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1.0 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 AMI 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

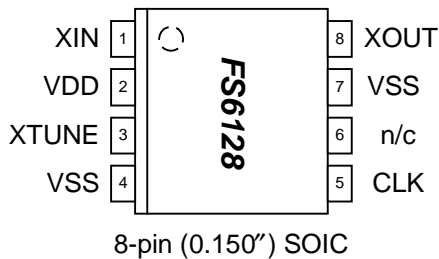


Table 1: Crystal / Output Frequencies

| DEVICE | f_{XIN} (MHz) | CLK (MHz) |
|-----------|-----------------|-----------|
| FS6128-04 | 13.500 | 27.000 |
| FS6128-05 | 13.500 | 13.500 |
| FS6128-06 | 13.500 | 54.000 |

NOTE: Contact AMI for custom PLL frequencies

Figure 2: Block Diagram

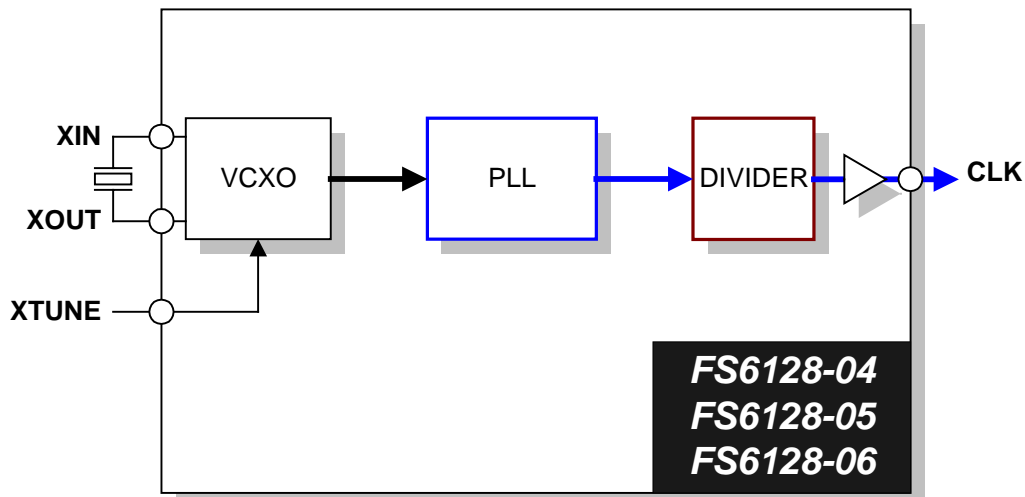


Table 2: Pin Descriptions

Key: AI = Analog Input; AO = Analog Output; DI = Digital Input; DI^U = Input with Internal Pull-Up; DI_D = Input with Internal Pull-Down; DIO = Digital Input/Output; DI-3 = Three-Level Digital Input, DO = Digital Output; P = Power/Ground; # = Active Low pin

| 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 |

3.0 Functional Block Description

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.

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

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

where:

C₀ = the shunt (or holder) capacitance of the crystal

C₁ = the motional capacitance of the crystal

C_{L1} and C_{L2} = the two extremes (minimum and maximum) of the applied load capacitance presented by the FS6128.

EXAMPLE: A crystal with the following parameters is used: C₁ = 0.025pF and C₀ = 6pF. Using the minimum and maximum C_{L1} = 10pF, and C_{L2} = 20pF, the tuning range (peak-to-peak) is:

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

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).

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4.0 Electrical Specifications

Table 3: Absolute Maximum Ratings

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.

| PARAMETER | SYMBOL | MIN. | MAX. | UNITS |
|---|----------|--------------|--------------|-------|
| Supply Voltage ($V_{SS} = \text{ground}$) | V_{DD} | $V_{SS}-0.5$ | 7 | V |
| Input Voltage, dc | V_I | $V_{SS}-0.5$ | $V_{DD}+0.5$ | V |
| Output Voltage, dc | V_O | $V_{SS}-0.5$ | $V_{DD}+0.5$ | V |
| Input Clamp Current, dc ($V_I < 0$ or $V_I > V_{DD}$) | I_{IK} | -50 | 50 | mA |
| Output Clamp Current, dc ($V_I < 0$ or $V_I > V_{DD}$) | I_{OK} | -50 | 50 | mA |
| Storage Temperature Range (non-condensing) | T_S | -65 | 150 | °C |
| Ambient Temperature Range, Under Bias | T_A | -55 | 125 | °C |
| Junction Temperature | T_J | | 125 | °C |
| Lead Temperature (soldering, 10s) | | | 260 | °C |
| Input Static Discharge Voltage Protection (MIL-STD 883E, Method 3015.7) | | | 2 | kV |



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/DESCRIPTION | MIN. | TYP. | MAX. | UNITS |
|-------------------------------------|------------|------------------------|------|------|------|-------|
| Supply Voltage | V_{DD} | $3.3V \pm 10\%$ | 3.0 | 3.3 | 3.6 | V |
| Ambient Operating Temperature Range | T_A | | 0 | | 70 | °C |
| Crystal Resonator Frequency | f_{XTAL} | Fundamental Mode | 12 | 13.5 | 18 | MHz |

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Table 5: DC Electrical Specifications

Unless otherwise stated, $V_{DD} = 3.3V \pm 10\%$, no load on any output, and ambient temperature range $T_A = 0^\circ C$ to $70^\circ C$. 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.

