

Multi-Cal-PGA308 System

This user's guide describes the characteristics, operation, and the use of the Multi-Cal-PGA308 System evaluation module (EVM). It covers all pertinent areas involved to properly use this EVM board. The document includes the physical printed circuit board layout, schematic diagrams, and circuit descriptions.

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1 Overview

The Multi-Cal-PGA308 System Evaluation Module is a set of EVMs that is used to calibrate multiple [PGA308 sensor modules](#). The PGA308 is a programmable analog sensor signal conditioner. All components in the Multi-Cal-PGA308 can be expanded to calibrate up to 64 sensors simultaneously. For a more detailed description of the PGA308, please refer to the product data sheet ([SBOS440](#)) available from the Texas Instruments web site at <http://www.ti.com>. Additional support documents are listed in the section of this guide entitled [Related Documentation from Texas Instruments](#).

The Multi-Cal-PGA308 System Evaluation Module consists of two printed circuit boards (PCBs). One board (the USB DAQ Platform) generates the signals required to communicate with the Multi-Cal-PGA308, which is the second board (Multi-Cal-Master PCA), as well as support and configuration circuitry. The complete Multi-Cal-PGA308 contains a series of PCBs, and can be expanded to meet your specific system requirements.

The PGA309 and the PGA308 sensor modules share the same hardware platform for the Multi-Cal-PGA308. The [Multi-Cal-PGA308 Evaluation Module User Guide \(SBOU087\)](#) describes how to set up and use the hardware with either device.

Throughout this document, the abbreviation *EVM* and the term *evaluation module* are synonymous with the Multi-Cal-PGA308 System Evaluation Module.

1.1 Related Documentation from Texas Instruments

The following document provides information regarding Texas Instruments integrated circuits used in the assembly of the Multi-Cal-PGA308 System EVM. This user's guide is available from the TI website under literature number [SBOU105](#). Any letter appended to the literature number corresponds to the document revision that is current at the time of the writing of this document. Newer revisions may be available from the TI web site at <http://www.ti.com/>, or call the Texas Instruments Literature Response Center at (800) 477-8924 or the Product Information Center at (972) 644-5580. When ordering, identify the document by both title and literature number.

Document	Literature Number
PGA308 Product Data Sheet	SBOS440
USB DAQ Platform Users Guide	SBOU056
Multi-Cal-System Evaluation Module User Guide	SBOU087
Multi-Cal-Test EVM User's Guide	SBOU088
Multi-Cal-Master EVM User's Guide	SBOU089
Multi-Cal-System Cable User's Guide	SBOU092
Multi-Cal-Slave EVM User's Guide	SBOU094
Multi-Cal-Interface User's Guide	SBOU093

1.2 Information About Cautions and Warnings

This document contains caution statements.

CAUTION

This is an example of a caution statement. A caution statement describes a situation that could potentially damage your software or equipment.

The information in a caution or a warning is provided for your protection. Please read each caution carefully.

1.3 Applications Questions

If you have questions about this or other Texas Instruments evaluation modules, post a question in the *Amplifiers* forum at <http://e2e.ti.com>. Include in the subject heading the product in which you are interested.

2 Multi-Cal-PGA308 System EVM Software Overview

This section discusses how to install and use the Multi-Cal-PGA308 System EVM software.

2.1 Multi-Cal-PGA308 System EVM Software Installation

Follow these steps to install the Multi-Cal-PGA308 System EVM software:

- Step 1. Software can be downloaded from the [Multi-Cal-Master-EVM web page](#), or from the disk included with the Multi-Cal-Master-EVM, which contains a folder called *Install_software*.
- Step 2. Find the file called *setup.exe*. Double-click the file to start the installation process.
- Step 3. Follow the on-screen prompts to install the software.

To remove the application, use the Windows Control Panel utility, *Add/Remove Software*.

2.2 Test the Operation of the Multi-Cal-PGA308 Software

The Multi-Cal-PGA308 software can be operated through the Windows *Start* menu. From *Start*, select *All Programs*; then select the *Multi-Cal-PGA308 EVM* program. shows how the software should appear if the EVM is functioning properly. If the software does not start normally, check the power and USB connection. See Section 4 of the *Multi-Cal-System Evaluation Module User Guide* ([SBOU087](#)) for more detailed troubleshooting tips. [Figure 1](#) also shows the summary tab. When the software is running, this tab displays calibration results.

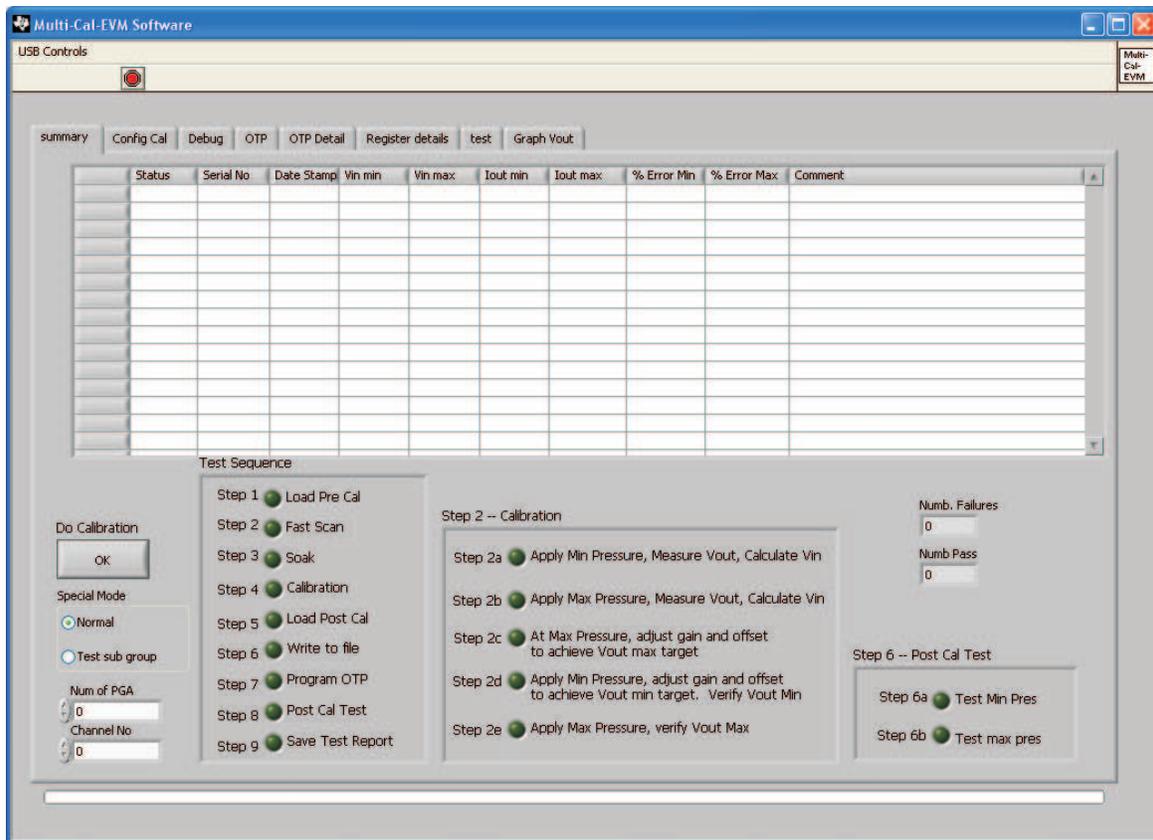


Figure 1. Multi-Cal-PGA308 Software: Functioning Properly

Before starting a calibration, you must set up the software to calibrate according to your sensor module design. For example, the software must be set up differently if you are calibrating a three-wire module, a four-wire module, or a current output module. The output swing, overscale, underscale, and fault setup requirements can also be different according to your system application. This design-specific information is stored in the *model* file. You can select different model files using the **Select Model File** button as shown in [Figure 2](#).

The software includes several example model files for typical configurations. In this document, we will discuss how to create your own custom model file in [Section 3](#).

