T228-1, T228-2

VCXO Clock Generator IC
0.5 MHz to 70 MHz

P R E L I M I N A R Y

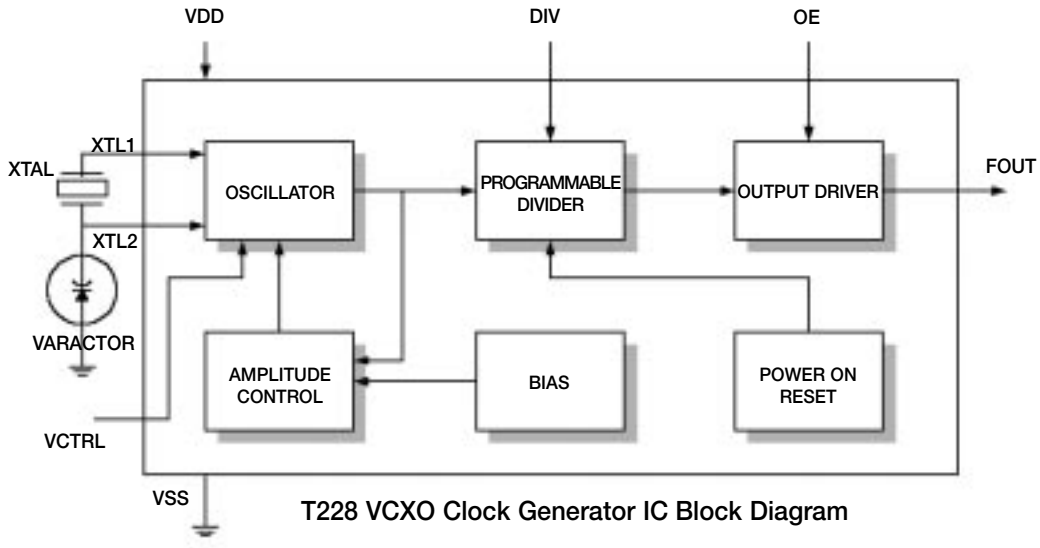
GENERAL DESCRIPTION

TLSI's family of CMOS VCXO Clock Generators is ideally suited for a wide range of applications in which cost, size, power, and the number of discrete components need to be minimized. These ICs are designed to exhibit excellent temperature stability and phase noise performance. The device incorporates a programmable divider that allows the user to select output frequencies lower than the crystal frequency while providing 50% output symmetry. Typical tuning frequency range is ± 200 PPM (crystal and varactor dependent). The devices are available as die, probed wafer, or in surface-mount packages.

FEATURES

- Crystal Frequency Range 8 MHz to 70 MHz
- Supply Voltage 3 V to 5.5 V
- Operating Temperature -40°C to +85°C
- Power less than 100 mW
- Start-Up Time less than 5 mS
- Phase Noise at 100 kHz offset from Fc less than -140 dBc/Hz
- Rise and Fall Times less than 3 nS
- Programmable Frequency Division
  - T228-1: 1,4,16
  - T228-2: 1,2,8
- Nominal Output Duty Cycle 45% to 55%
- Output Drive Capability of 50 pF
- Tuning Input Impedance 120 kΩ
- Internal Crystal Load Capacitance 20 pF

BLOCK DIAGRAM



T228 VCXO Clock Generator IC Block Diagram

ISO9001 A8898

tlsi Silicon Driven™

ABSOLUTE MAXIMUM RATINGS*

* Operation of the device at or beyond these specifications may result in permanent damage or affect operation and reliability of the product.

