

## OVERVIEW

The CF5014 series are fundamental frequency crystal oscillator ICs. They are available for frequencies up to 60MHz. The chip layout is optimized, resulting in a large reduction in chip size, when compared to existing devices.

## FEATURES

- 2.7 to 5.5V operating supply voltage range
- Up to 60MHz oscillation frequency range
- - 40 to 85°C operating temperature range
- Oscillation capacitors built-in
  - $C_G = 18\text{pF}$ ,  $C_D = 18\text{pF}$
- Inverter amplifier feedback resistor built-in
- Standby function
  - High impedance in standby mode, oscillator stops
- Low standby current
  - Power-save pull-up resistor built-in
- $f_O$ ,  $f_O/2$ ,  $f_O/4$ ,  $f_O/8$ , or  $f_O/16$  output frequency, determined by internal connection
- CMOS output duty level (1/2VDD)
- Molybdenum-gate CMOS process
- Chip form (CF5014AL×)

## SERIES CONFIGURATION

Version	Recommended operating frequency range <sup>1</sup> [MHz]			Built-in capacitance [pF]		Output frequency	Standby function
	$V_{DD} = 2.7$ to $3.6\text{V}$		$V_{DD} = 4.5$ to $5.5\text{V}$	$C_G$	$C_D$		
	$C_L = 15\text{pF}$	$C_L = 30\text{pF}$	$C_L = 30\text{pF}$				
CF5014AL1	4 to 60	4 to 40	4 to 60	18	18	$f_O$	Yes
CF5014AL2						$f_O/2$	Yes
CF5014AL3						$f_O/4$	Yes
CF5014AL4						$f_O/8$	Yes
CF5014AL5						$f_O/16$	Yes

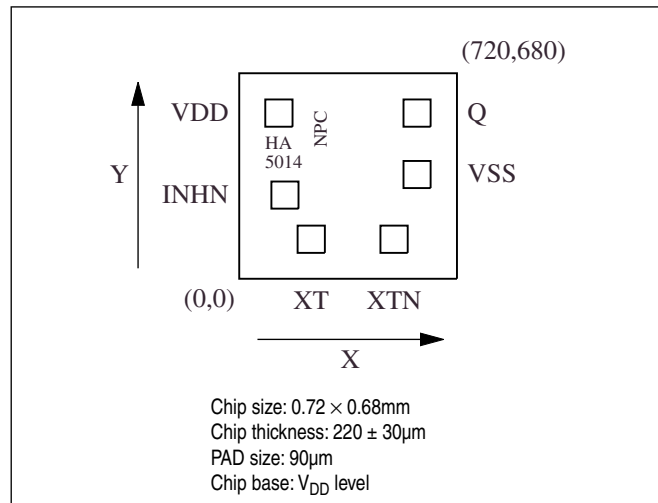
1. The recommended operating frequency is a yardstick value derived from the crystal used for NPC characteristics authentication. However, the oscillator frequency band is not guaranteed. Specifically, the characteristics can vary greatly due to crystal characteristics and mounting conditions, so the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

