

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×S)
- Power-save pull-up resistor built-in (SM5009AL×S)
- Inverter amplifier feedback resistor built-in
- 16 mA ($V_{DD} = 4.5$ V) drive capability (SM5009AK×S, AL×S, AN×S, CN×S)
- 4 mA ($V_{DD} = 4.5$ V) drive capability (SM5009AH×S)
- Output three-state function
- 2.25 to 5.5 V supply voltage (CF5009AL×)
- 2.7 to 5.5 V supply voltage (SM5009AH×S, AL×S, AN×S, CN×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×××S)
- Chip form (CF5009×××)

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×××.

2. SM5009AH×S: $V_{DD} = 4.5$ to 5.5V

SM5009AK×S: $T_a = -20$ to $+85^\circ\text{C}$

3. SM5009AH×S, AN×S, AL×S: $T_a = -20$ to $+80^\circ\text{C}$

SM5009CN×S: $T_a = -10$ to $+70^\circ\text{C}$

4. SM5009AN×S, AL×S: $T_a = -20$ to $+80^\circ\text{C}$

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

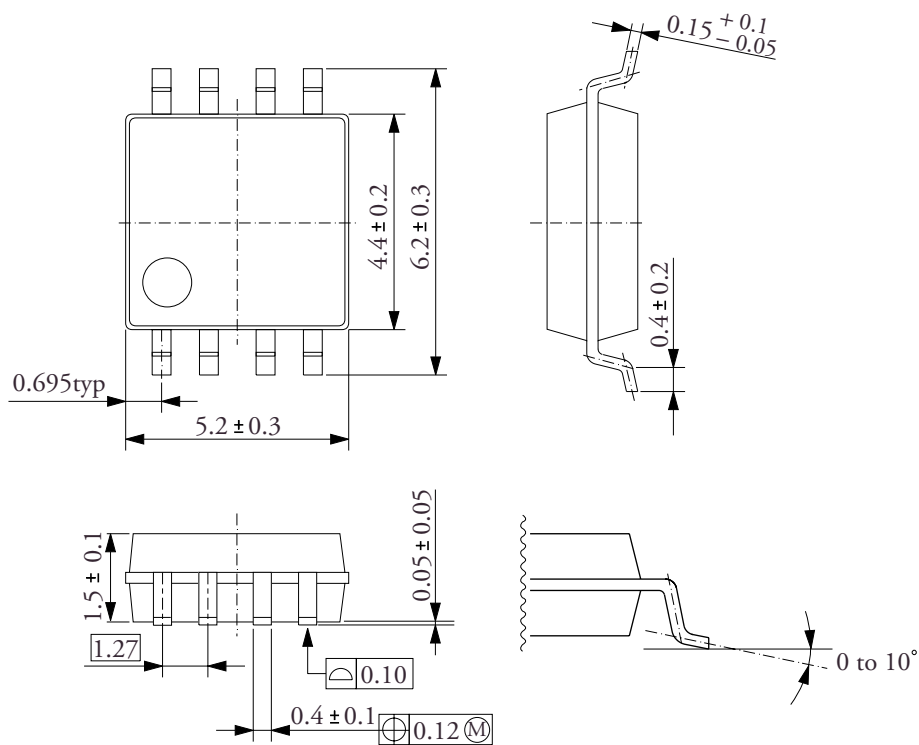
ORDERING INFORMATION

Device	Package
SM5009×××S	8-pin SOP
CF5009×××-1	Chip form

PACKAGE DIMENSIONS

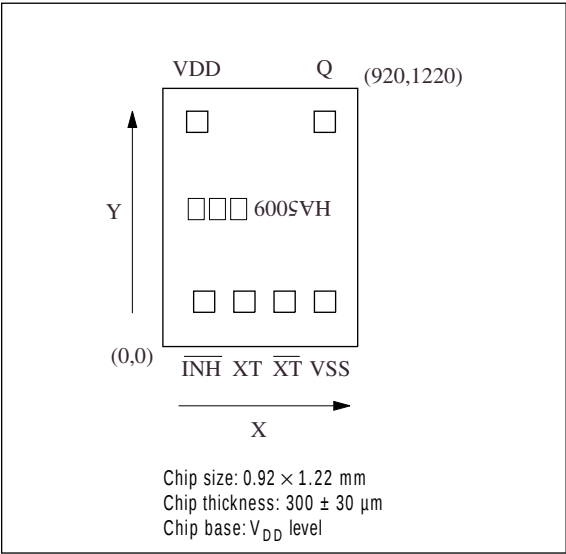
(Unit:mm)

