

### OVERVIEW

The WF5091A is a 32.768kHz output crystal oscillator module IC with built-in frequency adjustment functions by EEPROM. The WF5091A is ideal for wide range of operating supply voltage, low current consumption, low jitter, crystal oscillator module.

### FEATURES

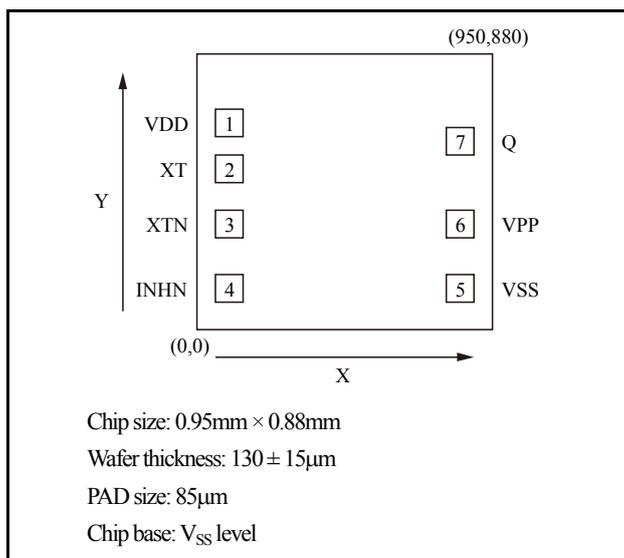
- Oscillation and output frequency: 32.768kHz
- Wide range of operating supply voltage: 1.2 to 5.5V
- Operating temperature of oscillation operation: -40 to +85°C
- Low current consumption: 1μA typ. ( $V_{DD}=3.3V$ , no load)
- CMOS input / output
- $\pm 0.4mA$  output drive capability ( $V_{DD}=3.3V$ )
- $f_0$  adjustment function by EEPROM (3-wire serial interface)
- Output disable function

### ORDERING INFORMATION

Device	Package
WF5091A	Wafer form

**PAD LAYOUT**

(Unit:  $\mu\text{m}$ )

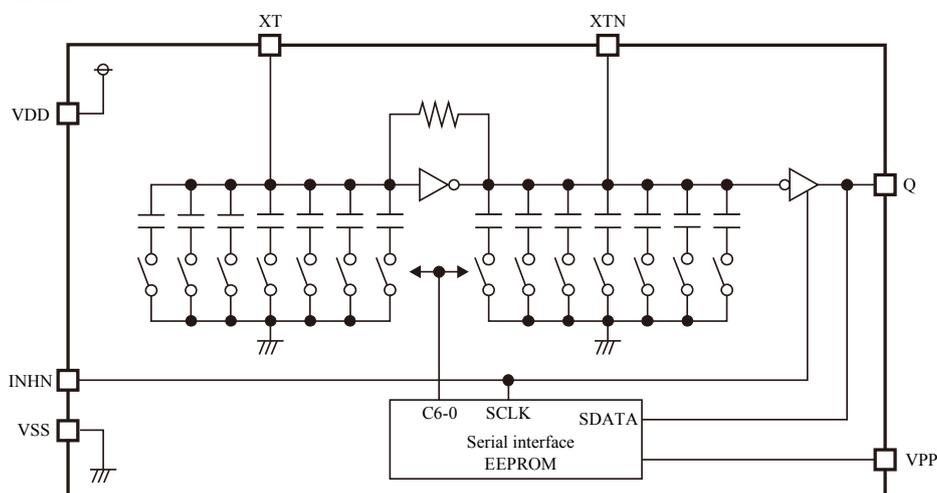


**PIN DESCRIPTION and PAD COORDINATES**

No.	PIN	I/O <sup>*1</sup>	Description	PAD coordinate [ $\mu\text{m}$ ]	
				X	Y
1	VDD	-	(+) supply voltage	112.5	648.8
2	XT	I	Crystal input connection pin	112.5	514.8
3	XTN	O	Crystal output connection pin	112.5	332.2
4	INHN (SCLK)	I	Input pin controlled output state (Hi-Z output at LOW, 32.768kHz output at HIGH, OPEN connection prohibit) SCLK (Clock input) pin in serial interface mode	112.5	120.5
5	VSS	-	(-) ground	837.5	120.5
6	VPP	-	Serial interface enable pin HIGH: serial interface mode (EEPROM read/write), LOW or OPEN: normal mode Pull-down resistor built-in	837.5	332.2
7	Q (SDATA)	I/O	32.768kHz output pin SDATA (Data input/output) pin in serial interface mode	837.5	596.5