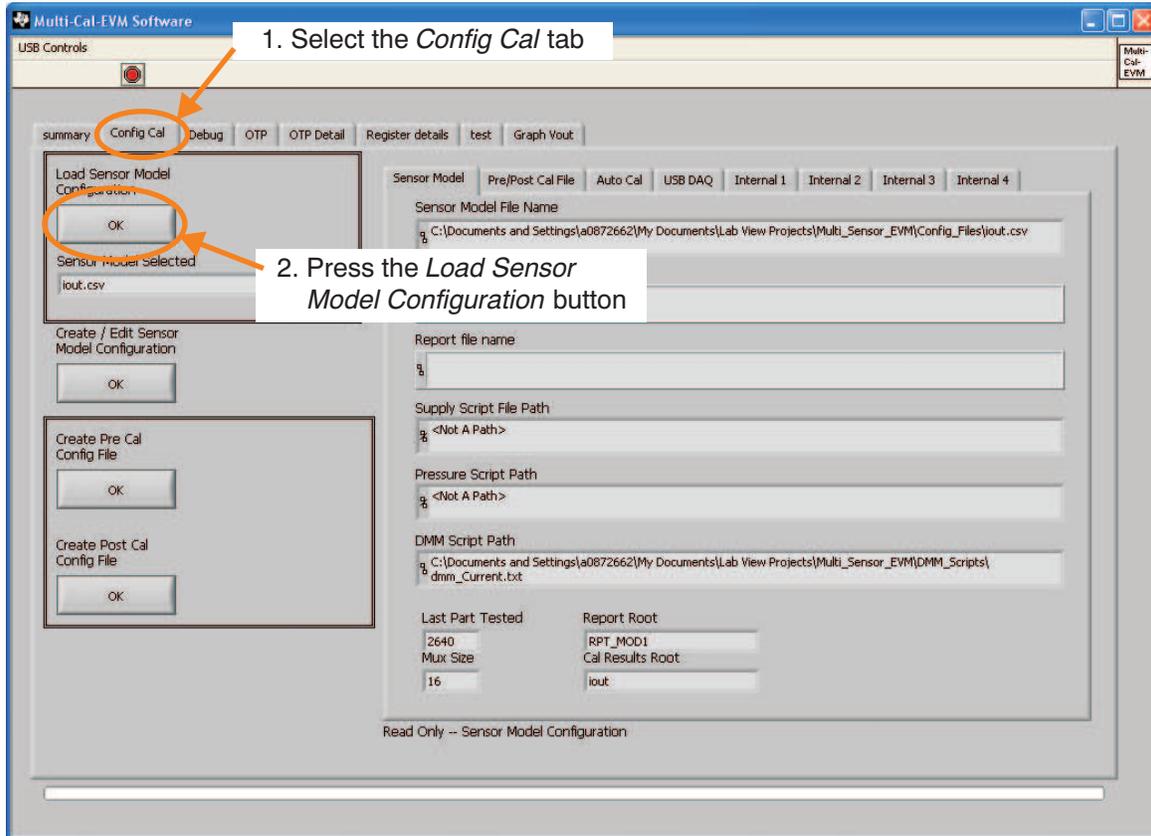


Figure 2. Multi-Cal-PGA308 Software: Select Sensor Model

Figure 3 shows the window that appears when you press the **Load Sensor Model Configuration** button in the *Config Cal* tab. Note that the example files are given to demonstrate the three common PGA308 configurations (specifically, *iout.csv*, *Vout_3_wire.csv*, and *Vout_4_wire.csv*). Note that the three sensor model files can be used to calibrate the Multi-Cal-Test PCA boards with the jumper settings given in Table 3 of the *Multi-Cal-System Evaluation Board User Guide* ([SBOU087](#)).

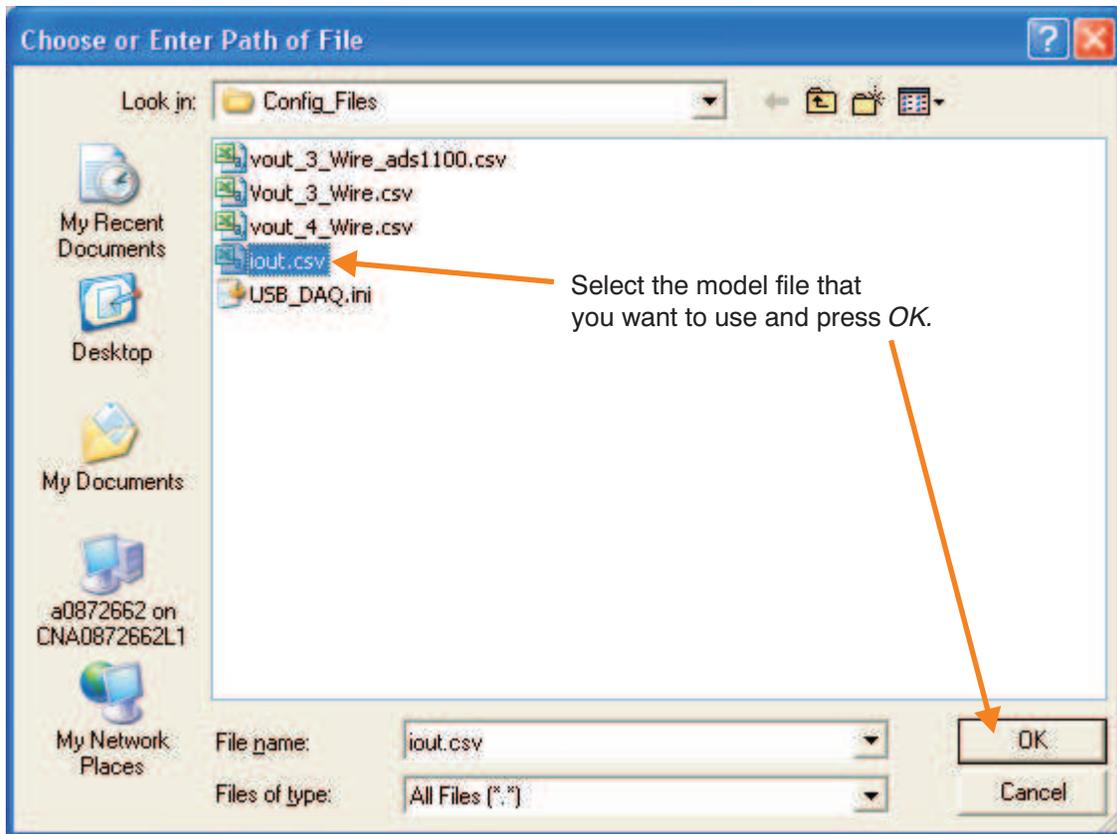


Figure 3. Multi-Cal-PGA308 Software: Select Model File

After the selecting the specific sensor model file, the *Sensor Model Selected* field updates. To edit the sensor model file, press the **Create Model File** button as shown in [Figure 4](#).

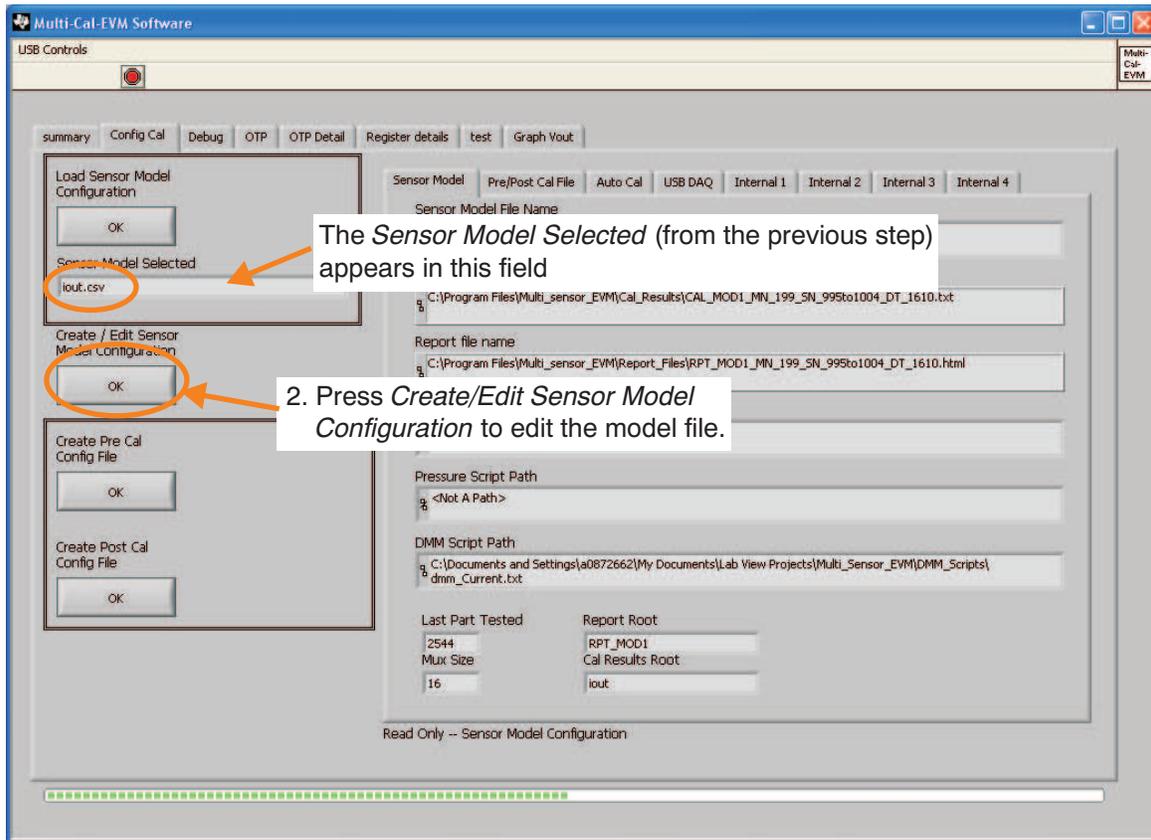


Figure 4. Multi-Cal-PGA308 Software: Create Model File

Figure 5 shows the *Edit Model File* window. The model file contains the key information that makes a model unique. For example, the model file determines if the sensor module is a *voltage output* or *current output* module. Each field in the Edit Model File window is discussed detail in Section 3.

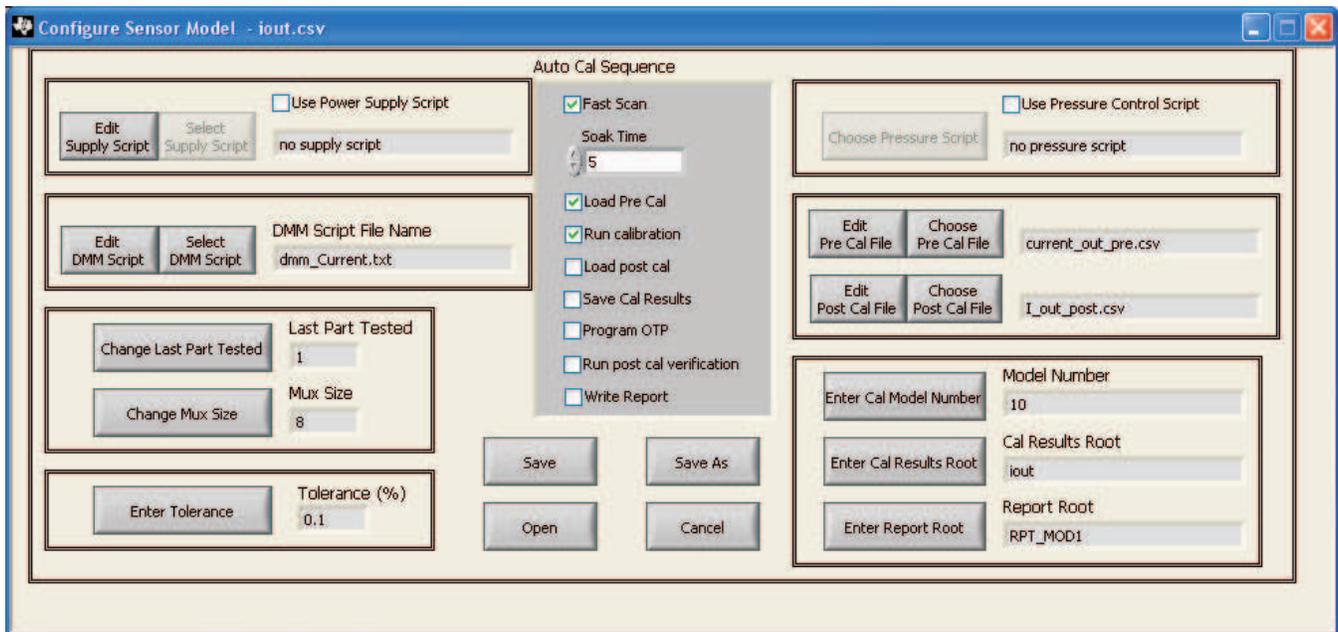


Figure 5. Multi-Cal-PGA308 Software: Edit Model File Window

2.3 Starting a Calibration

The Multi-Cal-PGA308 software is used to calibrate PGA308 bridge sensor modules. The calibration automatically determines the sensor output over temperature and adjusts the gain and offset of the PGA308 to achieve the desired output swing. The user of the calibration software must only adjust the stimulus (for example, pressure) as prompted by the software. The measurements, calculations, and adjustments are performed automatically by the software.

