

ASSP

Dual Serial Input PLL Frequency Synthesizer

MB15F78UL

DESCRIPTION

The Fujitsu MB15F78UL is a serial input Phase Locked Loop (PLL) frequency synthesizer with a 2600 MHz and a 1200 MHz prescalers. A 32/33 or a 64/65 for the 2600 MHz prescaler, and a 16/17 or a 32/33 for the 1200 MHz prescaler can be selected for the prescaler that enables pulse swallow operation.

The BiCMOS process is used, as a result a supply current is typically 4.5 mA at 2.7 V. The supply voltage range is from 2.4 V to 3.6 V. A refined charge pump supplies well-balanced output current with 1.5 mA and 6 mA selectable by serial date. The data format is the same as the previous one MB15F08SL, MB15F78SP. Fast locking is achieved for adopting the new circuit.

The new package (BCC20) decreases a mount area of MB15F78UL more than 30% comparing with the former BCC16 (for dual PLL) .

MB15F78UL is ideally suited for wireless mobile communications, such as GSM and PCS.

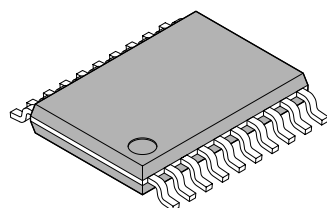
FEATURES

- High frequency operation : RX synthesizer : 2600 MHz Max.
: TX synthesizer : 1200 MHz Max.
- Low power supply voltage : $V_{CC} = 2.4$ to 3.6 V
- Ultra low power supply current : $I_{CC} = 4.5$ mA Typ.
($V_{CC} = V_p = 2.7$ V, $T_a = +25$ °C, $SW_{TX} = SW_{RX} = 0$, in TX/RX locking state)

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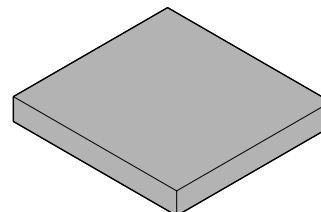
PACKAGES

20-pin plastic TSSOP



(FPT-20P-M06)

20-pad plastic BCC



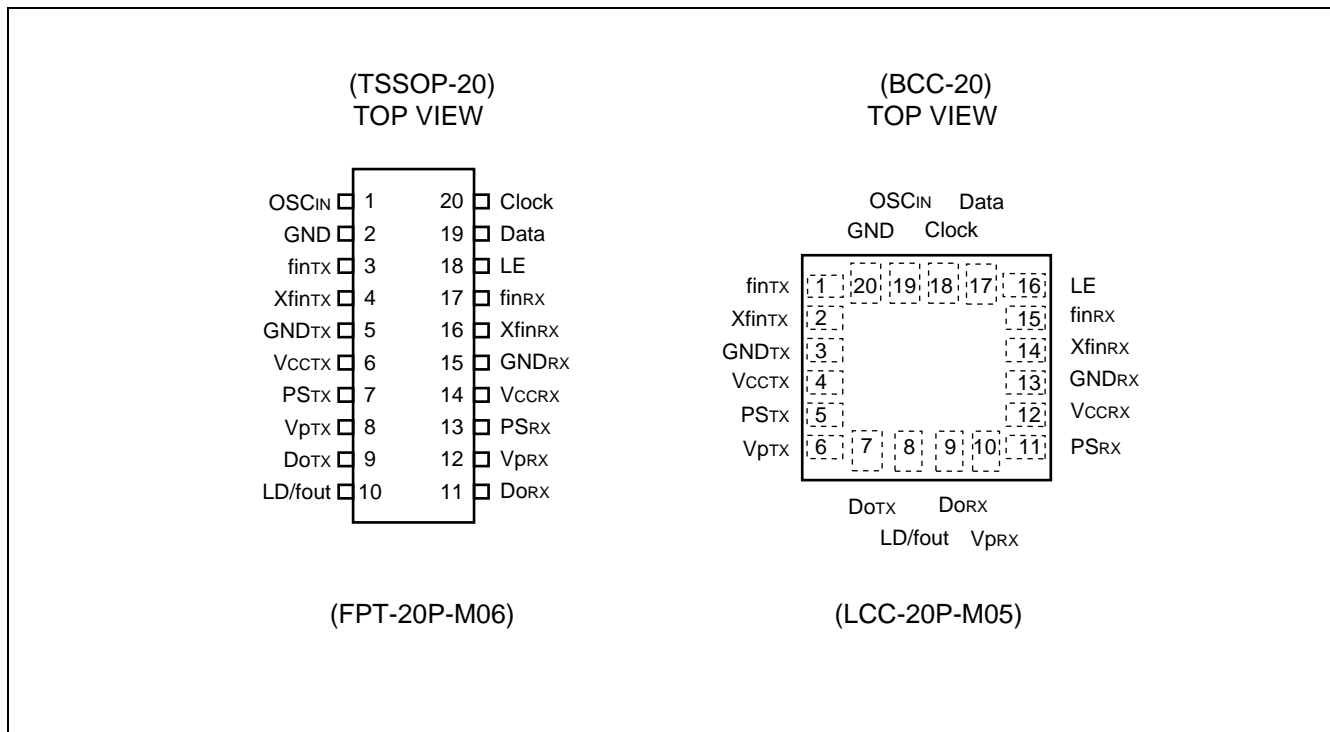
(LCC-20P-M05)

MB15F78UL

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- Direct power saving function : Power supply current in power saving mode
 Typ. 0.1 μ A ($V_{CC} = V_p = 2.7$ V, $T_a = +25^\circ\text{C}$)
 Max. 10 μ A ($V_{CC} = V_p = 2.7$ V)
- Software selectable charge pump current : 1.5 mA/6.0 mA Typ.
- Dual modulus prescaler : 2600 MHz prescaler (32/33 or 64/65) /1200 MHz prescaler (16/17 or 32/33)
- 23-bit shift register
- Serial input binary 14-bit programmable reference divider : $R = 3$ to 16,383
- Serial input programmable divider consisting of :
 - Binary 7-bit swallow counter : 0 to 127
 - Binary 11-bit programmable counter : 3 to 2,047
- Built-in high-speed tuning, low-noise phase comparator, current-switching type constant current circuit
- On-chip phase control for phase comparator
- On-chip phase comparator for fast lock and low noise
- Built-in digital locking detector circuit to detect PLL locking and unlocking
- Operating temperature : $T_a = -40$ to $+85^\circ\text{C}$
- Serial data format compatible with MB15F08SL