\*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 <sup>*1</sup>	$V_{DD}$	Between VDD and VSS	-0.3 to +6.5	V
Program supply voltage <sup>*1</sup>	$V_{PP}$	Between VPP and VSS	-0.3 to +22.0	V
Input voltage 1 <sup>*1*2</sup>	$V_{IN}$	Q pin	-0.3 to $V_{DD}+0.3$	V
Input voltage 2 <sup>*1</sup>	$V_{IN2}$	INH pin	-0.3 to +6.5	V
Output voltage <sup>*1*2</sup>	$V_{OUT}$	Q pin	-0.3 to $V_{DD}+0.3$	V
Output current <sup>*3</sup>	$I_{OUT}$	Q pin	$\pm 3$	mA
Junction temperature <sup>*3</sup>	$T_j$	-	+125	°C
EEPROM rewrite cycles <sup>*3</sup>	$N_{EW}$	-	100	times
Storage temperature <sup>*4</sup>	$T_{STG}$	-	-65 to +150	°C

\*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. Do not exceed the absolute maximum ratings. If they are exceeded, a characteristic and reliability will be degraded.

\*4. When stored in nitrogen or vacuum atmosphere applied to IC itself only (excluding packaging materials).

### Recommended Operating Conditions

$V_{SS}=0V$

Parameter	Symbol	Conditions	Rating			Unit
			MIN	TYP	MAX	
Operating supply voltage	$V_{DD}$	Between VDD and VSS <sup>*1</sup>	1.2		5.5	V
Input voltage	$V_{IN}$	Input pins	$V_{SS}$		$V_{DD}$	V
Program supply voltage	$V_{PPW}$	VPP pin, EEPROM write mode $T_a=25^\circ C$ , $V_{DD}=3.0$ to $3.6V$	19.0		20.0	V
	$V_{PPR}$	VPP pin, EEPROM read mode $T_a=25^\circ C$ , $V_{DD}=3.0$ to $3.6V$	$1.8V_{DD}$		7.0	
Operating temperature	$T_a$	Condensation free	-40		+85	°C

\*1. Mount a ceramic chip capacitor that is larger than  $0.1\mu F$  proximal to IC between VDD and VSS in order to obtain stable operation of WF5091A. In addition, the wiring pattern between IC and capacitor should be as wide as possible.

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

$V_{DD}=1.2$  to  $5.5V$ ,  $V_{SS}=0V$ ,  $T_a=-40$  to  $+85^\circ C$ ,  $C_{LOUT}=15pF$  unless otherwise noted.

