OVERVIEW

The WF5095A is 32.768kHz output crystal oscillator module IC that has EEPROM and a digital temperature compensation function by temperature sensor. The WF5095A can be selected the temperature compensation range by a user and it is ideal for high frequency accuracy, low current consumption, DTCXO modules.

FEATURES

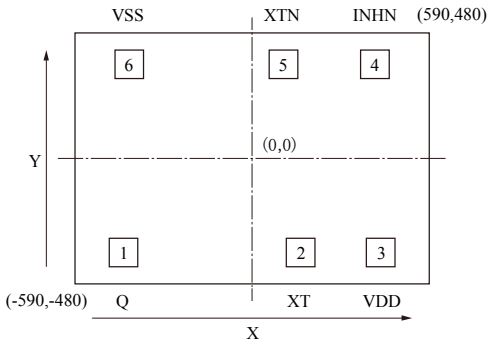
- Oscillation and output frequency: 32.768kHz
- Wide range of operating supply voltage: 1.3 to 5.5V (Oscillation output)
  : 2.0 to 5.5V (Temperature compensation)
- Operating temperature of oscillation operation: -40 to +105°C
- Temperature compensation operating range: select either -40 to +85°C or -40 to +105°C
- High frequency accuracy: -40 to +85°C selection → ±3.0ppm (-10 to +60°C)
  ±5.0ppm (-40 to +85°C)
  : -40 to +105°C selection → ±3.0ppm (0 to +50°C)
  ±5.0ppm (-30 to +70°C)
  ±7.0ppm (-40 to +105°C)
- Low current consumption: 1μA typ. (V_{DD}=3.3V, no load, temperature compensation interval 2sec)
- CMOS input / output
- ±0.4mA output drive capability (V_{DD}=2.0V)
- 15pF output load capacitance
- Output disable function

ORDERING INFORMATION

Device	Package
WF5095A-4-Z1	Wafer form

PAD LAYOUT

(Unit: µm)



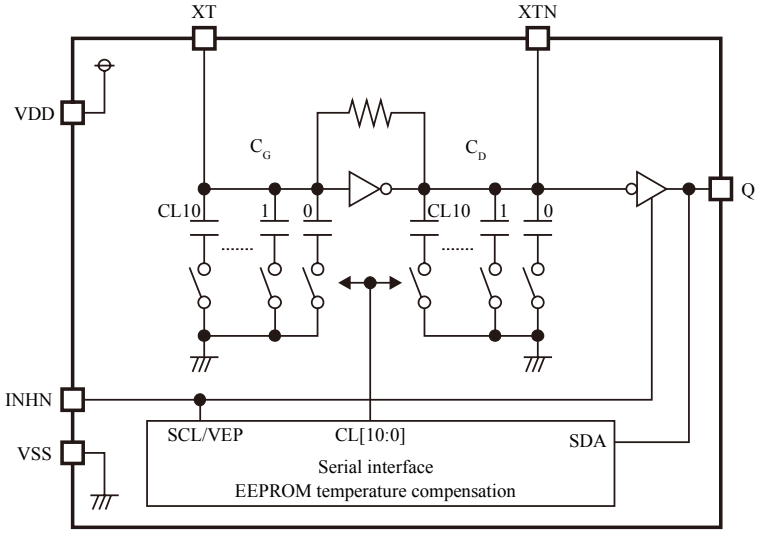
Chip size: 1.18mm × 0.96mm
Wafer thickness: 130µm
PAD size: 70µm
Chip base: V_{SS} level

PIN DESCRIPTION and PAD COORDINATES

No.	PIN	I/O*1	Description	PAD coordinate [µm]	
				X	Y
1	Q (SDA)	I/O	32.768kHz output pin SDA(Data input/output) pin in serial interface mode	-410.6	-379.0
2	XT	I	Crystal input connection pin	115.3	-379.0
3	VDD	-	(+) supply voltage	395.4	-379.0
4	INHN (SCL)	I	Input pin controlled output state(Hi-Z output at LOW, 32.768kHz output at High, OPEN connection prohibit) SCL(Clock input) pin in serial interface mode	383.7	379.0
5	XTN	O	Crystal output connection pin	70.6	379.0
6	VSS	-	(-) ground	-395.4	379.0

*1. I/O: Input / Output pin I: Input pin O: Output pin

BLOCK DIAGRAM



SPECIFICATIONS

Absolute Maximum Ratings

V_{SS}=0V

Parameter	Symbol	Conditions	Rating	Unit
Supply voltage range[*1]	V_{DD}	Between VDD and VSS	-0.3 to +6.5	V
Program supply voltage range[*1]	V_{EP}	Between INHN and VSS	-0.3 to +22.0	V
Input voltage range[*1*2]	V_{IN}	Input pins (XT, INHN[*4])	-0.3 to V_{DD}+0.3	V
Output voltage range[*1*2]	V_{OUT}	Output pins (XTN, Q)	-0.3 to V_{DD}+0.3	V
Output current[*1]	I_{OUT}	Q pin	±10	mA
Junction temperature	T_j	-	+150	°C
Storage temperature range[*3]	T_{STG}	Exclude EEPROM data retention	-55 to +150	°C
EEPROM rewrite cycles	N_{EW}	-	100	times

*1. This parameter rating is the values that must never exceed even for a moment. This product may suffer breakdown if this parameter rating is exceeded. Operation and characteristics are guaranteed only when the product is operated at recommended operating conditions.
*2. V_{DD} is a V_{DD} value of recommended operating conditions.
*3. When stored in nitrogen or vacuum atmosphere applied to IC itself only (excluding packaging materials).
*4. The value is in normal operation except program read/write operation.