- 8-pin SOP



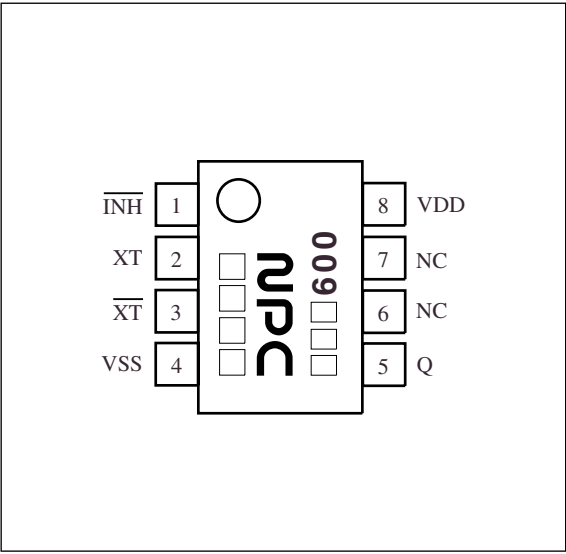
PAD LAYOUT

(Unit:μm)



PINOUT

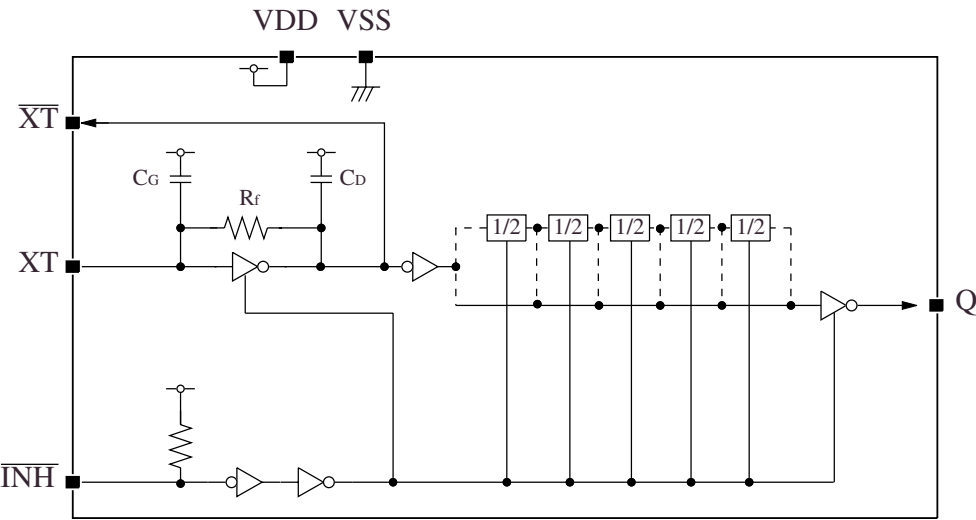
(Top view)



