

## OVERVIEW

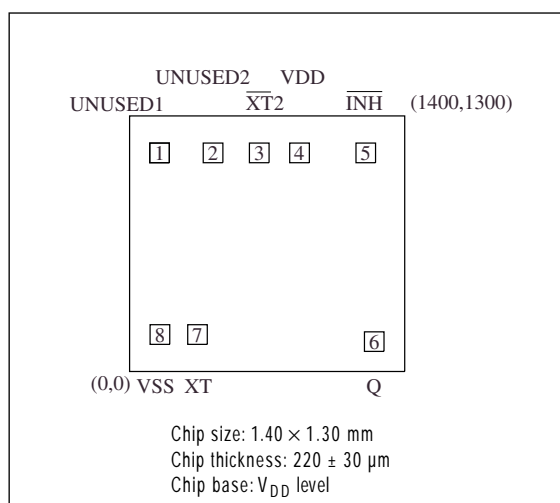
The CF5008 series are VCXO module ICs that employ a circuit structure with low parasitic capacitance effects and a wide frequency range. Built-in components mean that few external components are required to construct a VCXO.

## FEATURES

- Up to 30 MHz operation
- Inverter amplifier feedback resistor built-in
- 8 mA ( $V_{DD} = 5\text{ V}$ ), 4 mA ( $V_{DD} = 3\text{ V}$ ) drive capability
- 2.7 to 5.5 V supply voltage
- Circuit structure with low parasitic capacitance effects
  - Direct connection to varicap diodes and crystal
- Few external components required to form a VCXO
- Amplitude limiting resistor  $R_d$  built-in
- Chip form (CF5008A $\times$ )

## PAD LAYOUT

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



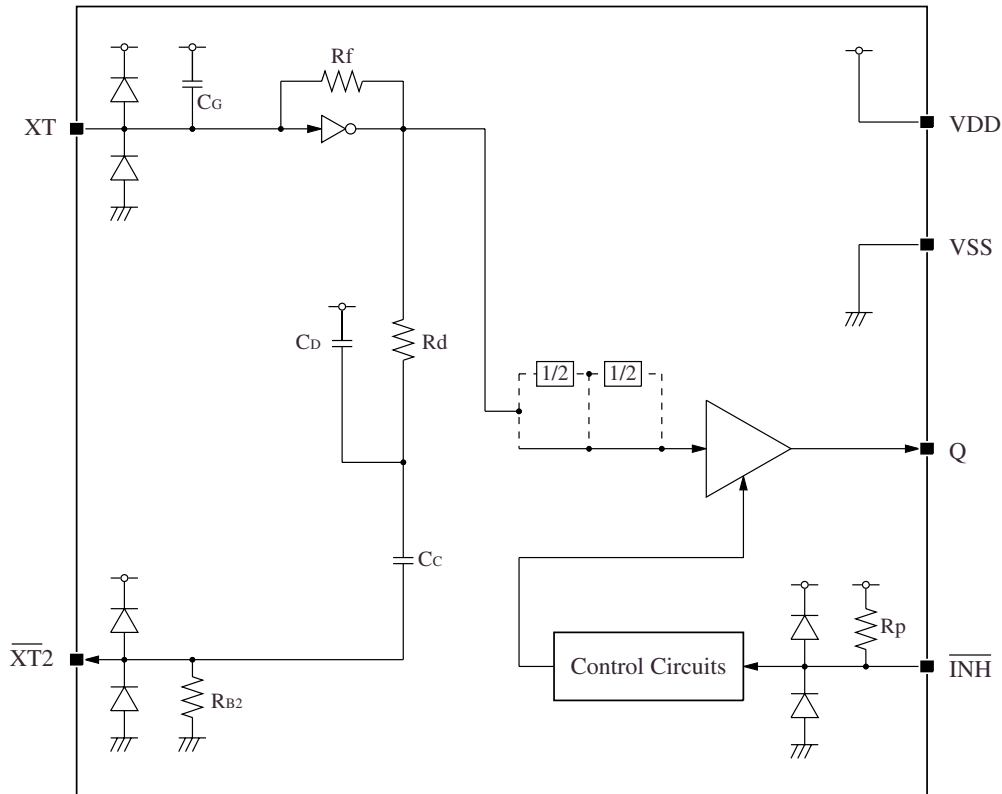
## SERIES CONFIGURATION

Version	Output frequency	Input level	Output duty level	Standby output state
CF5008A1	$f_0$	CMOS	CMOS	High impedance
CF5008A2	$f_0/2$	CMOS	CMOS	High impedance
CF5008A3	$f_0/4$	CMOS	CMOS	High impedance

