

## OVERVIEW

The SM5009 series are crystal oscillator module ICs that incorporate low crystal current type oscillating circuit to limit oscillator-stage current, so that they can reduce crystal current lower than the existing products. Since the oscillating circuit has oscillator capacitors with excellent frequency response and feedback resistor built-in, just connecting crystal realizes stable fundamental oscillation responding up to 40MHz. The SM5009 series are ideal for SMD type crystal oscillator using a strip-shaped crystal blank.

## FEATURES

- Low crystal current oscillator
- Up to 40MHz operating frequency range (fundamental oscillation)
- Operating supply voltage range
  - 3V operation: 2.7 to 3.6V
  - 5V operation: 4.5 to 5.5V
- -40 to 85°C operating temperature range
- Oscillation capacitors  $C_G$ ,  $C_D$  built-in
- Inverter amplifier feedback resistor built-in
- Standby function
  - Oscillator stops (AL series), high impedance in standby mode
- Low standby current
- Power-save pull-up resistor built-in (AL series)
- Frequency divider built-in ( $f_O$ ,  $f_O/2$ ,  $f_O/4$ ,  $f_O/8$ ,  $f_O/16$ ,  $f_O/32$  determined by internal connection)
- Output drive capability
  - AL×, AN×, AK×, CN×: 16mA ( $V_{DD} = 4.5V$ )
  - AH×: 4mA ( $V_{DD} = 4.5V$ )
- Output load:  $C_L = 50pF$  max.
- Output duty level
  - CMOS level (1/2 VDD): AL×, AN×, AH×, CN×
  - TTL level (1.4V): AK×
- Molybdenum-gate CMOS process
- 8-pin SOP (SM5009×××S)
- Chip form (CF5009×××)

## SERIES CONFIGURATION

Version <sup>1</sup>	3V operation		5V operation		Output duty level	Output frequency	INH Input level	Standby mode	
	Recommended operating frequency range <sup>2</sup> [MHz]	Output load <sup>3</sup> (max) [pF]	Recommended operating frequency range <sup>2</sup> [MHz]	Output load <sup>3</sup> (max) [pF]				Oscillator stop function	Output state
CF5009AL1	Up to 40	50	Up to 40	50	CMOS	$f_O$	CMOS	Yes	Hi-Z
CF5009AL2						$f_O/2$			
CF5009AL3						$f_O/4$			
CF5009AL4						$f_O/8$			
CF5009AL5						$f_O/16$			
CF5009AL6						$f_O/32$			
CF5009AN1	Up to 40	30	Up to 40	50	CMOS	$f_O$	TTL	No	Hi-Z
CF5009AN2					$f_O/2$				
CF5009AN3					$f_O/4$				
CF5009AN4					$f_O/8$				
CF5009AN5					$f_O/16$				
CF5009AN6					$f_O/32$				
CF5009CN1	Up to 30	15	Up to 30	50	CMOS	$f_O$	TTL	No	Hi-Z
CF5009CN2						$f_O/2$			
CF5009AK1	-	-	Up to 40	15	TTL	$f_O$	TTL	No	Hi-Z
CF5009AK2						$f_O/2$			
CF5009AH1	Up to 16	15	Up to 30	15	CMOS	$f_O$	TTL	No	Hi-Z
CF5009AH2						$f_O/2$			
CF5009AH3						$f_O/4$			
CF5009AH4						$f_O/8$			

1. Package devices (8-pin SOP) have designation SM5009×××S.

2. The recommended operating frequency is a yardstick value derived from the crystal used for NPC characteristics authentication. However, the oscillator frequency band is not guaranteed. Specifically, the characteristics can vary greatly due to crystal characteristics and mounting conditions, so the oscillation characteristics of components must be carefully evaluated.

3. Output load value is the maximum load capacitance that allows drive.

## APPLICATIONS

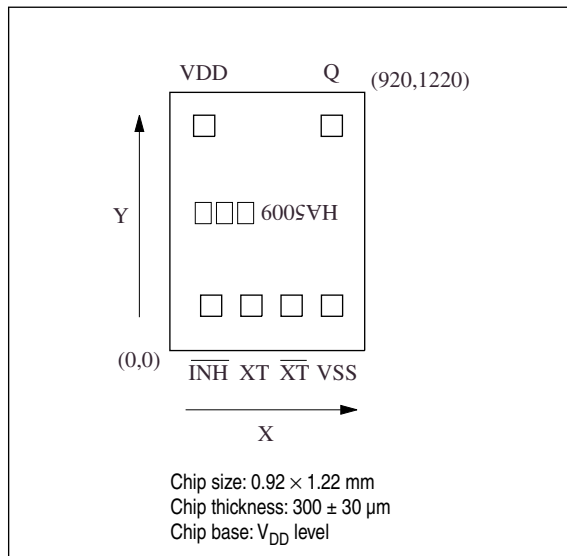
- SMD type crystal oscillator module

## ORDERING INFORMATION

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

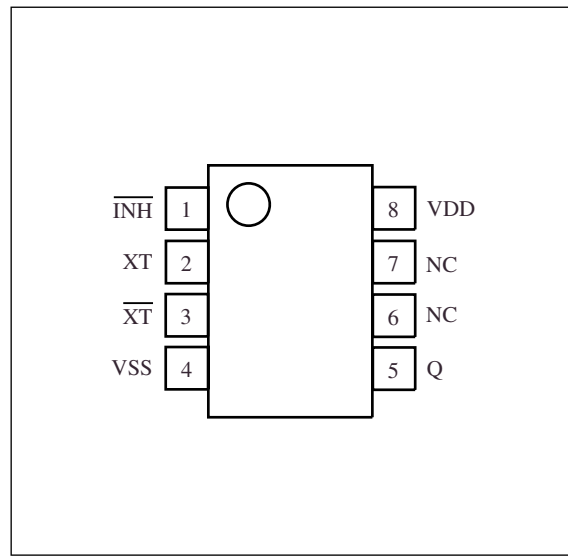
**PAD LAYOUT**

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



**PINOUT**

(Top view)



