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mess • electronic

PICOSTRAIN

Manual

PSØ9-EVA-KIT

Evaluation System for PSØ9

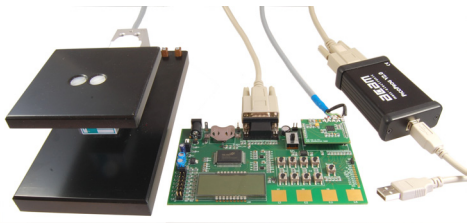

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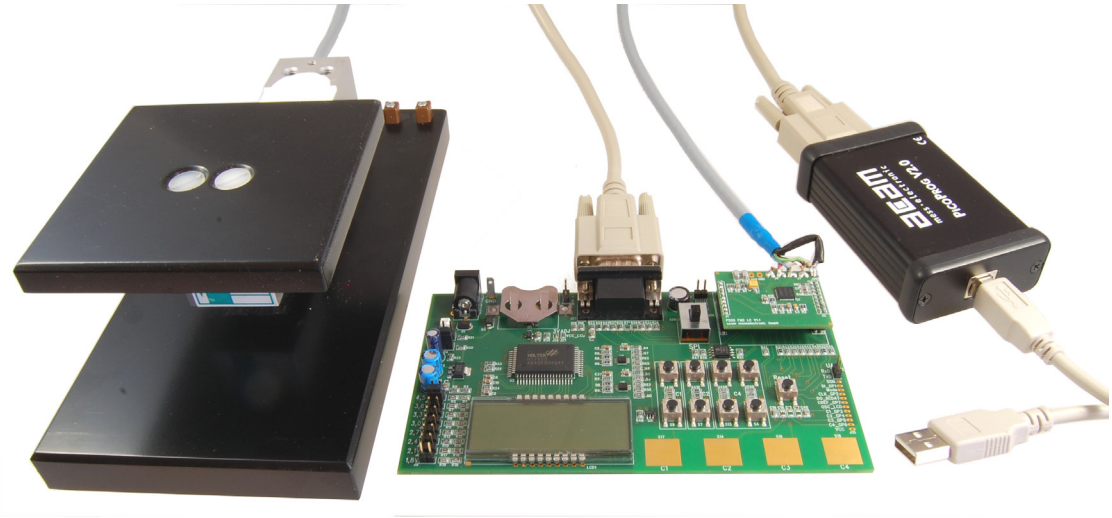
Table of Contents

		Page
1 Introduction		1-1
2 Connecting Strain Gauges	2.1 HR - High Resolution Module	2-2
	2.2 LC – Low Cost module	2-2
	2.3 Connecting the Modules ...	2-3
3 Motherboard	3.1 LCD	3-1
	3.2 External LCD driver	3-1
4 Load cell	4.1 Technical Specification	4-1
	4.2 Wiring diagram	4-1
5 Evaluation Software	5.1 Installing the PSØ9-EVA ...	5-2
	5.2 Running the Evaluation ...	5-3
6 Assembler Software	6.1 Installing the Assembler	6-2
	6.2 Running the Assembler	6-2
7 Miscellaneous	7.1 Literature Guide	7-2
	7.2 Document History	7-2
8 Appendix	8.1 Schematic Diagrams	8-2
	8.2 Layout PSØ9-EVA-HR Module	8-7
	8.3 Layout PSØ9-EVA-LC Module	8-8

1 Introduction

1.1 General

The PSØ9-EVA-KIT evaluation system provides a complete weighing system made of a main board with LCD panel, two plug-in modules, a 10kg load cell platform and Windows-based evaluation and assembler software. Optionally, the TTL-232R-3V3 cable, a USB TTL serial cable from FTDI is provided if the UART in the PSØ9 is to be tested. The EVA-Kit offers extensive and user-friendly configuration and evaluation of the PSØ9 single-chip solution for weigh scales.



