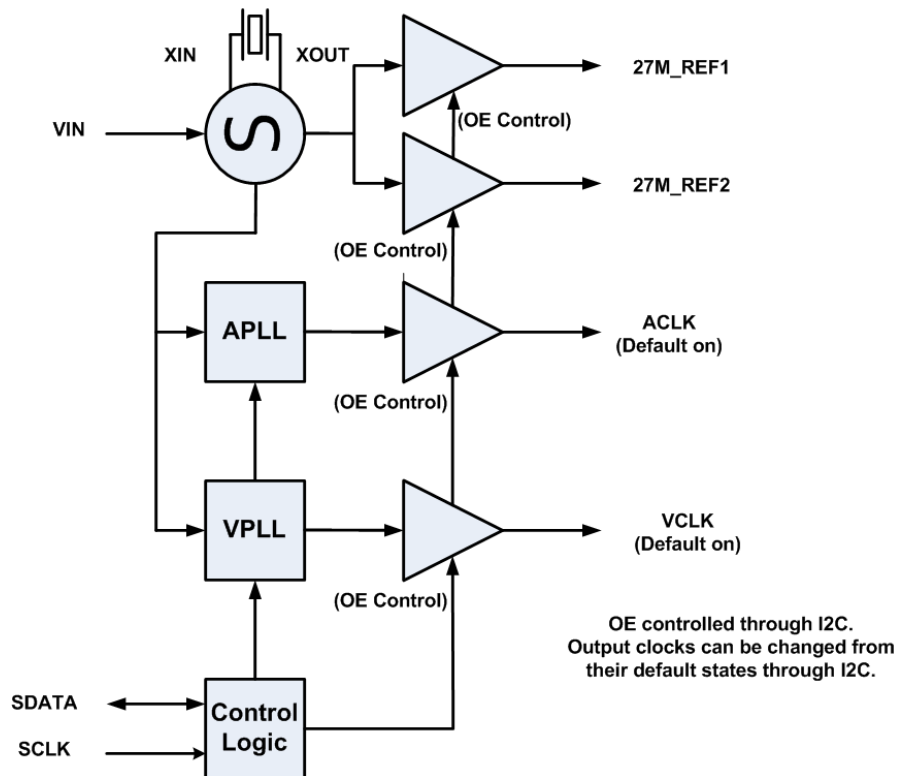


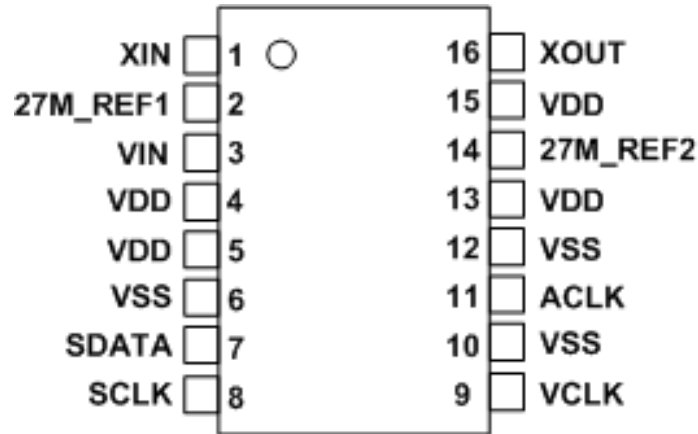
## Programmable Audio/Video CG with VCXO

Key Features	Description
<ul style="list-style-type: none"> <li>• Audio + video clock generation</li> <li>• Programmable on chip analog VCXO with typical pull range of +/-150ppm</li> <li>• VCXO control voltage, 0V to 3V</li> <li>• Uses 27MHz pullable crystal</li> <li>• 3.3V +/-10% power supply range</li> <li>• Available in both Commercial (0 to 70C) and Industrial (-40 to 85C) temperature grades</li> <li>• Low power dissipation and low jitter</li> <li>• Integrated internal voltage regulator</li> </ul>	<p>The SL38160AZC-17AH and SL38160AZC-23AH are programmable low power VCXO Clock Generators designed to enable clock recovery and to synthesize the audio and video clocks required for advanced multimedia applications. The product is designed using SpectraLinear proprietary programmable <b>EProClock™</b> technology to generate the output clocks.</p> <p>The product is offered in a space saving 16-pin TSSOP package.</p> <p>The two parts are identical except for IIC address, where the SL38160AZC-17AH uses D2(hex) while the SL38160AZC-23AH uses DA(hex).</p>
<p><b>Applications</b></p> <ul style="list-style-type: none"> <li>• HDTV &amp; SDTV</li> <li>• Wireless HDMI</li> <li>• Set Top Box</li> <li>• Media Center</li> <li>• DVR</li> </ul>	

### Block Diagram



**Pin Configuration**



**16-Pin TSSOP Package**

**Pin Description**

Pin Number	Pin Name	Pin Type	Pin Description
1	XIN	Input	Crystal oscillator input. Use fundamental parallel mode 27MHz crystal.
2	27M_REF1	Output	27 MHz reference clock output 1. (Default on) (Can be changed to off/synchronous stop, pulled low to VSS, through I2C)
3	VIN	Input	VCXO frequency control voltage
4, 5, 13, 15	VDD	Power	3.3V +/-10% Positive Power Supply.
6, 10,12	VSS	Power	Power supply ground for VDD.
7	SDATA	I/O	I2C Serial Data
8	SCLK	Input	I2C Clock
9	VCLK	Output	Video clock output. (Default on) (Can be changed to off/high impedance state through I2C)
11	ACLK	Output	Audio clock output .(Default on) (Can be changed to off/synchronous stop, pulled low to VSS, through I2C)
14	27M_REF2	Output	27 MHz reference clock output 2. (Default on) (Can be changed to off/synchronous stop, pulled low to VSS, through I2C)
16	XOUT	Output	Crystal oscillator output. Use fundamental parallel mode 27MHz crystal.

