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
- 6µA 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: Ta = –20 to +85°C
3. SM5009AH×S, AN×S, AL×S: Ta = –20 to +80°C
   SM5009CN×S: Ta = –10 to +70°C
4. SM5009AN×S, AL×S: Ta = –20 to +80°C

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

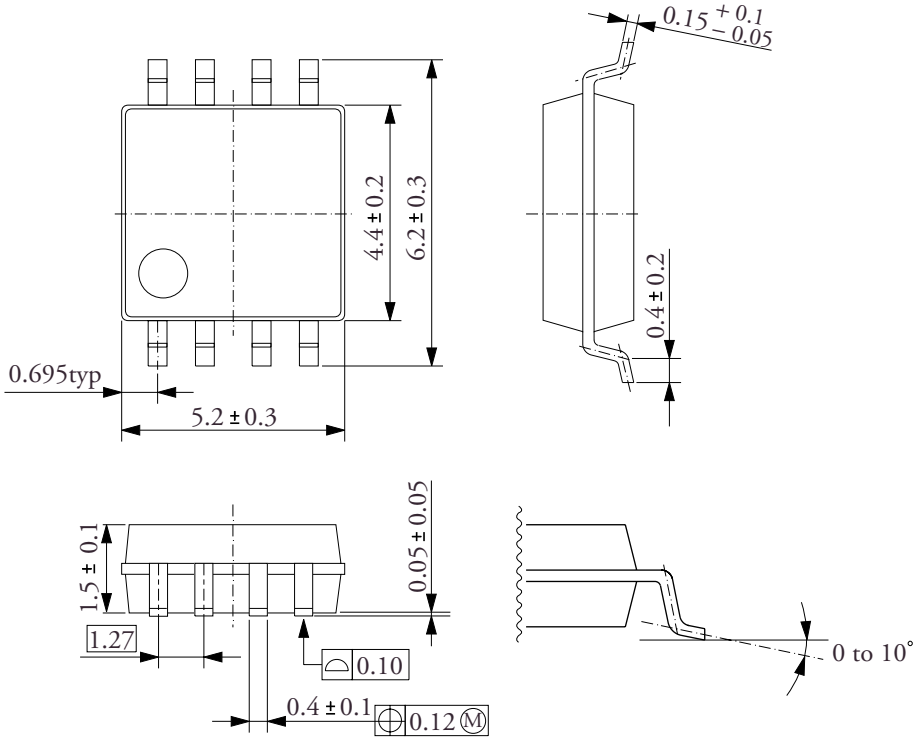
ORDERING INFORMATION

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

PACKAGE DIMENSIONS

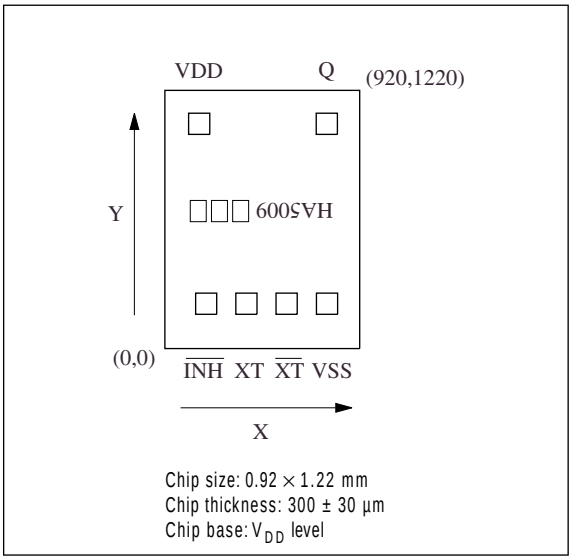
(Unit:mm)

