NIPPON PRECISION CIRCUITS INC.

SM5002L series
Crystal Oscillator Module ICs

OVERVIEW

The SM5002L series crystal oscillator module ICs fabricated in NPC's Molybdenum-gate CMOS. They comprise low-voltage low-current consumption oscillator circuits and output buffers. They incorporate built-in oscillation capacitance with superior frequency response to realize stable 3rd overtone oscillation without any external components.

FEATURES

- Oscillation frequency up to 100 MHz
- Third harmonic
- Capacitors C_G and C_D built-in
- Standby function (oscillator stops)
- 3 µA (typ) low standby current
- Inverter amplifier feedback resistance built-in
- $\overline{INH}$ pin pull-up resistance built-in
  - $\overline{INH}$= L : 2MΩ typ
  - $\overline{INH}$= H : 90kΩ typ
- CMOS input level
- 8 mA (V_{DD} = 3.0 V) output drive capability
- CMOS output duty level
- Output three-state function
- 2.7 to 3.6 V supply voltage
- Oscillator frequency output
- 8-pin SOP (SM5002L×S)
- Chip form (CF5002L×)

SERIES CONFIGURATION

Version	Recommended operating frequency range (MHz)	g_m (relative value)	Built-in capacitance		R_{f1} (kΩ)	C_f (pF)	Output duty level	Output current (mA)	Standby function
			C_G (pF)	C_D (pF)					
CF5002LA SM5002LAS	30 to 40	1.0	8	15	5.6	22	CMOS	8	Yes
CF5002LB SM5002LBS	40 to 50	1.5	8	15	4.7	22	CMOS	8	Yes
CF5002LC SM5002LCS	50 to 70	1.5	8	10	3.9	22	CMOS	8	Yes
CF5002LD SM5002LDS	70 to 90	2.0	8	10	3.9	22	CMOS	8	Yes
CF5002LE SM5002LES	85 to 100	2.0	8	10	2.7	22	CMOS	8	Yes
CF5002LF SM5002LFS	25 to 30	1.0	10	15	8.5	22	CMOS	8	Yes

