

HeliX™ Silicon Avalanche Photodiode Module

HeliX-902-200



Excelitas' HeliX Silicon Avalanche Photodiode Module delivers high responsivity from 300-1100nm, high dynamic range, high linearity and an excellent S/N ratio.

Excelitas' new HeliX Silicon Avalanche Photodiode (APD) Module is a compact, easy-to-use, analogue low-light-level detection (L³D) module employing Excelitas' leading-edge Si APD chips. The detector is in a hermetic TO package, mounted on a practical OEM based PCB which includes high-voltage power supply, temperature compensation, a low-noise transimpedance amplifier, APD bias monitor and micro-controller.

With this compact voltage-output module, the preamplifier gain is optimized to obtain maximum dynamic range and linearity with the APD at gain adjustable operating voltage. It optimises APD operation in key performance parameters such as higher sensitivity, and better signal-to-noise ratio across the 400nm - 1100nm wavelength range.

The HeliX APD module is offered as a standard, commercial-off-the-shelf (COTS) product. It contains a 0.5mm diameter reach-through Si APD.

In addition to our standard, off-the-shelf APD module, Excelitas also offers customized modules tailored to the needs of the customer. Depending upon customer requirements, modifications can include a different APD, a cost effective PCB module, optional calibration, bandwidth optimization, FC-connectorized packaging, and customized testing.

Key Features

- High responsivity: 650kV/W @ 900 nm
- Transimpedance amplifier
- 50Ω SMA output connector
- Temperature compensation to stabilise gain and responsivity
- User controllable gain and responsivity
- Single + 5V operating voltage at input provides HV and LV internal biases for APD and TIA
- Front plate can accommodate various APDs
- User-friendly compact footprint
- ROHS Compliant

Applications

- Fluorescence measurement
- Distributed temperature sensing (DTS), or distributed optical sensing
- Analytical instrumentation
- Flow cytometry
- Confocal laser endomicroscopy
- Laser range finding
- LIDAR
- Laser Scanning Ophthalmology

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Table 1. Electro-optical characteristics

Test conditions: Case temperature = 22°C, $V_{op} = +5V$, $R_L = 100\Omega$ differential DC coupled

Parameter	Minimum	Typical	Maximum	Units
Detector	Silicon reach-through APD C30902EH			
Active area chip diameter		0.5		mm
Peak Wavelength (λ)		900		nm
APD gain		150		
Module Responsivity (differential) at 830 nm at 900 nm		770 650		kV/W
Transimpedance differential output, 100 Ω load single ended, 50 Ω load		20 10		k Ω
-3dB Electrical bandwidth		200		MHz
Low frequency cut-off		1.5		kHz
Noise equivalent power (NEP) Average from 100 kHz to f-3dB, $\Delta f = 1.0$ Hz at 830nm at 900nm Output spectral noise voltage Averaged from 100 kHz to f-3dB		42 50		fW/√Hz
Rise time ⁽¹⁾		1.5		ns
Output impedance (single ended)		50		Ω
Output voltage swing (differential output)			1	V
Responsivity variation (over operating temp range)		+/-5		%
Positive Supply Voltage	4.5	5.0	5.5	V
Positive Supply Current		35	400	mA
Output offset voltage		0		V
Storage Temperature	-10		+70	°C
Operating Temperature	+5		+60	°C

(1) The module is fully operational at < 2 seconds after it is turned ON.

The physical layout is based around a PCB assembly packaged within a metal box, with mounting holes around the base.

The design is flexible for customer and application specific requirements.

