parameter		Symbol	Condition	Value			Unit
				Min.	Typ.*	Max.	
Power supply current	PLLVDD	I_{PLL}	PLLVDD = VCOVDD = 2.5 V PLL-Lock (400 MHz)	—	4.5	—	mA
	VCOVDD	I_{VCO}					
Power saving current	PLLVDD	I_{PLLPS}	PLLPS = "L"	—	1.0	10.0	µA
	VCOVDD	I_{VCOPS}	VCOPS = "L"	—	—	1.0	µA
Operating frequency	PLLfin	fin	AC coupling by 1000 pF capacitor	100	—	400	MHz
	OSCin	f_{OSC}	AC coupling by 1000 pF capacitor	3	—	26	MHz
Input sensitivity	OSCin	V_{OSC}	AC coupling by 1000 pF capacitor	0.5	—	—	Vp-p
Input current	OSCin	I_{OSC}	—	–100	—	100	µA
Output voltage Charge pump type : H Charge pump type : L	PLLDo	V_{OH}	I_{OH} = –0.3 mA	PLLVDD –0.8	—	—	V
		V_{OL}	I_{OL} = 0.3 mA	—	—	0.4	
Output current Type : H	PLLDo	I_{OH}	PLLVDD = 2.5 V V_{OH} = 1.5 V	—	–4.5	—	mA
		I_{OL}	PLLVDD = 2.5 V V_{OL} = 1.0 V	—	4.5	—	
Output current Type : L	PLLDo	I_{OH}	PLLVDD = 2.5 V V_{OH} = 1.5 V	—	–1.125	—	mA
		I_{OL}	PLLVDD = 2.5 V V_{OL} = 1.0 V	—	1.125	—	
High impedance cutoff current	PLLDo	I_{OFF}	0 V ≤ $PLLVD_O$ ≤ PLLVDD	—	—	3.0	nA

*: PLLVDD = VCOVDD = 2.5 V, Ta = +25 °C

■ REFERENCE CHARACTERISTICS

(PLLVDD = VCOVDD = 2.5 V, Ta = +25 °C)

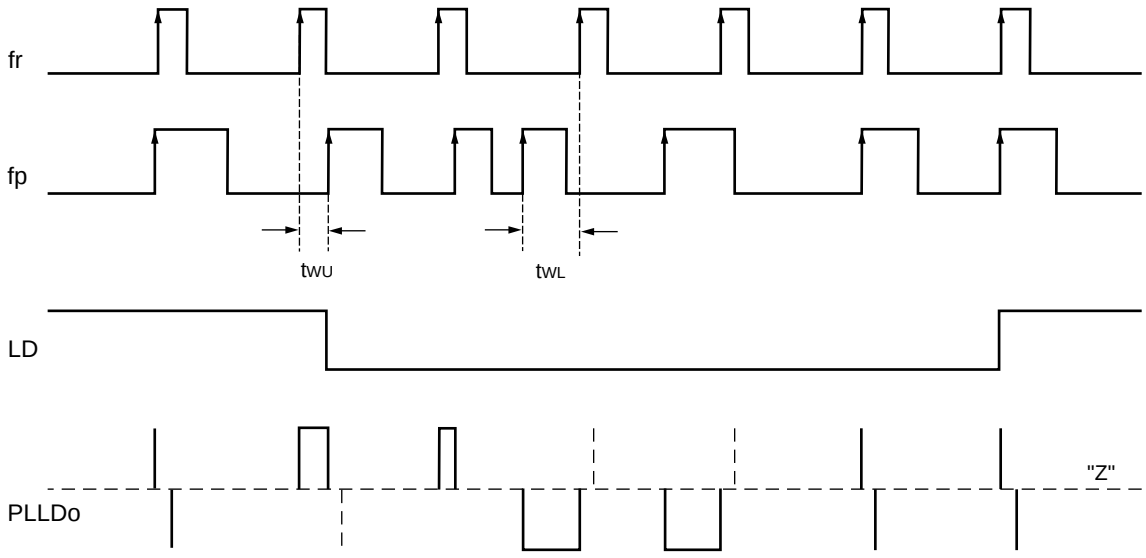
Parameter	Symbol	Condition	Value			Unit
			Min.	Typ.	Max.	
VCO variable range	Δf	$f_{VCO}1$ (at VCOCNT = 0.8 V) − $f_{VCO}2$ (at VCOCNT = 1.8 V)	4.0	—	—	MHz
VCO output level	V_{VCOout}	—	—	−12	—	dBm
SYN reference leakage	Lef1	Δ±fr	—	−67	—	dBc
	Lef2	Δ± (fr × 2)	—	−70	—	
SYN output S/N	S/N	Δ1 kHz	—	—	—	dBc
SYN output C/N	C/N1	Δ±50 kHz	—	−68	—	dBc
	C/N2	Δ±100 kHz	—	−74	—	
Spurious	Lsp1	2nd Harmonic (Δf_{VCO})	—	−3	—	dBc
	Lsp2	3rd Harmonic (Δ (f_{VCO} × 2))	—	−10	—	
	Lsp3	4th Harmonic (Δ (f_{VCO} × 3))	—	−18	—	
	Lsp4	Other (Δ (f_{VCO} × 4))	—	−30	—	
	Lsp5	TRX band (Δ (f_{VCO} × 5))	—	−35	—	
	Lsp6	TRX band (Δ (f_{VCO} × 6))	—	−40	—	
	Lsp7	Δ (f_{VCO} × 7)		−50	—	
	Lsp8	Δ (f_{VCO} × 8)		−55	—	
	Lsp9	Δ (f_{VCO} × 9)		−55	—	
	Lsp10	Δ (f_{VCO} × 10)		−60	—	
Lock-up time	T_{LOCK}	PLLPS “L” to “H” f_{VCO} within ± 300 Hz, V_{VCOout} = −12 ± 3 dBm	—	—	4.0	ms
VCO operating control voltage range	ΔV_{CNT}	—	0.5	—	VCOVDD − 0.2	V