PARAMETER	CONDITIONS	UNITS
Supply Voltage	V_{SS} - 0.5 ≤ V_{DD} ≤ 6.0	V
DC Input Voltage	V_{SS} - 0.5 ≤ V_{IN} ≤ V_{DD} + 0.5	V
DC Output Voltage	V_{SS} - 0.5 ≤ V_{OUT} ≤ V_{DD} + 0.5	V
Storage Temperature	-65 < T_S < +150	°C
Ambient Temperature	-40 < T_A < +85	°C
Junction Temperature	-65 < T_J < +125	°C
Soldering Temperature	T_{SLDR} < 260 for less than 10 seconds	°C

ELECTRICAL CHARACTERISTICS

DC CHARACTERISTICS

V_{DD} = 5.0 V, -40 °C < T_A < +85 °C unless otherwise specified

PARAMETER	CONDITIONS	SYMBOL	MIN	TYP	MAX	UNITS
Supply Voltage		V_{DD}	3.0	5.0	5.5	V
High-Level Output Voltage	I_{OH} = -1 mA	V_{OH}	4.5			V
Low-Level Output Voltage	I_{OL} = 20 mA	V_{OL}			0.5	V
High-Level Input Voltage		V_{IH}	4.0			V
Low-Level Input Voltage		V_{IL}			1.0	V
OE High-Level Input Current		I_{IH}			1.0	µA
OE Low-Level Input Current		I_{OL}		-10		µA
DIV High-Level Input Current	DIV = V_{DD}	I_{IH}		50		µA
DIV Low-Level Input Current	DIV = V_{SS}	I_{OL}		-50		µA
Supply Current	F=20 MHz, C_L=50 pf, DIV = OPEN	I_{DD}		11.5	18.0	mA
Tuning Range (See Tuning Range Section)		Δf		±200		ppm
Crystal Drive		V_{XTL}		1.0		V pp
High-Level Output Source Current	V_{OH} = 4.0 V	I_{OH}		-60		mA
Low-Level Output Sink Current	V_{OL} = 1.0 V	I_{OL}		60		mA
Short-Circuit Source Current	< 60 seconds	I_{OSH}			-40	mA
Short-Circuit Sink Current	< 60 seconds`	I_{OSL}	40			mA

ELECTRICAL CHARACTERISTICS (continued)

AC CHARACTERISTICS

V_{DD} = 5.0 V, -40 °C < T_A < +85 °C unless otherwise specified

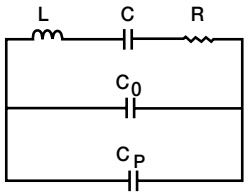
PARAMETER	CONDITIONS	SYMBOL	MIN	TYP	MAX	UNITS
Crystal Frequency Range		F_{XTL}	8.0		70.0	MHz
Output Duty Cycle		ODC	45		55	%
Power-Up Interval		T_{ON}		2.5	5.0	ms
Output Jitter		J_O		50		ps
Rise and Fall Time	C_L=25 pF	t_r, t_f		3		ns
Phase Noise	100 kHz offset from F_c	N_{PH}			-140	dBc/Hz
Temperature Stability		ΔF_{TEMP}		±15		ppm
Frequency vs. Load Capacitance		ΔF_{LC}		1		ppm
Frequency vs. Supply Voltage	V_{DD} ±15%	ΔF_{SV}		1		ppm
Tuning Input Impedance		Z_{TUNE}		120	200	kΩ

TUNING RANGE

Tuning Range depends on the design of the crystal and the capacitive loading of the printed circuit board and the variable capacitance of the varactor loading the T228 IC. The parallel resonant frequency of the crystal with any external capacitive loading is greater than the fixed series resonant frequency of the crystal by Δf:

$$\Delta f = Cx10^6/2(C_O+C_P) \text{ ppm}$$

where C is the series mechanical capacitance of the crystal, C_O is the parallel capacitance of the filter, and C_P is the additional loading capacitance used to tune the crystal. The loading capacitance is the equivalent capacitance of the 20 pF chip internal load capacitance in series with the varactor capacitance. All capacitances are in units of picofarads.



Oscillator Equivalent Circuit

Example: For a typical crystal, C = 0.02 pf and C_O= 5 pf. Using a Hyperabrupt Tuning Diode, the typical capacitance of the diode is 12.3 pF at 1 volt and 2.60 pf at 3 volts. The varactor diode appears in series with the 20 pF internal chip capacitance. In addition, assuming 2 pF stray board wiring capacitance across both the varactor and the chip terminals, the following calculations determine the pullability of the oscillator:

Frequency shift with 1 volt across the varactor diode:

C_P = 20 pF + 2 pF in series with 12.3 pF + 2 pF = (22.0x14.3)/(22.0+14.3) pF = 8.67 pF