1.2 System Overview

PSØ9-EVAL-MB Main Board

- LCD display 22 x 51mm²
- Interface to external LCD controller, Holtek HT1620
- Power select by 2 jumpers:
  - Battery holder for CR2032
  - Wall power supply, Voltage selectable by on-board jumpers
- 9 Push buttons (resistive keys)
- 4 Capacitive (touch) keys
- A SPDT switch to select either SPI or IIC serial interface between the PSØ9 and the PICOPROG programmer
- UART interface

PSØ9-EVAL HR-Module

- For up to 100,000 stable scale divisions & solar applications
- Up to 4 half bridges / Full bridge / Wheatstone bridge
- 4 layer PCB

PSØ9-EVAL LC-Module

- For up to 30,000 stable scale divisions and low cost applications
- Up to 4 half bridges / full bridge / Wheatstone bridge
- 2 layer PCB

PICOPROG V2.0 Programmer

- (USB to SPI/IIC interface)

10kg Load Cell

- 350 Ohm sensor
- Mounted on platform
- Wired as 2 half bridges with 1 span compensation resistor

Optional FTDI TTL-232R-3V3 cable (available upon request). This cable can be provided to test the UART of the PSØ9 by establishing communication between the UART of PSØ9 and a serial terminal application on a

Windows PC.

1.3 Component List

- PSØ9-EVA-MB Motherboard
- PSØ9-EVA-Module-HR Plug-in module- High resolution
- PSØ9-EVA-Module-LC Plug-in module- Low cost
- PICOPROG V2.0 Programmer
- Demo scale 10kg load cell with platform
- High density DSUB15 cable Connecting the Evaluation board to the programmer
- USB cable Connecting PICOPROG to the PC
- Wall power supply
- CD-ROM Incl. software and data sheets
- Optional - FTDI TTL-232R-3V3 cable (upon request)

2 Connecting Strain Gauges 2-2

2.1 HR - High Resolution Module 2-2
2.2 LC – Low Cost module 2-2
2.3 Connecting the Modules (HR and LC) 2-3
2.3.1 Capacitor Selection and Assembly 2-3
2.3.2 Half bridge 2-3
2.3.3 Half bridge connection for Solar Applications 2-4
2.3.4 Full bridge 2-5
2.3.5 Wheatstone Full Bridge 2-7
2.3.6 Quattro mode 2-8

2 Connecting Strain Gauges

The evaluation system comes with the load cell already connected to the plug-in module.

In the following we will explain how a user can apply his own load cell. In case of sensors with other than 350 Ohm resistance the discharge capacitor Cload has to be adapted.

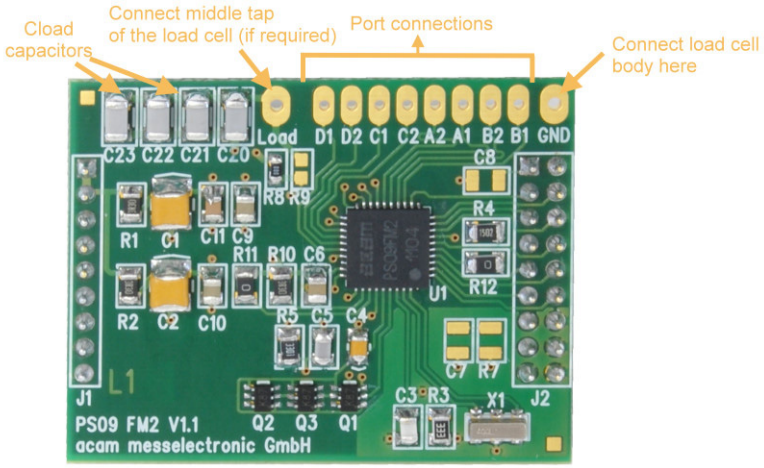
The 2 different plug-in modules are designed to support various applications of PSØ9. For high resolution and solar applications, for up to 100,000 stable scale divisions, the external bipolar comparator circuit is used. For applications with lower current consumption and low resolution requirement, the LC variant is used, running with the internal comparator. The LC module has minimum components and is the 'low-cost' variant therefore; however resolution will be clearly lesser than with the HR module.

2.1 HR - High Resolution Module

The HR module is targeted for high resolution and solar applications, for up to 100,000 stable scale divisions. The external bipolar comparator circuit is used in this module.

It is possible to measure up to 4 half bridges. Due to the PICOSTRAIN measurement principle the system does not need a full bridge. Two resistors, in the following called half bridge, are sufficient.

