AMERICAN MICROSYSTEMS, INC.

FS6130

VCXO Clock Generator IC

May 2000

1.0 Features

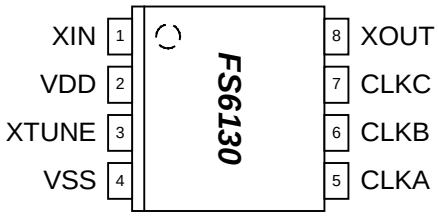
- On-chip tunable voltage-controlled crystal oscillator circuitry (VCXO) allows precise system frequency tuning (pull range typically 300ppm)
- Uses inexpensive fundamental-mode crystals
- Integrated phase-locked loop (PLL) multiplies VCXO frequency to the higher system frequencies needed
- 3.3V or 5V supply voltage available
- 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 FS6130 is a monolithic CMOS clock generator IC designed to minimize cost and component count in digital video/audio systems.

A high-resolution phase-locked loop generates three output clocks through an array of post-dividers. All frequencies are ratiometrically derived from the crystal oscillator frequency. The locking of all the output frequencies together can eliminate unpredictable artifacts in video systems and reduce electromagnetic interference (EMI) due to frequency harmonic stacking.

Figure 1: Pin Configuration



8-pin (0.150″) SOIC

Table 1: Font Information

DEVICE	VDD	F_{XIN} (MHz)	CLKA (MHz)	CLKB (MHz)	CLKC (MHz)
FS6130-03	5V	13.500	54.000	13.500	27.000

NOTE: Contact AMI for custom versions

Figure 2: Block Diagram

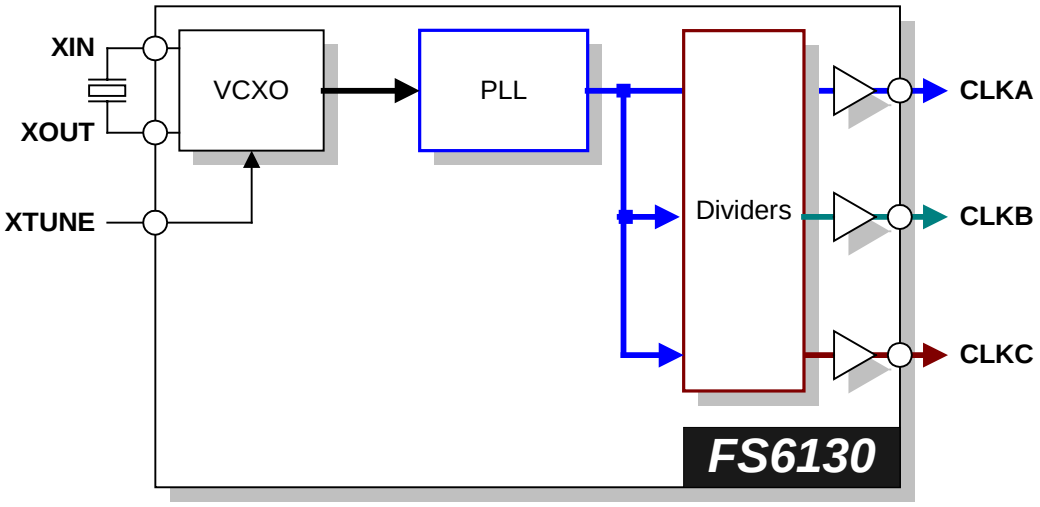


Table 2: Pin Descriptions

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 Crystal Feedback
2	P	VDD	Power Supply (+3.3V or +5V) – see Version Information
3	AI	XTUNE	VCXO Tune
4	P	VSS	Ground
5	DO	CLKA	Clock Output
6	DO	CLKB	Clock Output
7	DO	CLKC	Clock Output
8	AO	XOUT	VCXO Crystal Drive

3.0 Functional Block Description

3.1 Phase-Locked Loop (PLL)

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

3.2 Voltage-Controlled Crystal Oscillator (VCXO)

The VCXO provides a tunable, low-jitter frequency reference for the rest of the FS6109 system components. Loading capacitance for the crystal is internal to the FS6109. No external components (other than the crystal 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 total change (from one extreme to the other) in effective loading capacitance is t.b.d. nominal.

The oscillator operates the crystal resonator in the parallel-resonant mode. Crystal warping, or the “pulling” of the crystal oscillation frequency, is accomplished by altering the effective load capacitance presented to the crystal by the oscillator circuit. The actual amount that changing the load capacitance alters the oscillator frequency will be dependent on the characteristics of the crystal as well as the oscillator circuit itself.