Recommended Operating Conditions

V_{SS}=0V

Parameter	Symbol	Conditions	Rating			Unit
			MIN	TYP	MAX	
Operating supply voltage[*1]	V_{DD}	Oscillation output	1.3		5.5	V
		Temperature compensation operation[*2]	2.0		5.5	
Input voltage	V_{IN}	Input pins (XT, INHN[*3])	V_{SS}		V_{DD}	V
Operating temperature	T_a	Oscillation operation	-40		+105	°C
		Temperature compensation operation	-40		+85	
		Selectable by EEPROM write[*4]	-40		+105	
Program supply voltage	V_{EPW}	INHN pin EEPROM write mode, V_{DD}=2.7 to 5.5V Write the adjusted data to EEPROM in T_a=20 to 105°C.	19.0		20.0	V
	V_{EPR}	INHN pin EEPROM read mode, temperature compensation control registers write/read mode, V_{DD}=2.0 to 5.5V	V_{DD}+1.7		20.0	
EEPROM data retention	-	T_a=-40 to +105°C	10			years
Output load capacitance	C_{LOUT}	Q pin			15	pF

*1. Mount a ceramic chip capacitor that is larger than 0.1µF proximal to IC between VDD and VSS in order to obtain stable operation of WF5095A. In addition, the wiring pattern between IC and capacitor should be as wide as possible.
*2. When V_{DD} become less than 2V (Max), the internal detection circuit works and prohibits temperature compensation operation by intermittent operation. When V_{DD} return more than 2V (Max), the internal detection circuit enables temperature compensation operation by intermittent operation.
*3. The value is in normal operation except program read/write operation.
*4. In the case of use of temperature compensating ranges other than this, please ask our Sales section.

Note. Since it may influence the reliability if it is used out of range of recommended operating conditions, this product should be used within this range.

Electrical Characteristics

DC Characteristics

V_{DD}=1.3 to 5.5V, V_{SS}=0V, T_a=-40 to +105°C, C_{LOUT}=15pF unless otherwise noted.

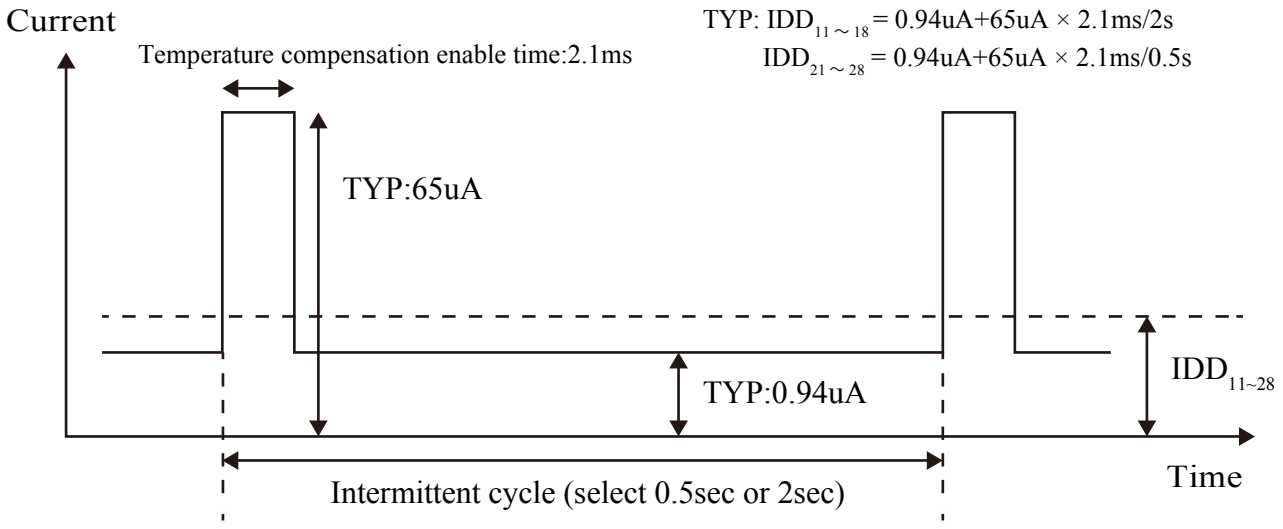
Parameter	Symbol	Conditions		Rating MIN	Rating TYP	Rating MAX	Unit
Current consumption in normal function[*4] (Select 2sec for temperature compensation interval)	I_{DD11}	Measurement circuit 1, C_{LOUT}=0pF, INHN=V_{DD}=3.3V	T_a=-40 to +85°C		1.0	2.0	µA
	I_{DD12}		T_a=-40 to +105°C			3.0	
	I_{DD13}	Measurement circuit 1, C_{LOUT}=0pF, INHN=V_{DD}=5.0V	T_a=-40 to +85°C		1.5	3.0	
	I_{DD14}		T_a=-40 to +105°C			4.0	
	I_{DD15}	Measurement circuit 2, C_{LOUT}=15pF, INHN=V_{DD}=3.3V	T_a=-40 to +85°C		2.7	3.7	
	I_{DD16}		T_a=-40 to +105°C			4.7	
	I_{DD17}	Measurement circuit 2, C_{LOUT}=15pF, INHN=V_{DD}=5.0V	T_a=-40 to +85°C		4.0	5.5	
	I_{DD18}		T_a=-40 to +105°C			6.5	
Current consumption in normal function[*4] (Select 0.5sec for temperature compensation interval)	I_{DD21}	Measurement circuit 1, C_{LOUT}=0pF, INHN=V_{DD}=3.3V	T_a=-40 to +85°C		1.2	2.5	µA
	I_{DD22}		T_a=-40 to +105°C			3.2	
	I_{DD23}	Measurement circuit 1, C_{LOUT}=0pF, INHN=V_{DD}=5.0V	T_a=-40 to +85°C		1.7	3.2	
	I_{DD24}		T_a=-40 to +105°C			4.2	
	I_{DD25}	Measurement circuit 2, C_{LOUT}=15pF, INHN=V_{DD}=3.3V	T_a=-40 to +85°C		2.9	4.2	
	I_{DD26}		T_a=-40 to +105°C			4.9	
	I_{DD27}	Measurement circuit 2, C_{LOUT}=15pF, INHN=V_{DD}=5.0V	T_a=-40 to +85°C		4.2	5.7	
	I_{DD28}		T_a=-40 to +105°C			6.7	
Current consumption in boot function	I_{BOOT1}	Measurement circuit 1, boot[*1], INHN=V_{DD}=3.3V, C_{LOUT}=0pF, T_a=-40 to +85°C			1.5	2.5	µA
	I_{BOOT2}	Measurement circuit 1, boot[*1], INHN=V_{DD}=3.3V, C_{LOUT}=0pF, T_a=-40 to +105°C				3.5	
Current consumption in disable function	I_{DIS1}	Measurement circuit 1, INHN=V_{SS}, V_{DD}=3.3V, T_a=-40 to +85°C			0.65	1.5	µA
	I_{DIS2}	Measurement circuit 1, INHN=V_{SS}, V_{DD}=3.3V, T_a=-40 to +105°C				2.1	
High-level input voltage	V_{IH1}	Measurement circuit 3, INHN pin[*2]		0.8V_{DD}			V
		Measurement circuit 3, Q pin[*3], V_{DD}=2.0V to 5.5V					
	V_{IH2}	Measurement circuit 3, INHN pin[*3], V_{DD}=2.0 to 5.5V Serial clock "H" level		V_{DD}+1.7			
Low-level input voltage	V_{IL1}	Measurement circuit 3, INHN pin[*2]				0.2V_{DD}	V
		Measurement circuit 3, Q pin[*3], V_{DD}=2.0 to 5.5V					
	V_{IL2}	Measurement circuit 3, INHN pin[*3], V_{DD}=2.0 to 5.5V Serial clock "L" level				V_{DD}	V
High-level output voltage	V_{OH1}	Measurement circuit 4, Q pin[*2], I_{OH}=-0.4mA, V_{DD}=2.0V		V_{DD}-0.4			V
	V_{OH2}	Measurement circuit 4, Q pin[*2], I_{OH}=-0.1mA, V_{DD}=1.3V		V_{DD}-0.4			
	V_{OH3}	Measurement circuit 5, Q pin[*3], I_{OH}=-0.1mA, V_{DD}=2.0V		V_{DD}-0.4			
Low-level output voltage	V_{OL1}	Measurement circuit 4, Q pin[*2], I_{OL}=0.4mA, V_{DD}=2.0V				0.4	V
	V_{OL2}	Measurement circuit 4, Q pin[*2], I_{OL}=0.1mA, V_{DD}=1.3V				0.4	
	V_{OL3}	Measurement circuit 5, Q pin[*3], I_{OL}=0.1mA, V_{DD}=2.0V				0.4	