Figure 2-1: High Resolution Module



2.2 LC – Low Cost module

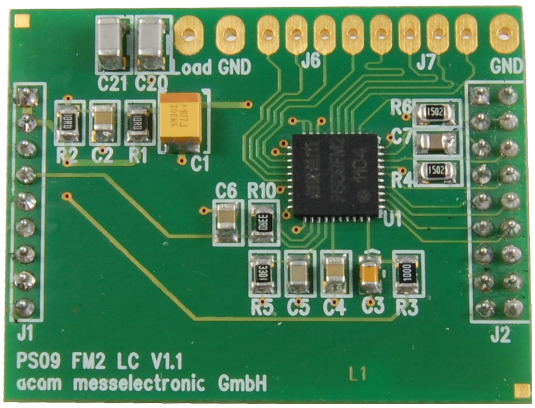
This is a low-cost version of the High resolution module, with minimum necessary components for operation. The following are the distinct features that differentiate the LC module from the HR module:

1. No external comparator. This makes the LC module suitable for applications with high, but not the highest resolution. The internal comparator is used. This reduces the base resolution by 0.8 bit compared to the external comparator.

2. The 4 MHz ceramic crystal oscillator is not present and there is no possibility to connect an external RC oscillator to PSØ9. Thus the PSØ9 can be operated only with the built in RC-oscillator. Operating the PSØ9 with the

internal RC oscillator is known to limit the resolution to approximately 16 bits. An advantage is the lower current consumption, which is around 1.2 mA current at 3V for maximum performance. To configure the internal oscillator for operation please refer to section 4.1 of PSØ9 data sheet.

Figure 2-2: Low-cost Module



2.3 Connecting the Modules (HR and LC)

2.3.1 Capacitor Selection and Assembly

The PICOSTRAIN measurement principle is based on measuring the discharge time of a capacitor. For this reason the correct size and material of the capacitors is significant to achieve best measuring results. In general we recommend a discharging time in the range of

$$\tau = 0.7 * R * C = 80 \text{ to } 120 \text{ µs}.$$

As material we recommend COG or CFCAP (Multilayer ceramic from Taiyo-Yuden). X7R capacitors can be used, too, but will show some minor loss in temperature stability.

The recommend values are:

Rsg = 350 Ohm → Cload = 300 nF to 400 nF

Rsg = 1000 Ohm → Cload = 100 nF to 150 nF

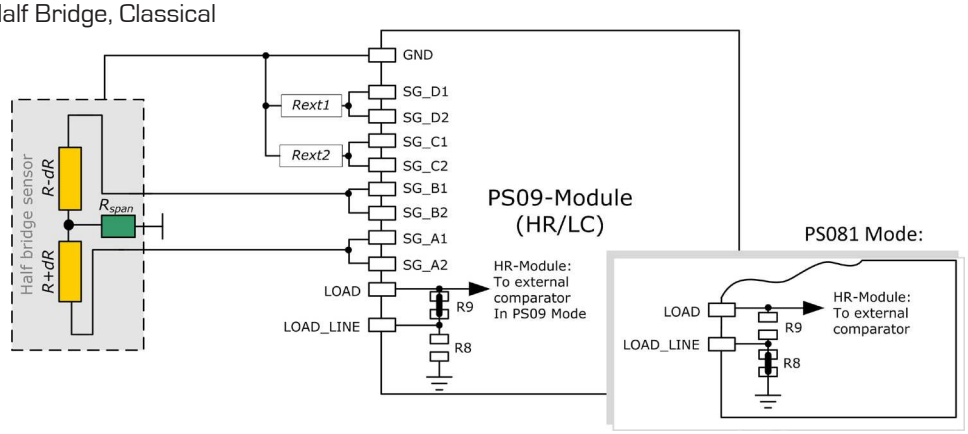
The plug-in module is pre-assembled with Cload = 4 x 100 nF = 400 nF.

2.3.2 Half bridge

A half bridge is sufficient to run the PSØ9 evaluation system. The following picture shows how to connect the half bridge the conventional way. It is basically connected to the pads A and B (SG_A1 and SG_A2, SG_B1 and SG_B2 are shorted). For the gain and temperature measurement, external resistors Rext1 and Rext2 are connected the pads C and D (also shorted).