Figure 6 shows how to start the calibration sequence. Throughout the calibration process, the software prompts you to adjust the stimulus (pressure) to a maximum or a minimum level. This adjustment can be automated if your stimulus (pressure) source can be controlled with IEEE488 or through an RS-232 interface. The entire calibration process takes approximately 1 minute per sensor. The *Test Sequence* LEDs shown in the screenshot illuminate as the calibration progresses.

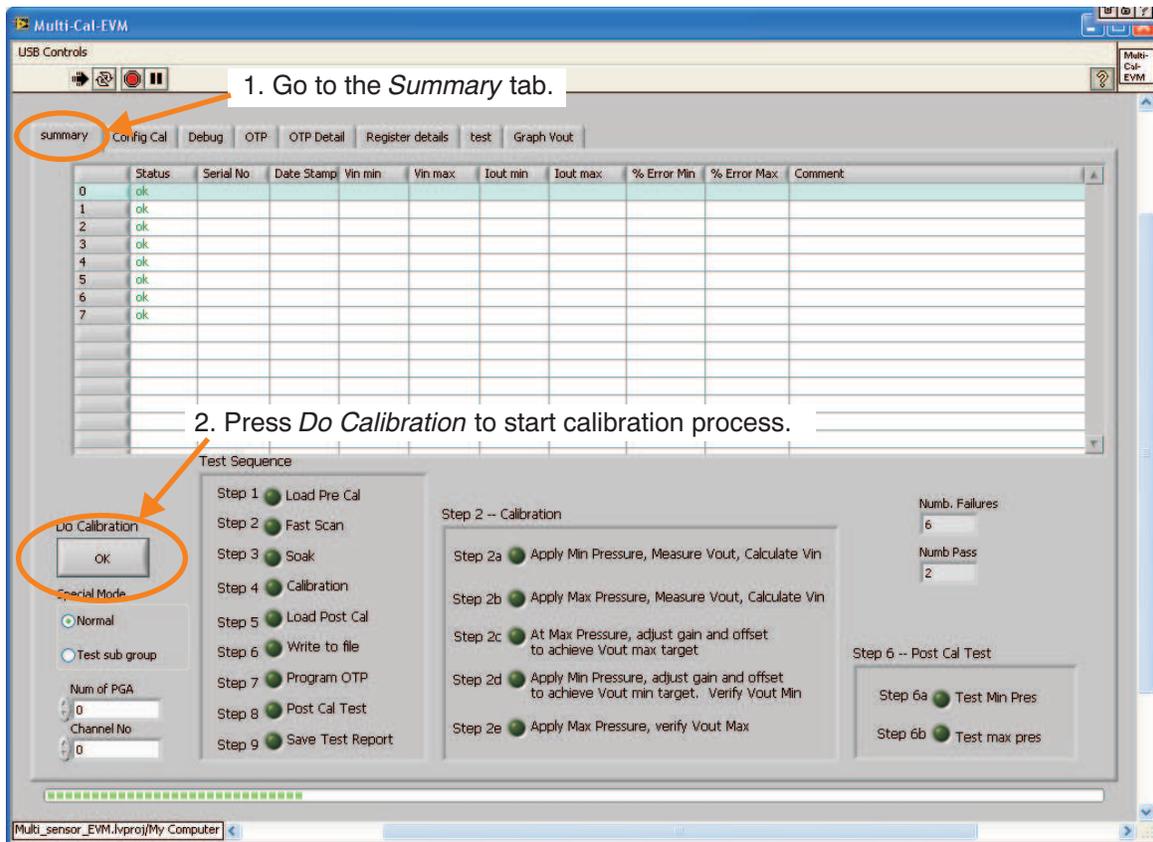


Figure 6. Multi-Cal-PGA308 Software: Start Calibration Process

After pressing the **Do Calibration** button, the Start_Calibration window appears (as shown in [Figure 7](#)). This window allows you to confirm several critical file parameters: the Serial Number, Date Code, Cal File, and Report File. The serial number and date code will be written into one-time programming memory (OTP) if you program OTP. The file names are automatically generated based on the date code and serial numbers. See [Figure 19](#) for a complete description of the file naming scheme.

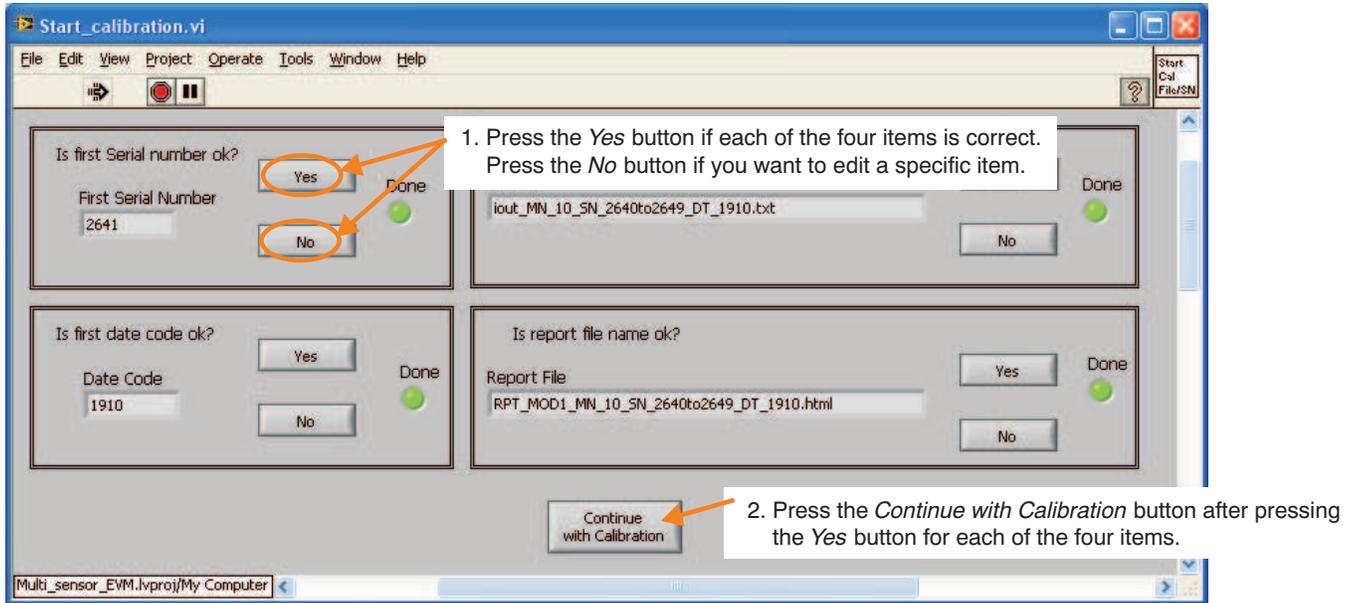


Figure 7. Multi-Cal-PGA308 Software: Start Calibration Script Window

In order to proceed with the calibration, you must press **Yes** to accept the entry for each field. You can change the values that are automatically generated, if necessary, by pressing **No**. Once you have accepted all the field entries, press the **Continue with Calibration** button to continue.

Note that the default values are written into OTP and into the filename when you program OTP. This option makes it easy to match the sensor module with its associated file. For example, if you read the serial number and date code out of OTP, you can easily search the filenames for the corresponding file.

Figure 8 shows the software running the first part of the calibration process (*Fast Scan*). The fast scan applies power to only one sensor module at a time and tests to see if that module functions. If the sensor module fails this test, the module is not powered during the calibration. When the fast scan is complete, power is then applied to all of the functional modules simultaneously. After power is applied to all modules, the software waits for the modules to stabilize (this period is called the *Soak* period). This step is included because some sensors must be powered for several minutes in order to stabilize (that is, achieve best accuracy). The soak period can be programmed to any length of time. Section 3 (see Figure 20) shows how to edit the soak time.