PIN ASSIGNMENTS

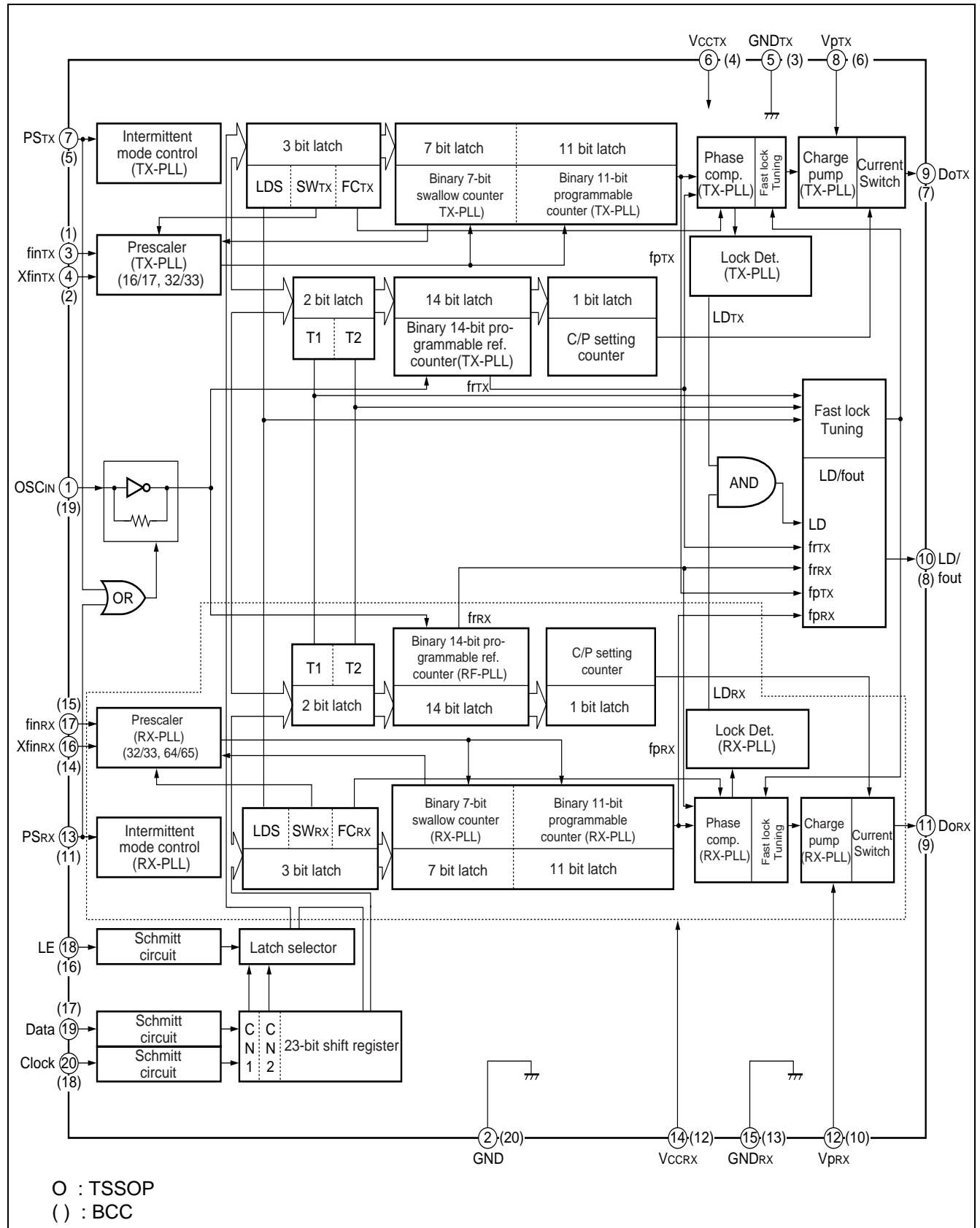


■ PIN DESCRIPTION

Pin no.		Pin name	I/O	Descriptions
TSSOP	BCC			
1	19	OSC _{IN}	I	The programmable reference divider input pin. TCXO should be connected with an AC coupling capacitor.
2	20	GND	—	Ground pin for OSC input buffer and the shift register circuit.
3	1	fin _{TX}	I	Prescaler input pin for the TX-PLL. Connection to an external VCO should be via AC coupling.
4	2	Xfin _{TX}	I	Prescaler complimentary input pin for the TX-PLL section. This pin should be grounded via a capacitor.
5	3	GND _{TX}	—	Ground pin for the TX-PLL section.
6	4	V _{CCTX}	—	Power supply voltage input pin for the TX-PLL section (except for the charge pump circuit) , the oscillator input buffer and the shift register.
7	5	PS _{TX}	I	Power saving mode control pin for the TX-PLL section. This pin must be set at "L" when the power supply is started up. (Open is prohibited.) PS _{TX} = "H" ; Normal mode/PS _{TX} = "L" ; Power saving mode
8	6	V _{pTX}	—	Power supply voltage input pin for the TX-PLL charge pump.
9	7	D _{OTX}	O	Charge pump output pin for the TX-PLL section.
10	8	LD/fout	O	Lock detect signal output (LD) /phase comparator monitoring output (fout) .The output signal is selected by LDS bit in the serial data. LDS bit = "H" ; outputs fout signal/LDS bit = "L" ; outputs LD signal
11	9	D _{ORX}	O	Charge pump output pin for the RX-PLL section.
12	10	V _{pRX}	—	Power supply voltage input pin for the RX-PLL charge pump.
13	11	PS _{RX}	I	Power saving mode control pin for the RX-PLL section. This pin must be set at "L" when the power supply is started up. (Open is prohibited.) PS _{RX} = "H" ; Normal mode/PS _{RX} = "L" ; Power saving mode
14	12	V _{CCR_X}	—	Power supply voltage input pin for the RX-PLL section (except for the charge pump circuit)
15	13	GND _{RX}	—	Ground pin for the RX-PLL section
16	14	Xfin _{RX}	I	Prescaler complimentary input pin for the RX-PLL section. This pin should be grounded via a capacitor.
17	15	fin _{RX}	I	Prescaler input pin for the RX-PLL. Connection to an external VCO should be via AC coupling.
18	16	LE	I	Load enable signal input pin (with the schmitt trigger circuit) When LE is set "H", data in the shift register is transferred to the corresponding latch according to the control bit in a serial data.
19	17	Data	I	Serial data input pin (with the schmitt trigger circuit) Data is transferred to the corresponding latch (TX-ref. counter, TX-prog. counter, RX-ref.counter, RX-prog.counter) according to the control bit in a serial data.
20	18	Clock	I	Clock input pin for the 23-bit shift register (with a schmitt trigger circuit) One bit of data is shifted into the shift register on a rising edge of the clock.

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■ BLOCK DIAGRAM



■ ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Rating		Unit	
		Min.	Max.		
Power supply voltage	V _{CC}	-0.5	4.0	V	
	V _p	V _{CC}	4.0	V	
Input voltage	V _i	-0.5	V _{CC} + 0.5	V	
Output voltage	LD/fout	V _o	GND	V _{CC}	V
	D _{OTX} , D _{ORX}	V _{DD}	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	Remarks
		Min.	Typ.	Max.		
Power supply voltage	V _{CC}	2.4	2.7	3.6	V	V _{CCR_X} = V _{CCT_X}
	V _p	V _{CC}	2.7	3.6	V	
Input voltage	V _i	GND	—	V _{CC}	V	
Operating temperature	T _a	-40	—	+85	°C	

Note : • V_{CCR_X}, V_{pRX}, V_{CCT_X} and V_{pTX} must supply equal voltage.

Even if either RX-PLL or TX-PLL is not used, power must be supplied to V_{CCR_X}, V_{pRX}, V_{CCT_X} and V_{pTX} to keep them equal.

It is recommended that the non-use PLL is controlled by power saving function.

- Although this device contains an anti-static element to prevent electrostatic breakdown and the circuitry has been improved in electrostatic protection, observe the following precautions when handling the device.
 - When storing and transporting the device, put it in a conductive case.
 - Before handling the device, confirm the (jigs and) tools to be used have been uncharged (grounded) as well as yourself. Use a conductive sheet on working bench.
 - Before fitting the device into or removing it from the socket, turn the power supply off.
 - When handling (such as transporting) the device mounted board, protect the leads with a conductive sheet.

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

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

Parameter	Symbol	Condition	Value			Unit	
			Min.	Typ.	Max.		
Power supply current	I_{CCTX}^{*1}	$f_{inTX} = 910\text{ MHz}$ $V_{CCTX} = V_{pTX} = 2.7\text{ V}$	1.1	1.7	2.4	mA	
	$I_{CCR X}^{*1}$	$f_{inRX} = 2500\text{ MHz}$ $V_{CCR X} = V_{pRX} = 2.7\text{ V}$	1.8	2.8	3.9	mA	
Power saving current	I_{PSTX}	$PS_{TX} = PS_{RX} = \text{"L"}$	—	0.1^{*2}	10	μA	
	I_{PSRX}	$PS_{TX} = PS_{RX} = \text{"L"}$	—	0.1^{*2}	10	μA	
Operating frequency	f_{inTX}^{*3}	f_{inTX}	TX PLL	100	—	1200	MHz
	f_{inRX}^{*3}	f_{inRX}	RX PLL	400	—	2600	MHz
	OSC_{IN}	f_{OSC}	—	3	—	40	MHz
Input sensitivity	f_{inTX}	P_{finTX}	TX PLL, $50\ \Omega$ system	-15	—	+2	dBm
	f_{inRX}	P_{finRX}	RX PLL, $50\ \Omega$ system	-15	—	+2	dBm
	OSC_{IN}	V_{OSC}	—	0.5	—	V_{CC}	V_{P-P}
"H" level input voltage	Data, LE, Clock	V_{IH}	Schmitt trigger input	$0.7 V_{CC} + 0.4$	—	—	V
"L" level input voltage		V_{IL}	Schmitt trigger input	—	—	$0.3 V_{CC} - 0.4$	V
"H" level input voltage	PS_{TX}	V_{IH}	—	$0.7 V_{CC}$	—	—	V
"L" level input voltage	PS_{RX}	V_{IL}	—	—	—	$0.3 V_{CC}$	V
"H" level input current	Data LE Clock	I_{IH}^{*4}	—	-1.0	—	+1.0	μA
"L" level input current		PS_{TX} PS_{RX}	I_{IL}^{*4}	—	-1.0	—	+1.0
"H" level input current	OSC_{IN}	I_{IH}	—	0	—	+100	μA
"L" level input current		I_{IL}^{*4}	—	-100	—	0	μA
"H" level output voltage	LD/fout	V_{OH}	$V_{CC} = V_p = 2.7\text{ V}$, $I_{OH} = -1\text{ mA}$	$V_{CC} - 0.4$	—	—	V
"L" level output voltage		V_{OL}	$V_{CC} = V_p = 2.7\text{ V}$, $I_{OL} = 1\text{ mA}$	—	—	0.4	V
"H" level output voltage	DO_{TX} DO_{RX}	V_{DOH}	$V_{CC} = V_p = 2.7\text{ V}$, $I_{DOH} = -0.5\text{ mA}$	$V_p - 0.4$	—	—	V
"L" level output voltage		V_{DOL}	$V_{CC} = V_p = 2.7\text{ V}$, $I_{DOL} = 0.5\text{ mA}$	—	—	0.4	V
High impedance cutoff current	DO_{TX} DO_{RX}	I_{OFF}	$V_{CC} = V_p = 2.7\text{ V}$ $V_{OFF} = 0.5\text{ V to }V_p - 0.5\text{ V}$	—	—	2.5	nA
"H" level output current	LD/fout	I_{OH}^{*4}	$V_{CC} = V_p = 2.7\text{ V}$	—	—	-1.0	mA
"L" level output current		I_{OL}	$V_{CC} = V_p = 2.7\text{ V}$	1.0	—	—	mA

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

Parameter	Symbol	Condition	Value			Unit	
			Min.	Typ.	Max.		
“H” level output current	D_{OTX}^{*8} D_{ORX}	I_{DOH}^{*4} $V_{CC} = V_p = 2.7\text{ V}$, $V_{DOH} = V_p / 2$, $T_a = +25\text{ }^\circ\text{C}$	CS bit = “H”	-8.2	-6.0	-4.1	mA
			CS bit = “L”	-2.2	-1.5	-0.8	mA
“L” level output current	D_{OTX}^{*8} D_{ORX}	I_{DOL} $V_{CC} = V_p = 2.7\text{ V}$, $V_{DOL} = V_p / 2$, $T_a = +25\text{ }^\circ\text{C}$	CS bit = “H”	4.1	6.0	8.2	mA
			CS bit = “L”	0.8	1.5	2.2	mA
Charge pump current rate	I_{DOL}/I_{DOH}	I_{DOMT}^{*5}	$V_{DO} = V_p / 2$	—	3	—	%
	vs V_{DO}	I_{DOVD}^{*6}	$0.5\text{ V} \leq V_{DO} \leq V_p - 0.5\text{ V}$	—	10	—	%
	vs T_a	I_{DOTA}^{*7}	$-40\text{ }^\circ\text{C} \leq T_a \leq +85\text{ }^\circ\text{C}$, $V_{DO} = V_p / 2$	—	5	—	%

*1 : Conditions ; $f_{osc} = 12.8\text{ MHz}$, $T_a = +25\text{ }^\circ\text{C}$, $SW = \text{“L”}$ in locking state.

*2 : $V_{CCTX} = V_{pTX} = V_{CCRX} = V_{pRX} = 2.7\text{ V}$, $f_{osc} = 12.8\text{ MHz}$, $T_a = +25\text{ }^\circ\text{C}$, in power saving mode.

$PS_{TX} = PS_{RX} = GND$

$V_{IH} = V_{CC}$, $V_{IL} = GND$ (at CLK, Data, LE)

*3 : AC coupling. 1000 pF capacitor is connected under the condition of Min. operating frequency.

