PCB PIEZOTRONICS INC.

General Purpose
Acceptance Test
ICP/Charge Mode Dynamic Pressure Sensor

1. Acceleration Sensitivity using the Frequency Response Console software (This test is also used for in process acceleration compensation).

   A. The equipment listed below used during this test is calibrated per ISO 10012 and former MIL-STD-45662A and the calibration records are on file.

      1) National Instruments DAQ card (or equivalent)
      2) Unit Under Test (UUT) Signal Conditioner (PCB Model 443B102 or equivalent)
      3) Reference Signal Conditioner (PCB Model 443B102 or equivalent)
      4) Reference ICP Accelerometer (PCB Model 301A04 or equivalent)
      5) Reference Power Supply (PCB Model 441A101 or equivalent)

   B. The equipment listed below used during this test and calibration is not required.

      1) Inline Voltage Amplifier, 40550-01, FIX-CAL-AMP NO FILTER; 54688-01, FIX-CAL-AMPLIFIER ASSEMBLY
      2) Power Amplifier for Shaker (Crown DC300A series II or equivalent)
      3) Shaker, 25 lb. minimum
      4) Pressure Sensor Test Mounting Adaptor
      5) Mounting Stud (081B05, 081A08, or equivalent)
      6) Relay Box (also referenced as interface box, patch panel, breakout box, etc.)
      7) Computer workstation equipped with Frequency Response Console software (EE178)
      8) All necessary cables

   C. Equipment Setup: Use the setup relevant to the sensor/assembly you are calibrating.

      1) Sensor with Coaxial Connection and Dual-Mode Signal Conditioner Setup
         • Model Examples: 103, 106, 112 & 113 style assemblies, 176M53 top level assembly

         1. Reference Figure 1.
         2. Connect the equipment as described below.
            a. Connect the Reference Sensor output cable/connector to the Reference Signal Conditioner input.
            b. Connect the Reference Signal Conditioner output to the REF INPUT port on the front of the Relay Box.
            c. Connect the unit under test (UUT) output cable/connector to the UUT Signal Conditioner input.
            d. Connect the UUT Signal Conditioner output to the UUT INPUT port on the front of the Relay Box.
            e. Connect the Relay Box ANALOG OUTPUT to the Power Amplifier input.
            f. Connect the Power Amplifier output to the Shaker input.
            g. Discharge the element before connecting inline voltage amplifier, so that amplifier is not blown.
            h. When testing acceleration on a pressure element in charge mode, attach an inline voltage amplifier onto the pressure element. In this case, the inline voltage amplifier capacitance must be tested before calculating acceleration sensitivity.

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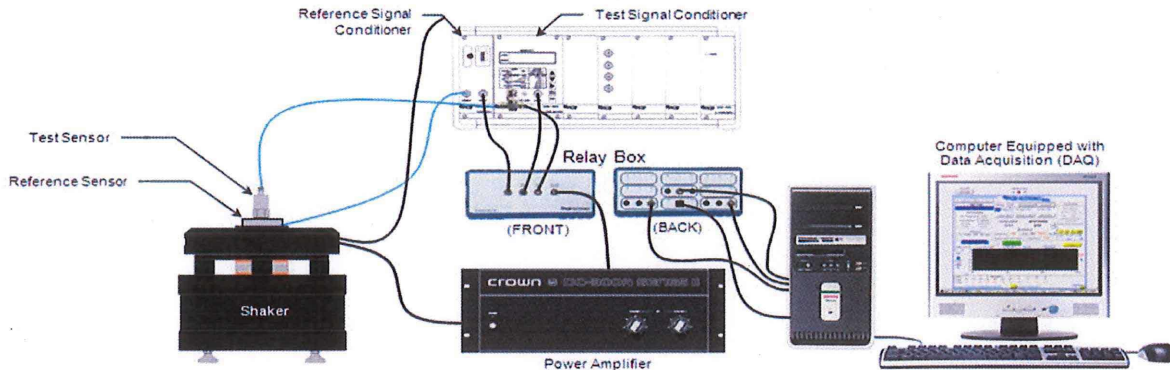QC035 REV. A 04/13/98

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Figure 1

2) <u>Sensor with Multi-Conductor Connector and Differential Amplifier Setup</u>
   - Model Examples: 176A02, 176A03, 176A05 & 176M18 style assemblies