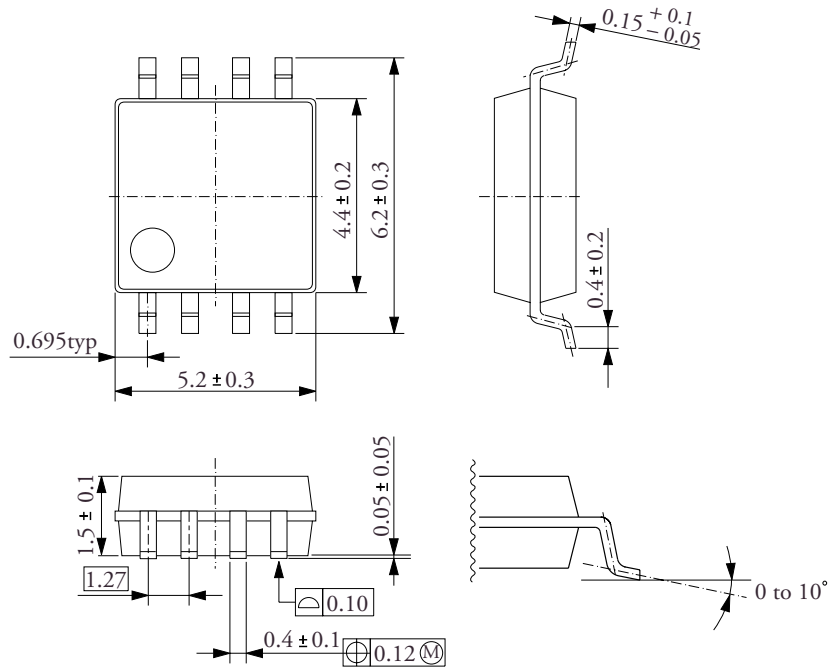
**PIN DESCRIPTION and PAD DIMENSIONS**

Number	Name	I/O	Description	Pad dimensions [ $\mu\text{m}$ ]	
				X	Y
1	INH	I	Output state control input. Standby mode when LOW, pull-up resistor built-in. In the case of the CF5009ALx, the oscillator stops and power-save pull-up resistor built in to reduce current consumption at standby mode.	195	212
2	XT	I	Amplifier input.	385	212
3	XT	O	Amplifier output.		
			Crystal oscillator connection pins. Crystal oscillator connected between XT and 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

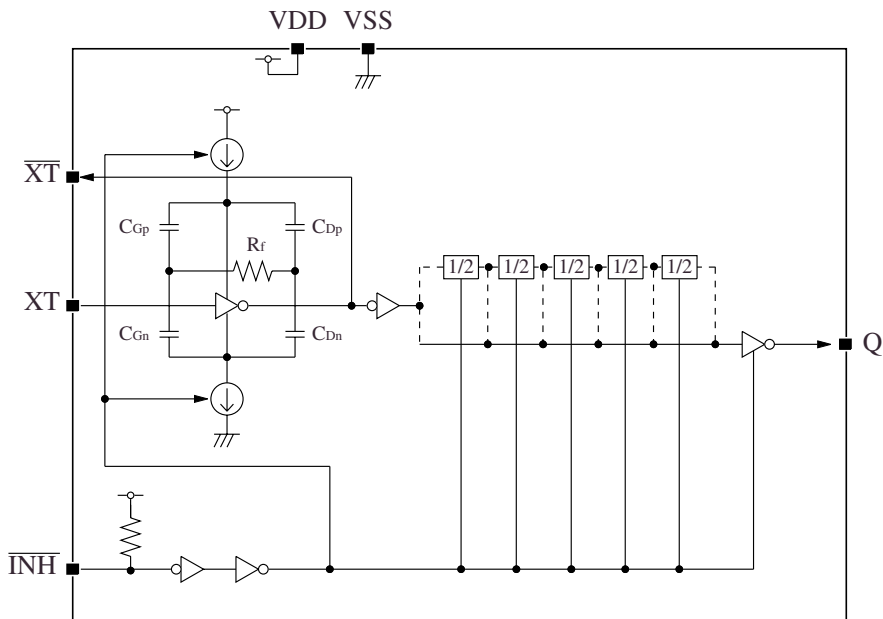
**PACKAGE DIMENSIONS**

(Unit: mm)

- 8-pin SOP



**BLOCK DIAGRAM**



Notes. The SM5009 series reduce crystal current by limiting driving current of oscillating-stage inverter and inhibiting oscillating amplitude. Depending on the characteristics of using crystal or the mounting condition, they may not oscillate normally. Please evaluate the oscillation start-up characteristics adequately with your actual device.

## FUNCTIONAL DESCRIPTION

### Standby Function

#### 5009 AL× series

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

#### 5009AH×, AK×, AN×, CN× series

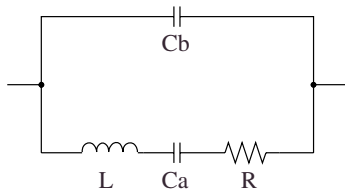
When  $\overline{\text{INH}}$  goes LOW, the output on Q becomes high impedance, but internally the oscillator does not stop.