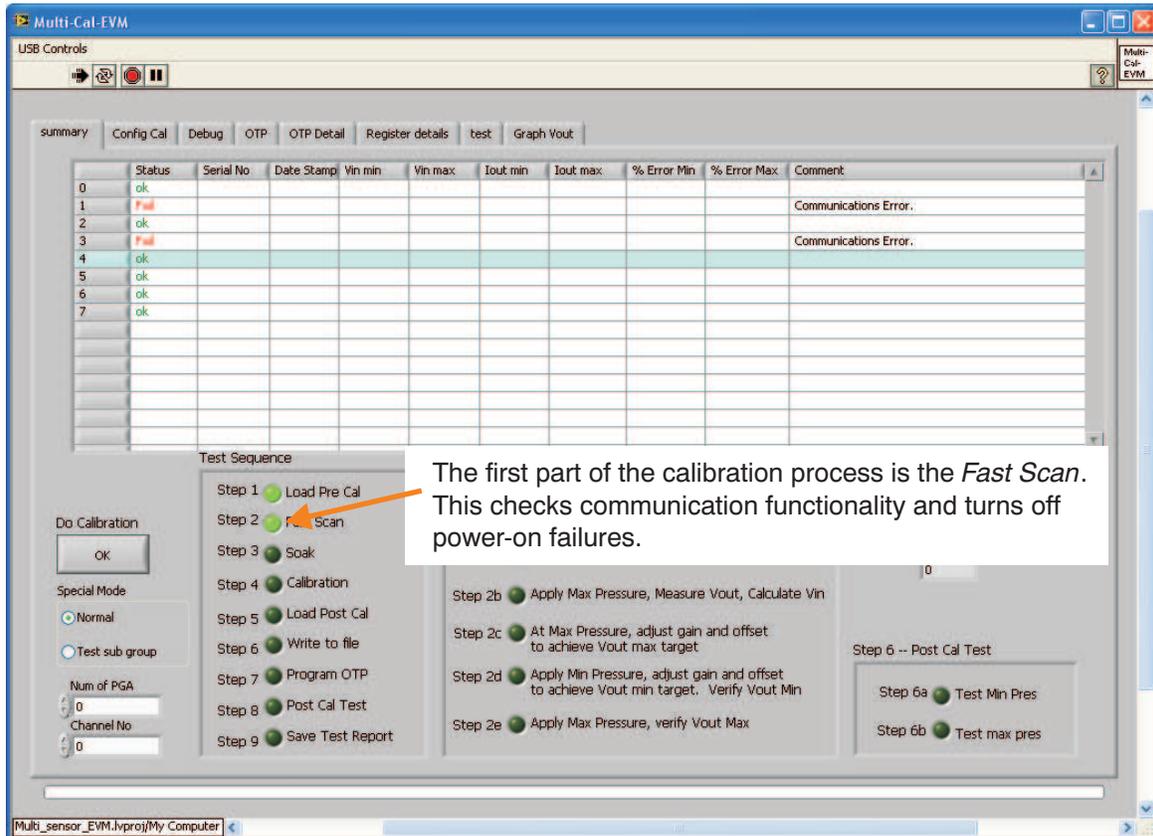


Figure 8. Multi-Cal-PGA308 Software: Fast Scan

At the end of the soak period, the software prompts you to apply the minimum stimulus to the sensor. At this point, you must adjust your stimulus (that is, pressure, strain, or acceleration) to its minimum level, as shown in Figure 9. If your stimulus source can be automatically controlled, this step can be automated. If this step is automated, the entire calibration sequence will be automated (consequently, you press the **Start** button and wait for it to finish). If you are using the test boards, you must set the switch to the *Low* position at this time.

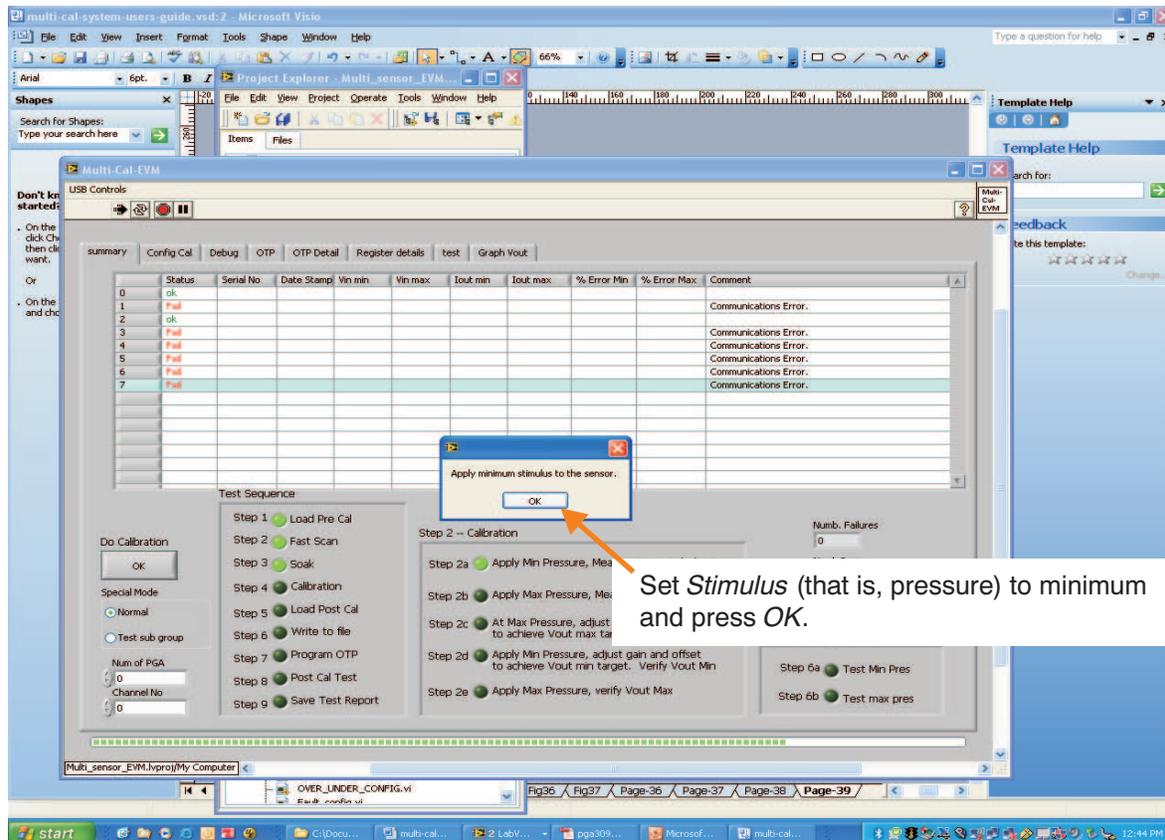


Figure 9. Multi-Cal-PGA308 Software: Set Stimulus Prompt

The first step of the calibration sequence is called Step 2a. During Step 2a, the software measures the PGA308 output and back-calculates the sensor output at minimum pressure. The sensor output is listed in the *Vin min* column of the software. Note that the software skips failures. Also note that power is not applied to failures.

Inspecting the table (shown in Figure 10) can give you confidence that the calibration is working correctly. If you are using a real-world sensor, you can compare the *Vin min* value to what you expect your sensor output to be. If you are using a test board, you can look at the the jumper position to know what sensor output to expect. For example, if the *Low* jumper on the test board is set to 6 mV, you should expect to see approximately 6 mV in the *Vin min* column of the table.

After Step 2a is done, a message prompts you to apply maximum pressure. Change the pressure to its maximum level and press **OK**, as Figure 10 shows.

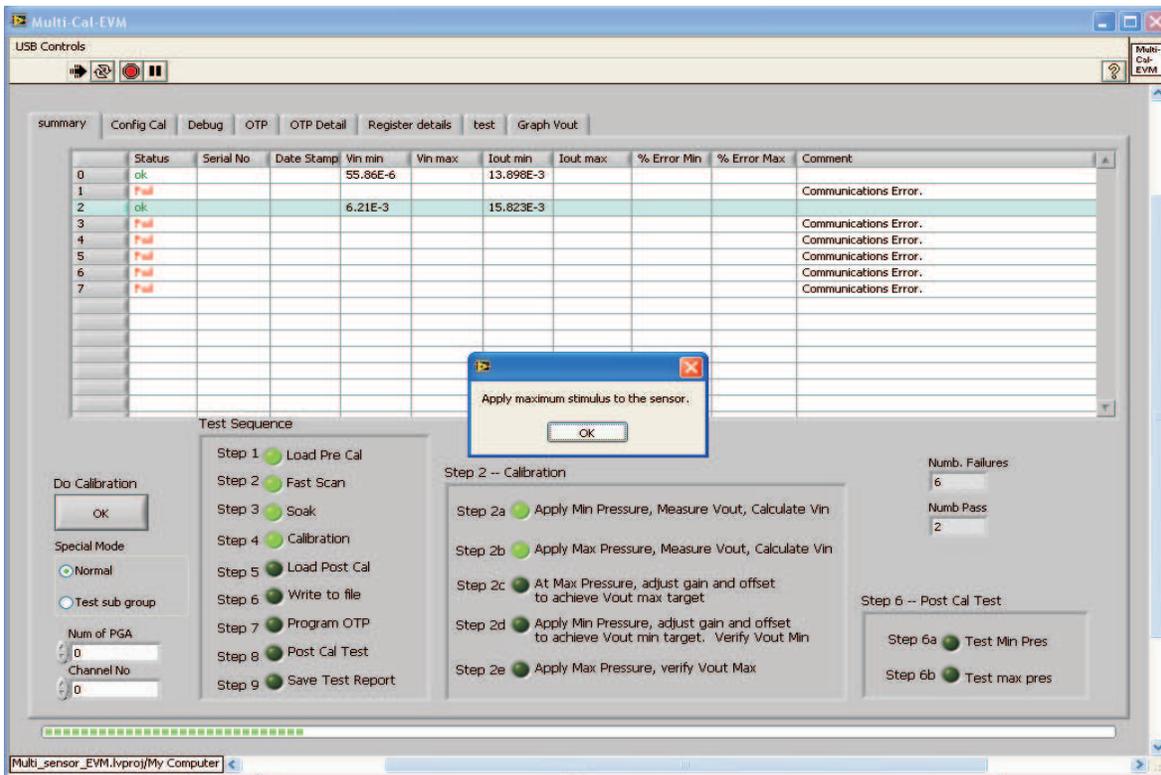


Figure 10. Multi-Cal-PGA308 Software: Change Pressure

The software continues to prompt you to adjust pressure at various points. The calibration sequence involves five pressure changes:

- Step 2a: Minimum pressure
- Step 2b: Maximum pressure
- Step 2c: Maximum pressure (additional calibration steps)
- Step 2d: Minimum pressure (final calibration)
- Step 2e: Maximum Pressure (verification)

Figure 11 illustrates the software after the Max Pressure calibration is complete (Step 2c). Note that the post calibration accuracy is shown for *Iout_max*. At this point in the calibration sequence, you will adjust the pressure to the minimum level and press **OK**.