*1. Boot function operates from oscillation start to 0.5s (t_{STA}+0.5s) after applying power supply.

*2. It is the value in normal operation except temperature compensation control registers and EEPROM access.

*3. It is the value in access to temperature compensation control registers and EEPROM.

*4. The contents of current consumption in normal function as shown below.


Current
Temperature compensation enable time:2.1ms
TYP: IDD11～18 = 0.94uA+65uA × 2.1ms/2s
IDD21～28 = 0.94uA+65uA × 2.1ms/0.5s
TYP:65uA
TYP:0.94uA
IDD11~28
Time
Intermittent cycle (select 0.5sec or 2sec)

Oscillation Characteristics

WF5095A oscillation characteristics is in the below crystal parameters.

Parameter	Symbol	Rating
Frequency	f0	32.768kHz
Frequency permission deviation	⊿f	±10ppm (25°C)
Peak temperature	Ti	25°C±5°C
Parabolic coefficient	B	-0.04ppm/°C^{2}min
Load capacitance	CL	7.5pF to 9.0pF
Serial resistance	R1	70kΩ max
Serial capacitance	C1	6.2fF
Parallel capacitance	C0	1.3pF

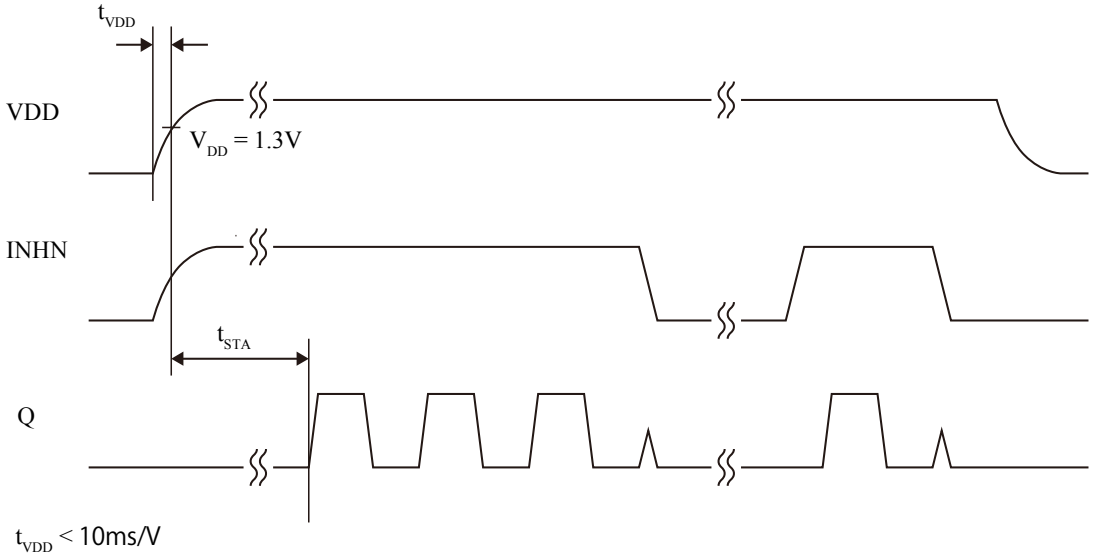
V_{DD}=1.3 to 5.5V, V_{SS}=0V, T_a=-40 to +105°C, C_{LOUT}=15pF unless otherwise noted.

Parameter	Symbol	Conditions	Rating			Unit
			MIN	TYP	MAX	
Oscillation frequency	fo	T_a= +25°C, V_{DD}=1.3 to 5.5V		32.768		kHz
Oscillation start up voltage	V_{STR}	Measurement circuit 2 V_{DD} rises gradually.			1.3	V
Oscillation stop voltage	V_{STO}	Measurement circuit 2 V_{DD} descends gradually.			1.3	V
Oscillation accuracy*1 Select -40 to +85°C	⊿f / fo	T_a=-10 to +60°C, V_{DD}=3.3V			± 3.0	ppm
		T_a=-40 to +85°C, V_{DD}=3.3V			± 5.0	
Oscillation accuracy*1 Select -40 to +105°C		T_a=0 to +50°C, V_{DD}=3.3V			± 3.0	ppm
		T_a=-30 to +70°C, V_{DD}=3.3V			± 5.0	
		T_a=-40 to +105°C, V_{DD}=3.3V			± 7.0	
Oscillation start up time	t_{STA}	T_a= +25°C, V_{DD}=1.3V			0.5	s
		T_a= -40 to +105°C, V_{DD}=1.3 to 5.5V			3.0	
Frequency-voltage characteristic	⊿f/⊿V	T_a= +25°C, V_{DD}=2.0 to 5.5V CL setting*2=200h to 7FFh			±1.0	ppm/V

*1. Oscillation accuracy is the theoretical value.