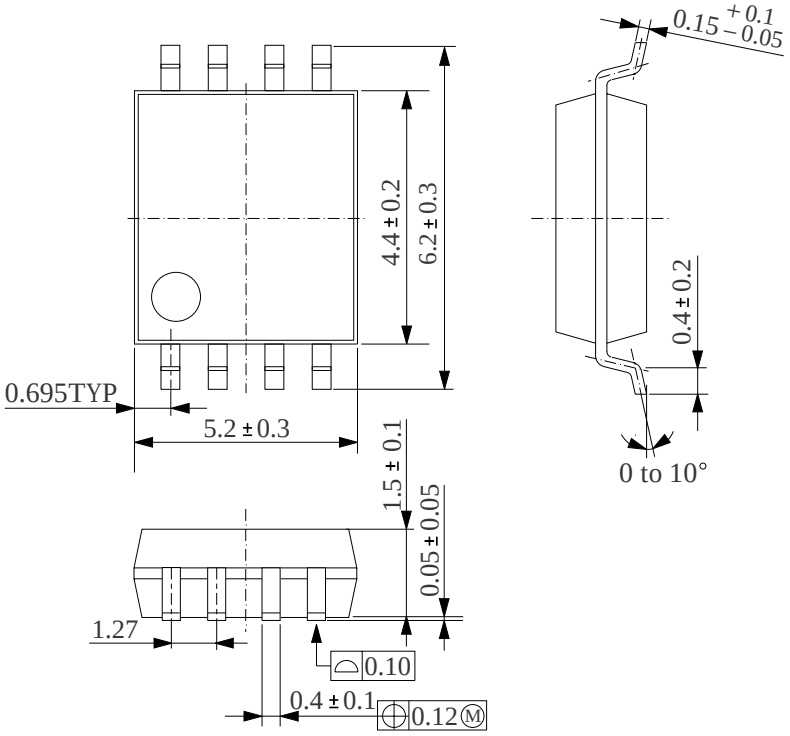
ORDERING INFORMATION

Device	Package
SM5002L×S	8-pin SOP
CF5002L×	Chip form

PACKAGE DIMENSIONS

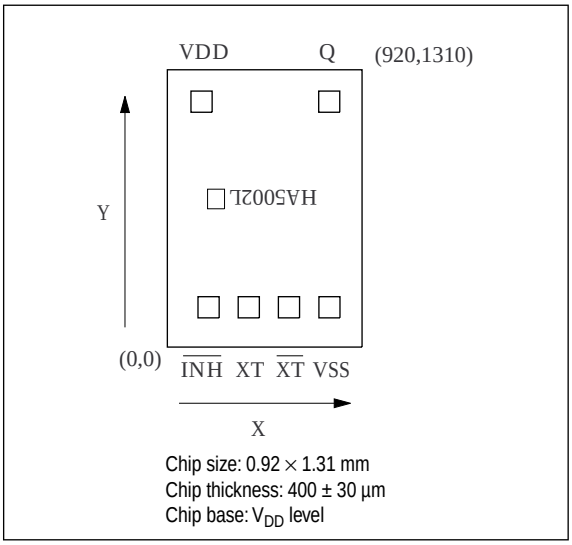
(UNIT : mm)

• 8-pin SOP



PAD LAYOUT

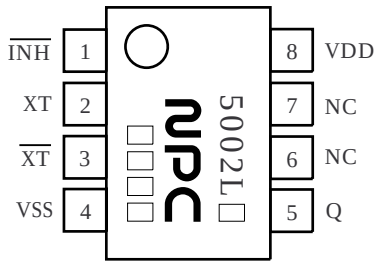
(Unit : µm)



Chip size: 0.92 × 1.31 mm
Chip thickness: 400 ± 30 µm
Chip base: V_{DD} level

PINOUT

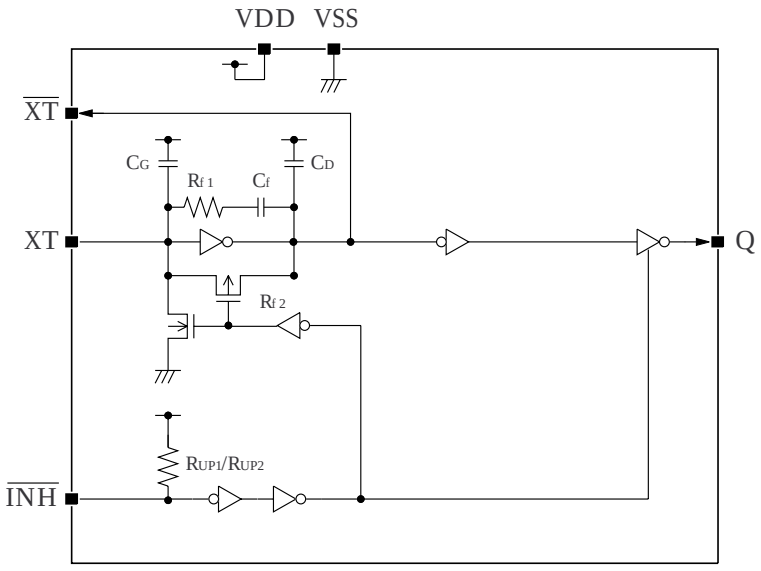
(Top View)



PIN DESCRIPTION and PAD DIMENSIONS

Number	Name	I/O	Description		Pad dimensions [µm]	
					X	Y
1	$\overline{INH}$	I	Output state control input. Oscillator stopped when LOW. Power-saving pull-up resistor built in		195	188
2	XT	I	Amplifier input.	Crystal oscillator connection pins. Crystal oscillator connected between XT and $\overline{XT}$	385	188
3	$\overline{XT}$	O	Amplifier output.		575	188
4	VSS	–	Ground		766	188
5	Q	O	Output. Output frequency. High impedance at standby operation		765	1159
6	NC	–	No connection		–	–
7	NC	–	No connection		–	–
8	VDD	–	Supply voltage		162	1159

BLOCK DIAGRAM



SPECIFICATIONS

Absolute Maximum Ratings

V_{SS} = 0 V unless otherwise noted.