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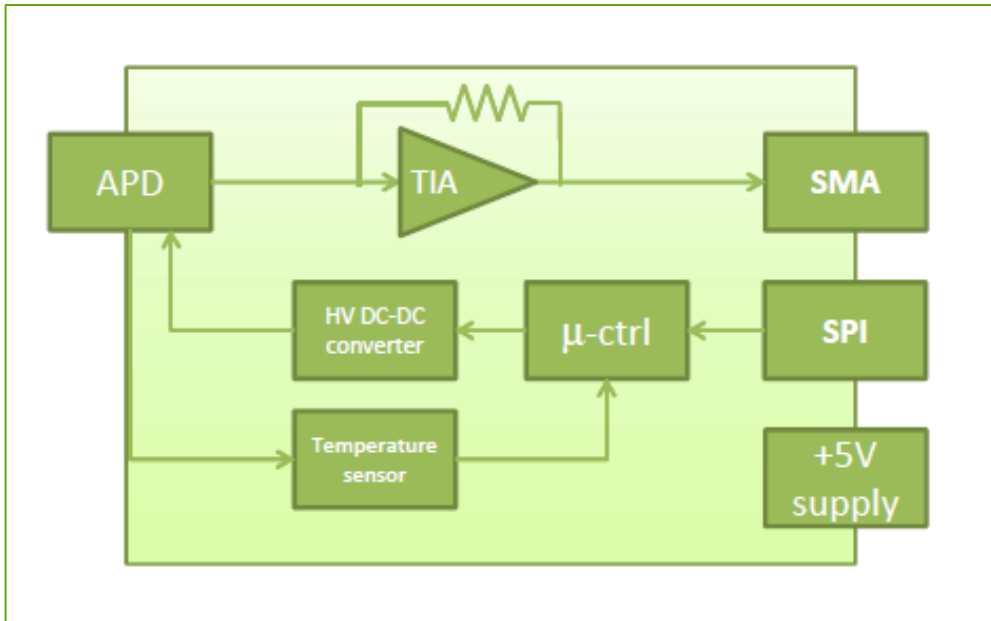


Figure 1 Module Block Diagram

The communication and power supply connection will be the Molex 87438-0643 6 pin 200mm pitch connector. The pins will be +5V/GND/SDO/SDI/SS/SCK. The APD module board will behave as slave on the SPI bus.

Power and communication connector pin-out:

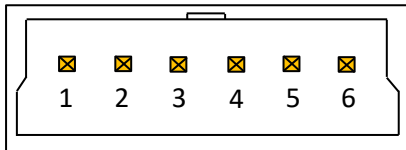
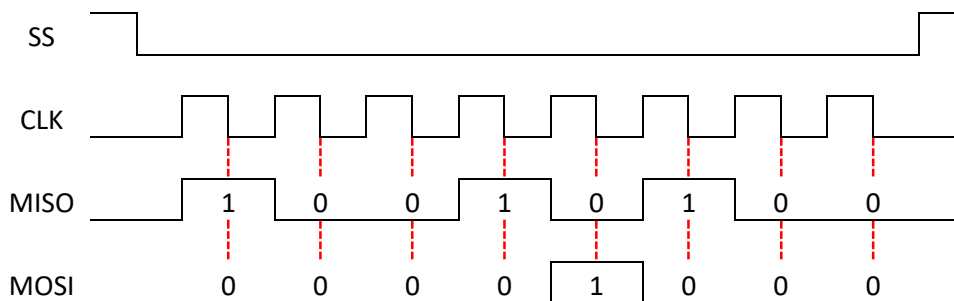


Figure 2 Connector Pin-out numbering and function

Pin	Function
1	Ground (GND)
2	Master IN / Slave OUT (MISO)
3	Slave Select (SS)
4	Clock IN (CLK)
5	Master OUT / Slave IN (MOSI)
6	Supply (+5V)

Timing diagram

The following figure presents an example of the transmission of 1 byte. The Slave sends the value 0x94 and the Master is sending the value 0x08.



