

## OVERVIEW

The CF5074B is VCXO module IC with built-in varicap diodes. The integrated varicap diode BiCMOS process allows the device to be fabricated on a single chip. A newly developed oscillator circuit features reduced drive level of crystal and wide pullrange. A VCXO module can be constructed with just the connection of a crystal unit, making the devices ideal as surface-mounted, compact VCXO modules.

## FEATURES

- 2.25 to 3.6V operating supply voltage range
- 50MHz to 80MHz operating frequency range
- Varicap diode built-in
- Oscillation start-up detector function
- CMOS output duty level
- 4mA (min) output drive capability
- 15pF output load
- Standby function
  - High impedance in standby mode
- BiCMOS process
- Chip form (CF5074B)

## APPLICATIONS

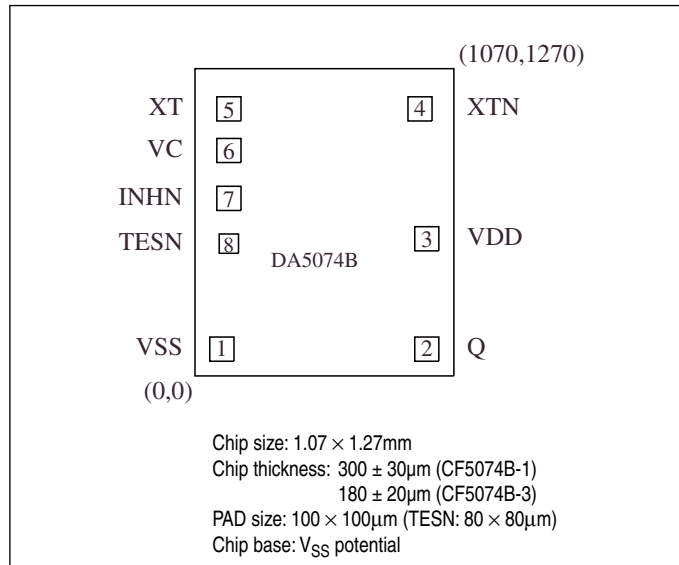
- VCXO modules

## ORDERING INFORMATION

Device	Package
CF5074B-1	Chip form
CF5074B-3	

**PAD LAYOUT**

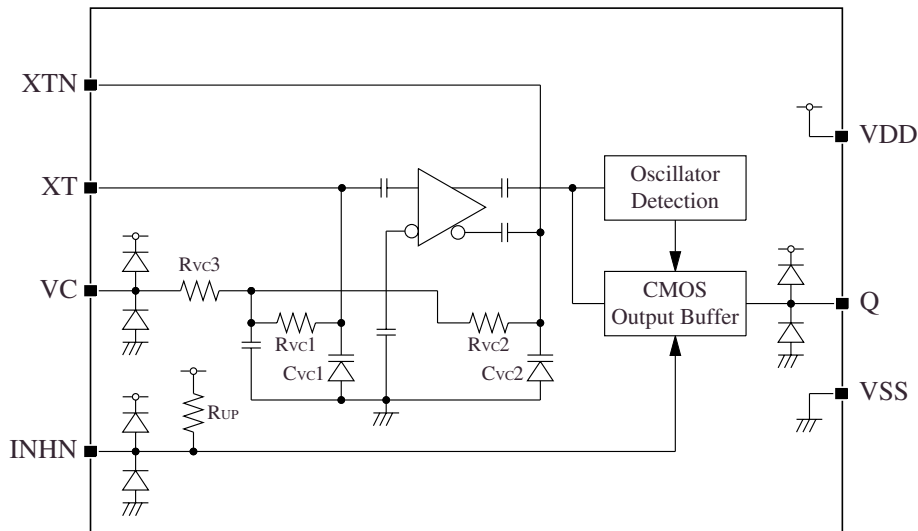
(Unit:  $\mu\text{m}$ )



