

OVERVIEW

The SM5009 series are crystal oscillator module ICs, that incorporate circuits to limit oscillator-stage current, controlling total current consumption. High-frequency capacitors are built-in, eliminating the need for external components to make a stable fundamental-harmonic oscillator.

FEATURES

- Capacitors C_G , C_D built-in
- Standby function
- 6 μ A typ ($V_{DD} = 5$ V) low standby current (SM5009AL \times S)
- Power-save pull-up resistor built-in (SM5009AL \times S)
- Inverter amplifier feedback resistor built-in
- 16 mA ($V_{DD} = 4.5$ V) drive capability (SM5009AK \times S, AL \times S, AN \times S, CN \times S)
- 4 mA ($V_{DD} = 4.5$ V) drive capability (SM5009AH \times S)
- Output three-state function
- 2.25 to 5.5 V supply voltage (CF5009AL \times)
- 2.7 to 5.5 V supply voltage (SM5009AH \times S, AL \times S, AN \times S, CN \times S)
- Oscillator frequency output (f_O , $f_O/2$, $f_O/4$, $f_O/8$, $f_O/16$, $f_O/32$ determined by internal connection)
- 8-pin SOP (SM5009 $\times\times\times$ S)
- Chip form (CF5009 $\times\times\times$)

SERIES CONFIGURATION

Version ^{1,2}	Supply voltage [V]	Output frequency	3V operating		5V operating		Built-in capacitance		Input level	Output duty level	Standby function
			Output load (max) [pF]	Recommended operating frequency range ³ [MHz]	Output load (max) [pF]	Recommended operating frequency range ⁴ [MHz]	C_G [pF]	C_D [pF]			
SM5009AH1S	2.7 to 5.5	f_O	15	16	15	30	6	10	TTL	CMOS	No
SM5009AH2S	2.7 to 5.5	$f_O/2$	15	16	15	30	6	10	TTL	CMOS	No
SM5009AH3S	2.7 to 5.5	$f_O/4$	15	16	15	30	6	10	TTL	CMOS	No
SM5009AH4S	2.7 to 5.5	$f_O/8$	15	16	15	30	6	10	TTL	CMOS	No
SM5009AK1S	4.5 to 5.5	f_O	-	-	15	40	6	10	TTL	TTL	No
SM5009AK2S	4.5 to 5.5	$f_O/2$	-	-	15	40	6	10	TTL	TTL	No
SM5009AN1S	2.7 to 5.5	f_O	30	40	50	40	6	10	TTL	CMOS	No
SM5009AN2S	2.7 to 5.5	$f_O/2$	30	40	50	40	6	10	TTL	CMOS	No
SM5009AN3S	2.7 to 5.5	$f_O/4$	30	40	50	40	6	10	TTL	CMOS	No
SM5009AN4S	2.7 to 5.5	$f_O/8$	30	40	50	40	6	10	TTL	CMOS	No
SM5009AN5S	2.7 to 5.5	$f_O/16$	30	40	50	40	6	10	TTL	CMOS	No
SM5009AN6S	2.7 to 5.5	$f_O/32$	30	40	50	40	6	10	TTL	CMOS	No
SM5009CN1S	2.7 to 5.5	f_O	15	30	50	30	6	10	TTL	CMOS	No
SM5009CN2S	2.7 to 5.5	$f_O/2$	15	30	50	30	6	10	TTL	CMOS	No
SM5009AL1S	2.7 to 5.5	f_O	30	40	50	40	6	10	CMOS	CMOS	Yes
SM5009AL2S	2.7 to 5.5	$f_O/2$	30	40	50	40	6	10	CMOS	CMOS	Yes
SM5009AL3S	2.7 to 5.5	$f_O/4$	30	40	50	40	6	10	CMOS	CMOS	Yes
SM5009AL4S	2.7 to 5.5	$f_O/8$	30	40	50	40	6	10	CMOS	CMOS	Yes
SM5009AL5S	2.7 to 5.5	$f_O/16$	30	40	50	40	6	10	CMOS	CMOS	Yes
SM5009AL6S	2.7 to 5.5	$f_O/32$	30	40	50	40	6	10	CMOS	CMOS	Yes

1. Chip form devices have designation CF5009 $\times\times\times$.

2. SM5009AH \times S: $V_{DD} = 4.5$ to 5.5V

SM5009AK \times S: $T_a = -20$ to +85°C

3. SM5009AH \times S, AN \times S, AL \times S: $T_a = -20$ to +80°C

SM5009CN \times S: $T_a = -10$ to +70°C

4. SM5009AN \times S, AL \times S: $T_a = -20$ to +80°C

Note: Recommended operating frequency is not the guaranteed value but is measured using NPC's standard crystal.

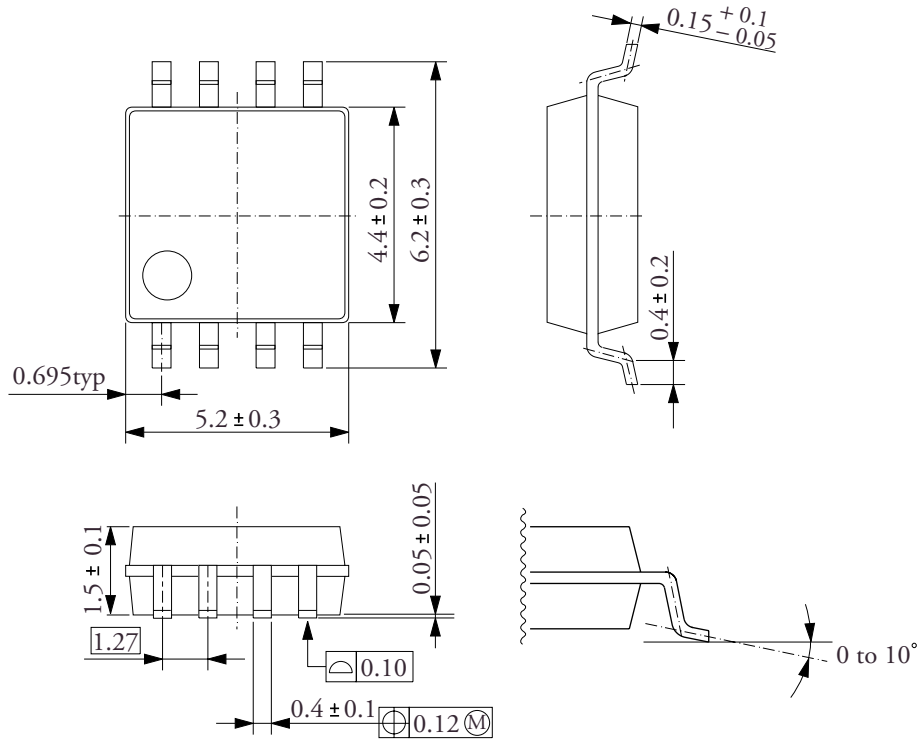
ORDERING INFORMATION

Device	Package
SM5009 $\times\times\times$ S	8-pin SOP
CF5009 $\times\times\times$ -1	Chip form