SPI mode: 0 (CKE = 1 and CKP = 0)

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Parameter	Minimum	Typical	Maximum	Units
Recommended bit rate		1464		bit/sec
Input low level		0.5		V
Input high level		2.6		V
Output low level		0.4		V
Output high level		2.4		V
Input leakage current		+/-5	+/-200	nA
Maximum sink current			25	mA
Maximum source current			25	mA
Maximum voltage on a communication pin			5	V

Software function

SPI is the communication protocol for the Helix APD module. The module's parameters can be changed using simple functions, sent on the SPI bus. The available functions are:

- Set APD Bias voltage
- Set temperature coefficient
- Control temperature compensation
- Set and Save chosen values for bias and temperature coefficient
- Return to factory default values
- Get APD case temperature

Table 1: Command list for communication protocol

Function	1st Byte	2nd Byte	3rd Byte	4th Byte	Description
Set Bias Voltage	0xCC	LSB	MSB	Checksum	Set a temporary bias value. This value will not stay if module is restarted.
Set Temperature Coefficient	0xDD	LSB	MSB	Checksum	Set a temporary temperature coefficient value. This value will not stay if module if restarted.
Turn Temperature Compensation ON/OFF	0xEE	1/0	X	Checksum	Allows turning off the temperature compensation by sending (0). The bias will remain the same even if the temperature of the module changes. Sending (1) will turn the temperature compensation back on.
Reset to Factory Default	0xF9	X	X	Checksum	This command brings back the module to the factory default values.
Set and Save Bias Voltage	0xFA	LSB	MSB	Checksum	Set a permanent bias value. This value will stay even if module is restarted. This does not overwrite the factory default values
Set and Save Temperature Coefficient	0xFB	LSB	MSB	Checksum	Set a permanent temperature coefficient value. This value will stay even if module is restarted. This does not overwrite the factory default values
Get Temperature / Reset Comm.	0xFF	None	None	None	Single byte command to receive the case temperature of the APD. This command does not change any other factor.

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The value of the 2nd and 3rd byte depends on the type of value being sent. The module requires the value to be sent to be an integer.

For bias voltages the desired value should be multiplied by 10 and temperature coefficient by 1000. This value is then divided in two bytes: LSB as the 2nd byte, and MSB as the 3rd byte.

Example:

To set the bias voltage to 123.4V:

Value to be sent: $123.4 \times 10 = 1234$ or 0x4D2

LSB: 0xD2

MSB: 0x04

Communication protocol

The communication protocol is based on a series of 8 bit commands sent to the module. The module responds to every command sent on the next transfer. The standard communication string contains 4 bytes (8bit words). A checksum needs to be added to the last byte to help prevent miscommunications. An example of the communication is as follows:

1st Byte - Command: **0xCC**

2nd Byte - Value LSB: **0xD2**

3rd Byte - Value MSB: **0x04**

4th Byte - Checksum: 2nd Byte XOR 3rd Byte = $0xD2 \text{ XOR } 0x04 = \mathbf{0xD6}$

SPI communication is a simultaneous bi-directional communication. While a byte is being sent another one is received at the same time. The module takes advantage of this communication by replying to the master to ensure that the command was received. The first response from the module is the default temperature measurement of the APD's case temperature. The temperature in the reply is in Celsius and is an integer. For example if reply is: 0x19 = 25, this means 25°C. The last byte is the checksum to be certain the value was received correctly. If the Checksum value returned is 0, it means there was an error in the transfer and the bias value was not updated.

Here is how the module handles this type of communication:

Set bias voltage

	1st Byte	2nd Byte	3rd Byte	4th Byte	Next byte
Sent	0xCC	0xD2	0x04	0xD6	X
Received	X	Temperature (°C)	0xD2	0x04	1/0 (Checksum)

Table 2: Set bias voltage example

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Set temperature coefficient

	1st Byte	2nd Byte	3rd Byte	4th Byte	Next byte
Sent	0xDD	0xD2	0x04	0xD6	X
Received	X	Temperature (°C)	0xD2	0x04	1/0 (Checksum)

Table 3: Set temperature coefficient example

The example above in the Table 4 shows the communication string required for the temperature coefficient change. The value that is transmitted in this example is 1.234 V/°C. If Checksum value returned is 0, it means there was an error in the transfer and the temperature coefficient value was not updated. If Checksum value return is 1, then the temperature coefficient is confirmed and set.