$\Delta f_1 = 0.02x10^6/(2(5+8.67)$ ppm = 731.5 ppm

Frequency shift with 3 volts across the varactor diode:

C_P = 20 pF + 2 pF in series with 2.60 pF + 2 pF = (22.0x4.60)/(22.0+4.60) pF = 3.80 pF

$\Delta f_2 = 0.02x10^6/(2(5+3.80)$ ppm = 1136.4 ppm

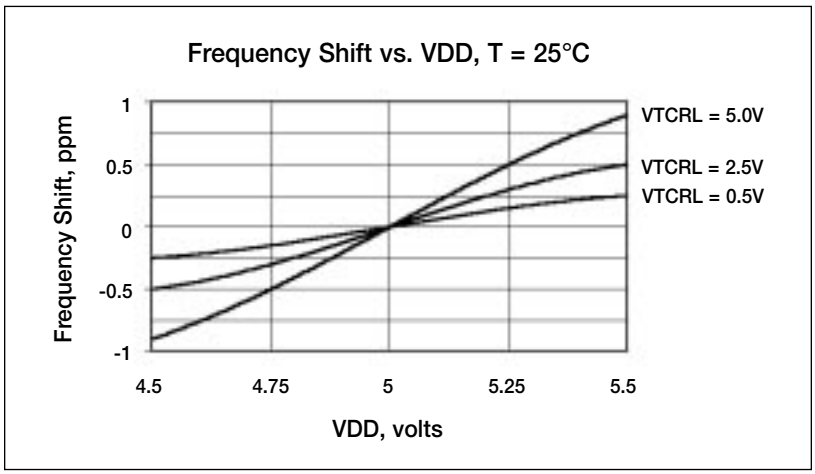
Total Tuning Range = $\Delta f_2 - \Delta f_1$ = 1136.4 ppm - 731.5 ppm = 405 ppm

