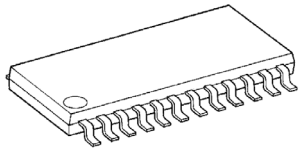
TOSHIBA Bi−CMOS Integrated Circuit Silicon Monolithic

TB2118FG

High Speed PLL For DTS

TB2118FG is a high−speed phase−locked loop (PLL) LSI for car audio tuners with a built−in charge pump circuit. All functions are controlled through serial bus lines. The device is used to configure high−performance digital tuning systems.



SSOP24-P-300-1.00

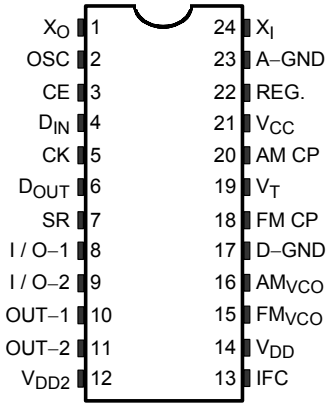
Weight: 0.31g (typ.)

Features

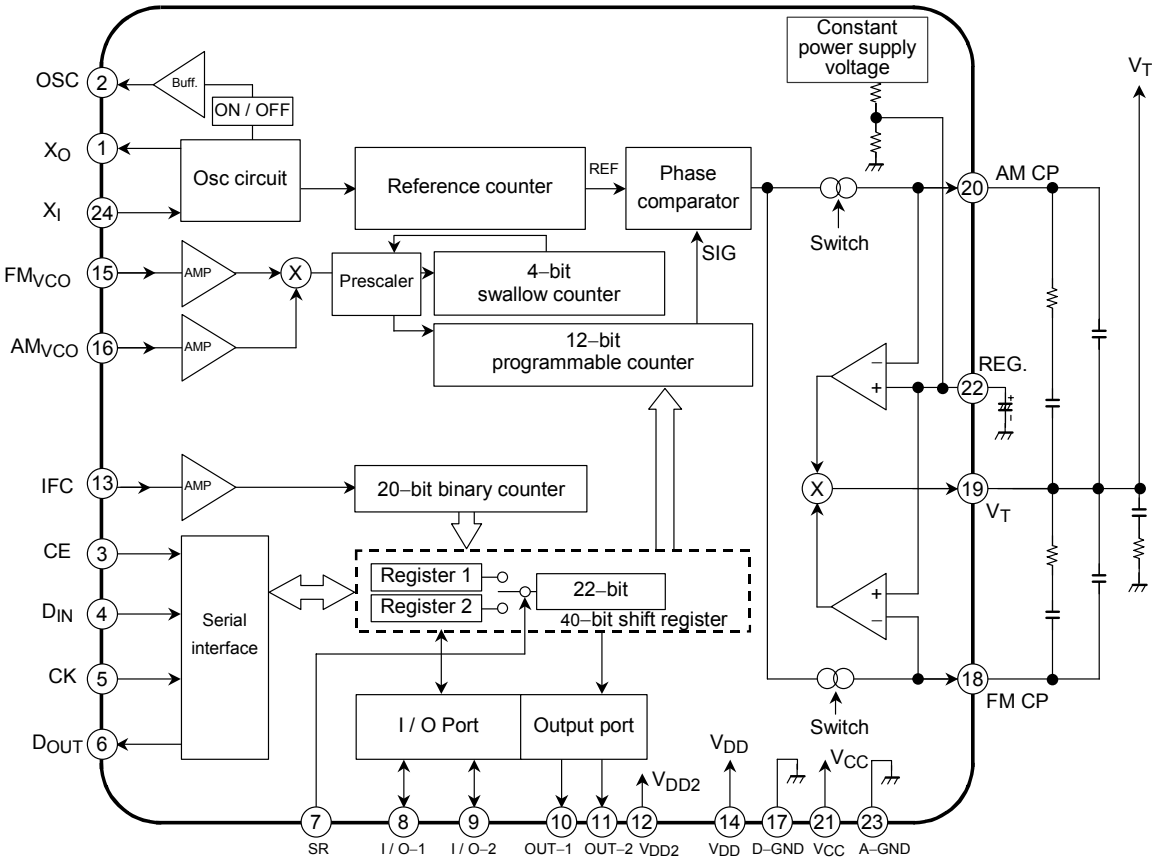
- Built−in high−speed program divider with built−in prescalers.
  FM: 30~150MHz (pulse swallowing method)
  AM: 1~40MHz (pulse swallowing method)
- Phase comparator outputs are constant current output for both FM and AM. Current values can be switched using serial data. In high−speed mode for large current output seek, the lockup time between FM band edges can be set to approx. 500μs by selecting an appropriate VT range and low−pass filter constant.
- RDS supported
  N−value data and charge pump output current data (total of 18−bits) can be selected using two resisters.
- Built−in low−pass filter op−amps for FM and AM.
- Built−in 20−bit binary counter for counting IF frequency.
- Crystal oscillator can be used 10.25MHz or 10.35MHz.
- Two output ports (open−collector output) and two I / O ports (CMOS) supported.
- Package is SSOP 24 pin.

(Note) Pins 1 and 24 are susceptible to surge. Take care when handling.