Turn temperature compensation ON/OFF

	1st Byte	2nd Byte	3rd Byte	4th Byte	Next byte
Sent	0xEE	0x01	0x00	0x01	X
Received	X	Temperature (°C)	0x01	0x00	1/0 (Checksum)

Table 5: Turn ON the temperature compensation example

The example above shows the communication string to turn ON the temperature compensation: sending “1” in the 2nd byte. To turn OFF the compensation, the 2nd byte would be 0x00. If Checksum value returned is 0, it means there was an error in the transfer and the temperature compensation status was not updated.

The factory default for the module for temperature compensation is “ON”. The module will always turn ON the temperature compensation whenever the module is restarted.

Reset to factory values

	1st Byte	2nd Byte	3rd Byte	4th Byte	Next byte
Sent	0xF9	0x01	0x00	0x01	X
Received	X	Temperature (°C)	0x01	0x00	1/0 (Checksum)

Table 6: Reset factory default values example

The example above shows the communication string to bring the module back to its factory default settings. If Checksum value returned is 0, it means there was an error in the transfer and the device was not updated.

Set and save bias voltage

The user can set and save chosen bias voltage for the APD module. The communication is the same than the “Set bias voltage” except the 1st byte is 0xFA.

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Set and save temperature coefficient

The user can set and save chosen temperature coefficient for the APD module. The communication is the same than the "Set temperature coefficient" except the 1st byte is 0xFB

