

**USER'S MANUAL**  
**MODEL 781 SIGNAL CONDITIONING UNIT**

Serial No. \_\_\_\_\_



850 Perimeter Road  
Manchester, NH 03103 USA  
Tel (603) 669-6400  
Fax (603) 622-2690  
sales@jewellinstruments.com  
www.jewellinstruments.com

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## 1.0 GENERAL INFORMATION

### 1.1 Introduction:

The model 781 Signal Conditioning Unit (SCU) is a compact module that may be used with all Jewell Instrument tilt sensors. Internal SCU electronics provide simultaneous excitation of two electrolytic tilt transducers, and condition the returned signals into two analog DC voltages. The SCU provides both single-ended and differential outputs on each of its two tilt channels. You may thus select the output that is best suited for your application.

The SCU also takes temperature readings from a National Semiconductor LM-35 temperature sensor, providing an analog output proportional to temperature. Temperature is provided as a single-ended output only.

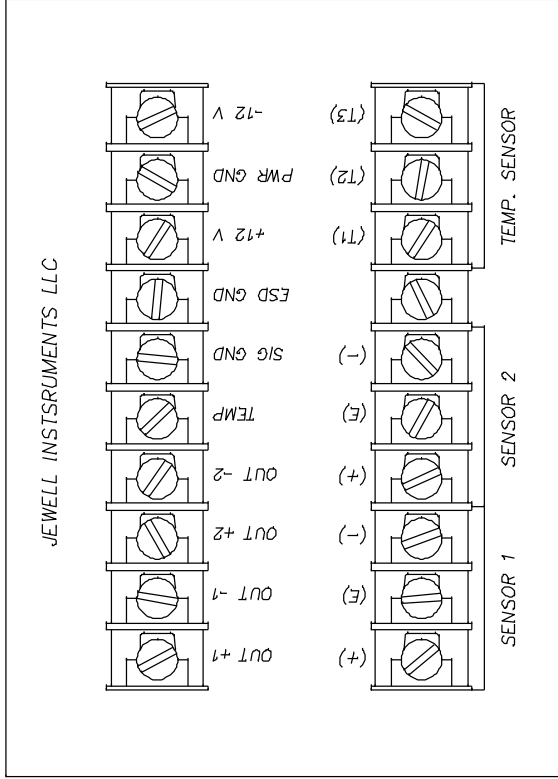
This manual explains the functions and use of the three control switches on the front panel of the SCU, and the input and output terminals on the rear panel (Figures 1 and 2). Basic maintenance and troubleshooting guidelines are given in the last section of the manual.

### 1.2 General Specifications:

INPUT CHANNELS	Two Jewell Instrument electrolytic tilt sensors, one LM-35 temperature sensor
TILT OUTPUT	Two channels of single-ended <u>and</u> differential analog outputs proportional to tilt
OUTPUT VOLTAGE	Approximately $\pm 8$ VDC (single-ended) and approximately $\pm 16$ VDC (differential)
OUTPUT IMPEDANCE	270 Ohms, short circuit and surge protected
GAIN RANGE	Two gains provided, x1 and x10 standard, other gains available upon customer request
OUTPUT FILTERS	Two low-pass integrators. Roll-off = 6 db per octave. Settling times set to customer specifications (see Appendix B).
TEMPERATURE OUTPUT	0.1°C/mV (single-ended), -40°C to +100°C [-40°F to +212°F] $\pm 0.75^\circ\text{C}$ [ $\pm 1.35^\circ\text{F}$ ] accuracy
POWER REQUIREMENTS	+11 to +15 VDC, -11 to -15 VDC, 12 mA typical, 250 mV P/P ripple max.

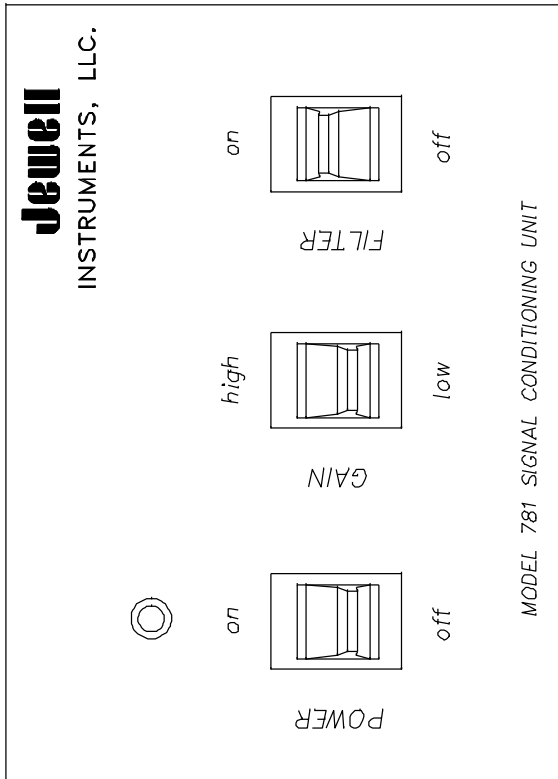
EXTERNAL CONNECTIONS	Dual screw-terminal barrier strips
TEMPERATURE RANGE	-20°C to +70°C [-4°F to +158°F] Operational -30°C to +100°C [-22°F to +212°F] Storage
HUMIDITY RANGE	0 to 100%, noncondensing & nonsubmersible
SIZE	3.5" x 5" x 8.4" (8.8 cm x 12.7 cm x 21.3 cm)
WEIGHT	2 lbs. (0.9 kg)
MATERIALS	Case: painted aluminum