## Absolute Maximum Ratings

Description	Condition	Min	Max	Unit
Supply voltage, VDD		-0.5	4.2	V
All Inputs and Outputs		-0.5	VDD+0.5	V
Ambient Operating Temperature	In operation	0	70	°C
Ambient Operating Temperature	Industrial grade, in operation	-40	85	°C
Storage Temperature	No power is applied	-65	150	°C
Junction Temperature	In operation, power is applied	-	125	°C
Soldering Temperature		-	260	°C
ESD Rating (Human Body Model)	JEDEC22-A114D	-4,000	4,000	V
ESD Rating (Charge Device Model)	JEDEC22-C101C	-1,500	1,500	V
ESD Rating (Machine Model)	JEDEC22-A115D	-250	250	V
Moisture Sensitivity Level	JEDEC (J-STD-020)	1		

Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or other conditions beyond those indicated in the operational sections of the specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## DC Electrical Characteristics

Unless otherwise stated VDD= 3.3V+/-10%, VIN=1.65V, Output Load=15pF and Ambient Temperature range 0 to +70°C for Commercial or -40 to +85°C for Industrial temperature option.

Description	Symbol	Condition	Min	Typ	Max	Unit
Operating Voltage	VDD	3.3V +/-10%	2.97	3.3	3.63	V
Input High Voltage	VIH		0.7xVDD	-	-	V
Input Low Voltage	VIL		-	-	0.3xVDD	V
Output High Voltage	VOH	IOH=-6mA	VDD-0.5	-	-	V
Output Low Voltage	VOL	IOL=6mA	-	-	0.5	V
Operating Supply Current	IDD	Output load = 0pF	-	20	25	mA
VIN Input Impedance	VIN <sub>R</sub>		1	-	-	MΩ
Input Pull-Down/Up Resistor			-	250	-	KΩ

## AC Electrical Characteristics

Unless otherwise stated VDD= 3.3V+/-10%, VIN=1.65V, Output Load=15pF for f<200MHz, 5pF for f>200MHz and Ambient Temperature range 0 to +70°C for Commercial or -40 to +85°C for Industrial temperature option.

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Input Frequency Range	FIN	Crystal input	-	27	-	MHz
Output Rise Time	Tr	VCLK and ACLK, all frequencies	-	-	1.5	ns
Output Rise Time	Tr	27M_REF1,27M_REF2 clocks	-	-	2.0	ns
Output Fall Time	Tf	VCLK and ACLK, all frequencies	-	-	1.5	ns
Output Fall Time	Tf	27M_REF1,27M_REF2 clocks	-	-	2.0	ns
Output Duty Cycle	-	All outputs ,f≤100MHz	45	50	55	%
Output Duty Cycle	-	All outputs, f>100MHz	40	50	60	%
Output Frequency Synthesis Error	FOUT	All Frequencies except 193.16MHz, which has a +15ppm error	-	-	0	ppm
Cycle to Cycle Jitter	-	27M_REF1, 27M_REF2 outputs	-	160	250	ps
Cycle to Cycle Jitter	-	VCLK output	-	175	350	ps
Cycle to Cycle Jitter	-	ACLK output	-	150	250	ps
Long Term Jitter <sup>1</sup>	-	27M_REF1, 27M_REF2 outputs	-	85	120	ps-rms
Long Term Jitter <sup>1</sup>	-	VCLK output	-	250	700	ps-rms
Long Term Jitter <sup>1</sup>	-	ACLK output	-	550	950	ps-rms
Frequency Settling Time	-	Time before valid clock output after programming frequency via IIC	-	-	0.5	ms
Power-up Time	TPUP	Time from VDD minimum to valid frequency output	-	-	5.5	ms
VCXO Pull Range <sup>2</sup>	ΔF <sub>VCXO</sub>	Monotonic VCXO Crystal Pull Range	-	+/-150	-	ppm

## Recommended Crystal Specifications (for VCXO applications)<sup>2</sup>

Symbol	Description	Comments	Min	Typ	Max	Unit
F <sub>NOM</sub>	Nominal frequency	Fundamental mode	-	27	-	MHz
F <sub>DELTA25</sub>	Frequency tolerance at 25°C		-20	-	20	ppm
F <sub>DELTA</sub>	Temperature tolerance	0 to 70°C (reference to 25°C )	-20	-	20	ppm
CL <sub>NOM</sub>	Nominal load capacitance		-	14	-	pF
R1	Equivalent series resistance	Fundamental mode (CL=series)	-	20	50	Ω
DL	Drive level	Nominal VDD @25°C over +/-150ppm Pull range	-	-	500	uW
C0	Shunt capacitance		-	3.0	7.0	pF