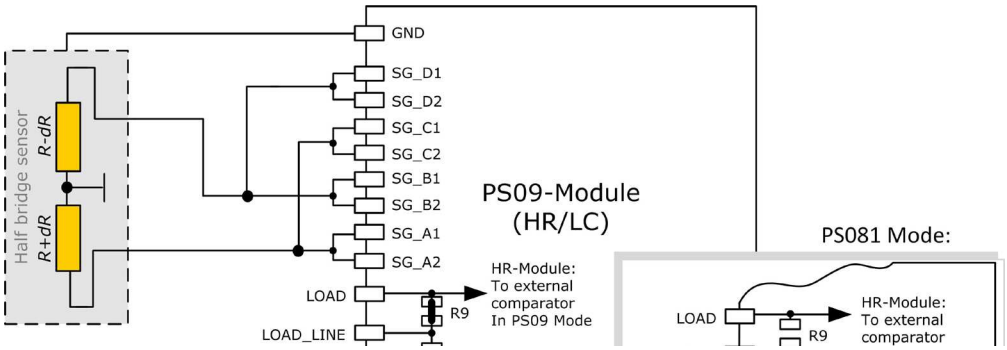
Value of Rext1 = Rext2 = Rsg, the strain gage resistance. For e.g. with respect to Figure 2-3a, for a load cell with Rsg = 350 Ohm and Rspan=45 Ohm, Rext1=Rext2= 350+45 = 395 Ohm

Figure 2-3a: Half Bridge, Classical



An alternative way of connecting a half bridge to PSØ9 is shown below, where the unused ports C and D are connected parallel to Ports A and B respectively. The external resistors are avoided in this connection. The option for using an external comparator is available only on the HR-module.

Figure 2-3b: Half Bridge, Alternative

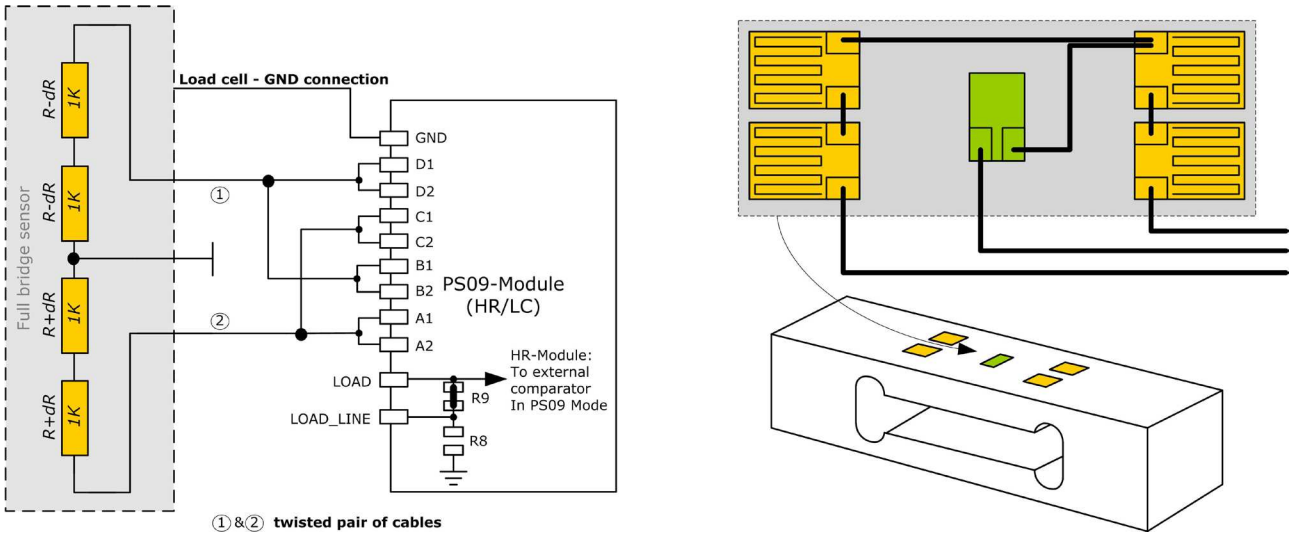


Please note: Both wiring options shown in figure 3a and 3b have to be done externally, i.e. at the solder pad of the module. There are no wiring or placement options on the module itself.

2.3.3 Half bridge connection for Solar Applications

In solar applications the reduction of the current consumption has the highest priority. The unique capability of PICOSTRAIN allows us to modify a full bridge load cell in such a way that it becomes a half bridge with twice the resistance. So with 1 kOhm strain gauges the load cell shows a total resistance of 2 kOhm. The current into the sensor is reduced by a factor of 2. This option is reasonable in case all the strain gauges are on one side of the load cell.