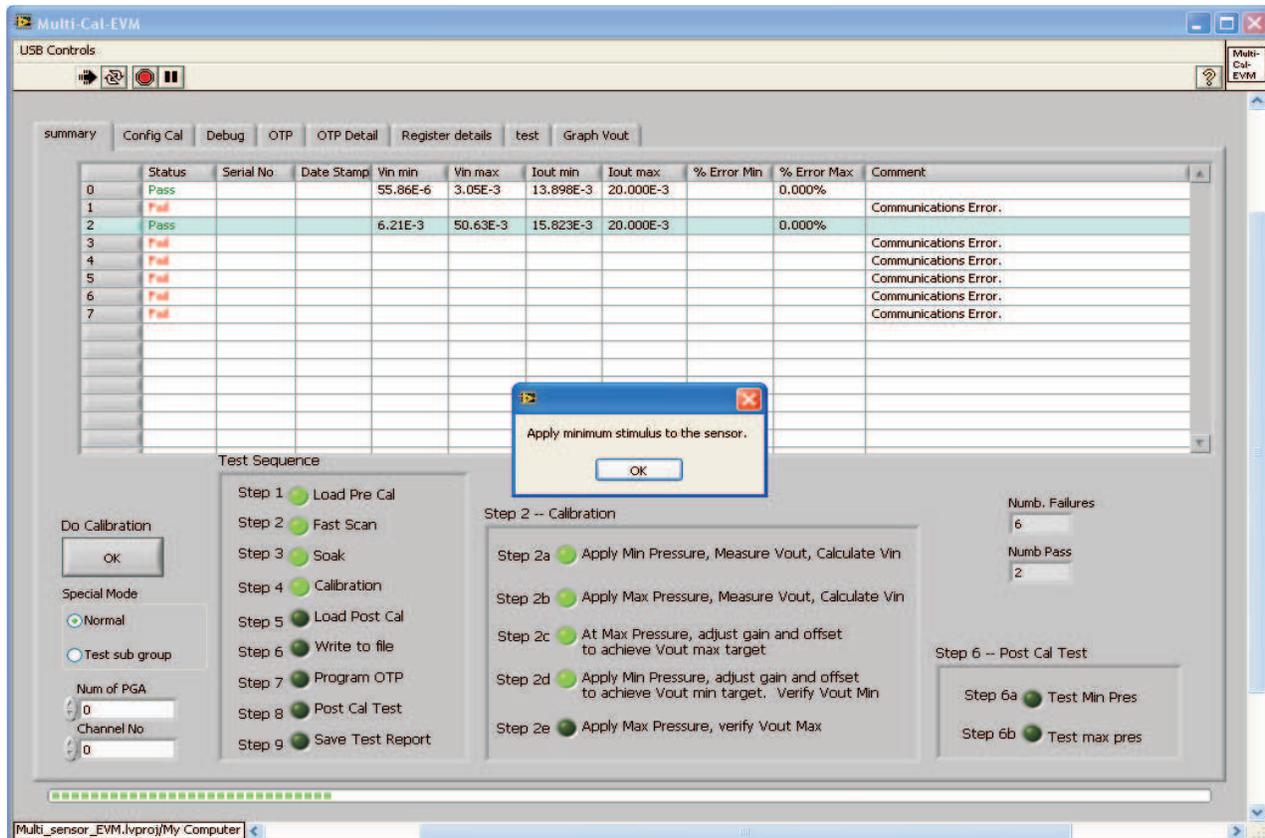


Figure 11. Multi-Cal-PGA308 Software: Change Pressure Again

If you are using the default software setup, the calibration is complete at this point. Note that the software setup can be changed to perform additional steps. For example, the OTP can be written to. The post-calibration accuracy is typically on the order of 0.02% using the test boards. For real-world sensor modules, the accuracy most likely depends on the repeatability of your specific sensor. Once the calibration process is finished, a screen prompt informs you that it is done, as [Figure 12](#) shows.

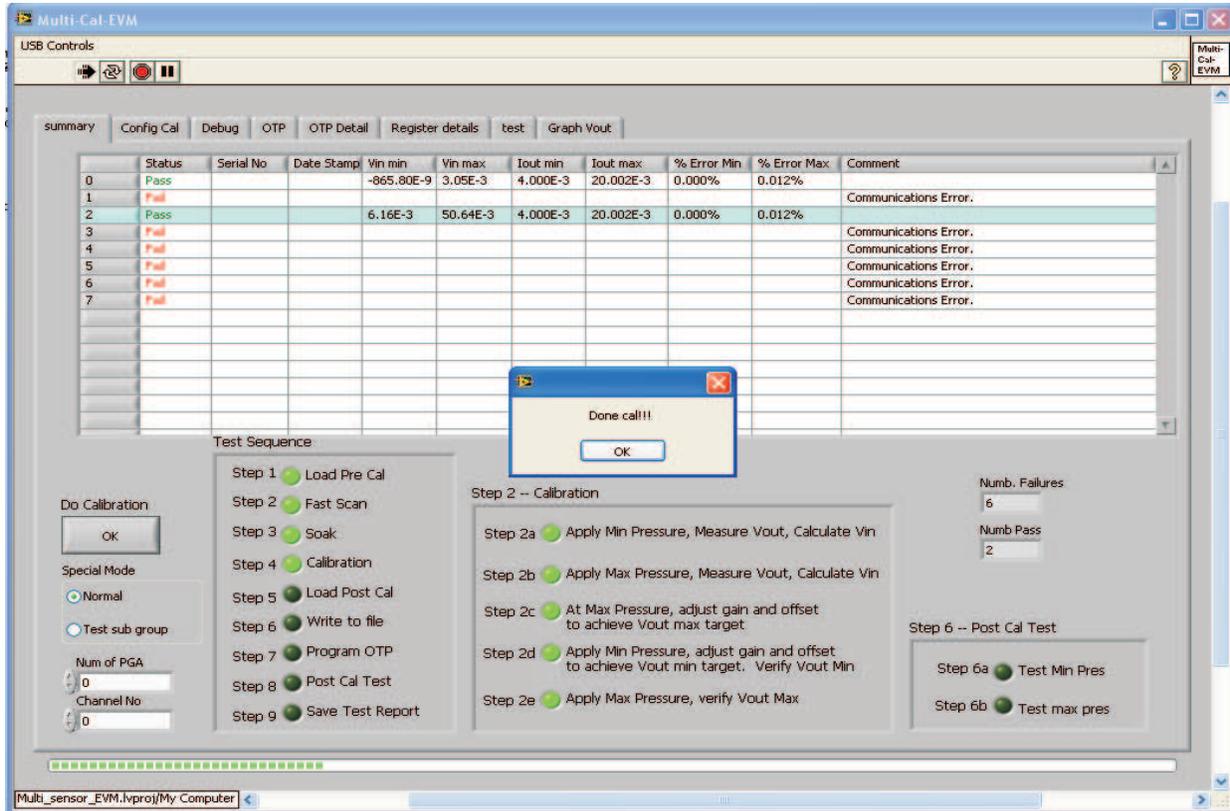


Figure 12. Multi-Cal-PGA308 Software: Calibration Complete

3 Model File: Detailed Description

The model file utility was introduced earlier; see [Figure 5](#). In this section, we will look at each part of this utility and learn how to customize your own model file.

[Figure 13](#) shows the *Power Supply Script* section in the Model File Editor window. The power-supply script can be used to automatically configure a power supply at the start of calibration. This option can be useful if you use different supply voltages for your different products. If you use 24 V for one product type and 5 V for another product type, for example, you can automatically control the supply voltage to prevent an accidental connection of a product to the wrong voltage. The script file is a text file that can communicate with any RS-232 or GPIB instrument.

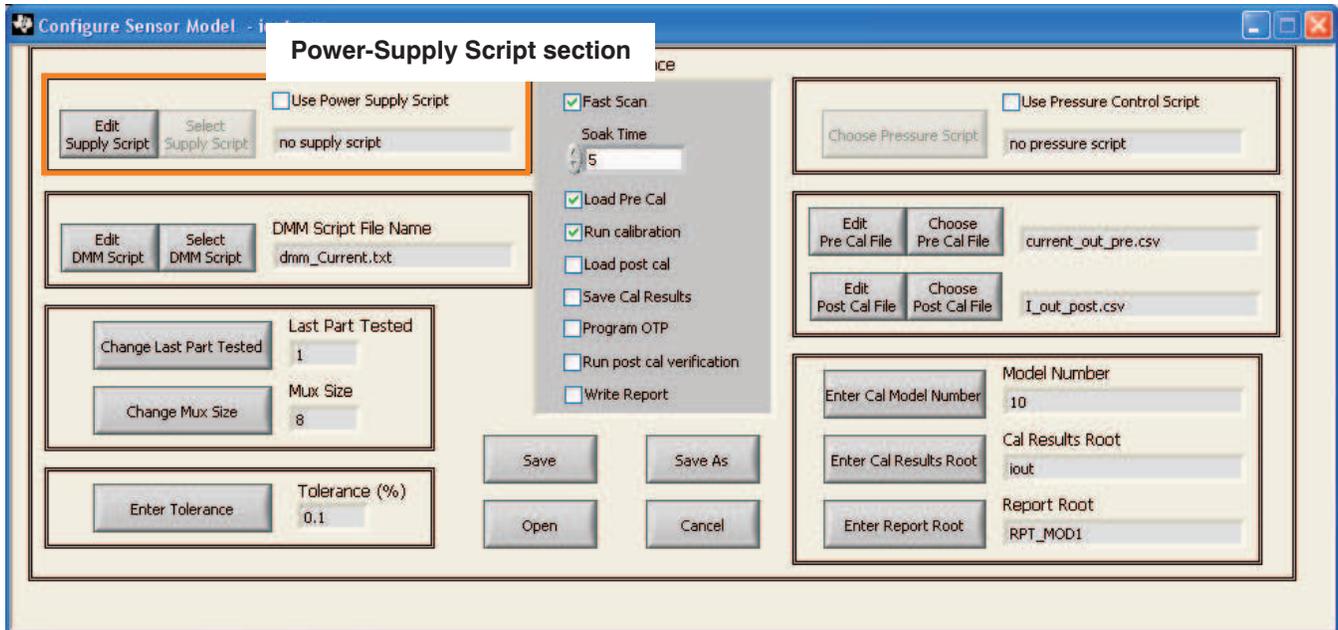


Figure 13. Multi-Cal-PGA308 Software Model File: Power-Supply Script

If you leave the *Use power supply script* option unchecked, the power-supply script is not used (as shown here). Pressing the **Edit Supply Script** button opens a text editor that allows you to edit the script. Pressing the **Select Supply Script** button allows you to choose the specific script file. This program has an example script for the Agilent E3631A supply. You may create more scripts for different instruments. [Section 4](#) of this document explains how to edit and create the script file for different instrument types.