*1 : An external components (inductance and capacitor) connected with VCOTANK are recommended to use an component with nominal value within 2%.

*2 : An capacitor connected between VCOTNKO and GND is less than 2.0 pF.

*3 : The condition of above reference data is fr ≥ 50 kHz.

■ PHASE COMPARATOR OUTPUT WAVE FORM



"Z" : High impedance

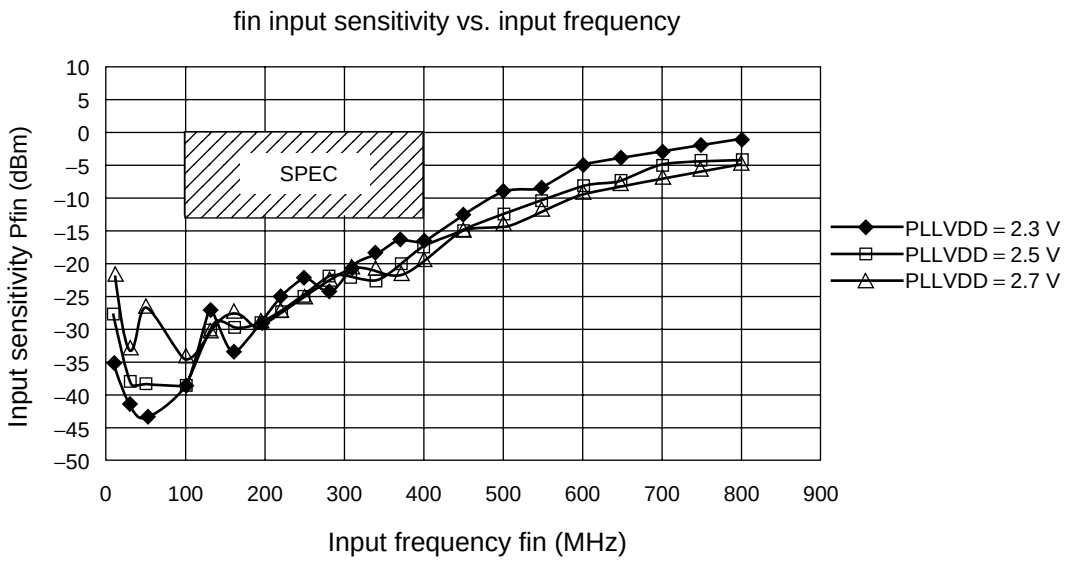
Notes : • Phase error detection range : -2π to $+2\pi$
- Spikes on Do pulse during locking state are output to prevent dead zone
- LD output becomes “L” level when phase error is t_{WU} or more.
- LD output becomes “H” level when phase error is t_{WL} or less and continues to be so for three cycles or more.
- t_{WU} and t_{WL} depend on OSCin input frequency.

