



### 1.0 Key Features

- Phase-locked loop (PLL) device synthesizes output clock frequency from crystal oscillator or external reference clock
- On-chip tunable voltage-controlled crystal oscillator (VCXO) allows precise system frequency tuning
- Typically used for generation of MPEG-2 decoder clock
- 3.3V supply voltage
- Very low phase noise PLL
- Use with “pullable” 14pF crystals – no external padding capacitors required
- Small circuit board footprint (8-pin 0.150” SOIC)
- Custom frequency selections available - contact your local ON Semiconductor sales representative for more information

### 2.0 Description

The FS6128 is a monolithic CMOS clock generator IC designed to minimize cost and component count in digital video/audio systems.

At the core of the FS6128 is circuitry that implements a voltage-controlled crystal oscillator (VCXO) when an external resonator (nominally 13.5MHz) is attached. The VCXO allows device frequencies to be precisely adjusted for use in systems that have frequency matching requirements, such as digital satellite receivers.

A high-resolution phase-locked loop generates an output clock (CLK) through a post-divider. The CLK frequency is ratiometrically derived from the VCXO frequency. The locking of the CLK frequency to other system reference frequencies can eliminate unpredictable artifacts in video systems and reduce electromagnetic interference (EMI) due to frequency harmonic stacking.

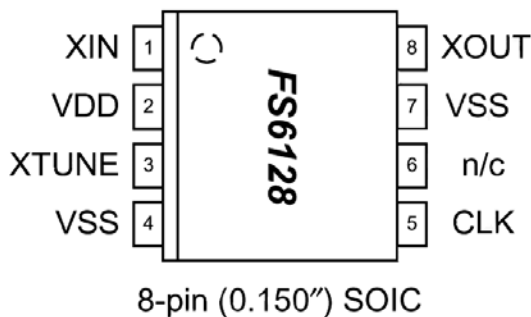


Figure 1: Pin Configuration

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Table 1: Crystal / Output Frequencies

Device	f <sub>XIN</sub> (MHz)	CLK (MHz)
FS128-04	13.500	27.000

Note: Contact ON Semiconductor for custom PLL frequencies.

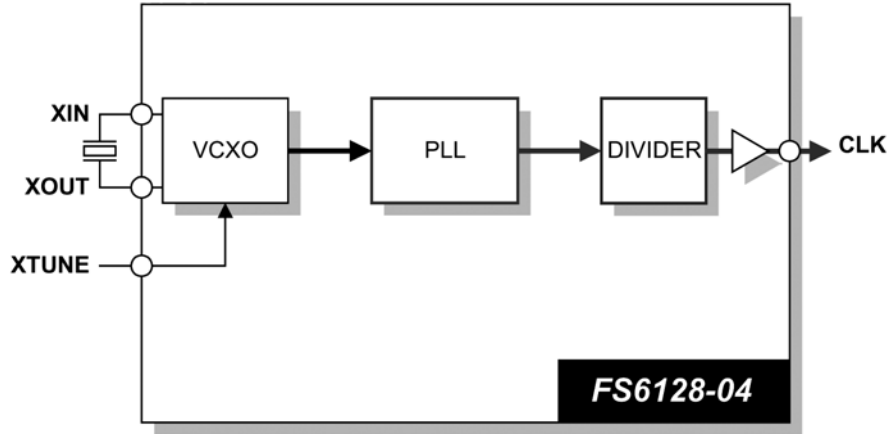


Figure 2: Block Diagram

Table 2: Pin Descriptions

Pin	Type	Name	Description
1	AI	XIN	VCXO feedback
2	P	VDD	Power supply (+3.3V)
3	AI	XTUNE	VCXO tune
4	P	VSS	Ground
5	DO	CLK	Clock output
6	-	n/c	No connection
7	DO	VSS	Ground
8	AO	XOUT	VCXO drive