• 8-pin SOP



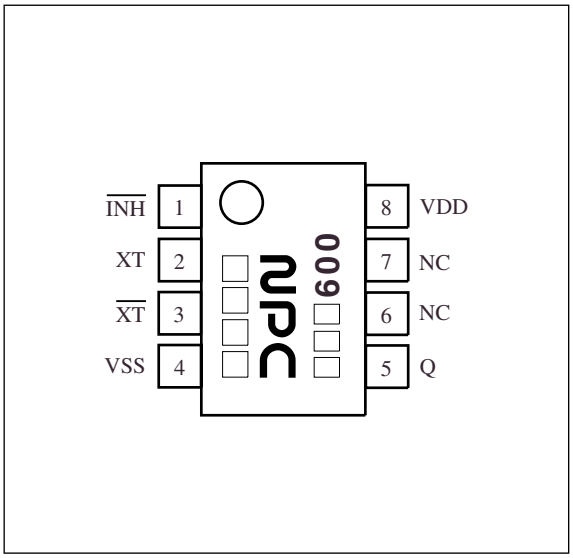
PAD LAYOUT

(Unit:µm)



PINOUT

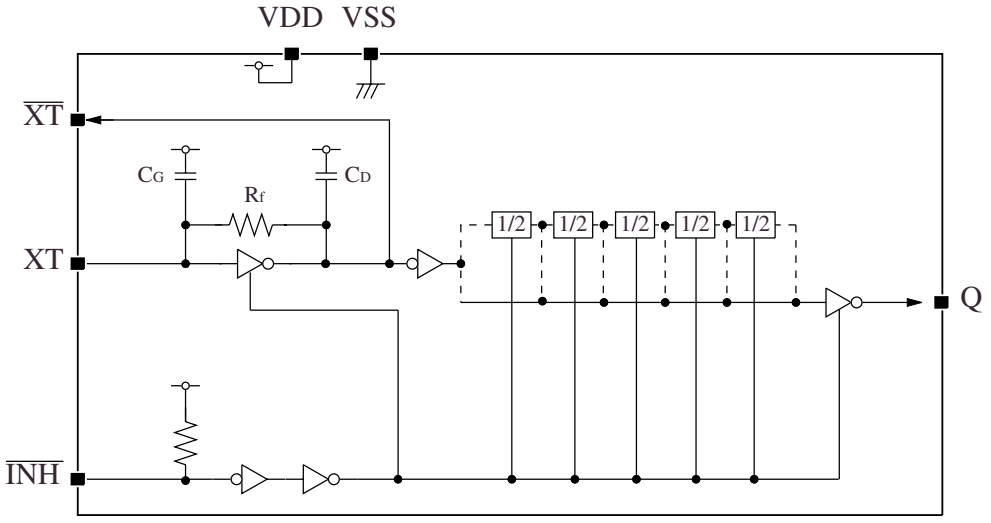
(Top view)



PIN DESCRIPTION and PAD DIMENSIONS

Number	Name	I/O	Description		Pad dimensions [µm]	
					X	Y
1	$\overline{INH}$	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.	Crystal oscillator connection pins. Crystal oscillator connected between XT and $\overline{XT}$	385	212
3	$\overline{XT}$	O	Amplifier output.		575	212
4	VSS	–	Ground		766	212
5	Q	O	Output. Output frequency (f_O, f_O/2, f_O/4, f_O/8, f_O/16, f_O/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

$V_{SS} = 0$ 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

$V_{SS} = 0$ V

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

Electrical Characteristics

5009AH series

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

Parameter	Symbol	Condition		Rating min	Rating typ	Rating max	Unit
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}	$\overline{INH}$ = 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	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, Ta = –40 to 85 °C unless otherwise noted.

Parameter	Symbol	Condition		Rating min	Rating typ	Rating max	Unit
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}	$\overline{INH}$ = 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	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

5009AK series

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

Parameter	Symbol	Condition		Rating min	Rating typ	Rating max	Unit
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, $\overline{INH}$ = 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}	$\overline{INH}$ = 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	
$\overline{INH}$ 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, 40 MHz		–	–210	–	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

5009AL series

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

Parameter	Symbol	Condition		Rating min	Rating typ	Rating max	Unit
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

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

Parameter	Symbol	Condition		Rating min	Rating typ	Rating max	Unit
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, $\overline{INH}$ = 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	–	12	26	mA
			CF5009AL2	–	8	17	
			CF5009AL3	–	6	13	
			CF5009AL4	–	5	11	
			CF5009AL5	–	5	10	
			CF5009AL6	–	4	9	
		$\overline{INH}$ = 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}	$\overline{INH} = V_{SS}$, 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	MΩ
	R_{UP2}	Measurement cct 4, V_{DD} = 5 V, $\overline{INH}$ = 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, Ta = –20 to 80 °C unless otherwise noted.