   1. Reference Figure 2.
   2. Connect the Equipment as shown.
      a. Connect the reference sensor output is connected to the reference signal conditioner input.
      b. Connect the reference signal conditioner output to the REF INPUT port on the front of the Relay Box.
      c. Connect the unit under test (UUT) output to the test signal conditioner input (Differential Amplifier in this case).
      d. Connect the test signal conditioner output to the UUT INPUT port on the front of the relay box.
      e. Connect the ANALOG OUTPUT from the Relay Box to the power amplifier input.
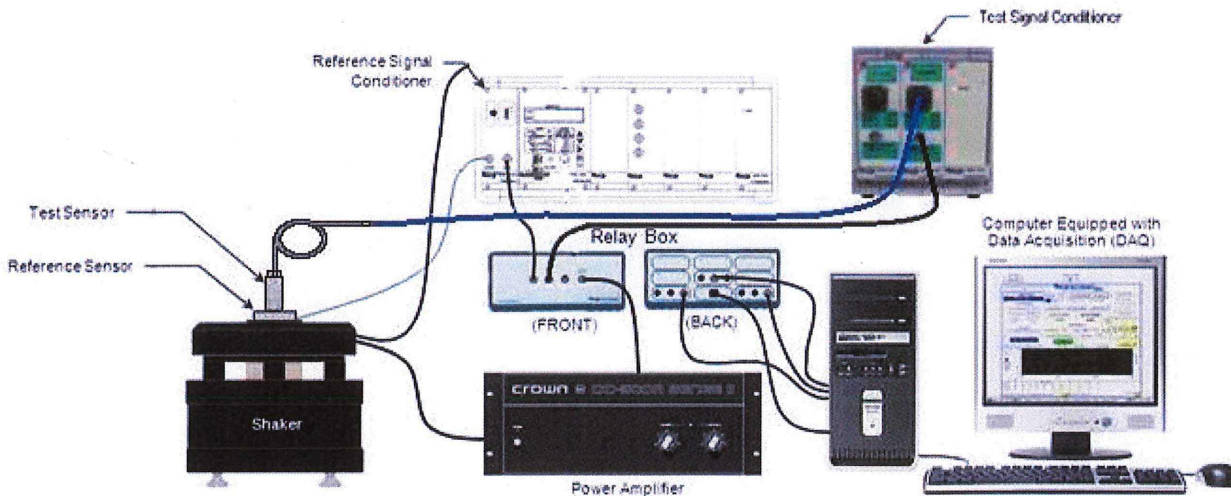   f. Connect the power amplifier output to the shaker input.

Figure 2

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3) **3-Wire IEPE Sensor with DC Power Supply Setup**
    - Model Examples: 106M168, 106M169 and 106M170 assemblies

1. Reference Figure 3.
2. Connect the equipment as shown.
    a. Connect the reference sensor output is to the reference signal conditioner input.
    b. Connect the reference signal conditioner output to the REF INPUT port on the front of the Relay Box.
    c. Connect the unit under test (UUT) output to the 62969-01Breakout Box input.
    d. Connect the 62969-01Breakout Box output to the UUT INPUT port on the front of the relay box.
    e. Connect the ANALOG OUTPUT from the Relay Box to the power amplifier input.
    f. Connect the power amplifier output to the shaker input.