Key: AI = Analog Input; AO = Analog Output; DI = Digital Input; DI<sup>u</sup> = Input With Internal Pull-Up; DI<sub>d</sub> = Input With Internal Pull-Down; DIO = Digital Input/Output; DI-3 = Three-Level Digital Input, DO = Digital Output; P = Power/Ground; # = Active Low Pin

## 3.0 Functional Block Diagram

### 3.1 Voltage-Controlled Crystal Oscillator (VCXO)

The VCXO provides a tunable, low-jitter frequency reference for the rest of the FS6128 system components. Loading capacitance for the crystal is internal to the FS6128. No external components (other than the resonator itself) are required for operation of the VCXO.

Continuous fine-tuning of the VCXO frequency is accomplished by varying the voltage on the XTUNE pin. The value of this voltage controls the effective capacitance presented to the crystal. The actual amount that this load capacitance change will alter the oscillator frequency depends on the characteristics of the crystal as well as the oscillator circuit itself.

It is important that the crystal load capacitance is specified correctly to “center” the tuning range. See Table 5.

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A simple formula to obtain the “pulling” capability of a crystal oscillator is:

$$\Delta f \text{ (ppm)} = \frac{C_1 \times (C_{L2} - C_{L1}) \times 10^6}{2 \times (C_0 + C_{L2}) \times (C_0 + C_{L1})}$$

where:

C<sub>0</sub> = the shunt (or holder) capacitance of the crystal

C<sub>1</sub> = the motional capacitance of the crystal

C<sub>L1</sub> and C<sub>L2</sub> = the two extremes (minimum and maximum) of the applied load capacitance presented by the FS6128.

EXAMPLE: A crystal with the following parameters is used: C<sub>1</sub> = 0.025pF and C<sub>0</sub> = 6pF. Using the minimum and maximum C<sub>L1</sub> = 10pF, and C<sub>L2</sub> = 20pF, the tuning range (peak-to-peak) is:

$$\Delta f = \frac{0.025 \times (20 - 10) \times 10^6}{2 \times (6 + 20) \times (6 + 10)} = 300 \text{ ppm}$$

## 3.2 Phase-Locked Loop (PLL)

The on-chip PLL is a standard frequency- and phase locked loop architecture. The PLL multiplies the reference oscillator frequency to the desired output frequency by a ratio of integers. The frequency multiplication is exact with a zero synthesis error (unless otherwise specified).

## 4.0 Electrical Specifications

Table 3: Absolute Maximum Ratings

Parameter	Symbol	Min.	Max.	Units
Supply voltage (V <sub>SS</sub> = ground)	V <sub>DD</sub>	V <sub>SS</sub> - 0.5	7	V
Input voltage, DC	V <sub>I</sub>	V <sub>SS</sub> - 0.5	V <sub>DD</sub> + 0.5	V
Output voltage, DC	V <sub>O</sub>	V <sub>SS</sub> - 0.5	V <sub>DD</sub> + 0.5	V
Input clamp current, DC (V <sub>I</sub> < 0 or V <sub>I</sub> > V <sub>DD</sub> )	I <sub>IK</sub>	-50	50	mA
Output clamp current, DC (V <sub>I</sub> < 0 or V <sub>I</sub> > V <sub>DD</sub> )	I <sub>OK</sub>	-50	50	mA
Storage temperature range (non-condensing)	T <sub>S</sub>	-65	150	°C
Ambient temperature range, under bias	T <sub>A</sub>	-55	125	°C
Junction temperature	T <sub>J</sub>		125	°C
Re-flow solder profile				Per IPC/JEDEC J-STD-020B
Input static discharge voltage protection (MLD-STD 883E, Method 3015.7)			2	kv

Note: Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. These conditions represent a stress rating only and functional operation of the device at these or any other conditions above the operational limits noted in this specification is not implied. Exposure to maximum rating conditions for extended conditions may affect device performance, functionality and reliability.

