NPC

5076 series

VCXO Module IC with Built-in Varicap

OVERVIEW

The 5076 series are miniature VCXO ICs that provide a wide frequency pulling range, even when using miniature crystal units for which a wide pulling range is difficult to provide. They employ a recently developed varicap diode fabrication process that provides a wide frequency pulling range and good linearity without any external components. Also, they employ a regulated voltage drive oscillator circuit that significantly reduces current consumption, crystal current, and oscillation characteristics supply voltage dependency. The 5076 series are ideal for miniature, wide pulling range, low power consumption, VCXO modules.

FEATURES

- VCXO with recently developed varicap diode built-in
- New fabrication process that significantly reduces parasitic capacitance and provides wide pulling range even when using miniature crystal units
- Regulated voltage drive oscillator circuit for reduced power consumption, crystal drive current, and oscillation characteristics voltage dependency
- Wide frequency pulling range
  - ± 160ppm (B1 version, f = 27MHz)
    (Crystal: γ = 300, C0 = 1.5pF)
- Operating supply voltage range: 1.6V to 2.0V
- Oscillation frequency range (for fundamental oscillation): 20MHz to 55MHz (varies with version)
- Low current consumption: 0.5mA
  (B1 version, f = 27MHz, no load, V_{DD} = 1.8V)
- Frequency divider built-in
  - Selectable by version: f_O, $f_O/2$, $f_O/4$, $f_O/8$, $f_O/16$
  - Frequency divider output for 1.3MHz (min) low frequency output
- VC pin input resistance: 10MΩ (min)
- CMOS output
- Two types of pad layout selectable by mounting method
  - A× version: for Flip Chip Bonding
  - B× version: for Wire Bonding
- Package: Wafer form (WF5076××)
  Chip form (CF5076××)

APPLICATIONS

- 2.5 × 2.0mm, 3.2 × 2.5mm size miniature VCXO modules for digital mobile TV tuner, digital TV (PDP, LCD), PND (Personal Navigation Device), etc.

ORDERING INFORMATION

Device	Package
WF5076××–4	Wafer form
CF5076××–4	Chip form

SERIES CONFIGURATION

Operating supply voltage range [V]	PAD layout	Recommended operating frequency range*1 [MHz]	Output frequency and version name*2				
			f_O output	f_O/2 output	f_O/4 output	f_O/8 output	f_O/16 output
1.6 to 2.0	Flip Chip Bonding	20 to 40	(5076A1)	(5076A2)	(5076A3)	(5076A4)	(5076A5)
		40 to 55	(5076AJ)	(5076AK)	(5076AL)	(5076AM)	(5076AN)
	Wire Bonding	20 to 40	5076B1	(5076B2)	(5076B3)	(5076B4)	(5076B5)
		40 to 55	(5076BJ)	(5076BK)	(5076BL)	(5076BM)	(5076BN)

*1. The recommended operating frequency is a yardstick value derived from the crystal used for NPC characteristics authentication. However, the oscillation frequency range 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.
*2. Versions in parentheses ( ) are under development. Please contact us for further details.

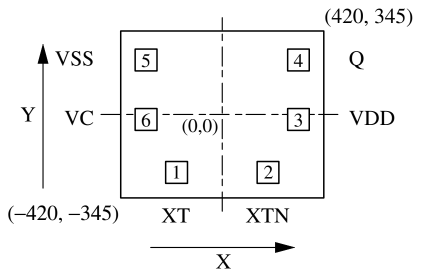
VERSION NAME

Device	Package	Version name
WF5076××–4	Wafer form	WF5076□□–4 Form WF: Wafer form CF: Chip (Die) form Oscillation frequency range, frequency divider function Pad layout type A: for Flip Chip Bonding B: for Wire Bonding
CF5076××–4	Chip form	