<sup>1</sup> Measured with 1000 samples at 10us delay on oscilloscope

<sup>2</sup> KDS 1C727000CC1K crystal

C1	Motional capacitance		-	11.8	-	fF
C0/C1	Ratio of shunt to motional capacitance				250	
F3 <sub>SEPHI</sub>	Third overtone separation, high side	Mechanical third (High side of 3xFNOM)	240	-	-	ppm
F3 <sub>SEPLO</sub>	Third overtone separation, low side	Mechanical third (Low side of 3xFNOM)	-	-	-240	ppm

## Serial Data Interface

To enhance the flexibility and function of the device, an I2C compatible interface is provided. Through the Serial Data Interface, various device functions, such as ACLK and VCLK frequency setting and individual clock output buffers can be individually enabled or disabled. The registers associated with the Serial Data Interface initialize to their default setting at power-up. Clock device register changes can be made after the device power up initialization process has completed.

## Data Protocol

The clock driver serial protocol accepts byte write, byte read, block write, and block read operations from the controller. For block write/read operation, Access the bytes in sequential order from lowest to highest (most significant bit first) with the ability to stop after any complete byte is transferred. For byte write and byte read operations, the system controller can access individually indexed bytes. The offset of the indexed byte is encoded in the command code described in the command code definition section.

The block write and block read protocol is outlined in the block read and block write protocol section, while The byte read and byte write protocol section outlines byte read and byte write information.

The slave receiver address is 11010010 (D2h) for the SL38160AZC-17AH.

The slave receiver address is 11011010 (DAh) for the SL38160AZC-23AH.

### Command Code Definition

Bit	Description
7	0 = Block read or block write operation, 1 = Byte read or byte write operation
(6:0)	Byte offset for byte read or byte write operation. For block read or block operations, these bits should be '0000000'

### Block Read and Block Write Protocol

Block Write Protocol		Block Read Protocol	
Bit	Description	Bit	Description
1	Start	1	Start
8:2	Slave address-7bits	8:2	Slave address-7bits
9	Write	9	Write
10	Acknowledge from slave	10	Acknowledge from slave
18:11	Command Code-8bits	18:11	Command Code-8bits
19	Acknowledge from slave	19	Acknowledge from slave
27:20	Byte Count-8bits	20	Repeat start
28	Acknowledge from slave	27:21	Slave address-7bits
36:29	Data byte 1-8bits	28	Read = 1
37	Acknowledge from slave	29	Acknowledge from slave
45:38	Data byte 2-8bits	37:30	Byte Count from slave 8bits
46	Acknowledge from slave	38	Acknowledge
...	Data Byte/Slave Acknowledges	46:39	Data byte 1 from slave-8bits
...	Data Byte N-8bits	47	Acknowledge
...	Acknowledge from slave	55:48	Data byte 2 from slave-8bits
...	Stop	56	Acknowledge
		...	Data bytes from slave/Acknowledge
		...	Data Byte N from slave-8bits
		...	NOT Acknowledge
		...	Stop

## Byte Read and Byte Write Protocol

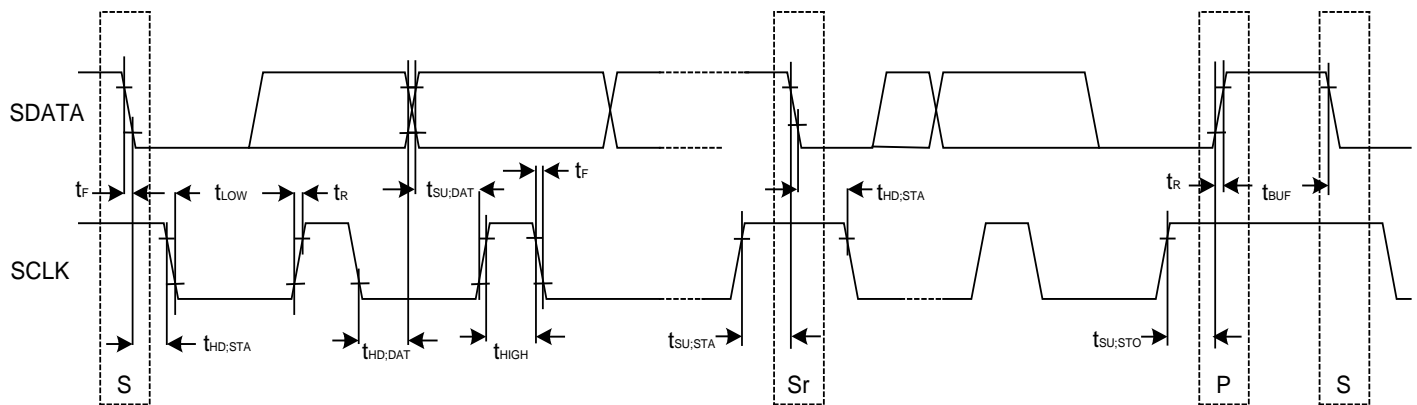
Byte Write Protocol		Byte Read Protocol	
Bit	Description	Bit	Description
1	Start	1	Start
8:2	Slave address-7bits	8:2	Slave address-7bits
9	Write	9	Write
10	Acknowledge from slave	10	Acknowledge from slave
18:11	Command Code-8bits	18:11	Command Code-8bits
19	Acknowledge from slave	19	Acknowledge from slave
27:20	Data byte-8bits	20	Repeat start
28	Acknowledge from slave	27:21	Slave address-7bits
29	Stop	28	Read
		29	Acknowledge from slave
		37:30	Byte Count from slave 8bits
		38	NOT Acknowledge
		39	Stop

**Note:** When writing to any register bytes between 32d to 63d (20h to 40h), an additional byte outside this range must be written to immediately afterward for proper loading to the register bytes within this range.