**PAD DESCRIPTION AND DIMENSIONS**

Pad No.	Name	I/O	Description	Pad dimensions [ $\mu\text{m}$ ]	
				X	Y
1	VSS	-	(-) supply pin	111	111
2	Q	O	Output pin. High-impedance in standby mode	958	111
3	VDD	-	(+) supply pin	958	567
4	XTN	O	Oscillator output. Crystal connection pin	930	1104
5	XT	I	Oscillator input. Crystal connection pin	140	1104
6	VC	I	Oscillation frequency control voltage input pin. Positive polarity (frequency increases with increasing voltage)	140	932
7	INHN	I	Output state control voltage input pin. Standby mode when LOW. Power-saving pull-up resistor built-in	140	734
8	TESN	I	Test pin (leave open)	140	547

**BLOCK DIAGRAM**



## ABSOLUTE MAXIMUM RATINGS

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

Parameter	Symbol	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
Storage temperature range	$T_{STG}$	-65 to +150	°C
Output current	$I_{OUT}$	20	mA

## RECOMMENDED OPERATING CONDITIONS

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

Parameter	Symbol	Rating			Unit
		Min	Typ	Max	
Operating supply voltage	$V_{DD}$	2.25	-	3.6	V
Output frequency	$f_{OUT}$	50	-	80	MHz
Output load capacitance	$C_L$	-	-	15	pF
Input voltage	$V_{IN}$	$V_{SS}$	-	$V_{DD}$	V
Operating temperature	$T_{OPR}$	-40	+25	+85	°C

## ELECTRICAL CHARACTERISTICS

$V_{DD} = 2.25$  to  $3.6V$ ,  $V_C = 0.5V_{DD}$ ,  $V_{SS} = 0V$ ,  $T_a = -40$  to  $+85^\circ C$  unless otherwise noted.

Parameter	Symbol	Conditions	Rating			Unit	
			Min	Typ	Max		
Current consumption	$I_{DD}$	Measurement circuit 2, load circuit 1, INHN = open, $C_L = 15pF$ , $f = 80MHz$	$V_{DD} = 2.25$ to $2.75V$	–	20	30	mA
			$V_{DD} = 3.0$ to $3.6V$	–	26	36	mA
HIGH-level output voltage	$V_{OH}$	Q: Measurement circuit 1, $I_{OH} = -4mA$	$V_{DD} - 0.4$	$V_{DD} - 0.2$	–	V	
LOW-level output voltage	$V_{OL}$	Q: Measurement circuit 1, $I_{OL} = 4mA$	–	0.2	0.4	V	
Output leakage current	$I_Z$	Q: Measurement circuit 6, INHN = LOW	$V_{OH} = V_{DD}$	–	–	10	$\mu A$
			$V_{OL} = V_{SS}$	–	–	10	$\mu A$
HIGH-level input voltage	$V_{IH}$	INHN	$0.7V_{DD}$	–	–	V	
LOW-level input voltage	$V_{IL}$	INHN	–	–	$0.3V_{DD}$	V	
INHN pull-up resistance	$R_{UP1}$	Measurement circuit 3	INHN = $V_{SS}$	0.4	0.8	1.2	$M\Omega$
	$R_{UP2}$		INHN = $0.7V_{DD}$	15	–	150	$k\Omega$
Oscillator block built-in resistance	$R_{VC1}$	Measurement circuit 4		75	150	225	$k\Omega$
	$R_{VC2}$			75	150	225	$k\Omega$
	$R_{VC3}$			10	30	90	$k\Omega$
Oscillator block built-in capacitance	$C_{VC}$	Capacitance of $C_{VC1}$ and $C_{VC2}$	$V_C = 0.3V$	13	16.3	19.6	pF
			$V_C = 1.65V$	6.7	8.9	10.9	pF
			$V_C = 3.0V$	3.3	4.7	6.1	pF
VC input resistance	$R_{VIN}$	Measurement circuit 7, $T_a = 25^\circ C$	10	–	–	$M\Omega$	
VC input impedance	$Z_{VIN}$	Measurement circuit 8, $V_C = 0V$ , $f = 10kHz$ , $T_a = 25^\circ C$	–	250	–	$k\Omega$	
VC input capacitance	$C_{VIN}$	Measurement circuit 8, $V_C = 0V$ , $f = 10kHz$ , $T_a = 25^\circ C$	–	60	–	pF	
Modulation bandwidth	fm	Measurement circuit 9, $-3dB$ frequency, $V_{DD} = 3.3V$ , $V_C = 3.3V_{p-p}$ , $T_a = 25^\circ C$ , crystal: $f = 80MHz$ , $C0 = 4.8pF$ , $\gamma \leq 440$	–	30	–	kHz	