PAD LAYOUT

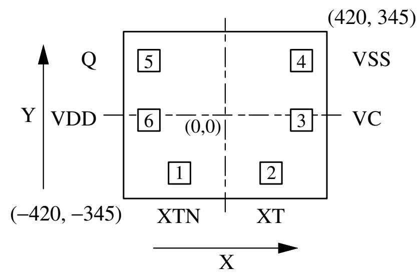
(Unit: µm)

■ 5076A× (for Flip Chip Bonding)



Chip size: 0.84 × 0.69mm
Chip thickness: 130µm ± 15µm
PAD size: 90µm × 90µm
Chip base: V_{SS} level

■ 5076B× (for Wire Bonding)



Chip size: 0.84 × 0.69mm
Chip thickness: 130µm ± 15µm
PAD size: 90µm × 90µm
Chip base: V_{SS} level

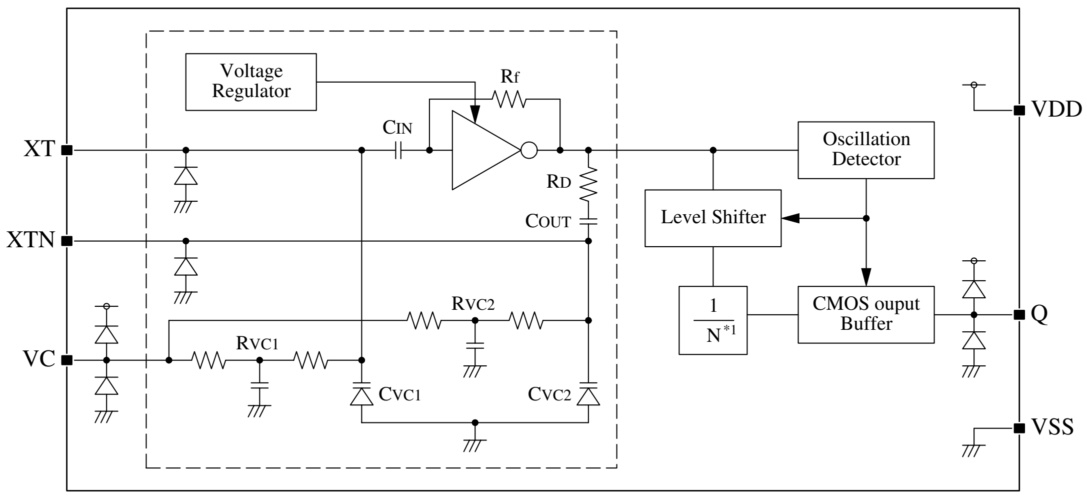
PAD DIMENSIONS

Pad No.	Pad dimensions [µm]	
	X	Y
1	–189	–240
2	189	–240
3	315	–21
4	315	225
5	–315	225
6	–315	–21

PIN DESCRIPTION

Pad No.		Pin	I/O	Description
5076A×	5076B×			
1	2	XT	I	Crystal connection pin (amplifier input)
2	1	XTN	O	Crystal connection pin (amplifier output)
3	6	VDD	–	(+) supply pin
4	5	Q	O	Clock output pin
5	4	VSS	–	(–) supply pin
6	3	VC	I	Oscillation frequency control voltage input pin (positive polarity) (frequency increases with increasing voltage)

BLOCK DIAGRAM



*1. N = 1, 2, 4, 8, 16

ABSOLUTE MAXIMUM RATINGS

$V_{SS} = 0V$

Parameter	Symbol	Conditions	Rating	Unit
Supply voltage range	V_{DD}	Between VDD and VSS	–0.5 to +5.0	V
Input voltage range*1	V_{IN}	Input pins	–0.5 to V_{DD} + 0.5	V
Output voltage range*1	V_{OUT}	Output pins	–0.5 to V_{DD} + 0.5	V
Storage temperature range	T_{STG}	Wafer form, chip form	–65 to +150	°C
Output current	I_{OUT}	Q pin	± 20	mA

*1. V_{DD} is a V_{DD} value of recommended operating conditions.