## ORDERING INFORMATION

Device	Package
CF5008A $\times$ -2	Chip form

## BLOCK DIAGRAM



## PAD DIMENSIONS

Number	Name	I/O	Description	Pad dimensions [ $\mu\text{m}$ ]	
				X	Y
1	UNUSED1	-	Not used.	153	1112
2	UNUSED2	-	Not used.	425	1112
3	$\overline{\text{XT2}}$	O	Oscillator output pin	660	1112
4	VDD	-	Supply voltage	865	1112
5	$\overline{\text{INH}}$	I	Output-control input pin. Q signal output enabled when HIGH or open. High-impedance output when LOW.	1202	1112
6	Q	O	Output pin	1245	152
7	XT	I	Oscillator input pin	346	188
8	VSS	-	Ground	155	188

## OSCILLATOR ELEMENT CONSTANTS (typical values)

	$R_{B2}$	$R_d$	$R_f$	$R_p$	$C_G$	$C_D$	$C_C$
CF5008A $\times$	50k $\Omega$	450 $\Omega$	150k $\Omega$	100k $\Omega$	20pF	10pF	70pF

## SPECIFICATIONS

### Absolute Maximum Ratings

$$V_{SS} = 0 \text{ V}$$

Parameter	Symbol	Condition	Rating	Unit
Supply voltage range	$V_{DD}$		-0.5 to 7.0	V
Input voltage range	$V_{IN}$		-0.5 to $V_{DD} + 0.5$	V
Output voltage range	$V_{OUT}$		-0.5 to $V_{DD} + 0.5$	V
Operating temperature range	$T_{opr}$		-40 to 85	°C
Storage temperature range	$T_{stg}$		-65 to 150	°C
Output current	$I_{OUT}$		25	mA

### Recommended Operating Conditions

$$V_{SS} = 0 \text{ V}, CL \leq 15 \text{ pF}, f \leq 32.5 \text{ MHz}$$

Parameter	Symbol	Condition	Rating			Unit
			min	typ	max	
Supply voltage	$V_{DD}$		2.7	-	5.5	V
Input voltage	$V_{IN}$		$V_{SS}$	-	$V_{DD}$	V
Operating temperature	$T_{OPR}$		-20	-	80	°C

**Electrical Characteristics**

$V_{DD} = 4.5$  to  $5.5$  V,  $V_{SS} = 0$  V,  $T_a = -20$  to  $80$  °C unless otherwise noted.

Parameter	Symbol	Condition	Rating			Unit	
			min	typ	max		
HIGH-level output voltage	$V_{OH}$	Q: Measurement cct 1, $I_{OH} = 8$ mA, $V_{DD} = 4.5$ V	4.0	4.2	-	V	
LOW-level output voltage	$V_{OL}$	Q: Measurement cct 1, $I_{OL} = 8$ mA, $V_{DD} = 4.5$ V	-	0.3	0.4	V	
Output leakage current	$I_Z$	Q: Measurement cct 2, $\overline{INH} = \text{LOW}$ , $V_{OH} = V_{DD}$	-	-	10	$\mu\text{A}$	
		Q: Measurement cct 2, $\overline{INH} = \text{LOW}$ , $V_{OL} = V_{SS}$	-	-	10		
HIGH-level input voltage	$V_{IH}$	$\overline{INH}$	$0.8V_{DD}$	-	-	V	
LOW-level input voltage	$V_{IL}$	$\overline{INH}$	-	-	$0.2V_{DD}$	V	
Current consumption	$I_{DD}$	$\overline{INH} = \text{open}$ , Measurement cct 3, load cct 1, $C_L = 15$ pF, $f = 30$ MHz	CF5008A1	-	28	65	mA
			CF5008A2	-	26	60	mA
			CF5008A3	-	25	58	mA
$\overline{INH}$ pull-up resistance	$R_{UP}$	Measurement cct 4	50	-	150	k $\Omega$	
Feedback resistance	$R_f$	Design value, determined by the internal wafer pattern	-	150	-	k $\Omega$	
Built-in resistance	$R_d$	Design value, determined by the internal wafer pattern	-	450	-	$\Omega$	
	$R_c$		-	0	-	$\Omega$	
	$R_{B2}$	Measurement cct 5	-	50	-	k $\Omega$	
Built-in capacitance	$C_G$	Design value, determined by the internal wafer pattern	-	20	-	pF	
	$C_D$		-	10	-	pF	
	$C_C$		-	70	-	pF	

