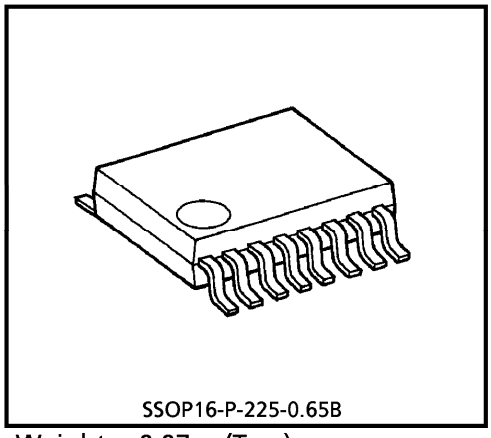
TOSHIBA Bi-CMOS INTEGRATED CIRCUIT SILICON MONOLITHIC

TB31206FN, TB31206AFN

PLL FREQUENCY SYNTHESIZER

FEATURES

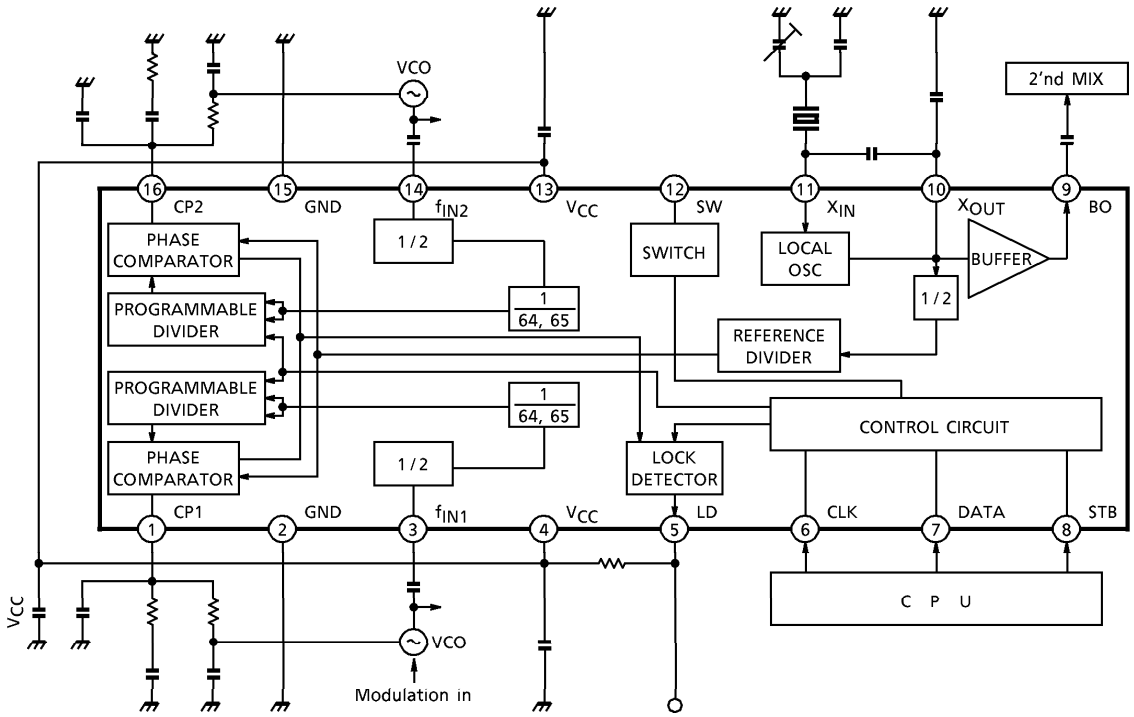
- One packaging CH1 / CH2 two systems prescaler and PLL.
- Low operating power supply voltage
  : V_{CC} = 2.7~5.5 V
- Low current consumption FN : I_{CC} = 16.5 mA (Typ.)
  AFN : I_{CC} = 14.5 mA (Typ.)
- Input frequency : f_{IN} = 520~1100 MHz
- High input sensitivity : V_{IN} = 92~107 dBμV
- Charge pump is constant current type, and is able to change output current by serial data
- Reference oscillation circuit is adopted circuit of bipolar, so getting the stable X'tal oscillation circuit
- Available standby control in CH1 and CH2 independent of each other
- The very small package : SSOP16pin (0.65 mm pitch)



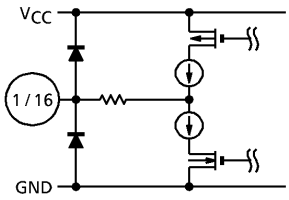
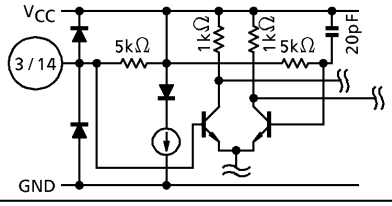
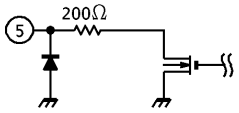
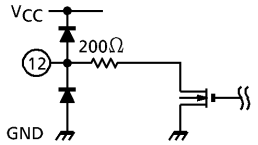
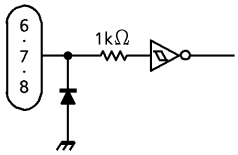
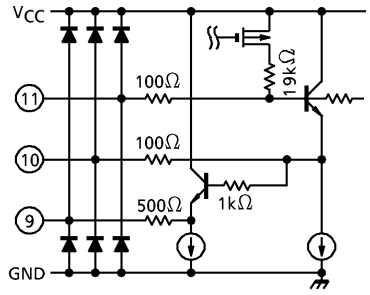
SSOP16-P-225-0.65B

Weight : 0.07 g (Typ.)