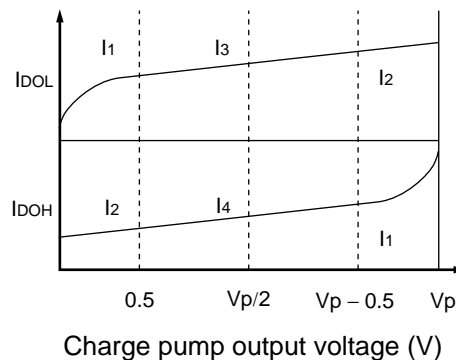
*4 : The symbol “-” (minus) means the direction of current flow.

*5 : $V_{CC} = V_p = 2.7\text{ V}$, $T_a = +25\text{ }^\circ\text{C}$ $(|I_3| - |I_4|) / [(|I_3| + |I_4|) / 2] \times 100\text{ }(\%)$

*6 : $V_{CC} = V_p = 2.7\text{ V}$, $T_a = +25\text{ }^\circ\text{C}$ $[(|I_2| - |I_1|) / 2] / [(|I_1| + |I_2|) / 2] \times 100\text{ }(\%)$ (Applied to both I_{DOL} and I_{DOH})

*7 : $V_{CC} = V_p = 2.7\text{ V}$, $[(|I_{DO(+85\text{ }^\circ\text{C})}| - |I_{DO(-40\text{ }^\circ\text{C})}|) / 2] / [(|I_{DO(+85\text{ }^\circ\text{C})}| + |I_{DO(-40\text{ }^\circ\text{C})}|) / 2] \times 100\text{ }(\%)$ (Applied to both I_{DOL} and I_{DOH})

*8 : When Charge pump current is measured, set $LDS = \text{“L”}$, $T1 = \text{“L”}$ and $T2 = \text{“H”}$.



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FUNCTIONAL DESCRIPTION

1. Pulse swallow function

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

- f_{VCO} : Output frequency of external voltage controlled oscillator (VCO)
- P : Preset divide ratio of dual modulus prescaler (16 or 32 for TX-PLL, 32 or 64 for RX-PLL)
- N : Preset divide ratio of binary 11-bit programmable counter (3 to 2,047)
- A : Preset divide ratio of binary 7-bit swallow counter ($0 \leq A \leq 127$, $A < N$)
- f_{osc} : Reference oscillation frequency (OSC_{IN} input frequency)
- R : Preset divide ratio of binary 14-bit programmable reference counter (3 to 16,383)

2. Serial Data Input

The serial data is entered using three pins, Data pin, Clock pin, and LE pin. Programmable dividers of TX/RX-PLL sections, programmable reference dividers of TX/RX-PLL sections are controlled individually.

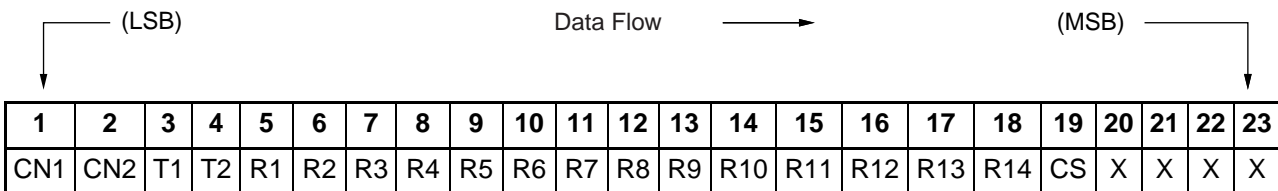
The serial data of binary data is entered through Data pin.

On rising edge of Clock, one bit of the serial data is transferred into the shift register. On a rising edge of load enable signal, the data stored in the shift register is transferred to one of latches depending upon the control bit data setting.

	The programmable reference counter for the TX-PLL	The programmable reference counter for the RX-PL	The programmable counter and the swallow counter for the TX-PLL	The programmable counter and the swallow counter for the RX-PLL
CN1	0	1	0	1
CN2	0	0	1	1

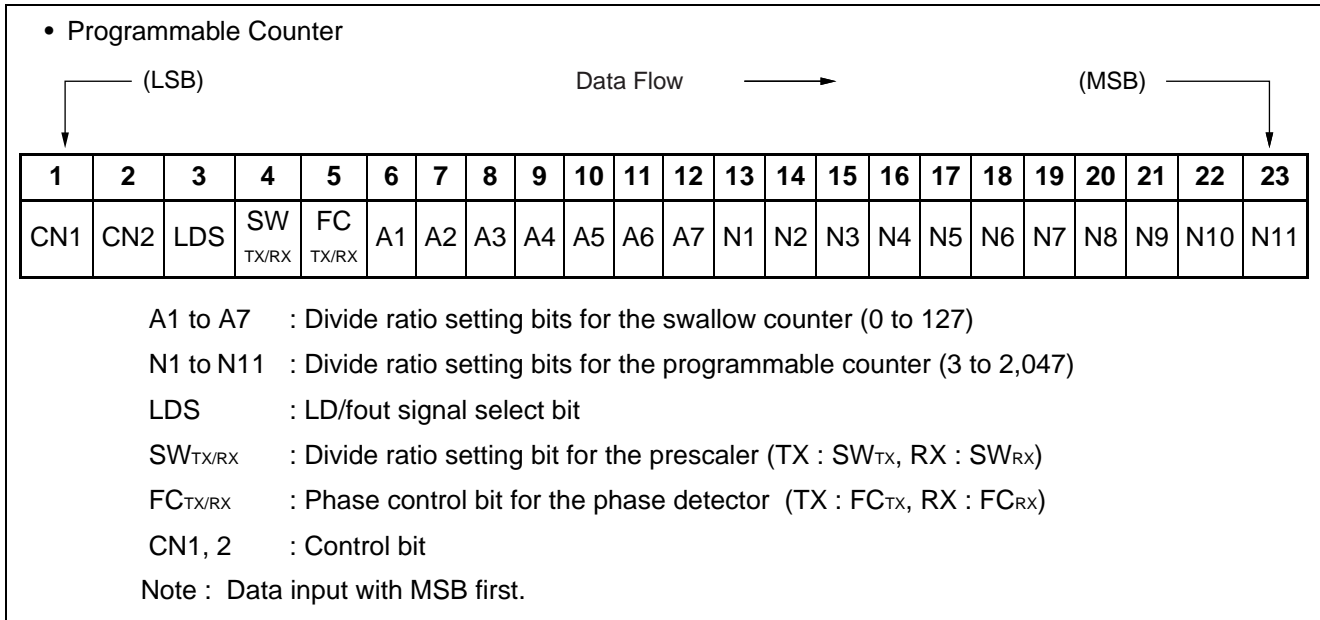
(1) Shift Register Configuration

- Programmable Reference Counter



- CS : Charge pump current select bit
- R1 to R14 : Divide ratio setting bits for the programmable reference counter (3 to 16,383)
- T1, 2 : LD/fout output setting bit
- CN1, 2 : Control bit
- X : Dummy bits (Set "0" or "1")

Note : Data input with MSB first.



(2) Data setting

• Binary 14-bit Programmable Reference Counter Data Setting

Divide ratio	R14	R13	R12	R11	R10	R9	R8	R7	R6	R5	R4	R3	R2	R1
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.

• Binary 11-bit Programmable Counter Data Setting

Divide ratio	N11	N10	N9	N8	N7	N6	N5	N4	N3	N2	N1
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.

• Binary 7-bit Swallow Counter Data Setting

Divide ratio	A7	A6	A5	A4	A3	A2	A1
0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	1
•	•	•	•	•	•	•	•
•	•	•	•	•	•	•	•
•	•	•	•	•	•	•	•
127	1	1	1	1	1	1	1

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- Prescaler Data Setting

Divide ratio	SW = "H"	SW = "L"
Prescaler divide ratio TX-PLL	16/17	32/33
Prescaler divide ratio RX-PLL	32/33	64/65

- Charge Pump Current Setting

Current value	CS
±6.0 mA	1
±1.5 mA	0

- LD/fout output Selectable Bit Setting

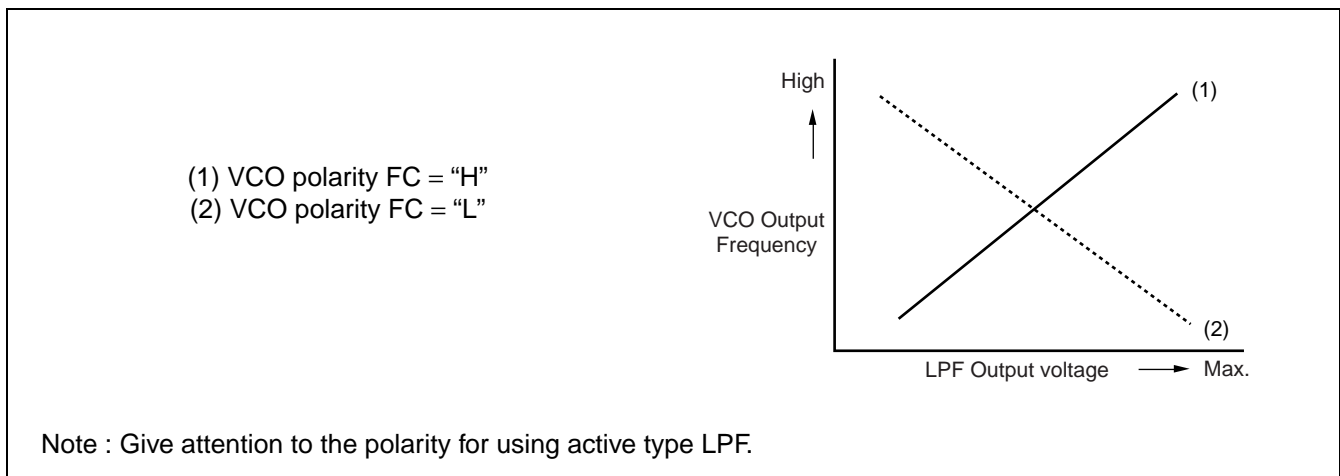
LD/fout pin state		LDS	T1	T2
LD output		0	0	0
		0	1	0
		0	1	1
fout output	frTX	1	0	0
	frRX	1	1	0
	fpTX	1	0	1
	fpRX	1	1	1

- Phase Comparator Phase Switching Data Setting

Phase comparator input	FC = "H"	FC = "L"
	DoTX/DoRX	DoTX/DoRX
fr > fp	H	L
fr < fp	L	H
fr = fp	Z	Z

Z : High-impedance

Depending upon the VCO and LPF polarity, FC bit should be set.