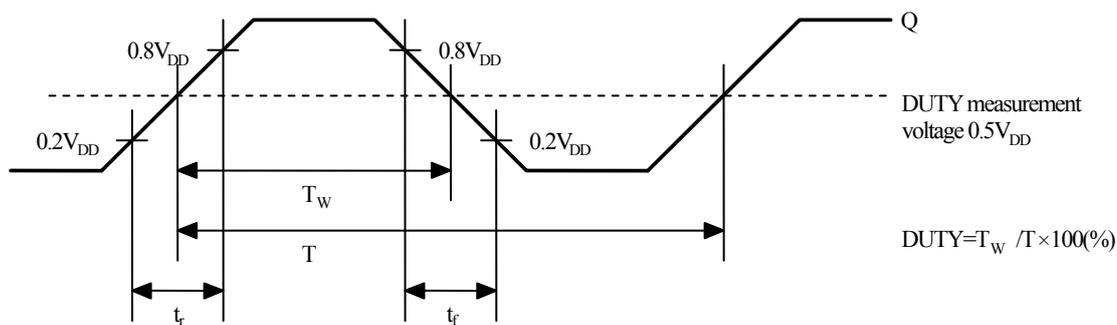
Parameter	Symbol	Conditions	Rating			Unit
			MIN	TYP	MAX	
Operating current consumption	$I_{DD1}$	Measurement circuit 1, $C_{LOUT}=0pF$ INHN='H', $V_{DD}=3.3V$		1.0	2.0	$\mu A$
		Measurement circuit 1, $C_{LOUT}=0pF$ INHN='H', $V_{DD}=5.5V$		1.7	3.2	
	$I_{DD2}$	Measurement circuit 2, $C_{LOUT}=15pF$ INHN='H', $V_{DD}=3.3V$		2.7	3.7	
		Measurement circuit 2, $C_{LOUT}=15pF$ INHN='H', $V_{DD}=5.5V$		4.4	5.9	
Current consumption in boot function	$I_{BOOT}$	Measurement circuit 1, boot*1 $C_{LOUT}=0pF$ , $V_{DD}=3.3V$		1.5	2.5	$\mu A$
Current consumption in disable function	$I_{DIS}$	Measurement circuit 1, INHN=Low, $V_{DD}=3.3V$		0.9	1.5	$\mu A$
High-level output voltage	$V_{OH}$	Measurement circuit 4, $I_{OH}=-0.4mA$ $1.5V \leq V_{DD} \leq 5.5V$	$V_{DD}-0.4$			V
		Measurement circuit 4, $I_{OH}=-0.1mA$ $1.2V \leq V_{DD} < 1.5V$	$V_{DD}-0.4$			
Low-level output voltage	$V_{OL}$	Measurement circuit 4, $I_{OL}=0.4mA$ $1.5V \leq V_{DD} \leq 5.5V$			0.4	V
		Measurement circuit 4, $I_{OL}=0.1mA$ $1.2V \leq V_{DD} < 1.5V$			0.4	V
High-level input voltage 1	$V_{IH1}$	Measurement circuit 5, INHN pin $1.2V \leq V_{DD} < 1.5V$	$0.8V_{DD}$			V
		Measurement circuit 5, INHN pin $1.5V \leq V_{DD} \leq 5.5V$	$0.7V_{DD}$			
Low-level input voltage 1	$V_{IL1}$	Measurement circuit 5, INHN pin $1.2V \leq V_{DD} < 1.5V$			$0.2V_{DD}$	V
		Measurement circuit 5, INHN pin $1.5V \leq V_{DD} \leq 5.5V$			$0.3V_{DD}$	
High-level input voltage 2	$V_{IH2}$	Measurement circuit 5, VPP pin, $T_a=25^\circ C$ $V_{DD}=3.0$ to $3.6V$	$1.8V_{DD}$			V
Low-level input voltage 2	$V_{IL2}$	Measurement circuit 5, VPP pin, $T_a=25^\circ C$ $V_{DD}=3.0$ to $3.6V$			$1.3V_{DD}$	V
VPP pull-down resistor	$R_{pd}$			100		$k\Omega$

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

## AC Characteristics 1 (Clock Output Characteristics)

$V_{DD}=1.2$  to  $5.5V$ ,  $V_{SS}=0V$ ,  $T_a=-40$  to  $+85^\circ C$ ,  $C_{LOUT}=15pF$  unless otherwise noted.

Parameter	Symbol	Conditions	Rating			Unit
			MIN	TYP	MAX	
Output duty cycle	DUTY	Measurement circuit 2 $1.2V \leq V_{DD} \leq 5.5V$ , $V_{th}=0.5V_{DD}$	45	50	55	%
Output rise time	$t_r$	Measurement circuit 2 $0.2V_{DD} \rightarrow 0.8V_{DD}$			200	ns
Output fall time	$t_f$	Measurement circuit 2 $0.8V_{DD} \rightarrow 0.2V_{DD}$			200	ns
Output enable delay time	$t_{OE}$	Measurement circuit 3 INH $\bar{N}$ ="L" $\rightarrow$ "H"			16	$\mu s$
Output disable delay time	$t_{OD}$	Measurement circuit 3 INH $\bar{N}$ ="H" $\rightarrow$ "L"			16	$\mu s$