FIGURE 2

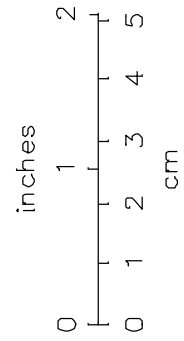


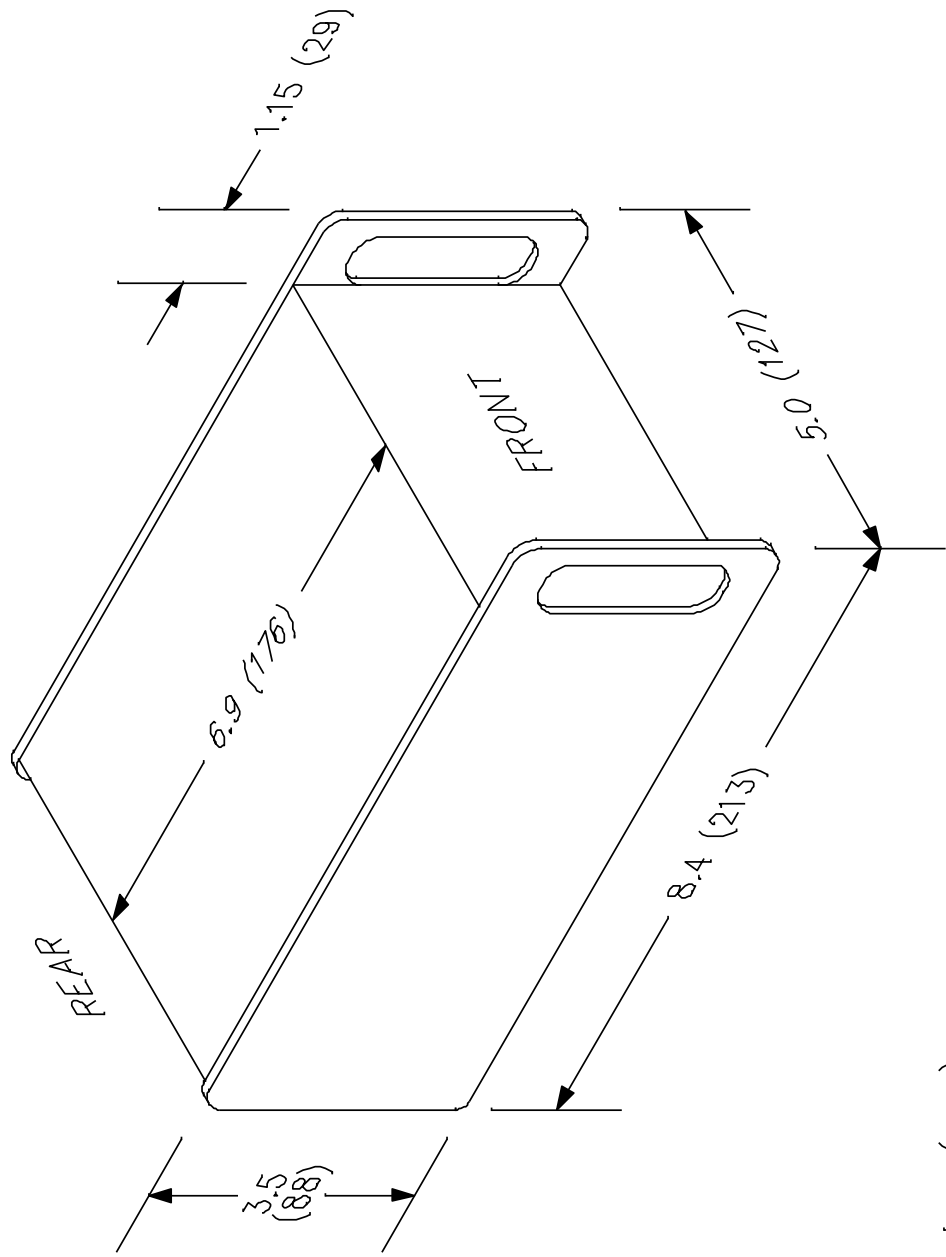
REAR

FIGURE 1



FRONT





Dimensions in inches (mm)

## 2.0 OPERATION

### 2.1 Using the Controls; Meaning of the Indicators:

There are three 2-position control switches on the front panel of the SCU (Figure 1). The first is the ON-OFF power switch, the second is the HIGH-LOW gain switch, and the third is the ON-OFF low-pass filter switch. The ratio between HIGH and LOW gain for your SCU is given in Appendix B, as are the filter time constants corresponding to the ON and OFF filter switch positions.