*2. CL setting is built-in capacitance value for crystal oscillation (C_L).

Timing chart at power supply



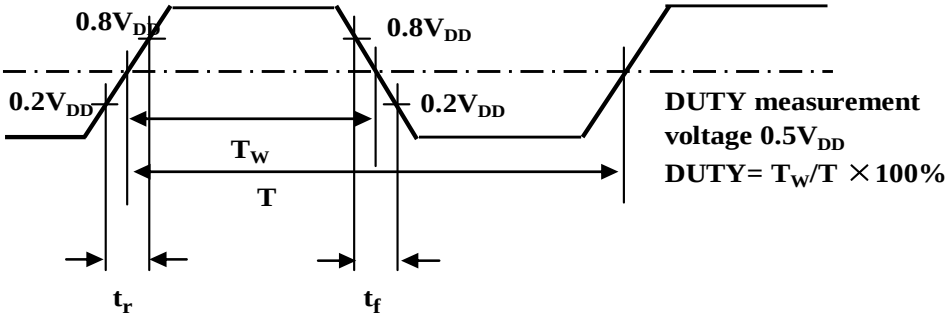
t_{VDD} < 10ms/V

AC Characteristics 1 (Q pin output characteristics)

V_{DD}=2.0 to 5.5V, V_{SS}=0V, T_a=-40 to +105°C unless otherwise noted.

Parameter	Symbol	Conditions	Rating			Unit
			MIN	TYP	MAX	
Output duty cycle	Duty1	Measurement circuit 2, C_{LOUT}=15pF, 0.5V_{DD} threshold, T_a=-40 to +85°C	40	50	60	%
	Duty2	Measurement circuit 2, C_{LOUT}=15pF, 0.5V_{DD} threshold, T_a=-40 to +105°C	35	50	65	%
Output rise time	t_r	Measurement circuit 2, C_{LOUT}=15pF, 20%→80%, V_{DD}=2.0V			50	ns
		Measurement circuit 2, C_{LOUT}=15pF, 20%→80%, V_{DD}=1.3V			200	
Output fall time	t_f	Measurement circuit 2, C_{LOUT}=15pF, 80%→20%, V_{DD}=2.0V			50	ns
		Measurement circuit 2, C_{LOUT}=15pF, 80%→20%, V_{DD}=1.3V			200	

Timing chart

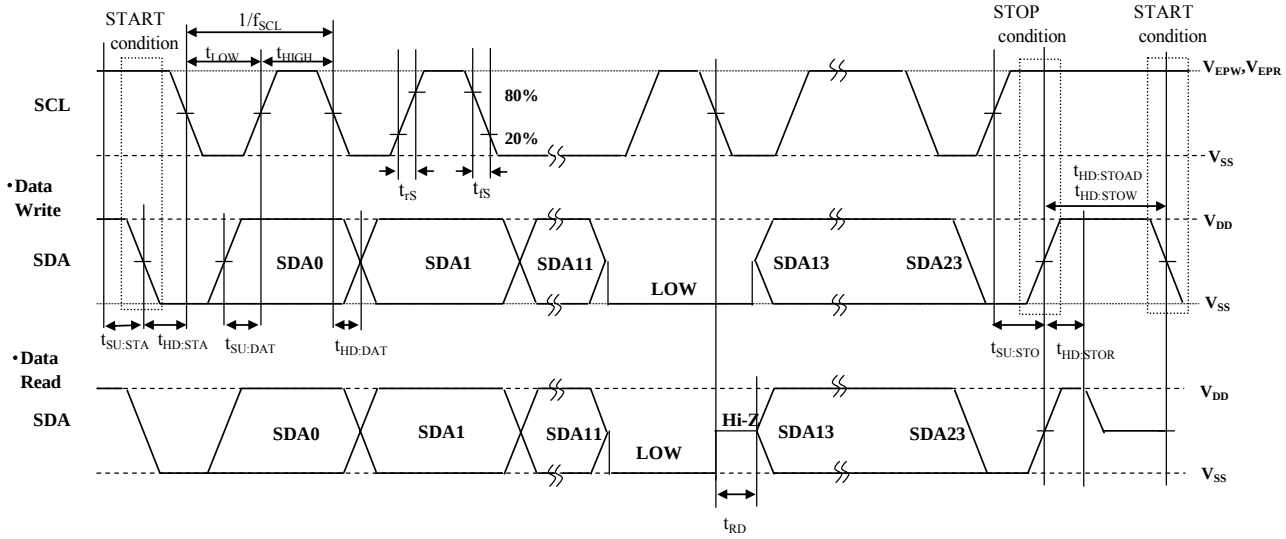


AC Characteristics 2

(2-wire type serial interface: When accessing to the temperature compensation control register or EEPROM)

V_{DD}=2.0 to 5.5V, V_{SS}=0V, V_{EPW}=19.0 to 20.0V, V_{EPR}=V_{DD}+1.7V to 20.0V, T_a=-40 to +105°C unless otherwise noted.