PACKAGE DIMENSIONS

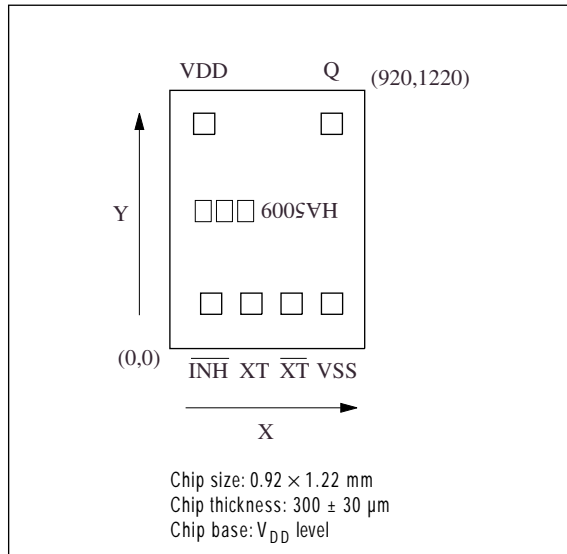
(Unit:mm)

- 8-pin SOP



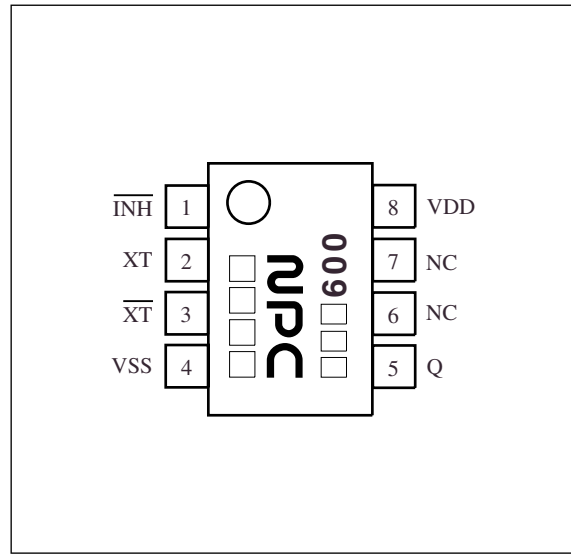
PAD LAYOUT

(Unit: μm)



PINOUT

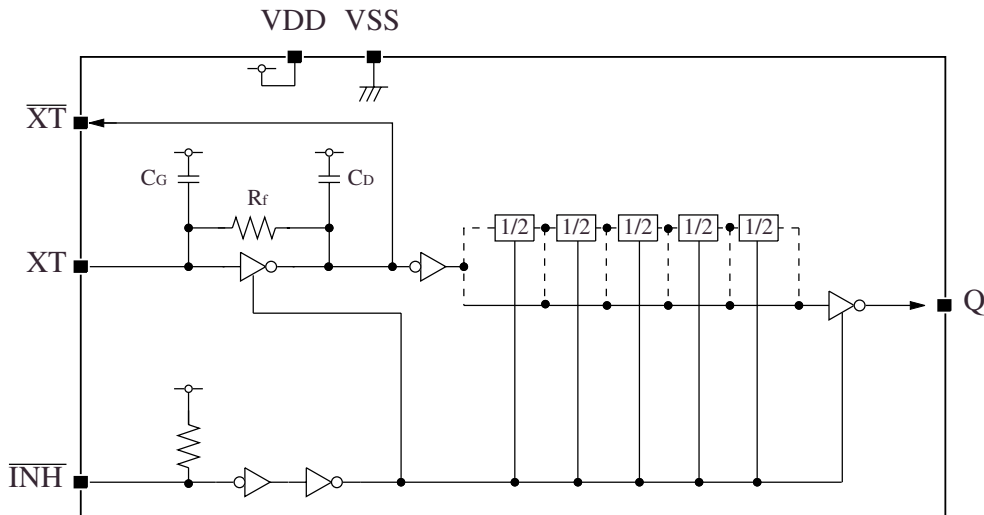
(Top view)



PIN DESCRIPTION and PAD DIMENSIONS

Number	Name	I/O	Description	Pad dimensions [μm]	
				X	Y
1	$\overline{\text{INH}}$	I	Output state control input. High impedance when LOW. In the case of the SM5009ALxS, the oscillator stops and Power-saving pull-up resistor built in.	195	212
2	XT	I	Amplifier input.	385	212
3	$\overline{\text{XT}}$	O	Amplifier output.		
Crystal oscillator connection pins. Crystal oscillator connected between XT and $\overline{\text{XT}}$				575	212
4	VSS	-	Ground	766	212
5	Q	O	Output. Output frequency ($f_0, f_0/2, f_0/4, f_0/8, f_0/16, f_0/32$) determined by internal connection	765	1062
6	NC	-	No connection	-	-
7	NC	-	No connection	-	-
8	VDD	-	Supply voltage	162	1062

BLOCK DIAGRAM



SPECIFICATIONS

Absolute Maximum Ratings

$$V_{SS} = 0 \text{ V}$$

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_{stg}	Chip form	-65 to 150	°C
		8-pin SOP	-55 to 125	
Output current	I_{OUT}		25	mA
Power dissipation	P_D	8-pin SOP	500	mW

Recommended Operating Conditions

$$V_{SS} = 0 \text{ V}$$

Parameter	Symbol	Series	Condition	Rating			Unit	
				min	typ	max		
Supply voltage	V_{DD}	AH series	$f \leq 30\text{MHz}$	4.5	-	5.5	V	
			$f \leq 16\text{MHz}$	2.7	-	3.3		
		AK series	$f \leq 40\text{MHz}$	4.5	-	5.5	V	
		AN series	$f \leq 40\text{MHz}$	2.7	-	5.5	V	
		CN series	$f \leq 30\text{MHz}$	2.7	-	5.5	V	
		AL series	Chip form	$f \leq 40\text{MHz}$	2.7	-	5.5	V
				$f \leq 30\text{MHz}$	2.3	-	2.7	
			8-pin SOP	$f \leq 20\text{MHz}$	2.25	-	2.75	
				$f \leq 14.4\text{MHz}$	2.4	-	2.7	
		Input voltage	V_{IN}	All series		V_{SS}	-	V_{DD}
Operating temperature	T_{OPR}	AH series	$f \leq 30\text{MHz}, 4.5\text{V} \leq V_{DD} \leq 5.5\text{V}$	-40	-	+85	°C	
			$f \leq 16\text{MHz}, 2.7\text{V} \leq V_{DD} \leq 3.6\text{V}$	-20	-	+80		
		AK series	$f \leq 30\text{MHz}$	-40	-	+85	°C	
			$30\text{MHz} < f \leq 40\text{MHz}$	-20	-	+80		
		AN series	Chip form	$f \leq 40\text{MHz}, 2.7\text{V} \leq V_{DD} < 4.5\text{V}$	-20	-	+80	°C
				$f \leq 40\text{MHz}, 4.5\text{V} \leq V_{DD} \leq 5.5\text{V}$	-40	-	+85	
			8-pin SOP	$f \leq 40\text{MHz}, 2.7\text{V} \leq V_{DD} < 4.5\text{V}$	-20	-	+80	
				$f \leq 40\text{MHz}, 4.5\text{V} \leq V_{DD} \leq 5.5\text{V}$	-20	-	+80	
		CN series	$f \leq 30\text{MHz}, 2.7\text{V} \leq V_{DD} < 4.5\text{V}$	-10	-	+70	°C	
			$f \leq 30\text{MHz}, 4.5\text{V} \leq V_{DD} \leq 5.5\text{V}$	-40	-	+85		
		AL series	Chip form	$f \leq 40\text{MHz}, 2.7\text{V} \leq V_{DD} \leq 5.5\text{V}$	-40	-	+85	°C
				$f \leq 30\text{MHz}, 2.3\text{V} \leq V_{DD} \leq 2.7\text{V}$	-20	-	+80	
				$f \leq 20\text{MHz}, 2.25\text{V} \leq V_{DD} \leq 2.75\text{V}$	-20	-	+80	
			8-pin SOP	$f \leq 40\text{MHz}, 2.7\text{V} \leq V_{DD} \leq 5.5\text{V}$	-20	-	+80	
				$f \leq 30\text{MHz}, 2.7\text{V} \leq V_{DD} \leq 5.5\text{V}$	-40	-	+85	
				$f \leq 14.4\text{MHz}, 2.4\text{V} \leq V_{DD} \leq 2.7\text{V}$	-20	-	+80	