BLOCK DIAGRAM



PIN FUNCTION (The values of resistor and capacitor are typical.)

PIN No.	PIN NAME	FUNCTION		INTERNAL EQUIVALENT CIRCUIT
1	CP1	Output terminal of charge pump. Charge pump is constant current output circuit, and output current is varied by input serial data.		
16	CP2			
2	GND	GND Terminal.		—
15	GND			
3	f_{IN1}	Input terminal of RF oscillation signal.		
14	f_{IN2}			
4	V_{CC}	Power Supply Terminal.		—
13	V_{CC}			
5	LD	Output terminal of lock detector. It is the open drain output.		
12	SW	Switchover terminal for constant of loop filter. It is the open drain output. When don't switch constant of loop filter, available general output.		
6	CLK	Input terminal of clock.	Input the serial data for controlling IC.	
7	DATA	Input terminal of serial data.		
8	STB	Input terminal of strobe signal.		
9	BO	Output terminal of buffer amplifier. The signal of local oscillation is output through the buffer amplifier.		
10	X_{OUT}	Output terminal of local oscillation signal.		
11	X_{IN}	Input terminal of local oscillation signal. In case of external input, connecting it to this terminal.		

DESCRIPTION OF FUNCTION AND OPERATION

1. Entry of serial data

- Serial data used to control the IC is input through three terminals, CLK, DATA and STB.

  ① During the rise of a clock pulse, data is fed to the shift register in the IC in order from the LSB.

  ② Upon the reception of all data, the strobe signal (STB) is made "H".

  ③ After the situation of ②, the data stored in the shift register is transferred to the latch in the block selected by the group code, whereby the IC is controlled.

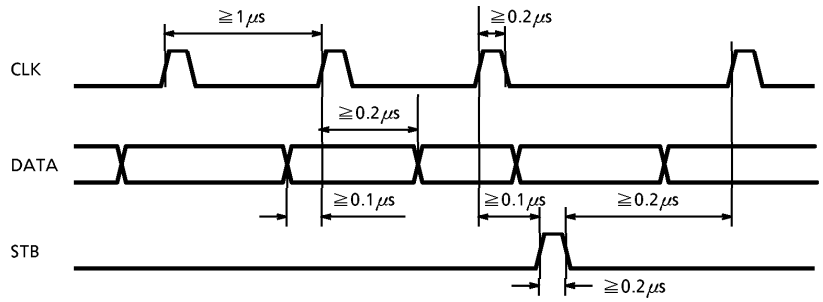
- The three terminals, CLK, DATA and STB, contains Schmitt trigger circuits to prevent the data errors by noise, etc.

○ Serial data group and group code

- The IC has control divided into four groups so that they may be controlled independent of one another. Each group is identified by a two-bit group code attached at the data end.

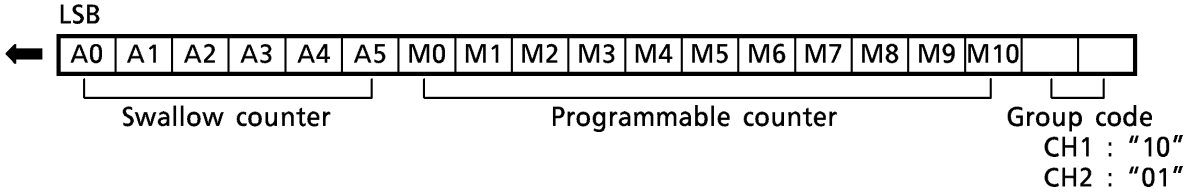
CODE	ITEM
10	Number of divisions by CH1 programmable divider (f_{IN1})
01	Number of divisions by CH2 programmable divider (f_{IN2})
11	Number of divisions by reference divider (X_{IN})
00	Optional control

○ Serial data input timing



2. CHANNEL dividers (CH1, CH2)

- These programmable dividers are composed of a half fixed divider, a 6bit swallow counter (6bit programmable divider), a 11bit programmable counter, and a two-modulars prescaler providing 64 and 65 divisions.
- The strategy of a swallow counter is used to set high reference frequency.
- Sending certain data to the swallow counter and the programmable counter allows the setting of any of 8064 to 262142 divisions (multiple of two).
- The programmable counter and swallow counter are set by each channel. Each channel is specified by a group code.

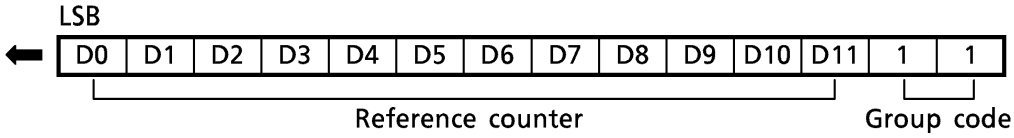


$$A = A0 + A1 \times 2^1 + \cdots + A5 \times 2^5$$
$$M = M0 + M1 \times 2^1 + \cdots\cdots + M10 \times 2^{10}$$
Number of divisions = 2 (64N + A)
$8064 \leqq$ Number of divisions $\leqq 262142$

(EX) A Signal of 900MHz is entered into f_{IN1}, being divided into 25.0kHz step.
(Reference frequency is 12.5kHz)
$900 \times 10^6 \div (25.0 \times 10^3 \div 2) = 72000$
$72000 = 2\ (64N + A)$
$\therefore\ N = 562,\ A = 32$

3. Reference divider

- This block generates the reference frequency for the PLL.
- This reference divider is composed of a 12bit reference counter and a half fixed divider.
- Sending certain data to the reference divider allows the setting of any of 6 to 8190 divisions (multiple of two).



$$D = D0 + D1 \times 2^1 + \cdots\cdots D10 \times 2^{10} + D11 \times 2^{11}$$
Number of divisions = 2D
$6 \leqq$ Number of divisions $\leqq 8190$

(EX) With a 12.8MHz X'tal oscillator connected, being divided into 25.0kHz step.
(Reference frequency is 12.5kHz)
$12.8 \times 10^6 \div (25.0 \times 10^3 \div 2) = 1024$
$2D = 1024$
$\therefore\ D = 512$

4. Optional control

- The optional control below is available.

