Teksym Corporation

GaugeLink

Power Interface Version 5

Operator's Manual

Version 1.0.4 d

August 14, 2018

This Manual with exceptions noted, is suitable for use with the Power Interface, version five (PI 5)

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1. Scope: This manual describes the functions of the Power Interface 5.

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2.14 Gain Ranges: Amplification of the gauge voltage is selected with the Range and Span selectors for each channel. The ranges overlap so that all gain from 13.31 to 174.33 are selectable to make the amplification proper for the particular gauge used.

The gain range and span settings produce the same results for all four channels of the PI 5. They are:

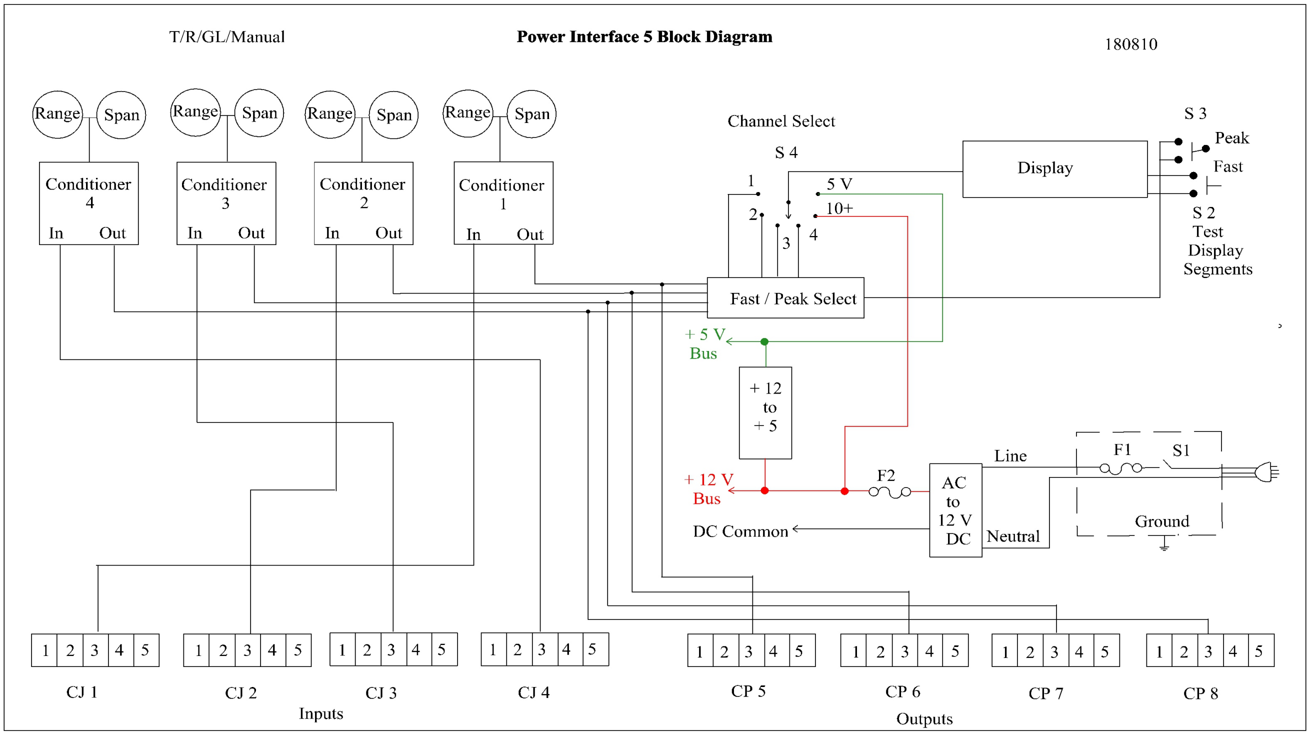
Range	Span at Minimum = 000	Span at Maximum = 1000
1	13.31	21.00
2	20.85	33.26
3	32.31	51.88
4	49.19	79.31
5	73.73	119.18
6	107.67	174.33

In practice, the gain is set by connecting the Gauge Gold Standard (GS) for that gauge size, then adjusting the Display voltage for that channel = 8.000 volts, since the GS is cut to 80 % of the full crack length to be sensed by that gauge. With this gain setting, the slope of the slope-intercept relationship of voltage to crack length is implemented.

No provision for setting the zero offset is included with these settings. The zero offset will be observed when the test gauge is connected to the channel. That voltage can then be used by the customer Data Acquisition/Control System to provide the zero voltage reading.