Parameter	Symbol	Conditions	Rating			Unit
			MIN	TYP	MAX	
SCL clock frequency	f_{SCL}	After start condition			500	kHz
Start condition setup time	$t_{SU;STA}$	-	0.3			µs
Start condition hold time	$t_{HD;STA}$	-	0.3			µs
Data setup time	$t_{SU;DAT}$	-	0.3			µs
Data hold time	$t_{HD;DAT}$	-	0.3			µs
Stop condition setup time	$t_{SU;STO}$	-	0.3			µs
Stop condition hold time	$t_{HD;STOW}$	EEPROM write mode	40			ms
	$t_{HD;STOAD}$	Execute AD conversion	8.1			ms
	$t_{HD;STOR}$	EEPROM read mode, Access the registers	0.2			µs
SCL "L" period	t_{LOW}	-	1			µs
SCL "H" period	t_{HIGH}	-	1			µs
SCL rise time	t_{rS}	20%→80%			0.2	µs
SCL fall time	t_{fS}	80%→20%			0.2	µs
Read data delay time	t_{RD}	C_{LOUT}=15pF			0.5	µs



FUNCTIONAL DESCRIPTION

INHN Function

Q outputs 32.768kHz when INHN goes "H" level. Q outputs Hi-Z and the oscillator circuit works when INHN goes "L" level. Please input the voltage of V_{IH1} or V_{IL1} to INHN certainly.

INHN	Q	Oscillator	Remarks
"H" level	32.768kHz	Operating	-
"L" level	Hi-Z	Operating	-
OPEN	-	-	Prohibit

Temperature Compensation Function

Built-in capacitance for crystal oscillation is the capacitance array. This is controlled by CL registers to adjust frequency. The data of EEPROM which makes the detection temperature of an internal thermometer an address is periodically stored in CL register. The adjustment data which becomes frequency constant to temperature is written in EEPROM. These data will change the value of built-in oscillator capacitance to adjust frequency. The temperature compensation interval is selected from 2sec or 0.5sec. This function doesn't depend on INHN=L or H.

Power Activation

It is the power-on clear circuit built-in. This circuit sets 200/H to CL registers at power activation. After starting oscillation, the first temperature compensation function will be worked at 0.5sec. After that, CL registers are set the data from EEPROM by selected temperature compensation interval. The boot function works to 0.5sec after starting oscillation from power activation.

TEMPERATURE COMPENSATION REGISTERS AND EEPROM TABLE

Address	Data										
A[7:0]	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
00h	-	DAD1	DAD0	AD7	AD6	AD5	AD4	AD3	AD2	AD1	AD0
01h	STA	TCL	WM1	WM0	TOSC	-	-	TS3	TS2	TS1	TS0
02h	-	-	TSC	CRC1	CRC0	CR5	CR4	CR3	CR2	CR1	CR0
03h	CL10	CL9	CL8	CL7	CL6	CL5	CL4	CL3	CL2	CL1	CL0
08h	-	-	T8	T7	T6	T5	T4	T3	T2	T1	T0
10h	C10	C9	C8	C7	C6	C5	C4	C3	C2	C1	C0
18h	Temerature compensation data（Address10h to F8h ［C10 to C0］）										
20h											
28h											
・											
・											
・											
F0h											
F8h											

*. The double line indicates EEPROM field.

Internal Registers

AD register

Address	Function	bit10	bit9	bit8	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
00h	A/D converter	-	DAD1	DAD0	AD7	AD6	AD5	AD4	AD3	AD2	AD1	AD0

● AD[7:0] bits

These are an A/D conversion result output bits of a temperature sensor. These are read only.

Maximum temperature setup is [0001 0000]. Minimum temperature setup is [1111 1111].

● DAD[1:0] bits

These are 2 LSB bits less than A/D conversion result, AD[7:0]. The data of AD and DAD is concatenated. Then, it becomes a 10-bit A/D conversion.

TS register

Address	Function	bit10	bit9	bit8	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
01h	for test	STA	TCL	WM1	WM0	TOSC	-	-	TS3	TS2	TS1	TS0

● TS[3:0] bits

These are the bits for test of our company. Please always write 0 when you write the data to these bits.

But, when you measure CR oscillation frequency to adjust analog circuit, please write 4h to TS[3:0].

Then, Q outputs CR oscillation signal. Please measure it and determine the adjustment data of CR oscillation frequency.

● TOSC bit, WM[1:0] bit, TCL bit

These are the bits for test of our company. Please always write 0 when you write the data to these bits.

● STA bit

This register is for AD conversion start up.

AD conversion starts when 1 is written in this bit, and then it will be finished after 8.1msec.

Normal intermittent operation is stopped by starting serial communication. And, AD conversion starts to use the data from serial communication. Please don't write and read from serial interface while AD conversion operates. Please access it after 8.1msec for next operation.

CR register

Address	Function	bit10	bit9	bit8	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
02h	analog circuit compensation data	-	-	TSC	CRC1	CRC0	CR5	CR4	CR3	CR2	CR1	CR0

● TSC bit

This is the register of the temperature compensation interval setup. .

T8 data of EEPROM is written in here during a normal function. The temperature compensation interval is 0.5sec when 0 is written in here, and it is 2sec when 1 is written in here.

● CR[5:0] bits, CRC[1:0] bits

These bits adjust CR oscillation frequency of temperature sensor. Please set the data to CRC/CR bits in the using temperature compensation ranges. The compensation data is the following table.

<table>
<tr><th>Field</th><th colspan="8">Description</th><th>Initial value</th></tr>
<tr><td rowspan="11">CR[5:0]
(T[5:0])</td><td colspan="8">CR oscillation frequency adjustment register
Written the trimming data T[5:0] in normal operation.

* Adjust CR oscillation frequency to near the below frequency by changing CR[5:0] at T_a=25°C. And then, write the adjustment CR data to T[5:0] in EEPROM.
・Temperature compensation range -40 to +85°C : 59kHz@25°C
・Temperature compensation range -40 to +105°C : 53.6kHz@25°C</td><td rowspan="11">000000</td></tr>
<tr><td>CR5</td><td>CR4</td><td>CR3</td><td>CR2</td><td>CR1</td><td>CR0</td><td colspan="2">CR oscillation frequency</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td colspan="2">No adjustment</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td colspan="2">+8.4%</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td colspan="2">+16.8%</td></tr>
<tr><td colspan="8">CR oscillation frequency adjustment step 8.4% 6bits</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td><td>1</td><td colspan="2">+512.4%</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td><td colspan="2">+520.8%</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td colspan="2">+529.2%</td></tr>
<tr><td>CRC[1:0]
(T[7:6])</td><td colspan="8">Initial setting data for counter of AD conversion
Written the trimming data T[7:6] in normal operation.
* Please write the below data to T[7:6] in EEPROM
・Temperature compensation range -40 to +85°C : 11
・Temperature compensation range -40 to +105°C : 00</td><td>00</td></tr>
</table>

CL register

Address	Function	bit10	bit9	bit8	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
03h	set C_L load capacitance	CL10	CL9	CL8	CL7	CL6	CL5	CL4	CL3	CL2	CL1	CL0

● CL bits

This register is for setting the C_L load capacitance of crystal oscillator when you acquire the adjustment data of temperature compensation.