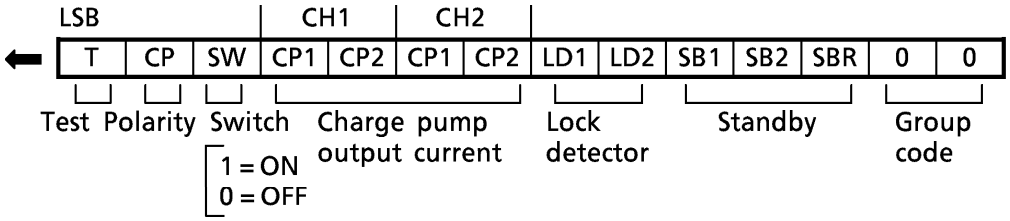
  ① Test mode (Usually set up T = "0").

  ② Control and polarity control of the charge pump output current for each channel.

  ③ Output terminal for lock detector.

  ④ Standby control of CH1, CH2 and reference divider.

  ⑤ Control of filter switch.



T : Bit for test mode
CP : Switchover bit for charge pump output polarity
SW : Control bit for filter switch
CP1, 2 : Switchover bit for charge pump output current
LD1, 2 : Control bit for lock detector output
SB1, 2 : Standby control bit for CH1, CH2
SRB : Standby control bit for reference divider

- Description of options including their control

  ① Test mode (T)

  Bit "T" is for test mode. In other than the test mode, set this bit at "0".

  ② Control of charge pump output current (CP1, CP2)

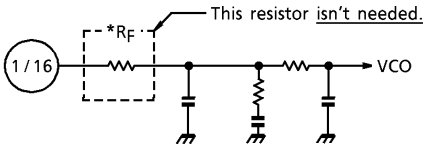
  This IC uses a constant current output type charge pump circuit. Output current is varied by serial data "CP1" and "CP2".

CHARGE PUMP OUTPUT CURRENT

CONTROL BIT		CHARGE PUMP OUTPUT CURRENT
CP1	CP2	
0	0	±100μA
0	1	±200μA
1	0	±400μA
1	1	±800μA

High speed lock up is possible by switching charge pump output current.

(Note)



Charge pump output polarity (CP)

Bit "CP" can be reversed charge pump output polarity.

CHARGE PUMP OUTPUT POLARITY

CP	OUTPUT POLARITY
0	Normal
1	Reverse

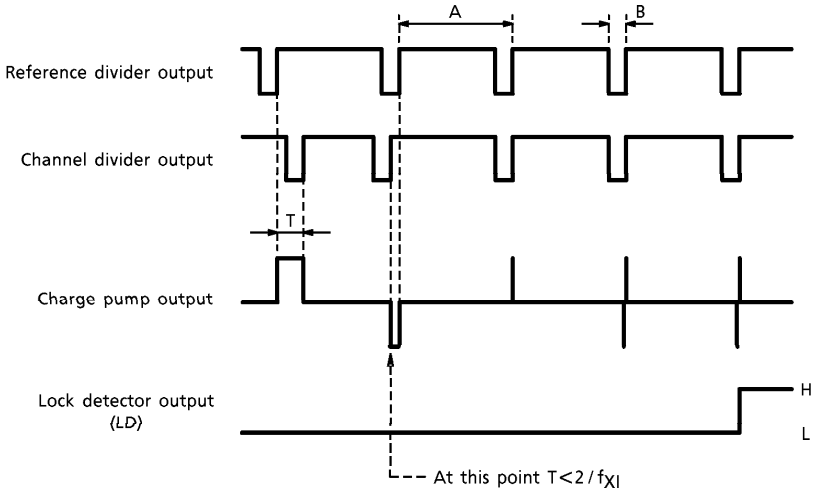
③ Lock detector output

When phase comparator detects phase difference, LD terminal (pin 5) outputs "L". When phase comparator locks, LD terminal outputs "H". On standby, outputs "H".
LD terminal output is controlled by "SB1", "SB2", "LD1" and "LD2".

CONTROL BIT				5PIN OUTPUT
SB1	SB2	LD1	LD2	
0	0	0	0	L
		0	1	CH2 only detect
		1	0	CH1 only detect
		1	1	CH1 * CH2
0	1	0	0	L
		0	1	H
		1	0	CH1 only detect
		1	1	CH1 only detect
1	0	0	0	L
		0	1	CH2 only detect
		1	0	H
		1	1	CH2 only detect
1	1	0	0	L
		0	1	H
		1	0	H
		1	1	H

→ Logical multiplication (AND) of CH1, CH2

About SB1, SB2 bit
- 0 : Normal operation
- 1 : Standby



f_{XI} .. X_{IN} operating frequency (X'tal OSC)

T .... The time difference of the pulse between reference divider output and channel divider output. (Phase difference)

f_{PC} .. Phase comparison frequency

$$A = \frac{\text{Number of divisions by reference divider}}{f_{XI}} \text{ (s)} = \frac{1}{f_{PC}} \text{ (s)}$$

$$B = 2 / f_{XI} \text{ (s)}$$

When the situation that T is less than B (T<B) continues more than $3 / f_{PC}$ (s), lock detector outputs "H".