Specifically, the motional capacitance of the crystal (usually referred to by crystal manufacturers as C_1), the static capacitance of the crystal (C_0), and the load capacitance (C_L) of the oscillator determine the “warping” or “pulling” capability of the crystal in the oscillator circuit.

A simple formula to obtain the warping 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 C_{L1} and C_{L2} are the two extremes of the applied load capacitance.

EXAMPLE: A crystal with the following parameters is used. With C_1 = 0.02pF, C_0 = 5pF, C_{L1} = 10pF, and C_{L2} = 22.66pF, the tuning range is

$$\Delta f = \frac{0.02 \times (22.66 - 10) \times 10^6}{2 \times (5 + 22.66) \times (5 + 10)} = 305\,ppm.$$

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} = 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 (3.3 volt system)	V_{DD}	SEE NOTE 1	3.0	3.3	3.6	V
Supply Voltage (5.0 volt system)	V_{DD}	SEE NOTE 1	4.5	5.0	5.5	V
Ambient Operating Temperature Range	T_A	SEE NOTE 1	0		70	°C
Crystal Resonator Frequency	f_{XTAL}	Fundamental Mode	5		18	MHz

NOTE 1: These specifications represent generic FS6130 device capability. Device specifications for a particular version (i.e. FS6130-xx) are guaranteed only with the operating voltage and reference frequency specified in Version Information.

Table 5: DC Electrical Specifications (V_{DD} = 3.3V nominal)

Unless otherwise stated, V_{DD} = 3.3V ± 10%, no load on any output, and ambient temperature range T_A = 0°C to 70°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 ±3σ 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} = 27MHz; C_L = 10pF, V_{DD} = 3.3V				mA
Crystal Oscillator						
Crystal Loading Capacitance	$C_{L(xtal)}$	As seen by a crystal connected to XIN and XOUT		20		pF
Crystal Drive Level		R_{XTAL}=20Ω;		200		uW
Crystal Oscillator Feedback (XIN)						
Threshold Bias Voltage	V_{TH}			860		mV
High-Level Input Current	I_{IH}			34		µA
Low-Level Input Current	I_{IL}			-21		µA
Crystal Oscillator Drive (XOUT)						
High-Level Output Source Current	I_{OH}	V(XIN) = 3.3V, V_O = 0V		-0.5		mA
Low-Level Output Sink Current	I_{OL}	V(XIN) = 0V, V_O = 3.3V		15		mA
Clock Outputs (CLKx)						
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

Table 6: DC Electrical Specifications (V_{DD} = 5V nominal)

Unless otherwise stated, V_{DD} = 5.0V ± 10%, no load on any output, and ambient temperature range T_A = 0°C to 70°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 ±3σ 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} = 27MHz; C_L = 10pF, V_{DD} = 5.0V				mA
Crystal Oscillator						
Crystal Loading Capacitance	$C_{L(xtal)}$	As seen by a crystal connected to XIN and XOUT		17		pF
Crystal Drive Level		R_{XTAL}=20Ω;		200		uW
Crystal Oscillator Feedback (XIN)						
Threshold Bias Voltage	V_{TH}					mV
High-Level Input Current	I_{IH}					µA
Low-Level Input Current	I_{IL}					µA
Crystal Oscillator Drive (XOUT)						
High-Level Output Source Current	I_{OH}	V(XIN) = 5V, V_O = 0V				mA
Low-Level Output Sink Current	I_{OL}	V(XIN) = 0V, V_O = 5V				mA
Clock Outputs (CLKx)						
High-Level Output Source Current *	I_{OH}	V_O = 2.0V				mA
Low-Level Output Sink Current *	I_{OL}	V_O = 0.4V				mA
Output Impedance *	z_{OH}	V_O = 0.1V_{DD}; output driving high				Ω
	z_{OL}	V_O = 0.1V_{DD}; output driving low				
Short Circuit Source Current *	I_{OSH}	V_O = 0V; shorted for 30s, max.				mA
Short Circuit Sink Current *	I_{OSL}	V_O = 5V; shorted for 30s, max.				mA

Table 7: AC Timing Specifications (V_{DD} = 3.3V nominal)

Unless otherwise stated, V_{DD} = 3.3V ± 10%, no load on any output, and ambient temperature range T_A = 0°C to 70°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 ±3σ from typical.

