OVERVIEW

The 5075 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 5075 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
  - $\pm$ 190ppm (B1 version, f = 27MHz)
    (Crystal: γ = 300, C0 = 1.5pF)
- Operating supply voltage range: 2.25V to 3.63V
- Oscillation frequency range (for fundamental oscillation): 20MHz to 55MHz (varies with version)

- Low current consumption: 1.0mA
  (B1 version, f = 27MHz, no load, V_{DD} = 3.3V)
- 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$\times$ version: for Flip Chip Bonding
  - B$\times$ version: for Wire Bonding
- Package: Wafer form (WF5075$\times\times$)
  Chip form (CF5075$\times\times$)

APPLICATIONS

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

ORDERING INFORMATION

Device	Package
WF5075$\times\times$–4	Wafer form
CF5075$\times\times$–4	Chip form

SERIES CONFIGURATION

Operating supply voltage range [V]	PAD layout	Recommended operating frequency range [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
2.25 to 3.63	Flip Chip Bonding	20 to 40	5075A1	5075A2	5075A3	5075A4	5075A5
		40 to 55	(5075AJ)	(5075AK)	(5075AL)	(5075AM)	(5075AN)
	Wire Bonding	20 to 40	5075B1	5075B2	5075B3	5075B4	5075B5
		40 to 55	5075BJ	(5075BK)	5075BL	(5075BM)	(5075BN)

*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.
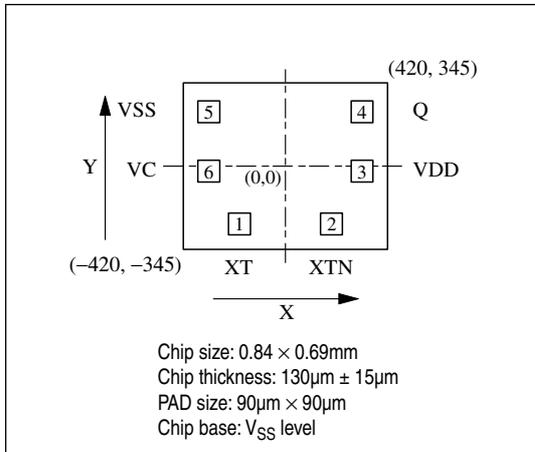
VERSION NAME

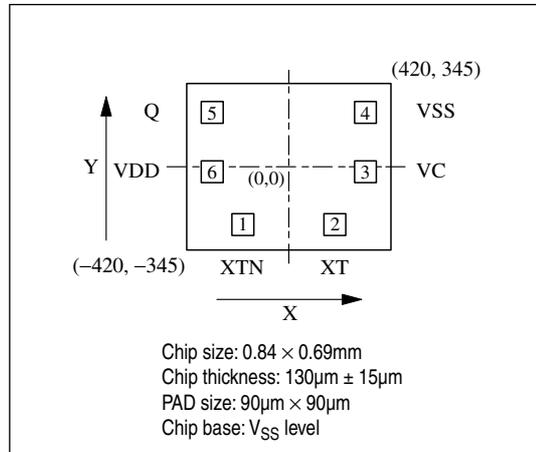| Device	Package	Version name
WF5075××–4	Wafer form	WF5075□□–4
CF5075××–4	Chip form	Form WF: Wafer form / CF: Chip (Die) form — Oscillation frequency range, frequency divider function — Pad layout type A: for Flip Chip Bonding B: for Wire Bonding

PAD LAYOUT

(Unit: μm)

■ 5075A× (for Flip Chip Bonding)

