

Zenith®

Single-Axis HP Accelerometer

Technical Datasheet - Preliminary



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1 General Description

Zenith® is a new precision acceleration sensor from Silicon Sensing. This single-axis digital accelerometer was developed specifically for applications demanding benchmark bias stability and low noise. It comprises a single-axis MEMS sensor assembly with a dedicated closed-loop control ASIC in the same surface mount package as its established stablemates Gemini® and CMS300. Sensor data is output via a digital SPI® interface.

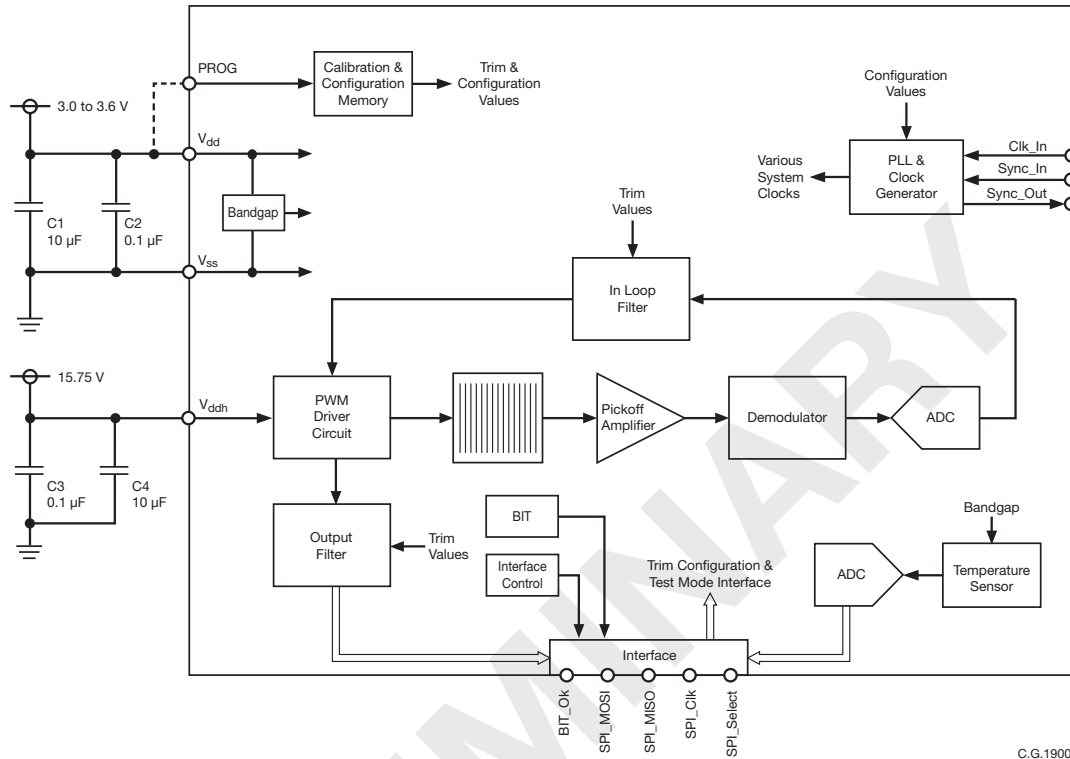
Zenith® is supplied in the 'flat package' configuration providing a single in-plane axis of linear acceleration sensing within a ± 14 g dynamic range. The package is a PCBA surface mountable standard ceramic LCC device, which is hermetically sealed providing full environmental protection.

Precise in plane linear acceleration sensing is achieved by a Silicon MEMS detector formed by a sprung mass acting as a moving plate of variable capacitance created by an array of interlaced 'fingers'. This structure also provides critical damping to prevent resonant gain. Applied linear acceleration results in a change of capacitance which is measured by demodulation of the square wave excitation and then fed through a closed loop control circuit to instantaneously restore the proof mass to its null position, the magnitude of the restoration drive being proportional to the applied linear acceleration. The closed loop feedback ensures very high linearity across the full operational dynamic range and low vibration rectification error.

Features

- Small (10.4 x 6.0 x 2.2 mm)
- Typical velocity random walk (0.003 m/s/√hr †)
- High resolution (330000 LSB/g)
- Bias instability (2.5 μg_{rms} †)
- In-plane and orthogonal sensing options (CAS150 and CAS170)
- High linearity over dynamic range (< 300 ppm)
- Vibration rectification error ($< 70 \mu\text{g}/\text{g}^2$ typical)
- Single-axis MEMS accelerometer in a hermetically sealed ceramic LCC surface mount package for temperature and humidity resistance
- Dynamic range $> \pm 14$ g
- Digital (SPI®) output of linear acceleration and temperature
- Wide bandwidth (> 400 Hz, 425 Hz typical)
- Temperature range (full performance) -40 to +105 °C
Temperature range (operational) -50 to +125 °C
- Integral temperature sensor
- RoHS compliant