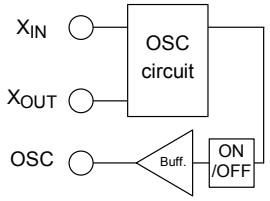
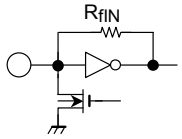
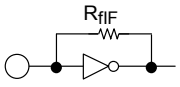
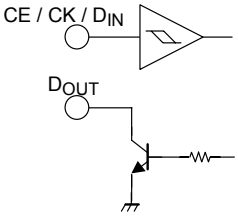
Pin Connection



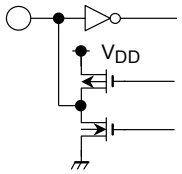
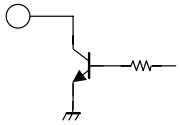
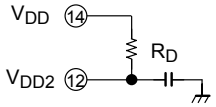
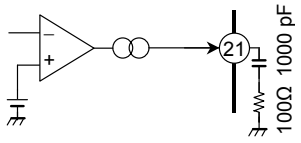
Block Diagram



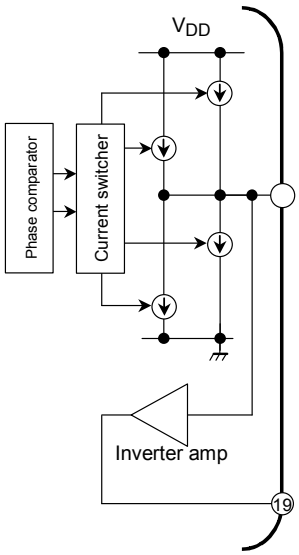
Pin Function

Pin No.	Symbol	Pin Name	Function And Operation	Remarks
1	X_O	Crystal oscillator pins	・Serial data input: Setting F0 and F1 bits selects the frequency of the crystal oscillator to be connected.	
24	X_I			
2	OSC	Crystal oscillator output pin	・Setting the OSC bit outputs the oscillation frequency. 0 = output off 1 = output on	—
15	FM_{VCO}	FM band local signal input	・Serial data input: When AM / FM bit = "0" FM_{VCO} is selected. ・Input signal is directly transferred to the swallow counter. ・Input frequency: 30 to 150MHz ・Divided frequency: 528 to 65.535	
16	AM_{VCO}	AM band local signal input	・Serial data input: When AM / FM bit = "1" AM_{VCO} is selected. ・When mode = "1" AM band is selected (by pulse swallow). Input frequency: 1.0 to 40MHz Divided frequency: 528 to 65.535	
13	IFC	IF signal input	・input frequency: 0.1 to 15MHz ・The selected signal is input to a 20−bit general−purpose counter via a gate circuit.	
3	CE	Chip enable input	Serial interface pins. ・Data used for controlling TB2118FG are exchanged between controllers. ・Control data are input via D_{IN} in sync. With clock input via CK. Control data input start / stop is specified using CE. ・General−purpose counter data are output in sync. With clock input via CK from D_{OUT}. ・The CK / CE / D_{IN} pin is schmitt trigger input.	
5	CK	Clock input		
4	D_{IN}	Serial data input		
6	D_{OUT}	Serial data output		

Pin Function

Pin No.	Symbol	Pin Name	Function And Operation	Remarks
7	SR	Register control pin.	・Selects register 1 or 2. "L" = register 1 output "H" = register 2 output	—
8	I / O−1	I / O ports	・Input or output is switched in units of bits by serial data input. ・CMOS input / CMOS output ・At power on, set to input ports.	
9	I / O−2			
10	OUT−1	Output ports	・Open collector output ports.	
11	OUT−2			
12	V_{DD2}		・Single power supply for reference frequency block ・V_{DD2} = 3.0 to 5.5V (note that $V_{DD} \geq V_{DD2}$) ・Due to the crystal high−frequency receive interference characteristic, we recommend an R_D setting so that V_{DD2} = 3.5V.	
14	V_{DD}	CMOS power pins	・Power pins for digital block (digital circuits). ・V_{CC} = 4.5 to 5.5V, D−GND = 0V	—
17	D−GND			
21	V_{CC}	Bipolar power pins	・Power pins for analog block (eg, op−amps, constant−voltage supply) ・V_{CC} = 8 to 10V, A−GND = 0V	
23	A−GND			
22	REG.	Ripple filter connecting pin.	Ripple filter connecting pin for internal constant voltage supply. Insert about 10μF (as high as possible) between this pin and A−GND.	—
19	V_T	Tuning voltage	・Input from the plus terminal of the op−amp is internally biased to 2.5V. ・External crystal for phase correction is required because low gain is set by high through rate.	