Electrical Characteristics

5009AH series

3 V operation: $V_{DD} = 2.7$ to 3.3 V, $V_{SS} = 0$ V, $T_a = -20$ to 80 °C unless otherwise noted.

Parameter	Symbol	Condition	Rating			Unit	
			min	typ	max		
HIGH-level output voltage	V_{OH}	Q: Measurement cct 1, $I_{OH} = 2$ mA	2.2	-	-	V	
LOW-level output voltage	V_{OL}	Q: Measurement cct 1, $I_{OL} = 2$ mA	-	-	0.4	V	
Output leakage current	I_z	Q: Measurement cct 2, $\overline{INH} = \text{LOW}$, $V_{OH} = V_{DD}$	-	-	10	μA	
		Q: Measurement cct 2, $\overline{INH} = \text{LOW}$, $V_{OL} = V_{SS}$	-	-	10		
HIGH-level input voltage	V_{IH}	\overline{INH}	2.0	-	-	V	
LOW-level input voltage	V_{IL}	\overline{INH}	-	-	0.3	V	
Current consumption	I_{DD}	$\overline{INH} = \text{open}$, Measurement cct 3, load cct 2, $C_L = 15$ pF, 16 MHz crystal oscillator	SM5009AH1S CF5009AH1	-	4.5	10	mA
			SM5009AH2S CF5009AH2	-	3	7	
			SM5009AH3S CF5009AH3 SM5009AH4S CF5009AH4	-	1.5	3	
\overline{INH} pull-up resistance	R_{UP}	Measurement cct 4, $V_{DD} = 3$ V, $\overline{INH} = V_{SS}$	40	-	200	$\text{k}\Omega$	
Negative resistance	$-R_L$	$V_{DD} = 3$ V, $T_a = 25$ °C, 16 MHz	-	-450	-	Ω	
Feedback resistance	R_f	Measurement cct 5	0.4	-	1.1	$\text{M}\Omega$	
Built-in capacitance	C_G	Design value, determined by the internal wafer pattern	5.58	6	6.42	pF	
	C_D		9.3	10	10.7	pF	

5 V operation: $V_{DD} = 4.5$ to 5.5 V, $V_{SS} = 0$ V, $T_a = -40$ to 85 °C unless otherwise noted.

Parameter	Symbol	Condition	Rating			Unit	
			min	typ	max		
HIGH-level output voltage	V_{OH}	Q: Measurement cct 1, $I_{OH} = 4$ mA	4.0	-	-	V	
LOW-level output voltage	V_{OL}	Q: Measurement cct 1, $I_{OL} = 4$ mA	-	-	0.4	V	
Output leakage current	I_z	Q: Measurement cct 2, $\overline{INH} = \text{LOW}$, $V_{OH} = V_{DD}$	-	-	10	μA	
		Q: Measurement cct 2, $\overline{INH} = \text{LOW}$, $V_{OL} = V_{SS}$	-	-	10		
HIGH-level input voltage	V_{IH}	\overline{INH}	2.0	-	-	V	
LOW-level input voltage	V_{IL}	\overline{INH}	-	-	0.8	V	
Current consumption	I_{DD}	$\overline{INH} = \text{open}$, Measurement cct 3, load cct 2, $C_L = 15$ pF, 30 MHz crystal oscillator	SM5009AH1S CF5009AH1	-	9	20	mA
			SM5009AH2S CF5009AH2	-	6	13	
			SM5009AH3S CF5009AH3 SM5009AH4S CF5009AH4	-	4	9	
\overline{INH} pull-up resistance	R_{UP}	Measurement cct 4, $V_{DD} = 5$ V, $\overline{INH} = V_{SS}$	40	-	200	$\text{k}\Omega$	
Negative resistance	$-R_L$	$V_{DD} = 5$ V, $T_a = 25$ °C, 30 MHz	-	-340	-	Ω	
Feedback resistance	R_f	Measurement cct 5	0.4	-	1.1	$\text{M}\Omega$	
Built-in capacitance	C_G	Design value, determined by the internal wafer pattern	5.58	6	6.42	pF	
	C_D		9.3	10	10.7	pF	

SM5009 series

5009AK series

$V_{DD} = 4.5$ to 5.5 V, $V_{SS} = 0$ V, $T_a = -40$ to 85 °C unless otherwise noted.

Parameter	Symbol	Condition	Rating			Unit	
			min	typ	max		
HIGH-level output voltage	V_{OH}	Q: Measurement cct 1, $I_{OH} = 16$ mA	4.0	–	–	V	
LOW-level output voltage	V_{OL}	Q: Measurement cct 1, $I_{OL} = 16$ mA	–	–	0.4	V	
Output leakage current	I_Z	Q: Measurement cct 2, $\overline{INH} = \text{LOW}$, $V_{OH} = V_{DD}$	–	–	10	μA	
		Q: Measurement cct 2, $\overline{INH} = \text{LOW}$, $V_{OL} = V_{SS}$	–	–	10		
HIGH-level input voltage	V_{IH}	\overline{INH}	2.0	–	–	V	
LOW-level input voltage	V_{IL}	\overline{INH}	–	–	0.8	V	
Current consumption	I_{DD}	$\overline{INH} = \text{open}$, Measurement cct 3, load cct 1, $C_L = 15$ pF, 40 MHz crystal oscillator, $T_a = -20$ to $+80$ °C	SM5009AK1S	–	12	26	mA
			CF5009AK1	–	12	26	
			SM5009AK2S	–	8	17	
			CF5009AK2	–	8	17	
\overline{INH} pull-up resistance	R_{UP}	Measurement cct 4, $V_{DD} = 5$ V, $\overline{INH} = V_{SS}$	40	–	200	k Ω	
Negative resistance	$-R_L$	$V_{DD} = 5$ V, $T_a = 25$ °C, 40 MHz	–	–210	–	Ω	
Feedback resistance	R_f	Measurement cct 5	0.4	–	1.1	M Ω	
Built-in capacitance	C_G	Design value, determined by the internal wafer pattern	5.58	6	6.42	pF	
	C_D		9.3	10	10.7	pF	