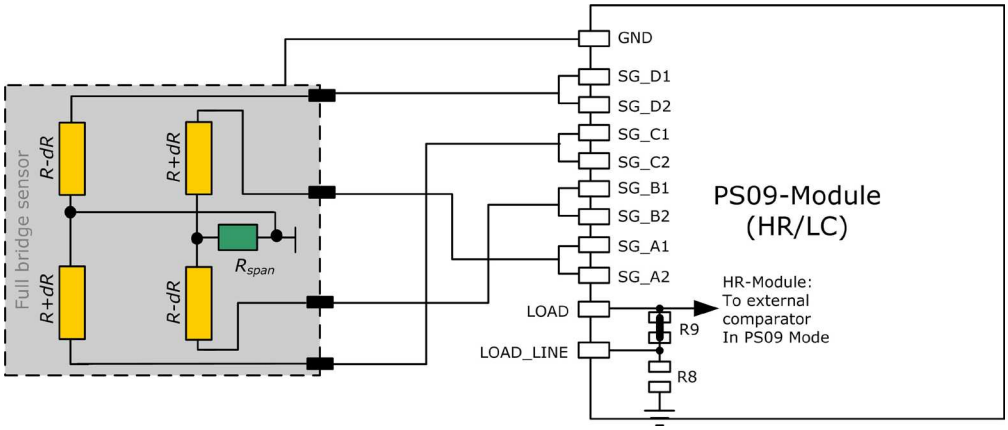
Figure 2-4: Half Bridge, Solar



2.3.4 Full bridge

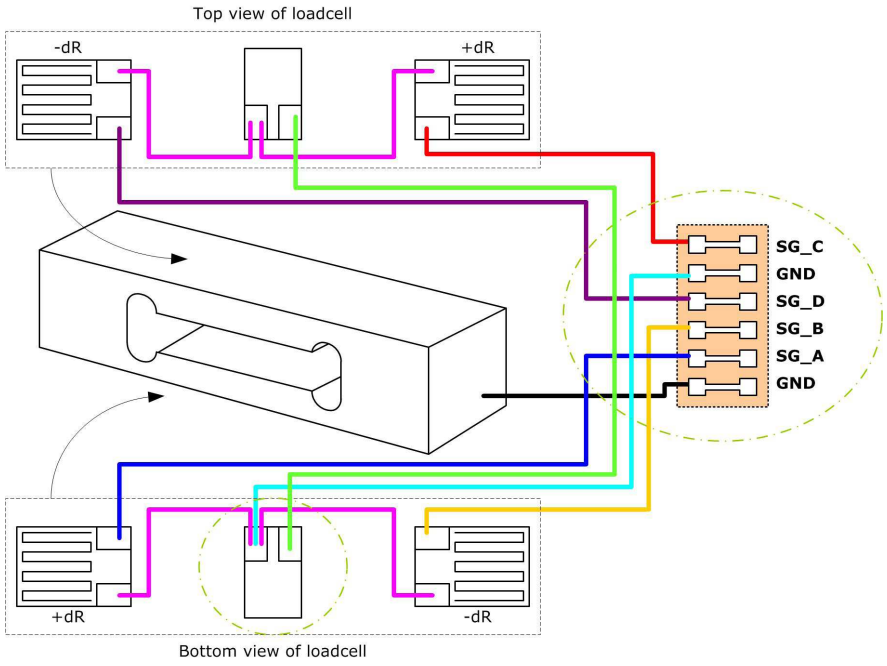
For PICOSTRAIN a full bridge is ideally separated into two half bridges. This wiring can increase the resolution compared to Wheatstone bridges by 0.6 bit.