④ Standby control (SB1, SB2, SBR)

Standby control by three bits (SB1, SB2, SBR).
Bits "SB1" and "SB2" do standby control of CH1, CH2. Bit "SBR" does standby control of reference divider.

CONTROL BIT			STATE			
SB1	SB2	SBR	CH1	CH2	REFERENCE DIVIDER	
0	0	*	ON	ON	ON	Interlocking mode
0	1	*	ON	OFF	ON	
1	0	*	OFF	ON	ON	
1	1	0	OFF	OFF	ON	REFERENCE DIVIDER ON mode
1	1	1	OFF	OFF	OFF	

Note : * is don't care.

⑤ Filter switch control (SW)

Control of SW terminal by bit "SW".
This terminal is for switching constant of loop filter.
Output type of this terminal is open drain output. Switching the resistor of loop filter by this terminal with switching charge pump output current, high mode and normal mode can operate PLL by ideal braking factor.
When constant of loop filter don't change switch, available general output.

FILTER SWITCH CONTROL

SW	OUTPUT
0	OFF
1	ON

5. X'tal oscillation circuit and buffer amplifier

This IC has a stable oscillation circuit composed of bipolar.
In case of the external input of reference frequency directly, use X_{IN} terminal (pin 11).
For the common use of X'tal of the X'tal oscillation circuit for the PLL and X'tal of the local oscillation to 2'nd MIX, output terminal of local oscillation signal with buffer amplifier (pin 9) may be used.
This terminal (pin 9) is provided with a buffer amplifier.

MAXIMUM RATINGS (Ta = 25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Power Supply Voltage	V_{CC}	6	V
Power Dissipation	P_D	560	mW
Operating Temperature	T_{opr}	−30~85	°C
Storage Temperature	T_{stg}	−55~150	°C

ELECTRICAL CHARACTERISTICS
(Unless otherwise specified, V_{CC} = 3.0V, Ta = 25°C)

CHARACTERISTIC	SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Power Supply Voltage	V_{CC}	1	—	2.7	3.0	5.5	V
Operating Current Consumption : FN	I_{CCQ}	1	CH1, CH2 operating	—	16.5	21.5	mA
Operating Current Consumption : AFN				—	14.5	19.5	
f_{IN} Operating Frequency	f_{IN1}	1	V_{IN1} = 92~107dBμV *1	520	—	1100	MHz
	f_{IN2}	1	V_{IN2} = 92~107dBμV *1	520	—	1100	
f_{IN} Input Sensitivity	V_{IN1}	1	f_{IN1} = 520~1100MHz *1	92	—	107	dBμV
	V_{IN2}	1	f_{IN2} = 520~1100MHz *1	92	—	107	
X_{IN} Operating Frequency	f_{XI}	1	V_{XI} = 102~112dBμV Sin-wave*1	5	—	25	MHz
X_{IN} Input Voltage	V_{XI}	1	f_{XI} = 5~25MHz	102	107	112	dBμV
Input Voltage	V_{IH}	—	STB, DATA, CLK	V_{CC} ×0.8	V_{CC}	5.7	V
	V_{IL}	—	STB, DATA, CLK	−0.2	0	V_{CC} +0.2	
CLK Input Frequency	f_{CLK}	—	CLK	—	—	1.0	MHz
Charge Pump Output Current	I_{CP1}	1	"CP1" = 0, "CP2" = 0, V_{CP} = 1.5V	—	±100	—	μA
	I_{CP2}	1	"CP1" = 0, "CP2" = 1, V_{CP} = 1.5V	—	±200	—	
	I_{CP3}	1	"CP1" = 1, "CP2" = 0, V_{CP} = 1.5V	—	±400	—	
	I_{CP4}	1	"CP1" = 1, "CP2" = 1, V_{CP} = 1.5V	—	±800	—	
Charge Pump OFF Leak Current	CP_{OFF}	1	Standby mode, V_{CP} = 1.5V	−1.0	—	1.0	μA

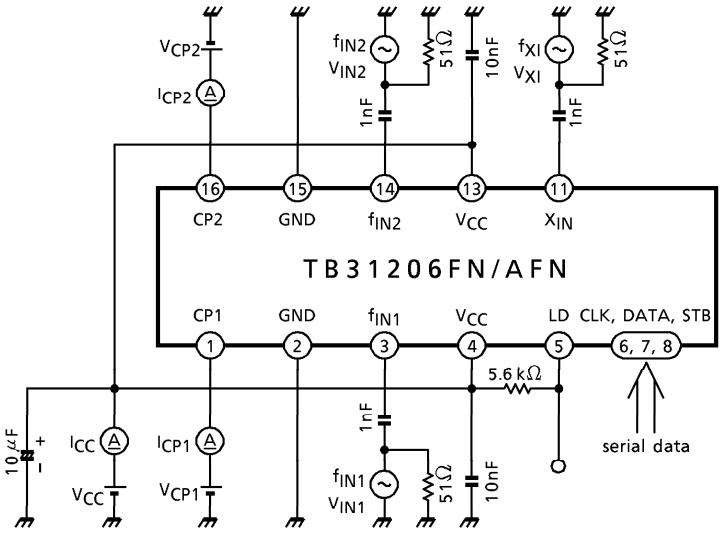
*1 : When input is terminated with 50Ω.