  $t_{WU} \geq 8/f_{OSC}$ [s] : i.e. $t_{WU} \geq 625$ ns, $f_{OSC} = 12.8$ MHz

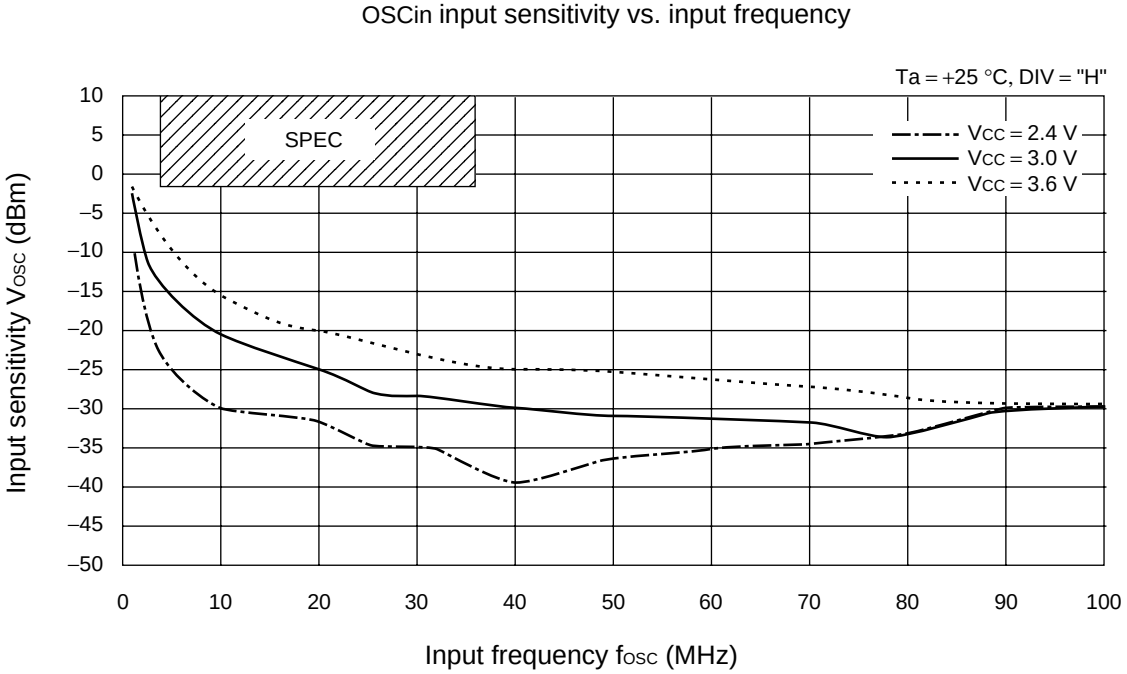
  $t_{WL} \leq 16/f_{OSC}$ [s] : i.e. $t_{WL} \leq 1250$ ns, $f_{OSC} = 12.8$ MHz

