The following Application Note details the process for connecting an .SH. Series (Ceramic) Electrolytic Tilt Sensor to the SSY0135-XX Signal Conditioning Module, and the communication protocol. The .XX at the end of the part number will denote the actual type sensor used.

**General Specifications**

- Resolution: 12 bits
- Current supply: 5 mA @ 12VDC
- Stability over temperature: +/- 2 bits
- Temperature resolution: 1 Deg Celsius
- Operating temperature: -20C + 70C
- Response Time: 25 ms
- Clock Speed: 10Mhz

**Sensor Connections**

The sensor leads should be soldered to the circuit board in the following manner.
**Application Note**  
**SSY0135 - RS232 (MICRO-50) Signal Conditioner Operating Instructions**

### Input/Output Connections

<table>
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<th>Circuit Board Connection JP3</th>
<th>Function</th>
<th>Corresponding PC Serial Port connection *</th>
</tr>
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<tr>
<td>Pin #</td>
<td></td>
<td>Pin #</td>
</tr>
<tr>
<td>1</td>
<td>Input = +7 to +30Vdc</td>
<td>none</td>
</tr>
<tr>
<td>2</td>
<td>Ground</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
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*A DB9 type connector is required to connect to the PC serial port (not supplied)*

### Communication Protocol

All functions are available in the single axis configuration. The serial port is setup for the following protocol.

**RS232C**

- **Baudrate**: 19200
- **Data width**: 8 bits
- **Stop bit**: 1
- **Parity**: none
- **Flow Control**: none

### Commands

All the commands have to be sent in the upper case mode in ASCII format.

- **A** Reset board
- **B** Read Pitch (not used in single axis configuration)
- **C** Read Roll
- **D** Read Temperature
- **E** Reserved
- **F** Stores offset for the roll and pitch
- **G** Reserved
- **H** Send calibration data
- **I** Turn off excitation

When the **A** command is sent to the SSY0135, it resets itself, and sends back the ASCII character 'R' when it is ready to accept a new command.

**B** and **C** command will be followed by 4 bytes. The first 3 bytes will be ASCII characters, representing the angle in Hexadecimal (to translate into an angle see the calibration sheet). The last byte is the Line Feed 10 (A in hexadecimal).
Application Note
SSY0135 - RS232 (MICRO-50) Signal Conditioner Operating Instructions

When $F$ is received the unit turns off the sensor excitation. It stores the next 4 characters (ASCII format) as an offset for the pitch axis (not used in single axis configuration), and then stores the next four characters for the roll axis. The values are stored in the nonvolatile memory of the microcontroller in hexadecimal format. Once the microcontroller has stored the values in its memory, it restarts the excitation and sends .R. to the host. It will take 20 seconds to read a stable output from the time the excitation is turned back on. This is equivalent to turning the unit power on.

The microcontroller will do a two's complement addition with the reading from the analog to digital converter. It should be noted that when the offset is added to the result of the analog to digital converter the output on the end of the scale can change the sign.

$H$ tells the signal conditioner to send to the host, in the following order, the pitch offset, the roll offset and the temperature coefficient. The temperature coefficient is set to 1 and is reserved for future extensions.

$I$ command turns off the excitation to the microcontroller. This allows the user to save power. It will take 20 seconds for the measurement to be stable once the excitation is turned on. The excitation is turned back on when the microprocessor is reset with the command $A$ or the power is turned off and on.

$D$ command will connect the output of the temperature sensor to the amplifier’s input. The SSY0135 will send the data with the same format as for the pitch and roll. The gain adjustment does not affect the temperature measurement. The scale factor is 1 counts per Degree Celsius (160 (0A0Hex) AT 25).

Circuit Block Diagram

![Circuit Diagram]

Note. Gain Adjustment is accomplished by adjusting the potentiometer (R20) on the circuit board.
Connecting to a PC

The output of the MICRO-50 can be read directly with a PC by using Hyper-terminal. Setup Hyper-terminal the following way. HyperTerminal is located in the folder Programs\Accessories\Communications. The setup is found in the menu File ‘Properties’.

In the window "Connect using", select the serial port the MICRO-50 is attached to. Press the button to configure.

Setup as follows:
bits per second = 19200
data bits = 8
parity = none
stop bits = 1
Flow control = none

The output of the SSY0135 is ASCII characters, in Hexadecimal format (see COMMANDS above).

Example
For instance at 0 degree tilt the output of the unit is 800(HEX). To convert it in decimal use this equation:
First byte * 16^2 + Second byte * 16 + third byte
8*16^2 + 0*16 + 0 = 2048
If the unit is tilted and the output is A11 the conversion in decimal is:
(10) A*16^2 + 1*16 + 1 = 2577
The output can be converted to an angle the following way:
(2577-2048)* (the scale factor provided with the unit calibration sheet).

To linearize the SSY0135 for a dual axis sensor type SP50XX, use the following characteristic equation:
Coeff3 X output^3 + Coeff2 X output^2 + Coeff1 X output

The following are the coefficients:
60 degrees angle
Coeff1 = 0.0468
Coeff2 = 0
Coeff3 = -0.000000004
45 degrees angle
Coeff1 = 0.03125
Coeff2 = 0
Coeff3 = -0.00000002
20 degrees angle
Coeff1 = 0.0129
Coeff2 = 0
Coeff3 = -0.000000003
The output when the sensor is at 0 degrees is 2048. 2048 should be subtracted from the output before applying the equation.