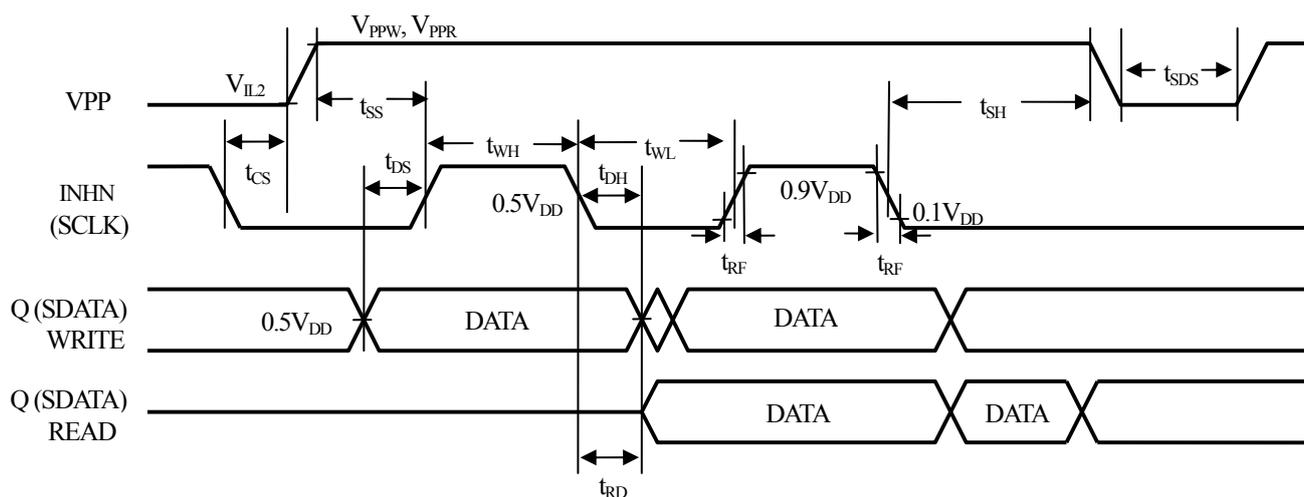


Output switching waveform

## AC Characteristics 2 (Serial Interface Characteristics)

$V_{DD}=3.0$  to  $3.6V$ ,  $V_{SS}=0V$ ,  $T_a=25^\circ C$ ,  $C_{LOUT}=5pF$  unless otherwise noted.

Parameter	Symbol	Conditions	Rating			Unit
			MIN	TYP	MAX	
VPP setup time	$t_{SS}$		1			$\mu s$
VPP hold time	$t_{SH}$		1			$\mu s$
VPP deselect time	$t_{SDS}$		1			$\mu s$
SCLK setup time	$t_{CS}$		1			$\mu s$
SCLK HIGH-level pulse width	$t_{WH}$	EEPROM write mode	20			ms
		EEPROM read mode	2			$\mu s$
SCLK LOW-level pulse width	$t_{WL}$	EEPROM write mode	2			$\mu s$
		EEPROM read mode	2			$\mu s$
SCLK rise/fall time	$t_{RF}$	$0.1V_{DD}-0.9V_{DD}$ , $0.9V_{DD}-0.1V_{DD}$			100	ns
Write data setup time	$t_{DS}$		1			$\mu s$
Write data hold time	$t_{DH}$		1			$\mu s$
Read data delay time	$t_{RD}$	$C_{LOUT}=5pF$			1	$\mu s$



Serial interface timing chart

Note. EEPROM read/write in serial interface mode is limited to  $V_{DD}=3.0$  to  $3.6V$ .

## FUNCTIONAL DESCRIPTION

### INH Function

Q outputs 32.768kHz when INHN connects HIGH level. Q outputs Hi-Z and the oscillator circuit works when INHN connects LOW level. Oscillation does not stop. Always ensure to input  $V_{IH1}$  or  $V_{IL1}$  to INHN.