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

■ 5075B× (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
5075A×	5075B×			
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
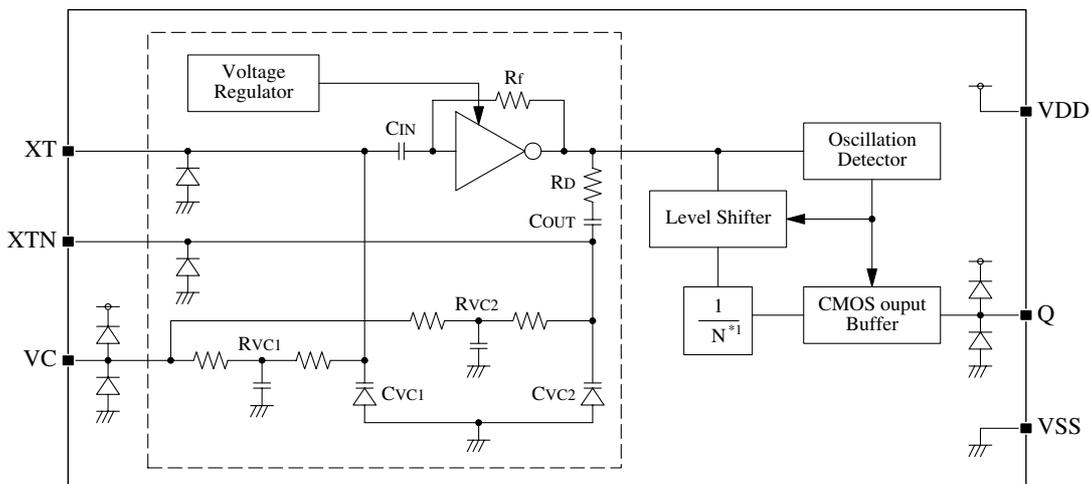
*1. N = 1, 2, 4, 8, 16

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}	$C_{LOUT} \leq 15pF$		2.25	–	3.63	V
Input voltage	V_{IN}	VC pin		V_{SS}	–	V_{DD}	V
Operating temperature	T_{OPR}			−40	–	+85	°C
Oscillation frequency[*1]	f_O	5075×1 to 5075×5		20	–	40	MHz
		5075×J to 5075×N		40	–	55	MHz
Output frequency	f_{OUT}	$C_{LOUT} \leq 15pF$	5075×1 to 5075×5	1.25	–	40	MHz
			5075×J to 5075×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 5075 series. In addition, the wiring pattern between IC and capacitor should be as wide as possible.

ELECTRICAL CHARACTERISTICS

5075×1 to 5075×5

V_{DD} = 2.25 to 3.63V, V_C = 0.5V_{DD}, V_{SS} = 0V, Ta = –40 to +85°C unless otherwise noted.

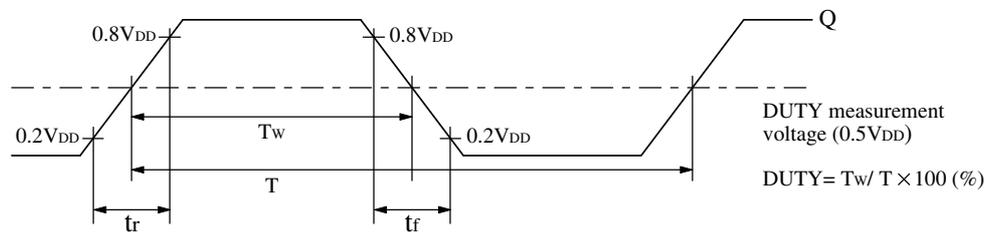| Parameter	Symbol	Conditions		Rating			Unit
				Min	Typ	Max	
Current consumption	I_{DD}	5075×1 (f_O), Measurement circuit 1, no load, f_O = 27MHz, f_{OUT} = 27MHz	V_{DD} = 2.5V	–	0.7	1.4	mA
			V_{DD} = 3.3V	–	1.0	2.0	mA
		5075×2 (f_O/2), Measurement circuit 1, no load, f_O = 27MHz, f_{OUT} = 13.5MHz	V_{DD} = 2.5V	–	0.6	1.2	mA
			V_{DD} = 3.3V	–	0.8	1.6	mA
		5075×3 (f_O/4), Measurement circuit 1, no load, f_O = 27MHz, f_{OUT} = 6.75MHz	V_{DD} = 2.5V	–	0.5	1.0	mA
			V_{DD} = 3.3V	–	0.7	1.4	mA
		5075×4 (f_O/8), Measurement circuit 1, no load, f_O = 27MHz, f_{OUT} = 3.38MHz	V_{DD} = 2.5V	–	0.5	1.0	mA
			V_{DD} = 3.3V	–	0.6	1.2	mA
		5075×5 (f_O/16), Measurement circuit 1, no load, f_O = 27MHz, f_{OUT} = 1.69MHz	V_{DD} = 2.5V	–	0.4	0.8	mA
			V_{DD} = 3.3V	–	0.6	1.2	mA
HIGH-level output voltage	V_{OH}	Q pin, Measurement circuit 2, I_{OH} = –2.8mA		$V_{DD} – 0.4$	–	–	V
LOW-level output voltage	V_{OL}	Q pin, Measurement circuit 2, I_{OL} = 2.8mA		–	–	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 = 0.3V	–	5.6	–	pF
			V_C = 1.65V	–	3.1	–	pF
			V_C = 3.0V	–	1.5	–	pF
	C_{VC2}		V_C = 0.3V	–	8.4	–	pF
			V_C = 1.65V	–	4.7	–	pF
			V_C = 3.0V	–	2.3	–	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} = 3.3V, V_C = 3.3Vp-p, Ta = 25°C, f_O = 27MHz		–	25	–	kHz