■ TYPICAL CHARACTERISTICS

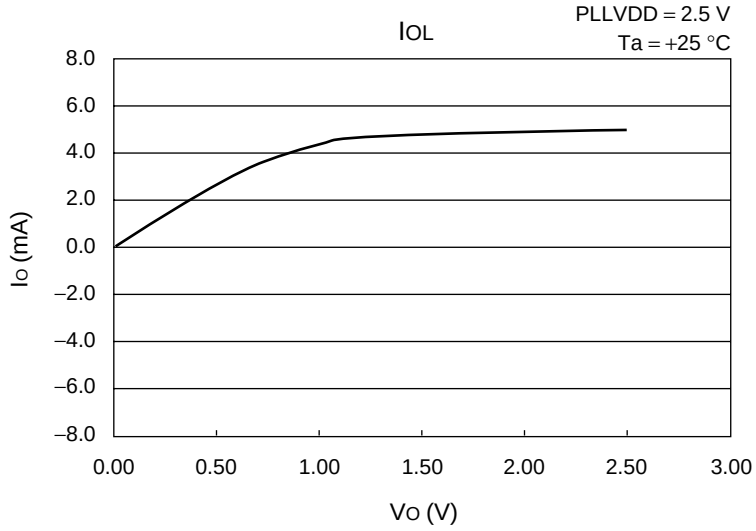
1. fin input sensitivity

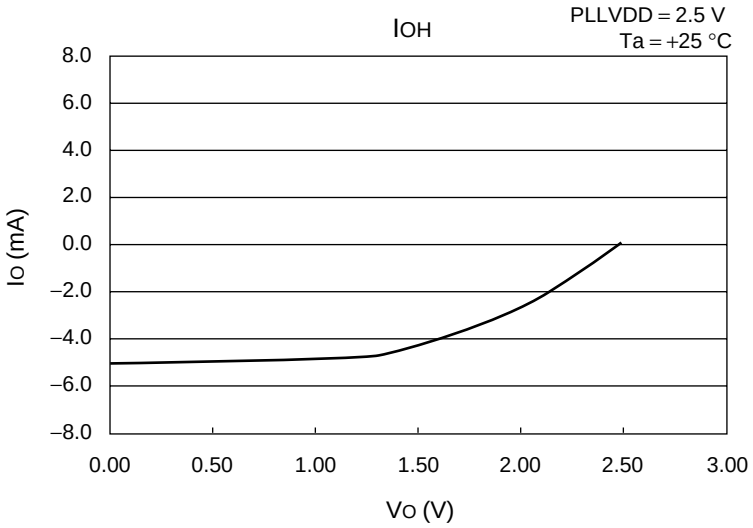


2. OSCin input sensitivity



3. Do output current





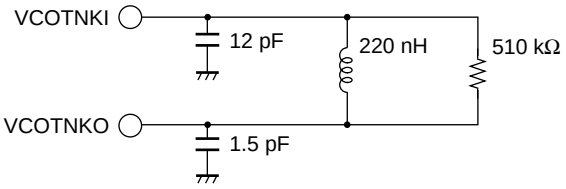
■ REFERENCE CHARACTERISTICS DATA

PLLVDD = VCOVDD = 2.5 V, Ta = +25 °C

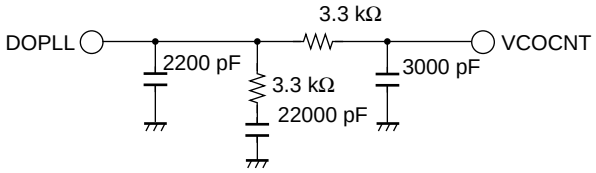
f_{VCO} = 129.55 MHz, OSCin = 12.8 MHz, fr = 50 kHz

[Measurement circuit]