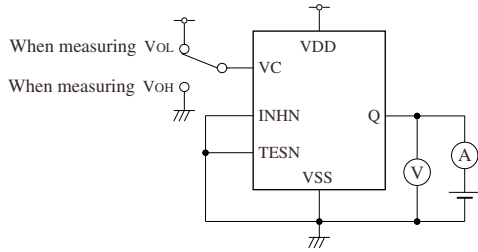
## SWITCHING CHARACTERISTICS

$V_{DD} = 2.25$  to  $3.6V$ ,  $V_C = 0.5V_{DD}$ ,  $V_{SS} = 0V$ ,  $T_a = -40$  to  $+85^\circ C$  unless otherwise noted.

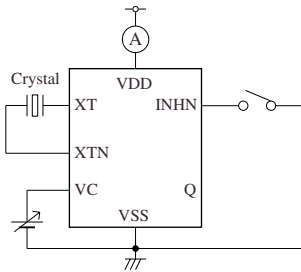
Parameter	Symbol	Conditions	Rating			Unit	
			Min	Typ	Max		
Output rise time	$t_{r1}$	Measurement circuit 2, load circuit 1, $0.2V_{DD} \rightarrow 0.8V_{DD}$ , $T_a = 25^\circ C$ , $C_L = 15pF$	–	2.5	4	ns	
Output fall time	$t_{f1}$	Measurement circuit 2, load circuit 1, $0.8V_{DD} \rightarrow 0.2V_{DD}$ , $T_a = 25^\circ C$ , $C_L = 15pF$	–	2.5	4	ns	
Output duty cycle	Duty	Measurement circuit 2, load circuit 1, $T_a = 25^\circ C$ , $C_L = 15pF$	$V_{DD} = 2.5V$	40	50	60	%
			$V_{DD} = 3.3V$	45	50	55	%
Output disable delay time	$t_{PLZ}$	Measurement circuit 5, load circuit 1, $T_a = 25^\circ C$ , $C_L \leq 15pF$	–	–	100	ns	
Output enable delay time	$t_{PZL}$		–	–	100	ns	