Parameter	Symbol	Condition	Rating	Unit
Supply voltage range	V_{DD}		–0.5 to 7.0	V
Input voltage range	V_{IN}		–0.5 to V_{DD} + 0.5	V
Output voltage range	V_{OUT}		–0.5 to V_{DD} + 0.5	V
Operating temperature range	T_{opr}		–40 to 85	°C
Storage temperature range	T_{stg1}	Chip form	–65 to 150	°C
	T_{stg2}	8-pin SOP	–40 to 125	
Output current	I_{OUT}		25	mA
Power dissipation	P_D	Ta ≤ 85°C, 8-pin SOP	200	mW
Soldering temperature	T_{sld}	8-pin SOP	255	°C
Soldering time	t_{sld}	8-pin SOP	10	s

Recommended Operating Conditions

CF5002L× series (Chip form)

V_{SS} = 0 V unless otherwise noted.

Parameter	Symbol	Conditions	Limits			Units
			min	typ	max	
Supply voltage	V_{DD}	C_L ≤ 15pF, f ≤ 70 MHz	2.7	–	3.6	V
		C_L ≤ 15pF, 70 < f ≤ 100 MHz	3.0	–	3.6	V
		C_L ≤ 30pF, f ≤ 70 MHz	3.0	–	3.6	V
Input voltage	V_{IN}		V_{SS}	–	V_{DD}	V
Operating temperature	T_{OPR}		–20	–	80	°C

SM5002L×S series (8-pin SOP)

V_{SS} = 0 V unless otherwise noted.

Parameter	Symbol	Conditions	Limits			Units
			min	typ	max	
Supply voltage	V_{DD}	C_L ≤ 15pF, f ≤ 50 MHz	2.7	–	3.6	V
		C_L ≤ 15pF, 50 < f ≤ 70 MHz	3.0	–	3.6	V
		C_L ≤ 30pF, f ≤ 50 MHz	3.0	–	3.6	V
Input voltage	V_{IN}		V_{SS}	–	V_{DD}	V
Operating temperature	T_{OPR}		–20	–	80	°C

Electrical Characteristics

V_{DD} = 2.7 to 3.6 V, V_{SS} = 0 V, T_a = –20 to 80 °C, unless otherwise noted.