## ORDERING INFORMATION

Device	Package
CF5014AL×-2	Chip form

### PAD LAYOUT

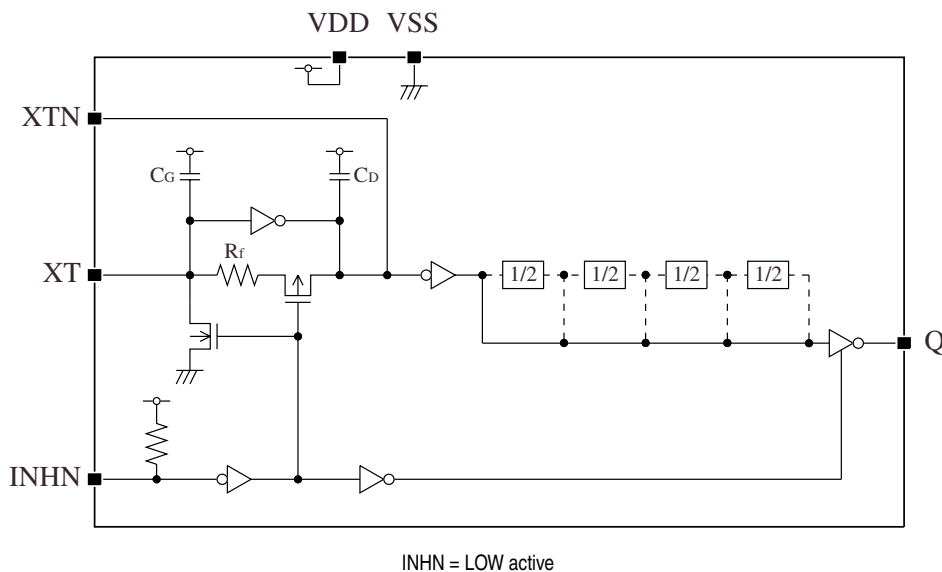
(Unit:  $\mu\text{m}$ )



### PIN DESCRIPTION and PAD DIMENSIONS

Name	I/O	Description	Pad dimensions [ $\mu\text{m}$ ]	
			X	Y
INHN	I	Output state control input. High impedance when LOW (oscillator stops). Power-saving pull-up resistor built-in.	151	277
XT	I	Amplifier input	238	131
XTN	O	Amplifier output		
VSS	-	Ground	588	345
Q	O	Output. Output frequency ( $f_O, f_{O/2}, f_{O/4}, f_{O/8}, f_{O/16}$ ) determined by internal connection	588	548
VDD	-	Supply voltage	131	548

### BLOCK DIAGRAM



## 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	$T_{STG}$		-65 to +150	°C
Output current	$I_{OUT}$		12	mA

### Recommended Operating Conditions

#### 3V operation

$$V_{SS} = 0V$$

Parameter	Symbol	Condition	Rating	Unit
Supply voltage	$V_{DD}$		2.7 to 3.6	V
Input voltage	$V_{IN}$		$V_{SS}$ to $V_{DD}$	V
Operating temperature	$T_{OPR}$		-40 to +85	°C
Operating frequency	$f_{OSC}$	$C_L \leq 15pF$	4 to 60	MHz
		$C_L \leq 30pF$	4 to 40	MHz

#### 5V operation

$$V_{SS} = 0V$$

Parameter	Symbol	Condition	Rating	Unit
Supply voltage	$V_{DD}$		4.5 to 5.5	V
Input voltage	$V_{IN}$		$V_{SS}$ to $V_{DD}$	V
Operating temperature	$T_{OPR}$		-40 to +85	°C
Operating frequency	$f_{OSC}$	$C_L \leq 30pF$	4 to 60	MHz

## Electrical Characteristics

### 3V operation

$V_{DD} = 2.7$  to  $3.6V$ ,  $V_{SS} = 0V$ ,  $T_a = -40$  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, $V_{DD} = 2.7V$ , $I_{OH} = 4mA$	2.1	2.4	–	V	
LOW-level output voltage	$V_{OL}$	Q: Measurement cct 1, $V_{DD} = 2.7V$ , $I_{OL} = 4mA$	–	0.3	0.4	V	
HIGH-level input voltage	$V_{IH}$	INH N	$0.7V_{DD}$	–	–	V	
LOW-level input voltage	$V_{IL}$	INH N	–	–	$0.3V_{DD}$	V	
Output leakage current	$I_Z$	Q: Measurement cct 2, INH N = LOW	$V_{OH} = V_{DD}$	–	–	10	$\mu A$
			$V_{OL} = V_{SS}$	–	–	10	$\mu A$
Current consumption	$I_{DD}$	Measurement cct 3, load cct 1, INH N = open, $C_L = 15pF$ , $f = 60MHz$	CF5014AL1	–	6.5	13	mA
			CF5014AL2	–	4	8	mA
			CF5014AL3	–	3	6	mA
			CF5014AL4	–	2.5	5	mA
			CF5014AL5	–	2	4	mA
Standby current	$I_{ST}$	Measurement cct 3, INH N = LOW	–	–	5	$\mu A$	
INH N pull-up resistance	$R_{UP1}$	Measurement cct 4	2	6	18	$M\Omega$	
	$R_{UP2}$		30	100	300	$k\Omega$	
Feedback resistance	$R_f$	Measurement cct 5	100	300	600	$k\Omega$	
Built-in capacitance	$C_G$	Design value. A monitor pattern on a wafer is tested.	15.3	18	20.7	pF	
	$C_D$		15.3	18	20.7	pF	