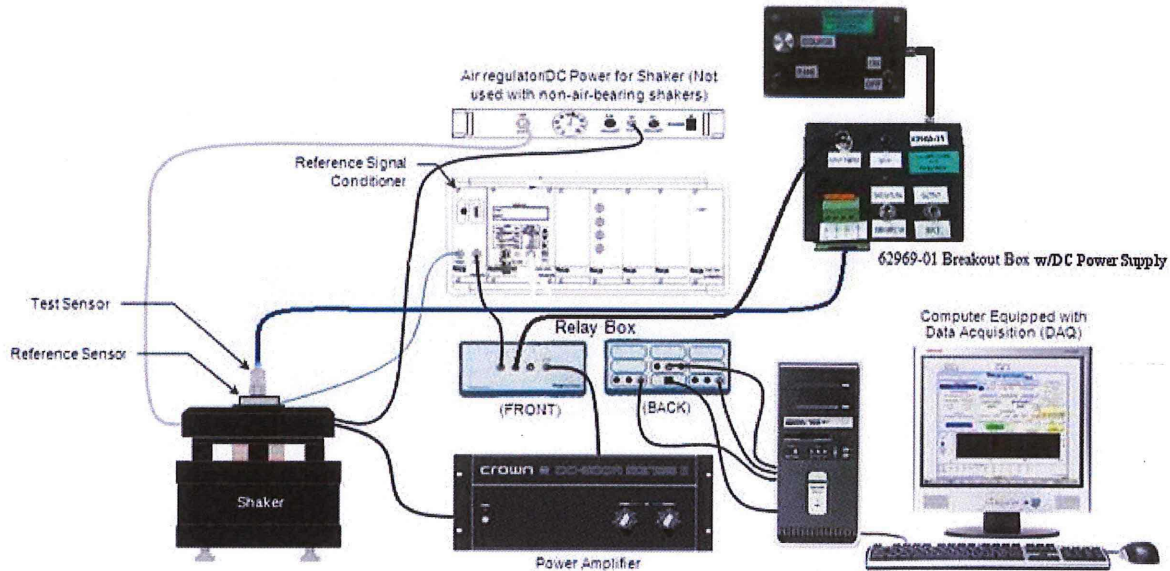Figure 3

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D. Program Setup

1) Reference Figure 4.
2) Launch the FR Console Program located on the Computer Workstation.
3) Reference Figure 5.
4) After signing into the program with your workstation login, check "System Messages" that all systems check out.
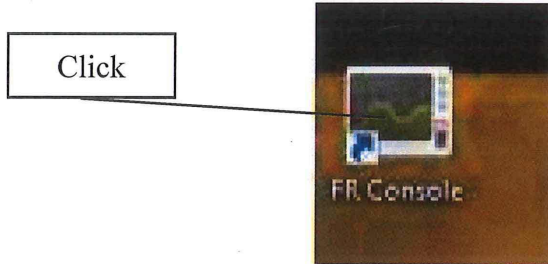5) Select "Perform Vibration Calibration" on the Main Screen as shown.
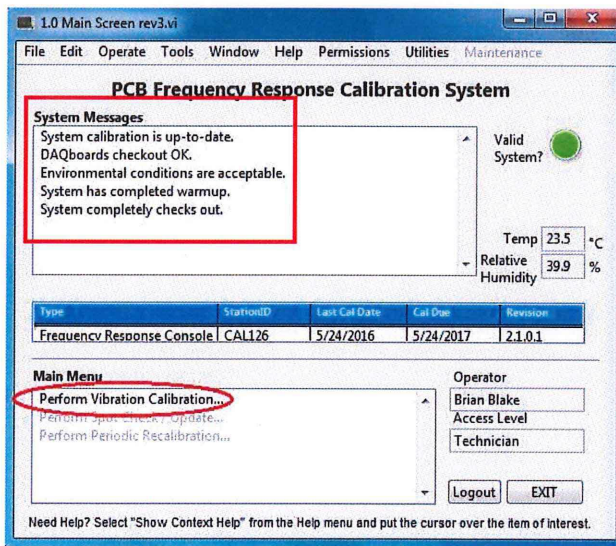
Click

FR Console

Figure 4

Figure 5

6) Reference Figure 6. This is the "Select Model/Profile" window.
7) Scan the router or enter model/assembly number in to the "Model" field.

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Figure 6

8) Reference Figure 7.
9) In the column, Profile Type, the value field should display "menu not used". If field states anything else, click on down arrow to pick "menu not used" from the menu options.
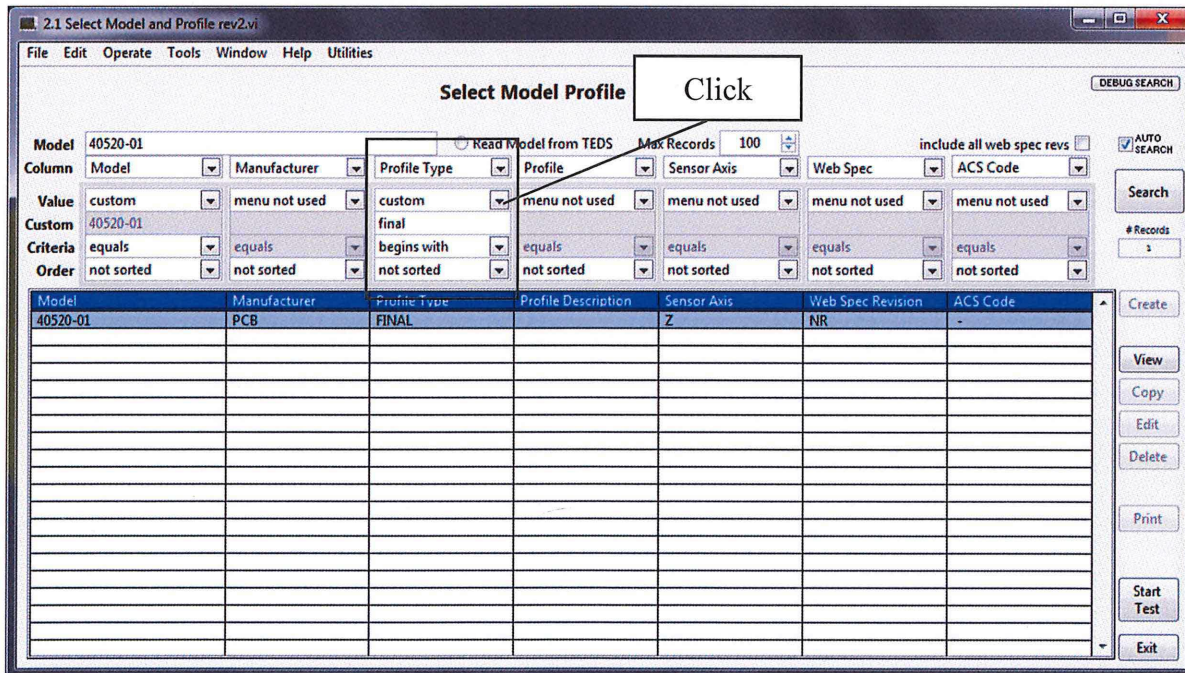