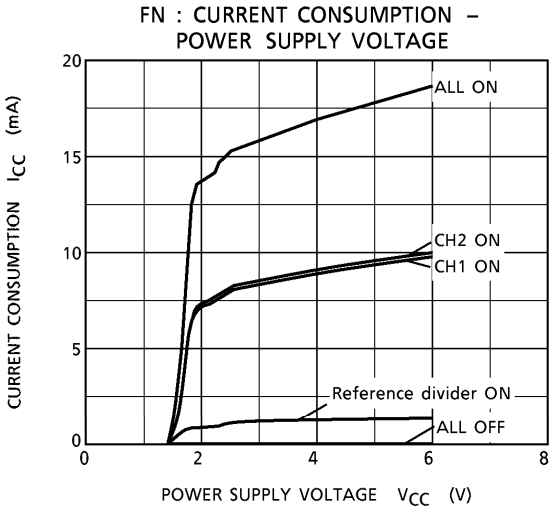
REFERENCE DATA (Typ.)

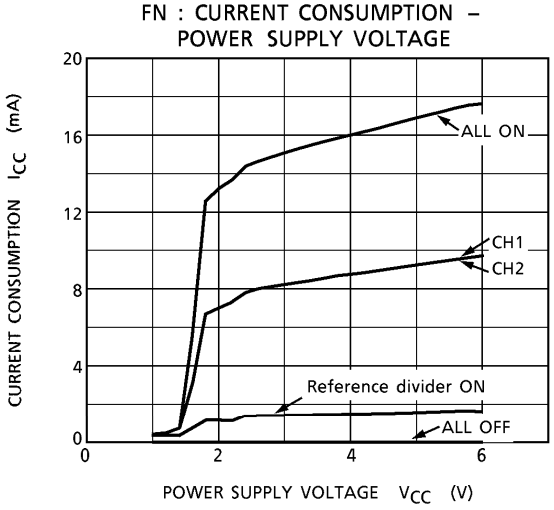
CH1	CH2	REFERENCE DIVIDER	CURRENT CONSUMPTION		UNIT
			FN	AFN	
N	N	ON	16.5	14.5	mA
N	S	ON	9.0	8.0	mA
S	N	ON	9.0	8.0	mA
S	S	ON	1.4	1.4	mA
S	S	OFF	0	0	μA

N : Normal operating
S : Standby mode

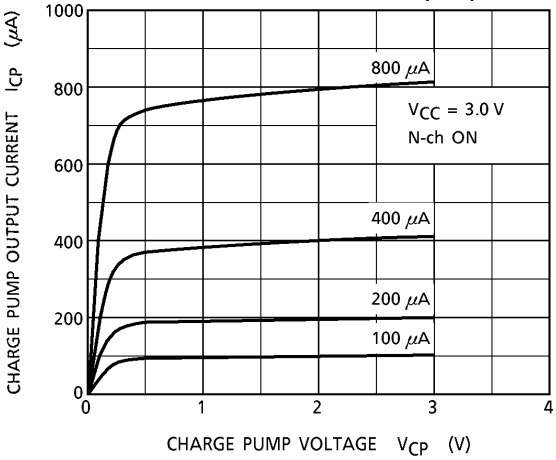
TEST CIRCUIT



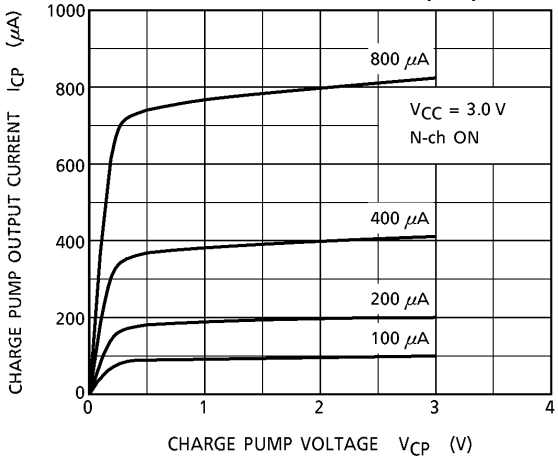




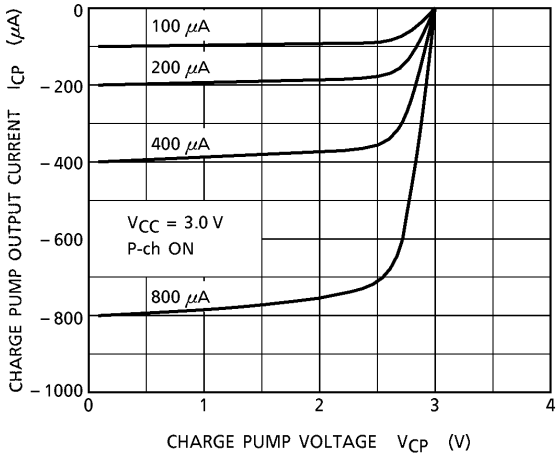
CHARGE PUMP OUTPUT CURRENT – CHARGE PUMP VOLTAGE (CH1)



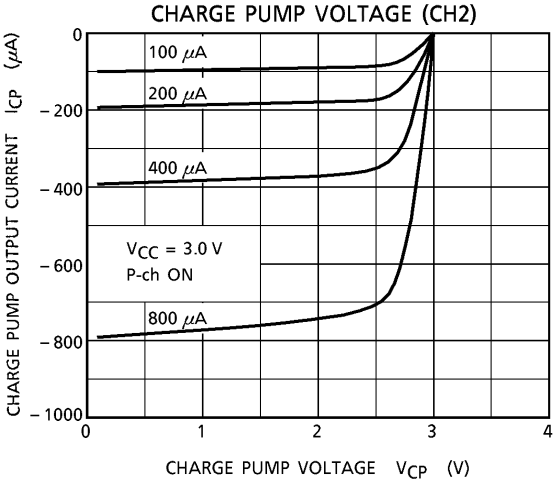
CHARGE PUMP OUTPUT CURRENT – CHARGE PUMP VOLTAGE (CH2)