SM5009 series

5009AL series

3 V operation: $V_{DD} = 2.7$ to 3.3 V, $V_{SS} = 0$ V, $T_a = -40$ to 85 °C unless otherwise noted.

Parameter	Symbol	Condition	Rating			Unit	
			min	typ	max		
HIGH-level output voltage	V_{OH}	Q: Measurement cct 1, $I_{OH} = 8$ mA	2.2	-	-	V	
LOW-level output voltage	V_{OL}	Q: Measurement cct 1, $I_{OL} = 8$ mA	-	-	0.4	V	
Output leakage current	I_Z	Q: Measurement cct 2, $\overline{INH} = LOW$, $V_{OH} = V_{DD}$	-	-	10	μA	
		Q: Measurement cct 2, $\overline{INH} = LOW$, $V_{OL} = V_{SS}$	-	-	10		
HIGH-level input voltage	V_{IH}	\overline{INH}	$0.7V_{DD}$	-	-	V	
LOW-level input voltage	V_{IL}	\overline{INH}	-	-	$0.3V_{DD}$	V	
Current consumption	I_{DD}	$\overline{INH} = open$, Measurement cct 3, load cct 2, $C_L = 15$ pF, 40 MHz crystal oscillator	CF5009AL1	-	8	17	mA
			CF5009AL2	-	5	11	
			CF5009AL3	-	4	9	
			CF5009AL4	-	3	7	
			CF5009AL5	-	3	6	
			CF5009AL6	-	2	5	
		$\overline{INH} = open$, Measurement cct 3, load cct 2, $C_L = 15$ pF, 40 MHz crystal oscillator, $T_a = -20$ to $+80$ °C	SM5009AL1S	-	8	17	
			SM5009AL2S	-	5	11	
			SM5009AL3S	-	4	9	
			SM5009AL4S	-	3	7	
			SM5009AL5S	-	3	6	
			SM5009AL6S	-	2	5	
Standby current	I_{ST}	$\overline{INH} = V_{SS}$, Measurement cct 3	-	2	5	μA	
\overline{INH} pull-up resistance	R_{UP1}	Measurement cct 4, $V_{DD} = 3$ V, $\overline{INH} = V_{SS}$	0.6	-	12	M Ω	
	R_{UP2}	Measurement cct 4, $V_{DD} = 3$ V, $\overline{INH} = 2.1$ V	40	-	200	k Ω	
Negative resistance	$-R_L$	$V_{DD} = 3$ V, $T_a = 25$ °C, 40 MHz	-	-200	-	Ω	
Feedback resistance	R_f	Measurement cct 5	0.4	-	1.1	M Ω	
Built-in capacitance	C_G	Design value, determined by the internal wafer pattern	5.58	6	6.42	pF	
	C_D		9.3	10	10.7	pF	

SM5009 series

5 V operation: $V_{DD} = 4.5$ to 5.5 V, $V_{SS} = 0$ V, $T_a = -40$ to 85 °C unless otherwise noted.

Parameter	Symbol	Condition	Rating			Unit	
			min	typ	max		
HIGH-level output voltage	V_{OH}	Q: Measurement cct 1, $I_{OH} = 16$ mA	4.0	–	–	V	
LOW-level output voltage	V_{OL}	Q: Measurement cct 1, $I_{OL} = 16$ mA	–	–	0.4	V	
Output leakage current	I_z	Q: Measurement cct 2, $\overline{INH} = \text{LOW}$, $V_{OH} = V_{DD}$	–	–	10	μA	
		Q: Measurement cct 2, $\overline{INH} = \text{LOW}$, $V_{OL} = V_{SS}$	–	–	10		
HIGH-level input voltage	V_{IH}	\overline{INH}	$0.7V_{DD}$	–	–	V	
LOW-level input voltage	V_{IL}	\overline{INH}	–	–	$0.3V_{DD}$	V	
Current consumption	I_{DD}	$\overline{INH} = \text{open}$, Measurement cct 3, load cct 2, $C_L = 15$ pF, 40 MHz crystal oscillator	CF5009AL1	–	12	26	mA
			CF5009AL2	–	8	17	
			CF5009AL3	–	6	13	
			CF5009AL4	–	5	11	
			CF5009AL5	–	5	10	
			CF5009AL6	–	4	9	
		$\overline{INH} = \text{open}$, Measurement cct 3, load cct 2, $C_L = 15$ pF, 40 MHz crystal oscillator, $T_a = -20$ to $+80$ °C	SM5009AL1S	–	12	26	
			SM5009AL2S	–	8	17	
			SM5009AL3S	–	6	13	
			SM5009AL4S	–	5	11	
			SM5009AL5S	–	5	10	
			SM5009AL6S	–	4	9	
Standby current	I_{ST}	$\overline{INH} = V_{SS}$, Measurement cct 3	–	6	15	μA	
\overline{INH} pull-up resistance	R_{UP1}	Measurement cct 4, $V_{DD} = 5$ V, $\overline{INH} = V_{SS}$	0.3	–	6	$\text{M}\Omega$	
	R_{UP2}	Measurement cct 4, $V_{DD} = 5$ V, $\overline{INH} = 3.5$ V	40	–	200	$\text{k}\Omega$	
Negative resistance	$-R_L$	$V_{DD} = 5$ V, $T_a = 25$ °C, 40 MHz	–	–400	–	Ω	
Feedback resistance	R_f	Measurement cct 5	0.4	–	1.1	$\text{M}\Omega$	
Built-in capacitance	C_G	Design value, determined by the internal wafer pattern	5.58	6	6.42	pF	
	C_D		9.3	10	10.7	pF	

SM5009 series

5009AN/CN series

3 V operation: $V_{DD} = 2.7$ to 3.3 V, $V_{SS} = 0$ V, $T_a = -20$ to 80 °C unless otherwise noted.

Parameter	Symbol	Condition	Rating			Unit	
			min	typ	max		
HIGH-level output voltage	V_{OH}	Q: Measurement cct 1, $I_{OH} = 8$ mA	SM5009AN1S, CF5009AN1 SM5009AN2S, CF5009AN2	2.2	-	-	V
			SM5009AN3S, CF5009AN3 SM5009AN4S, CF5009AN4 SM5009AN5S, CF5009AN5 SM5009AN6S, CF5009AN6 SM5009CN1S, CF5009CN1 SM5009CN2S, CF5009CN2	2.1	-	-	
LOW-level output voltage	V_{OL}	Q: Measurement cct 1, $I_{OL} = 8$ mA	-	-	0.4	V	
Output leakage current	I_Z	Q: Measurement cct 2, $\overline{INH} = \text{LOW}$, $V_{OH} = V_{DD}$	-	-	10	μA	
		Q: Measurement cct 2, $\overline{INH} = \text{LOW}$, $V_{OL} = V_{SS}$	-	-	10		
HIGH-level input voltage	V_{IH}	\overline{INH}	2.0	-	-	V	
LOW-level input voltage	V_{IL}	\overline{INH}	-	-	0.3	V	
Current consumption	I_{DD}	$\overline{INH} = \text{open}$, Measurement cct 3, load cct 2, $C_L = 15$ pF, 40 MHz crystal oscillator	SM5009AN1S, CF5009AN1	-	8	17	mA
			SM5009AN2S, CF5009AN2	-	5	11	
			SM5009AN3S, CF5009AN3	-	4	9	
			SM5009AN4S, CF5009AN4	-	3	7	
			SM5009AN5S, CF5009AN5	-	3	6	
			SM5009AN6S, CF5009AN6	-	2	5	
		$\overline{INH} = \text{open}$, Measurement cct 3, load cct 2, $C_L = 15$ pF, 30 MHz crystal oscillator, $T_a = -10$ to $+70$ °C	SM5009CN1S, CF5009CN1	-	7	15	
			SM5009CN2S, CF5009CN2	-	4	9	
\overline{INH} pull-up resistance	R_{UP}	Measurement cct 4, $V_{DD} = 3$ V, $\overline{INH} = V_{SS}$	40	-	200	k Ω	
Negative resistance	$-R_L$	$V_{DD} = 3$ V, $T_a = 25$ °C, 40 MHz	-	-100	-	Ω	
Feedback resistance	R_f	Measurement cct 5	0.4	-	1.1	M Ω	
Built-in capacitance	C_G	Design value, determined by the internal wafer pattern	5.58	6	6.42	pF	
	C_D		9.3	10	10.7	pF	