3. Power Saving Mode (Intermittent Mode Control Circuit)

Status	PS _{TX} /PS _{RX} pins
Normal mode	H
Power saving mode	L

The intermittent mode control circuit reduces the PLL power consumption.

By setting the PS pins low, the device enters into the power saving mode, reducing the current consumption. See the Electrical Characteristics chart for the specific value.

The phase detector output, Do, becomes high impedance.

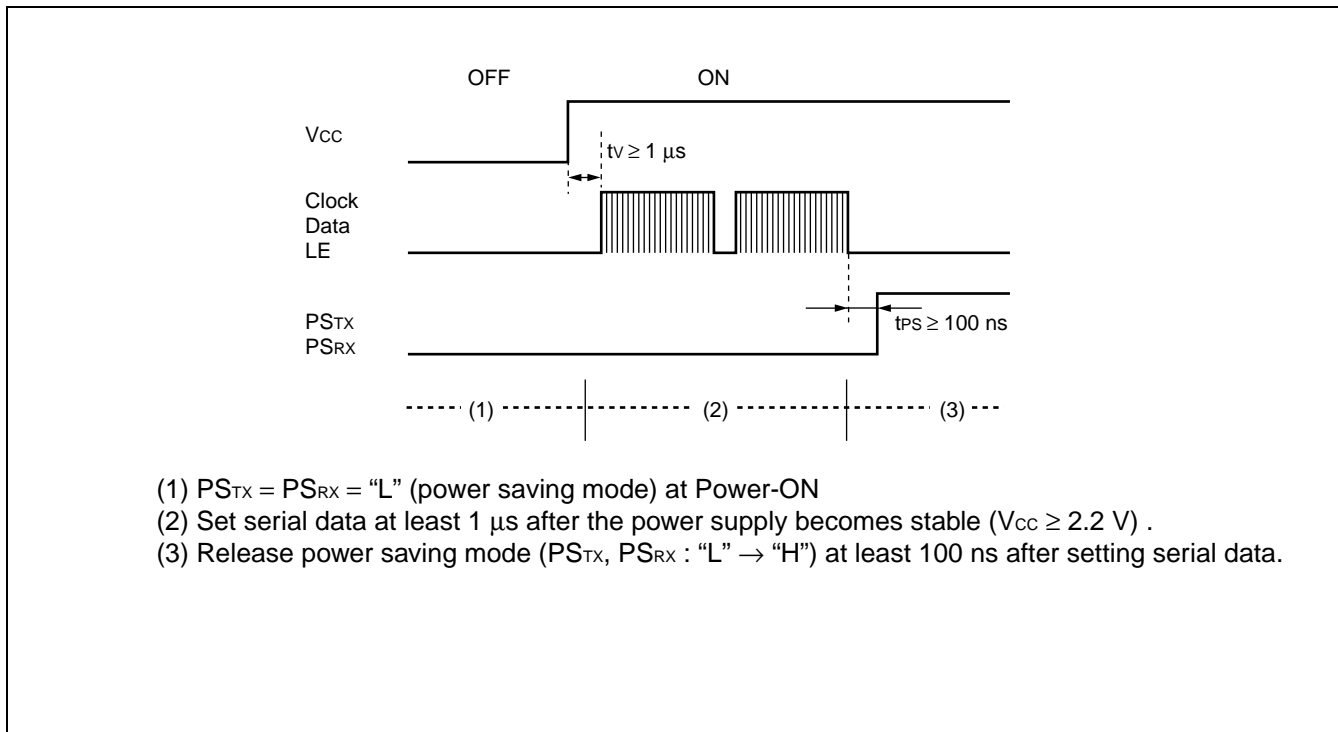
For the dual PLL, the lock detector, LD, is as shown in the LD Output Logic table.

Setting the PS pins high, releases the power saving mode, and the device works normally.

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

To prevent a major VCO frequency jump, the intermittent mode control circuit limits the magnitude of the error signal from the phase detector when it returns to normal operation.

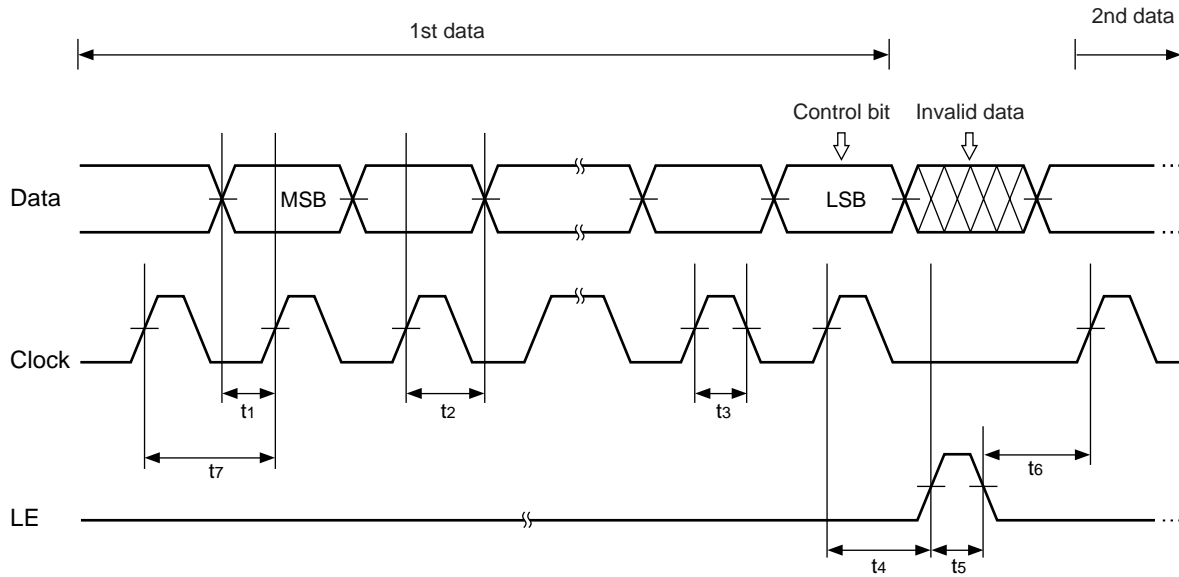
- Notes :
- When power (V_{CC}) is first applied, the device must be in standby mode, PS_{TX} = PS_{RX} = Low, for at least 1 μ s.
 - PS pins must be set at "L" at Power-ON



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4. Serial data input timing

Divide ratio setting is performed through a serial interface using the Data pin, Clock pin, and LE pin. Setting data is read into the shift register at the rise of the Clock signal, and transferred to a latch at the rise of the LE signal. The following diagram shows the data input timing.

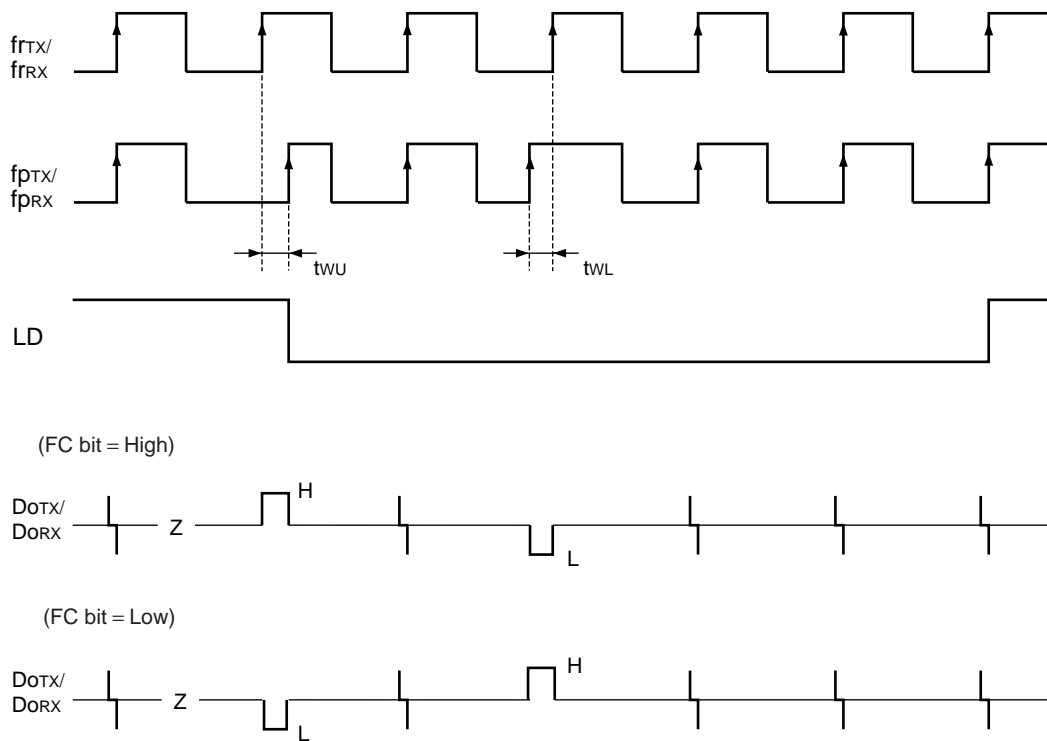


Parameter	Min.	Typ.	Max.	Unit
t ₁	20	—	—	ns
t ₂	20	—	—	ns
t ₃	30	—	—	ns
t ₄	30	—	—	ns