Figure 7

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10) Reference Figure 8.
11) Click on the appropriate profile, FINAL or Precal.
   NOTE: Do not use Engineering Profiles for "Final or Precal". If a profile does not show up, see Engineering.
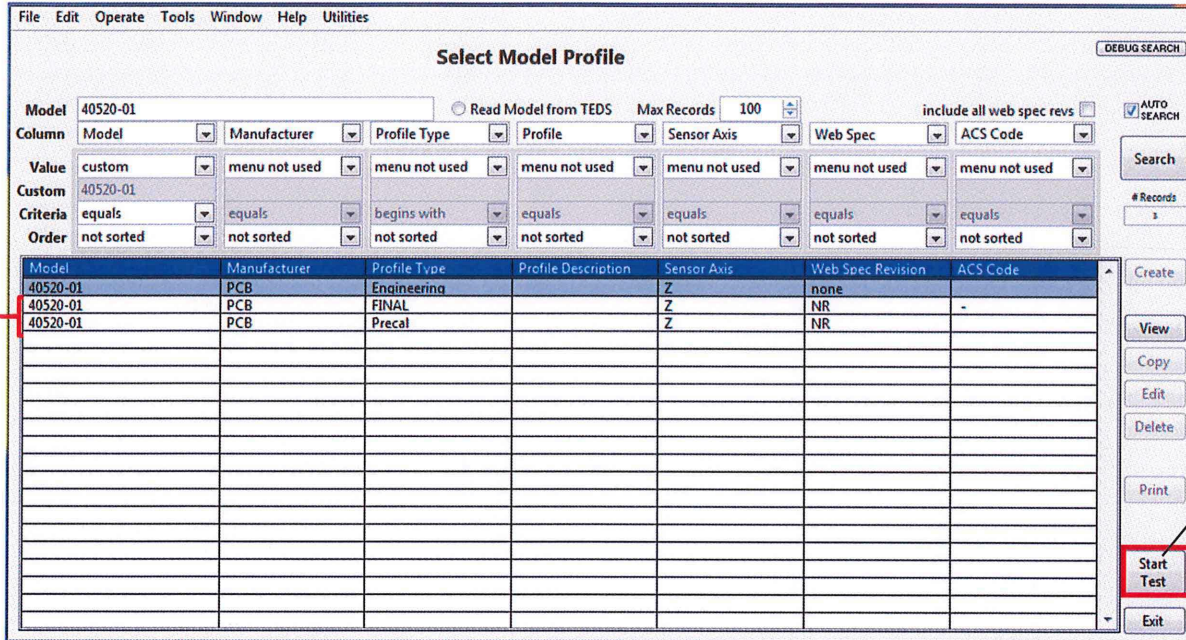

Figure 8

12) Install appropriate fixture(s) to the reference sensor, as called out on the B.O.M. and/or router.
13) Install a sensor in to the fixture and torque to the correct torque as called out on the sensor specification sheet.
14) To find the element specification sheet refer to Section F.
15) For elements, short the element before threading on the amplifier.
16) Attach cable sensor.
17) Reference Figure 8.
18) Click, "Start Test".
19) The program will run through a set of prompts to scan the bar codes for the following MERC equipment (Unit Under Test, Exciter, Reference, Conditioner):
   a. UUT Signal Conditioner
   b. Mod Range Exciter
   c. ICP Accelerometer Reference
   d. ICP Reference Conditioner

20) Reference Figure 9.
21) Enter the Job Number and Serial/Symbol Number in the appropriate prompts. A hand scanner can auto-complete these fields by scanning the job number and serial number bar codes on the job serial sheet. If serial sheet is unavailable, fields need to be entered manually.

22) Observe the UUT Information window and verify that the gain of UUT Signal Conditioner matches the Output on UUT signal conditioner and hit "Run Test".