2.15 Gauge Length Output voltages: The PI 5 Display displays one selected Fast or Peak signal for all four channels. Simultaneous and continuous analog Fast and Peak signal voltages for all four channels are available at the four output connectors.

3.Functional:



4. Method of Measuring Crack Length:

The pattern of the crack Gauge foil allows a specimen crack to be transferred to the foil of the crack gauge which is a resistive path which grows as the crack progresses. A constant current is sent through the gauge path. The resulting voltage produced by the increasing crack length represents the magnitude of the crack length. The GaugeLink Power Interface produces the constant current and then amplifies the gauge voltage which is amplified so that the voltage produced when the gauge crack reaches 100 % of the designed crack length will equal 10.00 volts.

The constant electrical current is generated for each of four gauge channels. This current is sent to the I (current), (red) terminal of the gauge. It passes through the gauge and exits at the C (common), (black) connection. The voltage generated across the gauge resistance is proportional to crack length. This voltage is sensed at the + (plus signal) (green) and – (minus signal) (white) connections. The signal voltage is returned to the Power Interface for amplification to a full scale voltage of + 10.00 volts. This voltage is sent to the appropriate connector and pin connections of the “Output Connect” terminals on the right rear of the Power Interface. The channel voltage of 10.00 volts represents a full crack length of 100%

Because the gauge has a significant resistance at the beginning (0 mm) crack length, there is a significant zero offset voltage which must be accommodated by the data acquisition system connected to the Power Interface Output connections. The voltage increase from the beginning 0 mm reading to the 100% 10 volt reading is linear with increasing crack length up to 100% of crack length = 10.000 volts.

5 Introduction to the GaugeLink System:

5.1 Definition: The GaugeLink System consists of all setup, connections and operations and of a crack gauge to a laboratory instrumentation system such as a volt meter, data acquisition system or a test system Interface. Calibrate the PI amplifier gain to provide a 10 volt full scale signal for a particular gauge size. Sense and hold for a period greater than 1 fatigue cycle, the maximum resistance experienced. Output the amplified Fast and Peak signal to a Data acquisition system or Test Controller.

5.2 Purpose: The output voltage produced by the Power Interface is proportional to the crack of the length of the gauge connected.

5.3 Calibration: Special fixtures consisting of gauges cut with an 80% crack are first connected to the input of a channel. The output of the channel is selected for the Display and the Range and Span selectors for that channel are adjusted to have the Display read 8.000 volts (80% of the full crack). The channel is now calibrated to the gauge to be connected to the channel input. Upon connection of the new test gauge, a zero offset voltage will be displayed and that value inputted to the Data acquisition/Control System for proper conversion to 0-100% of engineering units (mm).

5.4 Fast Setup and Checkout:

5.1 A quick guide to turn on and setup of the PI 5 for those who disdain manuals.

Connect Power cord to PI and AC outlet
Connect Terminators to unused inputs
Connect Gold Standard('s) (GS) to operational input channels
Switch on at Power Inlet (rear)
Switch Channel Selector to 10 +. Reading should be > 11 volts
Switch Channel Selector to 5 +. Reading should be between 4.95 – 5.05 V
Switch Channel Selector to select channel(s).
Adjust select channel(s) range and span for 8.000 volts (80% of gauge range)
Connect external Control/Data Acquisition to operational Output connectors
Switch power off at Power Inlet
Remove GS('s)
Connect gauge(s) to operational input(s)
Switch on at Power Inlet
Switch Channel selector to operational inputs(s)
Record “zero mm” voltage
Apply “zero mm” voltage reading and 100% mm = 10 volts to Control/Data Acquisition setup.
Start test

5.2 Fast Checkout:

After using the system, the following guide can provide a fast evaluation of the PI 5

performance:

<u>A Guide to PI 5 Checkout in 20 Minutes</u>

<u>Date:</u> ____________ By: ________ PI 5 S/N: ___________GS Model No: __________ S/N: _______

<u>Items:</u> A: PI 5, B: 3 Terminators, C: 1 GS, D: 1 Voltmeter (DVM)

Vd=voltage read on front panel display, Vo= Voltage read on pins of output connectors

<u>Step 1:</u> Connect GS to Input 1
Connect Terminators to input channels 2-3-4.
Switch Front Panel Input knob to 10+
Set **<u>all four</u>** range and span selectors to nominal values for this GS
Do **<u>not</u>** connect Data Acquisition/Control System wiring.
All 10+ voltage readings should be between11-12 volts
All + 5 voltage readings should be between 4.95 and 5.05 volts.