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

5075×J to 5075×N

V_{DD} = 2.25 to 3.63V, 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}	5075×J (f_O), Measurement circuit 1, no load, f_O = 48MHz, f_{OUT} = 48MHz	V_{DD} = 2.5V	–	1.2	2.4	mA
			V_{DD} = 3.3V	–	1.6	3.2	mA
		5075×K (f_O/2), Measurement circuit 1, no load, f_O = 48MHz, f_{OUT} = 24MHz	V_{DD} = 2.5V	–	0.9	1.8	mA
			V_{DD} = 3.3V	–	1.3	2.6	mA
		5075×L (f_O/4), Measurement circuit 1, no load, f_O = 48MHz, f_{OUT} = 12MHz	V_{DD} = 2.5V	–	0.8	1.6	mA
			V_{DD} = 3.3V	–	1.0	2.0	mA
		5075×M (f_O/8), Measurement circuit 1, no load, f_O = 48MHz, f_{OUT} = 6MHz	V_{DD} = 2.5V	–	0.7	1.4	mA
			V_{DD} = 3.3V	–	0.9	1.8	mA
		5075×N (f_O/16), Measurement circuit 1, no load, f_O = 48MHz, f_{OUT} = 3MHz	V_{DD} = 2.5V	–	0.7	1.4	mA
			V_{DD} = 3.3V	–	0.9	1.8	mA
HIGH-level output voltage	V_{OH}	Q pin, Measurement circuit 2, I_{OH} = –2.8mA	V_{DD} – 0.4	–	–	V
LOW-level output voltage	V_{OL}	Q pin, Measurement circuit 2, I_{OL} = 2.8mA	–	–	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 = 0.3V	–	5.6	–	pF
			V_C = 1.65V	–	3.1	–	pF
			V_C = 3.0V	–	1.5	–	pF
	C_{VC2}		V_C = 0.3V	–	8.4	–	pF
			V_C = 1.65V	–	4.7	–	pF
			V_C = 3.0V	–	2.3	–	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} = 3.3V, V_C = 3.3Vp-p, Ta = 25°C, f_O = 48MHz	–	23	–	kHz

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

SWITCHING CHARACTERISTICS

V_{DD} = 2.25 to 3.63V, 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	–	2.1	4.0	ns
Output fall time	t_f	Measurement circuit 6, 0.8V_{DD} → 0.2V_{DD}, C_{LOUT} = 15pF	–	2.1	4.0	ns
Output duty cycle	Duty	Measurement circuit 6, Ta = 25°C, C_{LOUT} = 15pF, V_{DD} = 3.3V	45	50	55	%