Figure 14 shows the *DMM Script* section of the Model File Editor window. The DMM script must be used to automatically control the digital multimeter during calibration. The script file is a text file that can be used to communicate with any RS-232 or GPIB instrument.

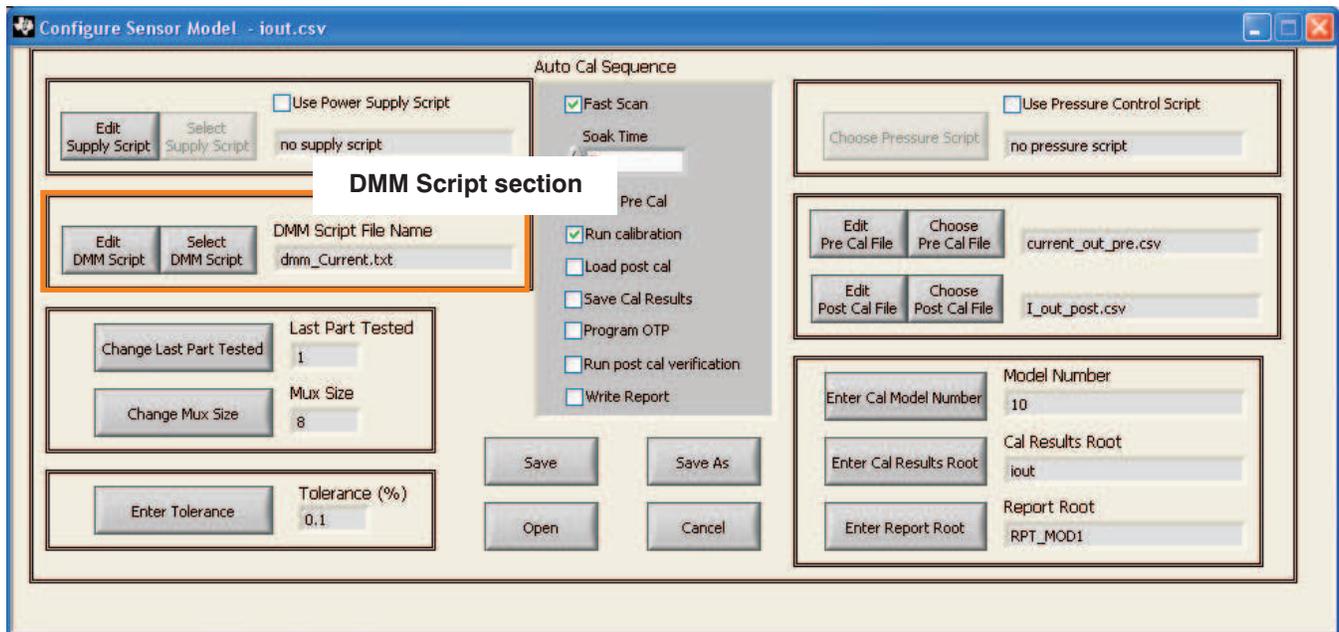


Figure 14. Multi-Cal-PGA308 Software Model File: DMM Script

Pressing the **Edit DMM Script** button opens a text editor that allows you to edit the script. Pressing the **Select DMM Script** button allows you to choose the script file. This program has an example script for the voltage and current mode of the Agilent 34401A supply. The scripts have also been written to facilitate the use of RS-232 or IEEE488. You may create more scripts for different instruments. [Section 4](#) of this document explains how to edit or create the script file for different instrument types.

Figure 15 shows the Pressure Script Section section in the Model File Editor window. The pressure script can be used to automatically select or change a pressure source during calibration. If this script is used, the calibration process is fully automatic (press the **Start** button and wait for it to finish). If you do not use the pressure script, the program prompts you to change the pressure several times during the calibration. Note that the term *pressure* refers to any stimulus applied to the sensor. Thus, the *pressure source* could actually be strain, acceleration, or some other stimulus.

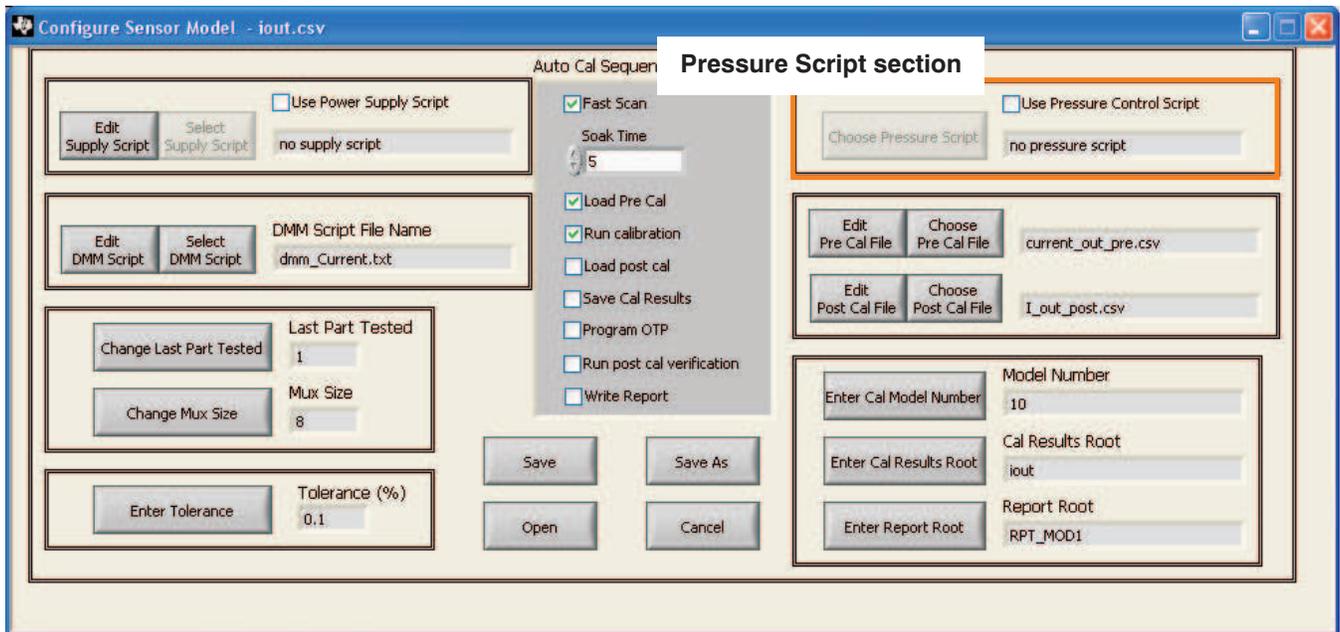


Figure 15. Multi-Cal-PGA308 Software Model File: Pressure Script

If you leave the *Use pressure script* box unchecked, the pressure script is not used (as shown here). Pressing the **Edit Pressure Script** button opens a text editor that allows you to edit the script. Pressing the **Select Pressure Script** button allows you to choose the script file. Section 4 of this document explains how to edit and create the script file for different instrument types.

Figure 16 shows the *Last Part Tested, Mux Size, and Tolerance* section in the Model File Editor window. The *Last Part Tested* field refers to the serial number of the last device that was tested. The software automatically generates the serial number of the sensor modules you calibrate based on this number. For example, if the last part tested is 8, the software assigns serial numbers starting at 9. The serial number is written into OTP so that you can identify the module by reading OTP. Typically, you must not change the *Last Part Tested* field because it automatically increments. However, if necessary, you can use the **Change Last Part Tested** button to re-set this number.