Version	$\overline{\text{INH}}$	Q	Oscillator
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
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

### 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.

### Current consumption and Output waveform with NPC's standard crystal



f [MHz]	R [ $\Omega$ ]	L [mH]	Ca [fF]	Cb [pF]
30	17.2	4.36	6.46	2.26
40	16.8	2.90	5.47	2.08

## SPECIFICATIONS

### Absolute Maximum Ratings

$V_{SS} = 0V$  unless otherwise noted.

Parameter	Symbol	Condition	Rating	Unit
Supply voltage range	$V_{DD}$		-0.5 to +7.0	V
Input voltage range	$V_{IN}$		-0.5 to $V_{DD} + 0.5$	V
Output voltage range	$V_{OUT}$		-0.5 to $V_{DD} + 0.5$	V
Operating temperature range	$T_{opr}$		-40 to +85	°C
Storage temperature range	$T_{stg}$	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

$V_{SS} = 0V$  unless otherwise noted.

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

**Electrical Characteristics**

**5009AL× series**

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

Parameter	Symbol	Condition	Rating			Unit	
			min	typ	max		
HIGH-level output voltage	$V_{OH}$	Q: Measurement cct 1, $I_{OH} = 8mA$	2.2	–	–	V	
LOW-level output voltage	$V_{OL}$	Q: Measurement cct 1, $I_{OL} = 8mA$	–	–	0.4	V	
HIGH-level input voltage	$V_{IH}$	$\overline{INH}$	$0.7V_{DD}$	–	–	V	
LOW-level input voltage	$V_{IL}$	$\overline{INH}$	–	–	$0.3V_{DD}$	V	
Output leakage current	$I_z$	Q: Measurement cct 2, $\overline{INH} = LOW$ , $V_{OH} = V_{DD}$	–	–	10	$\mu A$	
		Q: Measurement cct 2, $\overline{INH} = LOW$ , $V_{OL} = V_{SS}$	–	–	10		
Current consumption	$I_{DD}$	$\overline{INH} = open$ , Measurement cct 3, load cct 2, $C_L = 15pF$ , 40MHz 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, $C_L = 15pF$ , 40MHz crystal oscillator, $T_a = -20$ to $+80^\circ C$	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	$\mu A$	
$\overline{INH}$ pull-up resistance	$R_{UP1}$	Measurement cct 4, $V_{DD} = 3V$ , $\overline{INH} = V_{SS}$	0.6	–	12	$M\Omega$	
	$R_{UP2}$	Measurement cct 4, $V_{DD} = 3V$ , $\overline{INH} = 2.1V$	40	–	200	$k\Omega$	
Negative resistance	$-R_L$	$V_{DD} = 3V$ , $T_a = 25^\circ C$ , 40MHz	–	–200	–	$\Omega$	
Feedback resistance	$R_f$	Measurement cct 5	0.4	–	1.1	$M\Omega$	
Built-in capacitance	$C_G$	Design value. A monitor pattern on a wafer is tested.	5.58	6	6.42	pF	
	$C_D$		9.3	10	10.7	pF	

**SM5009 series**

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

Parameter	Symbol	Condition	Rating			Unit	
			min	typ	max		
HIGH-level output voltage	$V_{OH}$	Q: Measurement cct 1, $I_{OH} = 16mA$	4.0	–	–	V	
LOW-level output voltage	$V_{OL}$	Q: Measurement cct 1, $I_{OL} = 16mA$	–	–	0.4	V	
HIGH-level input voltage	$V_{IH}$	$\overline{INH}$	$0.7V_{DD}$	–	–	V	
LOW-level input voltage	$V_{IL}$	$\overline{INH}$	–	–	$0.3V_{DD}$	V	
Output leakage current	$I_Z$	Q: Measurement cct 2, $\overline{INH} = LOW$ , $V_{OH} = V_{DD}$	–	–	10	$\mu A$	
		Q: Measurement cct 2, $\overline{INH} = LOW$ , $V_{OL} = V_{SS}$	–	–	10		
Current consumption	$I_{DD}$	$\overline{INH} = open$ , Measurement cct 3, load cct 2, $C_L = 15pF$ , 40MHz 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, $C_L = 15pF$ , 40MHz crystal oscillator, $T_a = -20$ to $+80^\circ C$	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	$\mu A$	
$\overline{INH}$ pull-up resistance	$R_{UP1}$	Measurement cct 4, $V_{DD} = 5V$ , $\overline{INH} = V_{SS}$	0.3	–	6	$M\Omega$	
	$R_{UP2}$	Measurement cct 4, $V_{DD} = 5V$ , $\overline{INH} = 3.5V$	40	–	200	$k\Omega$	
Negative resistance	$-R_L$	$V_{DD} = 5V$ , $T_a = 25^\circ C$ , 40MHz	–	–400	–	$\Omega$	
Feedback resistance	$R_f$	Measurement cct 5	0.4	–	1.1	$M\Omega$	
Built-in capacitance	$C_G$	Design value. A monitor pattern on a wafer is tested.	5.58	6	6.42	pF	
	$C_D$		9.3	10	10.7	pF	