Switching Time Measurement Waveform

0.8V_{DD} 0.8V_{DD} Q

0.2V_{DD} Tw   0.2V_{DD} DUTY measurement voltage (0.5V_{DD})

T

tr   tf

DUTY= Tw/ T × 100 (%)

MEASUREMENT CIRCUITS

Measurement Circuit 1
Measurement parameter: I_{DD}

I_{DD} (A)

VDD
XT
Crystal
XTN
Q
VC
VSS
0.1µF

Measurement Circuit 2
Measurement parameter: V_{OH}, V_{OL}

Signal Generator
0.001µF
50Ω
VDD
XT
0.1µF
XTN
Q
50Ω
VC
V_{OH} V_{OL} (V)
0.1µF
V_S
VSS

ΔV
V_{OH}
V_S

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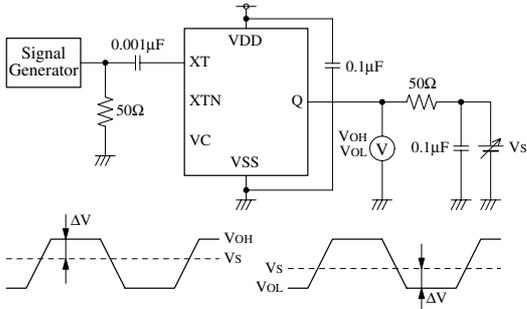
V_S adjusted such that $\Delta V = 50 \times I_{OH}$.

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}

I_{XT} (A)
VDD
XT
XTN
VC
VSS

I_{XTN} (A)
VDD
XT
XTN
VC
VSS

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

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

Measurement Circuit 4
Measurement parameter: R_{VIN}

VDD
I_{VIN} (A)
XT
XTN
VC
VSS

$$R_{VIN} = \frac{V_{DD}}{I_{VIN}}$$
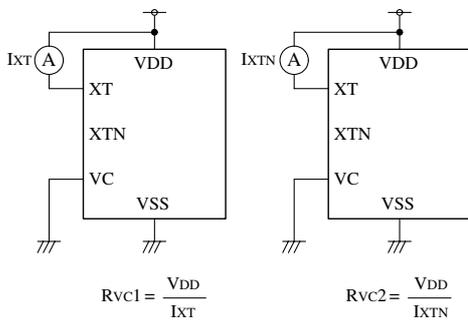
Measurement Circuit 5
Measurement parameter: fm

VDD
Crystal
XT
0.1µF
XTN
Q
Gain-phase Analyzer (HP 4194A)
Modulation signal
C1
R1
VC
C_{LOUT} = 15pF
VSS
R2
Modulaiton Analyzer (HP 8901B)
Demodulation signal
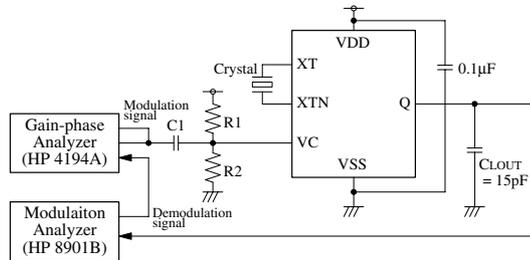
C1 = 33µF, R1 = R2 = 1MΩ
VC modulation signal: 100Hz to 100kHz, 0 to V_{DD}p-p

Measurement Circuit 6
Measurement parameter: Duty, t_r, t_f

VDD
Crystal
XT
XTN
Q
VC
0.1µF
C_{LOUT} = 15pF (Including probe capacitance)
VSS
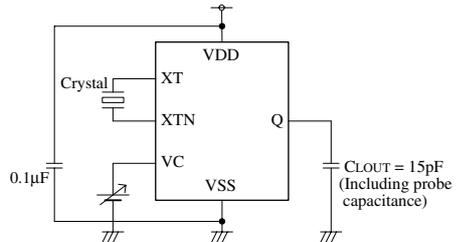
FUNCTIONAL DESCRIPTION