INH	Q	Oscillator	Remarks
HIGH	32.768kHz	Operating	-
LOW	Hi-Z	Operating	-
OPEN	-	-	Prohibit

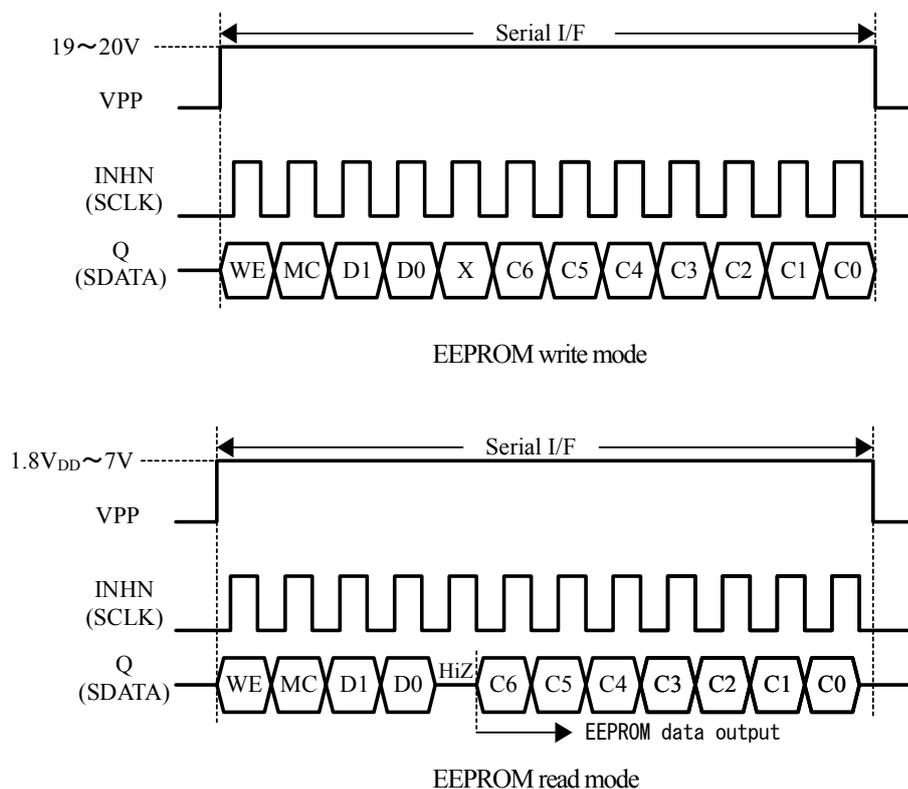
### EEPROM Program Specification

#### Serial interface only for an EEPROM program

The WF5091A transfers data using a 3-wire serial interface only for an EEPROM. Oscillation frequency can be adjusted by setting up oscillation part capacitor using this serial interface.

EEPROM read/write in serial interface mode is limited to  $V_{DD}=3.0$  to  $3.6V$ .

#### Timing chart of serial interface



When VPP input voltage rise above  $V_{IH2}$ , the IC enters serial interface mode. In serial interface mode, INHN is the clock input (SCLK), and Q is the data input/output (SDATA).

In EEPROM write mode, VPP input voltage should be  $V_{PPW}$  (19 to 20V), and SDATA is written in HIGH-level of SCLK.

In EEPROM read mode, VPP input voltage should be  $V_{PPR}$  (1.8V<sub>DD</sub> to 7.0V), and EEPROM data is output on the falling edge of the 5th clock pulse of SCLK.

When the VPP input voltage falls bellow  $V_{IH2}$  or open, normal operation resumes.\*1

\*1. When the VPP input voltage rises above 7V, data may be rewritten.

**Serial interface bit description**

(1)WE, MC

Operation mode setup

WE	MC	Operation mode	Note
0	0	EEPROM read mode	Internal EEPROM data read mode. Used to check EEPROM write status.
1	0	EEPROM write mode	Internal EEPROM data write mode. Unless VPP input voltage is V <sub>PPW</sub> (19 to 20V), EEPROM write is not performed normally.
0	1	Test mode	IC test mode.
1	1		Since this mode is the mode for IC test, use of this mode is prohibition.

Note. SCLK HIGH-level pulse width ( $t_{WH}$ ) after MC bit should be over 20ms in EEPROM write mode.

(2)D1, D0

Fixed bit. "D1" and "D0" should set up "0".

(3)X

Don't care bit. "X" set up "0" or "1".

(4)C6 to C0 (C[6:0])

Capacitance setting bit for  $f_0$  adjustment.C<sub>LOSC</sub> increments as the code increment every 1LSB. Refer to the following table for a setup.