**CF5014 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, $V_{DD} = 4.5V$ , $I_{OH} = 8mA$	3.9	4.2	–	V	
LOW-level output voltage	$V_{OL}$	Q: Measurement cct 1, $V_{DD} = 4.5V$ , $I_{OL} = 8mA$	–	0.3	0.4	V	
HIGH-level input voltage	$V_{IH}$	INH N	$0.7V_{DD}$	–	–	V	
LOW-level input voltage	$V_{IL}$	INH N	–	–	$0.3V_{DD}$	V	
Output leakage current	$I_Z$	Q: Measurement cct 2, INH N = LOW	$V_{OH} = V_{DD}$	–	–	10	$\mu A$
			$V_{OL} = V_{SS}$	–	–	10	$\mu A$
Current consumption	$I_{DD}$	Measurement cct 3, load cct 1, INH N = open, $C_L = 30pF$ , $f = 60MHz$	CF5014AL1	–	17	34	mA
			CF5014AL2	–	11.5	23	mA
			CF5014AL3	–	8.5	17	mA
			CF5014AL4	–	7	14	mA
			CF5014AL5	–	6	12	mA
Standby current	$I_{ST}$	Measurement cct 3, INH N = LOW	–	–	10	$\mu A$	
INH N pull-up resistance	$R_{UP1}$	Measurement cct 4	1	3	9	$M\Omega$	
	$R_{UP2}$		10	50	150	$k\Omega$	
Feedback resistance	$R_f$	Measurement cct 5	100	300	600	$k\Omega$	
Built-in capacitance	$C_G$	Design value. A monitor pattern on a wafer is tested.	15.3	18	20.7	pF	
	$C_D$		15.3	18	20.7	pF	

## Switching Characteristics

### 3V operation

$V_{DD} = 2.7$  to  $3.6V$ ,  $V_{SS} = 0V$ ,  $T_a = -40$  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 1, $0.1V_{DD}$ to $0.9V_{DD}$	$C_L = 15pF$	–	3	6	ns
	$t_{r2}$		$C_L = 30pF$	–	5	10	
Output fall time	$t_{f1}$	Measurement cct 3, load cct 1, $0.9V_{DD}$ to $0.1V_{DD}$	$C_L = 15pF$	–	3	6	ns
	$t_{f2}$		$C_L = 30pF$	–	5	10	
Output duty cycle <sup>1</sup>	Duty1	Measurement cct 3, load cct 1, $V_{DD} = 3.0V$ , $T_a = 25^\circ C$	$C_L = 15pF$ $f = 60MHz$	45	–	55	%
	Duty2		$C_L = 30pF$ $f = 40MHz$	45	–	55	%
Output disable delay time <sup>2</sup>	$t_{PLZ}$	Measurement cct 6, load cct 1, $V_{DD} = 3.0V$ , $T_a = 25^\circ C$ , $C_L = 15pF$	–	–	100	ns	
Output enable delay time <sup>2</sup>	$t_{PZL}$		–	–	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.

