NPC

OVERVIEW

The SM5024 series are fundamental crystal oscillator module ICs. They feature an oscillator circuit with builtin capacitors with excellent frequency response and an output buffer with high output drive capability. They are available in miniature 6-pin packages, making them ideal as DIP-type crystal oscillators.

FEATURES

- Operating supply voltage range
 - 3V operation: 2.7 to 3.6V
 - 5V operation: 4.5 to 5.5V
- Up to 30MHz operating frequency range (fundamental oscillation)
- -40 to 85°C operating temperature range
- Oscillator capacitors C_G, C_D built-in
- Feedback resistor R_f built-in
- f_O, f_O/2, f_O/4, f_O/8 output frequency, determined by internal connection
- Output drive capability
 - 8mA ($V_{DD} = 2.7V$)
 - $16mA(V_{DD} = 4.5V)$
- Output three-state function built-in High impedance outputs in standby mode
- CMOS output duty level (1/2VDD)
- Molybdenum-gate CMOS process
- Package: SOT23-6 (SM5024×××H)

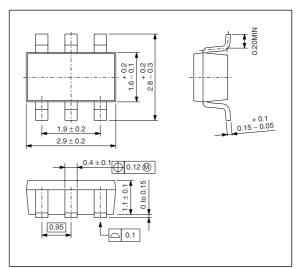
APPLICATIONS

DIP-type crystal oscillator modules

SERIES CONFIGURATION

PACKAGE DIMENSIONS

(Unit: mm)



Vereic	Version	Operating	Recommended operating	Built-in ca [p	pacitance F]	Output	Output	INHN input	Standb	y mode
versio		Supply voltage range [V]	frequency range ¹ [MHz]	C _G	CD	duty level	frequency	level	Oscillator stop function	Output state
SM5024	AL1H		4 to 30				f _O		Yes	
SM5024	AL2H	0.7 to 5.5			10	CMOS	f _O /2	- TTL		Hi-Z
SM5024/	AL3H	2.7 to 5.5		8	10		f _O /4		ies	n-z
SM5024/	AL4H						f _O /8			

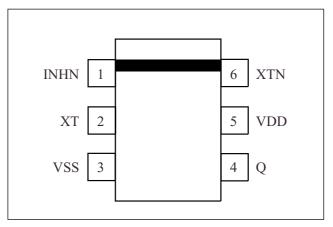
1. The recommended operating frequency is a yardstick value derived from the crystal used for NPC characteristics authentication. However, the oscillator frequency band is not guaranteed. Specifically, the characteristics can vary greatly due to crystal characteristics and mounting conditions, so the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

ORDERING INFORMATION

Device	Package
SM5024×××H	SOT23-6

PINOUT

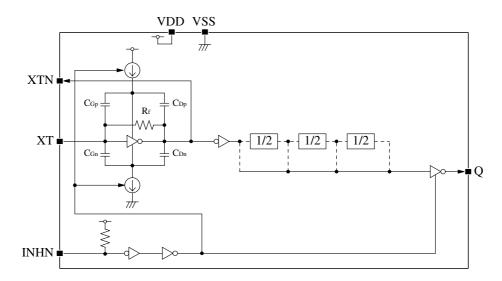
(Top view)



PIN DESCRIPTION

Name	I/O	Description						
INHN	I	Output state control input. H Pull-up resistor built-in.	utput state control input. High impedance when LOW. ull-up resistor built-in.					
XT	I	Amplifier input	Crystal connection pins.					
XTN	0	Amplifier output	Crystal is connected between XT and XTN.					
VSS	-	Ground						
Q	0	Output. Output frequency (f	$_{\rm O},f_{\rm O}/2,f_{\rm O}/4,f_{\rm O}/8)$ determined by internal connection					
VDD	_	Supply voltage	Supply voltage					

BLOCK DIAGRAM



INHN = LOW active

Notes. The SM5024 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. When this device is used for buffer application, please pay attention to input amplitude to the XT pin. If it's low input amplitude, the SM5024 series may not operate normally.

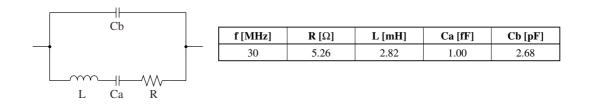
FUNCTIONAL DESCRIPTION

Standby Function

When INHN goes LOW, the oscillator stops and the oscillator output on Q becomes high impedance.

INHN	Q	Oscillator
HIGH (or open)	Any f_O, f_O/2, f_O/4, or f_O/8 output frequency	Normal operation
LOW	High impedance	Stopped

Current consumption and Output waveform with NPC's standard crystal



SPECIFICATIONS

Absolute Maximum Ratings

 $V_{SS} = 0V$

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}		-55 to +125	°C
Output current	I _{OUT}		20	mA
Power dissipation	PD		250	mW

Recommended Operating Conditions

3V operation

 $V_{SS} = 0V$, f \leq 30MHz, $C_L \leq$ 15pF unless otherwise noted.