## MEASUREMENT CIRCUITS

### Measurement Circuit 1

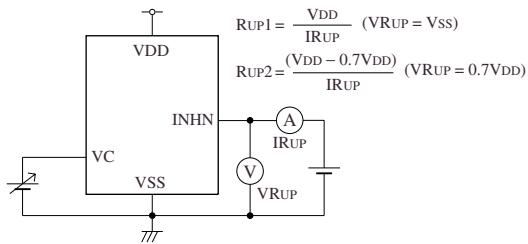


### Measurement Circuit 2



$V_C = 0.5V_{DD}$ , INHN = open, crystal oscillation

### Measurement Circuit 3

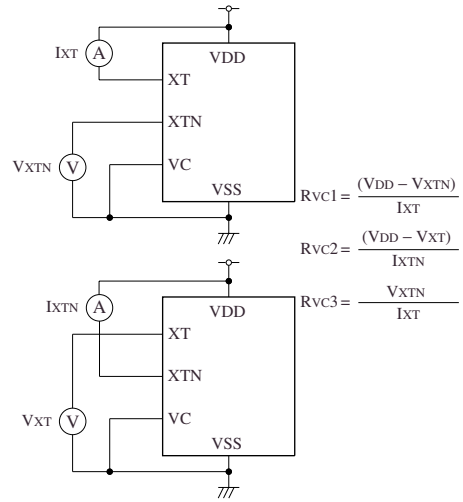


$V_C = 0.5V_{DD}$

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

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

### Measurement Circuit 4

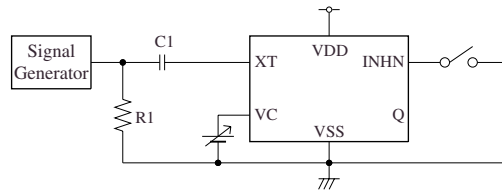


$$R_{VC1} = \frac{(V_{DD} - V_{XTN})}{I_{XT}}$$

$$R_{VC2} = \frac{(V_{DD} - V_{XT})}{I_{XTN}}$$

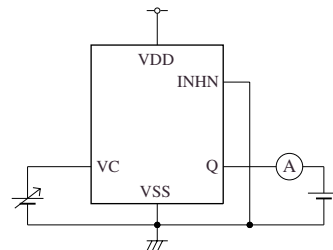
$$R_{VC3} = \frac{V_{XTN}}{I_{XT}}$$

### Measurement Circuit 5



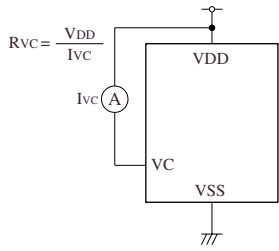
XT input signal: 10MHz, 1.0Vp-p  
 $C1 = 0.001\mu F$ ,  $R1 = 50\Omega$ ,  $V_C = 0.5V_{DD}$

### Measurement Circuit 6

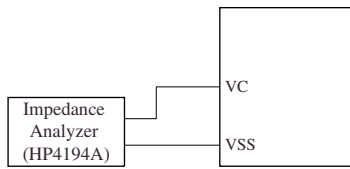


$V_C = 1/2V_{DD}$

**Measurement Circuit 7**

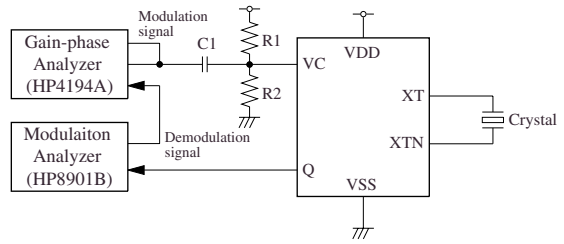


**Measurement Circuit 8**



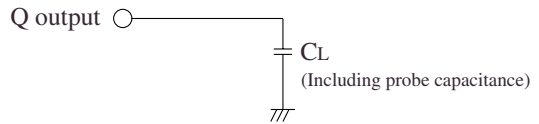
VC input signal: 100Hz to 10kHz, 0.1Vp-p,  $V_C = 0V$

**Measurement Circuit 9**



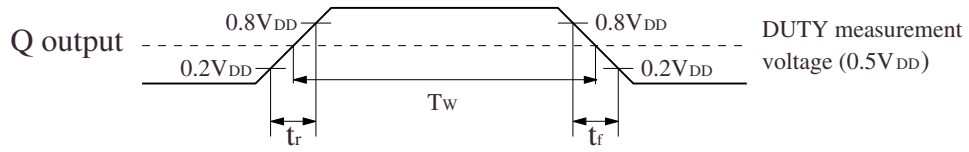
$C1 = 20\mu F$ ,  $R1 = R2 = 100M\Omega$ ,  $V_{DD} = 3.3V$   
 VC modulation signal: 100Hz to 100kHz, 3.3Vp-p