Parameter	Symbol	Condition		Rating min	Rating typ	Rating max	Unit
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, $\overline{INH}$ = 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}	$\overline{INH}$ = 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	
		$\overline{INH}$ = open, Measurement cct 3, load cct 2, C_L = 15 pF, 30 MHz crystal oscillator, Ta = –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	kΩ
Negative resistance	$–R_L$	V_{DD} = 3 V, Ta = 25 °C, 40 MHz		–	–100	–	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, Ta = –40 to 85 °C unless otherwise noted.

Parameter	Symbol	Condition		Rating min	Rating typ	Rating max	Unit
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	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}	$\overline{INH}$ = 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, Ta = –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	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	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

Switching Characteristics

5009AH series

3 V operation: V_{DD} = 2.7 to 3.3 V, V_{SS} = 0 V, Ta = –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, Ta = 25 °C, V_{DD} = 3 V, C_L = 15 pF	45	–	55	%
Output disable delay time	t_{PLZ}	Measurement cct 6, load cct 2, Ta = 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, Ta = –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, Ta = 25 °C, V_{DD} = 5 V, C_L = 15 pF	45	–	55	%
Output disable delay time	t_{PLZ}	Measurement cct 6, load cct 2, Ta = 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, Ta = –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, Ta = 25 °C, V_{DD} = 5 V, C_L = 15 pF		45	–	55	%
Output disable delay time	t_{PLZ}	Measurement cct 6, load cct 1, Ta = 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	Ta = –20 to +80 °C	40	–	–	MHz
			Ta = –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, Ta = –40 to 85 °C unless otherwise noted.

Parameter	Symbol	Condition		Rating min	Rating typ	Rating max	Unit
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.

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

Parameter	Symbol	Condition		Rating min	Rating typ	Rating max	Unit
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[2]	t_{PLZ}	Measurement cct 6, load cct 2, Ta = 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, Ta = –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.

5009AN/CN series

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

Parameter	Symbol	Condition		Rating min	Rating typ	Rating max	Unit
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, Ta = 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, Ta = 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
			Ta = –10 to +70 °C, SM5009CN×S, CF5009CN×	30	–	–	

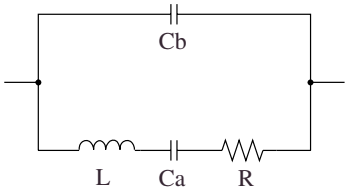
1. Determined by the lot monitor.

5 V operation: V_{DD} = 4.5 to 5.5 V, V_{SS} = 0 V, Ta = –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_{PLZ}	Measurement cct 6, load cct 2, Ta = 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 $\overline{\text{INH}}$ goes LOW, the output on Q becomes high impedance, but internally the oscillator does not stop.

AL series

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

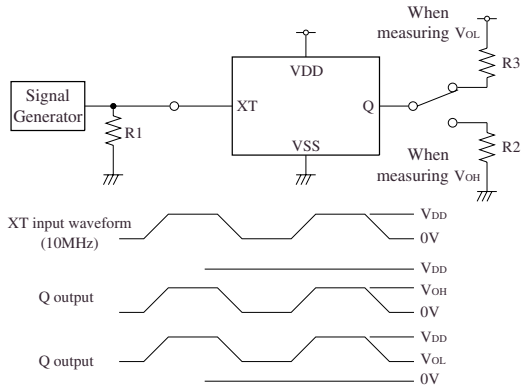
Version	$\overline{\text{INH}}$	Q	Oscillator
AH, AK, AN, CN series	HIGH (or open)	Any f_O , $f_O/2$, $f_O/4$, $f_O/8$, $f_O/16$ or $f_O/32$ output frequency	Normal operation
	LOW	High impedance	Normal operation
AL series	HIGH (or open)	Any f_O , $f_O/2$, $f_O/4$, $f_O/8$, $f_O/16$ or $f_O/32$ output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