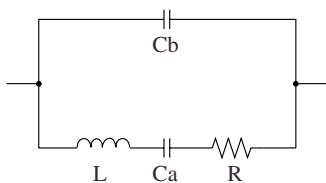
### 5V operation

$V_{DD} = 4.5$  to  $5.5V$ ,  $V_{SS} = 0V$ ,  $T_a = -40$  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 1, $0.1V_{DD}$ to $0.9V_{DD}$	$C_L = 15pF$	–	1.8	3.5	ns
	$t_{r2}$		$C_L = 30pF$	–	3	6	
Output fall time	$t_{f1}$	Measurement cct 3, load cct 1, $0.9V_{DD}$ to $0.1V_{DD}$	$C_L = 15pF$	–	1.8	3.5	ns
	$t_{f2}$		$C_L = 30pF$	–	3	6	
Output duty cycle <sup>1</sup>	Duty1	Measurement cct 3, load cct 1, $V_{DD} = 5.0V$ , $T_a = 25^\circ C$	$C_L = 30pF$ $f = 60MHz$	45	–	55	%
Output disable delay time <sup>2</sup>	$t_{PLZ}$	Measurement cct 6, load cct 1, $V_{DD} = 5.0V$ , $T_a = 25^\circ C$ , $C_L = 15pF$	–	–	100	ns	
Output enable delay time <sup>2</sup>	$t_{PZL}$		–	–	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.

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



f [MHz]	R [ $\Omega$ ]	L [mH]	Ca [fF]	Cb [pF]
40	8.23	5.72	2.77	2.20
50	16.12	6.88	1.48	1.15
60*	–	–	–	–

\* The 60MHz crystal data is confidential.

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## FUNCTIONAL DESCRIPTION

### Standby Function

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

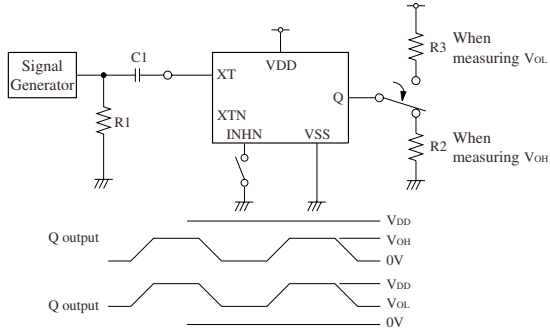
INHN	Q	Oscillator
HIGH (or open)	Any $f_O$ , $f_O/2$ , $f_O/4$ , $f_O/8$ or $f_O/16$ output frequency	Normal operation
LOW	High impedance	Stopped

### Power-save Pull-up Resistance

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

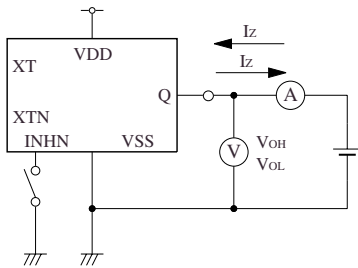
## MEASUREMENT CIRCUITS

### Measurement cct 1

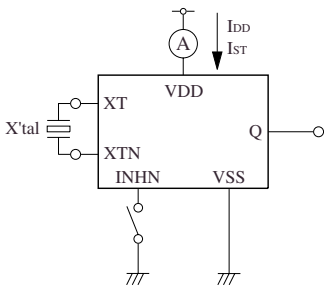


2Vp-p, 10MHz sine wave input signal  
 C1: 0.001 $\mu$ F  
 R1: 50 $\Omega$   
 R2: 525 $\Omega$  (3V operation)  
 488 $\Omega$  (5V operation)  
 R3: 575 $\Omega$  (3V operation)  
 512 $\Omega$  (5V operation)