| PARAMETER | SYMBOL | CONDITIONS/DESCRIPTION | MIN. | TYP. | MAX. | UNITS |
|---|---------------|---|------|------|------|----------|
| Overall | | | | | | |
| Supply Current, Dynamic, with Loaded Outputs | I_{DD} | $f_{XTAL} = 13.5MHz$; $C_L = 10pF$, $V_{DD} = 3.6V$ | | 30 | | mA |
| Supply Current, Static | I_{DD} | $XIN = 0V$, $V_{DD} = 3.6V$ | | 3 | | mA |
| Voltage Controlled Crystal Oscillator (contact factory for approved crystal sources or other application assistance) | | | | | | |
| 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 | | $f_{XTAL} = 13.5MHz$; $C_{L(xtal)} = 14pF$; $C_{1(xtal)} = 25fF$ (peak-to-peak) | | 300 | | ppm |
| VCXO Tuning Characteristic | | Note: positive change of XTUNE = positive change of VCXO frequency | | 150 | | ppm/V |
| Crystal Drive Level | | $R_{XTAL}=20\Omega$; $C_L = 20pF$ | | 200 | | uW |
| Clock Output (CLK) | | | | | | |
| High-Level Output Source Current * | I_{OH} | $V_O = 2.0V$ | | -40 | | mA |
| Low-Level Output Sink Current * | I_{OL} | $V_O = 0.4V$ | | 17 | | mA |
| Output Impedance * | Z_{OH} | $V_O = 0.1V_{DD}$; output driving high | | 25 | | Ω |
| | Z_{OL} | $V_O = 0.1V_{DD}$; output driving low | | 25 | | |
| Short Circuit Source Current * | I_{OSH} | $V_O = 0V$; shorted for 30s, max. | | -55 | | mA |
| Short Circuit Sink Current * | I_{OSL} | $V_O = 3.3V$; shorted for 30s, max. | | 55 | | mA |

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Table 6: AC Timing Specifications

Unless otherwise stated, $V_{DD} = 3.3V \pm 10\%$, no load on any output, and ambient temperature range $T_A = 0^\circ C$ to $70^\circ C$. 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.

| PARAMETER | SYMBOL | CONDITIONS/DESCRIPTION | MIN. | TYP. | MAX. | UNITS |
|--|-------------------|--|------|------|------|-------|
| Overall | | | | | | |
| VCXO Stabilization Time * | $t_{VCXOSTB}$ | From power valid | | 10 | | ms |
| PLL Stabilization Time * | t_{PLLSTB} | From VCXO stable | | 100 | | us |
| Synthesis Error | | (unless otherwise noted in Frequency Table) | | | 0 | ppm |
| Clock Output (CLK) | | | | | | |
| 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 $V_{DD}/2$, $C_L = 10pF$ | | 200 | | ps |
| Jitter, Long Term ($\sigma_j(\tau)$) * | $t_{j(LT)}$ | From 0-500 μs at $V_{DD}/2$, $C_L = 10pF$ compared to ideal clock source | | 100 | | ps |
| Rise Time * | t_r | $V_{DD} = 3.3V$; $V_O = 0.3V$ to $3.0V$; $C_L = 10pF$ | | 1.7 | | ns |
| Fall Time * | t_f | $V_{DD} = 3.3V$; $V_O = 3.0V$ to $0.3V$; $C_L = 10pF$ | | 1.7 | | ns |

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5.0 Package Information

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 | 0.33 | 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/DESCRIPTION | TYP. | UNITS |
|--|---------------|-------------------------------|------|-------|
| Thermal Impedance, Junction to Free-Air 8-pin 0.150" SOIC | Θ_{JA} | Air flow = 0 m/s | 110 | °C/W |
| Lead Inductance, Self | L_{11} | Corner lead | 2.0 | nH |
| | | Center lead | 1.6 | |
| Lead Inductance, Mutual | L_{12} | Any lead to any adjacent lead | 0.4 | nH |
| Lead Capacitance, Bulk | C_{11} | Any lead to V_{SS} | 0.27 | pF |

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6.0 Ordering Information

Table 9: Device Ordering Codes

| ORDERING CODE | DEVICE NUMBER | PACKAGE TYPE | OPERATING TEMPERATURE RANGE | SHIPPING CONFIGURATION |
|------------------|---------------|---|-----------------------------|------------------------|
| 11640-825 | FS6128-04 | 8-pin (0.150") SOIC (Small Outline Package) | 0° C to 70° C (Commercial) | Tape and Reel |
| 11640-835 | FS6128-04 | 8-pin (0.150") SOIC (Small Outline Package) | 0° C to 70° C (Commercial) | Tubes |
| 11640-102 | FS6128-05 | 8-pin (0.150") SOIC (Small Outline Package) | 0° C to 70° C (Commercial) | Tape and Reel |
| 11640-112 | FS6128-05 | 8-pin (0.150") SOIC (Small Outline Package) | 0° C to 70° C (Commercial) | Tubes |
| 11640-103 | FS6128-06 | 8-pin (0.150") SOIC (Small Outline Package) | 0° C to 70° C (Commercial) | Tape and Reel |
| 11640-113 | FS6128-06 | 8-pin (0.150") SOIC (Small Outline Package) | 0° C to 70° C (Commercial) | Tubes |

7.0 Revision Information

| DATE | PAGE | DESCRIPTION |
|---------|------|---------------------------|
| 1/21/00 | 1 | Fixed typographical error |
| 4/24/00 | 5 | Fixed formatting error |

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