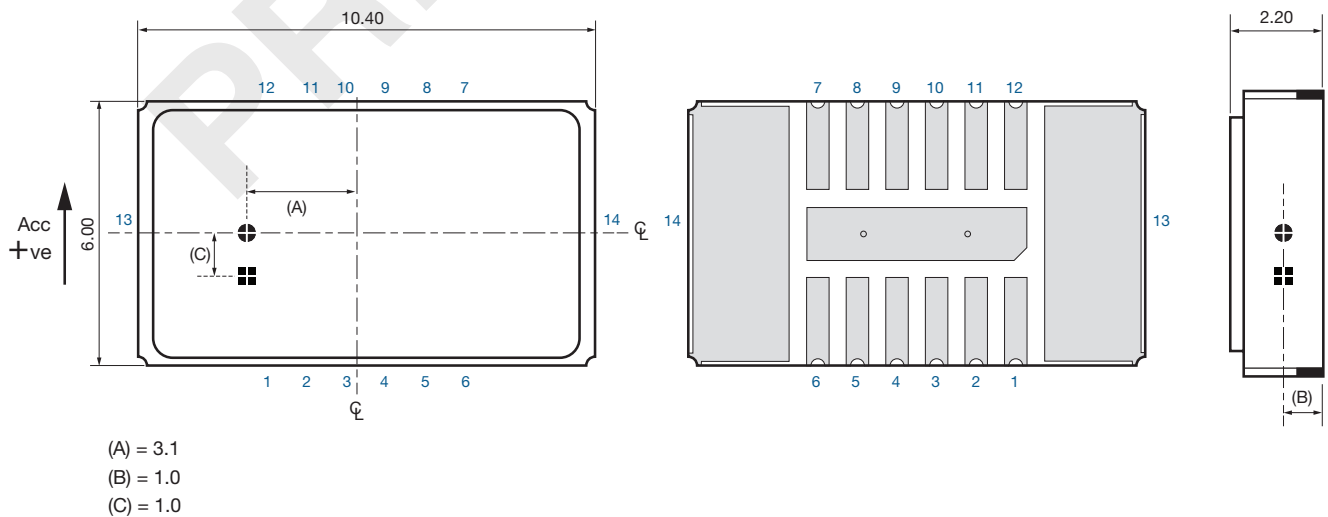
† TBC



C.G.19009

Figure 1.1 Functional Block Diagram

CAS150 Accelerometer Proof Mass C of G 
 CAS150 Inertial Reference Frame 
 (Centre of active MEMS)



C.G.19003

Figure 1.2 CAS150 Overall Dimensions

2 Ordering Information

Part Number	Sense Axes	Description	Measurement Range	Mode	Overall Dimensions	Supply Voltage
					mm	V
CAS150		Single-axis, linear accelerometer	±14 g	Digital SPI®	10.4x6.0x2.2H	V _{DD} 3.15 - 3.45 V _{HT} 15.75 ± 0.15
CAS150-EVB	TBD	Evaluation Boards for the CAS150 parts (includes the sensor)	±14 g		34x26	V _{DD} 3.15 - 3.45

3 Specification

The following performance is achieved by CAS150 operating in the EVB reference circuit defined in this datasheet. Unless stated otherwise the following specification applies across an operating temperature range -40 °C to +105 °C. Full stated performance under extended thermal conditions.

Parameter	Minimum	Typical	Maximum	Notes
Dynamic range	±14 g	-	-	-
Scale factor	-	330000 LSB/g	-	24-bit signed number
Scale factor @ +20 °C	-0.74 %	-	+0.74 %	Error from nominal scale factor at +20 °C, after EOLT calibration (post scale factor trim)
Scale factor over temperature (uncompensated)	-	+1.3 % / -0.8 %	-	Variation from ambient without thermal compensation
Scale factor linearity error	-	±120 ppm	±300 ppm	Error from BFSL over ((+g) to (-g)) full scale range (FSR) (14 g)
Scale factor asymmetry	-	±510 ppm †	±1000 ppm †	Difference between BFSL fit of 0 to +g and BFSL fit of 0 to -g
Scale factor repeatability over temperature	-	±120 ppm	±300 ppm	Residual error, post thermal compensation/modelling
Scale factor switch-on to switch-on repeatability over temperature	-	±180 ppm	±350 ppm	Repeatability between successive power cycles
Scale factor repeatability over shock and vibration	-	±120 ppm †	±300 ppm †	Repeatability over exposure to shocks up to 1000 g and vibration up to 10 g powered and unpowered
Scale factor stability (1 year)	-	±200 ppm †	±500 ppm †	1 year life (powered operation)

Specification Continued

Parameter	Minimum	Typical	Maximum	Notes
Scale factor stability over lifetime (12 years)	-	± 250 ppm [†]	± 700 ppm [†]	12 year life (unpowered operation, long term exposure to storage conditions)
Initial bias @ +20 °C	-360 mg	-	+360 mg	See Note 1
Bias over temperature (uncompensated)	-	± 0.15 mg/°C	± 0.34 mg/°C	Without Thermal Compensation/Modelling
Warm-up bias	-	± 0.6 mg [†]	± 1.7 mg [†]	The maximum change in uncompensated bias in the 3 hour duration after sensor is switched on across hot, cold and ambient temperatures
Bias repeatability over temperature	-	± 1.6 mg	± 3 mg	The bias repeatability over temperature is calculated as the range in the residual error, post thermal compensation/modelling
Bias switch-on to switch-on repeatability	-	+0.08 mg over temp	+0.5 mg over temp	Repeatability between successive power cycles
Bias repeatability over shock and vibration	-	± 0.5 mg [†]	± 1.5 mg [†]	Repeatability after exposure to shocks up to 1000 g and vibration up to 10 g powered and unpowered
Bias stability (1 year)	-	± 0.9 mg (1 σ)	± 2.1 mg	1 year life (powered operation)
Bias instability	-	2.5 μ g _{rms} [†]	5 μ g _{rms} [†]	At static temperature. Minimum on the Allan Variance curve
RMS noise	-	1.3 mg _{rms} [†]	1.8 mg _{rms} [†]	For a -3 dB sensor bandwidth of 450 Hz
Mean Noise Power Spectral Density (PSD) (0-100 Hz)	-	10 μ g $\sqrt{\text{Hz}}$ [†]	-	See Figures 5.6 and 5.7
Mean Noise Power Spectral Density (PSD) (0-200 Hz)	-	25 μ g $\sqrt{\text{Hz}}$ [†]	-	See Figures 5.6 and 5.7
Mean Noise Power Spectral Density (PSD) (20 - 2kHz)	-	TBC	-	-