Parameter	Symbol	Conditions		Limits			Units
				min	typ	max	
HIGH-level output voltage	V_{OH}	Q: Measurement cct 1, V_{DD} = 2.7 V, I_{OH} = 8 mA		2.2	2.4	–	V
LOW-level output voltage	V_{OL}	Q: Measurement cct 2, V_{DD} = 2.7 V, I_{OL} = 8 mA		–	0.3	0.4	V
Output leakage current	I_Z	Q: Measurement cct 2, $\overline{INH}$ = LOW, V_{DD} = 3.6V	$V_{OH} = V_{DD}$	–	–	10	µA
			$V_{OL} = V_{SS}$	–	–	10	µA
HIGH-level input voltage	V_{IH}	$\overline{INH}$ pin		$0.7V_{DD}$	–	–	V
LOW-level input voltage	V_{IL}	$\overline{INH}$ pin		–	–	$0.3V_{DD}$	V
Current consumption	I_{DD}	$\overline{INH}$ = open, Measurement cct 3, load cct 1, V_{DD} = 3.0 to 3.6 V	SM5002LAS, SM5002LFS CF5002LA, CF5002LF C_L = 30 pF, f = 30 MHz	–	10	18	mA
			SM5002LBS, CF5002LB C_L = 30 pF, f = 50 MHz	–	15	25	mA
			SM5002LCS, CF5002LC C_L = 30 pF, f = 70 MHz	–	20	35	mA
			SM5002LDS, SM5002LES CF5002LD, CF5002LE C_L = 15 pF, f = 100 MHz	–	25	45	mA
Standby current	I_{ST}	$\overline{INH}$ = LOW, Measurement cct 3		–	3	10	µA
$\overline{INH}$ pull-up resistance	R_{UP1}	Measurement cct 4, $\overline{INH}$ = LOW		0.4	–	4	MΩ
	R_{UP2}	Measurement cct 4, $\overline{INH}$ = $0.7V_{DD}$		50	–	150	kΩ
AC feedback resistance	R_{f1}	Design value, determined by the internal wafer pattern	SM5002LAS, CF5002LA	4.7	5.6	6.5	kΩ
			SM5002LBS, CF5002LB	4.0	4.7	5.4	kΩ
			SM5002LCS, SM5002LDS CF5002LC, CF5002LD	3.3	3.9	4.5	kΩ
			SM5002LES, CF5002LE	2.2	2.7	3.2	kΩ
			SM5002LFS, CF5002LF	7.2	8.5	9.8	kΩ
DC feedback resistance	R_{f2}	Measurement cct 5		50	–	150	kΩ
AC feedback capacitance	C_f	Design value, determined by the internal wafer pattern		19.8	22	24.2	pF
Built-in capacitance	C_G	Design value, determined by the internal wafer pattern	SM5002LAS, CF5002LA SM5002LBS, CF5002LB SM5002LCS, CF5002LC SM5002LDS, CF5002LD SM5002LES, CF5002LE	7.2	8	8.8	pF
			SM5002LFS, CF5002LF	9	10	11	pF
	C_D		SM5002LAS, CF5002LA SM5002LBS, CF5002LB SM5002LFS, CF5002LF	13.5	15	16.5	pF
			SM5002LCS, CF5002LC SM5002LDS, CF5002LD SM5002LES, CF5002LE	9	10	11	pF

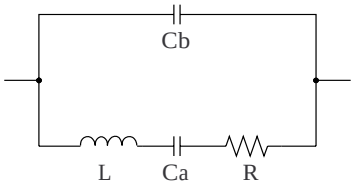
Switching Characteristics

V_{SS} = 0 V, T_a = –20 to 80 °C unless otherwise noted.

Parameter	Symbol	Conditions		Limits			Units
				min	typ	max	
Output rise time	t_{r1}	Measurement cct 3, load cct 1, $0.1V_{DD} \rightarrow 0.9V_{DD}$	V_{DD} = 2.7 to 3.6 V, C_L = 15 pF	–	2	4	ns
	t_{r2}		V_{DD} = 3.0 to 3.6 V, C_L = 30 pF	–	2.5	5	ns
Output fall time	t_{f1}	Measurement cct 3, load cct 1, $0.9V_{DD} \rightarrow 0.1V_{DD}$	V_{DD} = 2.7 to 3.6 V, C_L = 15 pF	–	2	4	ns
	t_{f2}		V_{DD} = 3.0 to 3.6 V, C_L = 30 pF	–	2.5	5	ns
Output duty cycle[1]	DUTY	Measurement cct 3, load cct 1, T_a = 25 °C, V_{DD} = 3.0 V	SM5002LAS, SM5002LFS CF5002LA, CF5002LF C_L = 30 pF, f = 30 MHz	45	–	55	%
			SM5002LBS, CF5002LB C_L = 30 pF, f = 50 MHz	45	–	55	%
			SM5002LCS, CF5002LC C_L = 30 pF, f = 70 MHz	45	–	55	%
			SM5002LDS, SM5002LES C_L = 15 pF, f = 100 MHz	40	–	60	%
			CF5002LD, CF5002LE C_L = 15 pF, f = 100 MHz	45	–	55	%
Output disable delay time[2]	t_{PLZ}	Measurement cct 6, T_a = 25 °C, V_{DD} = 2.7 V, load $C_L \leq$ 15 pF		–	–	100	ns
Output enable delay time[2]	t_{PZL}			–	–	100	ns