SM5009 series

5 V operation: $V_{DD} = 4.5$ to 5.5 V, $V_{SS} = 0$ V, $T_a = -40$ to 85 °C unless otherwise noted.

Parameter	Symbol	Condition	Rating			Unit	
			min	typ	max		
HIGH-level output voltage	V_{OH}	Q: Measurement cct 1, $I_{OH} = 16$ mA	SM5009AN1S, CF5009AN1 SM5009AN2S, CF5009AN2	4.0	-	-	V
			SM5009AN3S, CF5009AN3 SM5009AN4S, CF5009AN4 SM5009AN5S, CF5009AN5 SM5009AN6S, CF5009AN6 SM5009CN1S, CF5009CN1 SM5009CN2S, CF5009CN2	3.9	-	-	
LOW-level output voltage	V_{OL}	Q: Measurement cct 1, $I_{OL} = 16$ mA	-	-	0.4	V	
Output leakage current	I_Z	Q: Measurement cct 2, $\overline{INH} = LOW$, $V_{OH} = V_{DD}$	-	-	10	μ A	
		Q: Measurement cct 2, $\overline{INH} = LOW$, $V_{OL} = V_{SS}$	-	-	10		
HIGH-level input voltage	V_{IH}	\overline{INH}	2.0	-	-	V	
LOW-level input voltage	V_{IL}	\overline{INH}	-	-	0.8	V	
Current consumption	I_{DD}	$\overline{INH} = open$, Measurement cct 3, load cct 2, $C_L = 15$ pF, 40 MHz crystal oscillator	CF5009AN1	-	12	26	mA
			CF5009AN2	-	8	17	
			CF5009AN3	-	6	13	
			CF5009AN4	-	5	11	
			CF5009AN5	-	5	10	
			CF5009AN6	-	4	9	
		$\overline{INH} = open$, Measurement cct 3, load cct 2, $C_L = 15$ pF, 40 MHz crystal oscillator, $T_a = -20$ to $+80$ °C	SM5009AN1S	-	12	26	
			SM5009AN2S	-	8	17	
			SM5009AN3S	-	6	13	
			SM5009AN4S	-	5	11	
			SM5009AN5S	-	5	10	
			SM5009AN6S	-	4	9	
		$\overline{INH} = open$, Measurement cct 3, load cct 2, $C_L = 15$ pF, 30 MHz crystal oscillator	SM5009CN1S, CF5009CN1	-	10	22	
			SM5009CN2S, CF5009CN2	-	7	15	
\overline{INH} pull-up resistance	R_{UP}	Measurement cct 4, $V_{DD} = 5$ V, $\overline{INH} = V_{SS}$	40	-	200	k Ω	
Negative resistance	$-R_L$	$V_{DD} = 5$ V, $T_a = 25$ °C, 40 MHz	-	-210	-	Ω	
Feedback resistance	R_f	Measurement cct 5	0.4	-	1.1	M Ω	
Built-in capacitance	C_G	Design value, determined by the internal wafer pattern	5.58	6	6.42	pF	
	C_D		9.3	10	10.7	pF	

Switching Characteristics

5009AH series

3 V operation: $V_{DD} = 2.7$ to 3.3 V, $V_{SS} = 0$ V, $T_a = -20$ to 80 °C unless otherwise noted.

Parameter	Symbol	Condition	Rating			Unit
			min	typ	max	
Output rise time	t_{r1}	Measurement cct 3, load cct 2, $0.1V_{DD}$ to $0.9V_{DD}$, $C_L = 15$ pF	–	6	18	ns
Output fall time	t_{f1}	Measurement cct 3, load cct 2, $0.9V_{DD}$ to $0.1V_{DD}$, $C_L = 15$ pF	–	6	18	ns
Output duty cycle ¹	Duty	Measurement cct 3, load cct 2, $T_a = 25$ °C, $V_{DD} = 3$ V, $C_L = 15$ pF	45	–	55	%
Output disable delay time	t_{pLZ}	Measurement cct 6, load cct 2, $T_a = 25$ °C, $V_{DD} = 3$ V, $C_L \leq 15$ pF	–	–	100	ns
Output enable delay time	t_{pZL}		–	–	100	ns
Maximum operating frequency	f_{max}	Measurement cct 3	16	–	–	MHz

1. Determined by the lot monitor.

5 V operation: $V_{DD} = 4.5$ to 5.5 V, $V_{SS} = 0$ V, $T_a = -40$ to 85 °C unless otherwise noted.

Parameter	Symbol	Condition	Rating			Unit
			min	typ	max	
Output rise time	t_{r1}	Measurement cct 3, load cct 2, $0.1V_{DD}$ to $0.9V_{DD}$, $C_L = 15$ pF	–	4	12	ns
Output fall time	t_{f1}	Measurement cct 3, load cct 2, $0.9V_{DD}$ to $0.1V_{DD}$, $C_L = 15$ pF	–	4	12	ns
Output duty cycle ¹	Duty	Measurement cct 3, load cct 2, $T_a = 25$ °C, $V_{DD} = 5$ V, $C_L = 15$ pF	45	–	55	%
Output disable delay time	t_{pLZ}	Measurement cct 6, load cct 2, $T_a = 25$ °C, $V_{DD} = 5$ V, $C_L \leq 15$ pF	–	–	100	ns
Output enable delay time	t_{pZL}		–	–	100	ns
Maximum operating frequency	f_{max}	Measurement cct 3	30	–	–	MHz

1. Determined by the lot monitor.

5009AK series

$V_{DD} = 4.5$ to 5.5 V, $V_{SS} = 0$ V, $T_a = -40$ to 85 °C unless otherwise noted.