Parameter	Min.	Typ.	Max.	Unit
t ₅	100	—	—	ns
t ₆	20	—	—	ns
t ₇	100	—	—	ns

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

■ PHASE COMPARATOR OUTPUT WAVEFORM



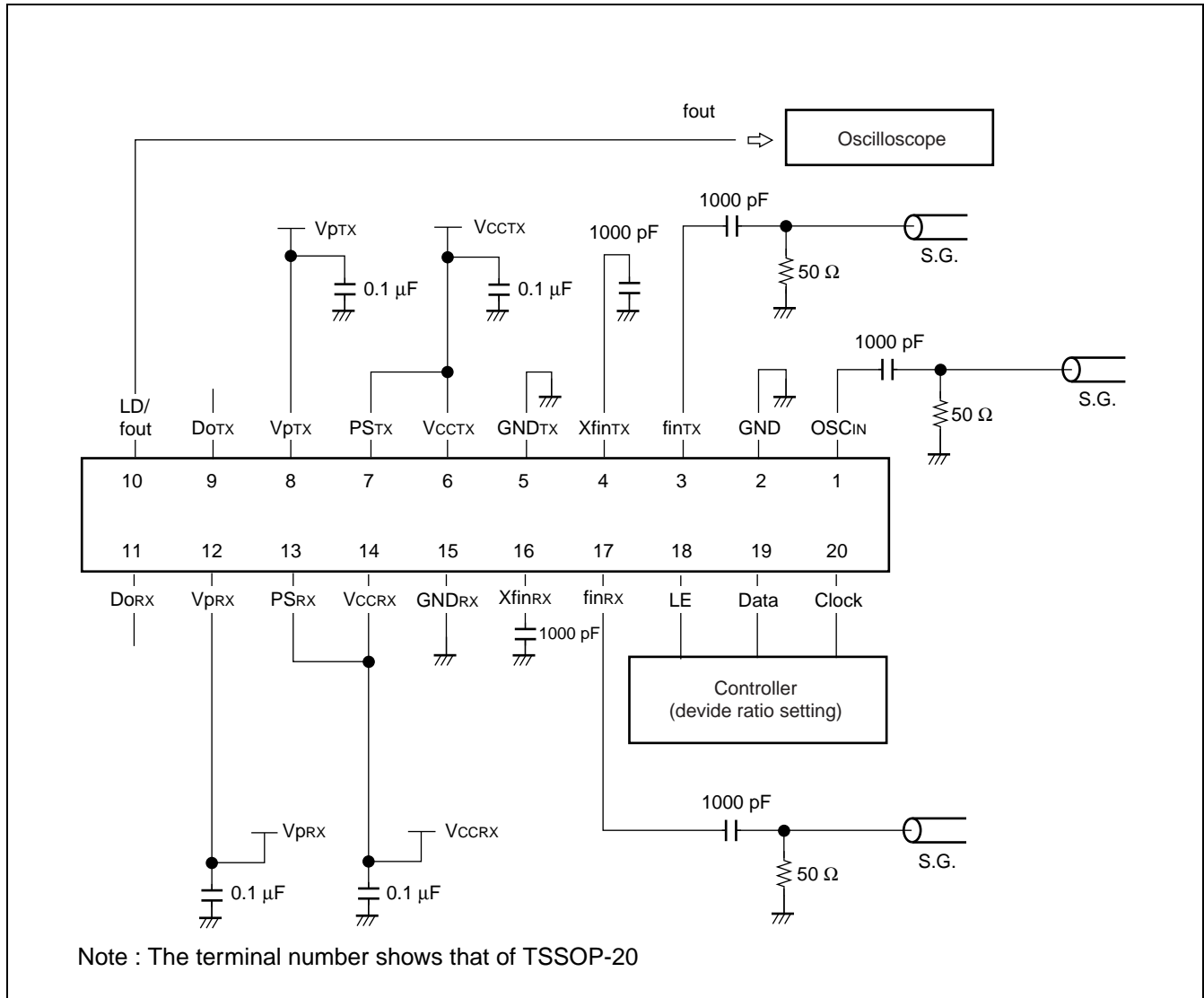
LD Output Logic Table

TX-PLL section	RX-PLL section	LD output
Locking state/Power saving state	Locking state/Power saving state	H
Locking state/Power saving state	Unlocking state	L
Unlocking state	Locking state/Power saving state	L
Unlocking state	Unlocking state	L

- Notes :
- Phase error detection range = -2π to $+2\pi$
 - Pulses on DoTX/DoRX signals are output to prevent dead zone.
 - LD output becomes low when phase error 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.
 - t_{wU} and t_{wL} depend on OSC_{IN} input frequency as follows.
 - $t_{wU} \geq 2/f_{osc}$: e.g. $t_{wU} \geq 156.3$ ns when $f_{osc} = 12.8$ MHz
 - $t_{wL} \leq 4/f_{osc}$: e.g. $t_{wL} \leq 312.5$ ns when $f_{osc} = 12.8$ MHz

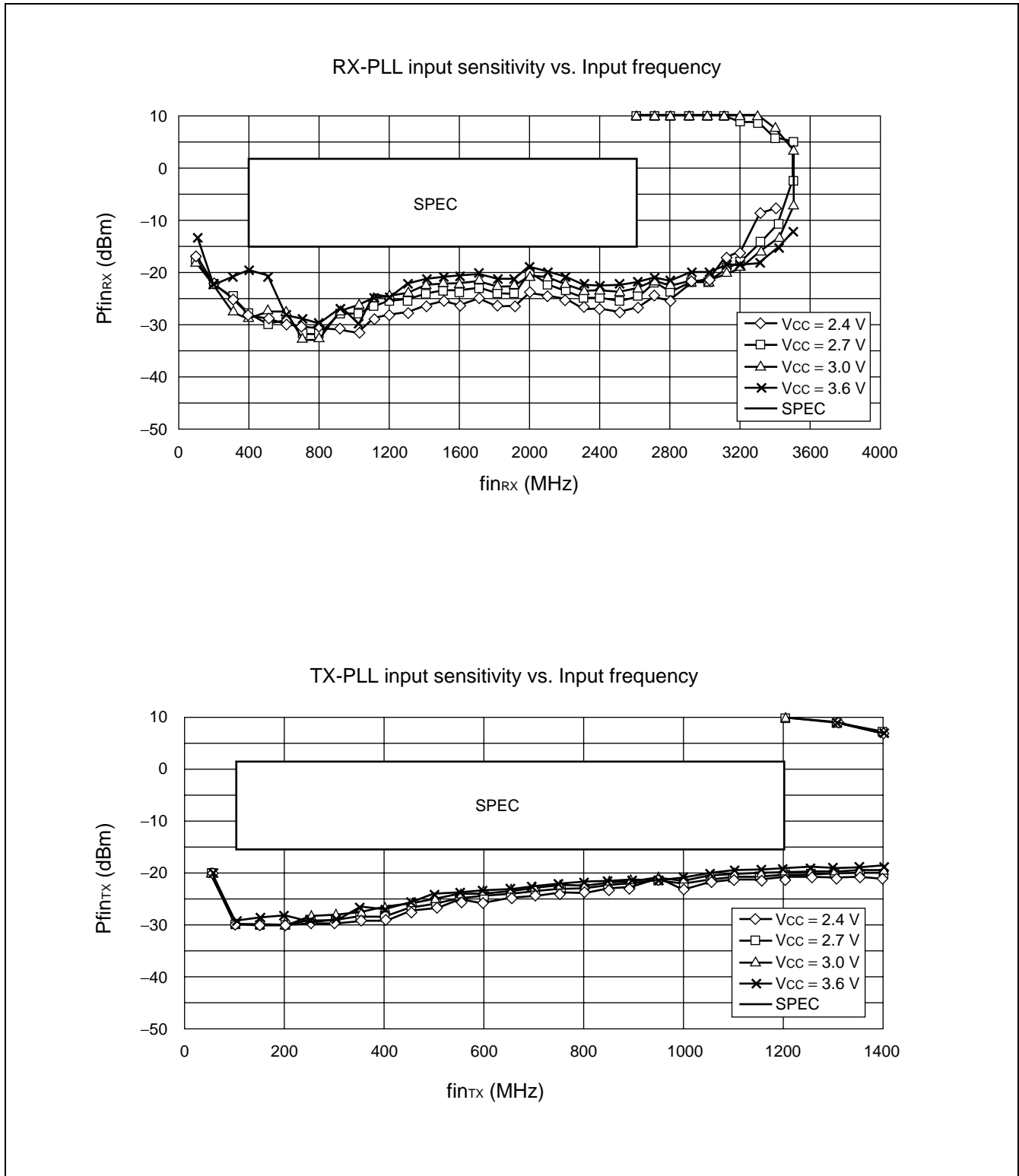
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■ TEST CIRCUIT (for Measuring Input Sensitivity f_{in}/OSC_{IN})