**SM5009 series**

**5009AN×/CN× series**

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

Parameter	Symbol	Condition	Rating			Unit	
			min	typ	max		
HIGH-level output voltage	$V_{OH}$	Q: Measurement cct 1, $I_{OH} = 8mA$	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, $I_{OL} = 8mA$	–	–	0.4	V	
HIGH-level input voltage	$V_{IH}$	$\overline{INH}$	2.0	–	–	V	
LOW-level input voltage	$V_{IL}$	$\overline{INH}$	–	–	0.3	V	
Output leakage current	$I_z$	Q: Measurement cct 2, $\overline{INH} = LOW$ , $V_{OH} = V_{DD}$	–	–	10	$\mu A$	
		Q: Measurement cct 2, $\overline{INH} = LOW$ , $V_{OL} = V_{SS}$	–	–	10		
Current consumption	$I_{DD}$	$\overline{INH} = open$ , Measurement cct 3, load cct 2, $C_L = 15pF$ , 40MHz 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, $C_L = 15pF$ , 30MHz crystal oscillator, $T_a = -10$ to $+70^\circ C$	SM5009CN1S, CF5009CN1	–	7	15	
			SM5009CN2S, CF5009CN2	–	4	9	
$\overline{INH}$ pull-up resistance	$R_{UP}$	Measurement cct 4, $V_{DD} = 3V$ , $\overline{INH} = V_{SS}$	40	–	200	$k\Omega$	
Negative resistance	$-R_L$	$V_{DD} = 3V$ , $T_a = 25^\circ C$ , 40MHz	–	–100	–	$\Omega$	
Feedback resistance	$R_f$	Measurement cct 5	0.4	–	1.1	$M\Omega$	
Built-in capacitance	$C_G$	Design value. A monitor pattern on a wafer is tested.	5.58	6	6.42	pF	
	$C_D$		9.3	10	10.7	pF	



**SM5009 series**

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

Parameter	Symbol	Condition	Rating			Unit	
			min	typ	max		
HIGH-level output voltage	$V_{OH}$	Q: Measurement cct 1, $I_{OH} = 16mA$	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, $I_{OL} = 16mA$	–	–	0.4	V	
HIGH-level input voltage	$V_{IH}$	$\overline{INH}$	2.0	–	–	V	
LOW-level input voltage	$V_{IL}$	$\overline{INH}$	–	–	0.8	V	
Output leakage current	$I_z$	Q: Measurement cct 2, $\overline{INH} = LOW$ , $V_{OH} = V_{DD}$	–	–	10	$\mu A$	
		Q: Measurement cct 2, $\overline{INH} = LOW$ , $V_{OL} = V_{SS}$	–	–	10		
Current consumption	$I_{DD}$	$\overline{INH} = open$ , Measurement cct 3, load cct 2, $C_L = 15pF$ , 40MHz 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, $C_L = 15pF$ , 40MHz crystal oscillator, $T_a = -20$ to $+80^\circ C$	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, $C_L = 15pF$ , 30MHz crystal oscillator	SM5009CN1S, CF5009CN1	–	10	22			
	SM5009CN2S, CF5009CN2	–	7	15			
$\overline{INH}$ pull-up resistance	$R_{UP}$	Measurement cct 4, $V_{DD} = 5V$ , $\overline{INH} = V_{SS}$	40	–	200	$k\Omega$	
Negative resistance	$-R_L$	$V_{DD} = 5V$ , $T_a = 25^\circ C$ , 40MHz	–	–210	–	$\Omega$	
Feedback resistance	$R_f$	Measurement cct 5	0.4	–	1.1	$M\Omega$	
Built-in capacitance	$C_G$	Design value. A monitor pattern on a wafer is tested.	5.58	6	6.42	pF	
	$C_D$		9.3	10	10.7	pF	

**SM5009 series**

**5009AK× series**

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

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

**SM5009 series**

**5009AH× series**

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

Parameter	Symbol	Condition	Rating			Unit	
			min	typ	max		
HIGH-level output voltage	$V_{OH}$	Q: Measurement cct 1, $I_{OH} = 2mA$	2.2	–	–	V	
LOW-level output voltage	$V_{OL}$	Q: Measurement cct 1, $I_{OL} = 2mA$	–	–	0.4	V	
HIGH-level input voltage	$V_{IH}$	$\overline{INH}$	2.0	–	–	V	
LOW-level input voltage	$V_{IL}$	$\overline{INH}$	–	–	0.3	V	
Output leakage current	$I_z$	Q: Measurement cct 2, $\overline{INH} = LOW$ , $V_{OH} = V_{DD}$	–	–	10	$\mu A$	
		Q: Measurement cct 2, $\overline{INH} = LOW$ , $V_{OL} = V_{SS}$	–	–	10		
Current consumption	$I_{DD}$	$\overline{INH} = open$ , Measurement cct 3, load cct 2, $C_L = 15pF$ , 16MHz crystal oscillator	SM5009AH1S CF5009AH1	–	4.5	10	mA
			SM5009AH2S CF5009AH2	–	3	7	
			SM5009AH3S CF5009AH3 SM5009AH4S CF5009AH4	–	1.5	3.5	
$\overline{INH}$ pull-up resistance	$R_{UP}$	Measurement cct 4, $V_{DD} = 3V$ , $\overline{INH} = V_{SS}$	40	–	200	$k\Omega$	
Negative resistance	$-R_L$	$V_{DD} = 3V$ , $T_a = 25^\circ C$ , 16MHz	–	–450	–	$\Omega$	
Feedback resistance	$R_f$	Measurement cct 5	0.4	–	1.1	$M\Omega$	
Built-in capacitance	$C_G$	Design value. A monitor pattern on a wafer is tested.	5.58	6	6.42	pF	
	$C_D$		9.3	10	10.7	pF	