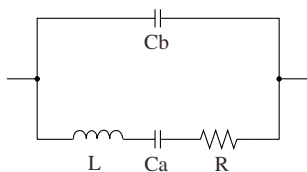
**Switching Characteristics**

$V_{DD} = 2.7$  to  $5.5$  V,  $V_{SS} = 0$  V,  $T_a = -20$  to  $80$  °C unless otherwise noted.

Parameter	Symbol	Condition	Rating			Unit	
			min	typ	max		
Output rise time	$t_{r1}$	Measurement cct 3, load cct 1, $0.1V_{DD}$ to $0.9V_{DD}$ , $C_L = 15$ pF	$V_{DD} = 2.7$ to $3.6$ V	-	3	8	ns
			$V_{DD} = 4.5$ to $5.5$ V	-	2.5	6	
Output fall time	$t_{f1}$	Measurement cct 3, load cct 1, $0.9V_{DD}$ to $0.1V_{DD}$ , $C_L = 15$ pF	$V_{DD} = 2.7$ to $3.6$ V	-	3	8	ns
			$V_{DD} = 4.5$ to $5.5$ V	-	2.5	6	
Output duty cycle <sup>1</sup>	Duty	Measurement cct 3, load cct 1, $T_a = 25$ °C, $C_L = 15$ pF, $f = 32$ MHz	$V_{DD} = 3.0$ V	42	-	58	%
			$V_{DD} = 5.0$ V	42	-	58	
Output disable delay time	$t_{pLZ}$	Measurement cct 6, load cct 1, $T_a = 25$ °C, $C_L \leq 15$ pF	-	-	100	ns	
Output enable delay time	$t_{pZL}$		-	-	100	ns	

1. Determined by the lot monitor.

**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

## FUNCTIONAL DESCRIPTION

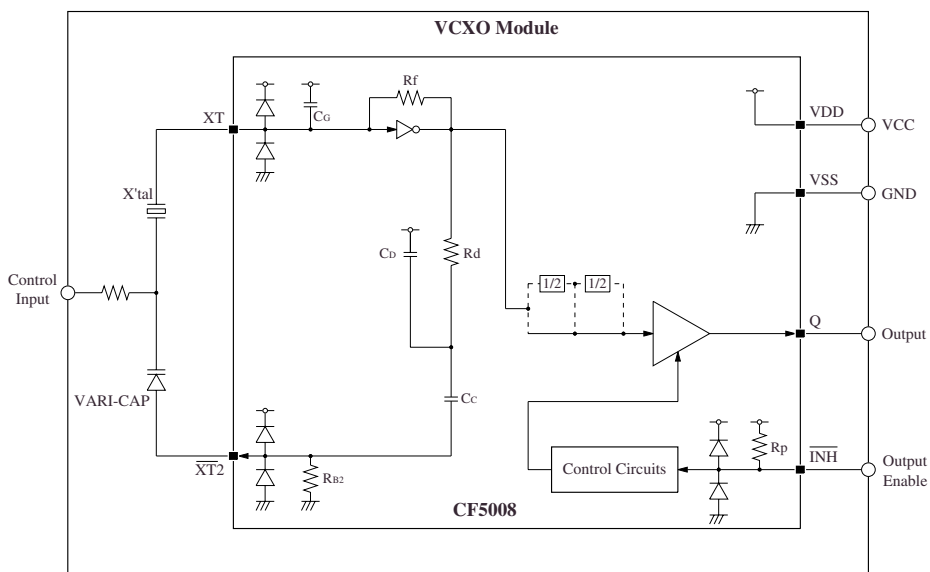
### Standby Function

The oscillator output on Q changes as shown in the following table when  $\overline{\text{INH}}$  goes LOW.