Figure 2-5: Full Bridge



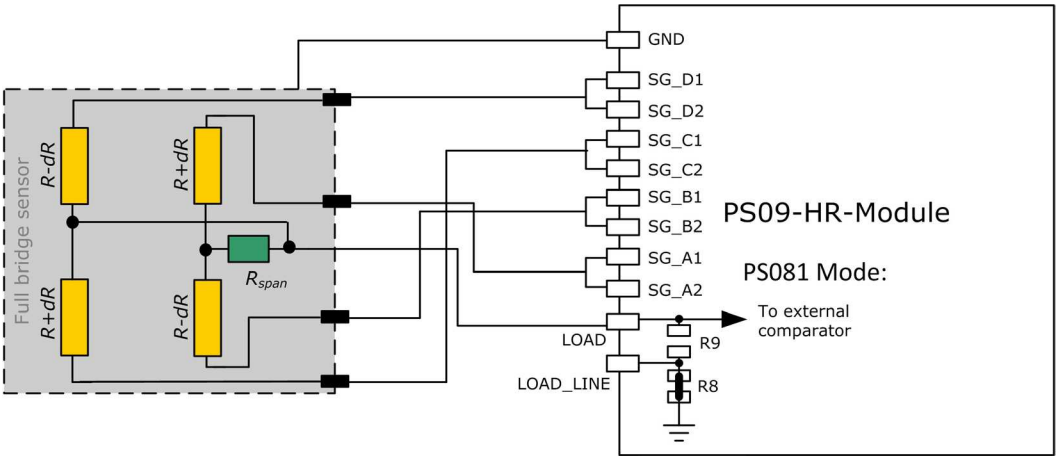
Existing sensors with Wheatstone bridge connection might be adapted just by changing the wiring according to the following picture.

Figure 2-6: Adapted Load Cell Wiring



For certain advantages like resolution, PSRR etc. depending on the application, it might be necessary to use the PSØ81 compatible mode of PSØ9. For details on this mode and its associated advantages, please refer to section 3.3.5 of PSØ9 data sheet.

Figure 2-7: PSØ81-compatible wiring

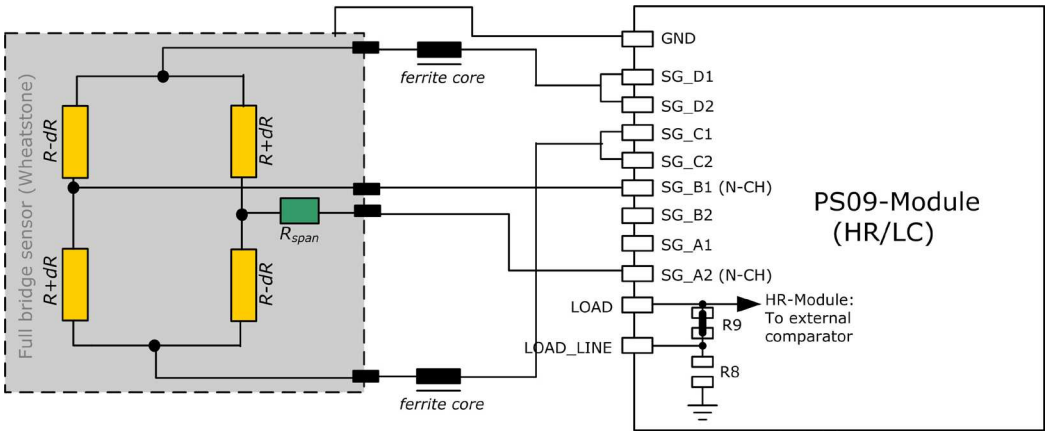


2.3.5 Wheatstone Full Bridge

Existing load cells in Wheatstone configuration can be connected to the module without any modification as long as they have only one or no compensation resistor. In case the bridge has two compensation resistors one of those needs to be shortened.

In general Wheastone wiring will end in 0.6 bit less resolution compared to PICOSTRAIN wiring. It might be reasonable to use Wheatstone bridges in case of cables to the sensor longer than 0.5 m. The following figure shows the connection of the Wheatstone bridge.

Figure 2-8: Wheatstone Bridge



The PICOSTRAIN measurement principle is based on measuring the discharge time of a capacitor. For this reason the correct size and material of the capacitors is significant to achieve best measuring results. For Wheatstone, the discharging time is furthermore reduced by the factor of 0.7, The following formula can be used to calculate the discharging capacitance.

$$\tau = 0.7 * 0.75 * R * C = 60 \text{ to } 110\ \mu s.$$

As material we recommend C0G or CFCAP (Multilayer ceramic from Taiyo-Yuden), X7R capacitors can be used, too, but will show some minor loss in temperature stability.