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

Parameter	Symbol	Condition	Rating			Unit	
			min	typ	max		
HIGH-level output voltage	$V_{OH}$	Q: Measurement cct 1, $I_{OH} = 4mA$	4.0	–	–	V	
LOW-level output voltage	$V_{OL}$	Q: Measurement cct 1, $I_{OL} = 4mA$	–	–	0.4	V	
HIGH-level input voltage	$V_{IH}$	$\overline{INH}$	2.0	–	–	V	
LOW-level input voltage	$V_{IL}$	$\overline{INH}$	–	–	0.8	V	
Output leakage current	$I_z$	Q: Measurement cct 2, $\overline{INH} = LOW$ , $V_{OH} = V_{DD}$	–	–	10	$\mu A$	
		Q: Measurement cct 2, $\overline{INH} = LOW$ , $V_{OL} = V_{SS}$	–	–	10		
Current consumption	$I_{DD}$	$\overline{INH} = open$ , Measurement cct 3, load cct 2, $C_L = 15pF$ , 30MHz 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, $V_{DD} = 5V$ , $\overline{INH} = V_{SS}$	40	–	200	$k\Omega$	
Negative resistance	$-R_L$	$V_{DD} = 5V$ , $T_a = 25^\circ C$ , 30MHz	–	–340	–	$\Omega$	
Feedback resistance	$R_f$	Measurement cct 5	0.4	–	1.1	$M\Omega$	
Built-in capacitance	$C_G$	Design value. A monitor pattern on a wafer is tested.	5.58	6	6.42	pF	
	$C_D$		9.3	10	10.7	pF	

Switching Characteristics

5009AL× series

3V operation:  $V_{DD} = 2.7$  to  $3.3V$ ,  $V_{SS} = 0V$ ,  $T_a = -40$  to  $85^\circ C$  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 $0.9V_{DD}$ , $C_L = 15pF$	–	3.5	9	ns	
		Measurement cct 3, load cct 2, $0.1V_{DD}$ to $0.9V_{DD}$ , $V_{DD} = 2.3$ to $2.7V$ , $T_a = -20$ to $+80^\circ C$ , $C_L = 15pF$	–	4	13		
	$t_{r2}$	Measurement cct 3, load cct 2, $0.1V_{DD}$ to $0.9V_{DD}$ , $C_L = 30pF$	–	5	12		
		Measurement cct 3, load cct 2, $0.1V_{DD}$ to $0.9V_{DD}$ , $V_{DD} = 2.4$ to $2.7V$ , $T_a = -20$ to $+80^\circ C$ , $C_L = 30pF$	–	5.5	16		
	$t_{r3}$	Measurement cct 3, load cct 2, $0.1V_{DD}$ to $0.9V_{DD}$ , $V_{DD} = 3.0$ to $3.6V$ , $f \leq 30MHz$ , $C_L = 50pF$	–	5	12		
		Measurement cct 3, load cct 2, $0.2V_{DD}$ to $0.8V_{DD}$ , $V_{DD} = 3.0$ to $3.6V$ , $f \leq 40MHz$ , $C_L = 50pF$	–	3.5	12		
Output fall time	$t_{f1}$	Measurement cct 3, load cct 2, $0.9V_{DD}$ to $0.1V_{DD}$ , $C_L = 15pF$	–	3.5	9	ns	
		Measurement cct 3, load cct 2, $0.9V_{DD}$ to $0.1V_{DD}$ , $V_{DD} = 2.3$ to $2.7V$ , $T_a = -20$ to $+80^\circ C$ , $C_L = 15pF$	–	4	13		
	$t_{f2}$	Measurement cct 3, load cct 2, $0.9V_{DD}$ to $0.1V_{DD}$ , $C_L = 30pF$	–	5	12		
		Measurement cct 3, load cct 2, $0.9V_{DD}$ to $0.1V_{DD}$ , $V_{DD} = 2.4$ to $2.7V$ , $T_a = -20$ to $+80^\circ C$ , $C_L = 30pF$	–	5.5	16		
	$t_{f3}$	Measurement cct 3, load cct 2, $0.9V_{DD}$ to $0.1V_{DD}$ , $V_{DD} = 3.0$ to $3.6V$ , $f \leq 30MHz$ , $C_L = 50pF$	–	5	12		
		Measurement cct 3, load cct 2, $0.8V_{DD}$ to $0.2V_{DD}$ , $V_{DD} = 3.0$ to $3.6V$ , $f \leq 40MHz$ , $C_L = 50pF$	–	3.5	12		
Output duty cycle <sup>1</sup>	Duty1	Measurement cct 3, load cct 2, $V_{DD} = 3V$ , $f \leq 40MHz$ , $T_a = 25^\circ C$ , $C_L = 30pF$	45	–	55	%	
		Measurement cct 3, load cct 2, $V_{DD} = 2.4V$ , $f \leq 14.4MHz$ , $T_a = 25^\circ C$ , $C_L = 30pF$	40	–	60		
		CF5009AL× only, Measurement cct 3, load cct 2, $V_{DD} = 2.5V$ , $f \leq 30MHz$ , $T_a = 25^\circ C$ , $C_L = 15pF$	40	–	60		
	Duty2	CF5009AL× only, Measurement cct 3, load cct 2, $V_{DD} = 3.3V$ , $f \leq 30MHz$ , $T_a = 25^\circ C$ , $C_L = 50pF$	45	–	55		
		CF5009AL× only, Measurement cct 3, load cct 2, $V_{DD} = 3.3V$ , $f \leq 40MHz$ , $T_a = 25^\circ C$ , $C_L = 50pF$	40	–	60		
Output disable delay time <sup>2</sup>	$t_{PLZ}$	Measurement cct 6, load cct 2, $V_{DD} = 3V$ , $T_a = 25^\circ C$ , $C_L \leq 15pF$	–	–	100	ns	
Output enable delay time <sup>2</sup>	$t_{PZL}$		–	–	100	ns	
Maximum operating frequency	$f_{max}$	Measurement cct 3	CF5009AL×	40	–	–	MHz
			SM5009AL×S	30	–	–	
		Measurement cct 3, $T_a = -20$ to $+80^\circ C$	SM5009AL×S	40	–	–	
			$V_{DD} = 2.4$ to $2.7V$ , SM5009AL×S	14.4	–	–	
			$V_{DD} = 2.3$ to $2.7V$ , CF5009AL×	30	–	–	
$V_{DD} = 2.25$ to $2.75V$ , CF5009AL×	20	–	–				