PIN DESCRIPTION and PAD DIMENSIONS

Number	Name	I/O	Description	Pad dimensions [μm]	
				X	Y
1	INH	I	Output state control input. High impedance when LOW. In the case of the SM5009AL×S, the oscillator stops and Power-saving pull-up resistor built in.	195	212
2	XT	I	Amplifier input.	385	212
3	XT	O	Amplifier output.	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	–	V
				$f \leq 30\text{MHz}$	2.3	–	
				$f \leq 20\text{MHz}$	2.25	–	
			8-pin SOP	$f \leq 40\text{MHz}$	2.7	–	
				$f \leq 14.4\text{MHz}$	2.4	–	
Input voltage	V_{IN}	All series		V_{SS}	–	V_{DD}	V
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	–	°C
				$f \leq 40\text{MHz}$, $4.5\text{V} \leq V_{DD} \leq 5.5\text{V}$	−40	–	
			8-pin SOP	$f \leq 40\text{MHz}$, $2.7\text{V} \leq V_{DD} < 4.5\text{V}$	−20	–	
				$f \leq 40\text{MHz}$, $4.5\text{V} \leq V_{DD} \leq 5.5\text{V}$	−20	–	
				$f \leq 30\text{MHz}$, $4.5\text{V} \leq V_{DD} \leq 5.5\text{V}$	−40	–	
		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	–	°C
				$f \leq 30\text{MHz}$, $2.3\text{V} \leq V_{DD} \leq 2.7\text{V}$	−20	–	
				$f \leq 20\text{MHz}$, $2.25\text{V} \leq V_{DD} \leq 2.75\text{V}$	−20	–	
			8-pin SOP	$f \leq 40\text{MHz}$, $2.7\text{V} \leq V_{DD} \leq 5.5\text{V}$	−20	–	
				$f \leq 30\text{MHz}$, $2.7\text{V} \leq V_{DD} \leq 5.5\text{V}$	−40	–	
				$f \leq 14.4\text{MHz}$, $2.4\text{V} \leq V_{DD} \leq 2.7\text{V}$	−20	–	

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, $\overline{INH}$ = 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}	$\overline{INH}$		2.0	–	–	V
LOW-level input voltage	V _{IL}	$\overline{INH}$		–	–	0.3	V
Current consumption	I _{DD}		SM5009AH1S CF5009AH1	–	4.5	10	mA
		$\overline{INH}$ = open, Measurement cct 3, load cct 2, C _L = 15 pF, 16 MHz crystal oscillator	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	kΩ
Negative resistance	–R _L	V _{DD} = 3 V, Ta = 25 °C, 16 MHz		–	–450	–	Ω
Feedback resistance	R _f	Measurement cct 5		0.4	–	1.1	MΩ
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, $\overline{INH}$ = 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}	$\overline{INH}$		2.0	–	–	V
LOW-level input voltage	V _{IL}	$\overline{INH}$		–	–	0.8	V
Current consumption	I _{DD}		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	kΩ
Negative resistance	–R _L	V _{DD} = 5 V, Ta = 25 °C, 30 MHz		–	–340	–	Ω
Feedback resistance	R _f	Measurement cct 5		0.4	–	1.1	MΩ
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, $\overline{\text{INH}} = \text{LOW}, V_{\text{OH}} = V_{\text{DD}}$		–	–	10	μA
		Q: Measurement cct 2, $\overline{\text{INH}} = \text{LOW}, V_{\text{OL}} = V_{\text{SS}}$		–	–	10	
HIGH-level input voltage	V _{IH}	$\overline{\text{INH}}$		2.0	–	–	V
LOW-level input voltage	V _{IL}	$\overline{\text{INH}}$		–	–	0.8	V
Current consumption	I _{DD}	$\overline{\text{INH}} = \text{open}$, Measurement cct 3, load cct 1, C _L = 15 pF, 40 MHz crystal oscillator, Ta = –20 to +80 °C	SM5009AK1S	–	12	26	mA
			CF5009AK1	–	12	26	
			SM5009AK2S	–	8	17	
			CF5009AK2	–	8	17	
$\overline{\text{INH}}$ pull-up resistance	R _{UP}	Measurement cct 4, V _{DD} = 5 V, $\overline{\text{INH}} = V_{\text{SS}}$		40	–	200	kΩ
Negative resistance	–R _L	V _{DD} = 5 V, Ta = 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