EEPROM data

Address	Function	bit10	bit9	bit8	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
08h	analog circuit compensation data	-	-	T8	T7	T6	T5	T4	T3	T2	T1	T0
10h	set C_L load capacitance in oscillator	C10	C9	C8	C7	C6	C5	C4	C3	C2	C1	C0
18h		C10	C9	C8	C7	C6	C5	C4	C3	C2	C1	C0
20h		C10	C9	C8	C7	C6	C5	C4	C3	C2	C1	C0
28h		C10	C9	C8	C7	C6	C5	C4	C3	C2	C1	C0
・		・	・	・	・	・	・	・	・	・	・	・
・		・	・	・	・	・	・	・	・	・	・	・
・		・	・	・	・	・	・	・	・	・	・	・
F8h		C10	C9	C8	C7	C6	C5	C4	C3	C2	C1	C0

● T bits

This is the analog circuit compensation data. Please write the adjustment CRC data and CR data in T[7:0]. T8 is for the temperature compensation interval setup. The temperature compensation interval is 0.5sec when 0 is written in here, and it is 2sec when 1 is written in here.

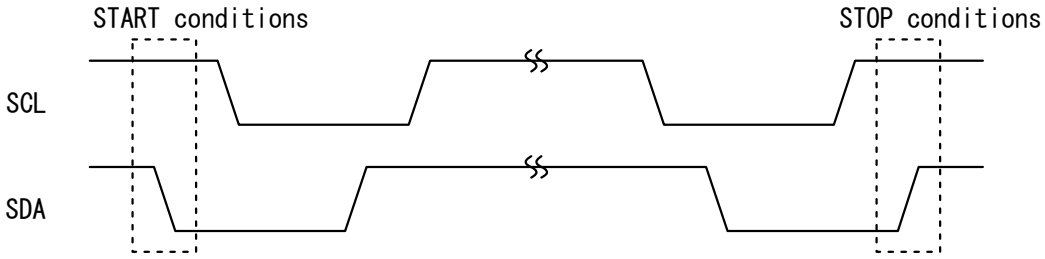
● C bits

This is the set value of C_L load capacitance of crystal oscillator. Please write the adjustment data for temperature compensation.

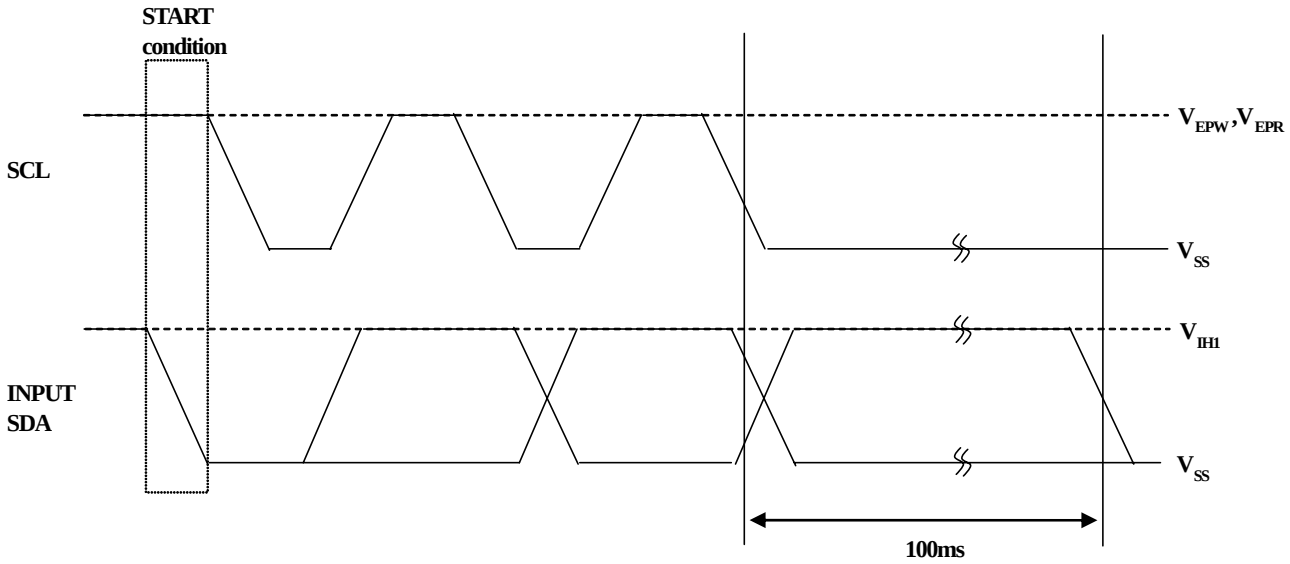
* About EEPROM data, please write the data to all address and all bits under predetermined conditions.
And it prohibited the accessing to the addresses except the above address.
Note that the data of 200H is written to each address in shipping this device.

2-WIRE TYPE SERIAL INTERFACE

While serial interface is not performing data transfer, SCL and SDA are High level. At this time, if SDA changed from High to Low, the state will be in START condition. After detecting START condition, it is possible to start access and to perform data transmission. And, when SCL is high level, if SDA changed from Low to High, the state will be in STOP condition. After detecting STOP condition, access is finished. These conditions are recognized on the way of data transfer too. Please make these conditions at the data transfer start timing and end timing. About the data transfer format, please refer to the next page.



WF5095A transmits and receives data by the 2-wire type serial interface of SCL (INHN: clock line) and SDA (Q: data line). High level of SCL is V_{IH2} and High level of SDA is V_{IH1}. Q output is disabled after receiving START condition and the operation code. The load resistance of Q pin is about 300Ω. In accessing, please drive by the buffer whose resistance is lower than this enough. If there is no clock input of 100ms or more in SCL on the way of communication, the interface is initialized and communication is finished.