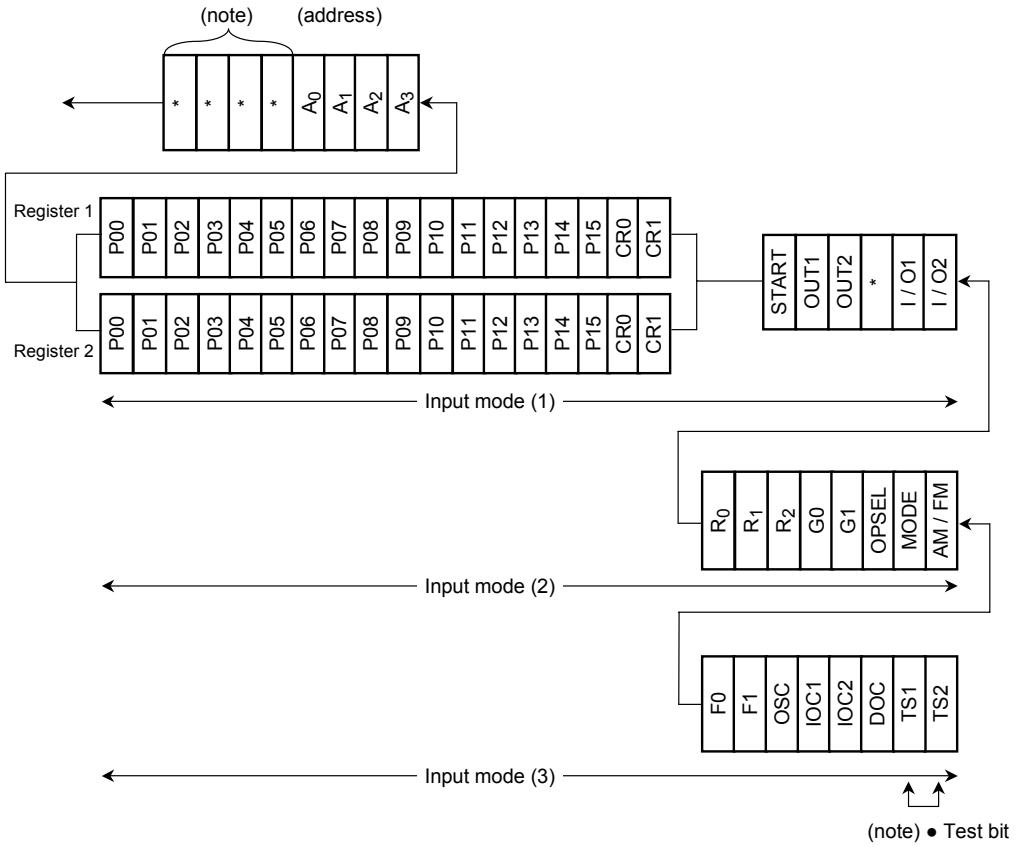
Pin Function

Pin No.	Symbol	Pin Name	Function And Operation	Remarks
20	AM CP	AM charge pump output	Charge pump output for AM ・Serial data input: When AM / FM = "1" error output from the phase comparator is output as constant current. $f_{REF} > f_{SIG}$: (−) current output $f_{REF} = f_{SIG}$: High impedance $f_{REF} < f_{SIG}$: (+) current output ・Serial data: Output current can be switched using CR0 and CR1 bits. ・Normally (when using AM op−amp), set the OP SEL bit to "1".	
18	FM CP	FM charge pump output	Charge pump output for FM ・Serial data input: When AM / FM = "0" error output from the phase comparator is output as constant current. $f_{REF} > f_{SIG}$: (−) current output $f_{REF} = f_{SIG}$: High impedance $f_{REF} < f_{SIG}$: (+) current output ・Serial data: Output current can be switched using CR0 and CR1 bits. ・Normally (when using FM op−amp), set the OP SEL bit to "0".	

Operation

1. Configuration of control data (serial data input / output)

1) Data input mode (valid data length changes according to the address.)

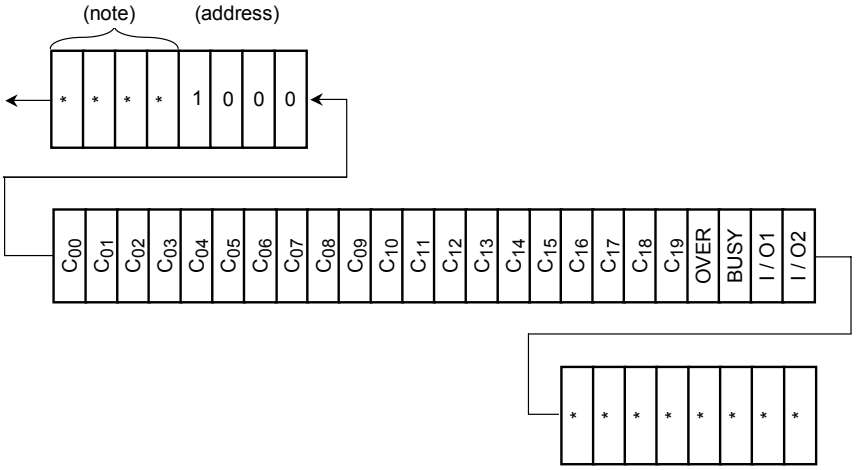


A_0	A_1	A_2	A_3	Input Mode	Valid Data Length	Remarks
0	#	0	1	(1)	24bits	Processes frequency change.
0	#	1	0	(2)	32bits	Processes band change.
0	#	1	1	(3)	40bits	Processes power on (initialization).

When "0" is set in bits marked with #, data are loaded to register 1; when "1" is set, to register 2.

(Note) ● Either "0" or "1" can be set in bits marked with *.
● TS1 and TS2 are pins for internal testing. At power on, be sure to clear to "0" (data set).

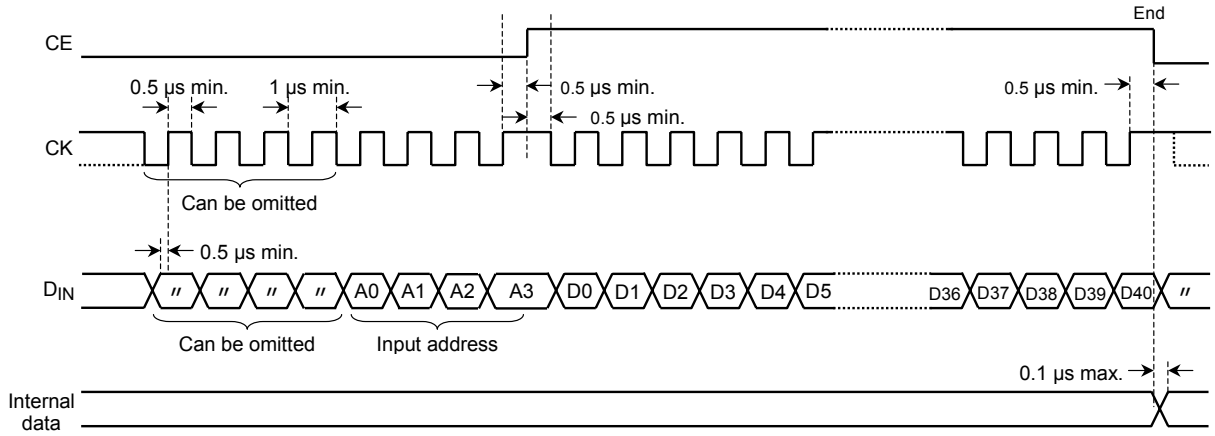
2) Data output mode



(Note) Either "0" or "1" can be set in bits marked with *.