There are two terminal strips on the back panel of the SCU (Figure 1). The lower terminal strip provides the connections to two tilt transducers, and one temperature sensor. The upper terminal strip provides the input connection for your external power supply, and the connection for the conditioned output of the tilt and temperature sensors. The names and functions of the terminal strip positions on the rear panel of the SCU, are listed below:

<b><u>NAME</u></b>	<b><u>FUNCTION</u></b>
SENSOR 1	The three terminal positions (+), (E), and (-) are for the three lead wires from the first tilt sensor. (E) is the center, or neutral wire. (+) and (-) are the positive and negative pick-ups respectively. For color coding of the sensor lead wires supplied with your SCU, see Appendix B.
SENSOR 2	The three terminal positions (+), (E), and (-) are for the three lead wires from the second tilt sensor.
TEMP. SENSOR	The three terminal positions (T1), (T2), and (T3) are for the three lead wires from the LM-35 temperature sensor. For the color coding of the temperature sensor lead wires supplied with your SCU, see Appendix B.
OUT +1	This is the Sensor 1 output signal. When operating the SCU in single-end mode, this signal is referenced to SIG GND. When operating the SCU in differential mode, this signal is referenced to OUT -1.
OUT -1	The signal carried on this terminal position is the OUT +1 signal multiplied by -1. OUT +1 is referenced to OUT -1 when a differential output is desired.
OUT +2	This is the Sensor 2 output signal. When operating the SCU in single-end mode, this signal is referenced to SIG GND. When operating the SCU in differential mode, this signal is referenced to OUT -2.

OUT -2	The signal carried on this terminal position is the OUT +2 signal multiplied by -1. OUT +2 is referenced to OUT -2 when a differential output is desired.
TEMP	This is the temperature output signal. It is a single-ended signal, and is referenced to SIG GND.
SIG GND	This is the reference ground for the single-ended outputs of the SCU.
ESD GND	This is a separate earth ground used for protection of the internal SCU circuitry from high-voltage surges. ESD GND is connected to the internal circuitry by transient surge absorbers. These absorbers are nonlinear resistors that change resistance as a function of the applied voltage (the higher the voltage, the lower their resistance). Their response time is approximately 50 nanoseconds. For maximum surge protection, ESD GND should be connected to an earthed pipe or ground rod.
+12 V	Connect +11 to +15 volts DC to this terminal.
PWR GND	Connect the power ground (power common) to this terminal
-12 V	Connect -11 to -15 volts DC to this terminal.

### 3.0 MAINTENANCE AND TROUBLESHOOTING

#### 3.1 Routine Maintenance:

The SCU is rugged and should require no maintenance other than occasional cleaning of the box with a soft cloth. Keep the SCU and tilt sensor from extremes of heat and cold. Extreme temperatures unnecessarily stress the electronic components. If possible, keep the SCU and sensors out of direct sun, because internal temperatures can build up to a level considerably greater than the ambient temperature.

The SCU is protected from dust and splashes by its rugged aluminum enclosure. The unit is not waterproof, so never allow it to be submerged, or allow standing water to accumulate inside.

**NOTE: WATER DAMAGE TO INTERNAL COMPONENTS VOIDS THE WARRANTY!**

Apart from the procedures described below, the SCU is not field-serviceable. Therefore, if you should encounter problems not described herein, please contact a Jewell Instruments sales representative at (603) 669-6400 for assistance.



### 3.2 Determining the Cause of Malfunctions:

Although the SCU is not field-serviceable, there are some basic things you can do if you should encounter problems.

If there is no output when you have connected the tilt sensor to the SCU, first make sure the terminal screws are tightened securely to the power supply and sensor lead wires. Also, check the potential, and the polarity of the power supply. Failure to obtain an output signal normally is the result of lack of power, or a broken wire or connection.