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Step 2: <u>Peak switch off..</u> Turn on PI 5. Display should read 11-12 volts Vd10+=_________
Step 3 Switch PI Input knob to +5. Vd (Display) should read 4.90-5.05 volts. Vd +5=_________

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Step 4 Switch PI 5 Input to Input 1. Turn on PI 5.
Set Channel 1 Range 1 & Span 1 to Display=8.00 V. Read Ch 1 display.Vdf1=__________
Step 5 Measure channel 1 Output <u>fast</u> voltage) with DVM at CO 1, Pin 1-2. Vof1=__________
Step 6 Peak switch on. Read Vd (Display) volts = 7.9-8.1 V Vdp1=__________
Measure channel 1 Output <u>peak</u> voltage
with DVM at CO 1 Pin 3-4 Should be 7.9-8.1 volts. Vop1=__________
<u>Peak switch off.</u> PI 5 power off.

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Step 7 Swap GS & Channel 2 terminator. Switch PI 5 Input to Input 2. Turn on PI 5.
Set Channel 2 Range 1 & Span 1 to Display=8.00 V. Read Ch 2 display.Vdf1=__________
Step 8 Measure channel 2 Output <u>fast</u> voltage) with DVM at CO 2, Pin 1-2. Vof1=__________
Step 9 Peak switch on. Read Vd (Display) volts = 7.9-8.1 V Vdp1=__________
Measure channel 2 Output <u>peak</u> voltage
with DVM at CO 1 Pin 3-4 Should be 7.9-8.1 volts. Vop1=__________
<u>Peak switch off.</u> PI 5 power off.

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Step 10 Swap GS & Channel 3 terminator. Switch PI 5 Input to Input 3. Turn on PI 5.
Set Channel 3 Range 1 & Span 1 to Display=8.00 V Read Ch 3 display. Vdf1=__________
Step 11 Measure channel 3 Output <u>fast</u> voltage) with DVM at CO 3, Pin 1-2. Vof1=__________
Step 12 Peak switch on. Read Vd (Display) volts = 7.9-8.1 V Vdp1=__________
Measure channel 3 Output <u>peak</u> voltage
with DVM at CO 3 Pin 3-4 Should be 7.9-8.1 volts. Vop1=__________
<u>Peak switch off.</u> PI 5 power off.

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Step 13 Swap GS & Channel 4 terminator. Switch PI 5 Input to Input 4. Turn on PI 5.
Set Channel 4 Range 1 & Span 1 to Display=8.00 V. Read Ch 4 display.Vdf1=_________
Step 14 Measure channel 4 Output <u>fast</u> voltage) with DVM at CO 4, Pin 1-2. Vof1=__________
Step 15 Peak switch on. Read Vd (Display) volts = 7.9-8.1 V Vdp1=__________
Measure channel 4 Output <u>peak</u> voltage

with DVM at CO 4 Pin 3-4 Should be 7.9-8.1 volts. Vop1=__________

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Checkout is now complete. If all voltages are within range, the PI5 is functioning properly.
Connection to the System Data Acquisition/Control can now be made.
Any voltages out of range indicate a need for PI 5 service.