Note. Absolute maximum ratings are the values that must never exceed even for a moment. This product may suffer breakdown if any one of these parameter ratings is exceeded. Operation and characteristics are guaranteed only when the product is operated at recommended supply voltage range.

RECOMMENDED OPERATING CONDITIONS

$V_{SS} = 0V$

Parameter	Symbol	Conditions		Rating			Unit
				Min	Typ	Max	
Operating supply voltage	V_{DD}	$C_{LOUT} \leq 15pF$		1.6	–	2.0	V
Input voltage	V_{IN}	VC pin		V_{SS}	–	V_{DD}	V
Operating temperature	T_{OPR}			–40	–	+85	°C
Oscillation frequency*1	f_O	5076×1 to 5076×5		20	–	40	MHz
		5076×J to 5076×N		40	–	55	MHz
Output frequency	f_{OUT}	$C_{LOUT} \leq 15pF$	5076×1 to 5076×5	1.25	–	40	MHz
			5076×J to 5076×N	2.5	–	55	MHz

*1. The oscillation frequency is a yardstick value derived from the crystal used for NPC characteristics authentication. However, the oscillation frequency range 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.

Note. Mount a ceramic chip capacitor that is larger than 0.01µF proximal to IC (within approximately 3mm) between VDD and VSS in order to obtain stable operation of 5076 series. In addition, the wiring pattern between IC and capacitor should be as wide as possible.

ELECTRICAL CHARACTERISTICS

5076×1 to 5076×5

V_{DD} = 1.6 to 2.0V, V_C = 0.5V_{DD}, V_{SS} = 0V, Ta = –40 to +85°C unless otherwise noted.

Parameter	Symbol	Conditions	Rating Min	Rating Typ	Rating Max	Unit
Current consumption	I_{DD}	5076×1 (f_O), Measurement circuit 1, no load, f_O = 27MHz, f_{OUT} = 27MHz, V_{DD} = 1.8V	–	0.5	1.0	mA
		5076×2 (f_O/2), Measurement circuit 1, no load, f_O = 27MHz, f_{OUT} = 13.5MHz, V_{DD} = 1.8V	–	0.4	0.8	mA
		5076×3 (f_O/4), Measurement circuit 1, no load, f_O = 27MHz, f_{OUT} = 6.75MHz, V_{DD} = 1.8V	–	0.3	0.6	mA
		5076×4 (f_O/8), Measurement circuit 1, no load, f_O = 27MHz, f_{OUT} = 3.38MHz, V_{DD} = 1.8V	–	0.3	0.6	mA
		5076×5 (f_O/16), Measurement circuit 1, no load, f_O = 27MHz, f_{OUT} = 1.69MHz, V_{DD} = 1.8V	–	0.3	0.6	mA
HIGH-level output voltage	V_{OH}	Q pin, Measurement circuit 2, I_{OH} = –2.0mA	V_{DD} – 0.4	–	–	V
LOW-level output voltage	V_{OL}	Q pin, Measurement circuit 2, I_{OL} = 2.0mA	–	–	0.4	V
Oscillator block built-in resistance	R_{VC1}	Measurement circuit 3	210	420	840	kΩ
	R_{VC2}		210	420	840	kΩ
Oscillator block built-in capacitance	C_{VC1}	Design value (a monitor pattern on a wafer is tested), Excluding parasitic capacitance. V_C = 0.2V	–	4.7	–	pF
		V_C = 0.9V	–	2.9	–	pF
		V_C = 1.6V	–	1.7	–	pF
	C_{VC2}	V_C = 0.2V	–	4.7	–	pF
		V_C = 0.9V	–	2.9	–	pF
		V_C = 1.6V	–	1.7	–	pF
VC input resistance	R_{VIN}	Measurement circuit 4, Ta = 25°C	10	–	–	MΩ
Modulation characteristics*1	fm	Measurement circuit 5, –3dB frequency, V_{DD} = 1.8V, V_C = 1.8Vp-p, Ta = 25°C, f_O = 27MHz	–	100	–	kHz

*1. The modulation characteristics may vary with the crystal used.