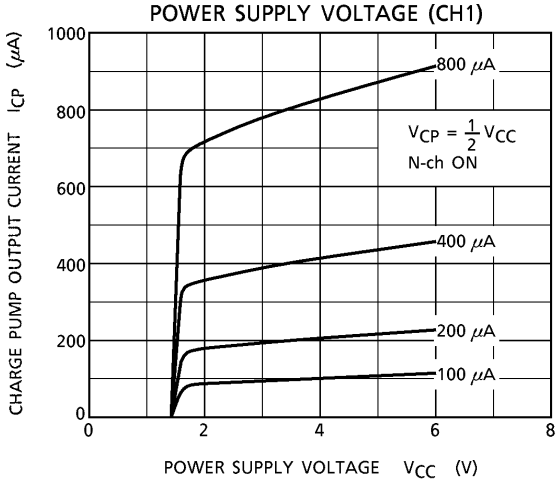
CHARGE PUMP OUTPUT CURRENT – CHARGE PUMP VOLTAGE (CH1)



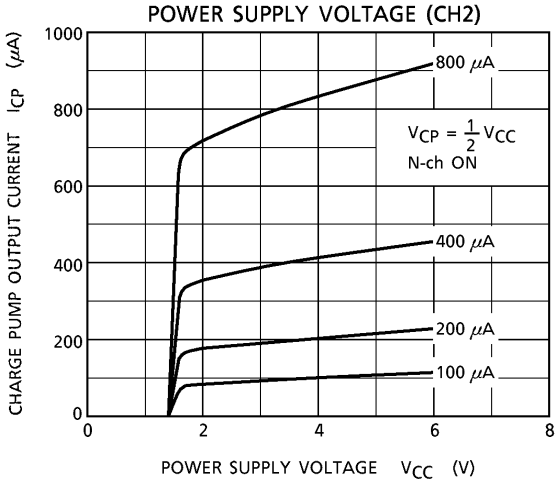
CHARGE PUMP OUTPUT CURRENT – CHARGE PUMP VOLTAGE (CH2)



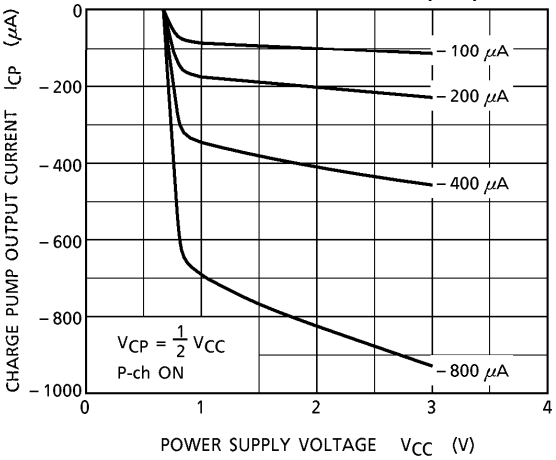
CHARGE PUMP OUTPUT CURRENT – POWER SUPPLY VOLTAGE (CH1)



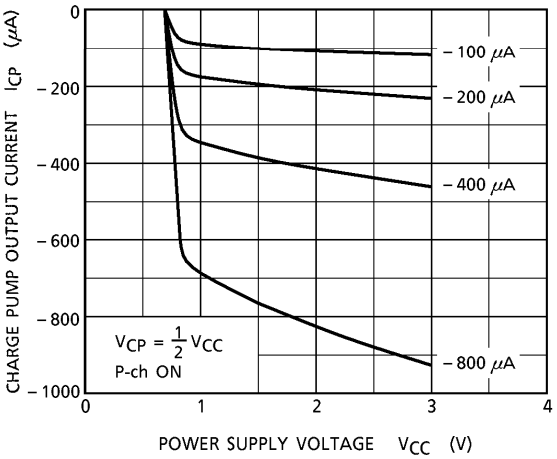
CHARGE PUMP OUTPUT CURRENT – POWER SUPPLY VOLTAGE (CH2)



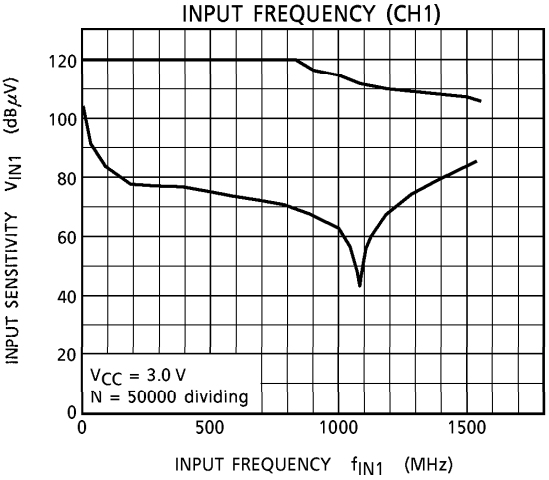
CHARGE PUMP OUTPUT CURRENT – POWER SUPPLY VOLTAGE (CH1)