## I2C-bus Timing Specification

PARAMETER	SYMBOL	STANDARD-MODE		FAST-MODE		UNIT
		MIN.	MAX.	MIN.	MAX.	
SCL Clock Frequency	$f_{SCL}$	0	100	0	400	KHz
START hold time	$t_{HD,STA}$	4.0	-	0.6	-	us
SCLK LOW period	$t_{LOW}$	4.7	-	1.3	-	us
SCLK HIGH period	$t_{HIGH}$	4.0	-	0.6	-	us
START Set-up time	$t_{SU,DAT}$	4.7	-	0.6	-	us

PARAMETER	SYMBOL	STANDARD-MODE		FAST-MODE		UNIT
		MIN.	MAX.	MIN.	MAX.	
SDA set-up time	$t_{SU,DAT}$	250	-	100	-	ns
SDA/SCLK rise time	$t_R$	-	1000	-	300	ns
SDA/SCLK fall time	$t_F$	-	300	-	300	ns
STOP set-up time	$t_{SU,STO}$	4.0	-	0.6	-	ns
Bus free time	$t_{BUF}$	4.7	-	1.3	-	us





**Table 1. Audio Clock Frequency Settings (pin 11)**

Audio Clk (MHz)	Register Byte# DEC and Bit [7:0] HEX Setting				
	Byte 40	Byte 41	Byte 42	Byte 43	Byte129
8.1920	04	02	1F	18	81
11.2896	0C	45	DE	78	81
12.2880	04	01	F6	38	81
<b>24.5760<sup>3</sup></b>	<b>04</b>	<b>01</b>	<b>F5</b>	<b>18</b>	<b>81</b>
16.9344	09	33	E9	D8	81
18.4320	04	01	F5	78	81
36.8640	04	01	F4	B8	81
16.3840	08	03	85	D8	81
22.5792	0C	45	DD	38	81
49.1520	08	03	84	98	81
33.8688	06	21	F5	38	81
73.7280	04	01	F4	58	81

**Table 2. Digital Television Video Clock Frequency Settings (pin 9)**

Video Clk (MHz)	Register Byte# (DEC) and Bit [7:0] HEX, Setting								
	Byte17	Byte18	Byte19	Byte22	Byte48	Byte49	Byte 50	Byte51	Byte128
13.50000	07	80	AB	C6	04	00	7E	C7	34
27.00000	07	80	AB	C6	04	00	5E	C7	34
54.00000	07	80	AB	C6	04	00	4E	C7	34
<b>74.17582<sup>3</sup></b>	<b>05</b>	<b>80</b>	<b>AB</b>	<b>DE</b>	<b>1F</b>	<b>6D</b>	<b>86</b>	<b>C7</b>	<b>36</b>
74.25000	07	00	AB	C6	05	80	86	C7	34
148.35170	05	80	AB	DE	1F	6D	82	C7	36
148.50000	07	80	AB	C6	05	80	82	C7	34