Specification Continued

Parameter	Minimum	Typical	Maximum	Notes
VRW	-	0.003 m/s/ $\sqrt{\text{hr}}$ †	0.005 m/s/ $\sqrt{\text{hr}}$ †	-1/2 slope on the Allan Variance (deviation) plot or the tangent (-1/2 slope) to the Allan Variance curve projected back to 1 second correlation time multiplied by 60
VRE	-	70 $\mu\text{g/g}^2$	100 $\mu\text{g/g}^2$	At 8 g_{rms} input vibration (flat random, 20 Hz - 2 kHz)
Bandwidth (-3 dB)	400 Hz	425 Hz	-	Output
Gain peak	-	1.5 dB	2 dB	Output gain peak
Recovery time	-	-	20 ms †	Recovery time from saturation, see Note 2
Temperature Sensor:				
Scale factor	-	142 LSB/°C	-	-
Offset	-	42706 LSB	-	At +20 °C
Start-Up:				
Start-up time	-	20 ms	75 ms	Availability of first SPI® message
Settling time	100 ms	150 ms	250 ms	Full performance
Recovery time	-	-	20 ms	Recovery time from saturation, see Note 2
Physical:				
Mass	-	0.4 g	-	-
Misalignment	-20 mrad	-	+20 mrad	-
Misalignment stability	-0.6 mrad	-	+0.6 mrad	Change over temperature
Electrical:				
V _{dd}	3.15 V	3.3 V	3.45 V	-
V _{HT}	15.70 V	15.75 V	15.80 V	-
I _{dd}	7 mA	10 mA	15 mA	Maximum includes start-up current
I _{HT}	1.5 mA	1.75 mA	2 mA	

Note 1: Maximum initial bias error at +20 °C.

Note 2: The performance specified is valid up to ± 14 g. Indicative acceleration data is provided above this limit.

† TBC

4 CAS150 Absolute Minimum / Maximum Ratings

	Minimum	Maximum
Electrical:		
V _{dd}	-0.3 V	+4.0 V
V _{HT}	-0.3 V	+40 V
V _{dd} and V _{HT} power supply ripple requirements	<1.5 mV _{rms} in the frequency range 10 Hz to 400 MHz	
ESD Protection:		
HBM	-	2 kV
Environmental:		
Temperature (operating)	-40 °C -50 °C (extended range)	+105 °C +125 °C (extended range)
Temperature (storage)	-55 °C	+150 °C
Humidity	-	95 % RH non-condensing
Shock (operating)	-	1000 g 1 ms 1/2 sine
Vibration (operating)	-	8 g _{rms} (20 Hz to 2 kHz)
Vibration (non-operating)	-	14 g _{rms} (20 Hz to 2 kHz) †
Life:		
Unpowered	15 yrs	-
Powered	12000 hrs	-
MTTF (MIL-HDBK-217F)	800000 hrs	-

Note 3: Exposure to the Absolute Maximum Ratings for extended periods may affect performance and reliability.

Note 4: The device will operate during the extended temperature range, however, performance within the extended range is not guaranteed.

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5 Typical Performance Characteristics - TBC

PRELIMINARY

6 Glossary of Terms

ACC	Accelerometer	PLL	Phase Locked Loop
ADC	Analogue to Digital Converter	PROG	Program
AHRS	Attitude and Heading Reference System	PWM	Pulse Width Modulation
ASIC	Application Specific Integrated Circuit	PWMH	Pulse Width Modulation High
BIT	Built-In Test	PWML	Pulse Width Modulation Low
BFSL	Best Fit Straight Line	RH	Relative Humidity
CDM	Charged Device Model	RoHS	Restriction of Hazardous Substances
Clk	Clock	RMS	Root Mean Square
CMOS	Complementary Metal Oxide Semiconductor	SOG	Silicon On Glass
CofG	Centre of Gravity	SPI®	Serial Peripheral Interface A registered trademark of Motorola, Inc.
CRC	Cyclic Redundancy Check	SSSL	Silicon Sensing Systems Limited
DRIE	Deep Reactive Ion Etch	TBC	To Be Confirmed
EOLT	End Of Line Test	TC	Time Constant
ESD	Electrostatic Discharge	VRE	Vibration Rectification Error
EVB	Evaluation Board	VRW	Vibration Random Walk
FSR	Full Scale Range		
HBM	Human Body Model		
HP	High Performance		
I/P	Input		
JEDEC	Joint Electron Device Engineering Council		
LCC	Leadless Chip Carrier		
LSB	Least Significant Bit/Byte		
MEMS	Micro-Electro Mechanical Systems		
MISO	Master In Slave Out		
MM	Machine Model		
MOSI	Master Out Slave In		
MSB	Most Significant Bit/Byte		
MTTF	Mean Time To Failure		
NEC	Not Electrically Connected (Do Not Connect)		
O/P	Output		
OTP	One Time Programmable		
PCBA	Printed Circuit Board Assembly		

7 Interface

Physical and electrical inter-connect information.