6. Components: The GaugeLink System consists of the following:

6.1 Power Interface Instrument

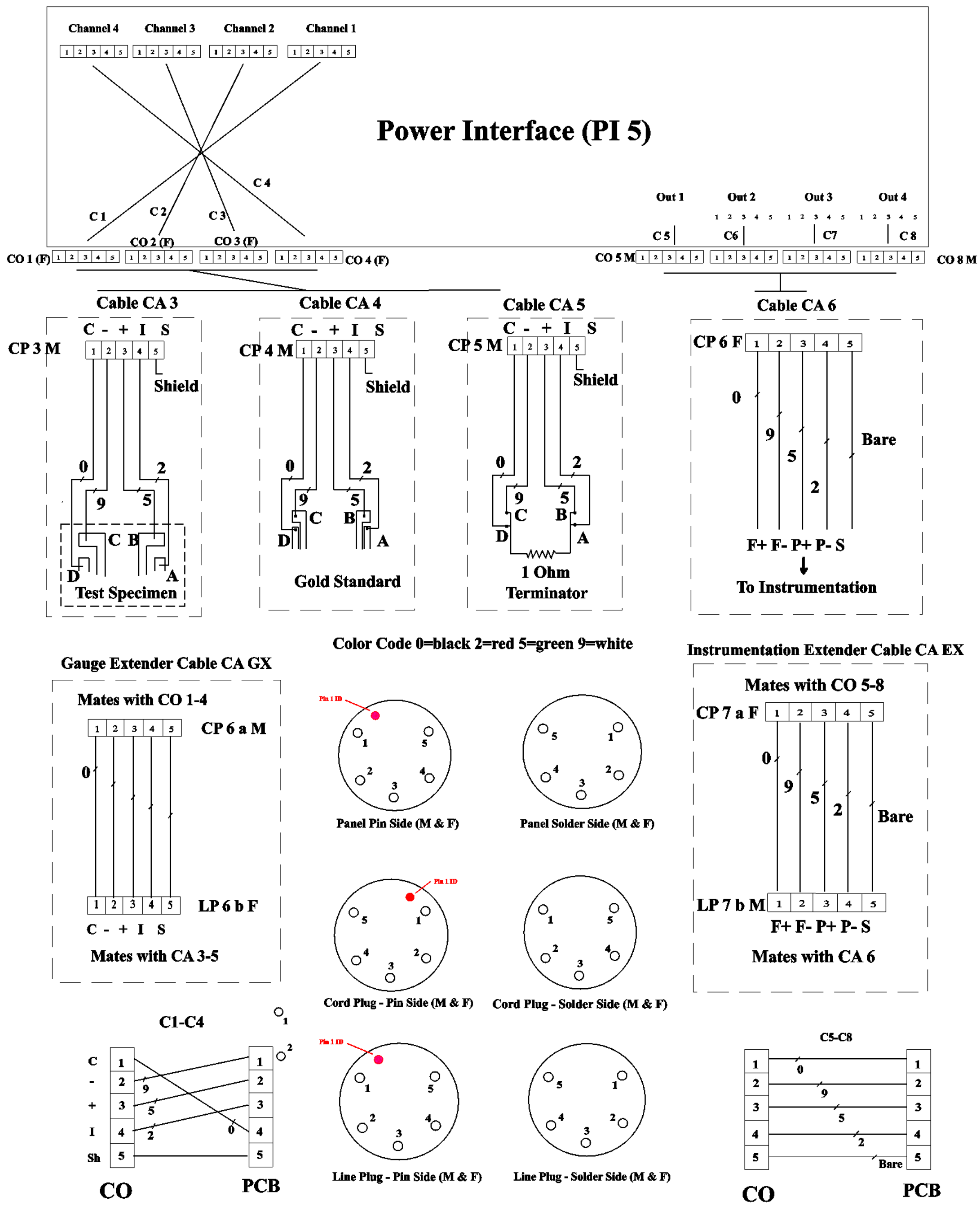
6.2 Gage calibrator (one for each size of crack gague)

6.3 Cables to connect the PI to the GC (CA 4). Cables are produced in various lengths.

6.4 Cables to connect the PI to the specimen (CA 3). Cables are produced in various lengths. The identification of the cable length follows the part identification on the label. For example a 10 foot long specimen table is designated CA - 3 -10. Daisy chaining cables (CA-DC) are only allowed by including unique cables designed for the purpose. The maximum interconnected length, can be up to 30 feet.