### CAUTION: ELECTROSTATIC SENSITIVE DEVICE

Permanent damage resulting in a loss of functionality or performance may occur if this device is subjected to a high energy electrostatic discharge.

Table 4: Operating Conditions

Parameter	Symbol	Conditions/Descriptions	Min.	Typ.	Max.	Units
Supply voltage	V <sub>DD</sub>	3.3V ± 10%	3.0	3.3	3.6	V
Ambient operating temperature range	T <sub>A</sub>	0			70	°C
Crystal resonator frequency	f <sub>XTAL</sub>	Functional mode	12	13.5	18	MHz

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Table 5: DC Electrical Specifications

Parameter	Symbol	Conditions/Descriptions	Min.	Typ.	Max.	Units
<b>Overall</b>						
Supply current, dynamic, with loaded outputs	$I_{DD}$	$f_{XAL} = 13.5\text{MHz}$ ; $C_L = 10\text{pF}$ ; $V_{DD} = 3.6\text{V}$		30		mA
Supply current, static	$I_{DD}$	$XIN = 0\text{V}$ ; $V_{DD} = 3.6\text{V}$		3		mA
<b>Voltage-Controlled Crystal Oscillator (contact factory for approved crystal sources or other application assistance)</b>						
Crystal loading capacitance at center tuning voltage	$C_{L(xtal)}$	Order crystal for this capacitance (parallel load) at desired center frequency		14		pF
Crystal resonator motional capacitance	$C_1$	Specified motional capacitance of the crystal will affect pullability (see text)		25		fF
XTUNE effective range			0		3	V
Synthesized load capacitance min.	$C_{L1}$	@V(XTUNE) = minimum value		10		pF
Synthesized load capacitance max.	$C_{L2}$	@V(XTUNE) = maximum value		20		pF
VCXO tuning range		$f_{XTAL} = 13.5\text{MHz}$ ; $C_{L(xtal)} = 14\text{pF}$ ; $C_1(xtal) = 25\text{fF}$ (peak-to-peak)		300		ppm
VCXO tuning characteristic		Note: positive change of XTUNE = positive change of VCXO frequency		150		ppm/V
Crystal drive level		$R_{XTAL} = 20\Omega$ ; $C_L = 20\text{pF}$		200		$\mu\text{W}$
<b>Clock Output (CLK)</b>						
High-level output source current*	$I_{OH}$	$V_O = 2.0\text{V}$		-40		mA
Low-level output sink current*	$I_{OL}$	$V_O = 0.4\text{V}$		17		mA
Output impedance*	$Z_{OH}$ $Z_{OL}$	$V_O = 0.1V_{DD}$ ; output driving high $V_O = 0.1V_{DD}$ ; output driving low		25 25		$\Omega$
Short circuit source current*	$I_{OSH}$	$V_O = 0\text{V}$ ; shorted for 30s, max.		-55		mA
Short circuit sink current*	$I_{OSL}$	$V_O = 3.3\text{V}$ ; shorted for 30s, max.		55		mA

Note: Unless otherwise stated  $V_{DD} = 3.3\text{V} \pm 10\%$  no load on any output and ambient temperature range  $T_A = 0^\circ\text{C}$  to  $70^\circ\text{C}$ . Parameters denoted with an asterisk (\*) represent nominal characterization data and are not production tested to any specific limits. Where given, MIN and MAX characterization data are  $\pm 3\sigma$  from typical. Negative currents indicate current flows out of the device.