$\overline{\text{INH}}$	Q	Oscillator
HIGH (or open)	$f_0$	Normal operation
LOW	High impedance	Normal operation

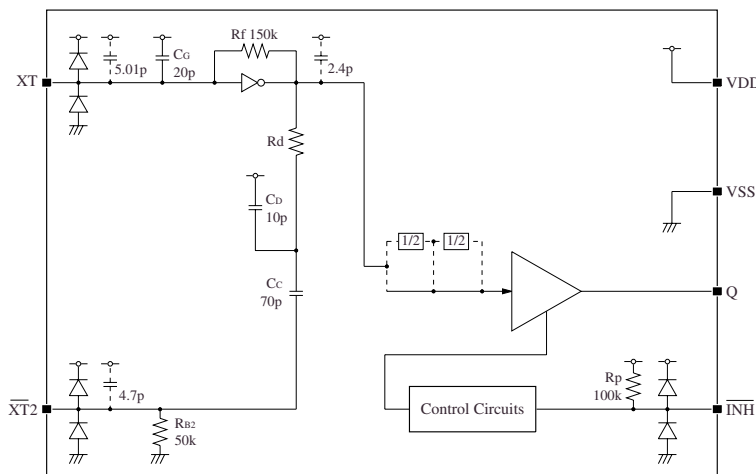
### TYPICAL APPLICATION CIRCUIT

Typical circuit structures ( $C_G$  and  $C_D$ ) that use a varicap device have a reduced frequency range due to the effects of parasitic capacitance. The CF5008 series, however, have built-in components  $C_C$  and  $R_{B2}$  that are connected in series with the varicap device, increasing the frequency output range.



### PARASITIC CAPACITANCE

Parasitic capacitance are unwanted capacitance effects that occur due to the junction capacitance where the protection diodes and transistor drains are connected to the substrate. The following equivalent circuit figure shows the calculated parasitic capacitances. The surface area for each component is calculated from the IC layout pattern, and the capacitance calculated per unit area.



## VARICAP (Variable Capacitance Diodes) SELECTION

The CF5008 series form a VCXO with addition of an external varicap (variable capacitance diode) device. This section examines the results using various varicap devices. When the equivalent circuit in figure 1 is used, the load capacitance  $C_L$  must be changed by a factor of 4 to 5 (10 to 40pF) to affect a  $\pm 100$ ppm frequency change. Varicap devices that can change the capacitance by a factor of 5 require a maximum capacitance in the range approximately 20 to 50pF. Devices matching this criteria are listed in the following table.

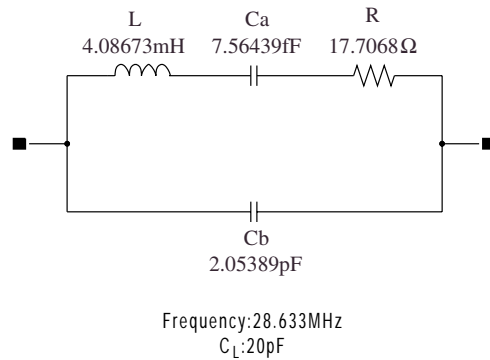
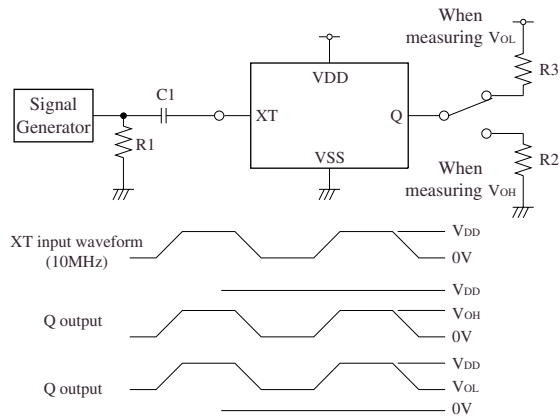