7.1 Physical and Electrical Interface, Pad Layout and Pinouts

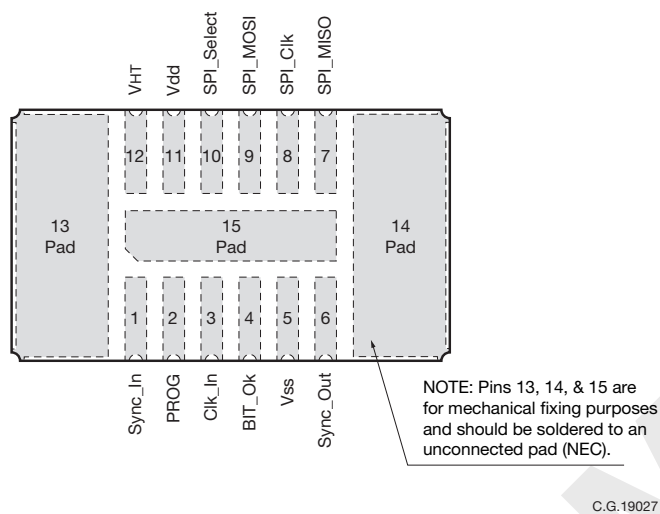


Figure 7.1 Pinout (Top View)

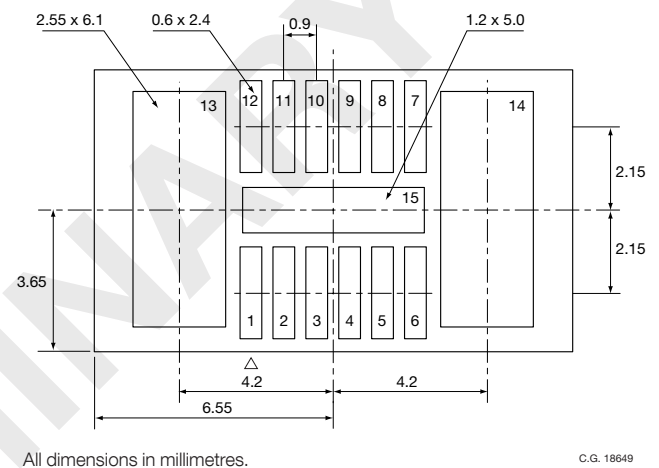


Figure 7.2 Recommended Pad Layout

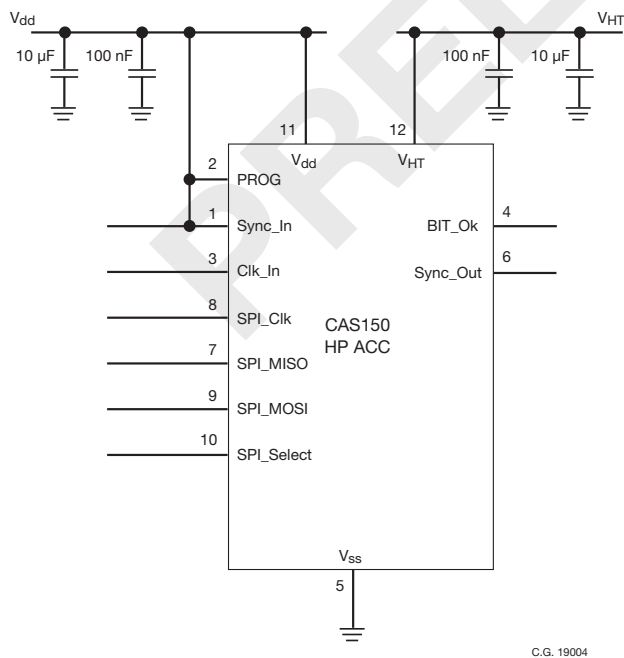


Figure 7.3 Recommended Circuit

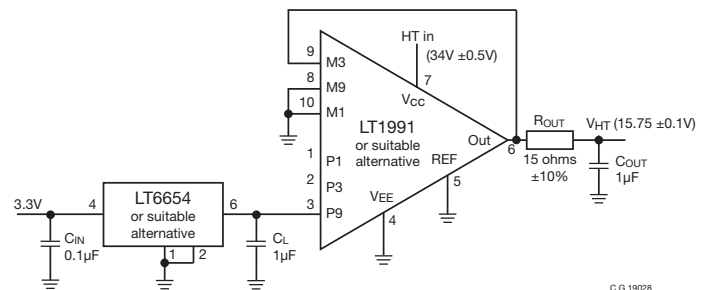


Figure 7.4 Recommended HT Supply

Pin Number	Pin Name	Signal Direction	Pin Function
1	Sync_In	Input	CMOS logic (with pull-up) used in the sensor start-up routine to synchronise the internal 48 kHz frame signal, used to time the internal data processing. If synchronisation is not required, then Sync_In shall be left open circuit (there is an internal pull-up) or tied to V_{dd} .
2	PROG	Input	Internal memory programming voltage. For normal operation leave disconnected or connect to V_{dd} .
3	Clk_In	Input	CMOS logic clock input for internal PLL. Nominally 12 MHz.
4	BIT_Ok	Output	CMOS logic indicating continuous built-in test status.
5	V_{ss}	-	Return connection for applied power (0 V).
6	Sync_Out	Output	CMOS logic. Can be used to synchronise other CAS150s.
7	SPI_MISO	Output	CMOS logic SPI® output data. Only enabled when SPI_Select is low. Tri-stated when SPI_Select is high.
8	SPI_Clk	Input	CMOS logic SPI® clock. 1.0 MHz to 12 MHz.
9	SPI_MOSI	Input	CMOS logic SPI® input data.
10	SPI_Select	Input	CMOS logic SPI® output data.
11	V_{dd}	-	Positive low voltage power supply to the sensor. Range from 2.7 V to 3.6 V. Should be decoupled with a 100 nF X7R dielectric ceramic capacitor and a 10 μ F bulk storage capacitor placed close to the device pin.
12	V_{HT}	-	Positive high voltage power supply to the sensor, 15.75 V. Should be decoupled with a 100 nF X7R dielectric ceramic capacitor and a 10 μ F bulk storage capacitor placed close to the device pin.
Centre and Side Pads (13, 14 & 15)	NEC	-	Not Electrically Connected. These pins provide additional mechanical fixing to the Host System and should be soldered to an unconnected pad.

Table 7.1 Input / Output Pin Definitions

Parameter	Minimum	Maximum	Units
Supply (Note 5, 6)			
Supply voltage (functional) (V_{dd})	2.7	3.6	V
Supply voltage (full specification) (V_{dd})	3.15	3.45	V
Supply voltage limits (V_{dd})	-0.3	4.0	V
Supply current (V_{dd})	-	15.0	mA
Supply voltage (functional) (V_{HT})	15.75 $\pm$ 0.15		V
Supply voltage limits (V_{HT})	-0.3	40	V
Supply current (V_{HT})	-	2.0	mA
Discretes/SPI®			
Input voltage low	-0.5	$0.3 \times V_{dd}$	V
Input voltage high	$0.7 \times V_{dd}$	$V_{dd} + 0.5$	V