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Note: For sensors that require the use of the Breakout Box w/ DC Power Supply, set the Gain to "1" as shown. If UUT gain miss match click on "Select UUT Conditioner" button to reload UUT Signal Conditioner.
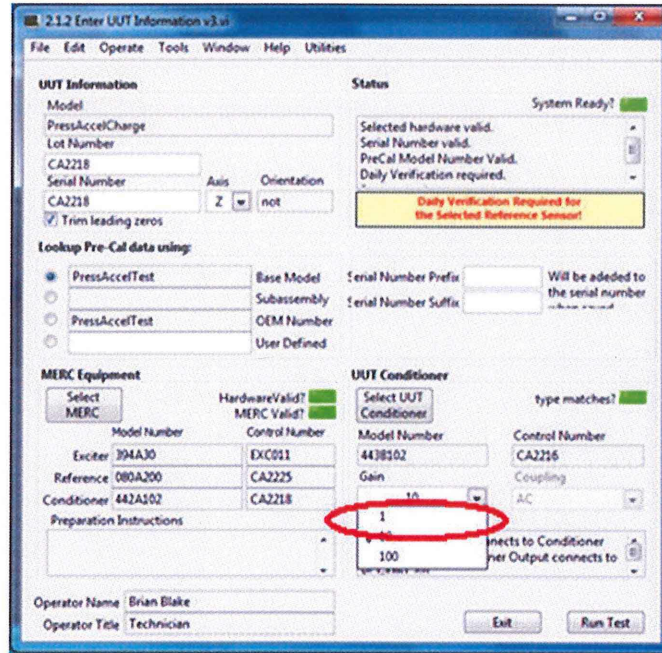

Figure 9

23) Program Setup Notes
   a. If any of the MERC equipment scans are un-successful, exit to the Main Screen, see Figure 6, and begin the Program Setup process again.
   b. If this is the first use of the system on any particular day, the program will automatically calibrate itself. Please allow the program to auto complete this process.

E. Performing the Calibration
   1) Verify the Power Amplifier of the shaker is turned on.
   2) Reference Figure 10.
   3) Once the Frequency Response window has loaded select "Run Sweep" to begin the test. If the power amplifier is too low or too high, the program will prompt you to adjust the setting to an appropriate level. Turn the knob on the power amplifier until the needle on the screen is inside the acceptable window.

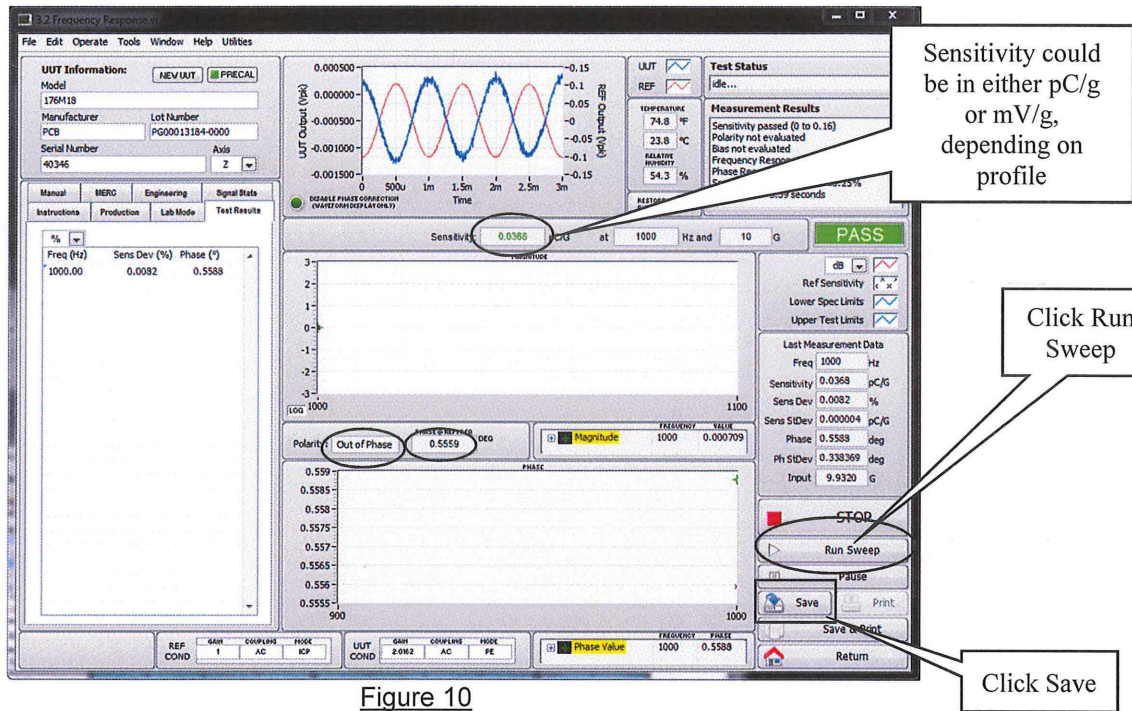| RELEASED	10/07/93	N/R	REVISED	07/15/16	C	REVISED			DRAWN	J.kessler	11/06/19	DRAWING NO.
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Figure 10