<VCOTANK CIRCUIT>



<Loop Filter>

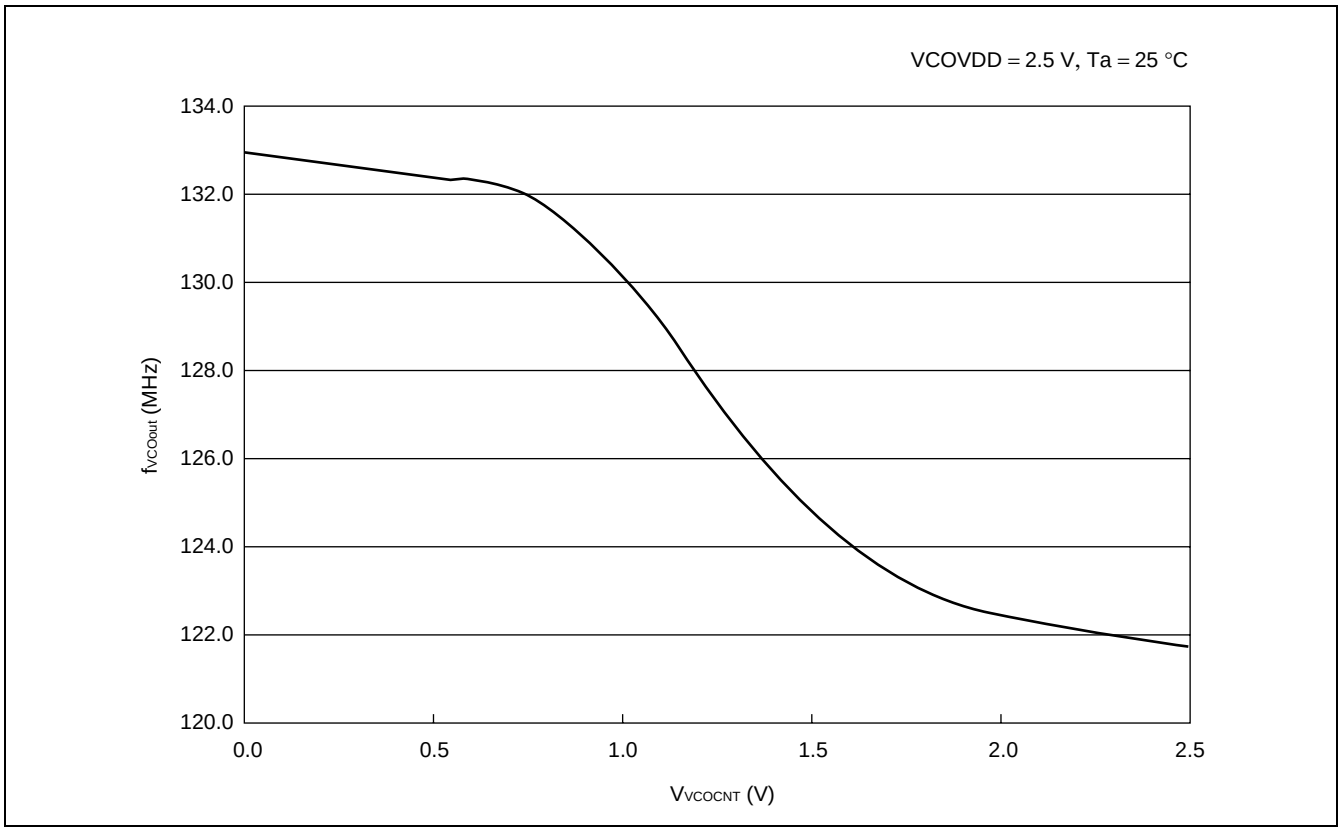


1. Measurement result

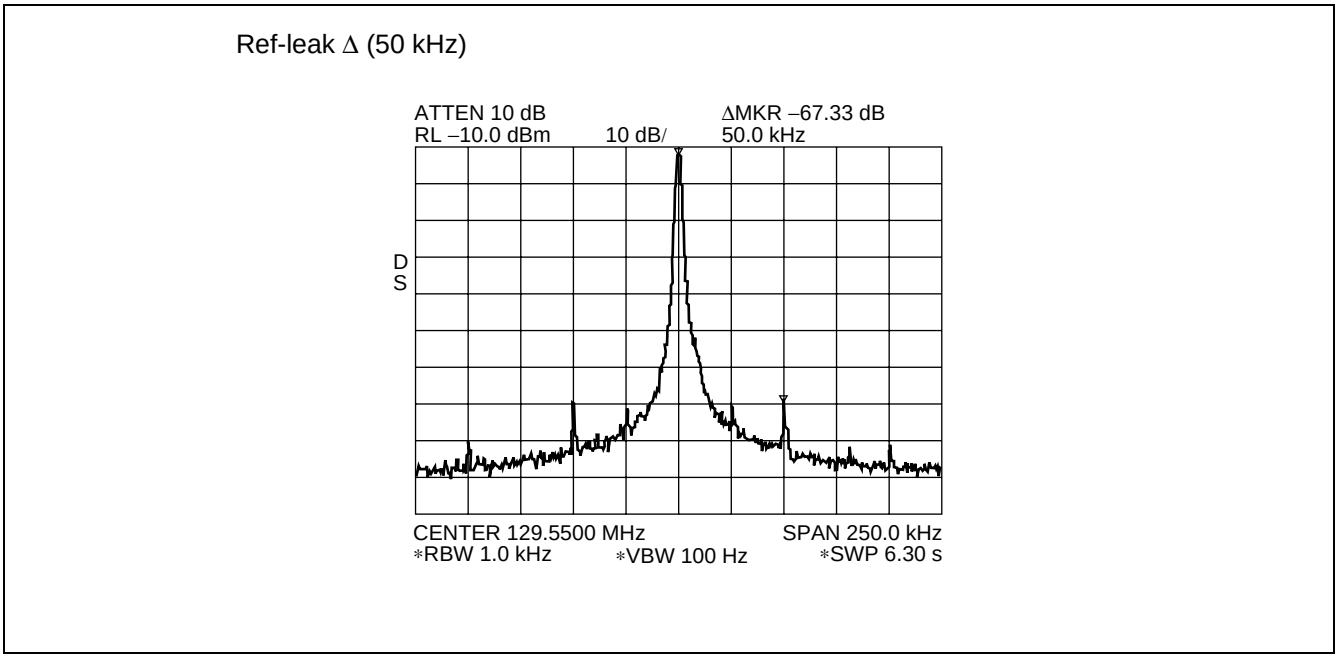
Parameter		Condition	Result	
VCO variable range	Δf	f_{VCO1} (@VCOCNT = 0.8 V) – f_{VCO2} (@VCOCNT = 1.8 V)	8.657	MHz
Reference leakage	Lref1 (+)	Δ+fr	–67.3	dBc
	Lref1 (–)	Δ–fr	–66.7	
	Lref2 (+)	Δ+ (fr × 2)	–72	
	Lref2 (–)	Δ– (fr × 2)	–72	
S/N	S/N	Δ1 kHz	–71.3	dBc
C/N (BW = 21kHz)	C/N1 (+)	Δ+50 kHz	–108	dBc/Hz
	C/N1 (–)	Δ–50 kHz	–108	
	C/N2 (+)	Δ+100 kHz	–113	
	C/N2 (–)	Δ–100 kHz	–113	
Spurious	Lsp1	2nd Harmonic (Δf_{VCO})	–4.2	dBc
	Lsp2	3rd Harmonic (Δ (f_{VCO} × 2))	–10.8	
	Lsp3	4th Harmonic (Δ (f_{VCO} × 3))	–23.3	
	Lsp4	Other (Δ (f_{VCO} × 4))	–26.0	
	Lsp5	TRX band (Δ (f_{VCO} × 5)	–29.2	
	Lsp6	TRX band (Δ (f_{VCO} × 6))	–35.7	
	Lsp7	Δ (f_{VCO} × 7)	–44.3	
	Lsp8	Δ (f_{VCO} × 8)	–49.2	
	Lsp9	Δ (f_{VCO} × 9)	–51.7	
	Lsp10	Δ (f_{VCO} × 10)	–60.7	
Lock-up time	T_{LOCK}	PLLPS “L” to “H” f_{VCO} within ± 300 Hz, V_{VCOout} = –12 ± 3 dBm	0.622	ms