GaugeLink Cable Connector Identification

DR 180806

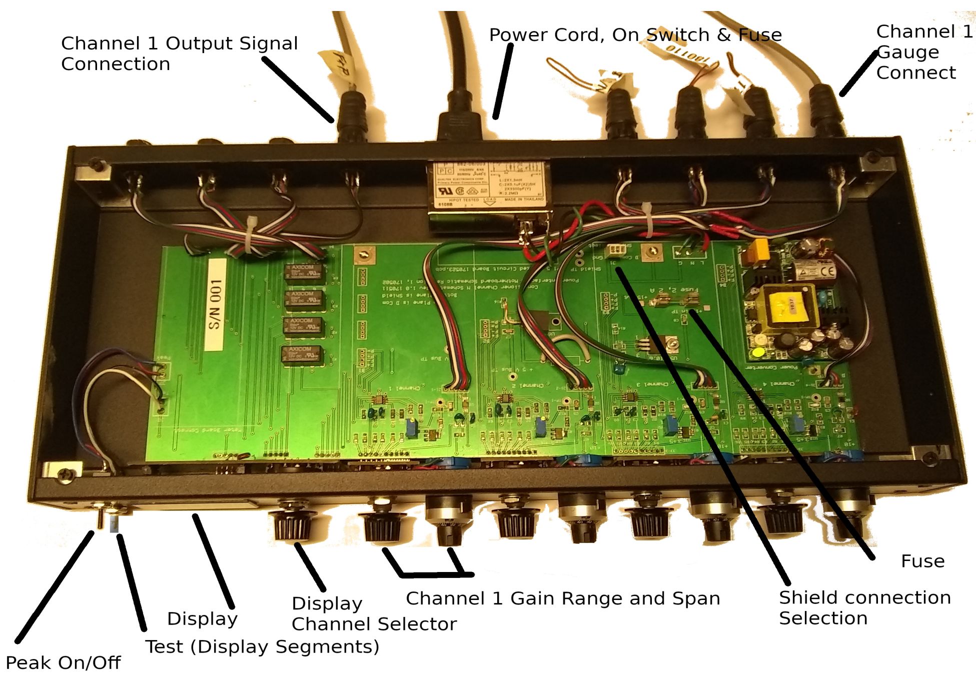


6.5 Terminators are special connectors with circuitry to connect to the inputs of any unused channels. These provide the proper connections to conditioner electronics so that improper terminations are eliminated. Failure to use these connectors can result in failure of the circuitry of a conditioner.

7.0 Human Interface (Front Panel, Rear Panel)

7.1 Front Panel

7.2 Top View



7.3 Rear Panel

8. PI Connections (Power Line, Gold standard, Gauge, System Data Collection. Shield)

8.1 Power

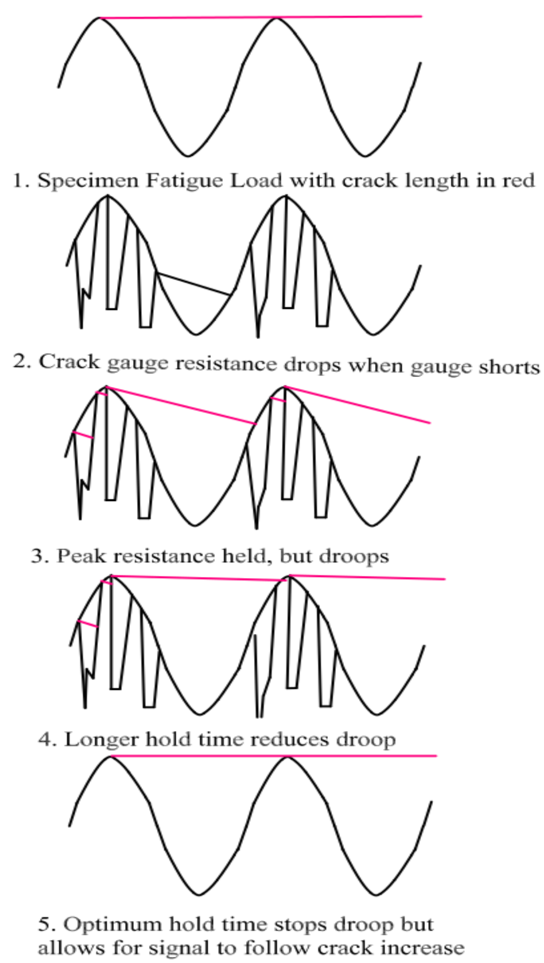
8.2 Input connections

8.3 Data acquisition and Control system connection

9. Fast and Peak Hold Output Voltages

During the fatigue cycle the force goes from a minimum to a maximum, during which period the crack opening also goes from a minimum to a maximum. As the crack gap narrows, the possibility of metal from the one side of the crack touch the mantle of the other side of the crack, causing a shorter current path which makes the output signal fluctuate. The best solution to this problem is to have the data acquisition system set to a sample period greater than one fatigue cycle, and then sample for the peak during that period so that the maximum crack opening will always be provided.

Peak sensing of crack signal with fatigue Loading



The Power Interface has circuitry to hold the peak crack length so that noisy voltages caused by the inter cycle gauge shorting does not hamper acquisition of the real crack length .

This Peak 10 volt full scale signal is continuously available at each channel's output connector P 5- P 8 with Fast signals on Pins 1 (+) and 2 (-). Peak signals are on each output connector at pins 3 (+) and 4 (-).