Output voltage low	-	0.4	V
Output voltage high	$0.8 \times V_{dd}$	-	V

Table 7.2 Electrical Characteristics

Note 5: The power supplies V_{dd} and V_{HT} can be applied in any order, but the V_{HT} must be settled within 7 ms after V_{dd} is applied.

Note 6: The V_{HT} supply shall be stable to within the limits defined in Table 7.3. See Section 7 for recommended V_{HT} Circuit.

	Initial error	TC	Stability	Hysteresis	Drift over life
V_{HT} regulator	± 3000 ppm max (when tested at 50 mv @ 15.75 V	± 12.5 ppm/ $^{\circ}$ C	± 100 ppm typical, max ± 250 ppm	<100 ppm typical	<120 ppm

Table 7.3 V_{HT} Regulator Stability

7.2 SPI® Digital Interface

This section defines the SPI® interface timing and the message types and formats to and from the CAS150 acceleration sensor.

7.2.1 Electrical Characteristics

The electrical characteristics of all digital signals are defined in Table 7.4.

Parameter	Minimum	Maximum	Units
Input voltage low	-0.5	0.3xV _{dd}	V
Input voltage high	0.7xV _{dd}	V _{dd} +0.5	V
Output voltage low	-	0.4	V
Output voltage high	0.8xV _{dd}	-	V
Leakage current	-2.0	2.0	μA
Pull-up current	10.0	50.0	μA

Table 7.4 SPI® Electrical Characteristics

7.2.2 SPI® Interface

The SPI® Interface will be 4 – wire Mode 0 with the sensor being a slave device.
SPI® Signals: SPI_MOSI, SPI_MISO, SPI_Clk, SPI_Select, SPI_Select, SPI_Clk and SPI_MOSI all have pull-up resistors in the Sensor ASIC.

SPI_MISO is held in tri-state if SPI_Select is HIGH and is driven if SPI_Select is LOW.

7.2.3 SPI® Signal Timings

The SPI® interface will transfer 7 bytes (56 bits) in each message.

Message Rate: 100 Hz (min) to 50 kHz (max)

SPI_Clk rate: 100 kHz (min) to 12 MHz (max)

The signal timings are shown in Figure 7.5 below.

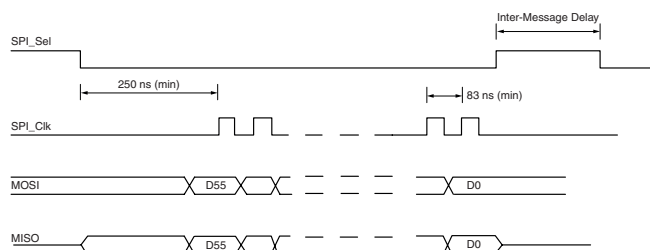


Figure 7.5 SPI® Interface Timing

Note 7: MSB of Byte 7 sent first, LSB of Byte 1 sent last.

Note 8: The requested SPI® output parameter is captured for output on the falling edge of SPI_Select. The data will be held until SPI_Select goes high. Therefore SPI_Select must be toggled between messages to allow the output data to be updated.

Note 9: The inter-message gap shall be 600 ns minimum.

7.2.4 Message to Sensor (MOSI)

Message Format:

The messages to the sensor shall be sent in the following order:

Byte 7 (D55:52): CRC (4 bits - see Message data CRC)

Byte 7 (D51:48): Data 6 (4 bits)

Byte 6: Data 5

Byte 5: Data 4

Byte 4: Data 3

Byte 3: Data 2

Byte 2: Data 1

Byte 1 (D7:0): Command Byte

Note 10: MSB of Byte 7 is sent first.