2. Characteristics wave form

- V_{VCOCNT}– f_{VCOout} Characteristics

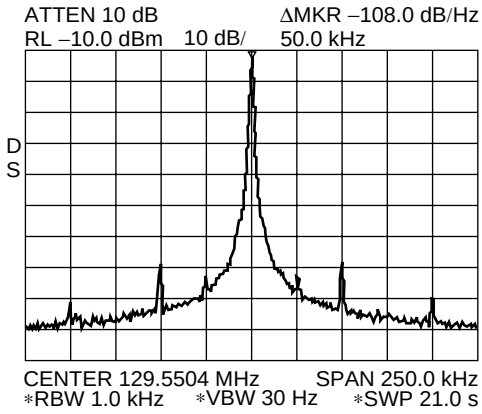


- Spectrum Wave Form (Reference Leakage)

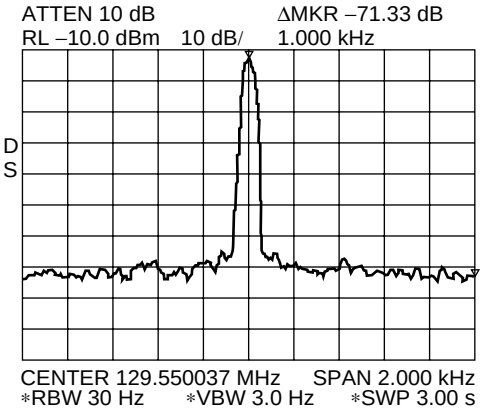


- Spectrum Wave Form (C/N, S/N, Sprious, Lock-up Time)

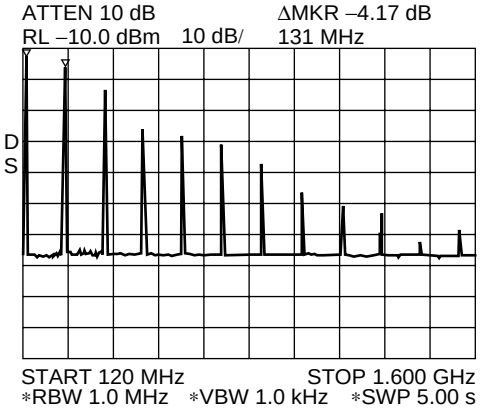
C/N Δ (50 kHz)