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 (5075B1)

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
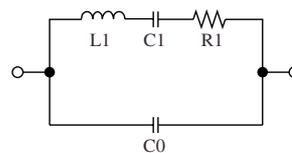
Frequency Pulling Range
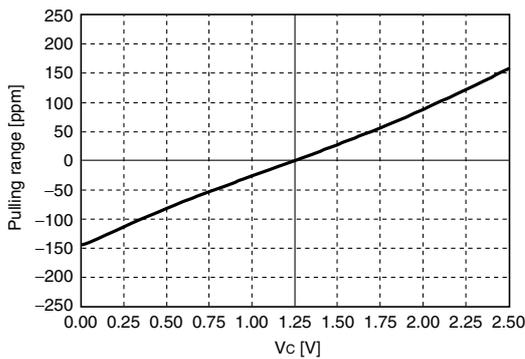
V_{DD} = 2.5V, f_{OUT} = 27MHz, Ta = R.T.
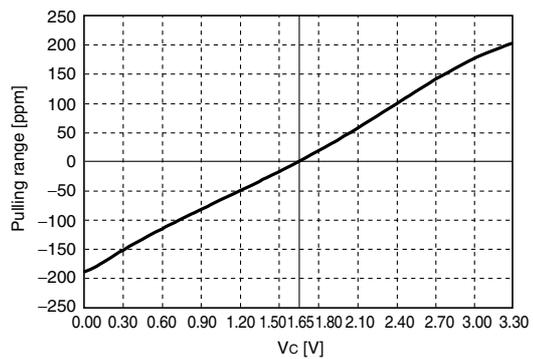
V_{DD} = 3.3V, f_{OUT} = 27MHz, Ta = R.T.

Pulling Sensitivity
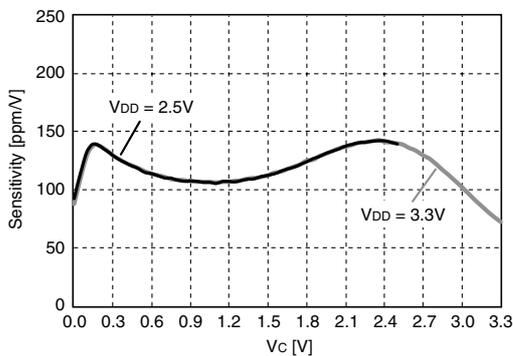
V_{DD} = 2.5V, 3.3V, f_{OUT} = 27MHz, Ta = R.T.

Measurement circuit

Current Consumption

(Left graph) $V_{DD} = 2.5V$, Ta = R.T.

I_{DD} [mA] vs Frequency [MHz]

C_{LOUT} = 15pF

$V_C = 0V$
$V_C = 1.25V$
$V_C = 2.5V$

$V_C = 0V$
$V_C = 1.25V$
$V_C = 2.5V$

C_{LOUT} = No load

(Right graph) $V_{DD} = 3.3V$, Ta = R.T.

I_{DD} [mA] vs Frequency [MHz]

$V_C = 0V$
$V_C = 1.65V$
$V_C = 3.3V$

C_{LOUT} = 15pF

$V_C = 0V$
$V_C = 1.65V$
$V_C = 3.3V$

C_{LOUT} = No load

Measurement circuit

I_{DD} (A)

VDD

Crystal — XT

XTN   Q

VC

0.1μF

VSS

Frequency Stability by Supply Voltage Change

Vc = 0V
Vc = 2.5V
Vc = 1.25V
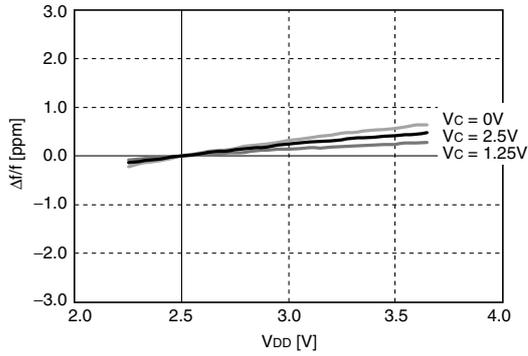
f_{OUT} = 27MHz, ± 0ppm at V_{DD} = 2.5V, Ta = R.T.