1. Monitored in sample lots.
2. Oscillator stop function is built-in. When $\overline{INH}$ goes LOW, normal output stops. When $\overline{INH}$ goes HIGH, normal output is not resumed until after the oscillator start-up time has elapsed.

Current consumption and Output waveform with NPC's standard crystal



f (MHz)	R (Ω)	L (mH)	Ca (fF)	Cb (pF)
30	18.62	16.24	1.733	5.337
50	22.17	7.40	1.370	4.105
70	25.42	4.18	1.254	5.170
100	16.60	3.56	0.726	5.394

FUNCTIONAL DESCRIPTION

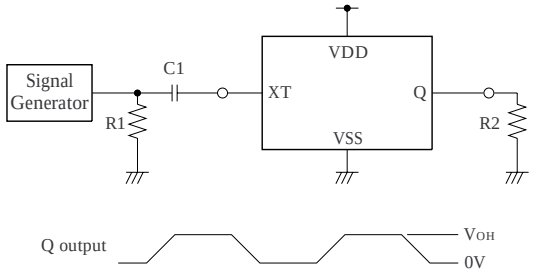
Standby Function

The oscillator stops when $\overline{INH}$ goes LOW. When the oscillator stops, the oscillator output on Q goes high impedance.

$\overline{INH}$	Q	Oscillator
HIGH (or open)	f_O output frequency	Normal operation
LOW	High impedance	Stopped

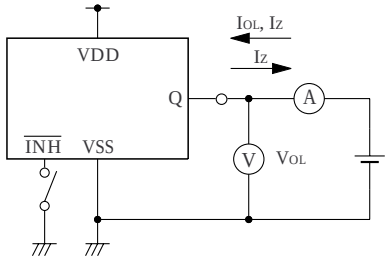
MEASUREMENT CIRCUITS

Measurement cct 1

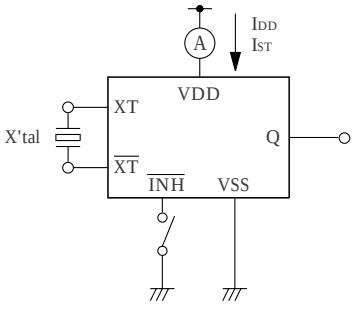


2.5V_{P-P} , 10MHz sine wave input signal
C1 : 0.001µF
R1 : 50Ω
R2 : 275Ω

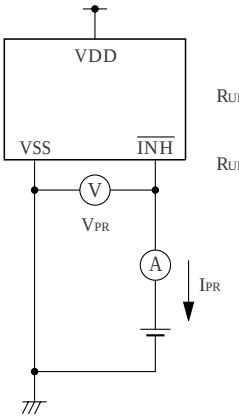
Measurement cct 2



Measurement cct 3



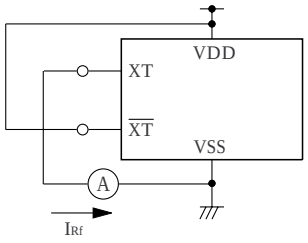
Measurement cct 4



$R_{UP1} = \frac{V_{DD}}{I_{PR}}$ ($V_{PR} = V_{SS}$)