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

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

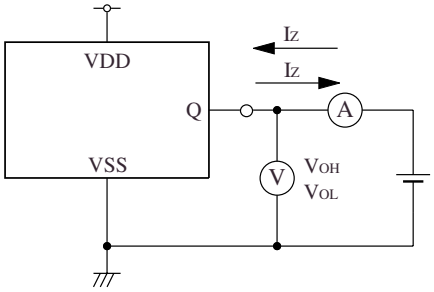
MEASUREMENT CIRCUITS

Measurement cct 1

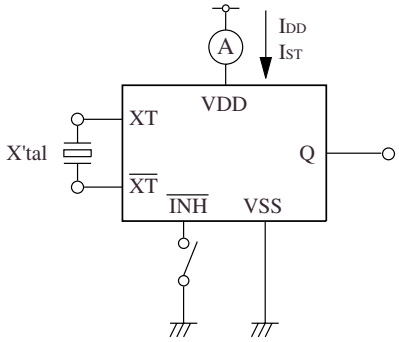


- 5009AK×, AL×, AN1, AN2
  R1 : 50Ω
  R2 : 250Ω(V_{DD} = 4.5V), 275Ω(V_{DD} = 2.7V)
  R3 : 256Ω(V_{DD} = 4.5V), 288Ω(V_{DD} = 2.7V)
- 5009AN3 to AN6, CN×
  R1 : 50Ω
  R2 : 245Ω(V_{DD} = 4.5V), 262Ω(V_{DD} = 2.7V)
  R3 : 256Ω(V_{DD} = 4.5V), 288Ω(V_{DD} = 2.7V)
- 5009AH×
  R1 : 50Ω
  R2 : 1000Ω(V_{DD}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

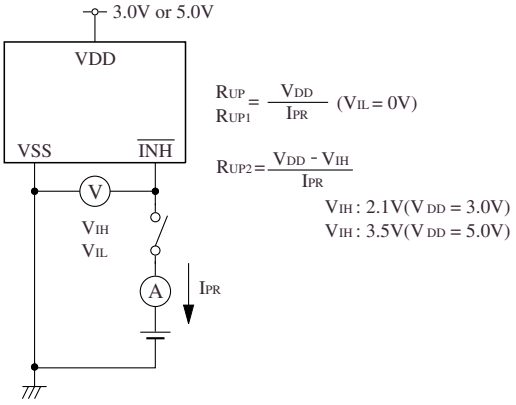
Measurement cct 2



Measurement cct 3



Measurement cct 4

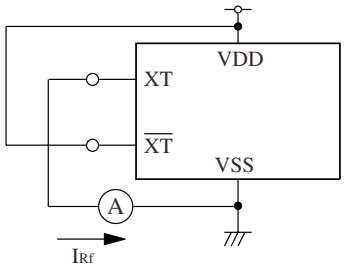


$R_{UP} = R_{UP1} = \frac{V_{DD}}{I_{PR}}$ (V_{IL} = 0V)

$R_{UP2} = \frac{V_{DD} - V_{IH}}{I_{PR}}$

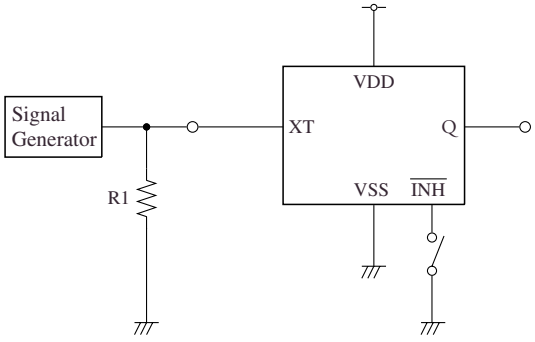
V_{IH} : 2.1V(V_{DD} = 3.0V)
V_{IH} : 3.5V(V_{DD} = 5.0V)