Figure 1. Crystal oscillator element equivalent circuit

Company	Product	Capacitance 1	Capacitance 2
HITACHI	HVU17	50.0 to 85.0pF (VR = 1V)	5.23 to 8.84pF (VR = 4.5V)
HITACHI	HVU359	24.8 to 29.8pF (VR = 1V)	6.00 to 8.30pF (VR = 4V)
HITACHI	HVU362	41.6 to 49.9pF (VR = 1V)	10.1 to 14.8pF (VR = 4V)
HITACHI	HVC374B	21.5 to 24.0pF (VR = 1V)	12.5 to 14.5pF (VR = 2V)
HITACHI	HVC375B	15.5 to 17.0pF (VR = 1V)	4.0pF typ (VR = 4V)
Panasonic	MA304	24.8 to 29.8pF (VR = 1V)	6.00 to 8.30pF (VR = 4V)
Panasonic	MA2S304	24.8 to 29.8pF (VR = 1V)	6.00 to 8.30pF (VR = 4V)
Panasonic	MA2ZV05	18.5 to 20.5pF (VR = 1V)	3.60 to 4.10pF (VR = 4V)
TOKO	KV1811E	21.5pF typ (VR = 1V)	4.00pF typ (VR = 4V)
TOKO	KV1812	16.0pF typ (VR = 1V)	3.00pF typ (VR = 4V)

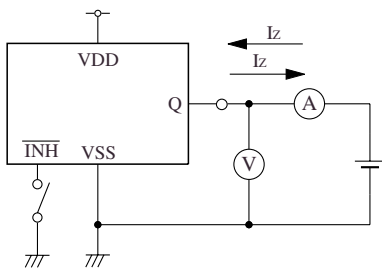
## MEASUREMENT CIRCUITS

### Measurement cct 1

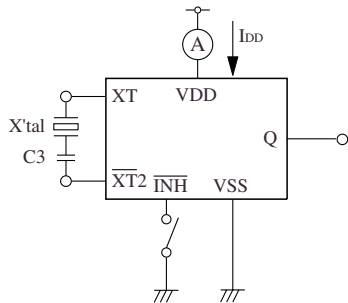


C1 : 0.001 $\mu$ F  
 R1 : 50 $\Omega$   
 R2 : 500 $\Omega$   
 R3 : 512.5 $\Omega$