<sup>3</sup> Default output frequency on power up

**Table 3. VGA Video Clock Settings (pin 9)<sup>4</sup>**

Screen Resolution	Refresh Rate (Hz)	Video Clock (MHz)	Register Byte# (DEC) and Bit [7:0] HEX, Setting											
			Byte 17	Byte 18	Byte 19	Byte 22	Byte 48	Byte 49	Byte 50	Byte 51	Byte 68	Byte 69	Byte 114	Byte 128
640 x 350	85	31.500	07	00	AB	C6	08	C0	D2	C7	03	83	3E	34
640 x 400	85	31.500	07	00	AB	C6	08	C0	D2	C7	03	83	3E	34
720 x 400	85	35.500	07	00	AB	C6	11	C1	90	C7	03	83	3E	34
	85.04	35.000	06	80	AB	C6	08	C0	D0	C7	03	83	3E	34
640 x 480	60	25.175	09	00	6B	86	FB	CF	22	C7	03	83	3E	34
	72	31.500	07	00	AB	C6	08	C0	D2	C7	03	83	3E	34
	75	31.500	07	00	AB	C6	08	C0	D2	C7	03	83	3E	34
	85	36.000	07	80	AB	66	03	00	50	C7	03	83	3E	34
800 x 600	56	38.100	05	80	AB	C6	1F	C2	52	C7	03	83	3E	34
	60	40.000	07	00	AB	C6	0A	00	D0	C7	03	83	3E	34
	72	50.000	05	80	AB	C6	19	02	4A	C7	03	83	3E	34
	75	49.500	07	00	AB	C6	05	80	8A	C7	03	83	3E	34
	85	56.250	07	80	AB	C6	06	40	8A	C7	03	83	3E	34
1024 x 768	43	44.900	05	00	AB	C6	70	46	D2	C7	03	83	3E	34
	60	65.000	05	80	AB	C6	20	82	4A	C7	03	83	3E	34
	70	75.000	07	00	AB	C6	0C	80	CA	C7	03	83	3E	34
	75	78.750	07	00	AB	C6	08	C0	C6	C7	03	83	3E	34
	85	94.500	0B	80	AB	C6	03	80	46	C7	03	83	3E	34
1152 x 864	75	108.000	0B	80	AB	C6	03	00	44	C7	03	83	3E	34
1280x768	60	68.250	06	80	6B	C6	16	C1	8A	C7	03	83	3E	34
	60	79.500	06	80	6B	C6	1A	82	46	C7	03	83	3E	34
	75	102.200	05	00	AB	C6	7F	CB	44	C7	03	83	3E	34
	85	117.500	06	00	6B	C6	3A	C4	84	C7	03	83	3E	34
1360 x 768	60	85.500	06	80	AB	C6	09	80	C6	C7	03	83	3E	34
1280 x 960	60	108.000	0B	80	AB	C6	03	00	44	C7	03	83	3E	34
	85	148.500	07	00	AB	C6	05	80	82	C7	03	83	3E	34
1280x1024	60	108.000	0B	80	AB	C6	03	00	44	C7	03	83	3E	34
	75	135.000	07	80	AB	C6	03	C0	44	C7	03	83	3E	34
	85	157.500	06	80	AB	C6	08	C0	C2	C7	03	83	3E	34
1400x1050	60	101.000	06	80	6B	C6	19	42	44	C7	03	83	3E	34
	60	121.750	05	00	6B	C6	79	C6	C6	C7	03	83	3E	34
	75	156.000	07	00	6B	C6	0D	00	C4	C7	03	83	3E	34
	85	179.500	06	00	6B	C6	59	C6	C2	C7	03	83	3E	34
1600x1200	60	162.000	07	80	AB	C6	03	00	42	C7	03	83	3E	34
	65	175.500	07	80	AB	C6	03	40	42	C7	03	83	3E	34
	70	189.000	07	80	AB	C6	03	80	42	C7	03	83	3E	34
	75	202.500	07	80	AB	C6	03	C0	42	C7	03	83	3E	34
	85	229.500	07	80	AB	C6	04	40	42	C7	03	83	3E	34

<sup>4</sup> Pin 9 is the video output clock used for both the Digital Television and VGA Video frequency settings



# SL38160-17AH

# SL38160-23AH

Screen Resolution	Refresh Rate (Hz)	Video Clock (MHz)	Register Byte# (DEC) and Bit [7:0] HEX, Setting											
			Byte 17	Byte 18	Byte 19	Byte 22	Byte 48	Byte 49	Byte 50	Byte 51	Byte 68	Byte 69	Byte 114	Byte 128
1920x1080i	50	72.000	07	80	AB	C6	04	00	4A	C7	03	83	3E	34
1920x1200 <sup>5</sup>	60	154.000	06	00	6B	C6	26	82	44	C7	03	83	3E	34
	60	193.160	05	80	AB	DE	32	F8	C2	C7	03	83	3E	36
	60	193.250	05	00	AB	C6	C1	4D	82	C7	03	83	3E	34
	75	245.250	06	80	6B	C6	1B	41	82	C7	03	83	3E	34
	85	281.250	06	80	6B	C6	1F	43	00	C7	0F	C3	BE	34
1792x 1344	60	204.750	31	00	AB	C6	16	C1	82	C7	03	83	3E	34
	75	261.000	07	00	AB	C6	07	40	C0	C7	0F	C3	BE	34
1856x1392	60	218.250	31	00	AB	C6	18	41	82	C7	03	83	3E	34
	75	288.000	07	00	AB	C6	08	00	C0	C7	0F	C3	BE	34
1920x 1440	60	234.000	31	80	AB	C6	0D	00	C2	C7	03	83	3E	34
	75	297.000	07	00	AB	C6	05	80	80	C7	0F	C3	BE	34

<sup>5</sup> 15ppm synthesis error

**Table 4. Output Control**

Output	Byte to change	Enable	Disable
REF-1	64d	04h <sup>6</sup>	08h
VCLK	117d	00h <sup>6</sup>	04h
ACLK	86d	04h <sup>6</sup>	08h
REF-2	96d	04h <sup>6</sup>	08h