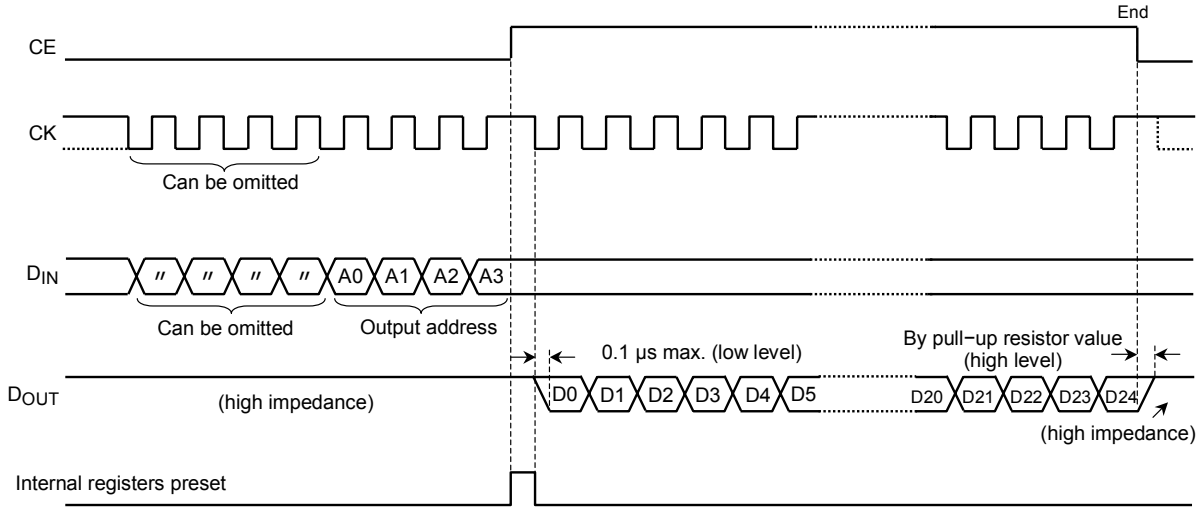
3) Serial data transfer formats

- Data input mode (at input, D_{OUT} becomes high impedance.)



(Note) ● When power for TB2118FG is fully on, input data after 100ms or more.
● Until data input starts, set the CE pin to GND to avoid any noise input.

● Data output mode



(Note) ● Normally, D_{OUT} is high impedance.
● During data output, data output mode is terminated by changing CE = H to L.

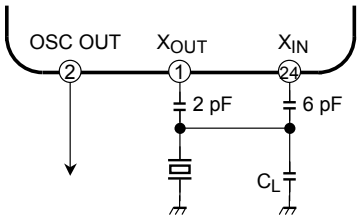
2. Setting reference frequency–related (reference divider block) items

1) Setting crystal oscillator (OSC)
With TB2118FG, the two–frequency oscillator shown below can be driven by self–oscillation.

F0 Bit	F1 Bit	Input Frequency
0	0	10.25MHz
0	1	10.35MHz

(Note) At power on, F0 / F1 = 0.

- Connection example



(Note) Use a crystal oscillator with R_S = 50Ω and less and C_L = 12pF or less.

2) Setting reference frequency (R_0, R_1, R_2)

R_0	R_1	R_2	10.25MHz	10.35MHZ
0	0	0	—	—
1	0	0	50kHz	50kHz
0	1	0	—	—
1	1	0	—	—
0	0	1	10kHz	—
1	0	1	—	9kHz
0	1	1	—	—
1	1	1	1kHz	—

(Note) Do not select settings where __ is enterd instead of frequency.

3) OSC output select (OSC) = oscillation frequency is output from the OSC out pin.

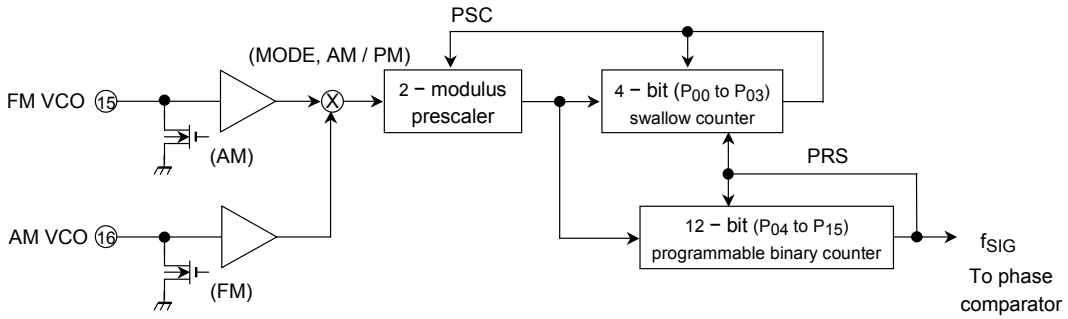
OSC	OSC Out Pin
0	Output off
1	Output on

(Note) At power on, OSC = 0.