4) Reference Figure 10.
5) After the test has completed the screen shown will appear. Record the sensitivity reading (pC/G) and Phase@ref freq. Note: utilize worksheet form TC012.
6) Observe the phase of the UUT and record as necessary NOTE: the program does not recognize an out of phase reading as a real number and because of this all out of phase readings are shown as negative. Record out of phase readings as positive numbers.
7) Click the Save button.
8) Reference Figure 11.

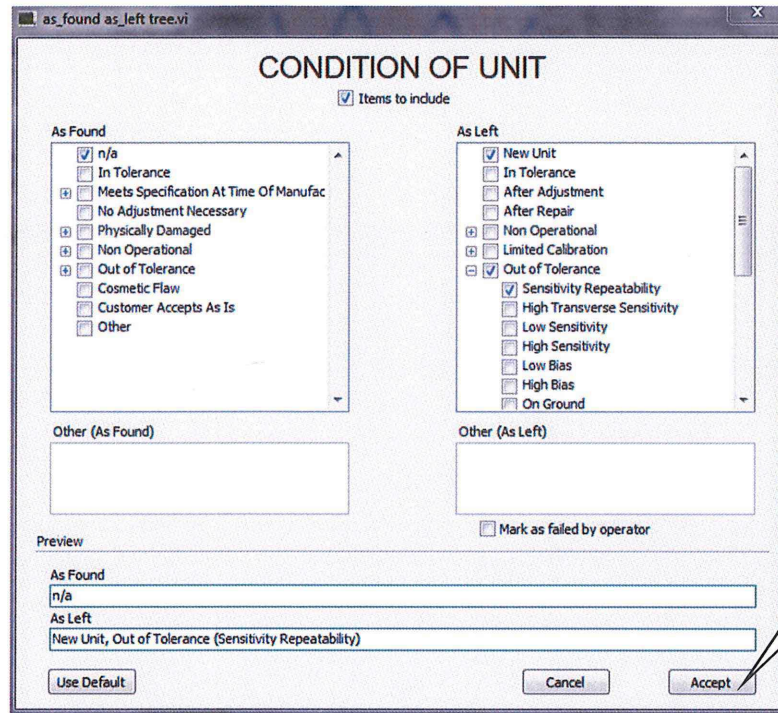| RELEASED	10/07/93	N/R	REVISED	07/15/16	C	REVISED			DRAWN	J.kessler	11/06/19	DRAWING NO.
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Figure 11

9) Uncheck any boxes that are not appropriate, then click Accept.
10) Reference Figure 12.