Vc = 3.3V
Vc = 0V
Vc = 1.65V
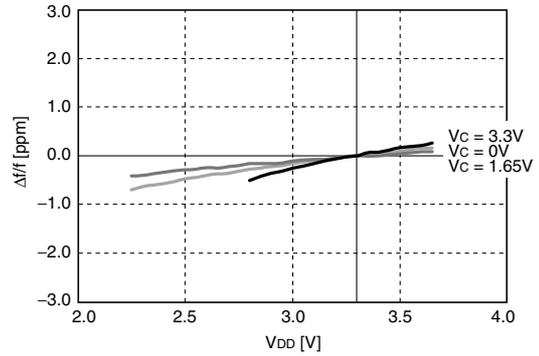
f_{OUT} = 27MHz, ± 0ppm at V_{DD} = 3.3V, Ta = R.T.

Measurement circuit

Crystal

XT

XTN

VC

VDD

Q

VSS

0.1μF

C_{LOUT} = 15pF
(Including probe capacitance)

Drive Level

30
25
20
15
10
5
0

Drive level [μW]

0.0 0.3 0.6 0.9 1.2 1.5 1.8 2.1 2.4 2.7 3.0 3.3
V_C [V]

V_{DD} = 2.5V
V_{DD} = 3.3V

V_{DD} = 2.5V, 3.3V, f_{OUT} = 27MHz, Ta = R.T.

Measurement circuit

VDD
XT
Crystal
Tektronix CT-6
Current Probe
$I_{X'tal}$
XTN
VC
VSS
Q
0.1μF
C_{LOUT} = 15pF
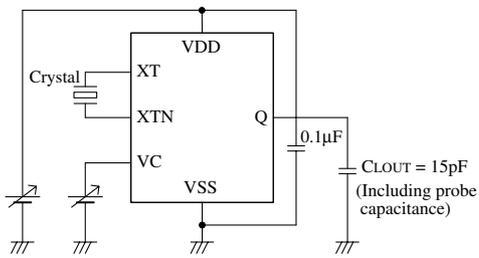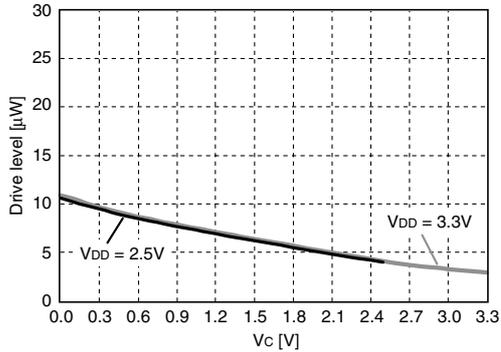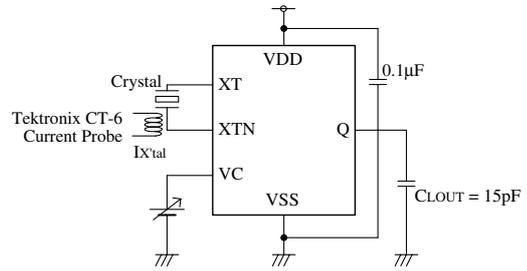
$DL = (I_{X'tal})^2 \times Re$
DL: drive level
$I_{X'tal}$: current flowing to crystal (RMS value)
Re: crystal effective resistance

Negative Resistance

Frequency [MHz]
15 20 25 30 35 40 45
0
−200
−400
−600
−800

Negative resistance [Ω]

V_C = 0V
V_C = 1.25V
V_C = 2.5V

V_{DD} = 2.5V, C0 = 2pF, Ta = R.T.