**Load Circuit 1**

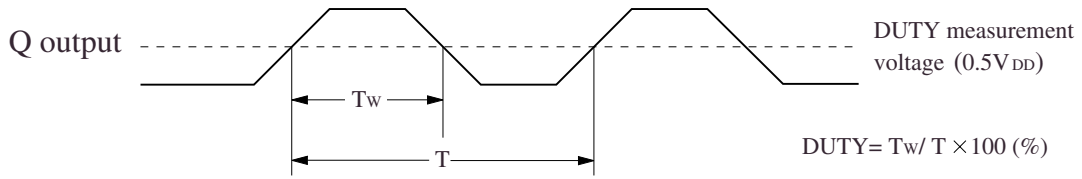


### Switching Time Measurement Waveform

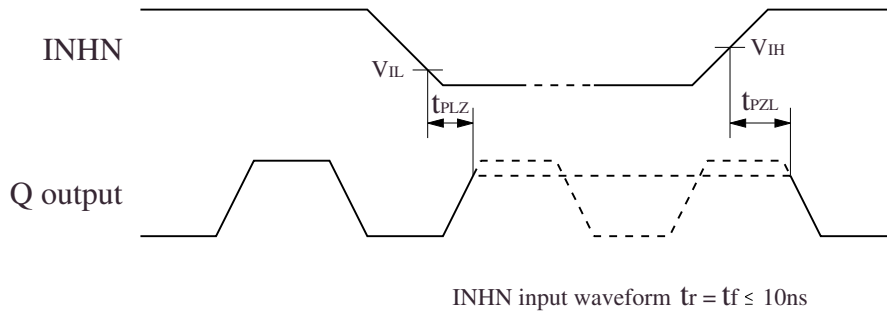
Output duty level,  $t_r$ ,  $t_f$



Output duty cycle



### Output Enable/Disable Delay Times



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## FUNCTIONAL DESCRIPTION

### Standby Function

When INHN goes LOW, the device is in standby mode. The Q output becomes high impedance and the oscillator circuit continues running.

INHN	Q	Oscillator
HIGH (or open)	$f_0$	Operating
LOW	High impedance	Operating

### Power-saving Pull-up Resistor

The INHN pin pull-up resistance changes in response to the input level (HIGH or LOW). When INHN is tied LOW, the pull-up resistance becomes large, reducing the current consumed by the resistance. When INHN is left open, the pull-up resistance becomes small, such that even if the input is affected by external noise the outputs are stable due to INHN being tied HIGH by the pull-up resistor.

### Oscillation Start-up Detector Function

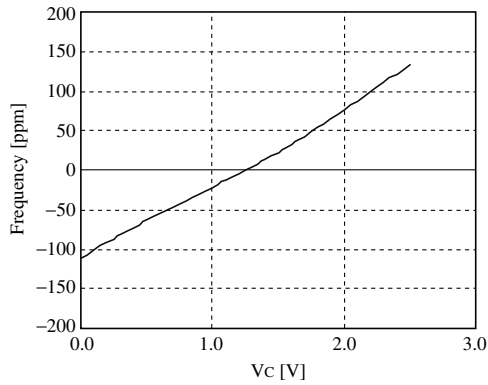
The devices also feature an oscillation start-up detector circuit. This circuit functions to disable the outputs until the oscillation starts. This prevents unstable oscillator output at oscillator start-up when power is applied.



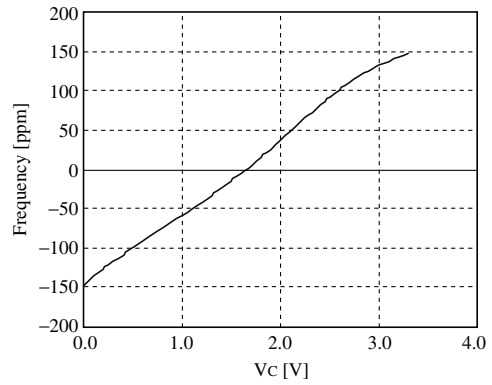
## TYPICAL CHARACTERISTICS

The following characteristics measured using the crystal for NPC characteristics authentication. Note that the characteristics will vary with the crystal used.