Parameter	Symbol	Condition	Rating			Unit
Operating supply voltage	V _{DD}		2.7	-	3.6	V
Input voltage	V _{IN}		V _{SS}	-	V _{DD}	V
Operating temperature	T _{OPR}		-20	I	+80	°C

5V operation

 V_{SS} = 0V, f \leq 30MHz, $C_L \leq$ 50pF unless otherwise noted

Parameter	Symbol	Condition	Rating			Unit
Operating supply voltage	V _{DD}		4.5	-	5.5	V
Input voltage	V _{IN}		V _{SS}	-	V _{DD}	V
Operating temperature	T _{OPR}		-40	-	+85	°C

Electrical Characteristics

3V operation

 $V_{SS} = 0V$, recommended operating conditions unless otherwise noted.

Parameter	Symbol	Symbol Condition			Rating			
		Condition			typ	max	Unit	
HIGH-level output voltage	V _{OH}	Q: Measurement cct 1, V_{DD} = 2.7V, I_{OH} =	8mA	2.1	2.4	-	V	
LOW-level output voltage	V _{OL}	Q: Measurement cct 2, V_{DD} = 2.7V, I_{OL} =	8mA	-	0.3	0.5	V	
HIGH-level input voltage	V _{IH}	INHN		2.0	-	-	V	
LOW-level input voltage	V _{IL}	INHN		-	-	0.5	V	
0 · · · · · · ·	Ιz	Q: Measurement cct 2, INHN = LOW, V _{DD} = 3.6V	$V_{OH} = V_{DD}$	-	-	10	μA	
Output leakage current			V _{OL} = V _{SS}	-	-	10	μA	
	I _{DD1}	Measurement cct 3, load cct 1,INHN = open, $C_L = 15pF$, f = 30MHz	SM5024AL1H	-	4	8	mA	
Current companying			SM5024AL2H	-	2.5	5	mA	
Current consumption			SM5024AL3H	-	2	4	mA	
			SM5024AL4H	-	1.5	3	mA	
INHN pull-up resistance	R _{UP}	Measurement cct 4	- 1	25	100	250	kΩ	
Feedback resistance	R _f	Measurement cct 5		200	600	1000	kΩ	
Duille in anna diana a	C _G		a la ta sta d	7.44	8	8.56	pF	
Built-in capacitance	CD	Design value. A monitor pattern on a wafe	er is tested.	9.3	10	10.7	pF	

5V operation

 $V_{SS} = 0V$, recommended operating conditions unless otherwise noted.

Parameter	Cumhal	Symbol Condition			Rating			
Farameter	Symbol				typ	max	Unit	
HIGH-level output voltage	V _{OH}	Q: Measurement cct 1, V_{DD} = 4.5V, I_{OH} =	16mA	3.9	4.2	-	V	
LOW-level output voltage	V _{OL}	Q: Measurement cct 2, V _{DD} = 4.5V, I _{OL} = 1	l6mA	-	0.3	0.5	V	
HIGH-level input voltage	V _{IH}	INHN		2.0	-	-	V	
LOW-level input voltage	V _{IL}	INHN		-	-	0.8	V	
0 · · · · · ·	Ιz	Q: Measurement cct 2, INHN = LOW, V _{DD} = 5.5V	$V_{OH} = V_{DD}$	-	-	10	μA	
Output leakage current			V _{OL} = V _{SS}	-	-	10	μA	
			SM5024AL1H	-	13	26	mA	
Current consumption			SM5024AL2H	-	7	14	mA	
Current consumption	I _{DD2}		SM5024AL3H	-	4	8	mA	
			SM5024AL4H	-	3	6	mA	
INHN pull-up resistance	R _{UP}	Measurement cct 4	•	25	100	250	kΩ	
Feedback resistance	R _f	Measurement cct 5		200	600	1000	kΩ	
Duille in an an iteration	C _G			7.44	8	8.56	pF	
Built-in capacitance	CD	Design value. A monitor pattern on a wafe	r is lested.	9.3	10	10.7	pF	

Switching Characteristics

3V operation

 $V_{DD} = 2.7$ to 3.6V, $V_{SS} = 0V$, Ta = -20 to +80°C unless otherwise noted.

Parameter	Symbol	Condition		Unit		
Falameter	Symbol	Condition	min	typ	max	Unit
Output rise time	t _{r1}	Measurement cct 6, load cct 1, $0.1V_{DD}$ to $0.9V_{DD}$, C _L = 15pF	-	5	10	ns
Output fall time	t _{f1}	Measurement cct 6, load cct 1, 0.9V _{DD} to 0.1V _{DD} , C _L = 15pF	-	5	10	ns
Output duty cycle ¹	Duty1	Measurement cct 6, load cct 1, V _{DD} = 3.0V, Ta = 25°C, C _L = 15pF, f \leq 30MHz	45	-	55	%
Output disable delay time ²	t _{PLZ}	Measurement cct 6, load cct 1, V_{DD} = 3.0V, Ta = 25°C,	-	-	100	ns
Output enable delay time ²	t _{PZL}	C _L = 15pF	-	-	100	ns

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

2. Oscillator stop function is built-in. When INHN goes LOW, normal output stops. When INHN goes HIGH, normal output is not resumed until after the oscillator start-up time has elapsed.