5076×J to 5076×N

V_{DD} = 1.6 to 2.0V, V_C = 0.5V_{DD}, V_{SS} = 0V, Ta = –40 to +85°C unless otherwise noted.

Parameter	Symbol	Conditions		Rating			Unit
				Min	Typ	Max	
Current consumption	I_{DD}	5076×J (f_O), Measurement circuit 1, no load, f_O = 48MHz, f_{OUT} = 48MHz, V_{DD} = 1.8V		–	0.9	1.8	mA
		5076×K (f_O/2), Measurement circuit 1, no load, f_O = 48MHz, f_{OUT} = 24MHz, V_{DD} = 1.8V		–	0.6	1.2	mA
		5076×L (f_O/4), Measurement circuit 1, no load, f_O = 48MHz, f_{OUT} = 12MHz, V_{DD} = 1.8V		–	0.5	1.0	mA
		5076×M (f_O/8), Measurement circuit 1, no load, f_O = 48MHz, f_{OUT} = 6MHz, V_{DD} = 1.8V		–	0.4	0.8	mA
		5076×N (f_O/16), Measurement circuit 1, no load, f_O = 48MHz, f_{OUT} = 3MHz, V_{DD} = 1.8V		–	0.4	0.8	mA
HIGH-level output voltage	V_{OH}	Q pin, Measurement circuit 2, I_{OH} = –2.0mA		V_{DD} – 0.4	–	–	V
LOW-level output voltage	V_{OL}	Q pin, Measurement circuit 2, I_{OL} = 2.0mA		–	–	0.4	V
Oscillator block built-in resistance	R_{VC1}	Measurement circuit 3		210	420	840	kΩ
	R_{VC2}			210	420	840	kΩ
Oscillator block built-in capacitance	C_{VC1}	Design value (a monitor pattern on a wafer is tested), Excluding parasitic capacitance.	V_C = 0.2V	–	4.7	–	pF
			V_C = 0.9V	–	2.9	–	pF
			V_C = 1.6V	–	1.7	–	pF
	C_{VC2}		V_C = 0.2V	–	4.7	–	pF
			V_C = 0.9V	–	2.9	–	pF
			V_C = 1.6V	–	1.7	–	pF
VC input resistance	R_{VIN}	Measurement circuit 4, Ta = 25°C		10	–	–	MΩ
Modulation characteristics*1	fm	Measurement circuit 5, –3dB frequency, V_{DD} = 1.8V, V_C = 1.8Vp-p, Ta = 25°C, f_O = 48MHz		–	35	–	kHz

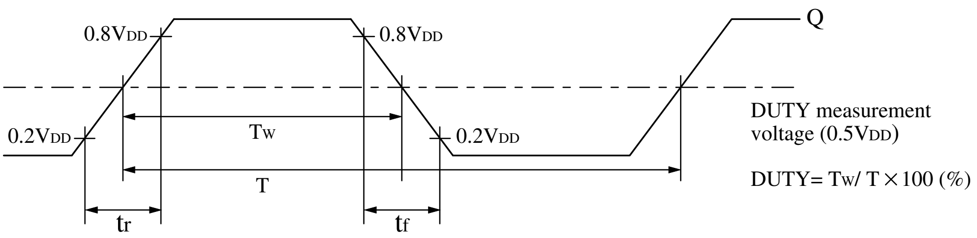
*1. The modulation characteristics may vary with the crystal used.

SWITCHING CHARACTERISTICS

V_{DD} = 1.6 to 2.0V, V_C = 0.5V_{DD}, V_{SS} = 0V, Ta = –40 to +85°C unless otherwise noted.

