Integrated Circuit Systems

ICS1527

Video Clock Synthesizer

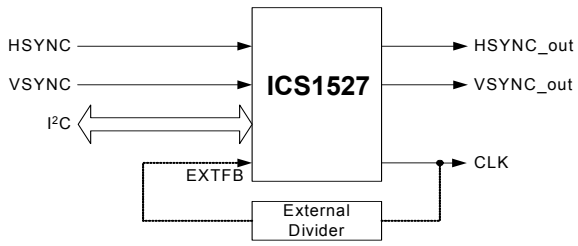
General Description

The ICS1527 is a low-cost, high-performance frequency generator. It is suited to general purpose phase controlled clock synthesis as well as line-locked and genlocked high-resolution video applications. Using ICS's advanced low-voltage CMOS mixed-mode technology, the ICS1527 is an effective clock synthesizer that supports video projectors and displays at resolutions from VGA to beyond XGA.

The ICS1527 offers single-ended clock outputs to 60 or 110 MHz. The HSYNC_out, and VSYNC_out pins provide the regenerated versions of the HSYNC and VSYNC inputs synchronous to the CLK output.

The advanced PLL uses either its internal programmable feedback divider or an external divider. The device is programmed by a standard I²C-bus™ serial interface and is available in a TSSOP16 package.

ICS1527 Functional Diagram



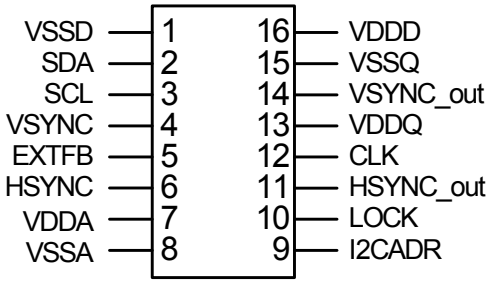
Features

- Lead-free packaging (Pb-free)
- Low jitter (typical 27 ps short term jitter)
- LVCMOS single-ended clock outputs
  - 60/110 MHz speed grades available
- Uses 3.3 V power supply
- 5 Volt tolerant Inputs (HSYNC, VSYNC)
- Coast (ignore HSYNC) capability via VSYNC pin
- Industry standard I²C-bus programming interface
- PLL Lock detection via I²C or LOCK output pin
- 16-pin TSSOP package

Applications

- Frequency synthesis
- LCD monitors, video projectors and plasma displays
- Genlocking multiple video subsystems

Pin Configuration (16-pin TSSOP)



ICS reserves the right to make changes in the preliminary device data identified in this publication without notice. ICS advises its customers to obtain the latest version of all device data to verify that information being relied upon is current and accurate.

Section 1 Overview

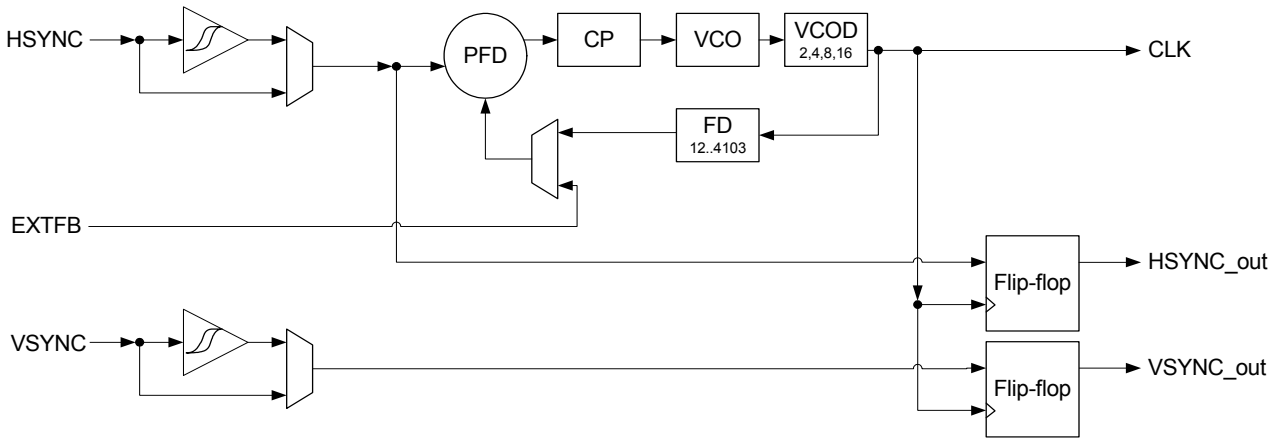
The ICS1527 is a user-programmable, high-performance general purpose clock generator. It is intended for graphics system line-locked and genlocked applications, and provides the clock signals required by high-performance analog-to-digital converters.