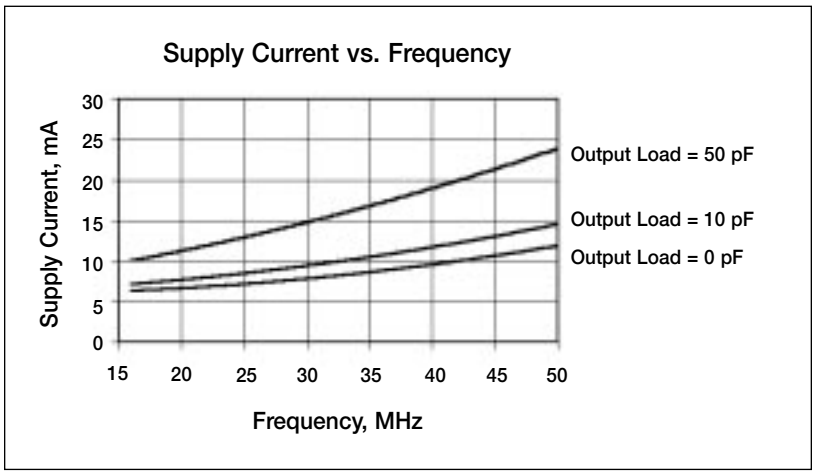
DIVIDER MODES

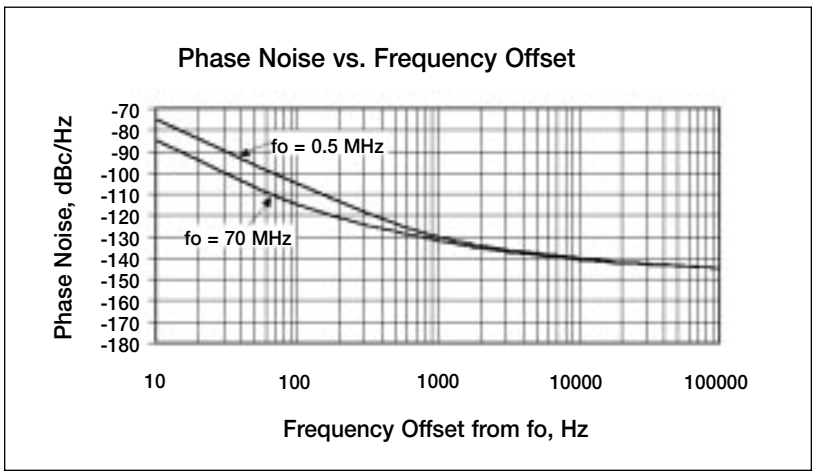
Undivided Crystal Frequency = F_{XTL}

DIV	FOUT T228-1	FOUT T228-2
OPEN	F_{XTL}	F_{XTL}
V_{SS}	$F_{XTL}/4$	$F_{XTL}/2$
V_{DD}	$F_{XTL}/16$	$F_{XTL}/8$

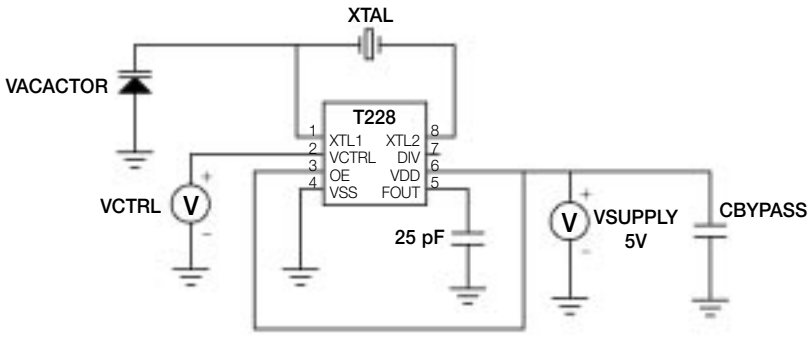
GRAPHS OF TYPICAL OPERATING CONDITIONS



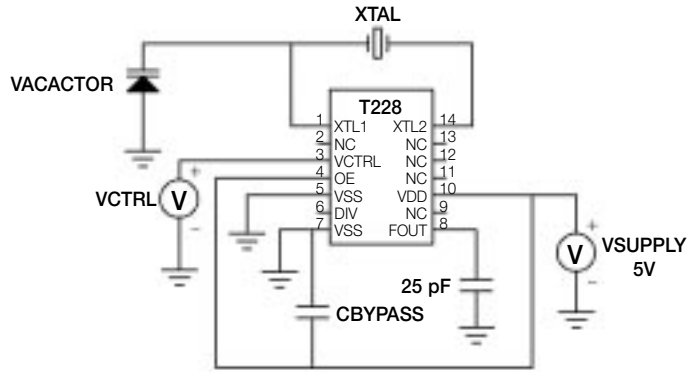




TEST CIRCUIT SCHEMATIC

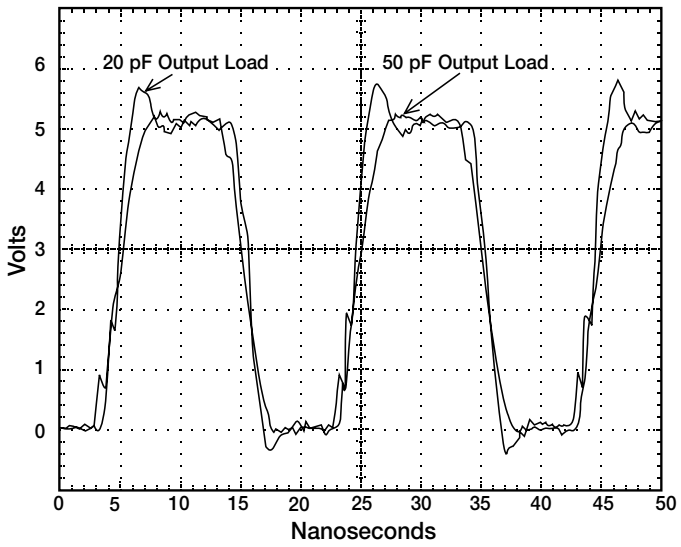


T228 TEST CIRCUIT 8-Pin Configuration



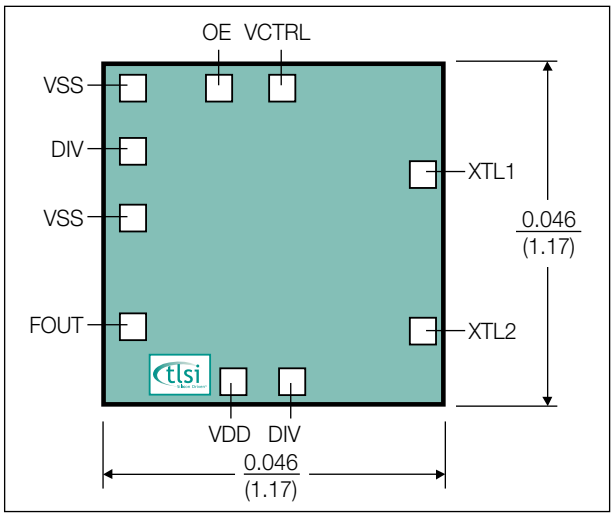
T228 TEST CIRCUIT 14-Pin Configuration

OUTPUT WAVEFORMS

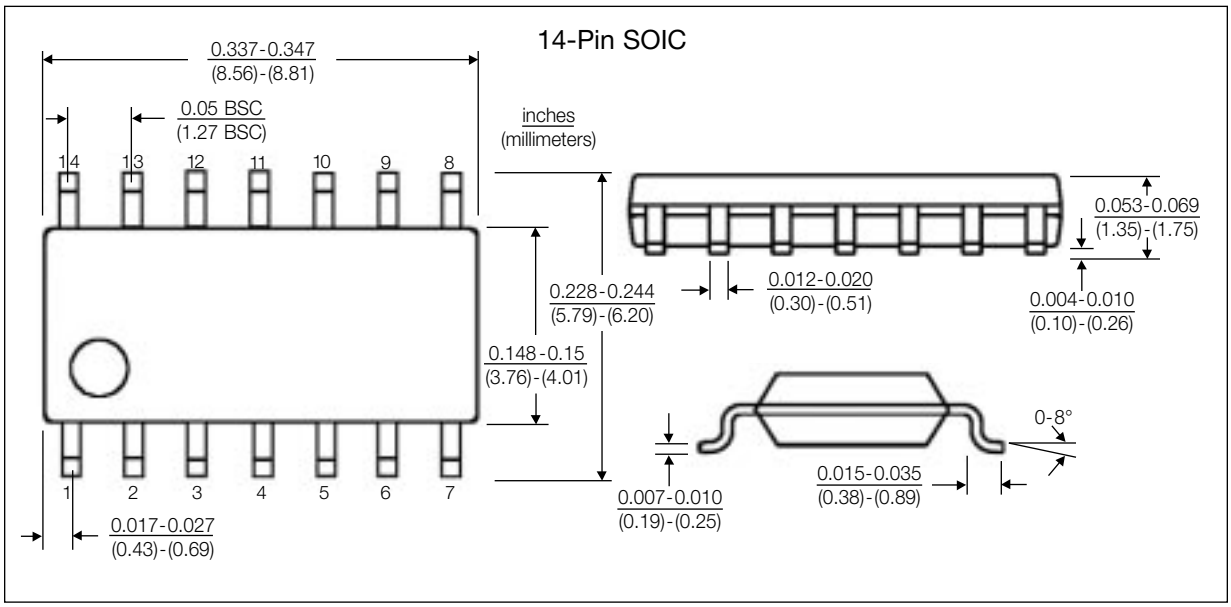


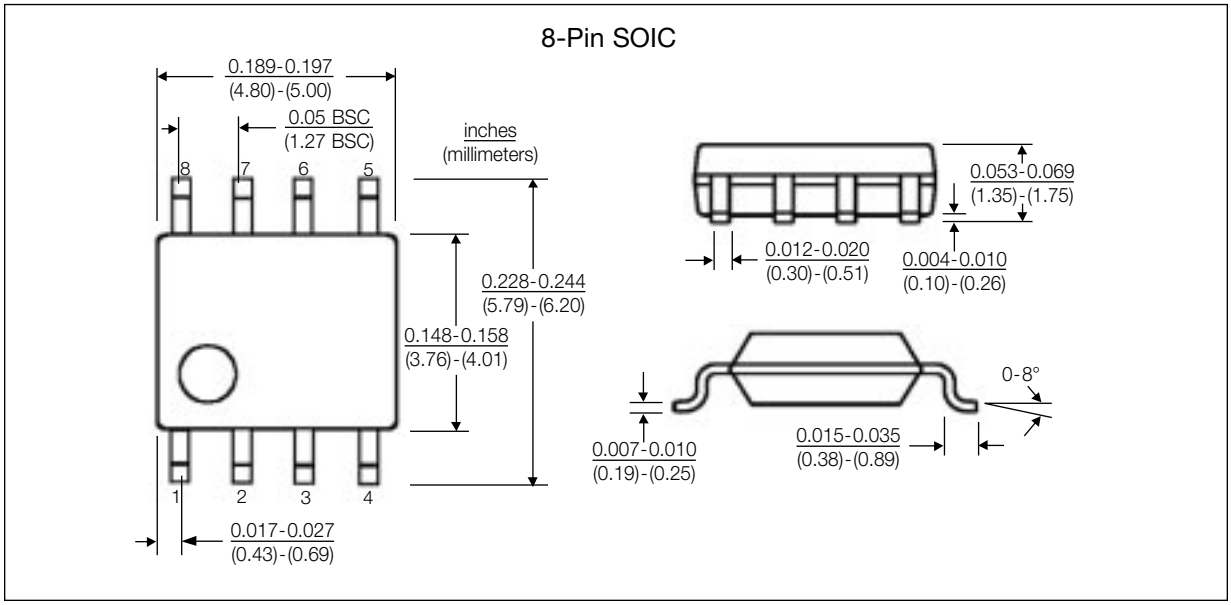
OUTPUT WAVEFORM, 50 MHz, with 20 pF and 50 pF loads

DIE SIZE