1. The duty cycle characteristic is checked the sample chips of each production lot.

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

5V operation:  $V_{DD} = 4.5$  to  $5.5V$ ,  $V_{SS} = 0V$ ,  $T_a = -40$  to  $85^\circ C$  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 $0.9V_{DD}$	$C_L = 15pF$	–	2	4	ns
	$t_{r2}$		$C_L = 30pF$	–	3.5	7	
	$t_{r3}$		$C_L = 50pF$	–	4	8	
Output fall time	$t_{f1}$	Measurement cct 3, load cct 2, $0.9V_{DD}$ to $0.1V_{DD}$	$C_L = 15pF$	–	2	4	ns
	$t_{f2}$		$C_L = 30pF$	–	3.5	7	
	$t_{f3}$		$C_L = 50pF$	–	4	8	
Output duty cycle <sup>1</sup>	Duty	Measurement cct 3, load cct 2, $V_{DD} = 5V$ , $T_a = 25^\circ C$ , $C_L = 50pF$		45	–	55	%
Output disable delay time <sup>2</sup>	$t_{PLZ}$	Measurement cct 6, load cct 2, $V_{DD} = 5V$ , $T_a = 25^\circ C$ , $C_L \leq 15pF$		–	–	100	ns
Output enable delay time <sup>2</sup>	$t_{PZL}$			–	–	100	ns
Maximum operating frequency	$f_{max}$	Measurement cct 3	CF5009AL×	40	–	–	MHz
			SM5009AL×S	30	–	–	
		Measurement cct 3, $T_a = -20$ to $+80^\circ C$	SM5009AL×S	40	–	–	

1. The duty cycle characteristic is checked the sample chips of each production lot.

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**

3V operation:  $V_{DD} = 2.7$  to  $3.3V$ ,  $V_{SS} = 0V$ ,  $T_a = -20$  to  $80^\circ C$  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 $0.9V_{DD}$ , $C_L = 15pF$	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 $0.9V_{DD}$ , $C_L = 30pF$	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 $0.1V_{DD}$ , $C_L = 15pF$	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 $0.1V_{DD}$ , $C_L = 30pF$	SM5009AN1S, CF5009AN1 SM5009AN2S, CF5009AN2	–	5	12	
			SM5009AN3S, CF5009AN3 SM5009AN4S, CF5009AN4 SM5009AN5S, CF5009AN5 SM5009AN6S, CF5009AN6 SM5009CN1S, CF5009CN1 SM5009CN2S, CF5009CN2	–	7	16	
Output duty cycle <sup>1</sup>	Duty	Measurement cct 3, load cct 2, $V_{DD} = 3V$ , $T_a = 25^\circ C$	$C_L = 30 pF$ , 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, $V_{DD} = 3V$ , $T_a = 25^\circ C$ , $C_L \leq 15pF$		–	–	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 $+70^\circ C$ , SM5009CN×S, CF5009CN×	30	–	–	

1. The duty cycle characteristic is checked the sample chips of each production lot.

## SM5009 series

5V operation:  $V_{DD} = 4.5$  to  $5.5V$ ,  $V_{SS} = 0V$ ,  $T_a = -40$  to  $85^\circ C$  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 $0.9V_{DD}$	$C_L = 15pF$	–	2	4	ns
	$t_{r2}$		$C_L = 30pF$	–	3.5	7	
	$t_{r3}$		$C_L = 50pF$	–	4	8	
Output fall time	$t_{f1}$	Measurement cct 3, load cct 2, $0.9V_{DD}$ to $0.1V_{DD}$	$C_L = 15pF$	–	2	4	ns
	$t_{f2}$		$C_L = 30pF$	–	3.5	7	
	$t_{f3}$		$C_L = 50pF$	–	4	8	
Output duty cycle <sup>1</sup>	Duty	Measurement cct 3, load cct 2, $V_{DD} = 5V$ , $T_a = 25^\circ C$ , $C_L = 50pF$		45	–	55	%
Output disable delay time	$t_{PLZ}$	Measurement cct 6, load cct 2, $V_{DD} = 5V$ , $T_a = 25^\circ C$ , $C_L \leq 15pF$		–	–	100	ns
Output enable delay time	$t_{PZL}$			–	–	100	ns
Maximum operating frequency	$f_{max}$	Measurement cct 3	SM5009AN×S, CF5009AN×	40	–	–	MHz
			SM5009CN×S, CF5009CN×	30	–	–	

1. The duty cycle characteristic is checked the sample chips of each production lot.

### 5009AK× series

$V_{DD} = 4.5$  to  $5.5V$ ,  $V_{SS} = 0V$ ,  $T_a = -40$  to  $85^\circ C$  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 $2.4V$ , $C_L = 15pF$		–	2	6	ns
Output fall time	$t_f$	Measurement cct 3, load cct 1, $2.4V$ to $0.4V$ , $C_L = 15pF$		–	2	6	ns
Output duty cycle <sup>1</sup>	Duty	Measurement cct 3, load cct 1, $V_{DD} = 5V$ , $T_a = 25^\circ C$ , $C_L = 15pF$		45	–	55	%
Output disable delay time	$t_{PLZ}$	Measurement cct 6, load cct 1, $V_{DD} = 5V$ , $T_a = 25^\circ C$ , $C_L \leq 15pF$		–	–	100	ns
Output enable delay time	$t_{PZL}$			–	–	100	ns
Maximum operating frequency	$f_{max}$	Measurement cct 3	$T_a = -20$ to $+80^\circ C$	40	–	–	MHz
			$T_a = -40$ to $+85^\circ C$	30	–	–	