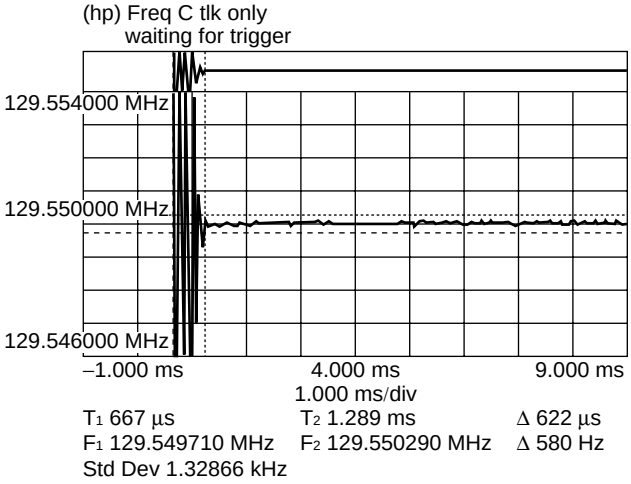
S/N Δ (1 kHz)



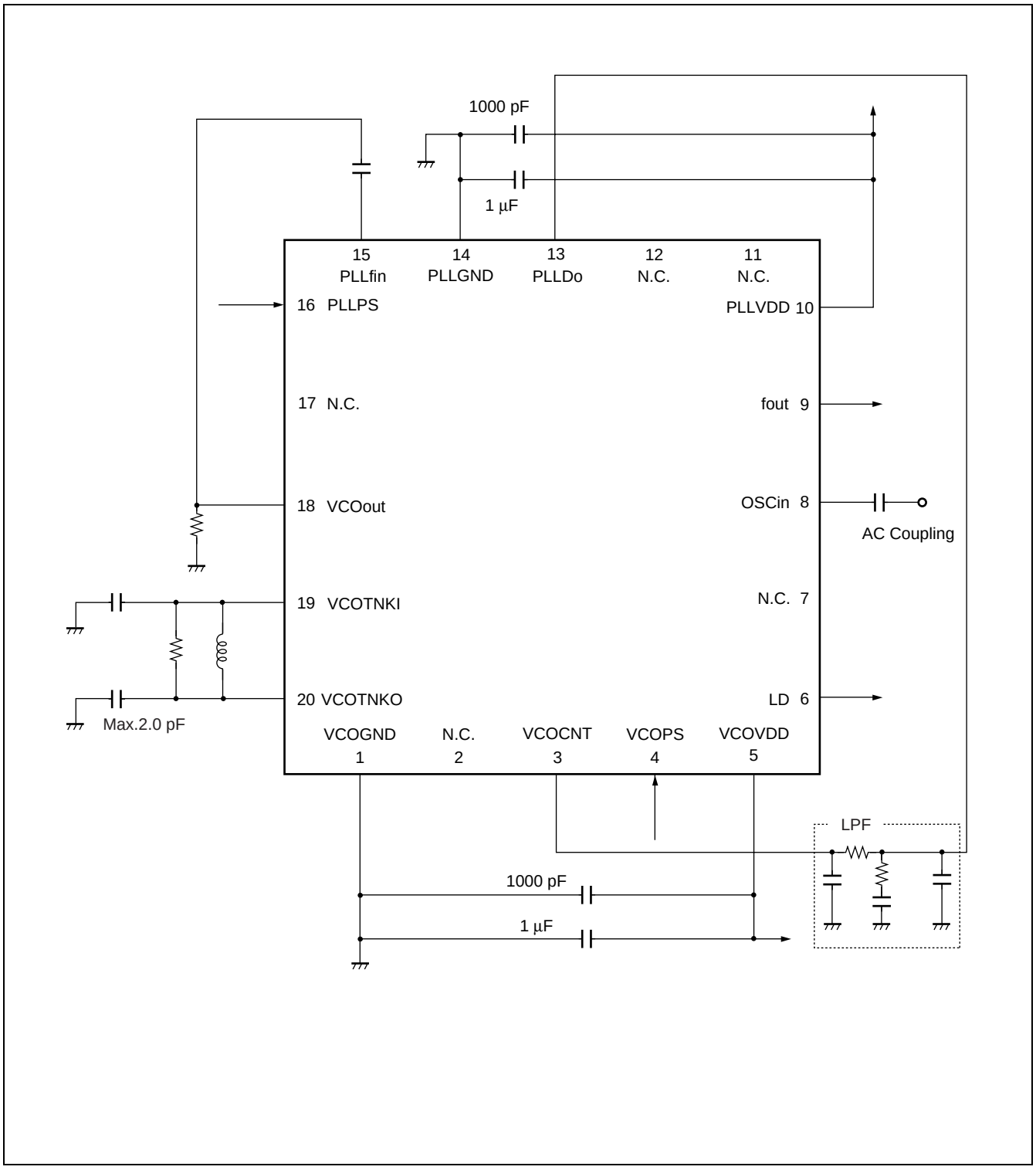
Sprious



Lock up time (PSmode to Lock, f_{VCO} within ± 300 Hz)