The ICS1527 has the ability to operate in line-locked mode with the HSYNC input.

1.1 Phase-Locked Loop

The phase-locked loop has a very wide input frequency range (8 kHz to 100 MHz). Not only is the ICS1527 an excellent, general purpose clock synthesizer, but it is also capable of line-locked operation. Refer to the block diagram below.

Figure 1-1 Simplified Block Diagram



Note: Polarity controls and other circuit elements are not shown in above diagram for simplicity

The heart of the ICS1527 is a voltage controlled oscillator (VCO). The VCO speed is controlled by the voltage on the loop filter. This voltage will be described later in this section.

The VCO's clock output is first passed through the VCO Divider (VCOD). The VCOD allows the VCO to operate at higher speeds than the required output clock.

NOTE: Under normal, locked operation the VCOD has no effect on the speed of the output clocks, just the VCO frequency.

The output of the VCOD is the full speed output frequency seen on the CLK. This clock is then sent through the 12-bit internal Feedback Divider (FD). The feedback divider controls how many clocks are seen during every cycle of the input reference.

The Phase Frequency Detector (PFD) then compares the feedback to the input and controls the filter voltage by enabling and disabling the charge pump. The charge pump has programmable current drive and will source and sink current as appropriate to keep the input and the HSYNC_out output aligned.

The input HSYNC and VSYNC can be conditioned by a high-performance Schmitt-trigger by sharpening the rising/falling edge.

The HSYNC_out and VSYNC_out signals are aligned with the output clock (CLK) via a set of flip flops.

1.2 Output Drivers and Logic Inputs

The ICS1527 uses low-voltage TTL (LVTTL) inputs and LVCMOS outputs, operating at the 3.3 V supply voltage. The LVTTL inputs are 5 V tolerant.

The LVCMOS drive resistive terminations or transmission lines.

1.3 Automatic Power-On Reset Detection

The ICS1527 has automatic power-on reset detection (POR) circuitry and it resets itself if the supply voltage drops below threshold values. No external connection to a reset signal is required.

Integrated Circuit Systems, 525 Race Street, San Jose, CA 95126, tel (408) 297-1201 www.icst.com

1.4 I²C Bus Serial Interface

The ICS1527 uses a 5 volt tolerant, industry-standard I²C-bus serial interface that runs at either low-speed (100 kHz) or high-speed (400 kHz). The interface uses 12 word addresses for control and status: one write-only, eight read/write, and three read-only addresses.

Two ICS1527 devices can sit on the same I²C bus, each selected by the Master according to the state of the I2CADR pin. The 7 bit device address is 0100110 (binary) when I2CADR is low. The device address is 0100111 (binary) when I2CADR is high. See Section 4, “Programming”

Integrated Circuit Systems, 525 Race Street, San Jose, CA 95126, tel (408) 297-1201 www.icst.com

Section 2 Pin Descriptions

Table 2-1 ICS1527 Pin Descriptions

PIN NO.	PIN NAME	TYPE	DESCRIPTION	COMMENTS	Notes
1	VSSD	POWER	Digital ground		
2	SDA	IN/OUT	Serial data	I^2C-bus	1
3	SCL	IN	Serial clock	I^2C-bus	1
4	VSYNC	IN	Vertical sync		1 & 2
5	EXTFB	IN	External feedback	From External Divider	1 & 2
6	HSYNC	IN	Horizontal sync	Clock input to PLL	1 & 2
7	VDDA	POWER	Analog supply	Power for analog circuitry	
8	VSSA	POWER	Analog ground	Ground for analog circuitry	
9	I2CADR	IN	I^2C device address	Chip I^2C address select	
10	LOCK	LVCMOS OUT	Lock	PLL lock	
11	HSYNC_out	LVCMOS OUT	HSYNC output	Schmitt-trigger filtered HSYNC realigned with the output pixel clock	
12	CLK	LVCMOS OUT	Pixel clock output	LVCMOS driver for full-speed clock	
13	VDDQ	POWER	Output driver supply	Power for output drivers	
14	VSYNC_out	LVCMOS OUT	VSYNC output	Schmitt-trigger filtered VSYNC realigned with the output pixel clock	
15	VSSQ	POWER	Output driver ground	Ground for output drivers	
16	VDDD	POWER	Digital supply	Power for digital sections	