3. Setting programmable counter block

1) Circuit configuration

The progammable counter block consists of a 2–modulus prescaler, 4–bit swallow counter, and 12–bit programmable binary counter.

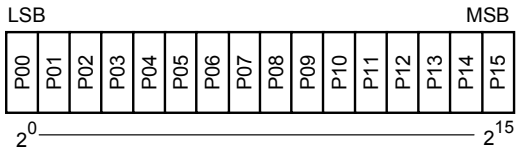


2) Setting input pin / dividing mode (AM / FM, mode)

AM / FM	Mode	Input Pin	Input Frequency	Divided Frequency	Dividing Mode
0	0	FM_{VCO}	30~150MHz	528~65.535	By pulse swallow (16–bit)
1	1	AM_{VCO}	1~40MHz		

3) Setting divided frequency (P_{00} to P_{15})

- By pulse swallow (in FW or SW mode), n = 528 to 65.535



4. Control of phase comparator and charge pumps

The phase comparator compares the phase difference between the reference frequency signal (f_{REF}) and the programmable counter divisor output (f_{SIG}) and outputs the result.
The constant current driver block outputs phase error signals as a current.

1) Setting charge pumps and op–amps (OPSEL)
The OPSEL bit is used to select a charge pump and an op–amp.

OPSEL	Charge Pump (CP) Output	Op–Amp	AM CP Output	FM CP Output
0	DOFM	FM amp	Hz	DO
1	DOAM	AM amp	DO	Hz

Hz = high impedance
DO = tri–state output

2) Setting current value (CRO)

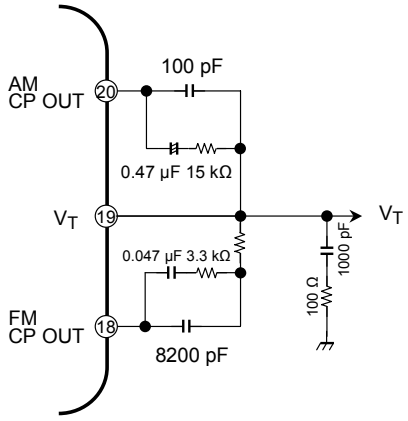
● AM / FM = "1" (AM_{IN} input)

CR1	CR0	AM CP Out Output Current
0	0	±0.3mA
0	1	±0.5mA

● AM / FM = "0" (FM_{IN} input)

CR1	CR0	FM CP Out Output Current
0	0	±250μA
1	0	±5mA

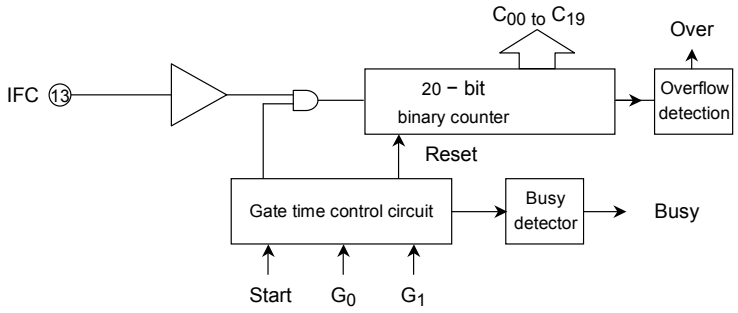
3) Connection example (the filter circuit is an example for reference. Check and design depending on the desired characteristics for your set.)



5. Control of general–purpose counter circuit

The general–purpose counter is a 20–bit counter used to measure the intermediate frequency. This is used at auto tuning for detecting a radio station. Setting "1" in the start bit starts counting after counter reset.

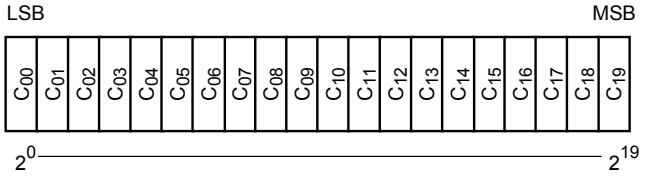
1) Circuit configuration



2) Setting IF counter gate time / wait time (G_0, G_1)

G_0	G_1	Gate Time	Wait Time
0	0	1ms	3.3~4.3ms
1	0	4ms	
0	1	16ms	7.3~8.3ms
1	1	64ms	

3) Counter output data (C_{00} to C_{19})