Never put any voltages other than the data acquisition differential inputs on the output connectors, P 5 – P 8, pins 1-4.

10. Calibration and Use:

10.1 Gain settings:

Gain settings determine the amount of amplification of the gauge voltage which will give a full scale amplifier a output voltage of 10.000 volts. With a combination of the range switch and span setting, a continuous rain job gains from 11.0 to 189 can be selected.

The range and gain settings are most easily set up with the use of a gauge gold standard (- 30 GS) which matches this size of the gauge intended to be used in testing. For example, if a 30 MM gauge is to be bonded to a specimen, the GS 30-80 is plugged into the input of the channel to be used. All gauge gold standards are cut to 80% of the full crack length for that gauge. For the 30 MM gauge the gold standard crack link will be 24 mm long.

Pin 1: C	Black
Pin 2: -	White
Pin 3: +	Green
Pin 4: I	Red.
Pin 5: Shield	Bare wire

For example, if a 30 MM gauge is to be bonded to a specimen, the GS 30-80 is plugged into the input of the channel to be used. All gauge gold standards are cut to 80% of the full crack length for that gauge. For the 30 MM gauge the gold standard crack link will be 24 mm long.

All channel conditioners provide 50.0 milliamps of gauge current, which when passing through a 30 MM gauge with an 80% crack will produce a --- millivolt signal. This signal connects to the input of the amplifier which must have its gaine adjusted so that the output will be 8.000 volts for this input signal. This is done by first setting display switch to select the signal a output from the channel in calibration. the range and gain settings are then the adjusted so that the display reads 8.000 volts. These range and gain settings should be the same for all following 30 MM gauges connected to this channel, but for rigorous test protocol the calibration procedure may be done prior to each test.

It may be found that the test results show a consistent linear variation of all data set in with the calibration protocol, such that a slight change in the gain settings may be warranted. For example if all test work showed that the PI 5 signal was consistently 1/2% above the real crack length, and calibration display voltage could be reduced by 1/2% to 7.96 volts when setup with the 30 mm GS.

Since the crack length and gauge resistance are linearly related, the voltage produced at the input of the amplifier will be linearly proportional to the crack length.

10.2 Zero offset: the design of a crack gauge results in a significant zero offset. For example, a 40 MM gauge properly scaled will get a zero offset of 4.30 volts. That gauge will provide an output of 10.00 volts when the crack reaches 40 MM.

The customer furnished Data Acquisition System (DAQ) may be scaled to engineering units The offset is to be accommodated by the DAQ which has provisions for zero offset. In scaling the DAQ to engineering units, the setting of zero MM will be accommodated by the zero crack voltage (4.30 v in the case of a 40 mm gauge and the one hundred MM setting will be represented by a voltage of 10.00 volts. The DAQ should then provide engineering units of 0 mm to 100 mm from input voltages(4.30 volts to 10 volts in the case of the 40 mm gauge.

Because the gauge physical size is both finite and substantial, the gauge mounted to the specimen will show a significant voltage above zero at the time the crack length is zero. Before the test is started this zero offset voltage must be accommodated by the data acquisition/control system.

10.3To Calibrate to a Gold Standard:

Setting the gain of the PI for a particular gauge size

Select the Gold Standard (GS) for the test gauge size
Connect the GS to the select input
Apply power
Select the test channel at the Channel Select knob
Move the select channel Range and Span controls so that the voltage display reads
8.000 volts (= 80% of gauge range)
Remove power, remove the GS

Connecting the Test Gauge to the input channel

Apply power
Record the select channel voltage which indicates the voltage of a zero mm crack length.
Input the zero crack length data into the Control/Data acquisition setup
The system is now ready for test. As the crack grows, the voltage will increase linearly with crack length so that at 10.000 volts, the crack will be 100% of gauge sense.

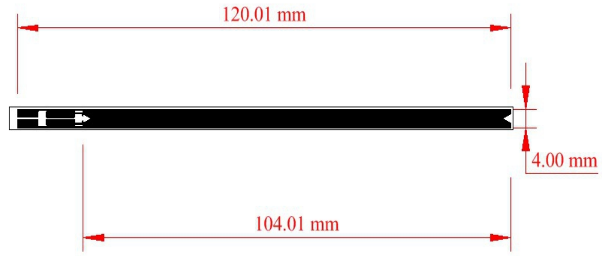
10.4 Connection to a gauge in test:

Replace the GS with the cable to the test gauge at the calibrated input. Connection to a gauge is made from one of four input connectors on the left rear, labeled “Gauge Connect.” The rear connector channel number correlates to the numerical channel selectors at the front panel.