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, Ta = –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	MΩ
	R _{UP2}	Measurement cct 4, V _{DD} = 3 V, $\overline{INH}$ = 2.1V		40	–	200	kΩ
Negative resistance	–R _L	V _{DD} = 3 V, Ta = 25 °C, 40 MHz		–	–200	–	Ω
Feedback resistance	R _f	Measurement cct 5		0.4	–	1.1	MΩ
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, $\overline{\text{INH}}$ = LOW, V _{OH} = V _{DD}		–	–	10	μA
		Q: Measurement cct 2, $\overline{\text{INH}}$ = LOW, V _{OL} = V _{SS}		–	–	10	
HIGH-level input voltage	V _{IH}	$\overline{\text{INH}}$		0.7V _{DD}	–	–	V
LOW-level input voltage	V _{IL}	$\overline{\text{INH}}$		–	–	0.3V _{DD}	V
Current consumption	I _{DD}	$\overline{\text{INH}}$ = 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	
		$\overline{\text{INH}}$ = open, Measurement cct 3, load cct 2, C _L = 15 pF, 40 MHz crystal oscillator, Ta = –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}	$\overline{\text{INH}}$ = V _{SS} , Measurement cct 3		–	6	15	μA
$\overline{\text{INH}}$ pull-up resistance	R _{UP1}	Measurement cct 4, V _{DD} = 5 V, $\overline{\text{INH}}$ = V _{SS}		0.3	–	6	MΩ
	R _{UP2}	Measurement cct 4, V _{DD} = 5 V, $\overline{\text{INH}}$ = 3.5V		40	–	200	kΩ
Negative resistance	–R _L	V _{DD} = 5 V, Ta = 25 °C, 40 MHz		–	–400	–	Ω
Feedback resistance	R _f	Measurement cct 5		0.4	–	1.1	MΩ
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

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, $\overline{INH} = \text{LOW}$, $V_{OH} = V_{DD}$		–	–	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, 40 MHz crystal oscillator	CF5009AN1	–	12	26	mA
			CF5009AN2	–	8	17	
			CF5009AN3	–	6	13	
			CF5009AN4	–	5	11	
			CF5009AN5	–	5	10	
			CF5009AN6	–	4	9	
		$\overline{INH} = \text{open}$, 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	
		$\overline{INH} = \text{open}$, 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.

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, Ta = –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, Ta = –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, Ta = –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, Ta = –20 to +80 °C, C _L = 30 pF	–	5.5	16		
Output duty cycle ¹	Duty	Measurement cct 3, load cct 2, Ta = 25 °C, V _{DD} = 3 V, f ≤ 40 MHz, C _L = 30 pF	45	–	55	%	
		Measurement cct 3, load cct 2, Ta = 25 °C, V _{DD} = 2.4 V, f ≤ 14.4 MHz, C _L = 30 pF	40	–	60		
		CF5009AL× only, Measurement cct 3, load cct 2, Ta = 25 °C, V _{DD} = 2.5 V, f ≤ 30 MHz, C _L = 15 pF	40	–	60		
Output disable delay time ²	t _{PLZ}	Measurement cct 6, load cct 2, Ta = 25 °C, V _{DD} = 3 V, C _L ≤ 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, Ta = –20 to +80 °C	SM5009AL×S	40	–	–	
		Measurement cct 3, Ta = –20 to +80 °C	V _{DD} = 2.4 to 2.7 V, SM5009AL×S	14.4	–	–	
			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	–	–	

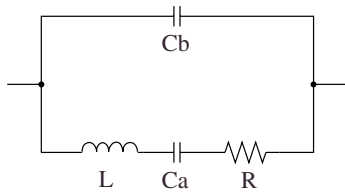
1. Determined by the lot monitor.

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, Ta = 25 °C, V _{DD} = 5 V, C _L = 50 pF		45	–	55	%
Output disable delay time	t _{P LZ}	Measurement cct 6, load cct 2, Ta = 25 °C, V _{DD} = 5 V, C _L ≤ 15 pF		–	–	100	ns
Output enable delay time	t _{P Z L}			–	–	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.

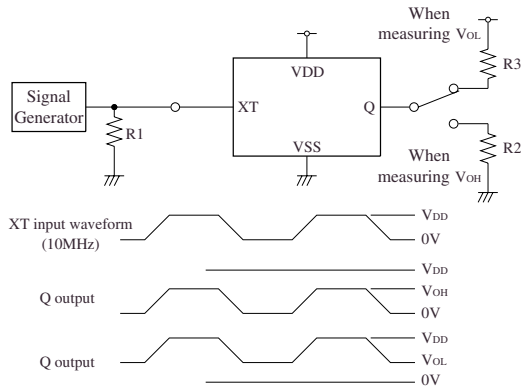
Version	$\overline{INH}$	Q	Oscillator
AH, AK, AN, CN series	HIGH (or open)	Any f_0 , $f_0/2$, $f_0/4$, $f_0/8$, $f_0/16$ or $f_0/32$ output frequency	Normal operation
	LOW	High impedance	Normal operation
AL series	HIGH (or open)	Any f_0 , $f_0/2$, $f_0/4$, $f_0/8$, $f_0/16$ or $f_0/32$ output frequency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