Frequency [MHz]
15 20 25 30 35 40 45
0
−200
−400
−600
−800

Negative resistance [Ω]

V_C = 0V
V_C = 1.65V
V_C = 3.3V
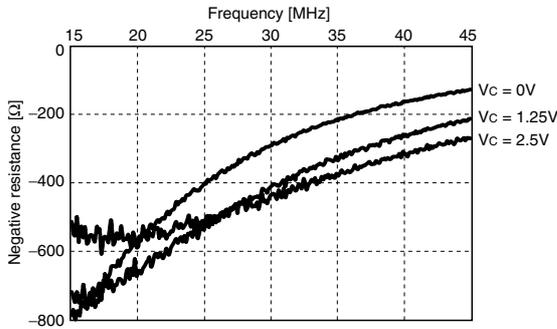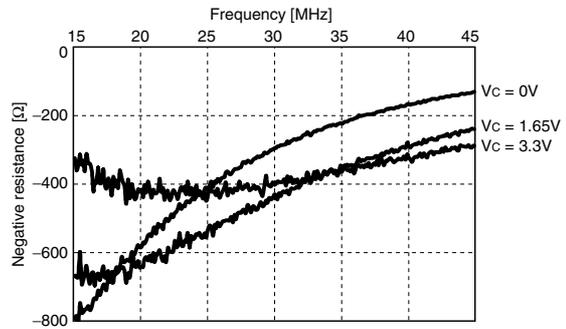
V_{DD} = 3.3V, C0 = 2pF, Ta = R.T.

Measurement circuit

Network Analyzer
(Agilent 4396B)
S-Parameter Test Set
(Agilent 85046A)
C0 = 2pF
XT
XTN
VC
VDD
VSS
Q
0.1μF
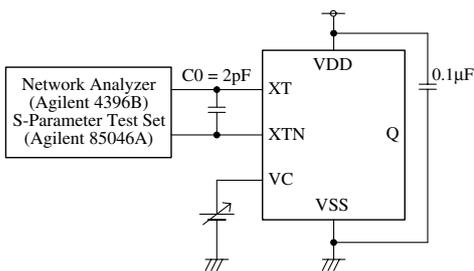
Note. "C0" value is set, concerning the actual crystal characteristics connected between XT and XTN. The data is measured with Agilent 4396B using NPC's original measurement jig. The values may vary with measurement jig and conditions.
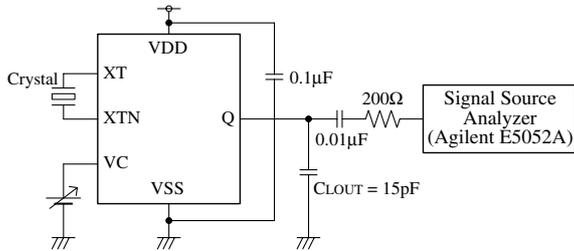
Phase Noise
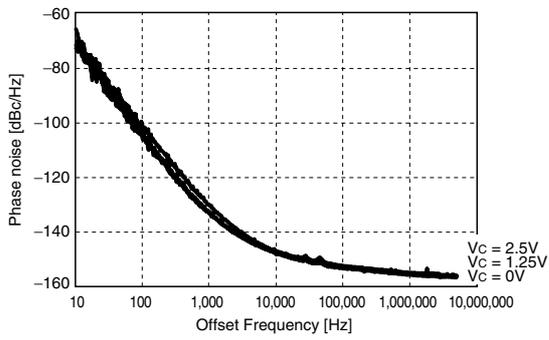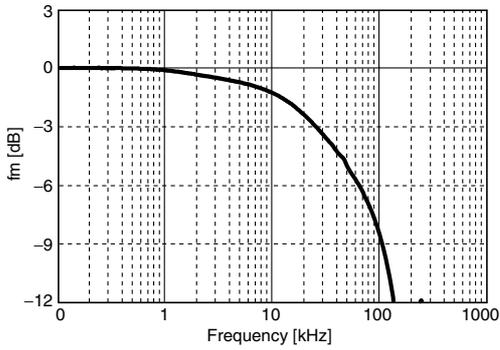