Parameter	Symbol	Condition	Rating			Unit	
			min	typ	max		
Output rise time	t_r	Measurement cct 3, load cct 1, $0.4V$ to $2.4V$, $C_L = 15$ pF	–	2	6	ns	
Output fall time	t_f	Measurement cct 3, load cct 1, $2.4V$ to $0.4V$, $C_L = 15$ pF	–	2	6	ns	
Output duty cycle ¹	Duty	Measurement cct 3, load cct 1, $T_a = 25$ °C, $V_{DD} = 5$ V, $C_L = 15$ pF	45	–	55	%	
Output disable delay time	t_{pLZ}	Measurement cct 6, load cct 1, $T_a = 25$ °C, $V_{DD} = 5$ V, $C_L \leq 15$ pF	–	–	100	ns	
Output enable delay time	t_{pZL}		–	–	100	ns	
Maximum operating frequency	f_{max}	Measurement cct 3	$T_a = -20$ to $+80$ °C	40	–	–	MHz
			$T_a = -40$ to $+85$ °C	30	–	–	

1. Determined by the lot monitor.

SM5009 series

5009AL series

3 V operation: $V_{DD} = 2.7$ to 3.3 V, $V_{SS} = 0$ V, $T_a = -40$ to 85 °C unless otherwise noted.

Parameter	Symbol	Condition	Rating			Unit	
			min	typ	max		
Output rise time	t_{r1}	Measurement cct 3, load cct 2, $0.1V_{DD}$ to $0.9V_{DD}$, $C_L = 15$ pF	-	3.5	9	ns	
		Measurement cct 3, load cct 2, $0.1V_{DD}$ to $0.9V_{DD}$, $V_{DD} = 2.3$ to 2.7 V, $T_a = -20$ to $+80$ °C, $C_L = 15$ pF	-	4	13		
	t_{r2}	Measurement cct 3, load cct 2, $0.1V_{DD}$ to $0.9V_{DD}$, $C_L = 30$ pF	-	5	12		
		Measurement cct 3, load cct 2, $0.1V_{DD}$ to $0.9V_{DD}$, $V_{DD} = 2.3$ to 2.7 V, $T_a = -20$ to $+80$ °C, $C_L = 30$ pF	-	5.5	16		
Output fall time	t_{f1}	Measurement cct 3, load cct 2, $0.9V_{DD}$ to $0.1V_{DD}$, $C_L = 15$ pF	-	3.5	9	ns	
		Measurement cct 3, load cct 2, $0.9V_{DD}$ to $0.1V_{DD}$, $V_{DD} = 2.3$ to 2.7 V, $T_a = -20$ to $+80$ °C, $C_L = 15$ pF	-	4	13		
	t_{f2}	Measurement cct 3, load cct 2, $0.9V_{DD}$ to $0.1V_{DD}$, $C_L = 30$ pF	-	5	12		
		Measurement cct 3, load cct 2, $0.9V_{DD}$ to $0.1V_{DD}$, $V_{DD} = 2.3$ to 2.7 V, $T_a = -20$ to $+80$ °C, $C_L = 30$ pF	-	5.5	16		
Output duty cycle ¹	Duty	Measurement cct 3, load cct 2, $T_a = 25$ °C, $V_{DD} = 3$ V, $f \leq 40$ MHz, $C_L = 30$ pF	45	-	55	%	
		Measurement cct 3, load cct 2, $T_a = 25$ °C, $V_{DD} = 2.4$ V, $f \leq 14.4$ MHz, $C_L = 30$ pF	40	-	60		
		CF5009AL× only, Measurement cct 3, load cct 2, $T_a = 25$ °C, $V_{DD} = 2.5$ V, $f \leq 30$ MHz, $C_L = 15$ pF	40	-	60		
Output disable delay time ²	t_{pLZ}	Measurement cct 6, load cct 2, $T_a = 25$ °C, $V_{DD} = 3$ V, $C_L \leq 15$ pF	-	-	100	ns	
Output enable delay time ²	t_{pZL}		-	-	100	ns	
Maximum operating frequency	f_{max}	Measurement cct 3	CF5009AL×	40	-	-	MHz
			SM5009AL×S	30	-	-	
		Measurement cct 3, $T_a = -20$ to $+80$ °C	SM5009AL×S	40	-	-	
			$V_{DD} = 2.4$ to 2.7 V, SM5009AL×S	14.4	-	-	
		Measurement cct 3, $T_a = -20$ to $+80$ °C	$V_{DD} = 2.3$ to 2.7 V, CF5009AL×	30	-	-	
			$V_{DD} = 2.25$ to 2.75 V, CF5009AL×	20	-	-	

1. Determined by the lot monitor.

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.

SM5009 series

5 V operation: $V_{DD} = 4.5$ to 5.5 V, $V_{SS} = 0$ V, $T_a = -40$ to 85 °C unless otherwise noted.

Parameter	Symbol	Condition		Rating			Unit
				min	typ	max	
Output rise time	t_{r1}	Measurement cct 3, load cct 2, $0.1V_{DD}$ to $0.9V_{DD}$	$C_L = 15$ pF	–	2	4	ns
	t_{r2}		$C_L = 30$ pF	–	3.5	7	
	t_{r3}		$C_L = 50$ pF	–	4	8	
Output fall time	t_{f1}	Measurement cct 3, load cct 2, $0.9V_{DD}$ to $0.1V_{DD}$	$C_L = 15$ pF	–	2	4	ns
	t_{f2}		$C_L = 30$ pF	–	3.5	7	
	t_{f3}		$C_L = 50$ pF	–	4	8	
Output duty cycle ¹	Duty	Measurement cct 3, load cct 2, $T_a = 25$ °C, $V_{DD} = 5$ V, $C_L = 50$ pF		45	–	55	%
Output disable delay time ²	t_{pLZ}	Measurement cct 6, load cct 2, $T_a = 25$ °C, $V_{DD} = 5$ V, $C_L \leq 15$ pF		–	–	100	ns
Output enable delay time ²	t_{pZL}			–	–	100	ns
Maximum operating frequency	f_{max}	Measurement cct 3	CF5009AL×	40	–	–	MHz
			SM5009AL×S	30	–	–	
		Measurement cct 3, $T_a = -20$ to $+80$ °C	SM5009AL×S	40	–	–	

1. Determined by the lot monitor.

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.

SM5009 series

5009AN/CN series

3 V operation: $V_{DD} = 2.7$ to 3.3 V, $V_{SS} = 0$ V, $T_a = -20$ to 80 °C unless otherwise noted.

Parameter	Symbol	Condition		Rating			Unit
				min	typ	max	
Output rise time	t_{r1}	Measurement cct 3, load cct 2, $0.1V_{DD}$ to $0.9V_{DD}$, $C_L = 15$ pF	SM5009AN1S, CF5009AN1 SM5009AN2S, CF5009AN2	-	3.5	9	ns
			SM5009AN3S, CF5009AN3 SM5009AN4S, CF5009AN4 SM5009AN5S, CF5009AN5 SM5009AN6S, CF5009AN6 SM5009CN1S, CF5009CN1 SM5009CN2S, CF5009CN2	-	5	13	
	t_{r2}	Measurement cct 3, load cct 2, $0.1V_{DD}$ to $0.9V_{DD}$, $C_L = 30$ pF	SM5009AN1S, CF5009AN1 SM5009AN2S, CF5009AN2	-	5	12	
			SM5009AN3S, CF5009AN3 SM5009AN4S, CF5009AN4 SM5009AN5S, CF5009AN5 SM5009AN6S, CF5009AN6 SM5009CN1S, CF5009CN1 SM5009CN2S, CF5009CN2	-	7	16	
Output fall time	t_{f1}	Measurement cct 3, load cct 2, $0.9V_{DD}$ to $0.1V_{DD}$, $C_L = 15$ pF	SM5009AN1S, CF5009AN1 SM5009AN2S, CF5009AN2	-	3.5	9	ns
			SM5009AN3S, CF5009AN3 SM5009AN4S, CF5009AN4 SM5009AN5S, CF5009AN5 SM5009AN6S, CF5009AN6 SM5009CN1S, CF5009CN1 SM5009CN2S, CF5009CN2	-	5	13	
	t_{f2}	Measurement cct 3, load cct 2, $0.9V_{DD}$ to $0.1V_{DD}$, $C_L = 30$ pF	SM5009AN1S, CF5009AN1 SM5009AN2S, CF5009AN2	-	5	12	
			SM5009AN3S, CF5009AN3 SM5009AN4S, CF5009AN4 SM5009AN5S, CF5009AN5 SM5009AN6S, CF5009AN6 SM5009CN1S, CF5009CN1 SM5009CN2S, CF5009CN2	-	7	16	
Output duty cycle ¹	Duty	Measurement cct 3, load cct 2, $T_a = 25$ °C, $V_{DD} = 3$ V	$C_L = 30$ pF, SM5009AN×S, CF5009AN×	45	-	55	%
			$C_L = 15$ pF, SM5009CN×S, CF5009CN×	40	-	60	
Output disable delay time	t_{pLZ}	Measurement cct 6, load cct 2, $T_a = 25$ °C, $V_{DD} = 3$ V, $C_L \leq 15$ pF		-	-	100	ns
Output enable delay time	t_{pZL}			-	-	100	ns
Maximum operating frequency	f_{max}	Measurement cct 3	SM5009AN×S, CF5009AN×	40	-	-	MHz
			$T_a = -10$ to $+70$ °C, SM5009CN×S, CF5009CN×	30	-	-	