Notes: 1. These LVTTL inputs are 5 V tolerant.
2. Connect to ground if unused.

Integrated Circuit Systems, 525 Race Street, San Jose, CA 95126, tel (408) 297-1201 www.icst.com

Section 3 Register map summary

Word Address	Name	Access	Bit Name	Bit#	Reset Value	Description
00h	Input Control	R / W	CPen	0	1	Charge Pump Enable 0=External Enable via VSYNC, 1=Always Enabled
			VSYNC_Pol	1	0	VSYNC Polarity (Charge Pump Enable) Requires 00h:0=0 0=Coast (charge pump disabled) while VSYNC low, 1=Coast (charge pump disabled) while VSYNC high
			HSYNC_Pol	2	0	HSYNC Polarity 0=Rising Edge, 1=Falling Edge
			Fbk_Pol	3	0	External Feedback Polarity 0=Positive Edge, 1=Negative Edge
			Fbk_Sel	4	0	External Feedback Select 0=Internal Feedback, 1=External
			Reserved	5	0	Reserved
			EnPLS	6	1	Enable PLL Lock Status Output 0=Disable, 1=Enable
			Reserved	7	0	Reserved
01h	Loop Control*	R / W	ICP0-2	0-2		ICP (Charge Pump Current) Bit 2,1,0 = {000 =1 µA, 001 = 2 µA, 010 = 4 µA... 110 = 64 µA, 111 = 128 µA}. Increasing the PF Detector Gain makes the loop respond faster, raising the loop bandwidth. The typical value when using the internal loop filter is 011.
			Reserved	3		Reserved
			VCOD0-1	4-5		VCO Divider Bit 5,4= {00 = ÷2, 01=÷4, 10=÷8, 11=÷16}
			Reserved	6-7		Reserved
02h	FdBk Div 0*	R / W	FBD0-7	0-7		Feedback Divider LSBs (bits 0-7)
03h	FdBk Div 1*	R / W	FBD8-11	0-3		Feedback Divider MSBs (bits 8-11) Divider setting = 12 bit word + 8 Minimum 12 = 000000000100 Maximum 4103 =111111111111
			Reserved	4-7		Reserved
04h	Reserved		Reserved	0-7	0	Reserved
05h	Schmitt-trigger*	R / W	Schmitt control	0	1	Schmitt-trigger control 0=Schmitt-trigger, 1=No Schmitt-trigger
			Metal_Rev	1-7	0	Metal Mask Revision Number
06h	Output Enables	R / W	Reserved	0	0	Reserved
			OE	1	0	Output Enable for CLK, HSYNC_out, VSYNC_out 0=High Impedance (disabled), 1=Enabled
			Reserved	2-7	0	Reserved

Integrated Circuit Systems, 525 Race Street, San Jose, CA 95126, tel (408) 297-1201 www.icst.com

Word Address	Name	Access	Bit Name	Bit#	Reset Value	Description
07h	Reserved		Reserved	0-6		Reserved
			Reserved	7	0	Part requires a 0 for correct operation
08h	Reset	Write	Reserved	0-7	0	Writing 5Ah resets part and commits values written to word addresses 01h-03h and 05h
09-0Fh	Reserved	Read	Reserved	0-7		Reserved
10h	Chip Ver	Read	Reserved	0-7		Reserved
11h	Chip Rev	Read	Chip Rev	0-7	01	Reserved
12h	Rd_Reg	Read	Reserved	0	N/A	Reserved
			PLL_Lock	1	N/A	PLL Lock Status 0=Unlocked, 1=Locked
			Reserved	2-7	0	Reserved