V_{DD} = 2.5V, f_{OUT} = 27MHz, Ta = R.T.
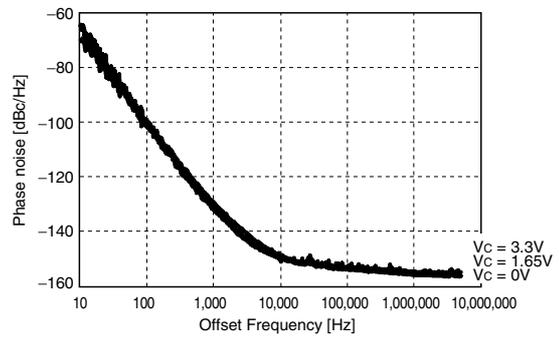
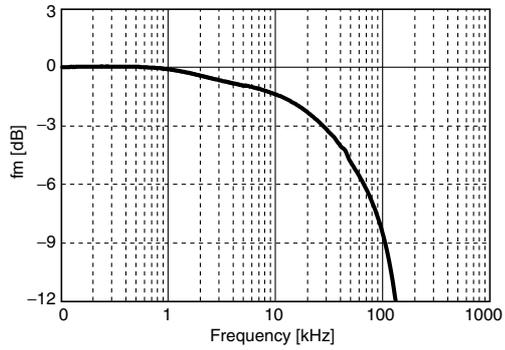V_{DD} = 3.3V, f_{OUT} = 27MHz, Ta = R.T.

Measurement circuit

Modulation Characteristics
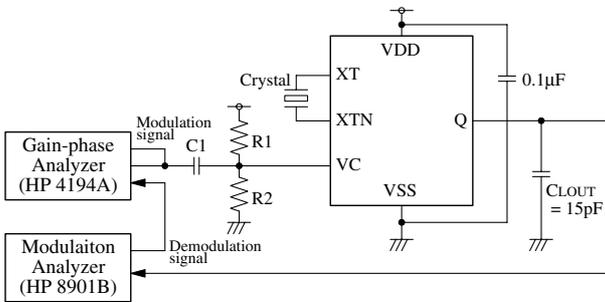

V_{DD} = 2.5V, f_{OUT} = 27MHz, Ta = R.T.
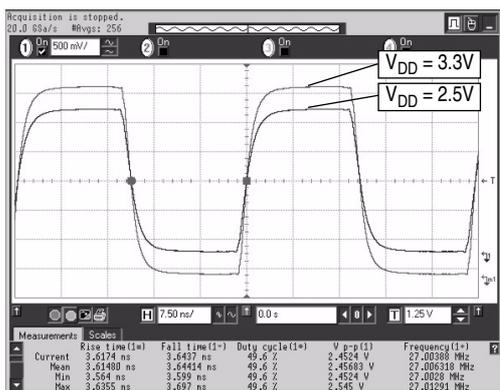

V_{DD} = 3.3V, f_{OUT} = 27MHz, Ta = R.T.

Measurement circuit

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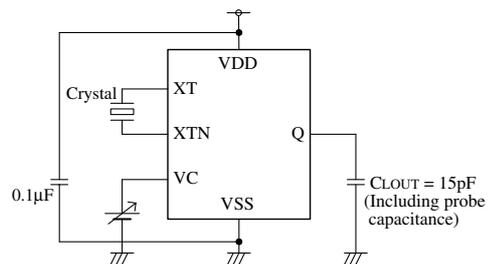VC modulation signal: 100Hz to 100kHz, 0 to V_{DD}p-p

Output Waveform

Measurement equipment: Oscilloscope; DSO80604B (Agilent)

Measurement circuit

V_{DD} = 2.5V, 3.3V, f_{OUT} = 27MHz, V_C = 0.5V_{DD},
C_{LOUT} = 15pF, Ta = R.T.

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