1. Determined by the lot monitor.

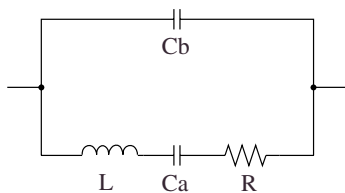
SM5009 series

5 V operation: $V_{DD} = 4.5$ to 5.5 V, $V_{SS} = 0$ V, $T_a = -40$ to 85 °C unless otherwise noted.

Parameter	Symbol	Condition	Rating			Unit	
			min	typ	max		
Output rise time	t_{r1}	Measurement cct 3, load cct 2, $0.1V_{DD}$ to $0.9V_{DD}$	$C_L = 15$ pF	-	2	4	ns
	t_{r2}		$C_L = 30$ pF	-	3.5	7	
	t_{r3}		$C_L = 50$ pF	-	4	8	
Output fall time	t_{f1}	Measurement cct 3, load cct 2, $0.9V_{DD}$ to $0.1V_{DD}$	$C_L = 15$ pF	-	2	4	ns
	t_{f2}		$C_L = 30$ pF	-	3.5	7	
	t_{f3}		$C_L = 50$ pF	-	4	8	
Output duty cycle ¹	Duty	Measurement cct 3, load cct 2, $T_a = 25$ °C, $V_{DD} = 5$ V, $C_L = 50$ pF	45	-	55	%	
Output disable delay time	t_{pLZ}	Measurement cct 6, load cct 2, $T_a = 25$ °C, $V_{DD} = 5$ V, $C_L \leq 15$ pF	-	-	100	ns	
Output enable delay time	t_{pZL}		-	-	100	ns	
Maximum operating frequency	f_{max}	Measurement cct 3	CF5009AN×, SM5009AN×S	40	-	-	MHz
			SM5009CN×S, CF5009CN×	30	-	-	

1. Determined by the lot monitor.

Current consumption and Output waveform with NPC's standard crystal



f (MHz)	R (Ω)	L (mH)	Ca (fF)	Cb (pF)
30	17.2	4.36	6.46	2.26
40	16.8	2.90	5.47	2.08

FUNCTIONAL DESCRIPTION

Standby Function

AH, AK, AN, CN series

When \overline{INH} goes LOW, the output on Q becomes high impedance, but internally the oscillator does not stop.

AL series

When \overline{INH} goes LOW, the oscillator stops and the oscillator output on Q becomes high impedance.

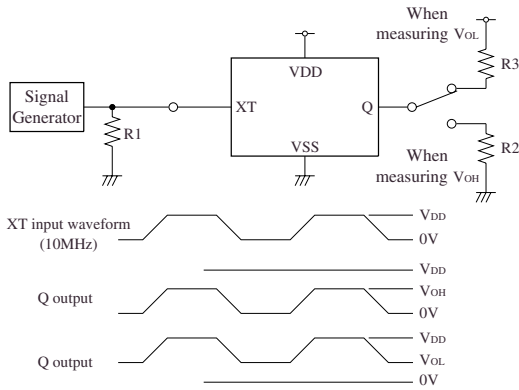
Version	\overline{INH}	Q	Oscillator
AH, AK, AN, CN series	HIGH (or open)	Any f_0 , $f_0/2$, $f_0/4$, $f_0/8$, $f_0/16$ or $f_0/32$ output frequency	Normal operation
	LOW	High impedance	Normal operation
AL series	HIGH (or open)	Any f_0 , $f_0/2$, $f_0/4$, $f_0/8$, $f_0/16$ or $f_0/32$ output frequency	Normal operation
	LOW	High impedance	Stopped

Power-save Pull-up Resistance (AL series only)

The \overline{INH} pull-up resistance changes in response to the input level (HIGH or LOW). When \overline{INH} goes LOW (standby state), the pull-up resistance becomes large to reduce the current consumption during standby.

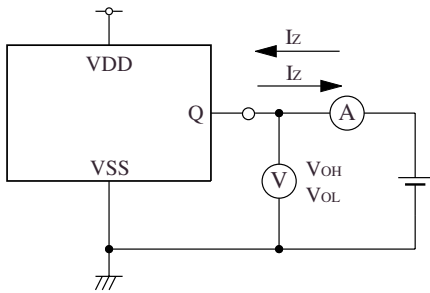
MEASUREMENT CIRCUITS

Measurement cct 1

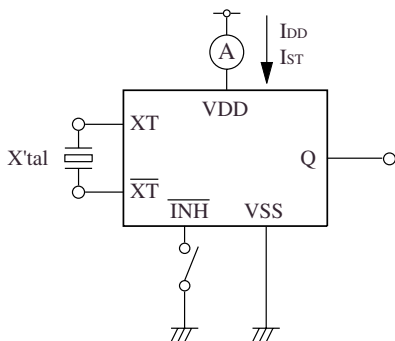


- 5009AK×, AL×, AN1, AN2
 R1 : 50Ω
 R2 : 250Ω(V_{DD} = 4.5V), 275Ω(V_{DD} = 2.7V)
 R3 : 256Ω(V_{DD} = 4.5V), 288Ω(V_{DD} = 2.7V)
- 5009AN3 to AN6, CN×
 R1 : 50Ω
 R2 : 245Ω(V_{DD} = 4.5V), 262Ω(V_{DD} = 2.7V)
 R3 : 256Ω(V_{DD} = 4.5V), 288Ω(V_{DD} = 2.7V)
- 5009AH×
 R1 : 50Ω
 R2 : 1000Ω(V_{DD} = 4.5V), 1100Ω(V_{DD} = 2.7V)
 R3 : 1025Ω(V_{DD} = 4.5V), 1150Ω(V_{DD} = 2.7V)