Parameter	Symbol	Conditions	Rating			Unit
			Min	Typ	Max	
Output rise time	t_r	Measurement circuit 6, 0.2V_{DD} → 0.8V_{DD}, C_{LOUT} = 15pF	–	3.1	6.0	ns
Output fall time	t_f	Measurement circuit 6, 0.8V_{DD} → 0.2V_{DD}, C_{LOUT} = 15pF	–	3.1	6.0	ns
Output duty cycle	Duty	Measurement circuit 6, Ta = 25°C, C_{LOUT} = 15pF, V_{DD} = 1.8V	45	50	55	%

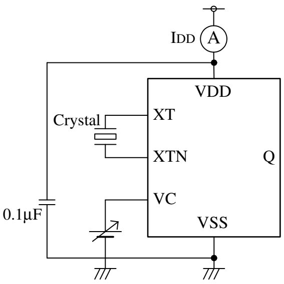
Switching Time Measurement Waveform



MEASUREMENT CIRCUITS

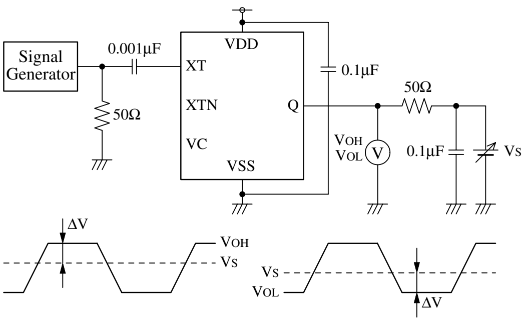
Measurement Circuit 1

Measurement parameter: I_{DD}



Measurement Circuit 2

Measurement parameter: V_{OH}, V_{OL}



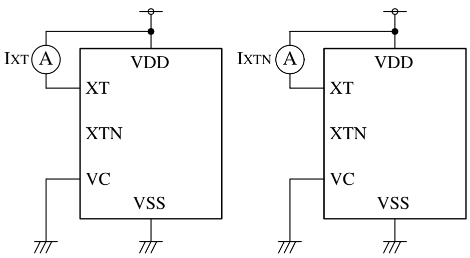
V_S adjusted such that $\Delta V = 50 \times I_{OH}$.

V_S adjusted such that $\Delta V = 50 \times I_{OL}$.

XT input signal: 1Vp-p, sine wave

Measurement Circuit 3

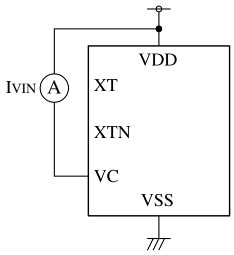
Measurement parameter: R_{VC1}, R_{VC2}



$R_{VC1} = \frac{V_{DD}}{I_{XT}}$ $R_{VC2} = \frac{V_{DD}}{I_{XTN}}$

Measurement Circuit 4

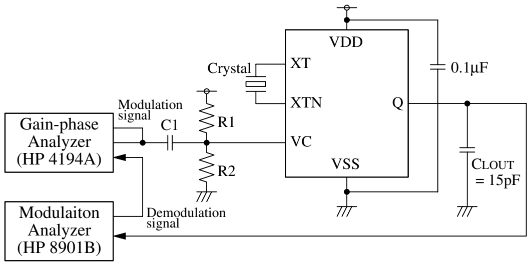
Measurement parameter: R_{VIN}



$R_{VIN} = \frac{V_{DD}}{I_{VIN}}$

Measurement Circuit 5

Measurement parameter: fm

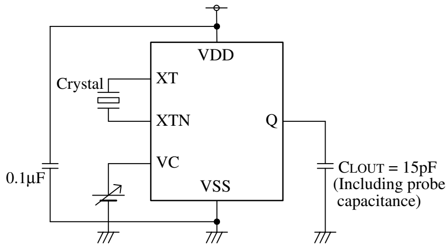


C1 = 33µF, R1 = R2 = 1MΩ

VC modulation signal: 100Hz to 100kHz, 0 to V_{DD}p-p

Measurement Circuit 6

Measurement parameter: Duty, t_r , t_f



FUNCTIONAL DESCRIPTION

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.