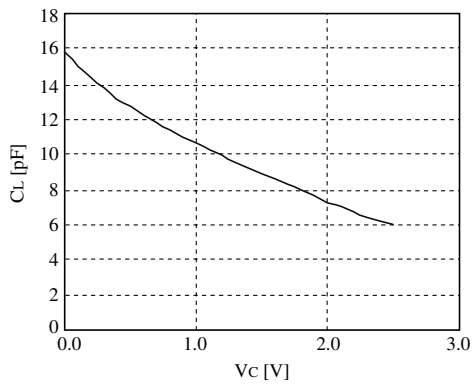
### Frequency Pullrange, Oscillator Equivalent Capacitance ( $C_L$ ) Characteristics



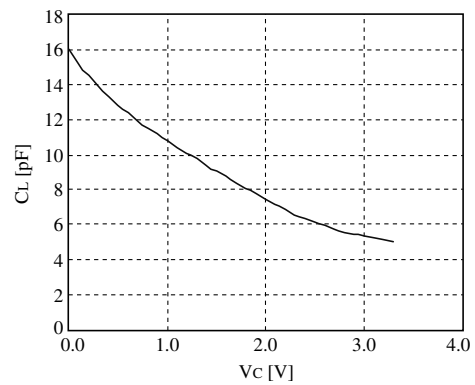
$V_{DD} = 2.5V$  ( $V_C = 1.25V$  reference)



$V_{DD} = 3.3V$  ( $V_C = 1.65V$  reference)

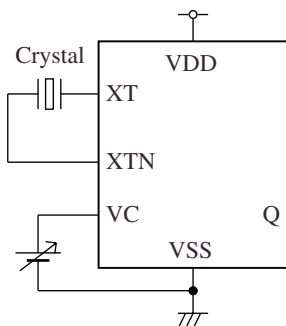


$V_{DD} = 2.5V$



$V_{DD} = 3.3V$

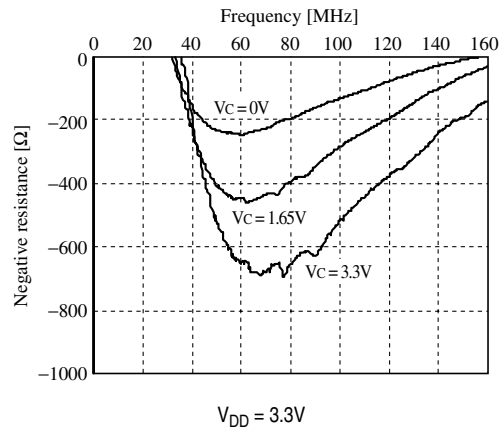
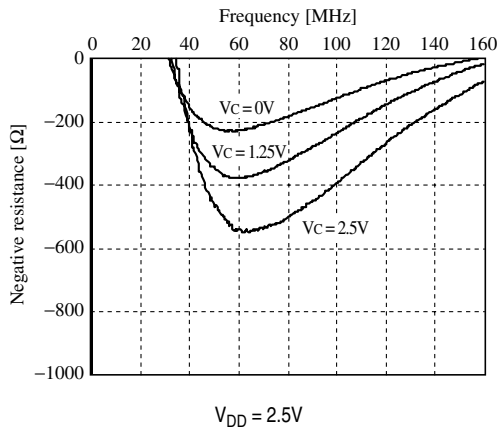
### Measurement circuit



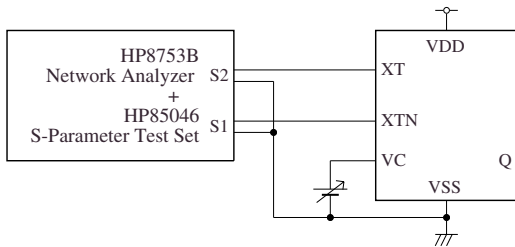
Crystal:  $f = 80\text{MHz}$ ,  $C_0 = 4.8\text{pF}$ ,  $\gamma = 440$

$C_L$ : Oscillator equivalent capacitance is determined by the oscillator frequency.