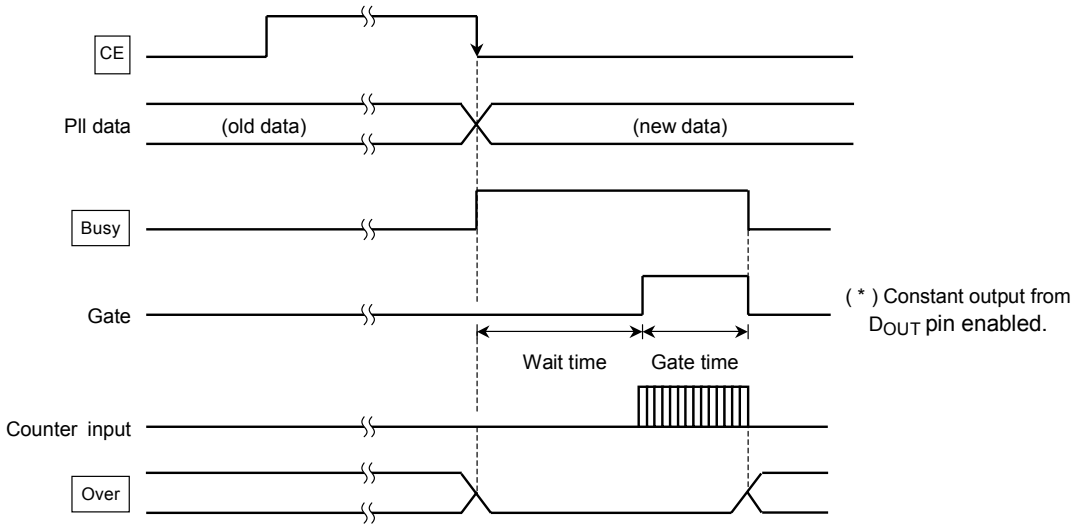
4) Detecting counter operating status

Busy	Counter Operating Status
0	Counting ended
1	Counting

Over	Counter Value
0	$N \leq 2^{20} - 1$
1	$N \geq 2^{20}$ (overflow)

(*) Setting the DOC bit to "1" enables constant output of busy state from the D_{OUT} pin.
Note that at this time, the busy status is the inversion of the busy bit: busy status = 0 (counting) and busy status = 1 (counting ended).
The DOC bit is set to "0" at power on.

5) Counter timing (when PLL data are updated and counting starts)



6. Setting general–purpose I / O ports

1) Setting output ports (OUT–1, OUT–2)

OUT1, 2	Output Port Status
0	Driver off (high impedance)
1	Driver on (low level)

2) Setting I / O control and I / O output ports (I / O1, I / O2, I / OC1, IOC2)

IOC1, 2	I / O Port Setting
0	Input port (CMOS input)
1	Output port (CMOS output)

I / O1, 2	Output Port Status
0	Low–level output
1	High–level output

(Note) Valid only when set to output port.

● At power on, I / O ports are set to input.

3) Reading I / O port data (I / O1, I / O2: Output mode data)

I / O1, 2	Input Port Status
0	Low–level output
1	High–level output

(Note) Valid only when set to input port.

7. Others

1) Control (DOC) of serial data output (D_{OUT})

DOC	D_{OUT} Output Status	Remarks
0	Other than in output made, high impedance.	—
1	Outputs BUSY status of general–purpose counter (constant output mode).	0: Counting 1: Counting ended

● At power on, DOC = 0.

Absolute Maximum Ratings (Ta = 25°C)

Characteristics	Symbol	Rating	Unit
Power supply voltage (1)	V_{DD}	−0.3~6.0	V
Power supply voltage (2)	V_{CC}	−0.3~11.0	V
V_{DD} input voltage	$V_{IN\ (1)}$	−0.3~V_{DD}+0.3	V
V_{CC} input voltage	$V_{IN\ (2)}$	−0.3~V_{CC}+0.3	V
Applied voltage on pins (6), (10), (11)	V_{CEO}	12	V
Powe dissipation	P_D	430	mW
Operating temperature	T_{opr}	−40~85	°C
Storage temperature	T_{stg}	−65~150	°C

Electrical Characteristics (unless otherwise specified, Ta = 25°C, V_{CC} = 8.5, V_{DD} = 5V, V_{DD2} = 3.5V, V_{SS} = GND = 0V)

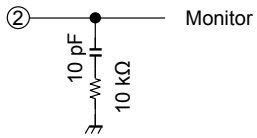
Supply Voltage And Current (V_{CC}, V_{DD}, V_{DD2}, A–GND, D–GND)

Characteristics	Symbol	Test Cir–cuit	Test Condition		Min.	Typ.	Max.	Unit
Operating power supply voltage	V_{CC}	—	Ta = −40~85°C		8.0	8.5	10.0	V
	V_{DD}				4.5	5.0	5.5	
	V_{DD2}				3.0	3.5	5.5	
Operating power supply current	I_{CC}	—	f_{xt} = 10.25MHz Ta = 25°C FM_{IN} = 150MHz	V_{CC} = 10V max.	—	17.0	25.0	mA
	I_{DD}			V_{DD} = 5.5V max.	—	20.0	29.0	
	I_{DD2}			V_{DD2} = 5.5V max.	—	0.25	1.0	

Crystal Oscillator Circuit (X_{TIN}, X_{TOUT})

Crystal oscillator frequency	f_{XT}	—	Connect the crystal oscillator to X_{TIN} and X_{TOUT}.	—	10.25	10.35	MHz
Oscillator output level	OSCO	1	OSC pin	100	560	—	mV_{rms}

Test Circuit 1



Operating Frequency Range (FM_{IN}, AM_{IN}, AM / FM IF)

Characteristics	Symbol	Test Cir–cuit	Test Condition	Min.	Typ.	Max.	Unit
FM_{VCO} operating frequency	f_{FM}	—	V_{IN} = 0.2Vp–p, sine wave input, capacitive coupling, by pulse swallow	30	~	150	MHz
AM_{VCO} operating frequency	f_{AM}	—	V_{IN} = 0.2Vp–p, sine wave input, capacitive coupling, by pulse swallow	1.0	~	40	MHz
IFC operating frequency	f_{IF}	—	V_{IN} = 0.2Vp–p, sine wave input, capacitive coupling, IFC pin	0.1	~	15	MHz

Input Range (FM_{VCO}, AM_{VCO}, IFC)

IFC input level	IFC V_{IN}	—	Input frequency 0.1~15MHz	0.2	~	V_{DD} –0.5	Vp–p
FM_{VCO} input level	FM_{VCO} V_{IN}	—	Input frequency 30~120MHz (*)	0.141	~	V_{DD} –0.5	Vp–p
			Input frequency 120~150MHz	0.2	~	V_{DD} –0.5	
AM_{VCO} input level	AM_{VCO} V_{IN}	—	Input frequency 1.0~15MHz (*)	0.113	~	V_{DD} –0.5	Vp–p
			Input frequency 15~40MHz	0.2	~	V_{DD} –0.5	

(*) Weekly code 9843~.