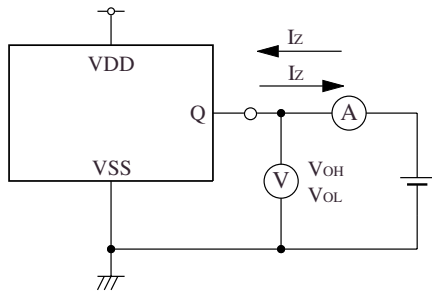
MEASUREMENT CIRCUITS

Measurement cct 1

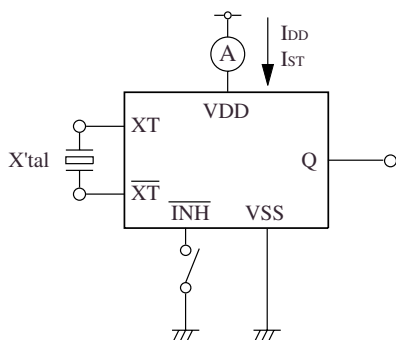


- 5009AK×, AL×, AN1, AN2
 $R1 : 50\Omega$
 $R2 : 250\Omega (V_{DD} = 4.5V), 275\Omega (V_{DD} = 2.7V)$
 $R3 : 256\Omega (V_{DD} = 4.5V), 288\Omega (V_{DD} = 2.7V)$
- 5009AN3 to AN6, CN×
 $R1 : 50\Omega$
 $R2 : 245\Omega (V_{DD} = 4.5V), 262\Omega (V_{DD} = 2.7V)$
 $R3 : 256\Omega (V_{DD} = 4.5V), 288\Omega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