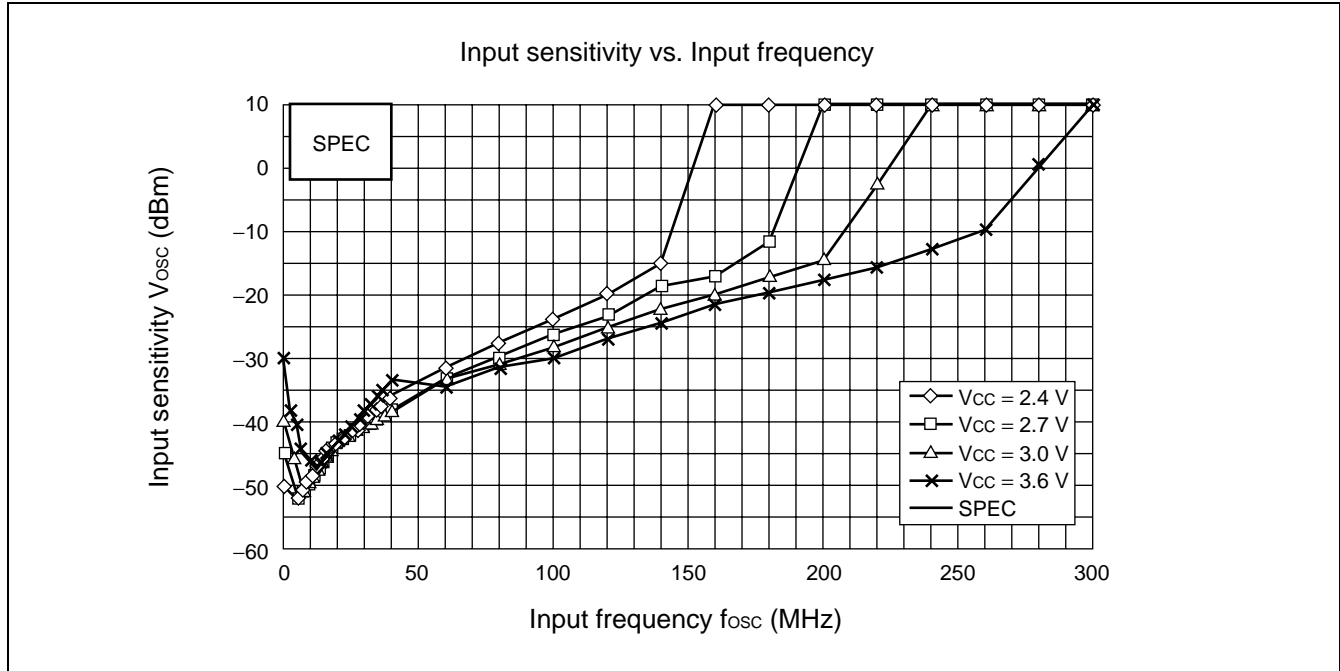
TYPICAL CHARACTERISTICS

1. fin input sensitivity



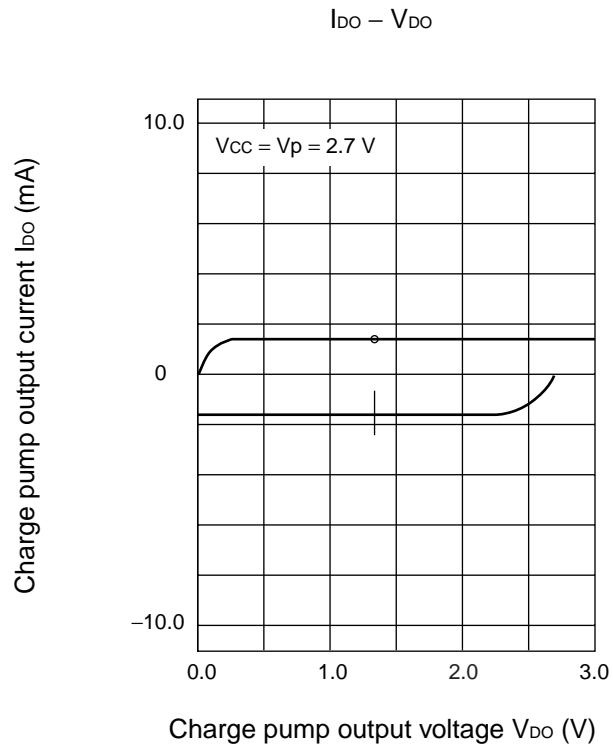
MB15F78UL

2. OSC_{IN} input sensitivity

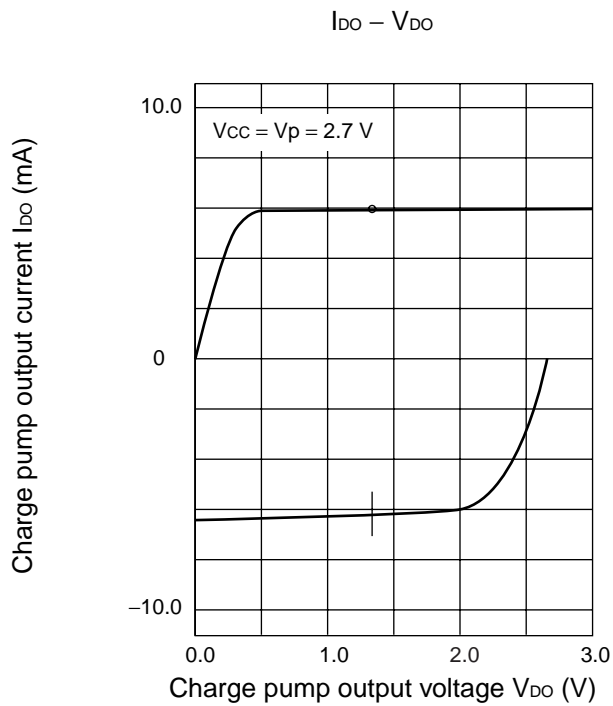


3. Do output current (RX PLL)

- 1.5 mA mode

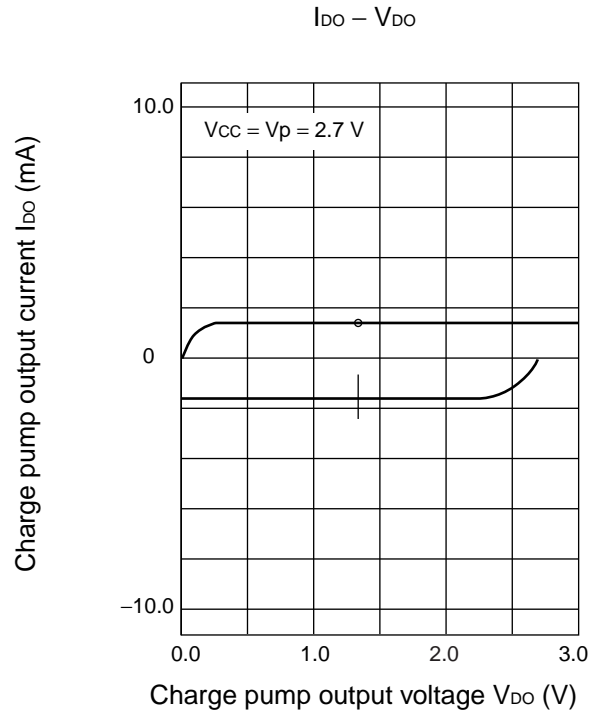


- 6.0 mA mode

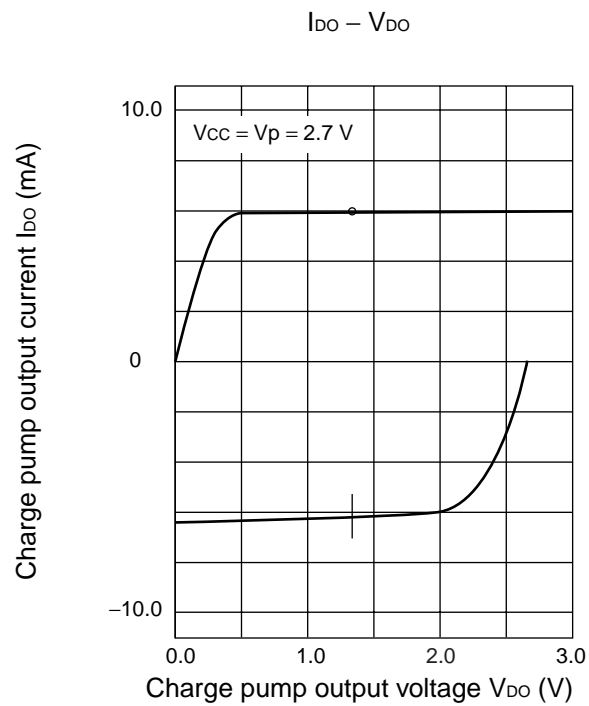


4. Do output current (TX PLL)

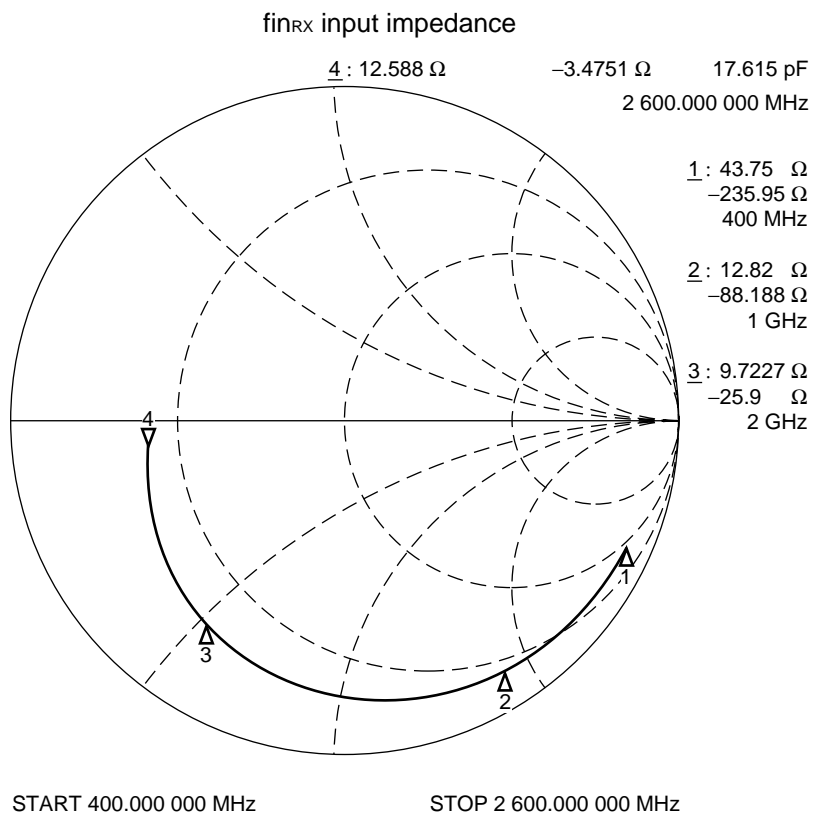
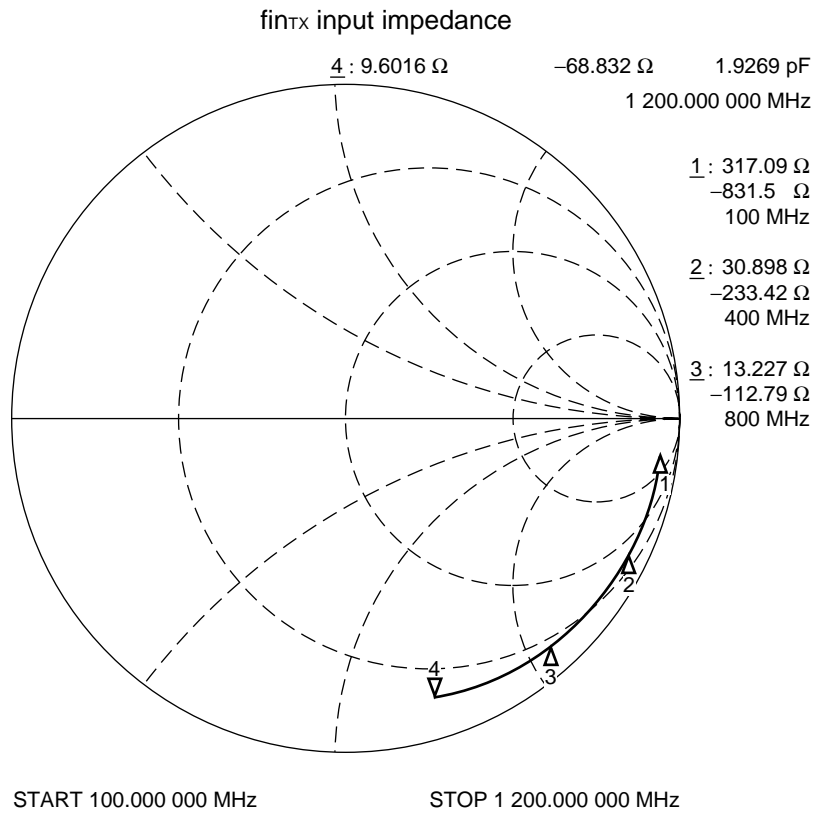
- 1.5 mA mode