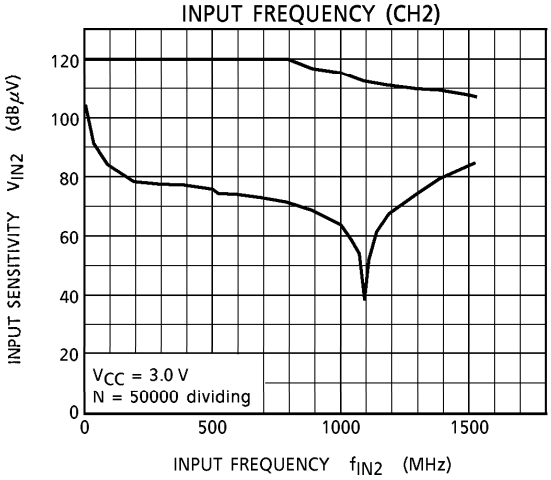
CHARGE PUMP OUTPUT CURRENT – POWER SUPPLY VOLTAGE (CH2)



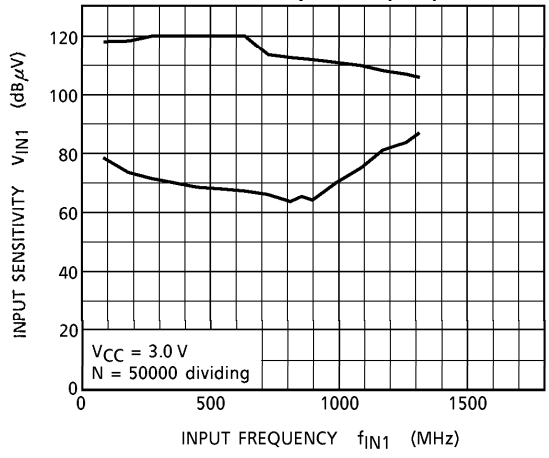
INPUT SENSITIVITY – INPUT FREQUENCY (CH1)



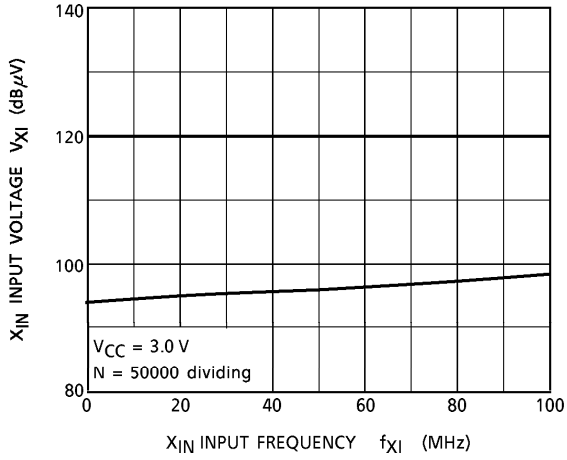
INPUT SENSITIVITY – INPUT FREQUENCY (CH2)



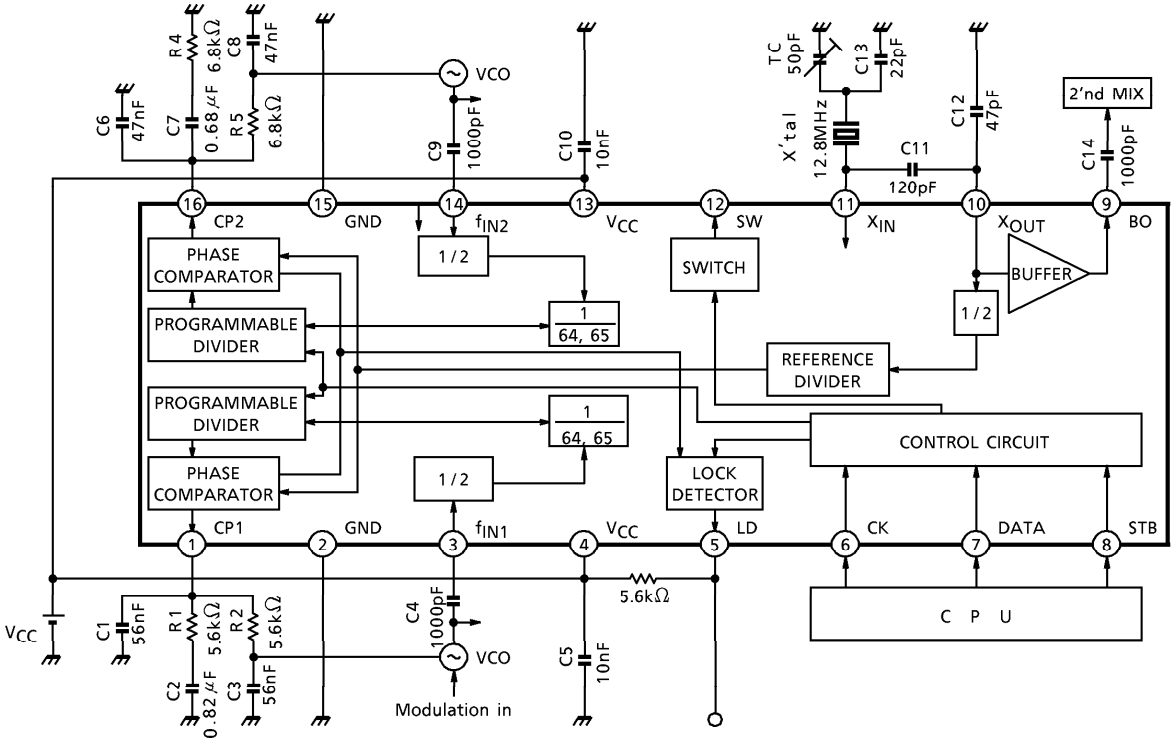
AFN : INPUT SENSITIVITY – INPUT FREQUENCY (CH1)