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Serial
Number
field

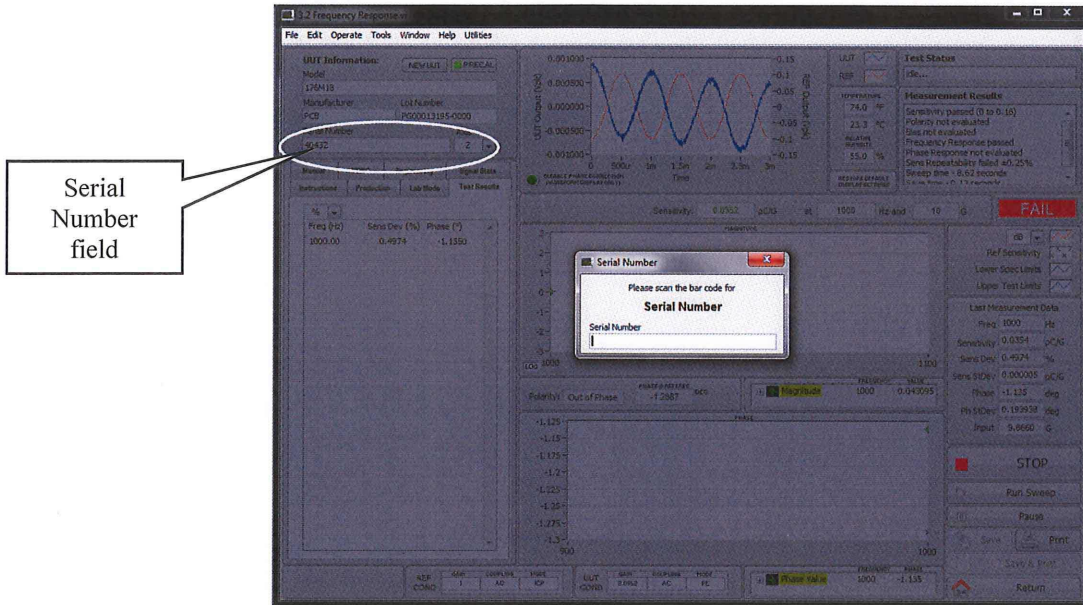Figure 12

11) Click on the Serial Number field.
12) Scan the bar code of the UUT.
13) Repeat the above steps for the rest of the UUT's.

Unusual conditions: In the event that the automated computer calibration system is nonfunctional, contact Engineering for assistance.

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F. **Referencing Element Specification Sheets**

   1) **Reference** Figure 13.
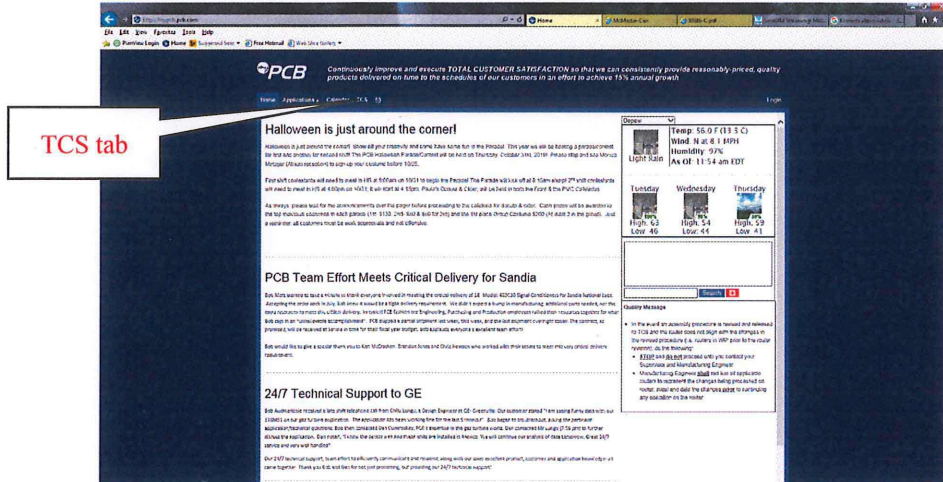
TCS tab

Figure 13

   2) **Click on the TCS tab.**
   3) **Reference** Figure 14.
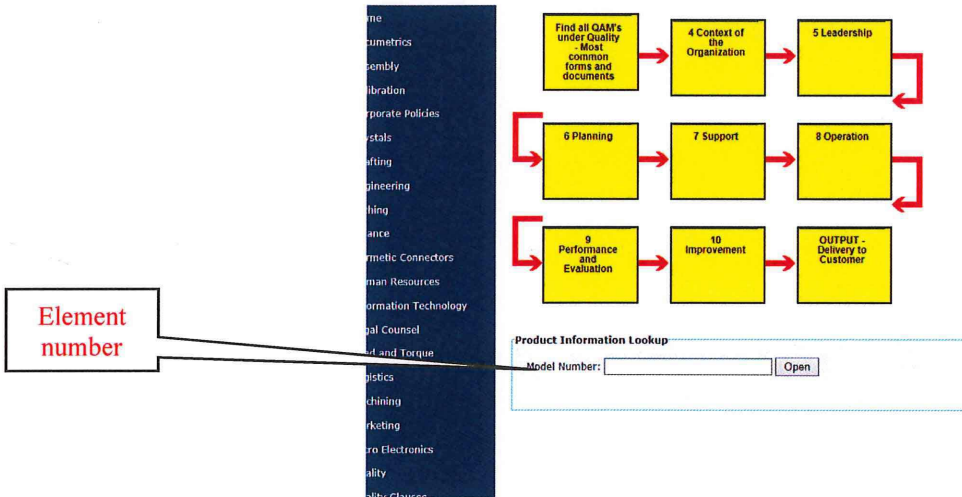
Element number

Figure 14

   4) **Enter the element number in the Model Number field, i.e. 40520-01.**
   5) **Reference** Figure 15.