Bit	Function		Capacitance (pF)	
	"1"	"0"	XT	XTN
C0	ON	OFF	0.14	0.14
C1	ON	OFF	0.28	0.28
C2	ON	OFF	0.56	0.56
C3	ON	OFF	1.12	1.12
C4	ON	OFF	2.24	2.24
C5	ON	OFF	4.48	4.48
C6	ON	OFF	8.96	8.96

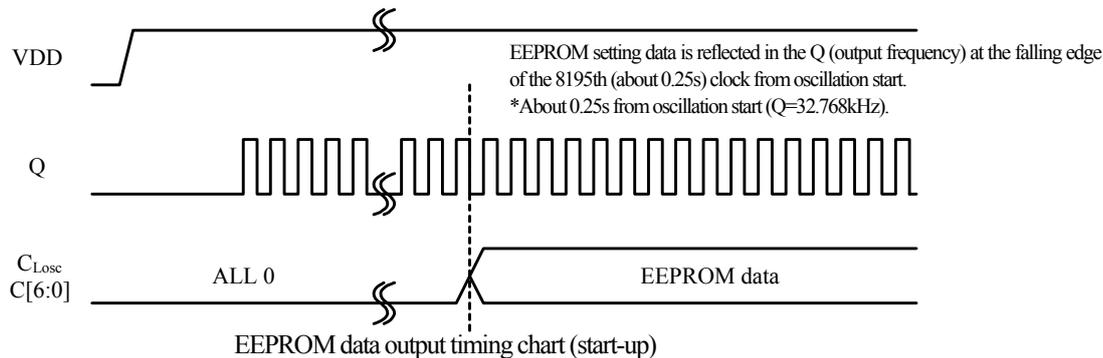
C<sub>LOSC</sub>: Oscillator circuit equivalent load capacitance

Also oscillator circuit load capacitance 6.0pF (Max) is added between XT and XTN.

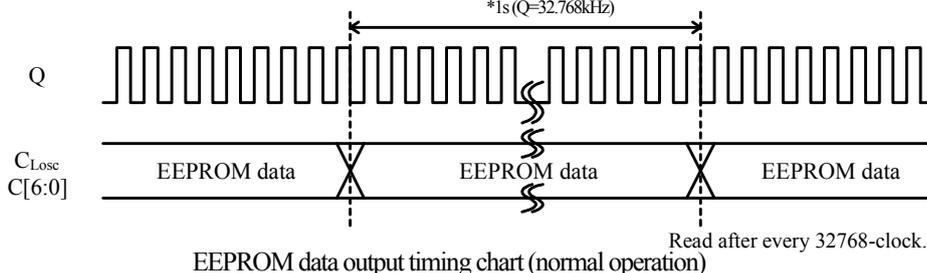
**EEPROM (f<sub>0</sub> adjustment) data setting timing chart**

EEPROM data is read at the following timing inside IC.