**Table 5. Power Down Control**

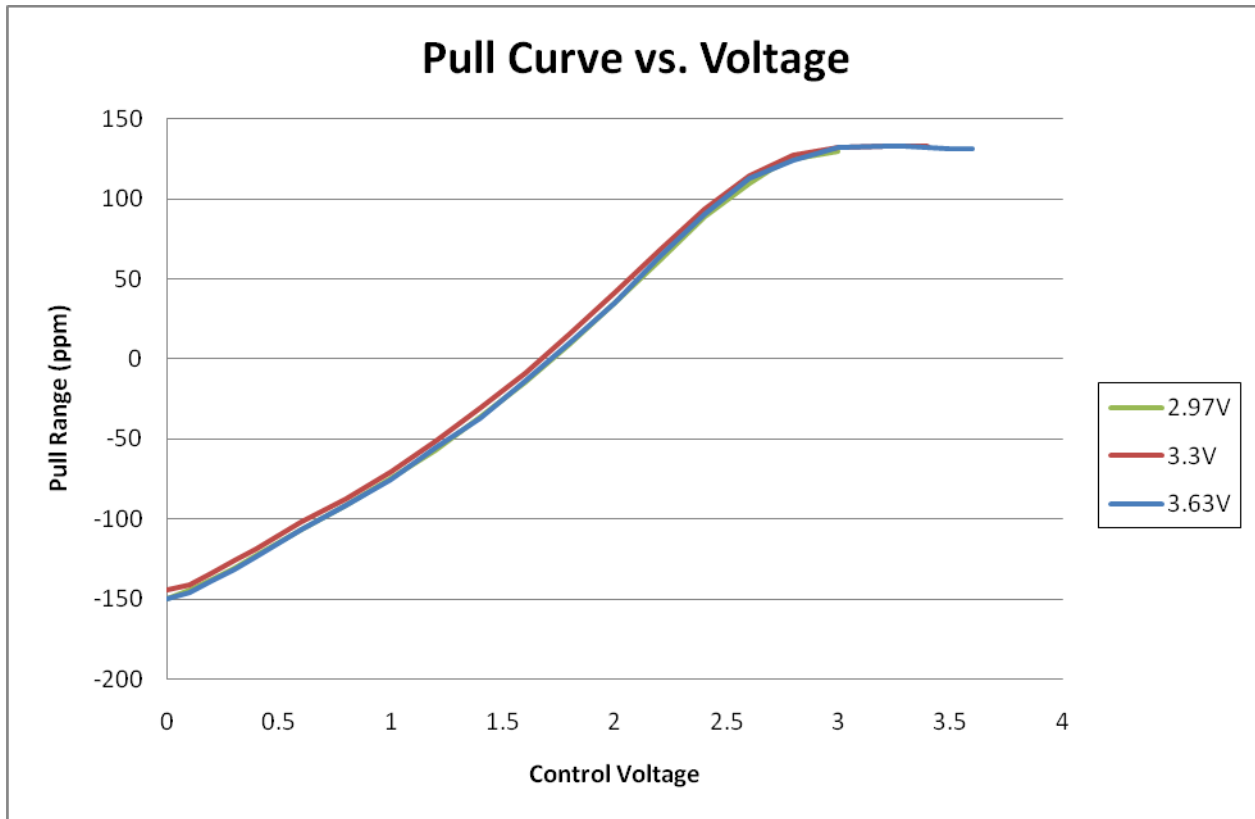
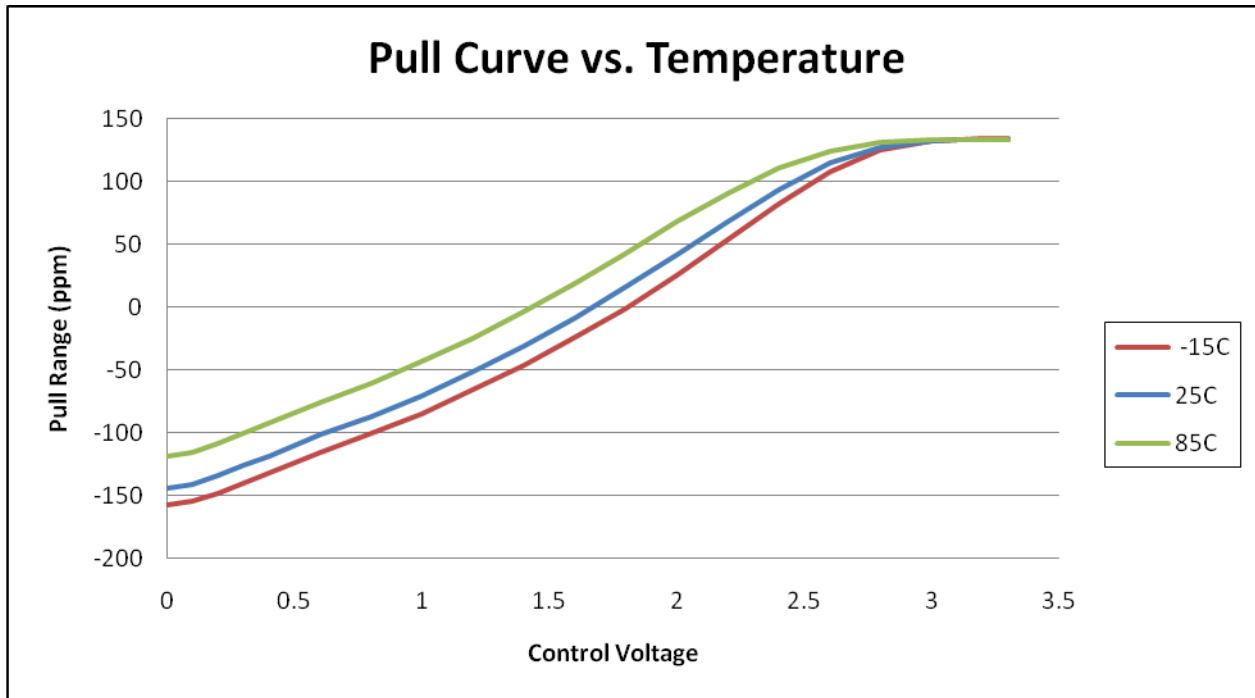
Byte to change	Active Mode	Powerdown Mode
29d	16h <sup>6</sup>	36h