Command Byte:

Bit 7 SSSL Use Only Set to '0'

Bit 6 SSSL Use Only Set to '0'

Bits 5:3 Input Data Type
SSSL Use Only Set to '000'
Selection ignored if bit 6 = '0'

Bits 2:0 Output Data Type
'000' = Acceleration + Temperature
'001' = SSSL Use Only
'010' = Acceleration and BIT status
'011' = SSSL Use Only
'100' = SSSL Use Only
'101' = SSSL Use Only
'110' = SSSL Use Only
'111' = SSSL Use Only

Note 11: To indicate to the user that a non-standard input data request was made (that could affect the operation of the device) the BIT_Ok flag will be set immediately to fail if a message with bit 6 set to '1' is received. A non-standard output data type can be determined by analysis of the message type bits in the output message.

Note 12: If the MOSI signal is connected to Vss (or Vdd) from power-up then the O/P message on MISO will default to Acceleration and Temperature. Bit 6 in the status message will indicate an SPI® error but this will not set the BIT_Ok discrete signal or the BIT_Flag in the status message.

If MOSI is set at '1' or '0' after power-up, then the last O/P message type will be repeated.

Message Data:

Table 7.5 defines the content of each byte of the input message.

Message Type	Data Byte	Byte Content
Acceleration and Temperature or Acceleration and BIT Status	1	Bits (7:0) - Ignored (set to '00')
	2	Bits (7:0) - Ignored (set to '00')
	3	Bits (7:0) - Ignored (set to '00')
	4	Bits (7:0) - Ignored (set to '00')
	5	Bits (7:0) - Ignored (set to '00')
	6	Bits (3:0) - Ignored (set to '00') Bits (7:4) - CRC (see Message data CRC)

Table 7.5 Message Content to Sensor

Message Data CRC:

In all messages to and from the Sensor a 4-bit CRC (data bits D55:52) shall be added. The CRC polynomial used shall be x^4+1 . A seed value of '1010' shall be used with a calculation order MSB to LSB. The CRC shall be checked for all I/P messages. If the CRC fails, then the message shall be ignored and an SPI® Error message output in the next message. The content of the message following a bad CRC message shall be the message type selected in the last 'good' message. The message type shall default on power-up to ACC/Temp message.

7.2.5 Message from Sensor (MISO)

Message Format:

The messages from the sensor shall be sent in the following order:

Byte 7 (D55:52): CRC (4 bits)
 Byte 7 (D51:48): Data 6 (4 bits)
 Byte 6: Data 5
 Byte 5: Data 4
 Byte 4: Data 3
 Byte 3: Data 2
 Byte 2: Data 1
 Byte 1 (D7:0): Status Byte

Note 13: MS Bit (55) of Byte 7 is sent first.

Status Byte:

The Status Byte content depends on the message requested:

Bit 7 Sensor BIT Status (see Note 14)
 '1' = BIT Fail
 '0' = BIT Sensor OK

Bit 6 SPI Error (see Note 15)
 '1' = SPI Message Error
 '0' = SPI Message OK

Bits 5 Test mode
 '1' = test mode
 '0' = normal operation

Bits 4 Over Range (see Note 16)
 '1' = Over range condition detected
 '0' = No Over range condition detected

Bits 3:0 Message Type
 '0000' = Acceleration and Temperature (Default)
 '0010' = Acceleration and BIT Status

All other message types
 = SSSL use only

Note 14: The Sensor BIT Status will be set to '1' (fail) if an internal continuous BIT test fails, indicating that the acceleration output may be suspect.

Note 15: The SPI® Error Bit will be set to '1' (fail) if a problem was detected with the input SPI® message for example too many or too few clock cycles or a CRC error. If this occurs, then the input message is ignored.

Note 16: The Over Range bit will be set if the applied acceleration exceeds the sensor limits.

Note 17: If the MOSI signal is connected to Gnd or V_{cc} from power-up then the O/P message on MISO will default to Acceleration and Temperature. Bit 6 in the status message will indicate an SPI® error but this will not set the BIT_Ok discrete signal or the BIT_Flag in the status message.

Message Data Content:

The output message data content will depend on the command byte from the previous input message. The content is indicated by bits (3:0) of the Status byte.

The comments column states whether the data is signed or unsigned.

Message Type	Data Byte	Byte Content	Comments
Acceleration and Temperature	1	Bits (7:0) - Acceleration Output (7:0)	Signed Number
	2	Bits (7:0) - Acceleration Output (15:8)	Signed Number
	3	Bits (7:0) - Acceleration Output (23:16) (see Note 12)	Signed Number
	4	Bits (7:0) - Temperature (7:0)	Unsigned Number
	5	Bits (7:0) - Temperature (15:8)	Unsigned Number
	6	Bits (3:0) - ('0000') Bits (7:4) - CRC (see Message data CRC)	-
Acceleration and BIT Status	1	Bits (7:0) - Acceleration Output (7:0)	Signed Number
	2	Bits (7:0) - Acceleration Output (15:8)	Signed Number
	3	Bits (7:0) - Acceleration Output (23:16) (see Note 12)	Signed Number
	4	Bits (7:0) - BIT Status (7:0)	Unsigned Number
	5	Bits (7:0) - BIT Status (15:8)	Unsigned Number
	6	Bits (3:0) - ('0000') Bits (7:4) - CRC (see Message data CRC)	-

Table 7.6 Message Content from Sensor

Note 18: In all messages to and from the Sensor a 4-bit CRC (data bits D55:52) shall be added. The CRC polynomial used shall be x^4+1 . A seed value of '1010' shall be used with a calculation order MSB to LSB. The CRC shall be checked for all I/P messages. If the CRC fails, then the message shall be ignored and an SPI® Error message output in the next message. The content of the message following a bad CRC message shall be the message type selected in the last 'good' message. The message type shall default on power-up to ACC/Temp message.