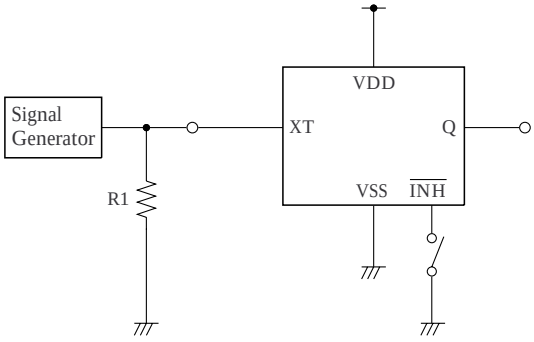
$R_{UP2} = \frac{V_{DD} - 0.7V_{DD}}{I_{PR}}$ ($V_{PR} = 0.7V_{DD}$)

Measurement cct 5



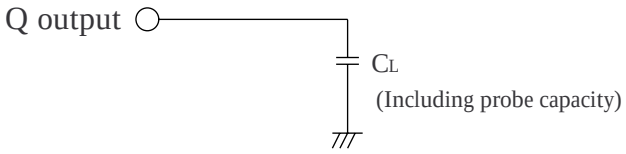
$R_{f2} = \frac{V_{DD}}{I_{Rf}}$

Measurement cct 6



R1 : 50Ω

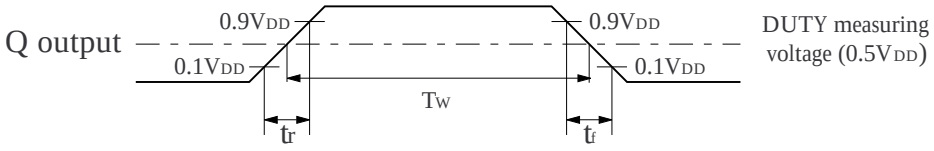
Load cct 1



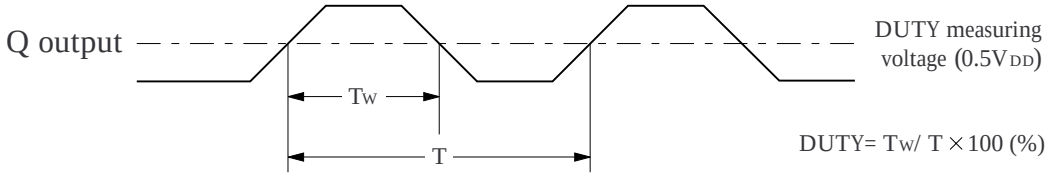
C_L = 15pF: t_{r1}, t_{f1} /DUTY, I_{DD} (70MHz < f ≤ 100MHz)
C_L = 30pF: t_{r2} , t_{f2} /DUTY, I_{DD} (f ≤ 70MHz)

Switching Time Measurement Waveform

Output duty level (CMOS)

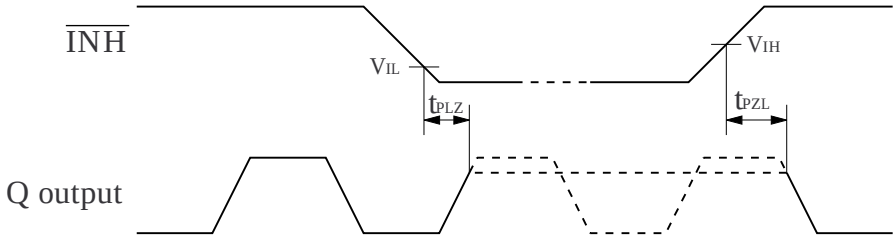


Output duty cycle (CMOS)



Output Enable/Disable Delay

The following figure shows the oscillator timing during normal operation. Note that when the device is in standby, the oscillator stops. When standby is released, the oscillator starts and stable oscillator output occurs after a short delay.



$\overline{INH}$ inputwaveform $t_r = t_f$ ≤10ns

NPC
NIPPON PRECISION CIRCUITS INC.

NIPPON PRECISION CIRCUITS INC.

4-3, Fukuzumi 2-chome
Koto-ku, Tokyo 135-8430, Japan
Telephone: 03-3642-6661
Facsimile: 03-3642-6698

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