***:When SCL isn't change from L state to H state for 100ms, the interface will be initialized automatically**

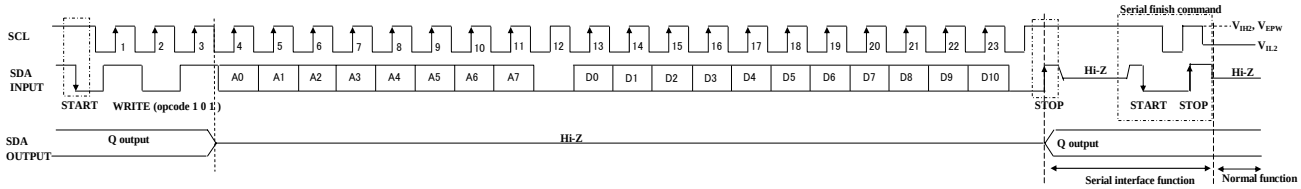
Data transmission Format of Temperature Compensating Control Register and EEPROM

Data transmission format of temperature compensating control register and EEPROM is the below. Please transmit from LSB data first.

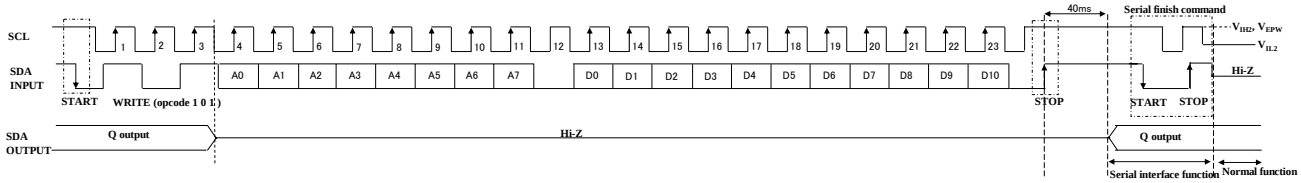
Data Write-in Format

The transmitter transmits 23 bits of WRITE opcode (101), an address and a data after start condition. And then, it transmits STOP condition. The data of registers are written in synchronizing with the rising edge of 23rd SCL clock. EEPROM is written by EEPROM write-in circuit. EEPROM write-in circuit starts after detecting STOP condition and write-in time takes 40msec. Please keep SCL and SDA of STOP condition (SCL=V_{EPW}, SDA=V_{IH1}) for 40msec. And, to finish serial communication, it needs to execute the procedure that is START condition - STOP condition - set V_{IL2} to SCL - release SDA (Hi-Z). But, continuation writing does not need this procedure.

Write-in the register

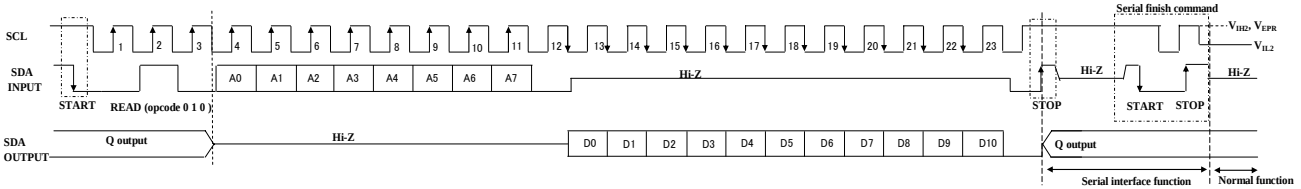


Write-in the EEPROM



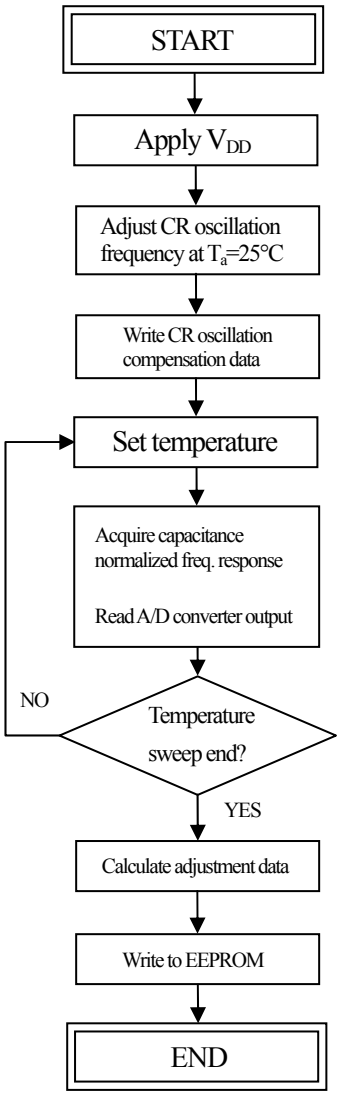
Data Read-out Format

The transmitter transmits 12 bits of READ opcode (010), an address and 1bit of Low after start condition. And, it releases SDA (Hi-Z) at the falling edge of 12th SCL clock. The receiver sends out the read data in synchronizing with the falling edge of 12th SCL clock. To finish serial communication, it needs to execute the same procedure as the above.



Temperature Compensation Adjustment Flow Chart

(Temperature compensation range: -40 to +85°C)



-Adjust CR oscillation frequency to near 59kHz
by changing CR[5:0] at T_a=25°C. Refer to the next page.

-Write the adjustment data to T[7:0]
T[7:6]=11
T[5:0]=CR[5:0]= the adjustment data of 59kHz

-Vary the oscillator circuit load capacitance CL, and determine the optimum load capacitance CL. Refer to the next page.

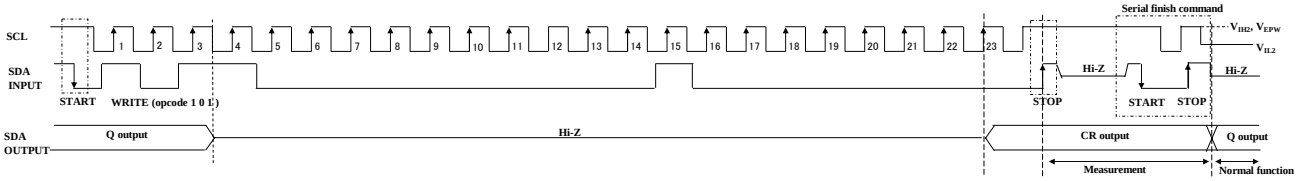
-Obtain the A/D converter output at the specified temperature.
To write 1 in STA bit start A/D conversion and finish it after 8.1msec.
It is recommended that data be obtained several times and then averaged.