XIN INPUT VOLTAGE – XIN INPUT FREQUENCY



APPLICATION CIRCUIT



Set up conditions (E-TACS)

1. Frequency bandwidth ; 32.975MHz
2. Frequency probability error ; ±1kHz
3. Lock up time ; 30ms (calculated value)
4. X'tal frequency (f_{XI}) ; 12.8MHz
5. Phase comparison frequency (f_{PC}) ; 12.5kHz
6. Charge pump current (I_{CP}) ; 800μA

TX (CH1)

·VCO frequency ; 888.5MHz (center)

·VCO conversion sensitivity ; 14MHz / V

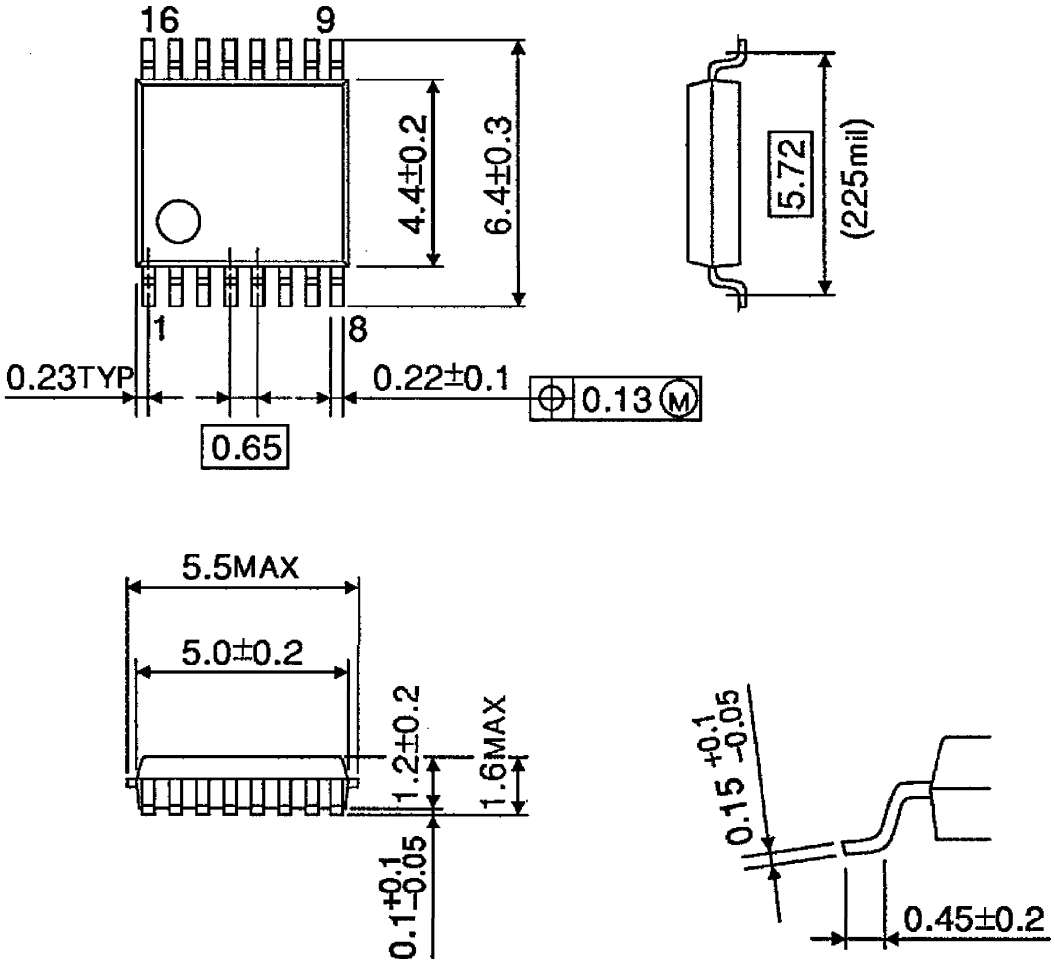
RX (CH2)

·VCO frequency ; 978.5MHz (center)

·VCO conversion sensitivity ; 13MHz / V

PACKAGE DIMENSIONS

SSOP16-P-225-0.65B Unit : mm



Weight : 0.07 g (Typ.)

RESTRICTIONS ON PRODUCT USE

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- TOSHIBA is continually working to improve the quality and reliability of its products. Nevertheless, semiconductor devices in general can malfunction or fail due to their inherent electrical sensitivity and vulnerability to physical stress. It is the responsibility of the buyer, when utilizing TOSHIBA products, to comply with the standards of safety in making a safe design for the entire system, and to avoid situations in which a malfunction or failure of such TOSHIBA products could cause loss of human life, bodily injury or damage to property.
  In developing your designs, please ensure that TOSHIBA products are used within specified operating ranges as set forth in the most recent TOSHIBA products specifications. Also, please keep in mind the precautions and conditions set forth in the "Handling Guide for Semiconductor Devices," or "TOSHIBA Semiconductor Reliability Handbook" etc..
- The TOSHIBA products listed in this document are intended for usage in general electronics applications (computer, personal equipment, office equipment, measuring equipment, industrial robotics, domestic appliances, etc.). These TOSHIBA products are neither intended nor warranted for usage in equipment that requires extraordinarily high quality and/or reliability or a malfunction or failure of which may cause loss of human life or bodily injury ("Unintended Usage"). Unintended Usage include atomic energy control instruments, airplane or spaceship instruments, transportation instruments, traffic signal instruments, combustion control instruments, medical instruments, all types of safety devices, etc.. Unintended Usage of TOSHIBA products listed in this document shall be made at the customer's own risk.
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