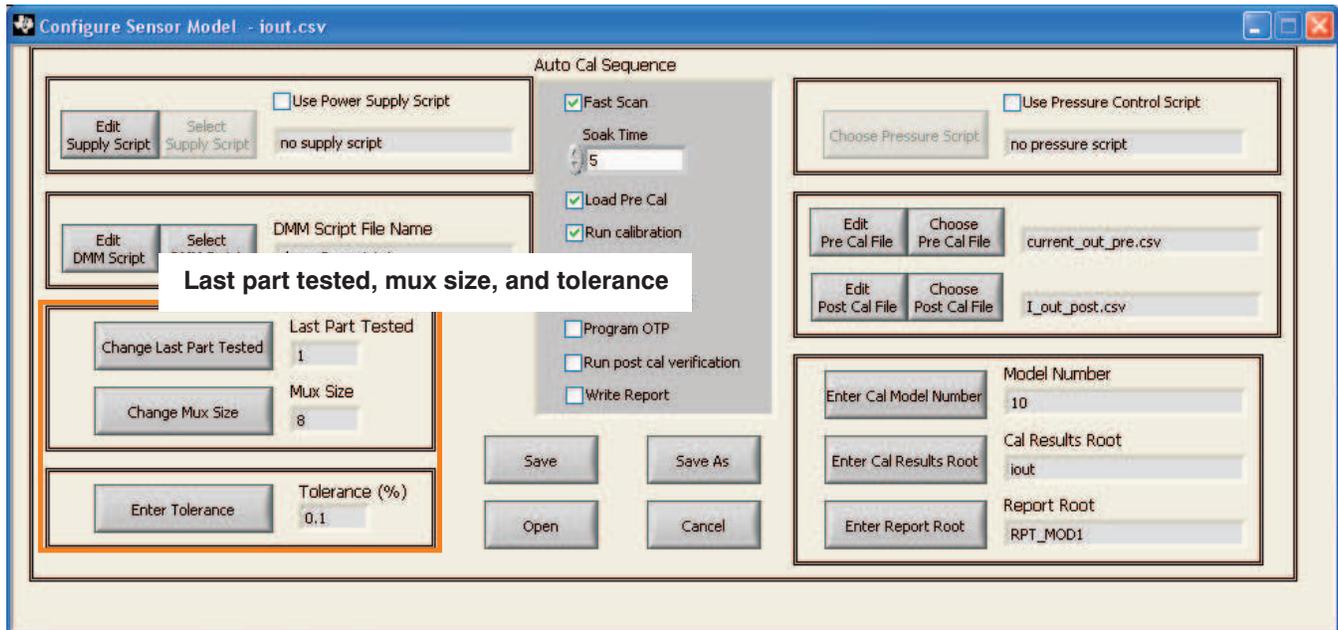


Figure 16. Multi-Cal-PGA308 Software Model File: Last Part Tested, Mux Size, and Tolerance Section

The **Change Mux Size** button is used when you expand the hardware to test more than eight devices. For example, adding one slave board allows you to calibrate 16 modules. In this case, you would change the mux size to 16.

The *Enter Tolerance* field sets the pass / fail limit for the sensor module accuracy. Typically, this limit is set to 0.1%. However, if your application requires different post-calibration accuracy, you may adjust this field manually.

Figure 17 shows the *Pre- and Post-calibration* files section of the Model File Editor window. The *Pre Cal File* field defines the registers, power supply, reference, and operation mode for the sensor module. The *Pre Cal File* is loaded at the start of the calibration process. When calibration is complete, you can load a *Post Cal File*. Typically, the *Post Cal File* is used if you want to use over-/underscale limits or fault detection. Overscale limits and fault detection should be turned off during calibration (in the Pre Cal File).

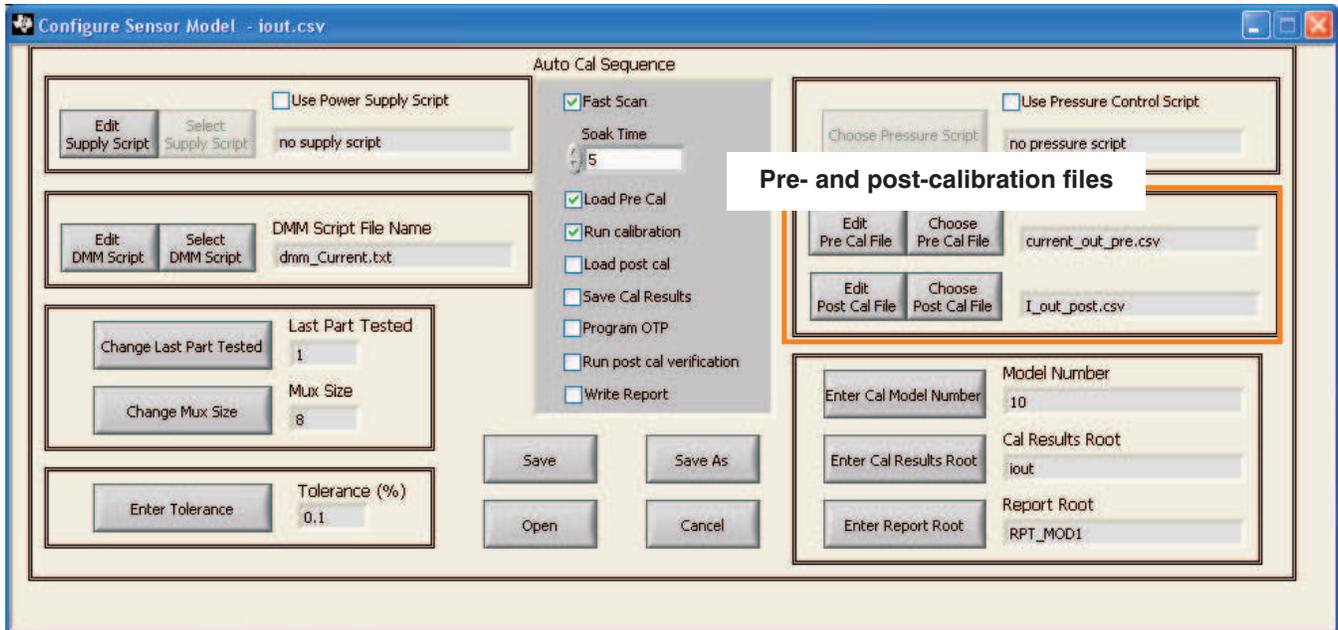


Figure 17. Multi-Cal-PGA308 Software Model File: Pre- and Post-Calibration Section

Figure 18 shows the *Model Information* section of the Model File Editor window. The *Model Number* field is a unique number that is associated with a particular sensor module product. This number is written into OTP to simplify identification of the module at a later date.

The *Cal Results Root* field shows the first part of the calibration results filename. The *Report Root* is the first part of the calibration report file name. Figure 18 shows how the filename is built.

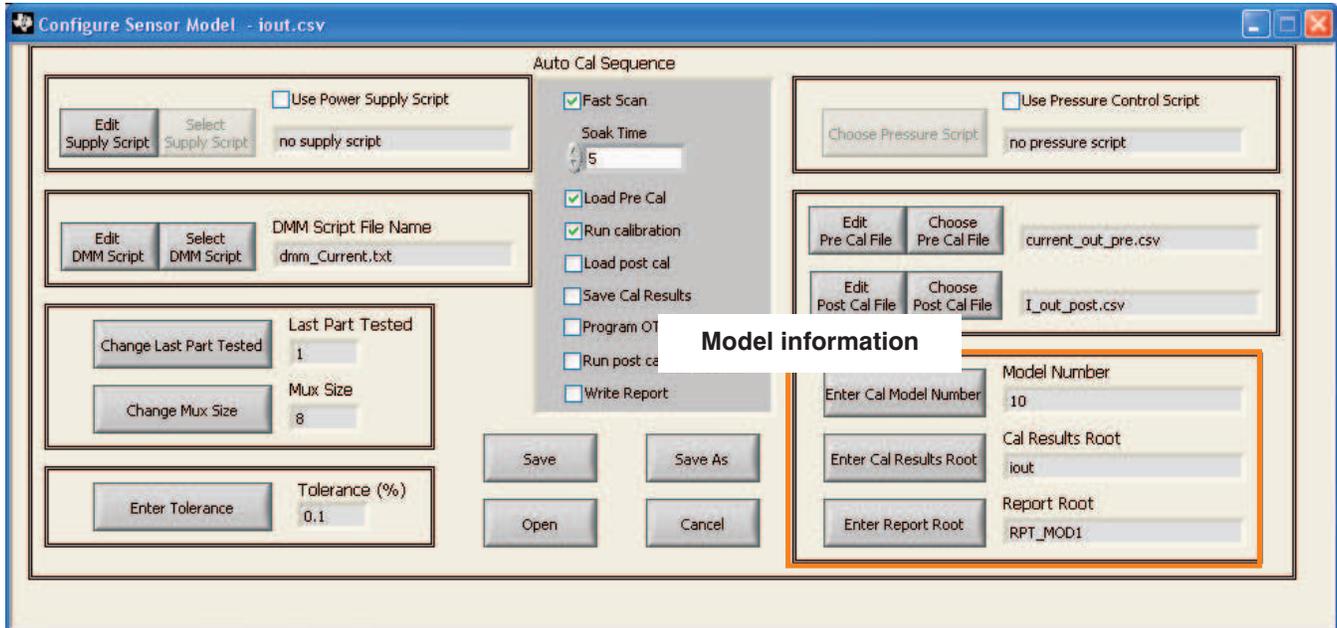
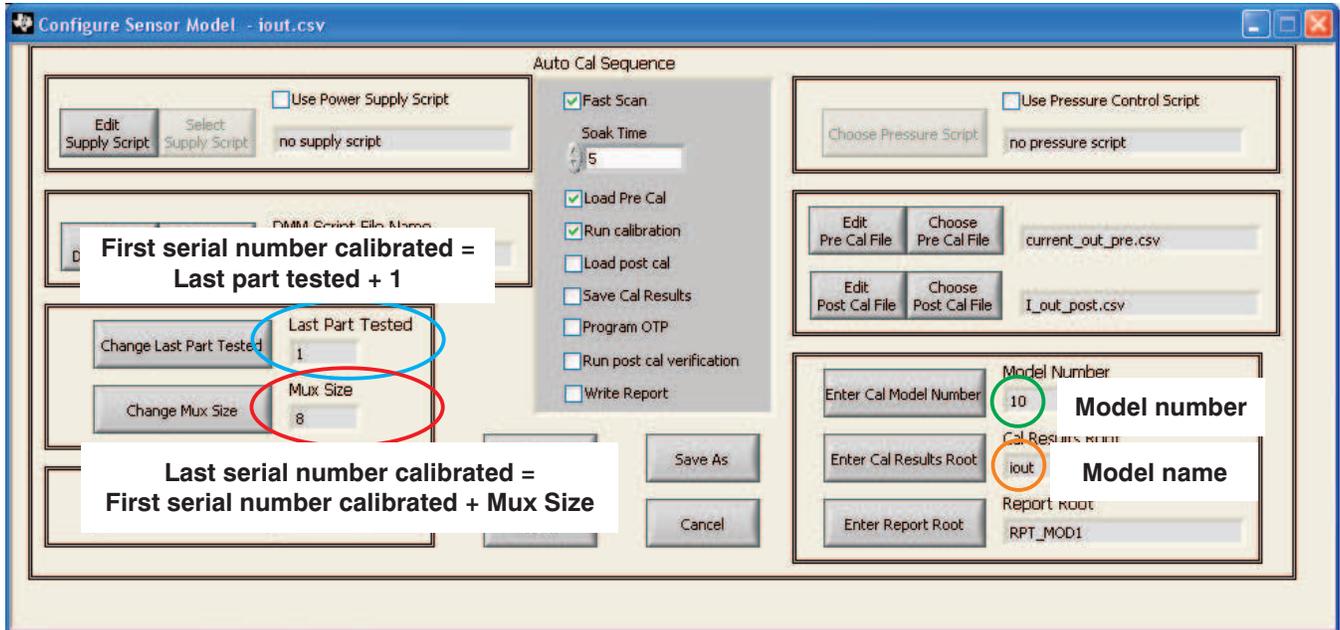