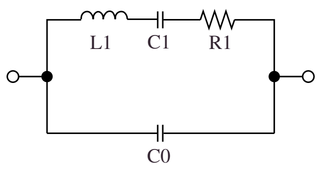
TYPICAL PERFORMANCE (5076B1)

The following characteristics measured using the crystal below. Note that the characteristics will vary with the crystal used.

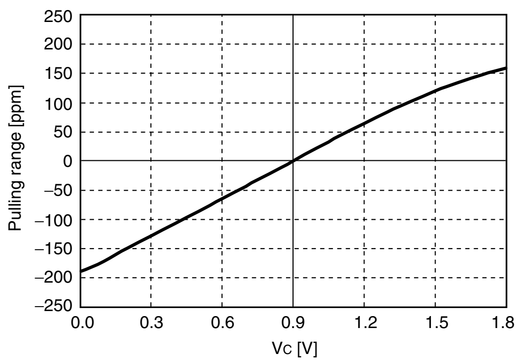
■ Crystal used for measurement

Parameter	f_O = 27MHz
C0 [pF]	1.5
γ (= C0/C1)	300

■ Crystal equivalent circuit

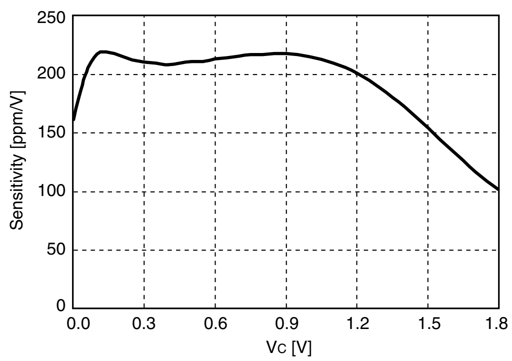


Frequency Pulling Range



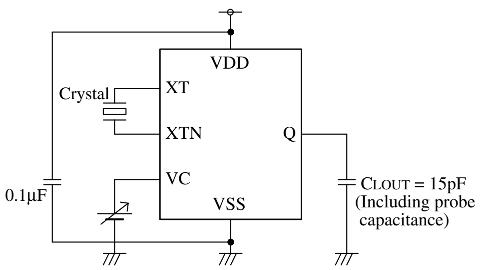
V_{DD} = 1.8V, f_{OUT} = 27MHz, Ta = R.T.

Pulling Sensitivity

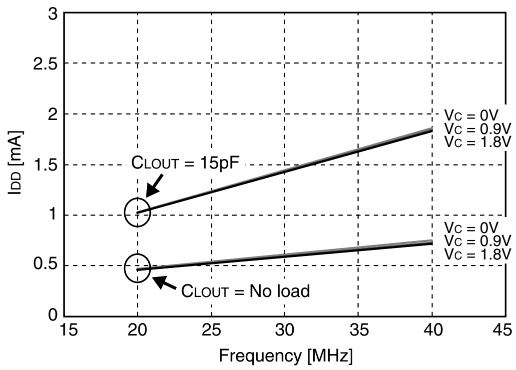


V_{DD} = 1.8V, f_{OUT} = 27MHz, Ta = R.T.

Measurement circuit

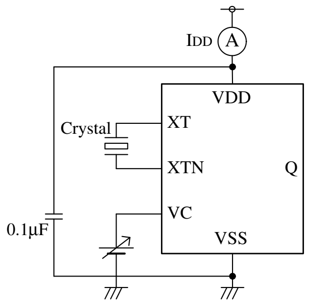


Current Consumption

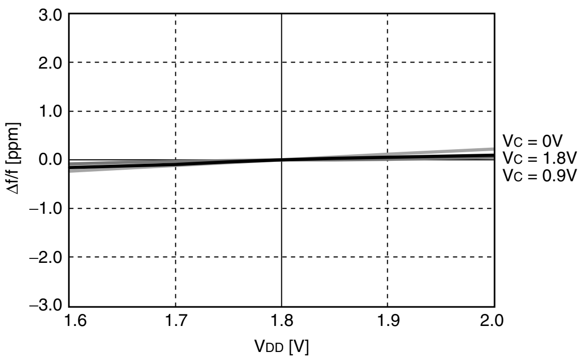


V_{DD} = 1.8V, Ta = R.T.