### Measurement cct 2

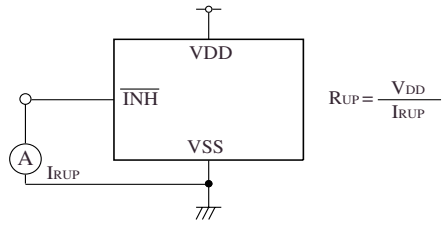


### Measurement cct 3

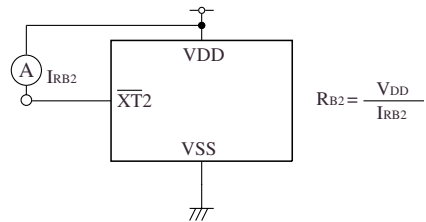


C3 : 15pF

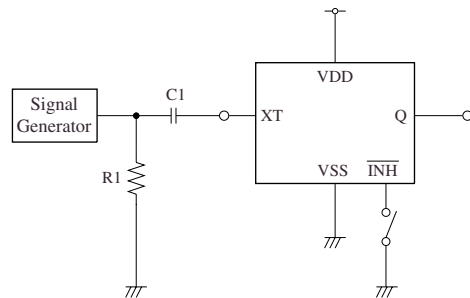
### Measurement cct 4



### Measurement cct 5

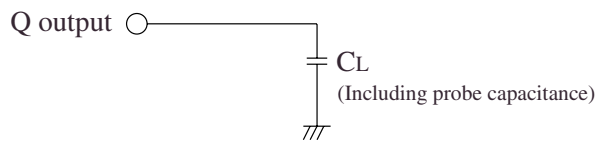


### Measurement cct 6



C1 : 0.001 $\mu$ F  
 R1 : 50 $\Omega$

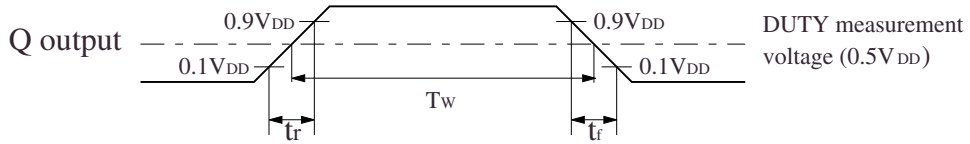
**Load cct 1**



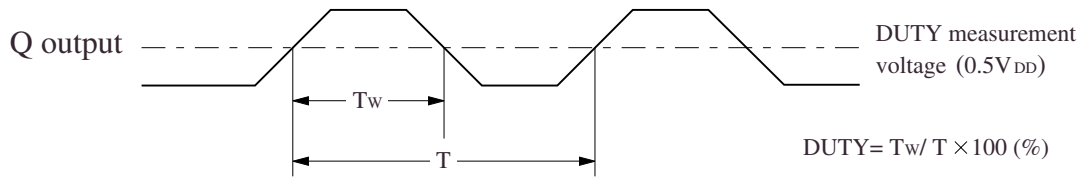
$C_L = 15\text{pF} : I_{DD}, \text{DUTY}, t_{r1}, t_{f1}$

**Switching Time Measurement Waveform**

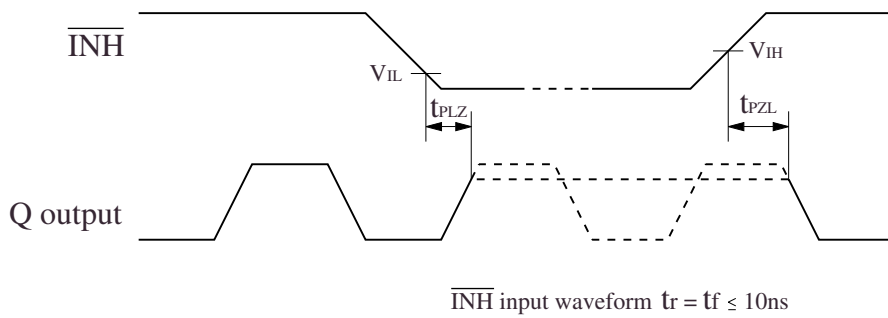
**Output duty level (CMOS)**



**Output duty cycle (CMOS)**



**Output Enable/Disable Delay**



NIPPON PRECISION CIRCUITS INC. reserves the right to make changes to the products described in this data sheet in order to improve the design or performance and to supply the best possible products. Nippon Precision Circuits Inc. assumes no responsibility for the use of any circuits shown in this data sheet, conveys no license under any patent or other rights, and makes no claim that the circuits are free from patent infringement. Applications for any devices shown in this data sheet are for illustration only and Nippon Precision Circuits Inc. makes no claim or warranty that such applications will be suitable for the use specified without further testing or modification. The products described in this data sheet are not intended to use for the apparatus which influence human lives due to the failure or malfunction of the products. Customers are requested to comply with applicable laws and regulations in effect now and hereinafter, including compliance with export controls on the distribution or dissemination of the products. Customers shall not export, directly or indirectly, any products without first obtaining required licenses and approvals from appropriate government agencies.



NIPPON PRECISION CIRCUITS INC.

4-3, Fukuzumi 2-chome  
Koto-ku, Tokyo 135-8430, Japan  
Telephone: +81-3-3642-6661  
Facsimile: +81-3-3642-6698  
<http://www.npc.co.jp/>  
Email: [sales@npc.co.jp](mailto:sales@npc.co.jp)

NC9816BE 2000.10