PARAMETER	SYMBOL	CONDITIONS/DESCRIPTION	CLOCK (MHz)	MIN.	TYP.	MAX.	UNITS
Overall							
Synthesis Error		(unless otherwise noted in Frequency Table)				0	ppm
Clock Output (CLKx)							
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			390		ps
Jitter, Long Term ($\sigma_y(\tau)$) *	$t_{j(LT)}$	From 0-500µs at V_{DD}/2, C_L = 10pF compared to ideal clock source			155		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

Table 8: AC Timing Specifications (V_{DD} = 5V nominal)

Unless otherwise stated, V_{DD} = 3.3V ± 10%, no load on any output, and ambient temperature range T_A = 0°C to 70°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 ±3σ from typical.

PARAMETER	SYMBOL	CONDITIONS/DESCRIPTION	CLOCK (MHz)	MIN.	TYP.	MAX.	UNITS
Overall							
Synthesis Error		(unless otherwise noted in Frequency Table)				0	ppm
Clock Output (CLKx)							
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			390		ps
Jitter, Long Term ($\sigma_y(\tau)$) *	$t_{j(LT)}$	From 0-500µs at V_{DD}/2, C_L = 10pF compared to ideal clock source			155		ps
Rise Time *	t_r	V_{DD} = 5V; V_O = 0.5V to 4.5V; C_L = 10pF			1.0		ns
Fall Time *	t_f	V_{DD} = 5V; V_O = 4.5V to 0.5V; C_L = 10pF			1.0		ns

5.0 Package Information

Table 9: 16-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	0.386	0.393	9.80	9.98
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°

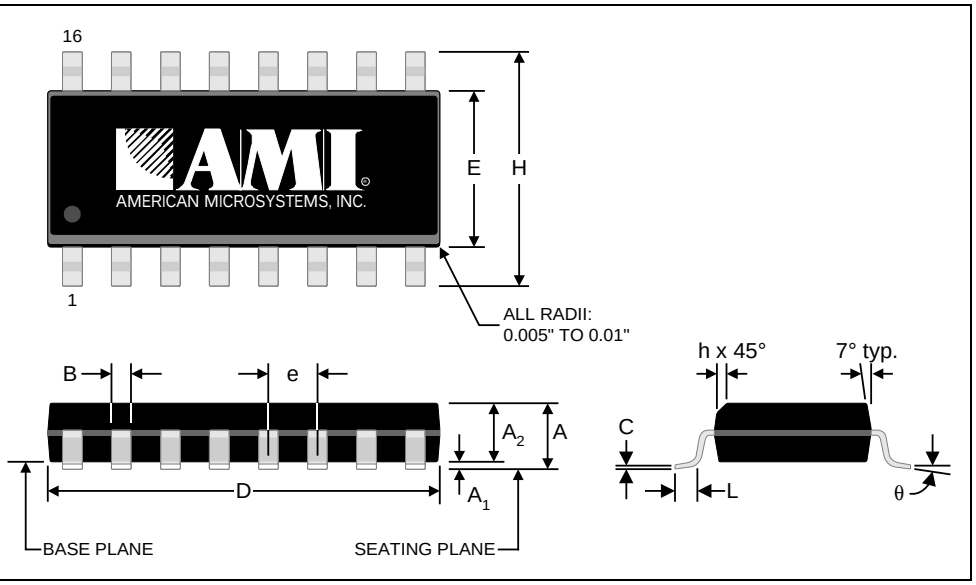


Table 10: 16-pin SOIC (0.150") Package Characteristics

PARAMETER	SYMBOL	CONDITIONS/DESCRIPTION	TYP.	UNITS
Thermal Impedance, Junction to Free-Air 16-pin 0.150" SOIC	Θ_{JA}	Air flow = 0 m/s	109	°C/W
Lead Inductance, Self	L_{11}	Corner lead	4.0	nH
		Center lead	3.0	
Lead Inductance, Mutual	L_{12}	Any lead to any adjacent lead	0.4	nH
Lead Capacitance, Bulk	C_{11}	Any lead to V_{SS}	0.5	pF

6.0 Ordering Information

ORDERING CODE	DEVICE NUMBER	PACKAGE TYPE	OPERATING TEMPERATURE RANGE	SHIPPING CONFIGURATION
t.b.d.	FS6130-01	8-pin (0.150") SOIC (Small Outline Package)	0° C to 70° C (Commercial)	Tape and Reel
t.b.d.	FS6130-01	8-pin (0.150") SOIC (Small Outline Package)	0° C to 70° C (Commercial)	Tubes
t.b.d.	FS6130-02	8-pin (0.150") SOIC (Small Outline Package)	0° C to 70° C (Commercial)	Tape and Reel
t.b.d.	FS6130-02	8-pin (0.150") SOIC (Small Outline Package)	0° C to 70° C (Commercial)	Tubes

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