Note 19: Depending on the status of a selection bit in the non-volatile memory the acceleration output will be: **Either** the default setting of the raw (48 kHz update) 22-bit filter output positioned in the most significant 22 bits of the SPI® interface parameter with the least significant two bits set to '00', **Or** the most significant 24 bits of the 25 bit sum of eight consecutive 22 bit samples. The least significant bit of the sum will be discarded. The output data will be updated every 8 frame cycles (6 kHz update). This scale factor is the same for either selection.

7.2.6 BIT Status Flag Format

BIT No.	BIT Flag	Comments
D0	Pickoff BIT	0 = OK 1 = Fail
D1	PLL BIT	0 = OK 1 = Fail
D2	PLL Lock BIT	0 = OK 1 = Not Locked
D3	Vref _BIT	0 = OK 1 = Fail
D4	Start	0 = OK 1 = Not Started
D5	ADC Demod Input Saturated	0 = OK 1 = Fail
D6	In Loop Filter Output Saturated	0 = OK 1 = Fail
D7	Out of Loop Filter Output Saturated	0 = OK 1 = Fail
D8	Checksum of OTP Error	0 = OK 1 = Fail
D9	Test Mode Status	0 = OK 1 = ON
D10	Test Data Input SPI® Command RXed	0 = OK 1 = Fail

D11	In Loop Offset Summer Exceeds 22 Bits	0 = OK 1 = Fail
D12	PWMH (over range high)	0 = OK 1 = Set
D13	PWML (over range low)	0 = OK 1 = Set
D14	ADC Offset Adder Overflow	Set to '0'
D15	Not Used	Set to '0'

Table 7.7 BIT Flag Format

If a bit failure listed in Table 7.7 (except for bit D10) is detected, then bit D7 of the Status byte of the SPI® output message will be set to '1' (Fail) and the BIT_Ok discrete signal will be set to '0' after a non-volatile memory programmable delay (default of 4 frames to 32 frames).

The SPI® status message and the discrete signal will be set to pass immediately if no fault is detected.

7.3 Sensor Discrete Signals

The operation of the sensor discrete signals is detailed in this section.

Sync_In

The rising edge of the input signal is used to define the synchronisation of the internal control loops. Used in the sensor start-up routine to synchronise the internal 48 kHz frame signal, used to time the internal data processing.

To synchronise the sensor, Sync_In should be held low for at least 8.5 ms after the power (V_{dd}) has stabilised. Sync_In is then taken high. The internal frame rising edge will be synchronised to the rising edge of Sync_In.

If synchronisation is not required, then Sync_In shall be left open circuit (there is an internal pull-up) or tied to V_{dd} .

Sync_Out

In normal operation Sync_Out is held low throughout the sensor start-up period then taken high synchronous to the internal frame rising edge.

This output can be reprogrammed (via a non-volatile memory bit) to output the internal frame signal (48 kHz).

If the 8 sample acceleration data summing function is enabled, then the frame signal (if enabled onto the Sync_Out pin) will be a 6 kHz signal. The rising edge of this signal will indicate that new acceleration data is available.

BIT_Ok

Bit_Ok will normally indicate the status of the internal BIT circuits of the sensor. BIT_Ok will be set low ('0') if an internal fault or condition that could affect the acceleration data output has been detected. For a full description of the faults affecting this output, see Section 7.2.6.

Note: Under test mode command other signals can be selected for output on the BIT_Ok discrete (SSSL use only).

Clk_In

Clk_In is the primary clock source for the sensor. All internal clocks are synchronised to Clk_In. The clock frequency shall be 12 MHz (± 250 ppm). The internal loops are updated every 250 cycles of Clk_in (nominally 48 kHz).

PROG

PROG is used to programme the internal non-volatile memory (OTP). This shall only be used during calibration. For normal operation this signal shall be tied to V_{dd} .

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Single-Axis HP Accelerometer
Technical Datasheet - Preliminary



8 Cleaning

Due to the natural resonant frequency of the sensor, ultrasonic cleaning should NOT be used to clean the CAS150 High Performance Accelerometer.

9 Soldering Information

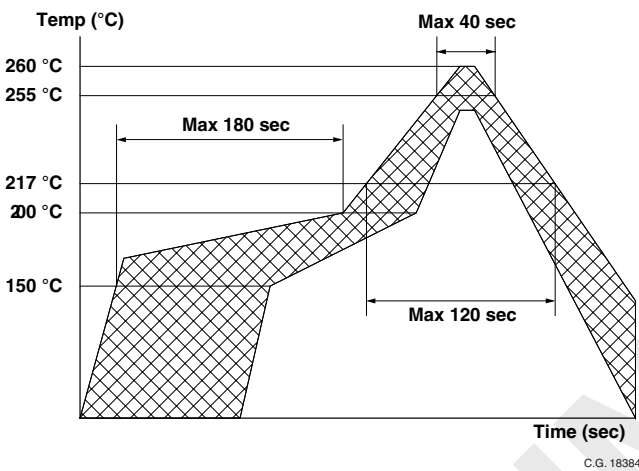


Figure 9.1 Recommended Reflow Solder Profile

Item	Code	Range
Year number	YY	00 - 99
Month number	MM	01 - 12
Lot number	LLL	000 - 999
Serial number	XXX	001 - 999

Table 10.1 Part Marking (Serial Number)

11 Packaging Information

The packaging will be in JEDEC waffle trays.