Input Connector Pin Conventions:

Pin 1: C	Black (0)
Pin 2: -	White (9)
Pin 3: +	Green (5)
Pin 4: I	Red (2)

Example of Gauge Connections to a100 DCB Gauge:



100 DCB Gauge

Excitation current (I) enters gauge at connection I

Excitation current leaves gauge at connection C (common)

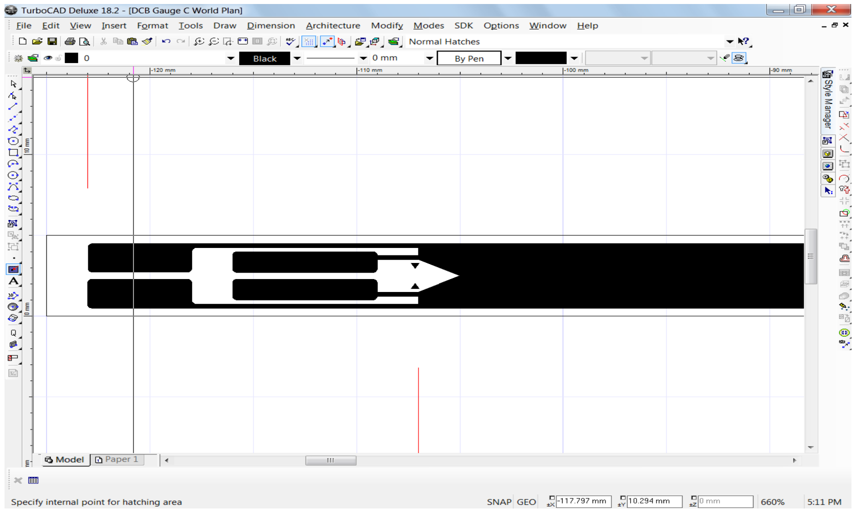
Gauge positive signal voltage proportional to crack length is generated at connection +

Gauge negative signal voltage proportional to crack length is generated at connection -

10.5 Specimen Wire connections:

Wire connection Conventions:

Note that it is the 'V' notch which is the starting point of the crack.



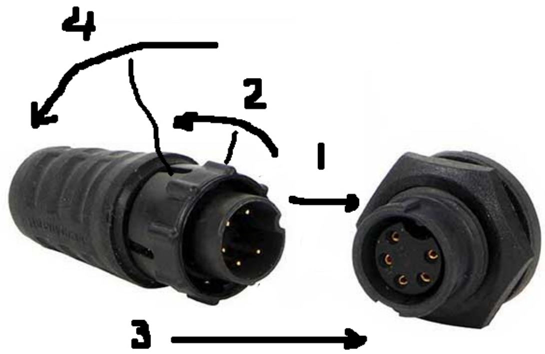
11. Special Considerations:

11.1 Connector Handling:

All cable interconnects of the GaugeLink system are made through 5 pin Switchcraft EN3 Series Weather tight connections. These connectors provide reliable connections but if mishandled can cause intermittent connections or failures.

When mating two connectors follow a **gentle** 4 step procedure as follows:

Gently rotate the plug to align the connectors into the receptacle about 10% of the way.
Gently push and rotate the collar (2) clockwise to align it so that it does not rotate.
Push the plug completely into the receptacle until it no longer moves.
Rotate the collar (2) clockwise to lock the plug into the receptacle.
Follow the same instructions in reverse to disconnect a plug.



11.2 Support for wires connected to gauge pads:

The electrical connections to the 100 DCB gauge are provided to allow a simple solder connection. Due to the very small size of the connector pads, it is recommended to first solder insulated wires to the pads so that 0 stress is applied to the solder pad. Then immobilize the wires with an epoxy glue before continuing the wire on to a connector which joins the wire to a cable.