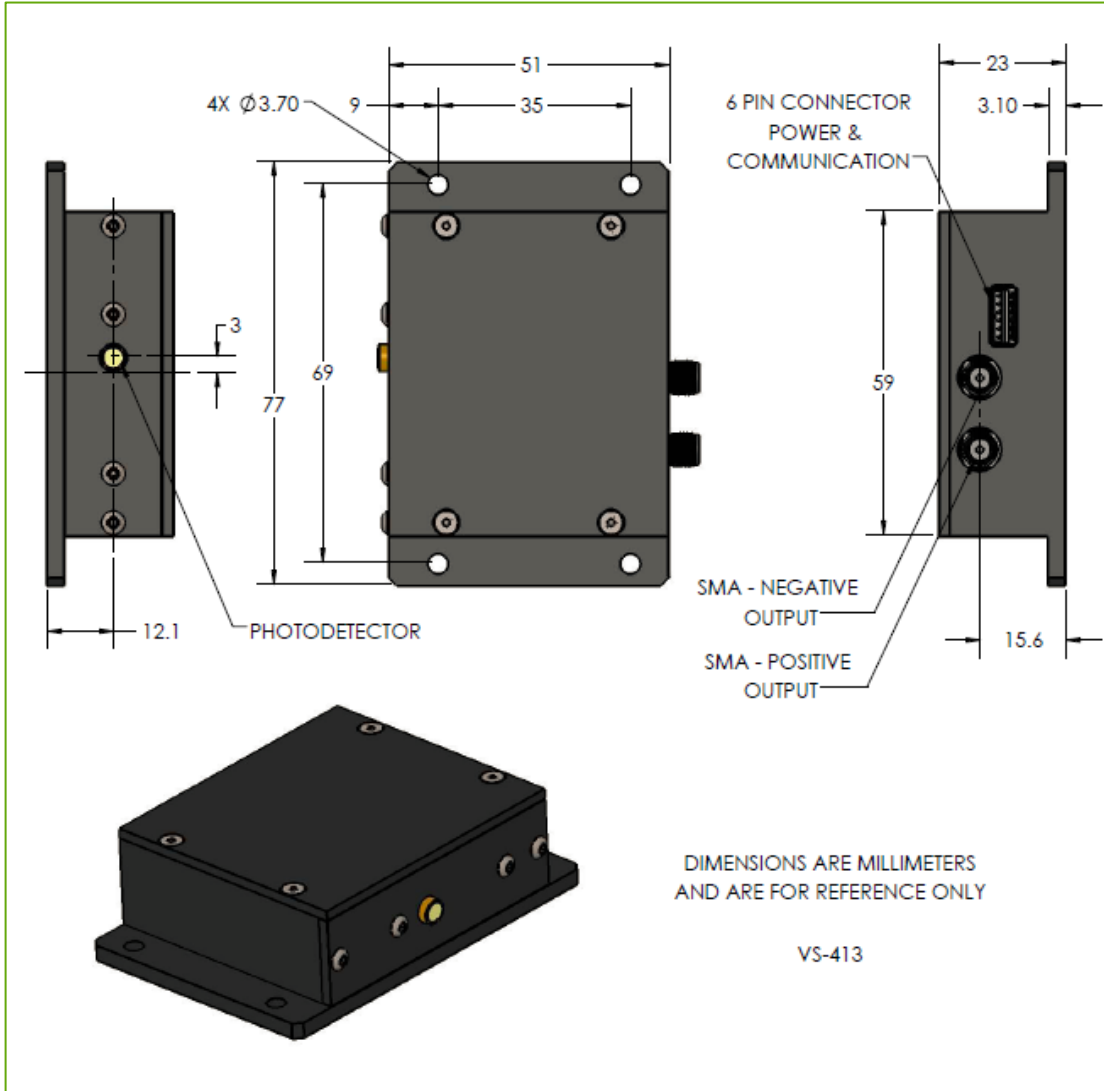


Figure 3 APD Module Dimensions

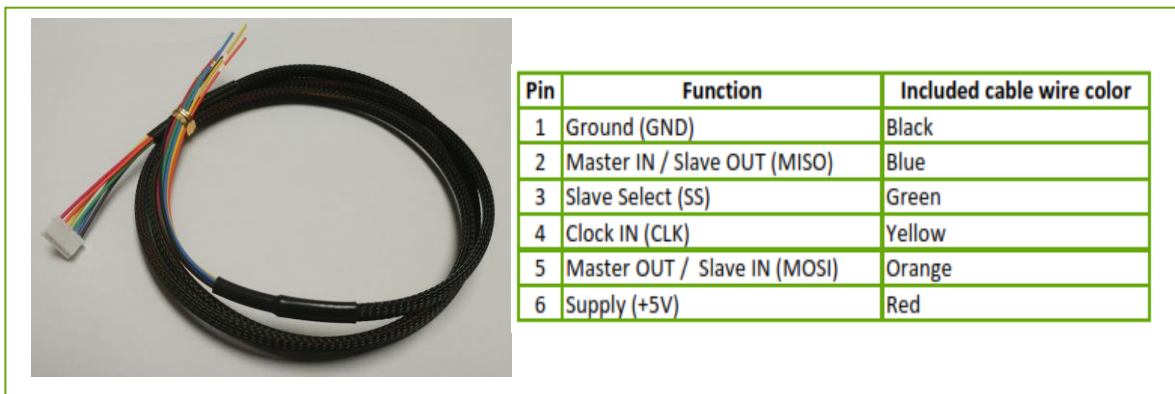


Figure 4 Cable Pin Configuration

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RoHS compliance

The Helix APD module is designed and built to be fully compliant with the European Union Directive 2011/65/EU – Restriction of the use of certain Hazardous Substances (RoHS) in Electrical and Electronic equipment.



About Excelitas Technologies

Excelitas Technologies is a global technology leader focused on delivering innovative, customized solutions to meet the lighting, detection and other high-performance technology needs of OEM customers.

Excelitas has a long and rich history of serving our OEM customer base with optoelectronic sensors and modules for more than 45 years beginning with PerkinElmer, EG&G, and RCA. The constant throughout has been our innovation and commitment to delivering the highest quality solutions to our customers worldwide.

From aerospace and defense to analytical instrumentation, clinical diagnostics, medical, industrial, and safety and security applications, Excelitas Technologies is committed to enabling our customers' success in their specialty end-markets. Excelitas Technologies has approximately 5,000 employees in North America, Europe and Asia, serving customers across the world.

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