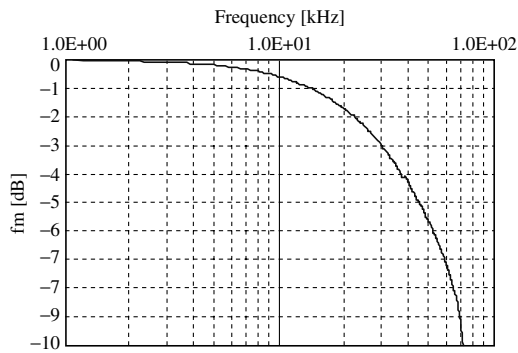
### Negative Resistance Characteristics



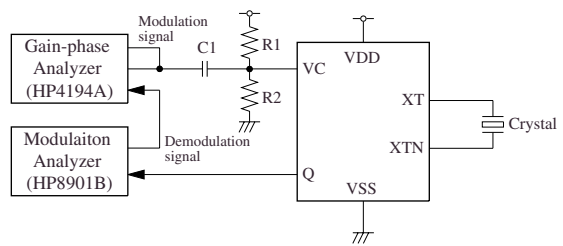
### Measurement circuit



### Modulation Characteristics



### Measurement circuit

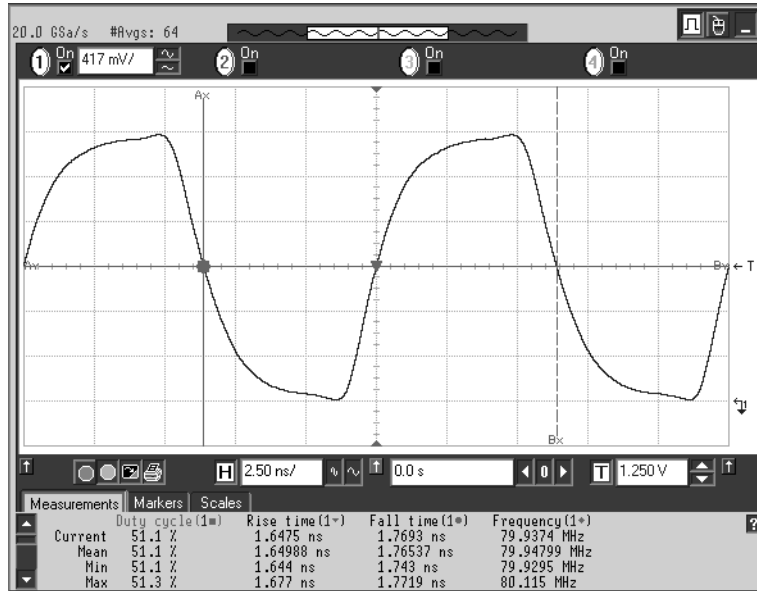


$C1 = 20\mu F$ ,  $R1 = R2 = 100M\Omega$ ,  $V_{DD} = 3.3V$   
 VC modulation signal: 100Hz to 100kHz, 3.3Vp-p

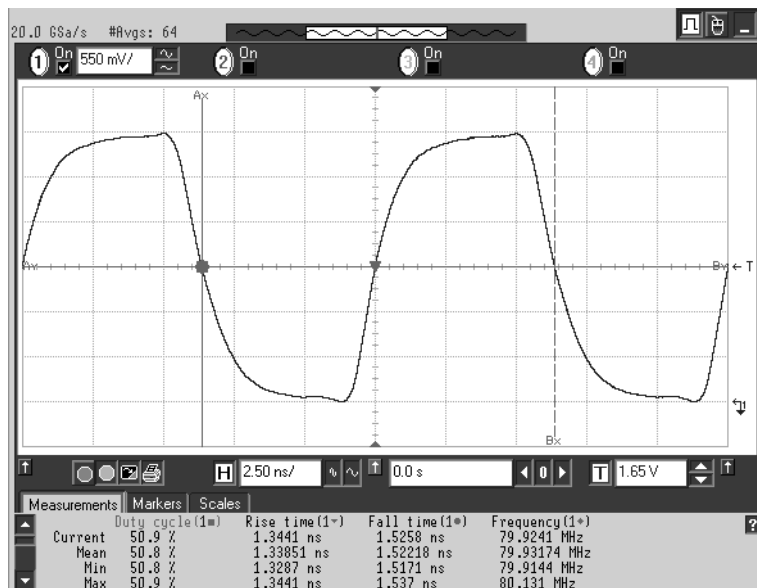
## Output Waveform

### Measurement equipment

- Oscilloscope: 54855A (Agilent)