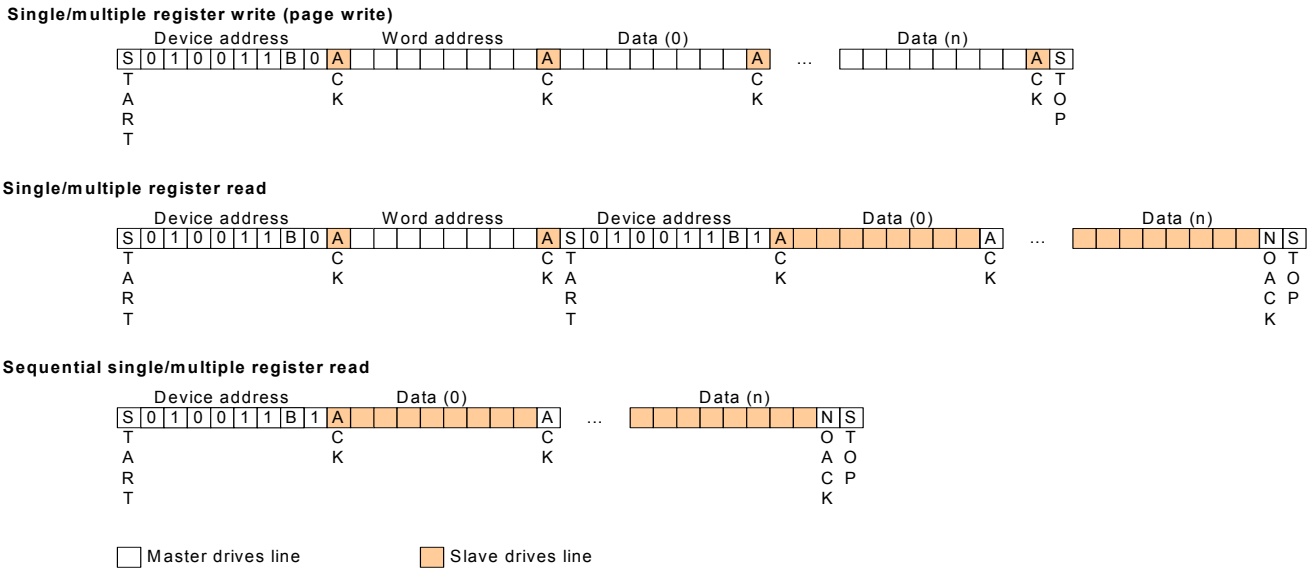
*. Written values to these registers do not take effect immediately, but require a commit via register 08h

Integrated Circuit Systems, 525 Race Street, San Jose, CA 95126, tel (408) 297-1201 www.icst.com

Section 4 Programming

4.1 Industry-Standard I²C Serial Bus: Data Format

Figure 4-1 ICS1527 Data Format for I²C 2-Wire Serial Bus



Notes:
The ICS1527 uses 16 byte pages (00h-0Fh is the first page, 10h-1Fh is the second page). Writing or reading beyond the end of page yields undefined results.

The ICS1527 has a device address of 010011B, where B is the state of the I2CADR pin.

Integrated Circuit Systems, 525 Race Street, San Jose, CA 95126, tel (408) 297-1201 www.icst.com

Section 5 AC/DC Operating Conditions

5.1 Absolute Maximum Ratings

Table 5-1 lists absolute maximum ratings for the ICS1527. Stresses above these ratings can cause permanent damage to the device. These ratings, which are standard values for ICS commercially rated parts, are stress ratings only. Functional operation of the ICS1527 at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods can affect product reliability. Electrical parameters are guaranteed only over the recommended operating temperature range.

Table 5-1 ICS1527 Absolute Maximum Ratings

Item	Rating
VDD, VDDA, VDDQ (measured to VSS)*	4.3 V
Digital Inputs	VSS –0.3 V to 5.5 V
Analog Inputs	VSS -0.3 V to 6.0 V
Analog Outputs	VSSA –0.3 V to VDDA +0.3 V
Digital Outputs	VSSQ –0.3 V to VDDQ +0.3 V
Storage Temperature	–65°C to +150°C
Junction Temperature	125°C
Soldering Temperature	260°C
ESD Susceptibility*	> 2 KV**

*. Measured with respect to VSS. During normal operations, the VDD supply voltage for the ICS1527 must remain within the recommended operating conditions.