PACKAGE INFORMATION





PIN FUNCTIONS

8-Pin Configuration

NUMBER	NAME	FUNCTION
1	XTL1	Crystal Connection, Lead 1
2	VCTRL	Frequency Control, V_{SS} -V_{DD}
3	OE	Output Enable
4	VSS	Power Supply Reference (normally ground)
5	FOUT	Frequency Output
6	VDD	Power Supply (nominally 5 volts)
7	DIV	Divider Programming Pin
8	XTL2	Crystal Connection, Lead 2

14-Pin Configuration

NUMBER	NAME	FUNCTION
1	XTL1	Crystal Connection, Lead 1
2	NC	No Connection
3	VCTRL	Frequency Control, V_{SS} -V_{DD}
4	OE	Output Enable
5	VSS	Power Supply Reference (normally ground)
6	DIV	Divider Programming Pin
7	VSS	Power Supply Reference (normally ground)
8	FOUT	Frequency Output
9	NC	No Connection
10	VDD	Power Supply (nominally 5 volts)
11	NC	No Connection
12	NC	No Connection
13	NC	No Connection
14	XTL2	Crystal Connection, Lead 2

ORDERING INFORMATION

PART NUMBER	ORDERING CODE	PACKAGE	SHIPPING FORM
T228-1	T228-1S8-T	8-Pin SOIC	Tube
T228-1	T228-1S8-TR	8-Pin SOIC	Tape and Reel
T228-1	T228-1S14-T	14-Pin SOIC	Tube
T228-1	T228-1S14-TR	14-Pin SOIC	Tape and Reel
T228-1	T228-1D-P	Die	Probed Wafer
T228-1	T228-1D-W	Die	Waffle Pack
T228-2	T228-2S8-T	8-Pin SOIC	Tube
T228-2	T228-2S8-TR	8-Pin SOIC	Tape and Reel
T228-2	T228-2S14-T	14-Pin SOIC	Tube
T228-2	T228-2S14-TR	14-Pin SOIC	Tape and Reel
T228-2	T228-2D-P	Die	Probed Wafer
T228-2	T228-2D-W	Die	Waffle Pack

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TLSI Incorporated, 770 Park Avenue, Huntington NY 11743 • 631-755-7005 • Fax 631-755-7626 • www.tlsi.com