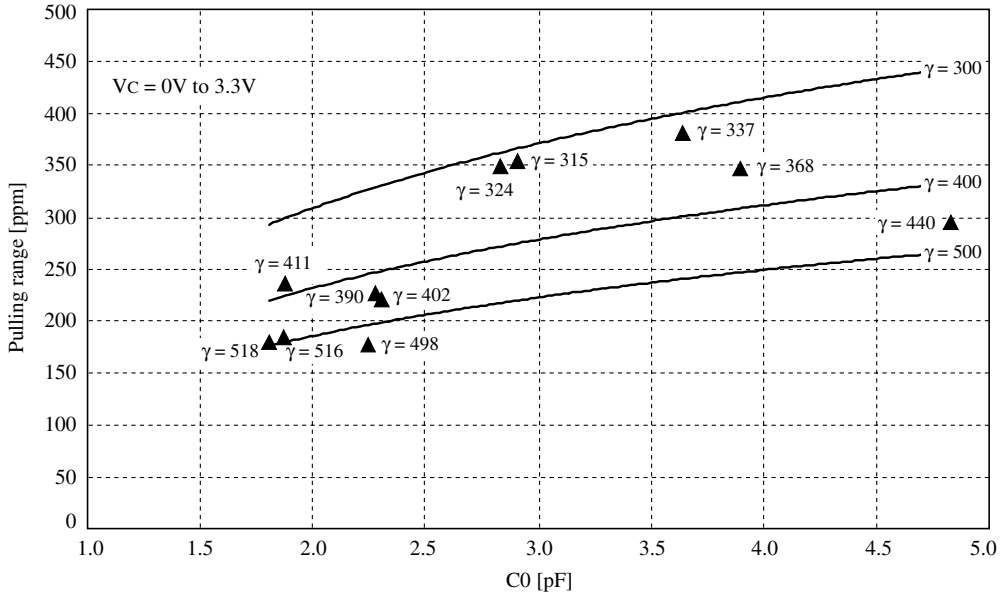


$V_{DD} = 2.5V$ , 15pF load,  $V_C = 1.25V$



$V_{DD} = 3.3V$ , 15pF load,  $V_C = 1.65V$

Relation Between Pulling Range and Constants for Crystal Units

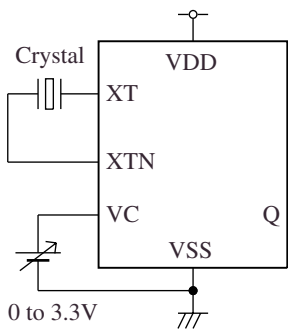


Measurement data when crystal is changed.

	A	B	C	D	E	F	G	H	I	J	L
$C_0$ [pF]	4.8	3.6	1.8	1.9	2.2	1.9	2.3	3.9	2.9	2.8	2.3
$\gamma$	440	337	518	411	498	516	402	368	315	324	390
Pulling range <sup>1</sup> [ppm]	295	381	179	235	177	184	220	346	354	349	227

1. Pulling range: Value of changes in VC voltage from 0V to 3.3V.

Measurement circuit



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**SEIKO NPC CORPORATION**

1-9-9, Hatchobori, Chuo-ku,  
Tokyo 104-0032, Japan  
Telephone: +81-3-5541-6501  
Facsimile: +81-3-5541-6510  
<http://www.npc.co.jp/>  
Email: [sales@npc.co.jp](mailto:sales@npc.co.jp)

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