- 6.0 mA mode

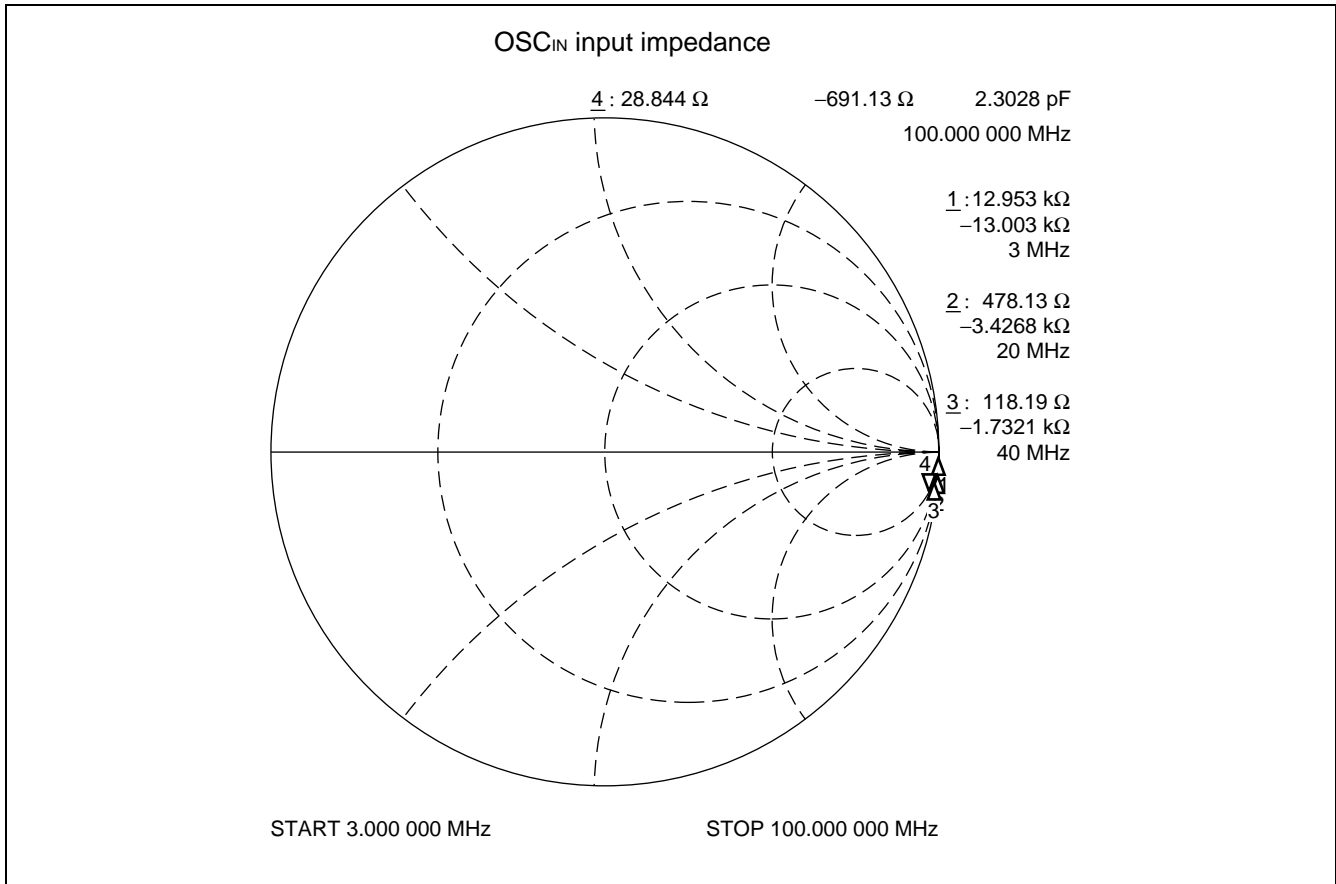


5. fin input impedance



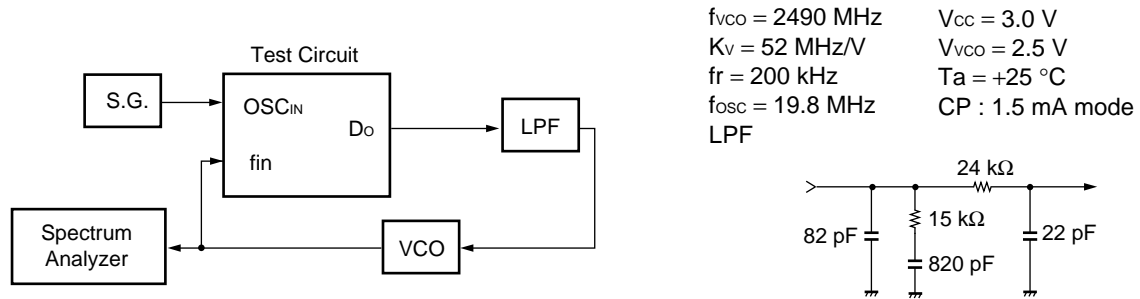
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6. OSC_{IN} input impedance



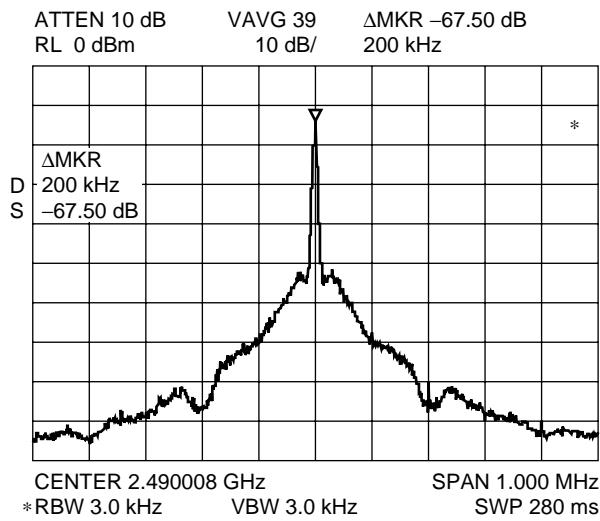
REFERENCE INFORMATION

(for Look-up time, Phase noise and Reference leakage)

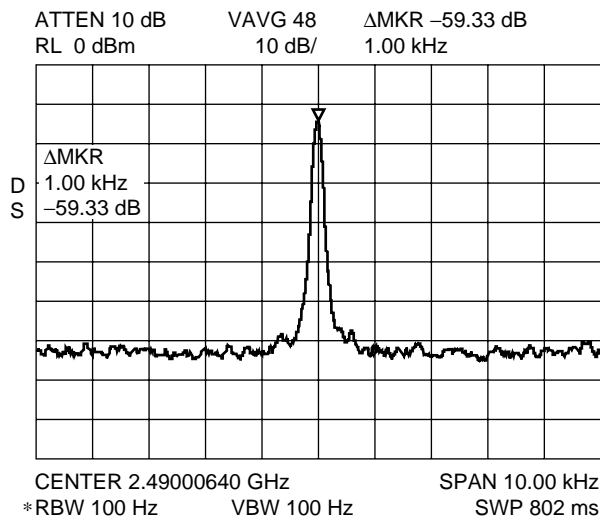


$f_{VCO} = 2490 \text{ MHz}$
 $K_V = 52 \text{ MHz/V}$
 $f_r = 200 \text{ kHz}$
 $f_{osc} = 19.8 \text{ MHz}$
 LPF
 $V_{CC} = 3.0 \text{ V}$
 $V_{VCO} = 2.5 \text{ V}$
 $T_a = +25 \text{ }^\circ\text{C}$
 CP : 1.5 mA mode

• PLL Reference Leakage



• PLL Phase Noise



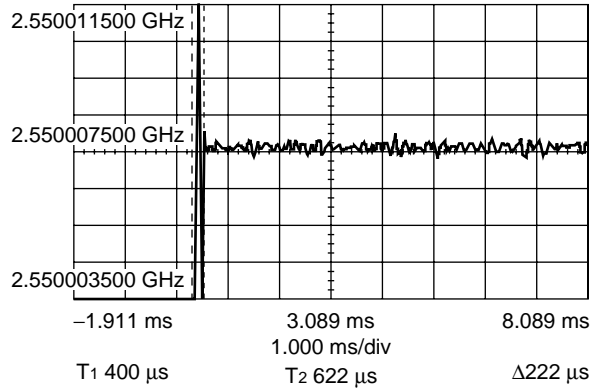
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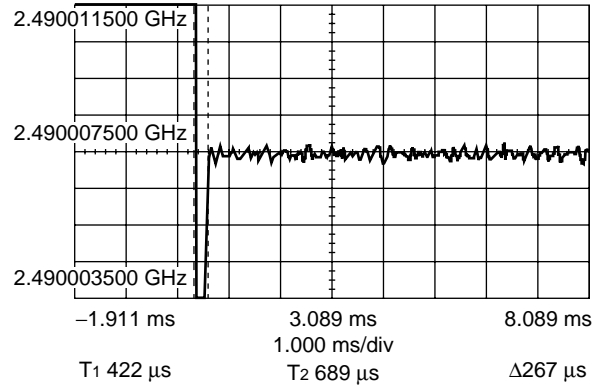
• PLL Lock-up time