Figure 18. Multi-Cal-PGA308 Software Model File: Model Information Section

Figure 19 illustrates how the filenames for the *Calibration Results File* and the *Report File* are created. The filename is generated automatically. The information contained in the filename is also written into the OTP of the sensor module. That is, the model number, serial number, and date code are written into OTP on the sensor. Thus, you can read the OTP of the sensor module and easily find the specific file associated with it.



Code: Week 46 Year 2009

Model name	Model number	First serial number calibrated		
iout	MN_10	SN_230to234	DT_4609	.txt
		Last serial number calibrated		

Figure 19. Multi-Cal-PGA308 Software Model File: File Name Generation

Figure 20 shows the *Auto Cal Sequence* section of the Model File Editor window. The Auto Cal Sequence allows you to turn on and turn off different steps in the calibration sequence. The meaning of each step is defined below.

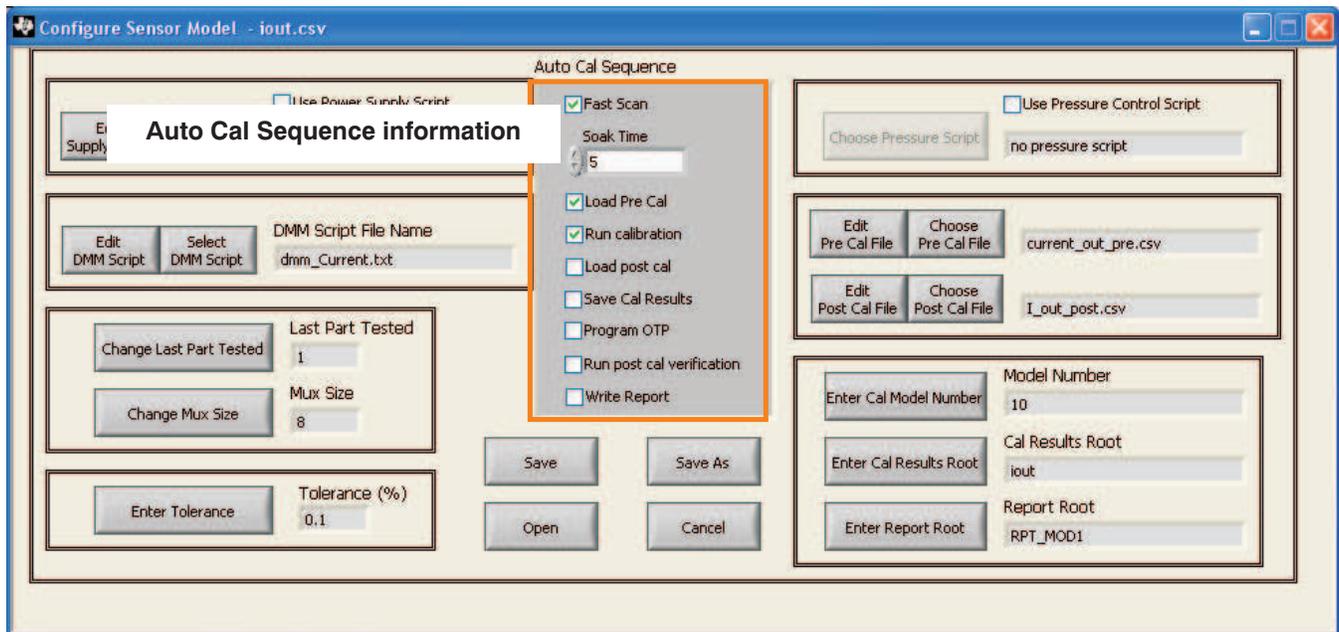


Figure 20. Multi-Cal-PGA308 Software Model File: Auto Cal Sequence Section

The various sections of the auto cal sequence are:

1. **Fast Scan:** Fast Scan applies power to one sensor at a time and checks for communication. The purpose of the Fast Scan is to fail shorted or damaged sensor modules before applying power to all of the devices. Devices that fail the Fast Scan step are not powered during the remainder of the calibration.
2. **Soak Time:** When the Fast Scan is complete, power is applied to all passing sensor modules simultaneously. Some sensors must be powered for several minutes (or hours, in some cases) before the output is accurate and stable. The soak time field allows you to set a wait time (in seconds) before calibration starts.
3. **Load Pre Cal:** The Pre Cal file defines the registers, power supply, reference, and operation mode for the sensor module.
4. **Run Calibration:** The calibration adjusts gain and offset on the PGA309 based on measurement results.
5. **Load Post Cal:** This step is not required. The post cal file is used when you want to use overscale limits, underscale limits, or fault settings. This file is the same as the Pre Cal File for these settings.
6. **Save Cal Results:** The register settings, reference voltage, operation mode, and other pertinent results are saved in this file. The filename is automatically generated according to the scheme described in [Figure 19](#).

4 Understanding the Instrument Script

The Multi-Cal-PGA308 must communicate automatically to instruments in order to perform an automatic calibration. All Multi-Cal-PGA308 EVMs must control the volt / ammeter automatically. The software can also be used to control the power supply and pressure source remotely. The script language was developed to allow you to customize the communication process to a variety of instruments without having to edit the LabView™ software.

The scripts allow you to communicate using RS-232 or IEEE488. The script shown in [Table 1](#) is an example of RS-232 communication. Note that each line in a script file contains a script command followed by an RS-232 or IEEE488 command. For example, the script command `write>` is followed by `MEAS:VOLT:DC? 10,0.00001`. The `write>` part of the command indicates that the string that follows will be written using RS-232. The `MEAS:VOLT:DC? 10,0.00001` part of the command was taken directly from the equipment user guide (see the Agilent 34401a DMM user guide). In general, the command to the right of the *greater than* symbol (>) can be edited according to your specific instrument requirements. [Table 1](#) and [Table 2](#) give comments that illustrate the meaning of each command.

Table 1. Script Reads Voltage on Agilent 34401A with RS-232 Port on the Computer

Row	Command	Comments
1	RS-232_COM_port>1	The COM port on your computer that is used for RS-232 communications (in this case, COM port = 1).
2	write>SYSTem:REMOte	Places the instrument into remote mode for communications.
3	pause>2.0	Wait 2.0 seconds before communicating.
4	parity>0	RS-232 parity set to 0.
5	baud_rate>9600	RS-232 baud rate set to 0.
6	num_bits>8	RS-232 number of bits 0.
7	flow_control>0	RS-232 flow control 0.
8	num_stopbits>20	RS-232 number of stop bits 2 (34401a interprets 20 as 2 for this command).
9	term_char>10	RS-232 term character 10.
10	write> MEAS:VOLT:DC? 10,0.00001	IEEE write to the instrument on COM port 1. This setting is taken from the Agilent 34401A user guide. This command causes the DMM to take a current reading.
11	read_dbl> 64	IEEE read of the results of the read taken in the previous command (row 3). The read is a double precision number 64 bytes long.

[Table 2](#) shows an example of a script that uses the IEEE488 card to communicate with the Agilent 34401A.

Table 2. Script Reads Voltage on Agilent 34401A with IEEE488 Card

Row	Command	Comments
1	IEEE488_address> 3	IEEE address of the instrument you are communicating with
2	pause>1.0	Wait 1 second before the next command.
3	write> MEAS:CURREN:DC? 50E-3,0.1E-6	IEEE write to the instrument at address 3. This setting is taken from the Agilent 34401A user guide. This command causes the DMM to take a current reading.
4	read_db1> 64	IEEE read of the results of the read taken in the previous command (row 3). The read is a double precision number 64 bytes long.

Evaluation Board/Kit Important Notice

Texas Instruments (TI) provides the enclosed product(s) under the following conditions:

This evaluation board/kit is intended for use for **ENGINEERING DEVELOPMENT, DEMONSTRATION, OR EVALUATION PURPOSES ONLY** and is not considered by TI to be a finished end-product fit for general consumer use. Persons handling the product(s) must have electronics training and observe good engineering practice standards. As such, the goods being provided are not intended to be complete in terms of required design-, marketing-, and/or manufacturing-related protective considerations, including product safety and environmental measures typically found in end products that incorporate such semiconductor components or circuit boards. This evaluation board/kit does not fall within the scope of the European Union directives regarding electromagnetic compatibility, restricted substances (RoHS), recycling (WEEE), FCC, CE or UL, and therefore may not meet the technical requirements of these directives or other related directives.

Should this evaluation board/kit not meet the specifications indicated in the User's Guide, the board/kit may be returned within 30 days from the date of delivery for a full refund. **THE FOREGOING WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY SELLER TO BUYER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.**

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EVM Warnings and Restrictions

It is important to operate this EVM within the input voltage range of 5.7V to 9V and the output voltage range of 0V to 5V.

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's Guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative.

During normal operation, some circuit components may have case temperatures greater than +25°C. The EVM is designed to operate properly with certain components above +25°C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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