1. The duty cycle characteristic is checked the sample chips of each production lot.

**SM5009 series**

**5009AH× series**

3V operation:  $V_{DD} = 2.7$  to  $3.3V$ ,  $V_{SS} = 0V$ ,  $T_a = -20$  to  $80^\circ C$  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 $0.9V_{DD}$ , $C_L = 15pF$	–	6	18	ns
Output fall time	$t_{f1}$	Measurement cct 3, load cct 2, $0.9V_{DD}$ to $0.1V_{DD}$ , $C_L = 15pF$	–	6	18	ns
Output duty cycle <sup>1</sup>	Duty	Measurement cct 3, load cct 2, $V_{DD} = 3V$ , $T_a = 25^\circ C$ , $C_L = 15pF$	45	–	55	%
Output disable delay time	$t_{PLZ}$	Measurement cct 6, load cct 2, $V_{DD} = 3V$ , $T_a = 25^\circ C$ , $C_L \leq 15pF$	–	–	100	ns
Output enable delay time	$t_{PZL}$		–	–	100	ns
Maximum operating frequency	$f_{max}$	Measurement cct 3	16	–	–	MHz

1. The duty cycle characteristic is checked the sample chips of each production lot.

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

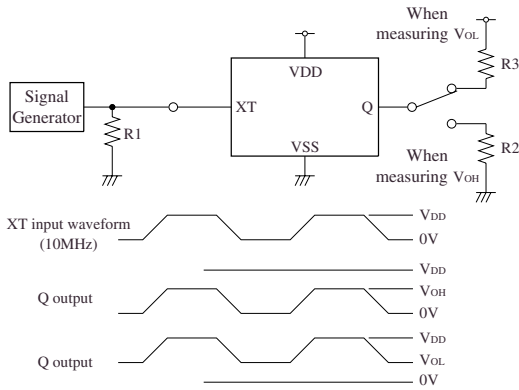
Parameter	Symbol	Condition	Rating			Unit
			min	typ	max	
Output rise time	$t_{r1}$	Measurement cct 3, load cct 2, $0.1V_{DD}$ to $0.9V_{DD}$ , $C_L = 15pF$	–	4	12	ns
Output fall time	$t_{f1}$	Measurement cct 3, load cct 2, $0.9V_{DD}$ to $0.1V_{DD}$ , $C_L = 15pF$	–	4	12	ns
Output duty cycle <sup>1</sup>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

1. The duty cycle characteristic is checked the sample chips of each production lot.



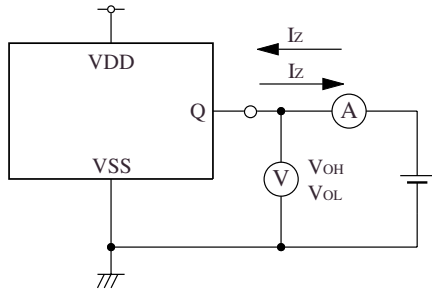
## MEASUREMENT CIRCUITS

### Measurement cct 1

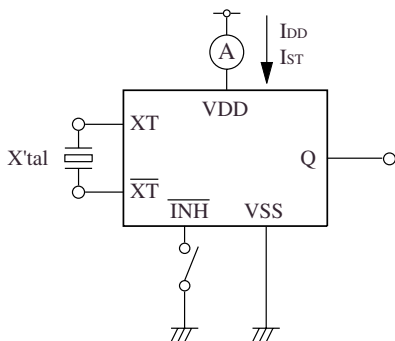


- 5009AKx, ALx, AN1, AN2  
R1: 50Ω  
R2: 250Ω( $V_{DD} = 4.5V$ ), 275Ω( $V_{DD} = 2.7V$ )  
R3: 256Ω( $V_{DD} = 4.5V$ ), 288Ω( $V_{DD} = 2.7V$ )
- 5009AN3 to AN6, CNx  
R1: 50Ω  
R2: 245Ω( $V_{DD} = 4.5V$ ), 262Ω( $V_{DD} = 2.7V$ )  
R3: 256Ω( $V_{DD} = 4.5V$ ), 288Ω( $V_{DD} = 2.7V$ )
- 5009AHx  
R1: 50Ω  
R2: 1000Ω( $V_{DD} = 4.5V$ ), 1100Ω( $V_{DD} = 2.7V$ )  
R3: 1025Ω( $V_{DD} = 4.5V$ ), 1150Ω( $V_{DD} = 2.7V$ )