■ APPLICATION EXAMPLE



■ USAGE PRECAUTIONS

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

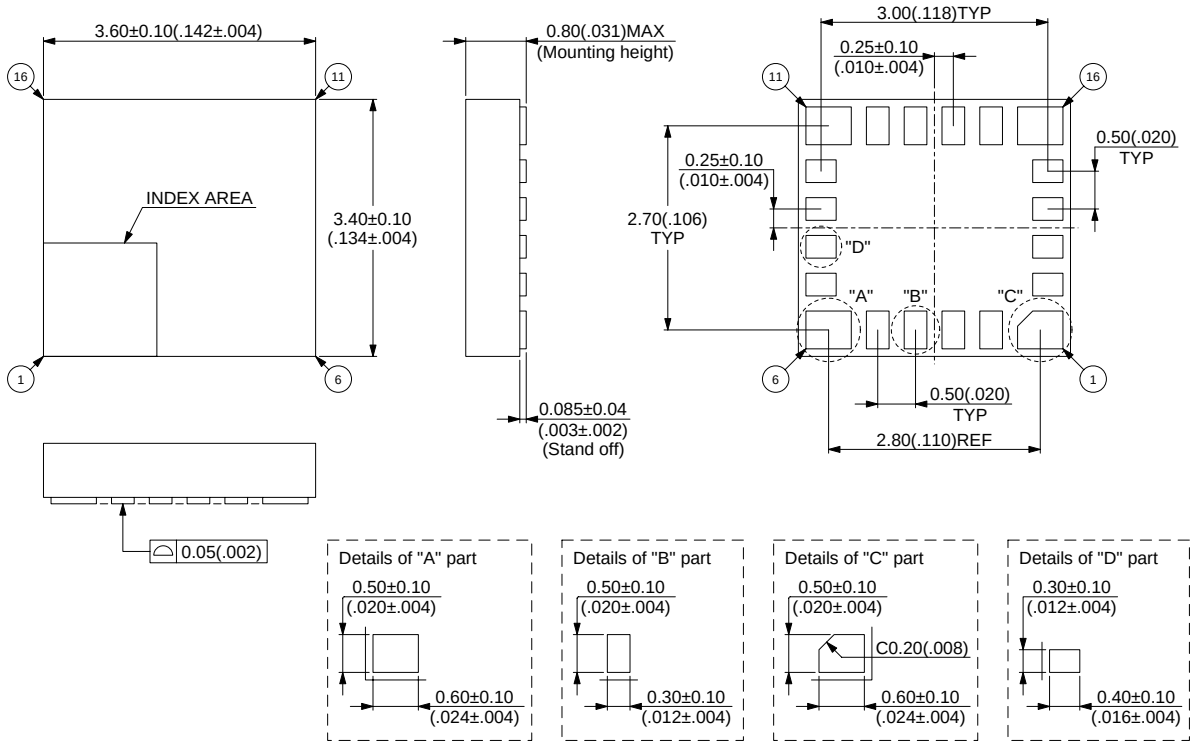
- Store and transport devices in conductive containers.
- Use properly grounded workstations, tools, and equipment.
- Turn off power before inserting device into or removing device from a socket.
- Protect leads with a conductive sheet when transporting a board-mounted device.

■ ORDERING INFORMATION

Part number	Package	Remarks
MB15C700PV	20-pad, Plastic BCC (LCC-20P-M04)	

■ PACKAGE DIMENSION

20-pad, plastic BCC
(LCC-20P-M04)



Dimensions in mm (inches)

■ CUSTOMER REQUESTING SPECIFICATIONS

Parameter			Option	Requirements
f_{VCO}		VCO output frequency	100 to 400 MHz $f_{VCO} = [(P \times N) + A] \times fr$ (N > A, P > A)	
f_{ORC}		Reference oscillation frequency	3 to 26 MHz $f_{osc} = R \times fr$	
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)	
ES request date/qty.			Typically 4 weeks from spec. fix to the first ES.	
CS request date/qty.			—	
MP request date/qty.			—	
Customer comments				

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