**. Electrostatic-sensitive devices. Do not open or handle except in a static-free workstation.

Table 5-2 Environmental Conditions

Parameter	Min.	Typ.	Max.	Units
Ambient Operating Temperature	0	–	+70	° C
Power Supply Voltage	+3.0	+3.3	+3.6	V

Table 5-3 DC Characteristics

Parameter	Symbol	Conditions	Min.	Max.	UNITS
Digital Supply Current	IDDD	VDDD = 3.6 V	-	25	mA
Output Driver Supply Current	IDDQ	VDDD = 3.6 V No drivers enabled	-	6	mA
Analog Supply Current	IDDA	VDDA = 3.6 V	-	5	mA
Power consumption				300	mW
Power-On-Reset (POR) Threshold		VSS		1.8	V

Integrated Circuit Systems, 525 Race Street, San Jose, CA 95126, tel (408) 297-1201 www.icst.com

Table 5-4 AC Characteristics

Parameter	Symbol	Min.	Typical	Max.	Units	Notes
General						
VCO Frequency	f_{VCO}	50		400	MHz	
VCO Gain	K		165		MHz/V	
AC Inputs						
EXTFB Input Frequency	f_{EXTFB}	8		10,000	kHz	
EXTFB Input High Voltage	V_{IH}			2.0	V	
EXTFB Input Low Voltage	V_{IL}	1.0			V	
Analog Input (HSYNC/VSYNC)						
HSYNC Input Frequency	f_{HSYNC}	8		10,000	kHz	
VSYNC Input Frequency	f_{VSYNC}	30		120	Hz	
Input High Voltage	V_{IH}	1.7		5.5	V	
Input Low Voltage	V_{IL}	VSS - 0.3		1.1	V	
Input Hysteresis		0.2		0.8	V	Schmitt trigger active
SDA, SCL Digital Inputs						
Input High Voltage	V_{IH}	2		5.5	V	
Input Low Voltage	V_{IL}	VSS - 0.3		0.8	V	
I^2CADDR Digital Input						
Input High Voltage	V_{IH}	2		VDD+0.3	V	
Input Low Voltage	V_{IL}	VSS - 0.3		0.8	V	
SDA Digital Output						
SDA Output Low Voltage	V_{OL}			0.4	V	IOUT = 3 mA
SDA Output High Voltage	V_{OH}			6.0	V	Determined by external Rset resistor
LVCMOS Outputs (CLK, HSYNC_out, VSYNC_out, LOCK)						
Output Frequency, ICS1527-110GLF	F_s	2.5		110	MHz	VDDD = 3.3 V
Output Frequency, ICS1527-60GLF	F_s	2.5		60	MHz	VDDD = 3.3 V
Duty Cycle	S_{DC}	45	50	55	%	2
Jitter, STJ, RMS	STJ		0.027		ns	30 kHz input to 50 MHz output
Jitter, STJ, pk-pk	STJ		0.200		ns	
Jitter, Input-Output	IOJ		2.500		ns	HSYNC in to CLK out
Output Low Voltage	V_{OL}			0.4	V	IOUT = 4 mA
Output High Voltage	V_{OH}	2.4			V	IOUT = -4 mA
HSYNC to HSYNC_out propagation delay (without Schmitt-trigger)			2	9	ns	1

Integrated Circuit Systems, 525 Race Street, San Jose, CA 95126, tel (408) 297-1201 www.icst.com

Parameter	Symbol	Min.	Typical	Max.	Units	Notes
HSYNC to HSYNC_out propagation delay (with Schmitt-trigger)			6	10	ns	1
CLK to HSYNC_out/ VSYNC_out skew				1.0	ns	
Clock and HSYNC_out/VSYNC_out Transition Time - Rise	T_{CR}		1.0	1.5	ns	2
Clock and HSYNC_out/VSYNC_out Transition Time - Fall	T_{CF}		1.0	1.5	ns	2
LOCK Transition Time - Rise	T_{LR}			3.0	ns	2
LOCK Transition Time - Fall	T_{LF}			2.0	ns	2