Serial Interface (CE, CK, D_{IN}, D_{OUT}, SR)

Input voltage	High level	V_{IH} (1)	—	CE, CK, D_{IN}, SR pins		V_{DD} –1.5	~	V_{DD}	V
	Low level	V_{IL} (1)				0	~	1.5	
Input current	High level	I_{IH} (1)	—		V_{IH} = 5V	–1.0	—	+1.0	μA
	Low level	I_{IL} (1)			V_{IL} = 0V	–1.0	—	+1.0	
Low–level output current		I_{OL} (1)	—	D_{OUT} pin	V_{OL} = 0.2V	0.8	3.0	—	mA
Output off–leak current		I_{OFF} (1)	—		V_{OH} = 5V	–1.0	—	+1.0	μA

Output Ports (out–1, out–2)

Low–level output current	I_{OL} (2)	—	V_{OL} = 0.2V	0.8	3.0	—	mA
Output off–leak current	I_{OFF} (2)	—	V_{OH} = 10V	–1.0	—	+1.0	μA

I / Oports (I / O–1, I / O–2)

Input current	High level	$I_{IH\ (2)}$	—	V_{IH} = 5V	–1.0	—	+1.0	μA
	Low level	$I_{IL\ (2)}$		V_{IL} = 0V	–1.0	—	+1.0	
Input voltage	High level	$V_{IH\ (2)}$	—		V_{DD} –1.5	~	V_{DD}	V
	Low level	$V_{IL\ (2)}$			0	~	1.5	
Output current	High level	$I_{OH\ (1)}$	—	V_{OH} = 4.0V	–5.0	–7.5	—	mA
	Low level	$I_{OL\ (3)}$		V_{OL} = 1.0V	3.5	4.5	—	

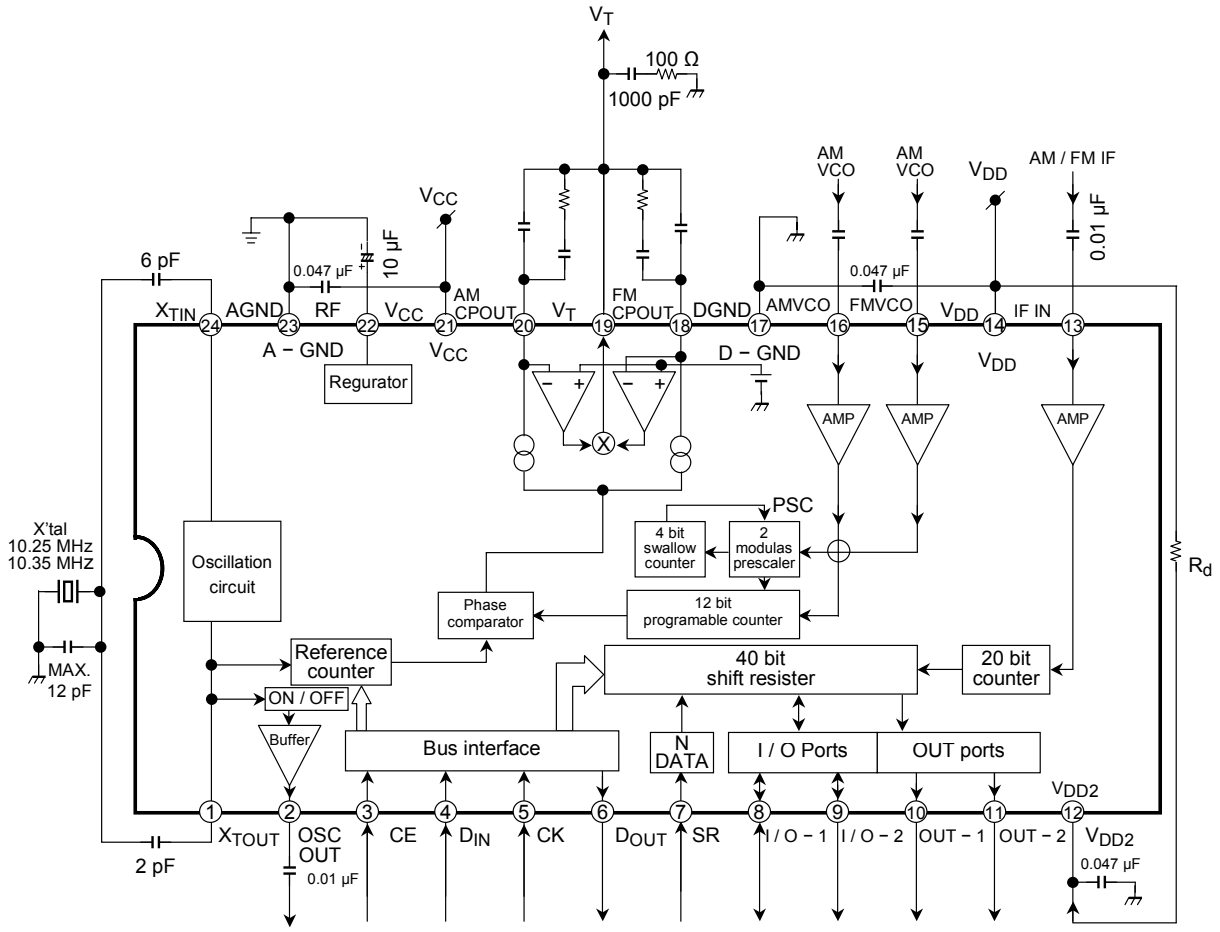
Charge Pumps ($AMCP_{OUT}$, $FMCP_{OUT}$)