Measurement circuit

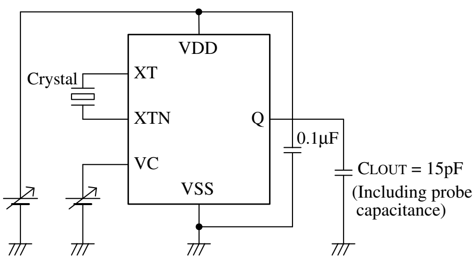


Frequency Stability by Supply Voltage Change

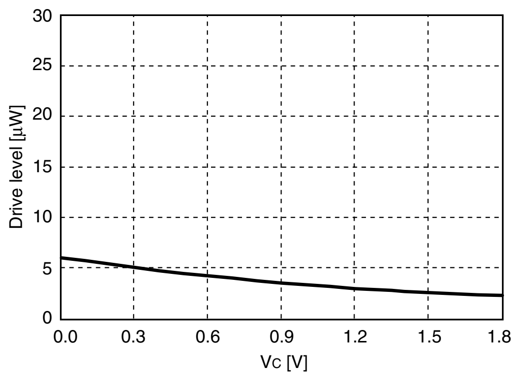


f_{OUT} = 27MHz, ± 0ppm at V_{DD} = 1.8V, Ta = R.T.

Measurement circuit

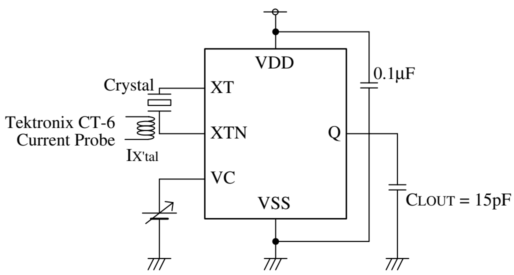


Drive Level



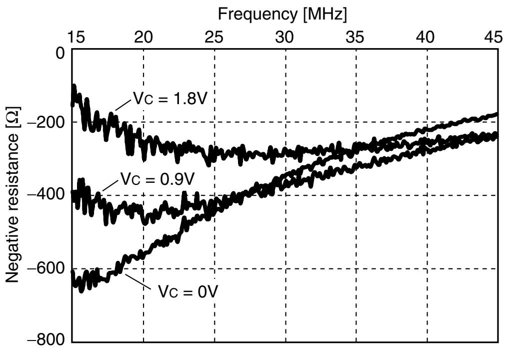
V_{DD} = 1.8V, f_{OUT} = 27MHz, Ta = R.T.

Measurement circuit



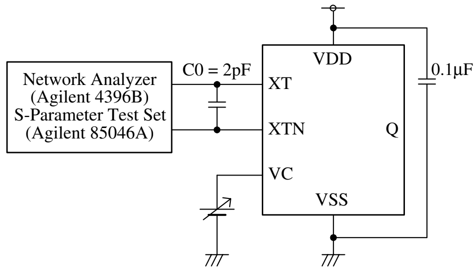
DL = $(I_{X'tal})^2 \times$ Re
DL: drive level
$I_{X'tal}$: current flowing to crystal (RMS value)
Re: crystal effective resistance

Negative Resistance



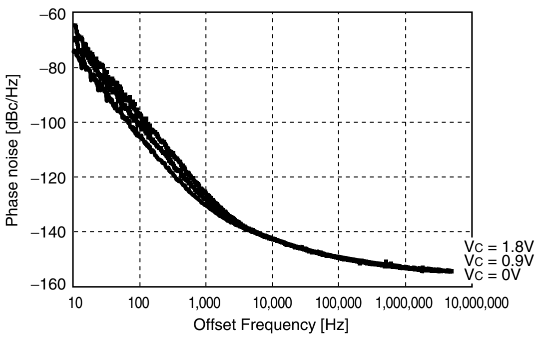
V_{DD} = 1.8V, C0 = 2pF, Ta = R.T.