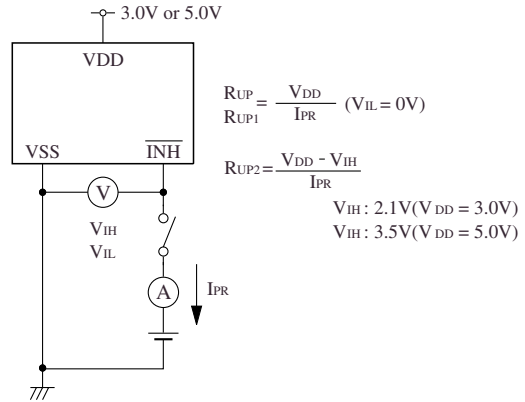
Measurement cct 2



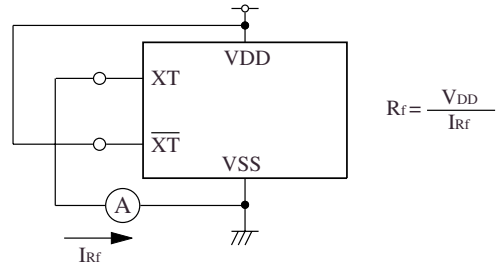
Measurement cct 3



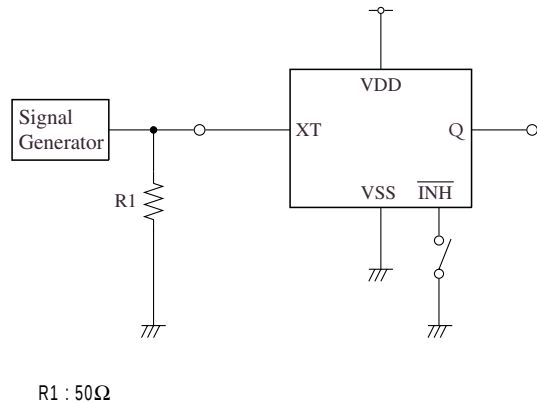
Measurement cct 4



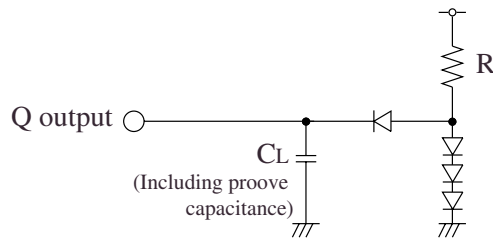
Measurement cct 5



Measurement cct 6

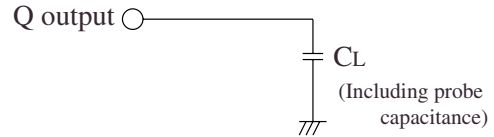


Load cct 1



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

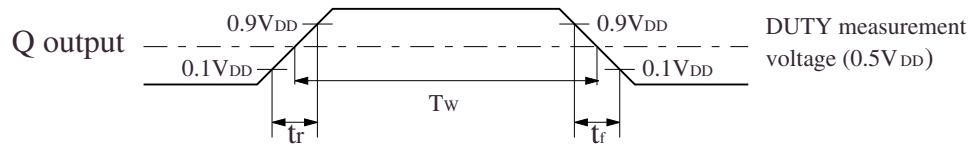
Load cct 2



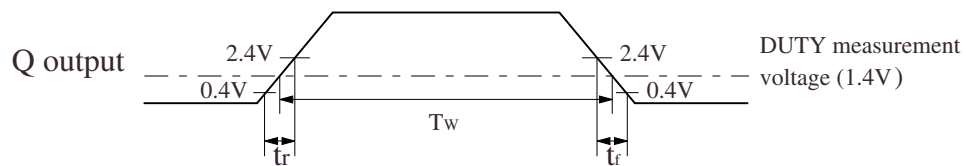
$C_L = 15\text{pF}$: DUTY, I_{DD} , t_1 , t_1
 $C_L = 30\text{pF}$: t_2 , t_2
 $C_L = 50\text{pF}$: t_3 , t_3

Switching Time Measurement Waveform

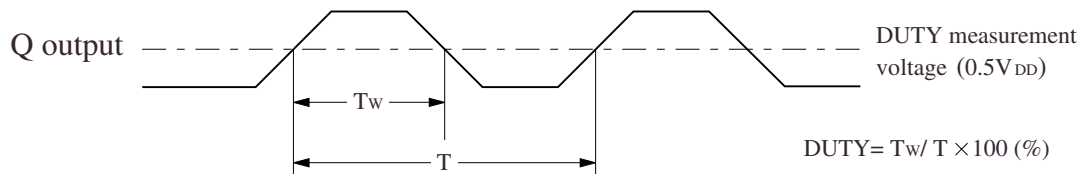
Output duty level (CMOS)



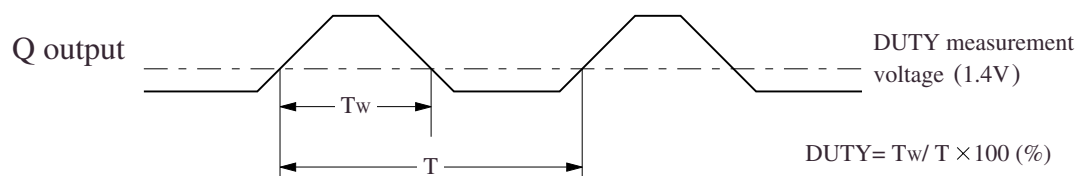
Output duty level (TTL)



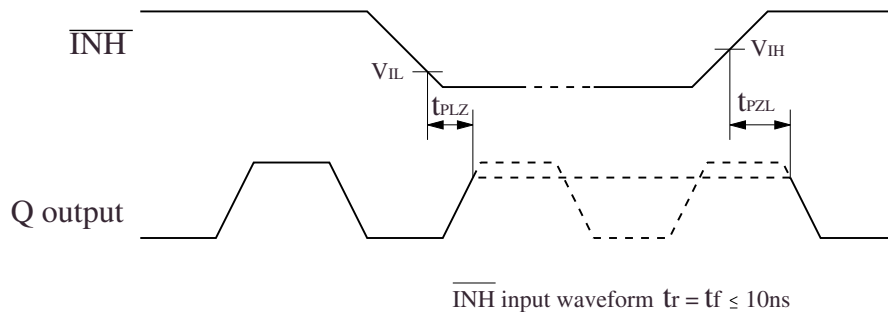
Output duty cycle (CMOS)



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.

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