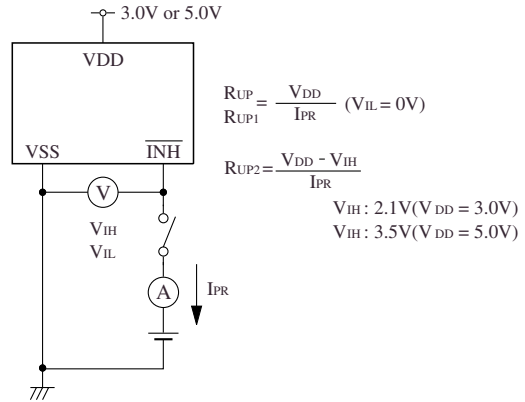
### Measurement cct 2



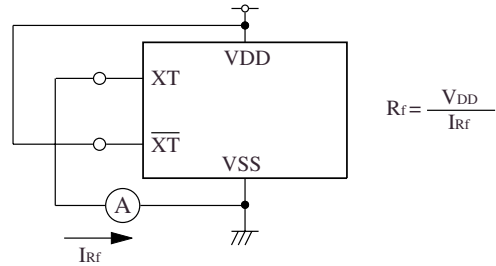
### Measurement cct 3



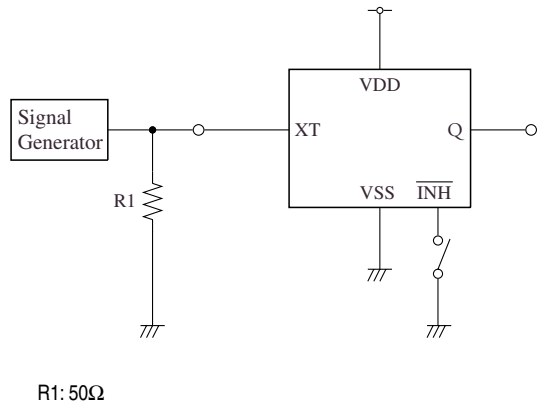
### Measurement cct 4



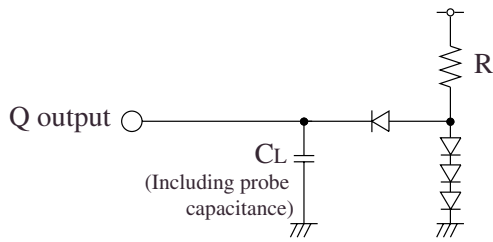
### Measurement cct 5



### Measurement cct 6

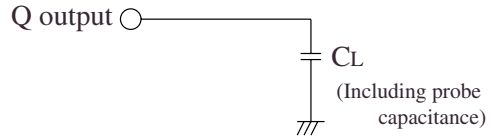


**Load cct 1**



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

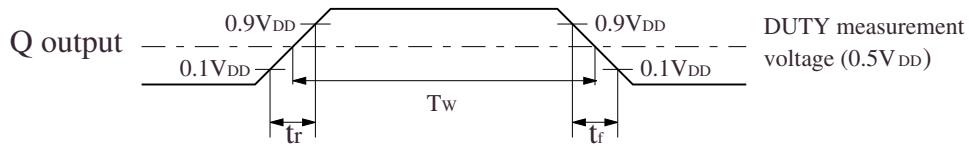
**Load cct 2**



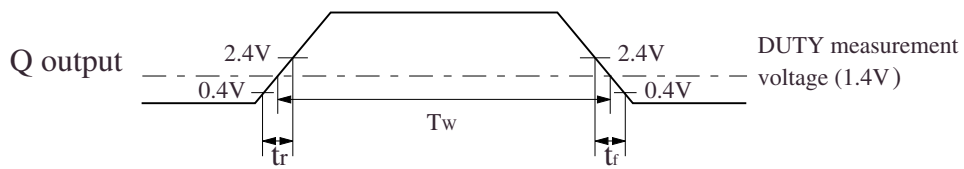
$C_L = 15\text{pF}$ : DUTY,  $I_{DD}$ ,  $t_{r1}$ ,  $t_{f1}$   
 $C_L = 30\text{pF}$ :  $t_{r2}$ ,  $t_{f2}$   
 $C_L = 50\text{pF}$ :  $t_{r3}$ ,  $t_{f3}$

**Switching Time Measurement Waveform**

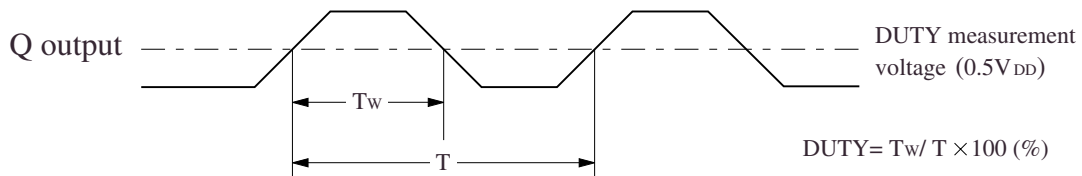
**Output duty level (CMOS)**



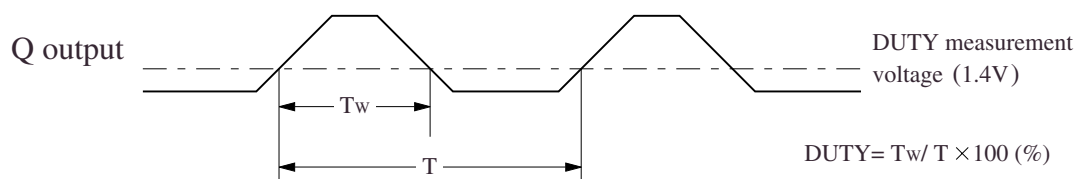
**Output duty level (TTL)**



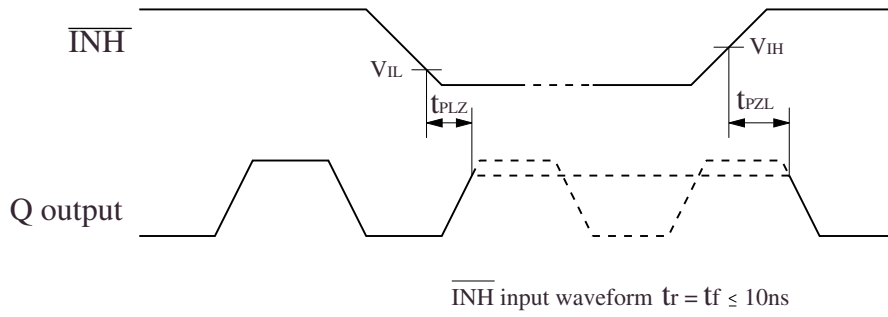
**Output duty cycle (CMOS)**



**Output duty cycle (TTL)**



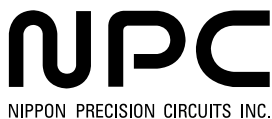
**Output Enable/Disable Delay**



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.

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

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