Measurement circuit



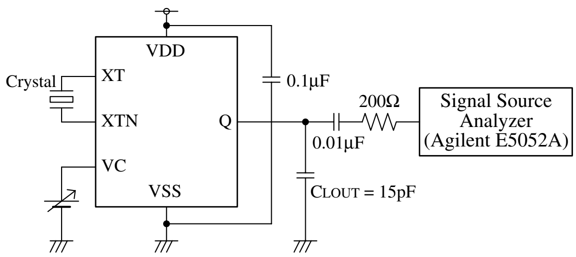
Note. "C0" value is set, concerning the actual crystal characteristics connected between XT and XTN. The data is measured with Agilent 4396B using NPC's original measurement jig. The values may vary with measurement jig and conditions.

Phase Noise

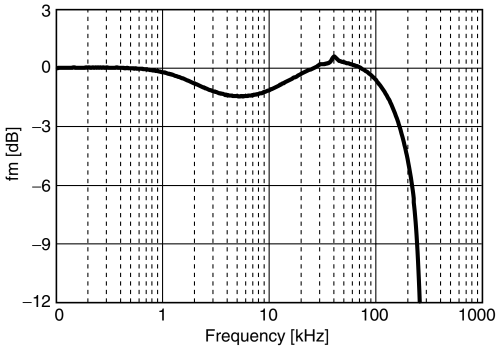


V_{DD} = 1.8V, f_{OUT} = 27MHz, Ta = R.T.

Measurement circuit

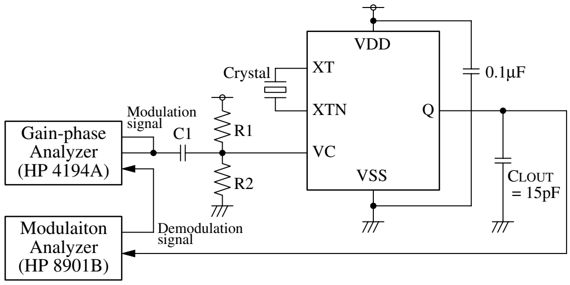


Modulation Characteristics



V_{DD} = 1.8V, f_{OUT} = 27MHz, Ta = R.T.

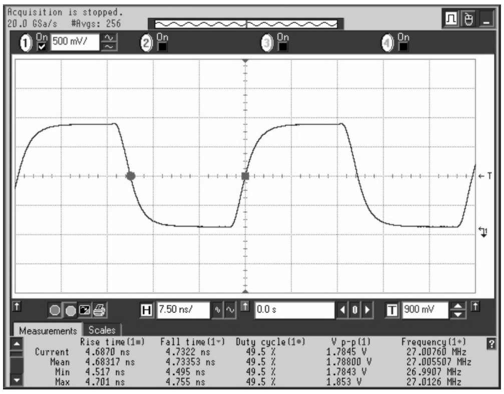
Measurement circuit



C1 = 33μF, R1 = R2 = 1MΩ
VC modulation signal: 100Hz to 100kHz, 0 to V_{DD}p-p

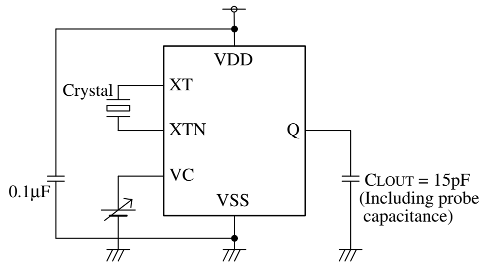
Output Waveform

Measurement equipment: Oscilloscope; DSO80604B (Agilent)



V_{DD} = 1.8V, f_{OUT} = 27MHz, V_C = 0.5V_{DD},
C_{LOUT} = 15pF, Ta = R.T.

Measurement circuit



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