11.3 Help: Questions can be addressed by telephone to 1-763-479-6190 or as an e mail to staff@teksym.com

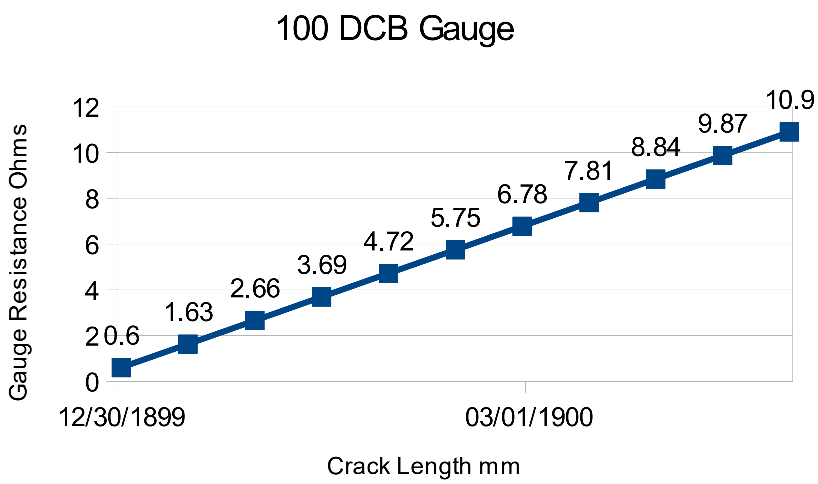
11.4 Shield Connection: Location of the jumper to allow connecting the shield plane to either AC ground, DC common or open (to allow user connection of a separate shield drive.)

Shield connections (Shield) on pin 5 can be made to Data acquisition/Control system electronics which provide shield drive for common mode rejection. If this mode is used, the connector J1 – Shield Connect, must be removed so that the shield plane of the GaugeLink system is not connected to either system ground or DC common.

11.5 Using fundamentals to implement special situations.

By example the ability to provide for special applications of Low Resistance Insulated Gauges with the Power Interface 5 is demonstrated. Assume that a 100 DCB gauge is to be modified to provide the data for a 50 mm full scale crack by cutting the gauge shorter. A new gain setting will be required.

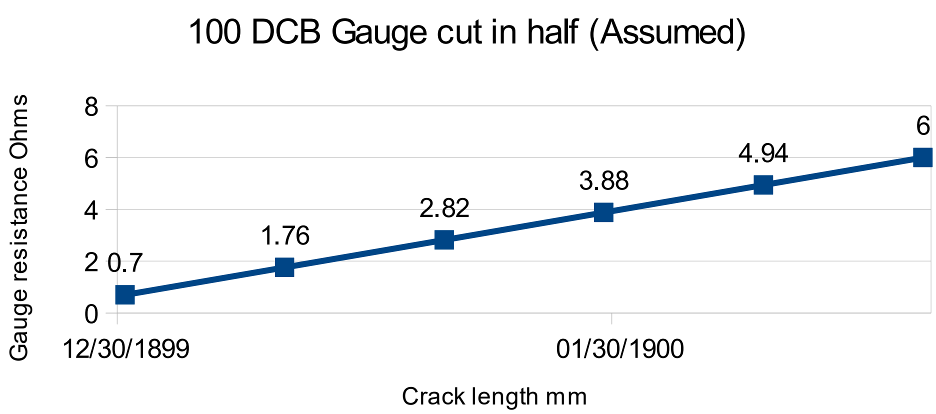
The resistance of the 100 DCB gauge with crack length is known:



Let us assume that a 100 DCB gauge is to have it's active crack length space reduce from 105 to 60 mm. The active length of 60 mm will give a smaller nonlinearity at 100% than the standard 100 DCB gauge which only has an excess of 5 mm. (Assumption #1)

The shorter length will increase the zero crack length resistance to 0.7 Ohms. (Assumption #2)

For a 100 DCB gauge cut to an active length of 60 mm, the resistance with a 50 mm crack is 6 Ohms. (Assumption #3)



The channel conditioner provides an excitation current of 0.050 A.

The full scale gauge voltage for a 50 mm crack will be = I x R = 0.050 x 6.000 = 0.300 volts

The amplification required for this gauge will be A = Vo/Vg = 10.000/ 0.300 = 33.33

The gain setting will require selecting the channel Range selector to 3. (A=32.31 to 51.88)

The gain difference over the full range of the span selector is 51.88-32.31=19.57

The amount S contributed by the span (0-1000 units) will be:

(33.33-32.31)/S=(51.88-32.31)/1000. Solving for S gives S = 052.

Setting the Span to 52 will set the channel gain to 33.33 so that the gauge resistance with a 50 mm crack will have an output voltage of 10.000 volts.

Note that the zero offset voltage with this gain will be: (Vg-o) x A = (0.050 x 0.7) x 33.33 = 1. 17 volts

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