Table 6: AC Timing Specifications

Parameter	Symbol	Conditions/Descriptions	Min.	Typ.	Max.	Units
<b>Overall</b>						
VCXO stabilization time*	$t_{VCXOSTB}$	From power valid		10		ms
PLL stabilization time*	$t_{PLLSTB}$	From VCXO stable		100		$\mu\text{s}$
Synthesis error		(Unless otherwise noted in frequency table)		0		ppm
<b>Clock Output (CLK)</b>						
Duty cycle*		Ratio of high pulse width (as measured from rising edge to next falling edge at $V_{DD}/2$ ) to one clock period	45		55	%
Jitter, period (peak-peak)*	$t_{j(\Delta P)}$	From rising edge to next rising edge at $V_{DD}/2$ , $C_L = 10\text{pF}$ 200 ps		200		ps
Jitter, long term ( $\sigma\gamma(\tau)$ )	$t_{j(LT)}$	From 0-500 $\mu\text{s}$ at $V_{DD}/2$ , $C_L = 10\text{pF}$ compared to ideal clock source		100		ps
Rise time*	$t_r$	$V_{DD} = 3.3\text{V}$ ; $V_O = 0.3\text{V}$ to $3.0\text{V}$ ; $C_L = 10\text{pF}$		1.7		ns
Fall time*	$t_f$	$V_{DD} = 3.3\text{V}$ ; $V_O = 3.0\text{V}$ to $0.3\text{V}$ ; $C_L = 10\text{pF}$		1.7		ns

Note: Unless otherwise stated,  $V_{DD} = 3.3\text{V} \pm 10\%$ , no load on any output, and ambient temperature range  $T_A = 0^\circ\text{C}$  to  $70^\circ\text{C}$ . Parameters denoted with an asterisk (\*) represent nominal characterization data and are not production tested to any specific limits. Where given, MIN and MAX characterization data are  $\pm 3\sigma$  from typical.

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## 5.0 Package Information – For Both ‘Green’ and ‘Non-Green’

Table 7: 8-pin SOIC (0.150") Package Dimensions

	Dimensions			
	Inches		Millimeters	
	Min.	Max.	Min.	Max.
A	0.061	0.068	1.55	1.73
A1	0.004	0.0098	0.102	0.249
A2	0.055	0.061	1.40	1.55
B	0.013	0.019	.033	0.49
C	0.0075	0.0098	0.191	0.249
D	0.189	0.196	4.80	4.98
E	0.150	0.157	3.81	3.99
e	0.050 BSC		1.27 BSC	
H	0.230	0.244	5.84	6.20
h	0.010	0.016	0.25	0.41
L	0.016	0.035	0.41	0.89
Θ	0°	8°	0°	8°

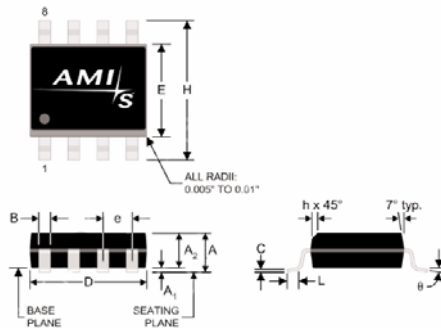


Table 8: 8-pin SOIC (0.150") Package Characteristics

Parameter	Symbol	Conditions/Descriptions	Typ.	Units
Thermal impedance, junction to free-air 8-pin 0.150" SOIC	$\Theta_{JA}$	Air flow = 0 m/s	110	°C/W
Lead inductance, self	$L_{11}$	Corner lead	2.0	nH
Lead inductance, mutual	$L_{12}$	Center lead Any lead to any adjacent lead	1.6 0.4	nH
Lead capacitance, bulk	$C_{11}$	Any lead to $V_{SS}$	0.27	pF

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## 6.0 Ordering Information


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Part Number	Package	Shipping Configuration	Temperature Range
FS6128-04G-XTD	8-pin (0.150") SOIC 'Green' or lead-free packaging	Tube/Tray	0°C to 70°C (commercial)
FS6128-04G-XTP	8-pin (0.150") SOIC 'Green' or lead-free packaging	Tape & Reel	0°C to 70°C (commercial)

## 7.0 Revision History

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Revision	Date	Modification
1	March 2004	Initial release
2	May 2008	Update to new ON Semiconductor template

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