2.49 GHz → 2.55 GHz within ± 1 kHz
Lch → Hch 222 μ s

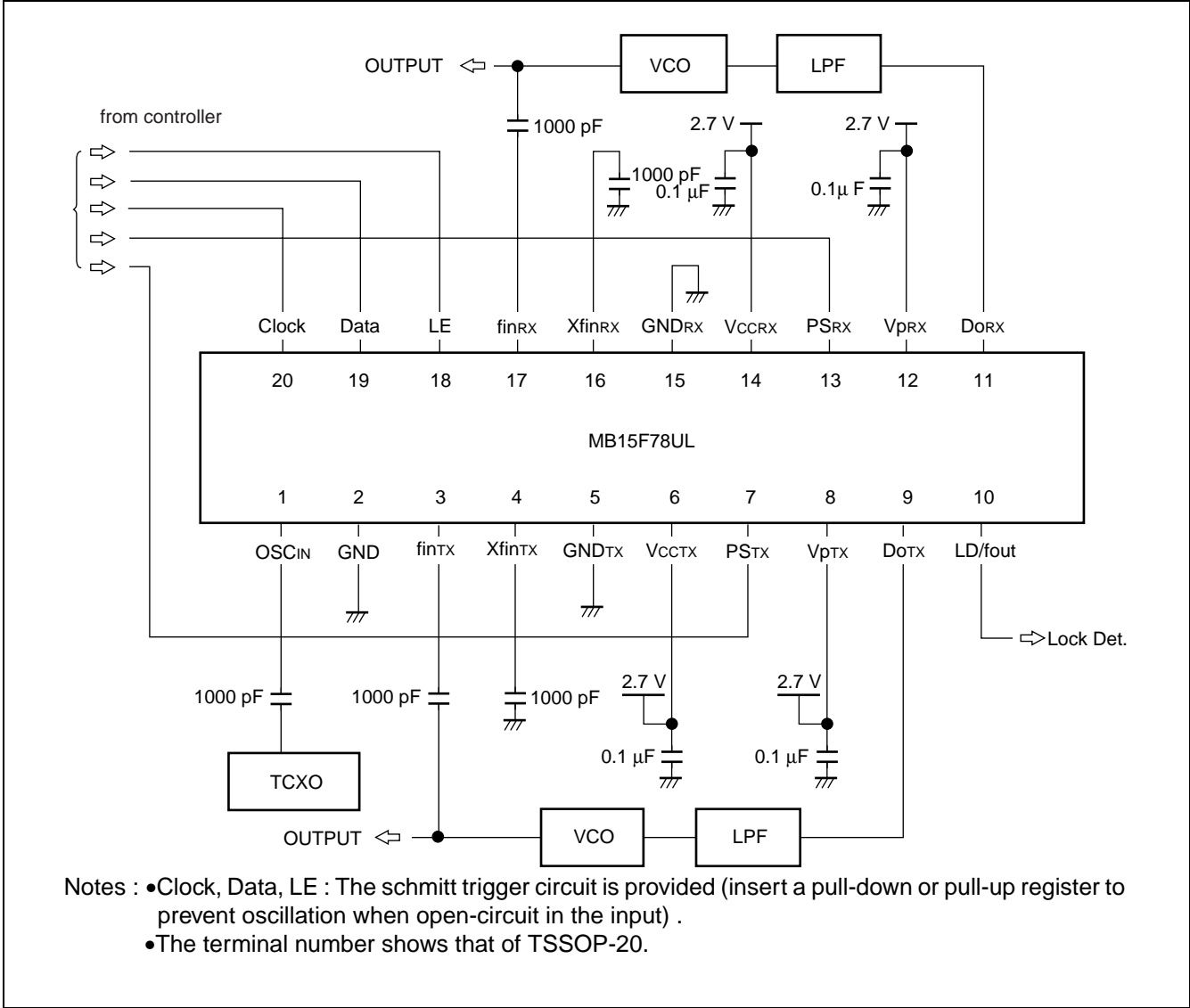


• PLL Lock-up time

2.55 GHz → 2.49 GHz within ± 1 kHz
Hch → Lch 267 μ s



APPLICATION EXAMPLE



MB15F78UL

■ USAGE PRECAUTIONS

- (1) $V_{CCR\text{X}}$, $V_{p\text{R}\text{X}}$, $V_{c\text{C}\text{T}\text{X}}$ and $V_{p\text{T}\text{X}}$ must be equal voltage.
Even if either RX-PLL or TX-PLL is not used, power must be supplied to $V_{CCR\text{X}}$, $V_{p\text{R}\text{X}}$, $V_{c\text{C}\text{T}\text{X}}$ and $V_{p\text{T}\text{X}}$ to keep them equal. It is recommended that the non-use PLL is controlled by power saving function.
- (2) 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.

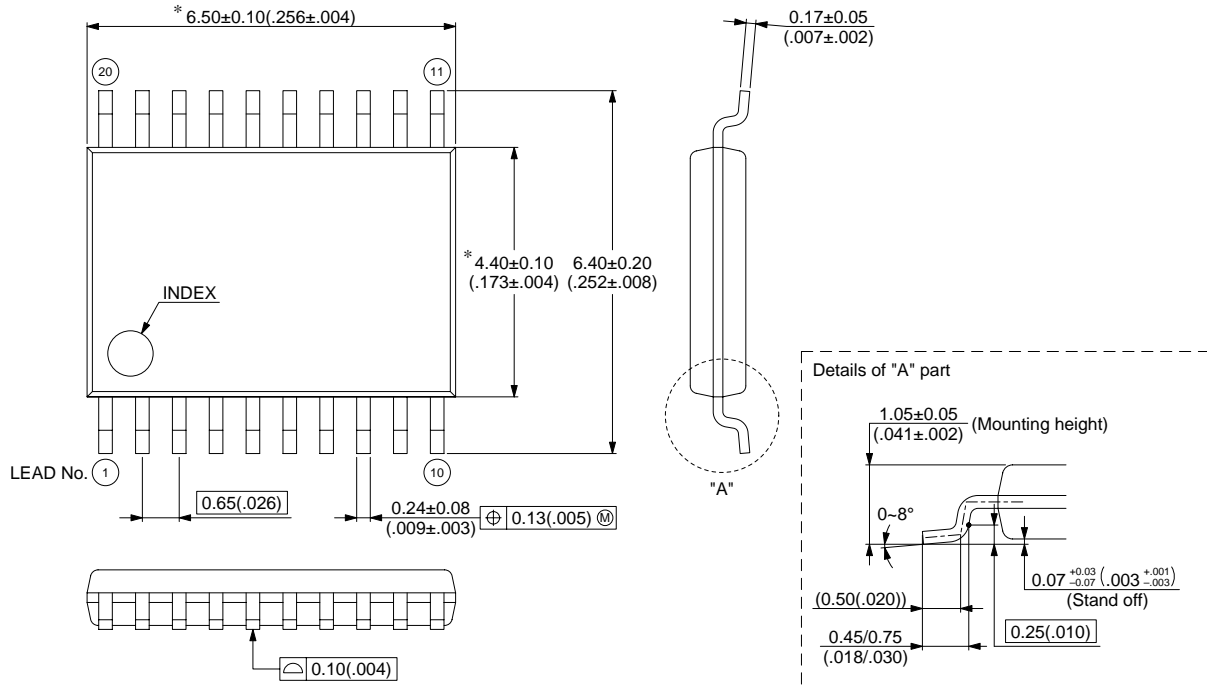
■ ORDERING INFORMATION

Part number	Package	Remarks
MB15F78ULPFT	20-pin, plastic TSSOP (FPT-20P-M06)	
MB15F78ULPVA	20-pad, plastic BCC (LCC-20P-M05)	

■ PACKAGE DIMENSIONS

20-pin plastic TSSOP
(FPT-20P-M06)

Note 1) * : These dimensions do not include resin protrusion.
Note 2) Pins width and pins thickness include plating thickness.



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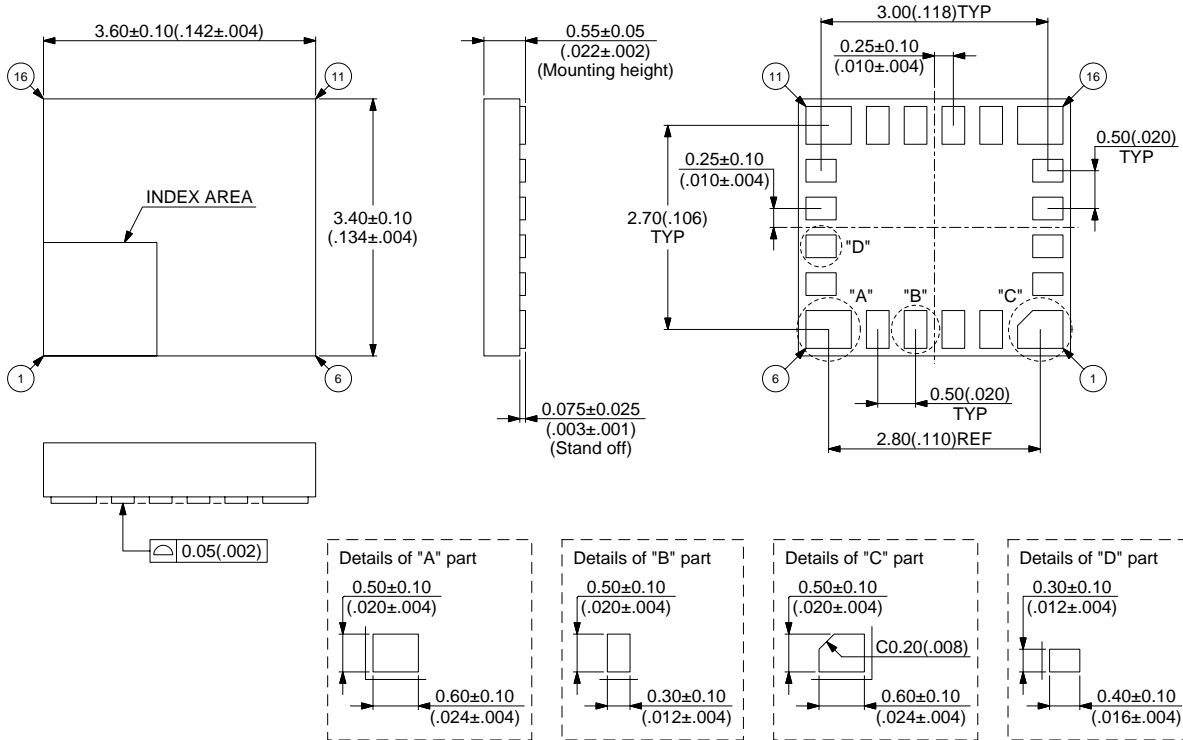
Dimensions in mm (inches)

(Continued)

MB15F78UL

(Continued)

20-pad plastic BCC
(LCC-20P-M05)



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Dimensions in mm (inches)

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