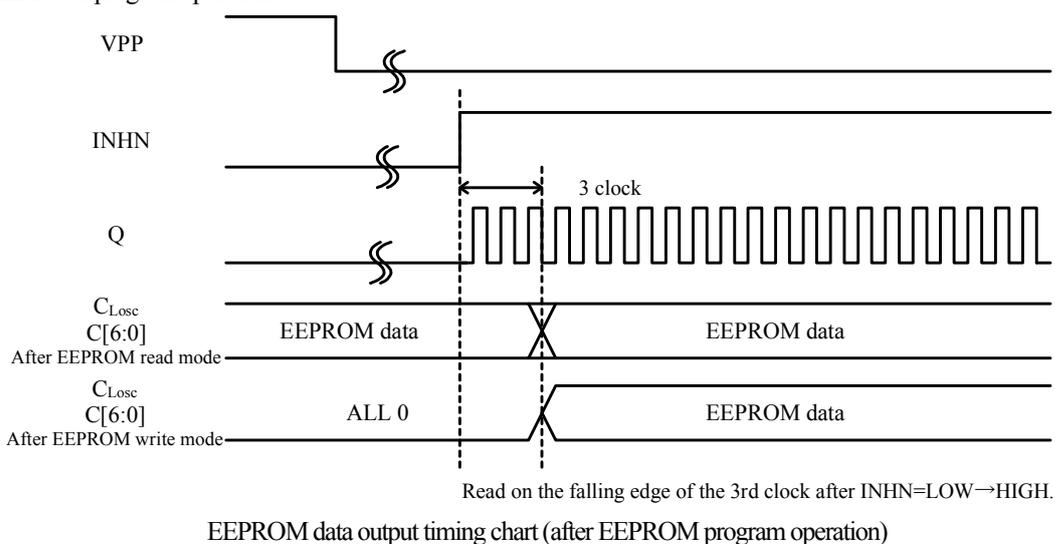
(1)Start-up



(2)Normal operation

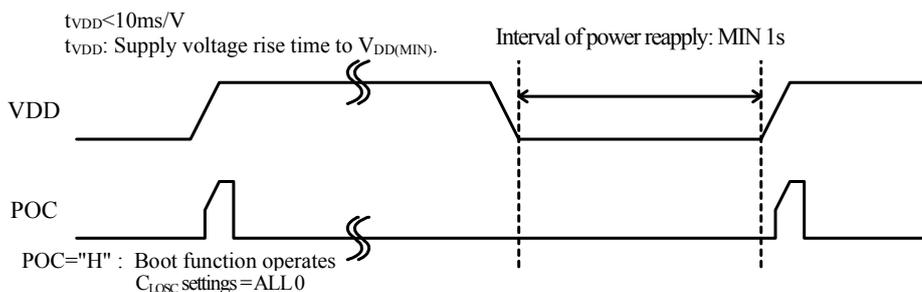


(3)After EEPROM program operation



**Power On Clear (POC) Function**

The WF5091A has a power-on-clear function.

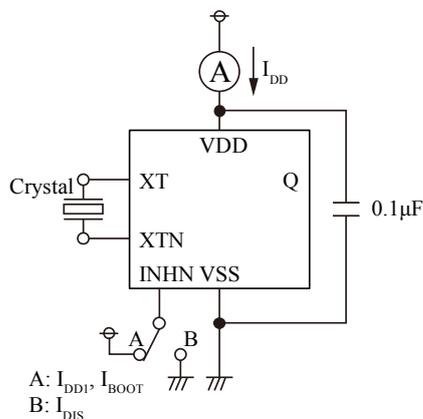


Interval of power reapply should be more than 1s.