**Table 6. Additional Bytes to Program**

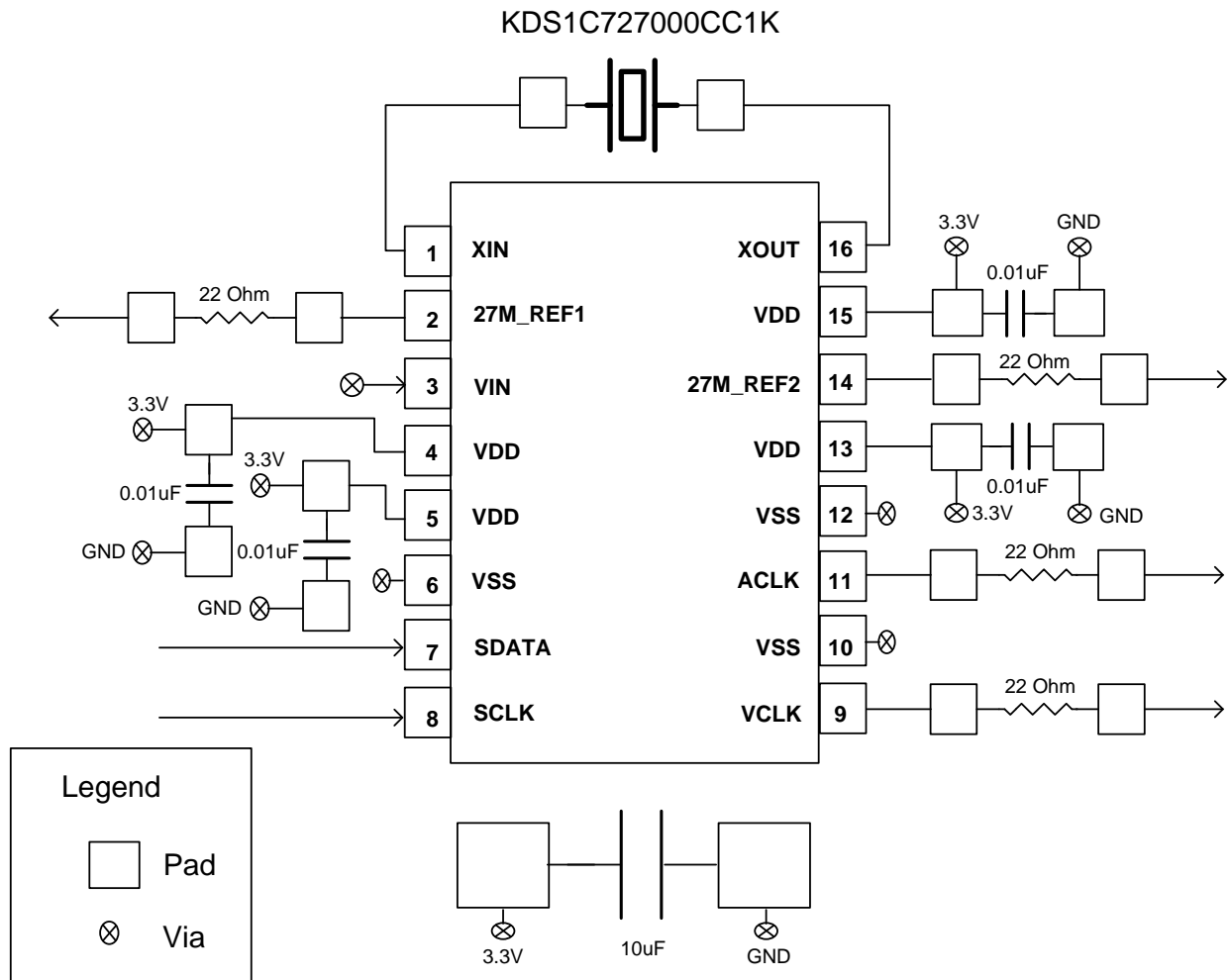
Byte to change	Value
126d	26h
130d	53h

Note: these bytes should be programmed once after device power up.