Note 1—Measured between chosen edge of HSYNC (00h:2) and rising edge of output

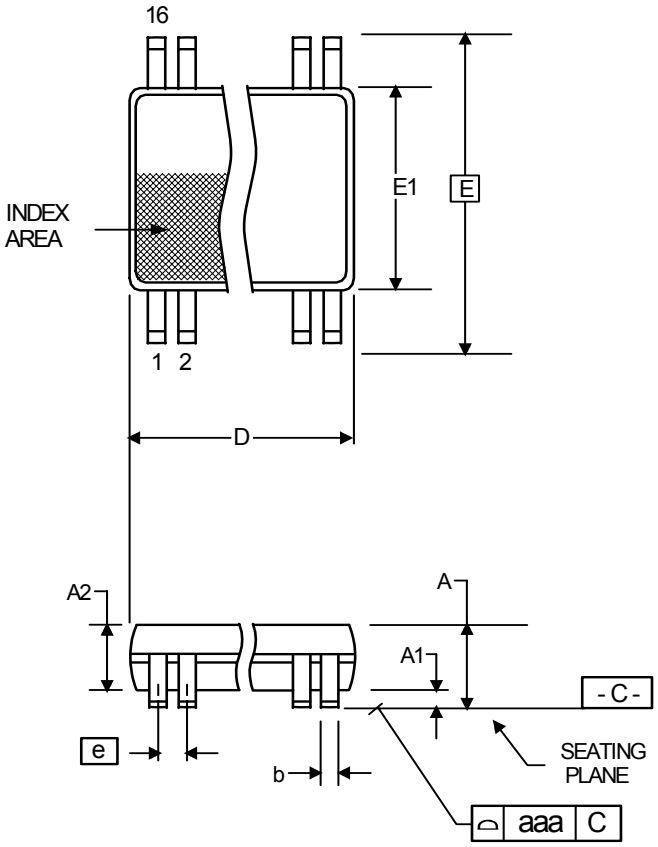
Note 2—Measured at 110 MHz, 3.3 VDC, 25^{o}C, 15 pF, unterminated

Integrated Circuit Systems, 525 Race Street, San Jose, CA 95126, tel (408) 297-1201 www.icst.com

Section 6 Package Outline and Package Dimensions

16-pin TSSOP 4.40 mm body, 0.65 mm pitch

Package dimensions are kept current with JEDEC Publication No. 95



	Millimeters		Inches	
Symbol	**Min**	**Max**	**Min**	**Max**
A	--	1.20	--	0.047
A1	0.05	0.15	0.002	0.006
A2	0.80	1.05	0.032	0.041
b	0.19	0.30	0.007	0.012
C	0.09	0.20	0.0035	0.008
D	4.90	5.1	0.193	0.201
E	6.40 BASIC		0.252 BASIC	
E1	4.30	4.50	0.169	0.177
e	0.65 Basic		0.0256 Basic	
L	0.45	0.75	0.018	0.030
α	0°	8°	0°	8°
aaa	--	0.10	--	0.004

Section 7 Ordering Information

Part / Order Number	Marking	Shipping packaging	Package	Temperature
ICS1527G-60LF	1527G2LF	Tubes	16-pin TSSOP	0 to +70° C
ICS1527G-60LFT	1527G2LF	Tape & Reel	16-pin TSSOP	0 to +70° C
ICS1527G-110LF	1527G1LF	Tubes	16-pin TSSOP	0 to +70° C
ICS1527G-110LFT	1527G1LF	Tape & Reel	16-pin TSSOP	0 to +70° C

While the information presented herein has been checked for both accuracy and reliability, Integrated Circuit Systems (ICS) assumes no responsibility for either its use or for the infringement of any patents or other rights of third parties, which would result from its use. No other circuits, patents, or licenses are implied. This product is intended for use in normal commercial applications. Any other applications such as those requiring extended temperature range, high reliability, or other extraordinary environmental requirements are not recommended without additional processing by ICS. ICS reserves the right to change any circuitry or specifications without notice. ICS does not authorize or warrant any ICS product for use in life support devices or critical medical instruments.