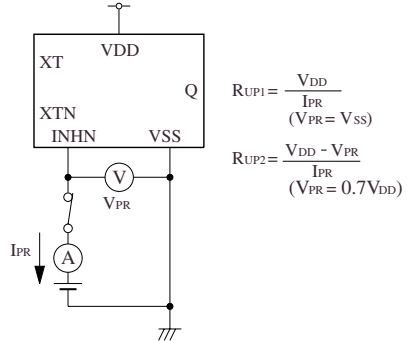
### Measurement cct 2



### Measurement cct 3



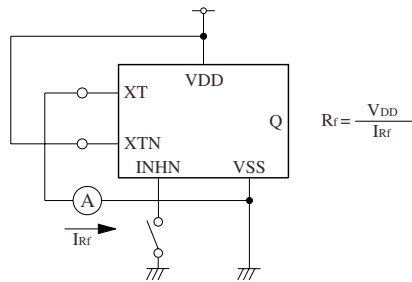
### Measurement cct 4



$$R_{UP1} = \frac{V_{DD}}{I_{PR}} \quad (V_{PR} = V_{SS})$$

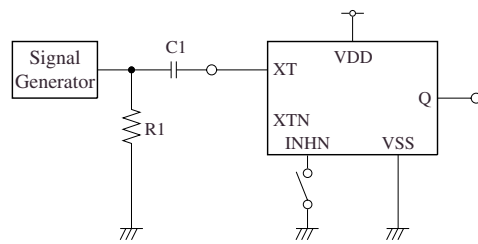
$$R_{UP2} = \frac{V_{DD} - V_{PR}}{I_{PR}} \quad (V_{PR} = 0.7V_{DD})$$

### Measurement cct 5



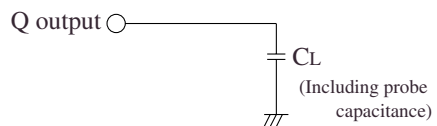
$$R_f = \frac{V_{DD}}{I_{rf}}$$

### Measurement cct 6



2Vp-p, 10MHz sine wave input signal  
 C1: 0.001 $\mu$ F  
 R1: 50 $\Omega$

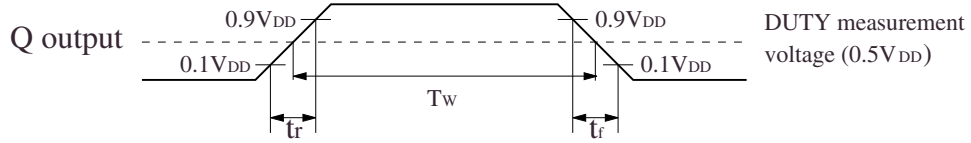
### Load cct 1



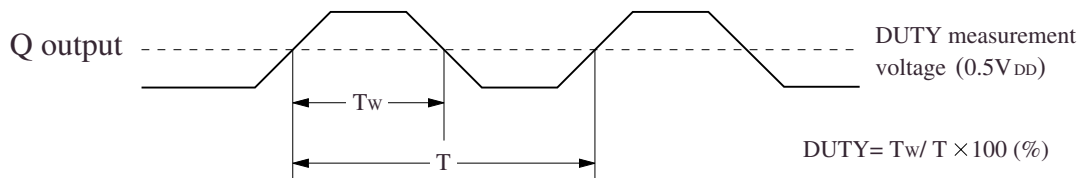


### Switching Time Measurement Waveform

#### Output duty level

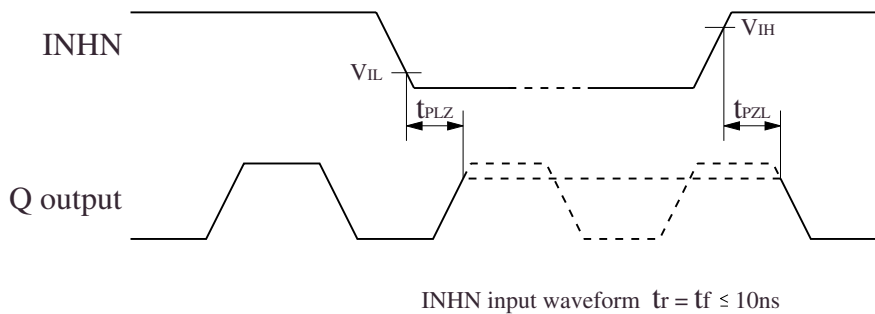


#### Output duty cycle



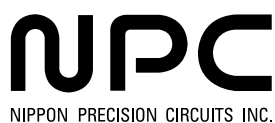
#### Output Enable/Disable Delay

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.



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