5V operation

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

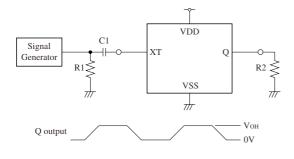
Parameter	Symbol Condition				– Unit		
Farameter	Symbol	Condition		min	typ	max	Unit
Output rise time	t _{r1}	Measurement cct 6, load cct 1,	C _L = 15pF	-	2.5	5	
Output rise time	t _{r2}	0.1V _{DD} to 0.9V _{DD}	C _L = 50pF	-	5	5 ns 10 5 ns 10 10	115
Output fall time	t _{f1}	Measurement cct 6, load cct 1,	C _L = 15pF	-	2.5	5	nc
	t _{f2}	0.9V _{DD} to 0.1V _{DD}		10	IIS		
Output duty cycle ¹	Duty2	Measurement cct 6, load cct 1, V_{DD} = 5.0V, C_L = 50pF, f \leq 30MHz	, Ta = 25°C,	45	-	55	%
Output disable delay time ²	t _{PLZ}	Measurement cct 6, load cct 1, V _{DD} = 5.0V	Measurement cct 6, load cct 1, V_{DD} = 5.0V, Ta = 25°C,		-	100	ns
Output enable delay time ²	t _{PZL}	C _L = 15pF		-	-	100	ns

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

2. Oscillator stop function is built-in. When INHN goes LOW, normal output stops. When INHN goes HIGH, normal output is not resumed until after the oscillator start-up time has elapsed.

MEASUREMENT CIRCUITS

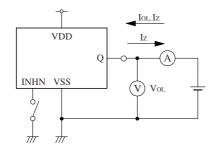
Measurement cct 1



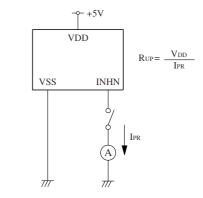
 $\begin{array}{l} 2.0 \text{Vp-p, 10MHz sine wave input signal (3V operation)} \\ 3.5 \text{Vp-p, 10MHz sine wave input signal (5V operation)} \\ \text{C1: } 0.001 \mu\text{F} \\ \text{R1: } 50 \Omega \\ \text{R2: } 263 \Omega \text{ (3V operation)} \\ 244 \Omega \text{ (5V operation)} \end{array}$

Measurement cct 2

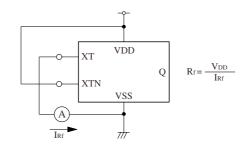
Measurement cct 3



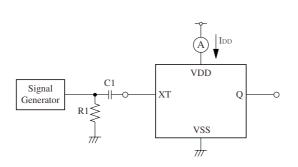
Measurement cct 4



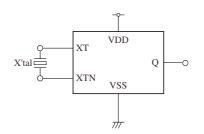
Measurement cct 5



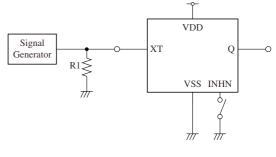
Measurement cct 6



2.0Vp-p, 30MHz sine wave input signal (3V operation) 3.5Vp-p, 30MHz sine wave input signal (5V operation) C1: $0.001\mu F$ R1: 50Ω

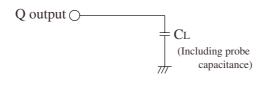


Measurement cct 7



R1: 50 Ω

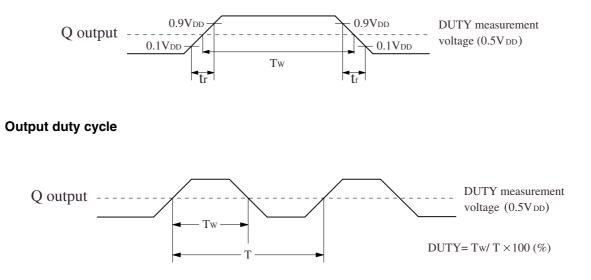
Load cct 1



 $\begin{array}{l} C_L = 15 p F: t_{r1}, \, t_{f1}, \, Duty1, \, I_{DD1} \\ C_L = 50 p F: t_{r2}, \, t_{f2}, \, Duty2, \, I_{DD2} \end{array}$

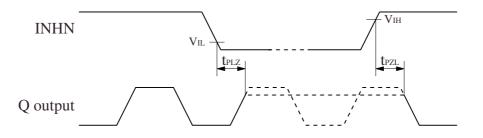
Switching Time Measurement Waveform

Output duty level, t_r, t_f



Output Enable/Disable Delay

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.



INHN input waveform $tr = tf \le 10ns$

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

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