Characteristics	Symbol	Test Cir–cuit	Test Condition	CR0 Bit	CR1 Bit	Min.	Typ.	Max.	Unit
FM charge pump output current	$I_{OFM\ (1)}$	—	DOFM pin	0	0	±0.20	±0.25	±0.4	mA
	$I_{OFM\ (2)}$			0	1	±4.0	±5.0	±7.0	
AM charge pump output current	$I_{OAM\ (1)}$	—	DOAM pin	0	0	±0.2	±0.3	±0.45	mA
	$I_{OAM\ (2)}$	—		1	0	±0.4	±0.5	±0.75	

OP–Amps (V_T)

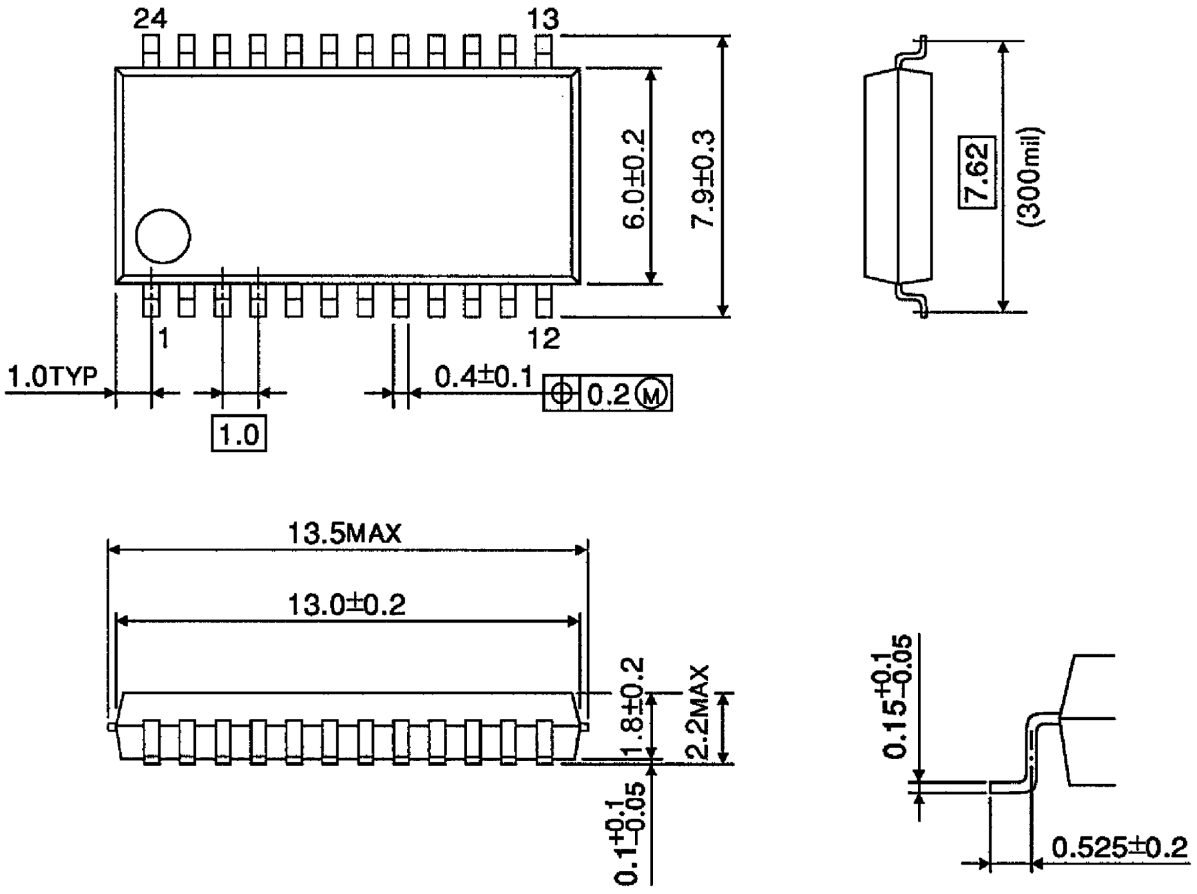
AM op–amp output current	I_{OL}	—	V_{IN} = V_{DD}, V_{OUT} = 8.5V	1.0	2.0	—	mA
	I_{OH}		V_{IN} = GND, V_{OUT} = 0V	–1.0	–2.0	—	
FM op–amp output current	I_{OL}	—	V_{IN} = V_{DD}, V_{OUT} = 8.5V	5.0	9.0	—	mA
	I_{OH}		V_{IN} = GND, V_{OUT} = 0V	–5.0	–9.0	—	
V_T output voltage	V_{VT}	—		0.3	~	VCC –1.1	V

Application Circuit 1



Package Dimensions

SSOP24-P-300-1.00 Unit : mm



Weight: 0.31g (typ.)

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060116EBA

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About solderability, following conditions were confirmed

- Solderability

  (1) Use of Sn-37Pb solder Bath
  - solder bath temperature = 230°C
  - dipping time = 5 seconds
  - the number of times = once
  - use of R-type flux

  (2) Use of Sn-3.0Ag-0.5Cu solder Bath
  - solder bath temperature = 245°C
  - dipping time = 5 seconds
  - the number of times = once
  - use of R-type flux