-Calculate all the data for temperature compensation adjustment from the data points acquired above.

-Write the data of TSC, CRC, CR and the temperature compensation adjustment data to each address of EEPROM in T_a=20 to 105°C.

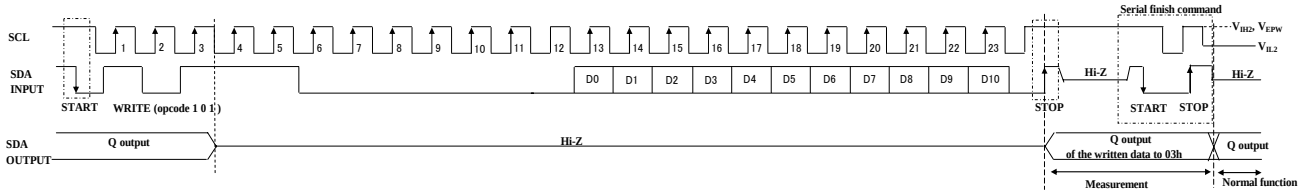
Adjust CR oscillation frequency

Write 004h to address 01h to confirm CR oscillation frequency. After confirm it, please complete the end procedure of serial communication. Refer to page 11.



Acquire capacitance normalized data

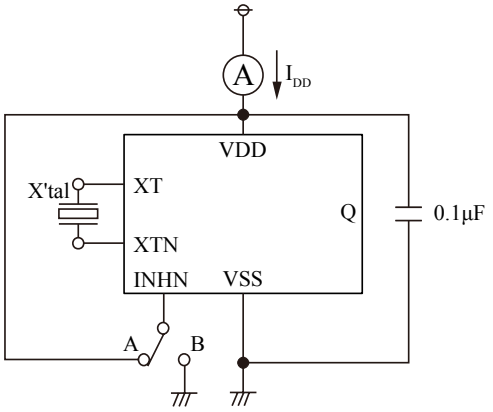
Write CL load capacitance data to address 03h. After recognized STOP condition, Q outputs crystal oscillation frequency with CL load capacitance data of address 03h. Please determine the optimum load capacitance by changing the data of address 03h.



MEASUREMENT CIRCUITS

MEASUREMENT CIRCUIT 1

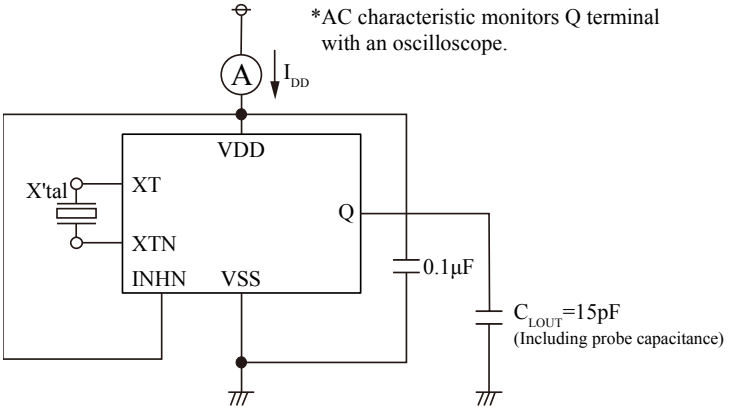
Measurement Parameter: $I_{DD11\ to\ 14}$, $I_{DD21\ to\ 24}$, $I_{BOOT1,2}$, $I_{DIS1,2}$



A: $I_{DD11\ to\ 14}$, $I_{DD21\ to\ 24}$, $I_{BOOT1,2}$
B: $I_{DIS1,2}$

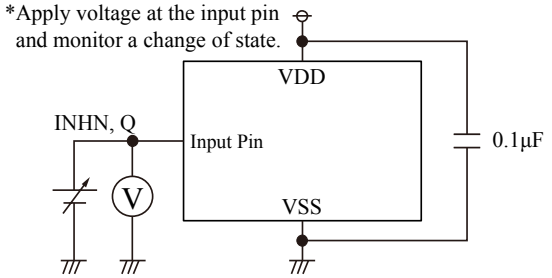
MEASUREMENT CIRCUIT 2

Measurement Parameter: $I_{DD15\ to\ 18}$, $I_{DD25\ to\ 28}$, $Duty_{1,2}$, t_r, t_f



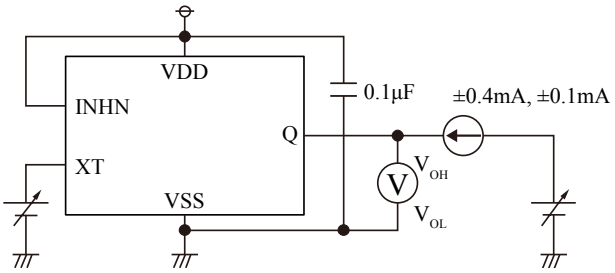
MEASUREMENT CIRCUIT 3

Measurement Parameter: V_{IH1}, V_{IH2}, V_{IL1}, V_{IL2}



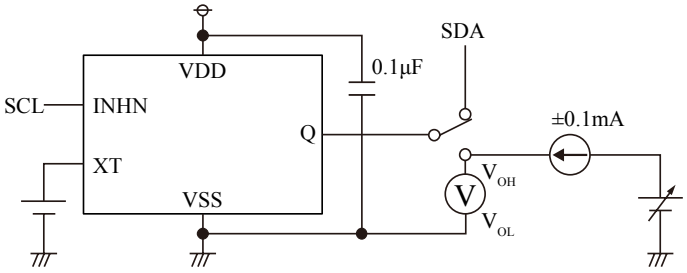
MEASUREMENT CIRCUIT 4

Measurement Parameter: $V_{OH1,2}$, $V_{OL1,2}$



MEASUREMENT CIRCUIT 5

Measurement Parameter: V_{OH3}, V_{OL3}



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