If you have established that the problem is internal to the SCU, and is not a bad connection or a bad sensor, check the sensor connections to the internal printed circuit board. To do this, first remove the top two screws in each side panel then gently lift away the SCU top panel. Small plastic connectors are used to attach the tilt and temperature sensor leads to the printed circuit board. Check to be sure that these connectors have not become loose or detached. If you remove any of these small plastic connectors, be sure to replace the Sensor 1, Sensor 2, and temperature connectors *exactly* as you found them. Figure 2 shows the proper connector locations. *CONNECTING THE TILT SENSOR WIRES TO THE TEMPERATURE POSITION ON THE PCB will cause PERMANENT TILT SENSOR DAMAGE that is not cover by the warranty.*

If an inspection of the connections to the printed circuit board does not correct the problem, please call a Jewell Instruments sales representative at (603) 669-6400 for assistance.

#### CAUTION

***NEVER USE AN OHMMETER TO MEASURE JEWELL INSTRUMENTS TILT SENSORS. APPLYING DC CURRENT THROUGH THE SENSORS WILL CAUSE PERMANENT DAMAGE THAT IS NOT COVERED BY THE WARRANTY***

## **APPENDIX A - Warranty and Assistance**

Jewell Instruments tilt sensing instrumentation is warranted against defects in materials and workmanship for one year from the date of delivery. We will repair or replace (at our option) products that prove to be defective during the warranty period provided they are returned prepaid to Jewell Instruments. No other warranty is expressed or implied. The warranty is void if the equipment is subjected to lightning strikes, or other large potential gradients, or if it is otherwise abused. After expiration of the warranty, Jewell will repair the equipment at its factory for parts and labor charges. Products returned after warranty expiration should be accompanied by a purchase order to cover repair costs. Jewell Instruments is not liable for consequential damages.

The remedies provided herein are the buyer's sole and exclusive remedies. Jewell shall not be liable for any direct, indirect, special, incidental, or consequential damages, whether based on contract, tort, or any other legal theory.

# APPENDIX B - Custom Specifications for your Equipment

Signal Conditioning Unit Serial No.: \_\_\_\_\_

## Transducer Wire Colors

The wire colors of the tilt and temperature transducers shipped with this unit correspond to the following functions (see Section 2.1):

Transducer Ser. No. _____		Transducer Ser. No. _____		Transducer Ser. No. _____	
Function	Wire Color	Function	Wire Color	Function	Wire Color
+		+		+	
E		E		E	
-		-		-	

Transducer Ser. No. _____		Transducer Ser. No. _____		Temperature Sensor	
Function	Wire Color	Function	Wire Color	Function	Wire Color
+		+		T1	Red
E		E		T2	Orange
-		-		T3	Yellow

## Filters

Your SCU has two single-pole RC low-pass filters (integrators) selected by the FILTER switch on the front panel. The time constant ( $\tau$ ) for each filter setting is listed below.

After an instantaneous change in tilt, the output signal settles to 90% of this value after three time constants, and to 98% of this value after four time constants. The corner or cutoff frequency  $f_c$  is defined as the frequency at which signal attenuation is 3 dB. Filter roll-off above the corner frequency is constant at 6 dB per octave (20 dB per decade). Corner frequency can be calculated as:  $f_c = 1/(2\pi\tau)$

$\tau$  values for filter settings:

ON: \_\_\_\_\_ seconds

OFF: \_\_\_\_\_ seconds

## Scale Factors

Your Signal Conditioning Unit has been calibrated for operation with the tilt transducers listed below. However, it will operate any Jewell Instruments tilt transducer. If you purchase new tilt transducers for use with the SCU, they should be calibrated with the SCU prior to use. Jewell Instruments will perform these calibrations if the Signal Conditioning Unit is shipped prepaid to our factory at the time the order for new transducers is placed.

Scale Factors are determined by moving the transducers through a range of angles and recording the SCU output at each angle. Linear regression analysis then determines the slope of the straight line that best fits the data. This slope is the Scale Factor. Reported below are Scale Factors and their corresponding maximum nonlinearity.

**Note:** Differential Scale Factors are double single-ended Scale Factors when expressed as volts per angular change. When Scale Factors are expressed as angular change per volt, differential Scale Factors are one half single-ended Scale Factors.

SCU serial number: \_\_\_\_\_

Calibration range units: \_\_\_\_\_

Scale Factor units: \_\_\_\_\_

"SENSOR 1" CHANNEL									
Transducer Serial No.	Calib. Temp. °F	Calib. Range, ±		Scale Factors				Single- ended	Differential
		High Gain	Low Gain	High Gain	Max. Nonlinearity	Low Gain	Max. Nonlinearity		

"SENSOR 2" CHANNEL									
Transducer Serial No.	Calib. Temp. °F	Calib. Range, ±		Scale Factors				Single- ended	Differential
		High Gain	Low Gain	High Gain	Max. Nonlinearity	Low Gain	Max. Nonlinearity		

Max. Nonlinearity = % of full calibration span.

The Scale Factor of the temperature output is 0.1°C/mV.