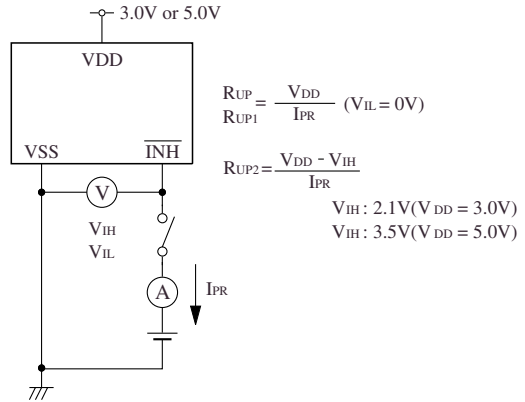
Measurement cct 2



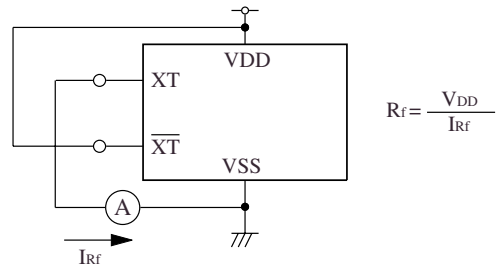
Measurement cct 3



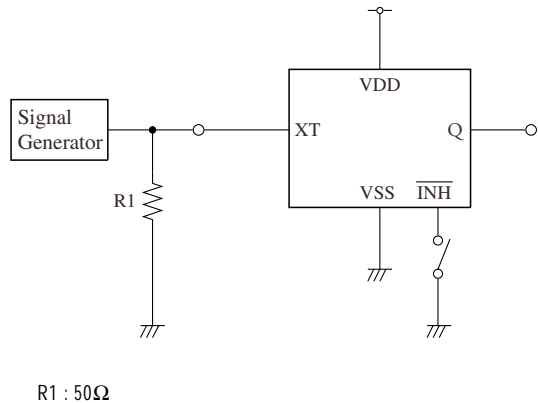
Measurement cct 4



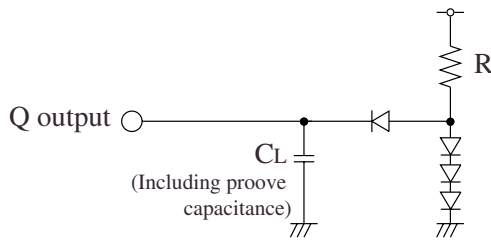
Measurement cct 5



Measurement cct 6

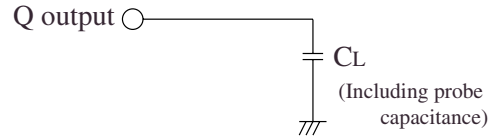


Load cct 1



$C_L = 15\text{pF}$: DUTY, I_{DD} , t_r , t_f
 $R = 400\Omega$

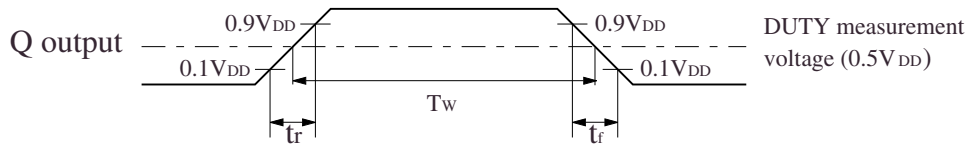
Load cct 2



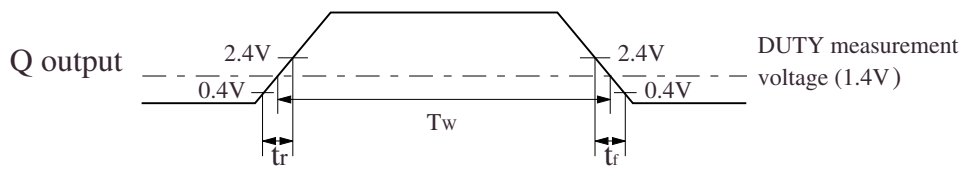
$C_L = 15\text{pF}$: DUTY, I_{DD} , t_r1 , t_f1
 $C_L = 30\text{pF}$: t_r2 , t_f2
 $C_L = 50\text{pF}$: t_r3 , t_f3

Switching Time Measurement Waveform

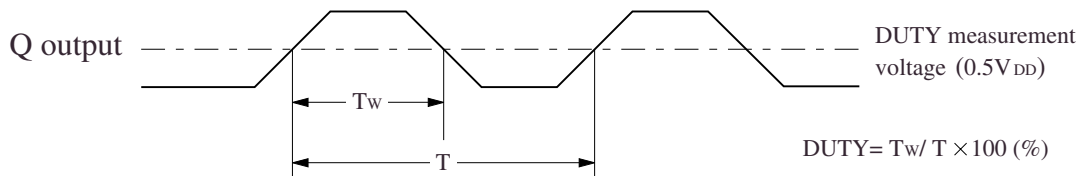
Output duty level (CMOS)



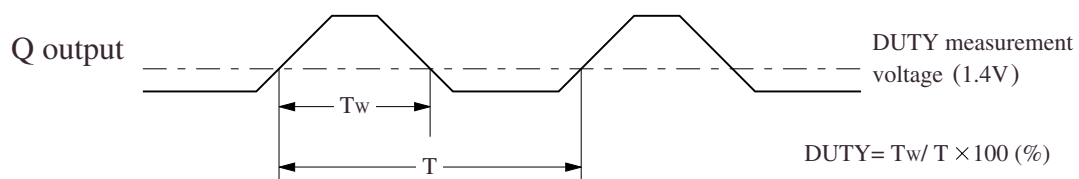
Output duty level (TTL)



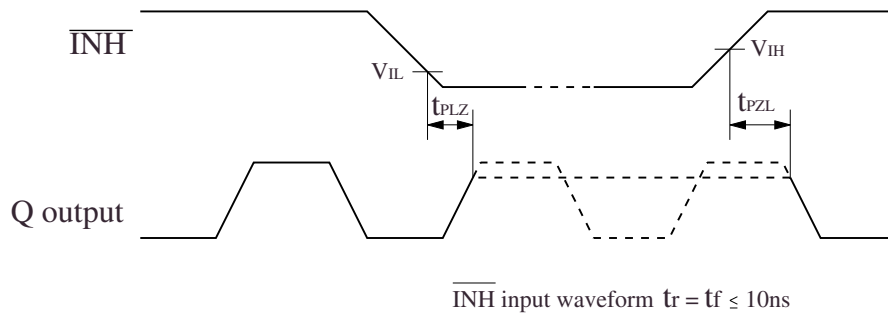
Output duty cycle (CMOS)



Output duty cycle (TTL)



Output Enable/Disable Delay



Note (AL series only) : 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.

NIPPON PRECISION CIRCUITS INC. reserves the right to make changes to the products described in this data sheet in order to improve the design or performance and to supply the best possible products. Nippon Precision Circuits Inc. assumes no responsibility for the use of any circuits shown in this data sheet, conveys no license under any patent or other rights, and makes no claim that the circuits are free from patent infringement. Applications for any devices shown in this data sheet are for illustration only and Nippon Precision Circuits Inc. makes no claim or warranty that such applications will be suitable for the use specified without further testing or modification. The products described in this data sheet are not intended to use for the apparatus which influence human lives due to the failure or malfunction of the products. Customers are requested to comply with applicable laws and regulations in effect now and hereinafter, including compliance with export controls on the distribution or dissemination of the products. Customers shall not export, directly or indirectly, any products without first obtaining required licenses and approvals from appropriate government agencies.

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

NC9801FE 2000.09