Product Information Lookup

Model Number: 40520-01   × | Open
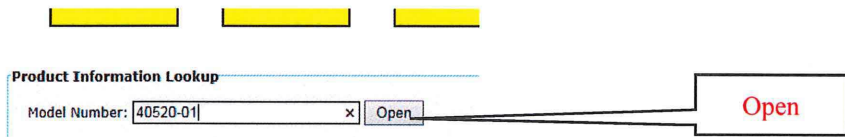
Open

Figure 15

   6) **Click on Open.**

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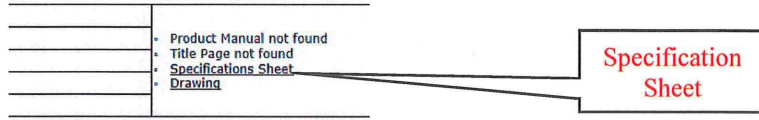
7) Reference Figure 16.

Figure 16

8) Click on Specification Sheet. All the element specifications will be found on this sheet, including mounting torque.

G. Calculating Results

Automated calculation is available using the form TC045 Pressure Acceleration Sensitivity Worksheet. For manual calculation, please follow the steps below.

1) Charge Output Pressure Element <u>with</u> Inline Amplifier
   a. Test Sensitivity Output in mV/g
   b. UUT Pressure Sensitivity in pC/g
   c. Acceleration Sensitivity Result in psi/g

First calculate the voltage sensitivity of the charge element with inline amplifier:

$$V = Q/C_t$$

Where:

V_{sens} is the voltage sensitivity in V/psi
Q is the charge sensitivity of the element in pC/psi
C_t is the total capacitance ($C_{element} + C_{amplifier}$) in picofarads (pF, Pico = 10^{-12})

Example:

If   The nominal element charge sensitivity is 1.1 pC/psi and the element capacitance is 21 pF and the voltage amplifier is unity gain with an input capacitance of 2.5 pF.

Then $V_{sens} = Q/(C_{element} + C_{amplifier}) = 1.1 \,(pC) / (21\,(pF) + 2.5\,(pF)) = 0.0468$ V/psi or <u>46.8 mV/psi</u>

Knowing the voltage sensitivity in mV/psi, now calculate the element accel sensitivity:

$$S_a = UUT_{out} / V_{sens}$$

Where:

S_a is the acceleration sensitivity in psi/g
UUT_{out} is the test unit output sensitivity in mV/g
V_{sens} is the unit under test voltage sensitivity in mV/psi (calculated above)

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Example:

If   The UUT output sensitivity is 0.145 mV/g and the UUT voltage sensitivity is 46.8 mV/psi.

Then $S_a = UUT_{out}/V_{sens} = 0.140 (mV/g) / 46.8 (mV/psi) = \boxed{0.0030\ psi/g}$

2) **Charge Output Pressure Sensor**
    a. **Test Sensitivity Output in pC/g**
    b. **UUT Pressure Sensitivity in pC/psi**
    c. **Acceleration Sensitivity Result in psi/g**

$$S_a = UUT_{out}/UUT_{sens}$$

Where:

S_a is the acceleration sensitivity in psi/g
UUT_{out} is the test unit output sensitivity in pC/g
UUT_{sens} is the unit under test pressure sensitivity in pC/psi

Example:

If   The UUT output sensitivity is 0.054 pC/g and the UUT pressure sensitivity is 15 pC/psi.

Then $S_a = UUT_{out}/UUT_{sens} = 0.054 (pC/g) / 15 (pC/psi) = \boxed{0.0036\ psi/g}$

3) **Voltage Output Pressure Sensor**
    a. **Test Sensitivity Output in mV/g**
    b. **UUT Pressure Sensitivity in mV/psi**
    c. **Acceleration Sensitivity Result in psi/g**

$$S_a = UUT_{out}/UUT_{sens}$$

Where:

S_a is the acceleration sensitivity in psi/g
UUT_{out} is the test unit output sensitivity in mV/g
UUT_{sens} is the unit under test pressure sensitivity in mV/psi

Example:

If   The UUT output sensitivity is 0.050 mV/g and the UUT pressure sensitivity is 25 mV/psi.

Then $S_a = UUT_{out}/UUT_{sens} = 0.050 (mV/g) / 25 (mV/psi) = \boxed{0.002\ psi/g}$

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Unit Under Test Connection	Unit Under Test Signal Conditioner	In Line ICP Amplifier	FR Console Model Profile
Coaxial	Dual-Mode Signal Conditioner	No	PressAccelCharge
Coaxial	Dual-Mode Signal Conditioner	Yes	PressAccelICP
Multi-Conductor	Differential Amplifier	No	PressAccelDiffAmp
3-Wire	Breakout Box w/ DC Power Supply	No	PressAccelCharge

*Table used as a guide when FR Console Model Profile is not specified on router

Reference . Select the appropriate Model Profile (unless Model Profile is specified on router) and then hit "Start Test".

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