<sup>6</sup> Default condition



**Typical Application Circuit**

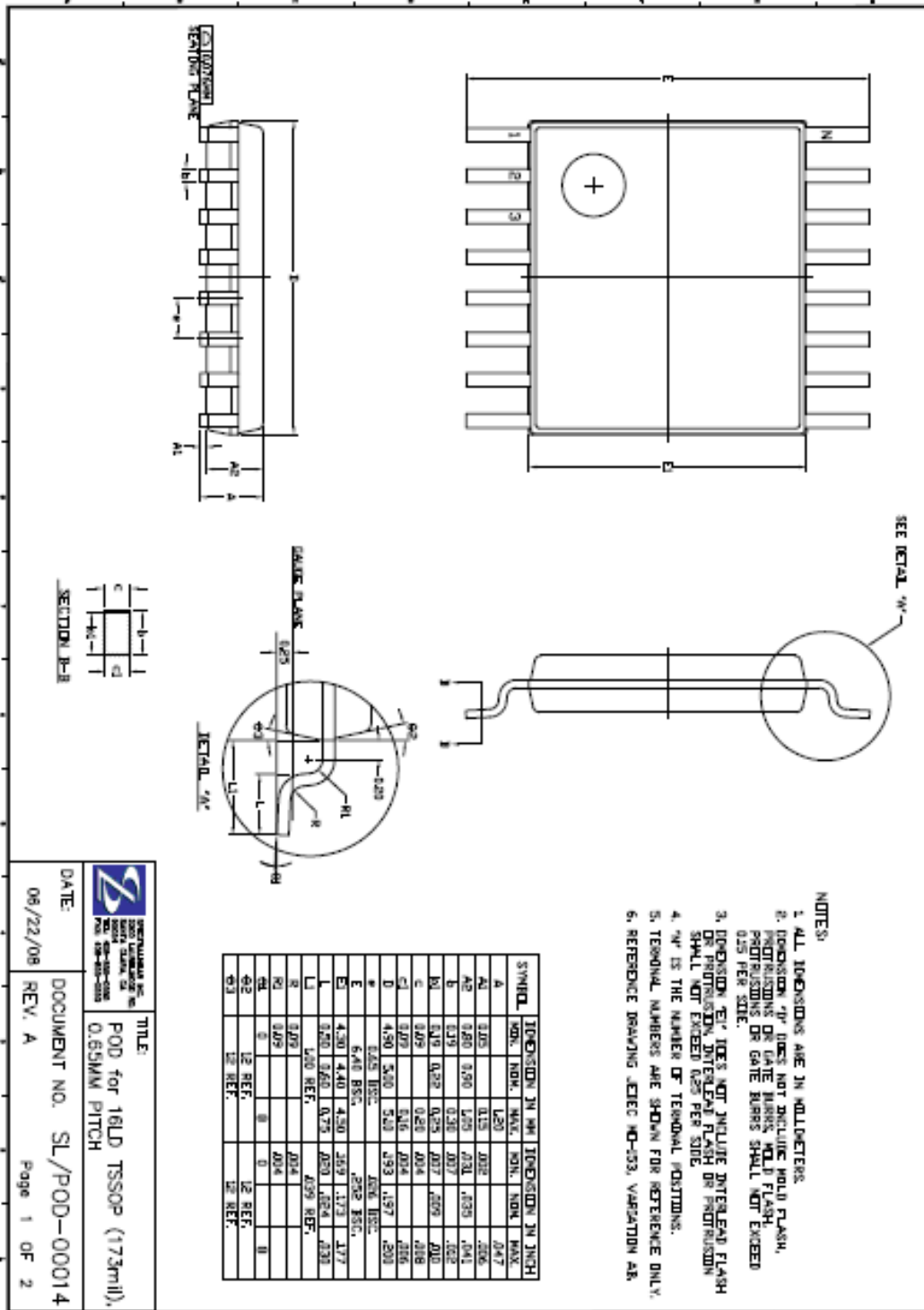


**General Guidelines:**

1. Place crystal on same side of the board.
2. Place 0.01 $\mu$ F capacitors as close as possible to the power pin.
3. Install one bulk capacitor (10 $\mu$ F). Note that this filtered power should connect to the 0.01 $\mu$ F capacitor pads first. This is known as pin-cap-via.
4. The 22 Ohm series resistors placed on clock outputs are board dependent. This is a nominal value for 50 Ohm impedance boards. Never share ground vias.
5. It is preferable to have a ground flood directly underneath the part.
6. If PCB process takes advantage of via-in-pad technology, then it is recommended that the ground side of all bypass capacitors have the GND via placed inside the pad to lower inductance to ground.

### Package Outline and Package Dimensions

16-Pin TSSOP Package (4.4mm)



## Thermal Characteristics

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Thermal Resistance Junction to Ambient	$\theta_{JA}$	Still air	-	<b>80</b>	-	°C/W
	$\theta_{JA}$	1m/s air flow	-	<b>70</b>	-	°C/W
	$\theta_{JA}$	3m/s air flow	-	<b>68</b>	-	°C/W
Thermal Resistance Junction to Case	$\theta_{JC}$	Independent of air flow	-	<b>36</b>	-	°C/W

## Ordering Information

Ordering Number	Marking	Shipping Package	Package	Temperature
SL38160AZC-17AH	SL38160AZC-17AH	Tube	16-pin TSSOP	0 to 70°C
SL38160AZC-17AHT	SL38160AZC-17AH	Tape and Reel	16-pin TSSOP	0 to 70°C
SL38160AZC-23AH	SL38160AZC-23AH	Tube	16-pin TSSOP	0 to 70°C
SL38160AZC-23AHT	SL38160AZC-23AH	Tape and Reel	16-pin TSSOP	0 to 70°C
SL38160AZI-17AH	SL38160AZI-17AH	Tube	16-pin TSSOP	-40 to 85°C
SL38160AZI-17AHT	SL38160AZI-17AH	Tape and Reel	16-pin TSSOP	-40 to 85°C
SL38160AZI-23AH	SL38160AZI-23AH	Tube	16-pin TSSOP	-40 to 85°C
SL38160AZI-23AHT	SL38160AZI-23AH	Tape and Reel	16-pin TSSOP	-40 to 85°C

Notes:

1. All SLI products are RoHS compliant.

## Document History Page

REV.	Issue Date	Originator	Description of change
A.1.0	7/8/10	D. Christenberry	Create initial datasheet as advance information.
B.1.0	9/2/10	D. Christenberry	Final datasheet
B. 1.1	10/5/10	D. Christenberry	New frequency support added per customer, also updated package drawing
B.1.2	10/14/10	D. Christenberry	Updated cy-cy jitter specifications
AA	10/28/10	D. Christenberry	Release version. Added additional bytes, 5pF load condition for f>200Mz
AB	1/16/11	D. Christenberry	Added Industrial temperature operation

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