10 Part Markings

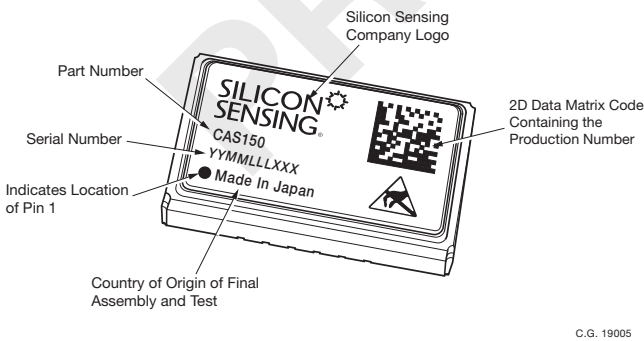


Figure 10.1 Part Marking

12 Internal Construction and Theory of Operation

Construction

The acceleration sensor is supplied as a PCBA surface mountable LCC ceramic packaged device. It comprises four main components: Silicon On Glass (SOG) MEMS Acceleration Sensor, ASIC, the Package Base and Lid. The MEMS Sensor and ASIC are housed in a hermetically sealed package cavity with a nitrogen back-fill, this has particular advantages over sensors supplied in plastic packages which have Moisture Sensitivity Level limitations.

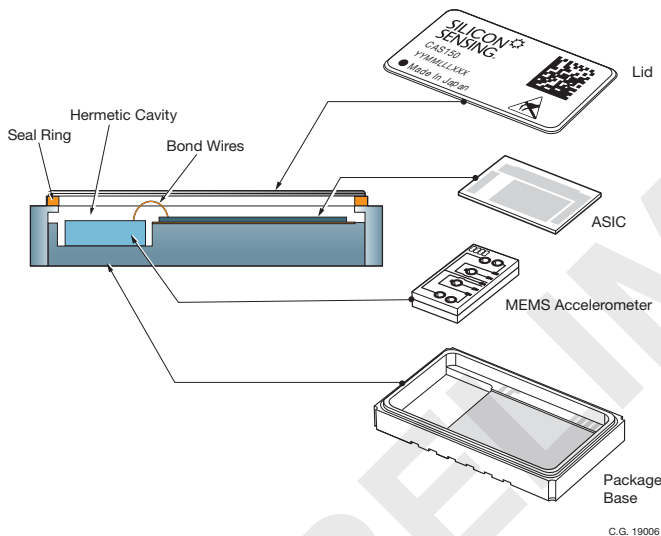


Figure 12.1 CAS150 Main Components

Silicon MEMS Sensor

The acceleration sensor is a one-piece silicon MEMS structure anodically bonded to top and bottom glass substrates to form a hermetically sealed SOG wafer sub-assembly. A DRIE bulk silicon process is used to create a finger-like spring/seismic proof mass structure. Figure 12.2 shows a schematic cross section through the SOG wafer.

Capacitive drive and pick-off signals are transmitted between the ASIC and the metallised transducer plates on the MEMS, using through-glass vias and wire bond interconnections.

Multiple inter-digitated fingers create increased capacitance thus enabling a high signal-to-noise ratio. The fingers are tapered to increase the resonant frequency and also have a high aspect ratio to provide highly stable performance. The differential gaps

between the static electrode fingers and those of the proof mass provide an air squeeze film damping.

Control of the MEMS accelerometer is handled by the ASIC.

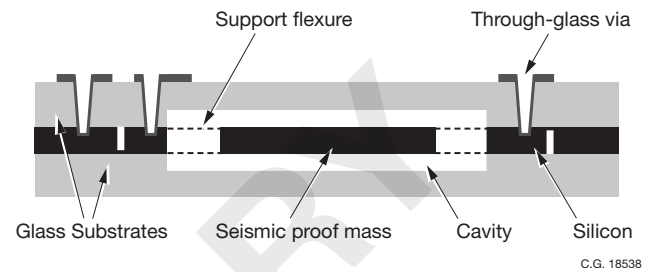


Figure 12.2 Schematic Section of the Silicon On Glass Accelerometer MEMS Wafer Sub-Assembly

ASIC

The ASIC is a 3.93 mm x 3.2 mm device fabricated using 0.35 μm CMOS process. ASIC and MEMS are physically separate and are connected electrically by using gold bond wires and thus the ASIC has no MEMS-to-ASIC internal tracking, meaning there is reduced noise pick-up. Gold bond wires also connect the ASIC to the internal bond pads on the Package Base.

Package Base and Lid

The LCC ceramic Package Base is a multi-layer aluminium oxide construction with internal bond wire pads connected through the Package Base via integral multi-level tungsten interconnects to a series of external solder pads. Similar integral interconnects in the ceramic layers connect the lid to V_{SS} , thus the sensitive elements are inside a Faraday shield. Internal and external pads are electroplated gold on electroplated nickel.

Zenith®

Single-Axis HP Accelerometer

Technical Datasheet - Preliminary



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13 Patent Applications

The following patent applications have been filed for this family of High Performance Accelerometers:

Patent Application	Status
US7047808	Granted
US7267006	Granted
173466GB01	Filed

PRELIMINARY

Zenith®

Single-Axis HP Accelerometer

Technical Datasheet - Preliminary



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