Measurement cct 5



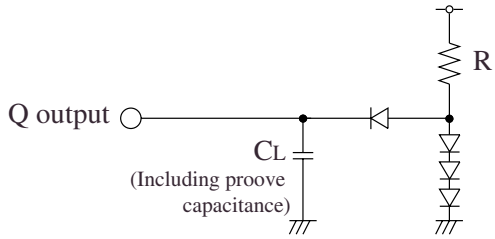
$R_f = \frac{V_{DD}}{I_{Rf}}$

Measurement cct 6



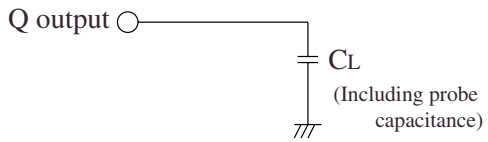
R1 : 50Ω

Load cct 1



C_L = 15pF : DUTY , I_{DD} , t_r , t_f
R = 400Ω

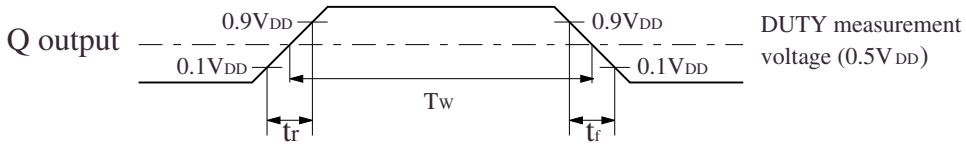
Load cct 2



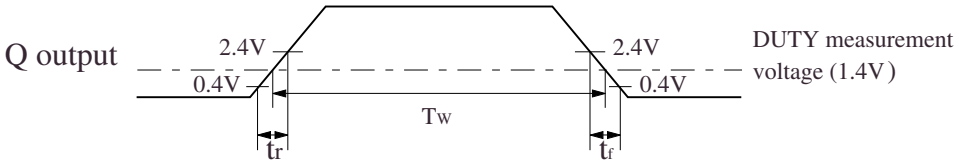
C_L = 15pF : DUTY , I_{DD} , t_{f1} , t_{f1}
C_L = 30pF : t_{f2} , t_{f2}
C_L = 50pF : t_{f3} , t_{f3}

Switching Time Measurement Waveform

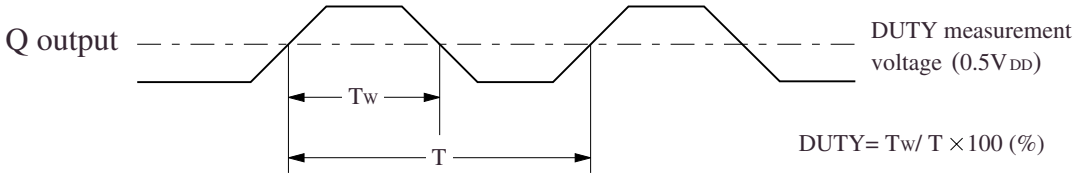
Output duty level (CMOS)



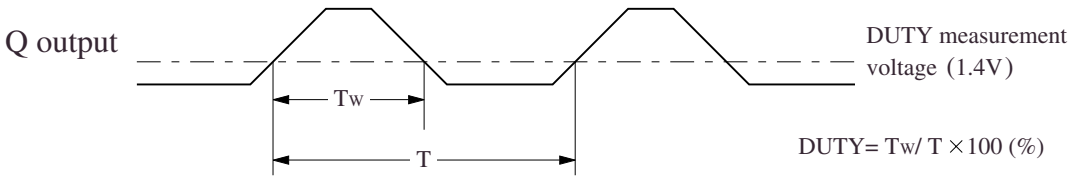
Output duty level (TTL)



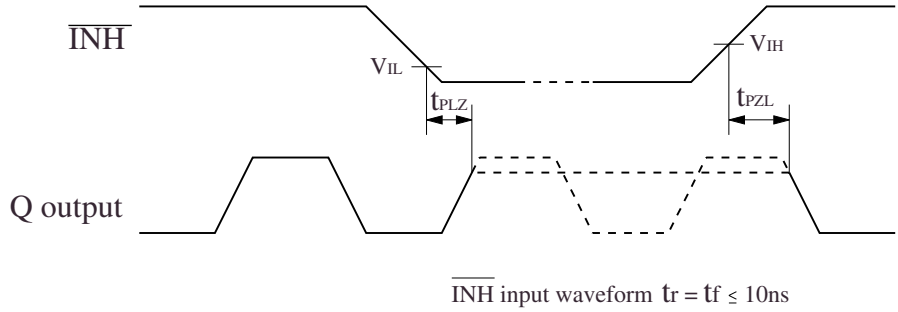
Output duty cycle (CMOS)



Output duty cycle (TTL)



Output Enable/Disable Delay



$\overline{INH}$ input waveform $t_r = t_f \leq 10ns$

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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