## MEASUREMENT CIRCUITS

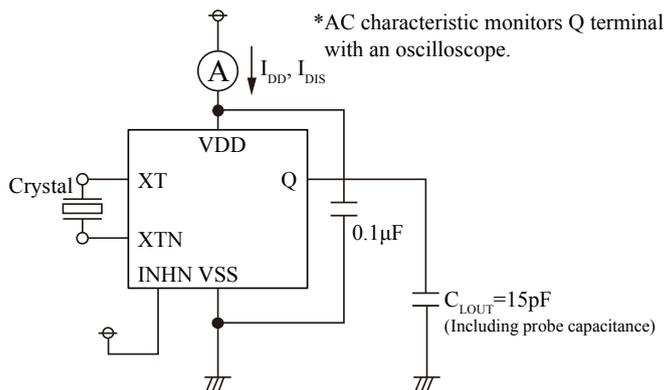
### MEASUREMENT CIRCUIT 1

Measurement Parameter:  $I_{DD1}$ ,  $I_{BOOT}$ ,  $I_{DIS}$



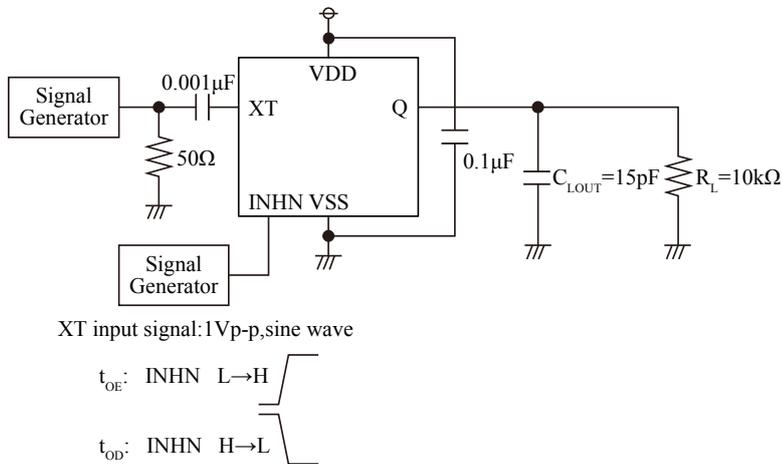
### MEASUREMENT CIRCUIT 2

Measurement Parameter:  $I_{DD2}$ , DUTY,  $t_r$ ,  $t_f$



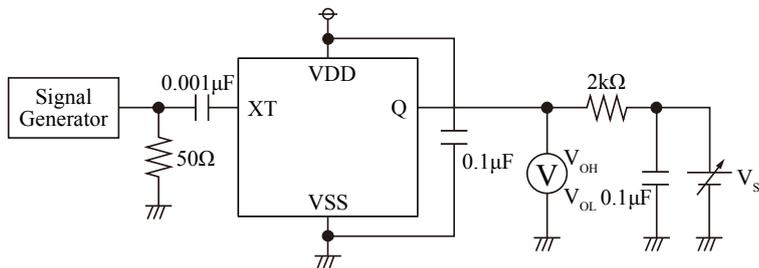
### MEASUREMENT CIRCUIT 3

Measurement Parameter:  $t_{OE}$ ,  $t_{OD}$

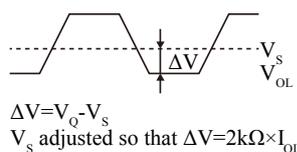
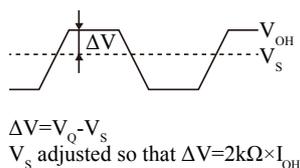


### MEASUREMENT CIRCUIT 4

Measurement Parameter:  $V_{OH}$ ,  $V_{OL}$



XT input signal: 1Vp-p, sine wave

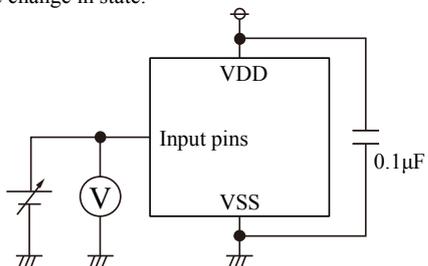


### MEASUREMENT CIRCUIT 5

Measurement Parameter:  $V_{IH}$ ,  $V_{IL}$

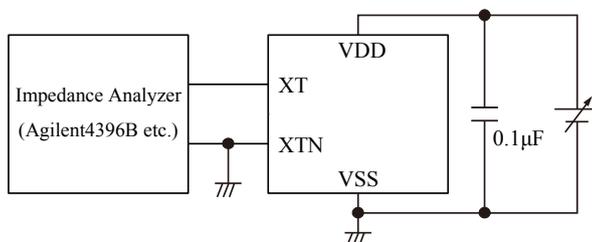
INHN, Q, VPP

\*Apply a voltage to input pins to monitor the change in state.



### MEASUREMENT CIRCUIT 6

Measurement Parameter:  $C_{LOSC}$



## DEFAULT EEPROM WRITE CODE

Devices are shipped with these values, but this code data set is not guaranteed. The EEPROM data retention deteriorates when subjected [exposed] to UV rays, high temperatures, plasma and other extremes. Strictly observe the following USAGE NOTES.

C6	C5	C4	C3	C2	C1	C0
0	1	1	0	0	1	1

## USAGE NOTES

### Writing All Bits in EEPROM

While NPC device EEPROM write code may be used as-is, we strongly urge that all bits in all registers be rewritten in EEPROM under the prescribed conditions at the customer's company.

Please pay your attention to the following points at time of using the products shown in this document.

1. The products shown in this document (hereinafter "Products") are designed and manufactured to the generally accepted standards of reliability as expected for use in general electronic and electrical equipment, such as personal equipment, machine tools and measurement equipment. The Products are not designed and manufactured to be used in any other special equipment requiring extremely high level of reliability and safety, such as aerospace equipment, nuclear power control equipment, medical equipment, transportation equipment, disaster prevention equipment, security equipment. The Products are not designed and manufactured to be used for the apparatus that exerts harmful influence on the human lives due to the defects, failure or malfunction of the Products. If you wish to use the Products in that apparatus, please contact our sales section in advance.  
In the event that the Products are used in such apparatus without our prior approval, we assume no responsibility whatsoever for any damages resulting from the use of that apparatus.
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