The recommend values for Wheatstone mode are:

Rsg = 350 Ohm →Cload = 300 nF to 400 nF

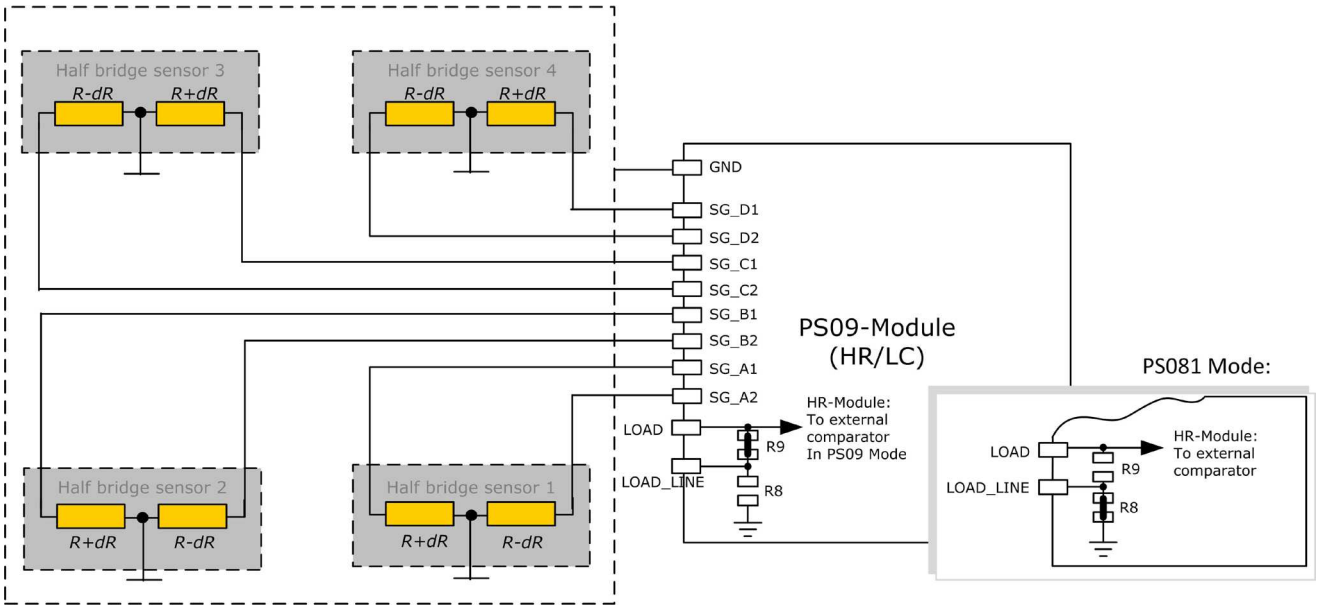
Rsg = 1000 Ohm →Cload = 100 nF to 200 nF

Please note: In Wheatstone mode the operation via SPI interface is recommended. If IIC is to be used, please operate in Single Conversion Mode. See also the bug report in the PS09 data sheet.

2.3.6 Quattro mode

In quattro mode the PSØ9 measures 4 half bridges. The 4 half bridges are measured independently and the gain of each half bridge can be corrected separately. Typical applications are bathroom-scales, baby or platform scales.

Figure 2-9: Connecting four half bridges or two full bridges in One sense mode



3 Motherboard

The motherboard connects to the PICOPROG programmer. It serves the various power options. It holds the LCD panel. The 9 push buttons (resistive keys) and 4 capacitive keys can be used in stand-alone operation.

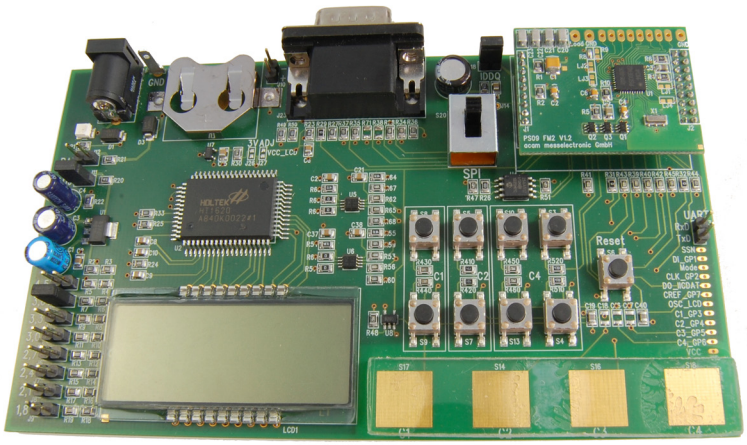
The jumpers for power select can also be used to measure the current consumption of the system.

3.1 LCD

The LCD has the following specification:

Duty ¼, Bias 1/3, Operating voltage 2.5V, Operating temperature 0°C to 50°C.

Figure 3-1: Motherboard

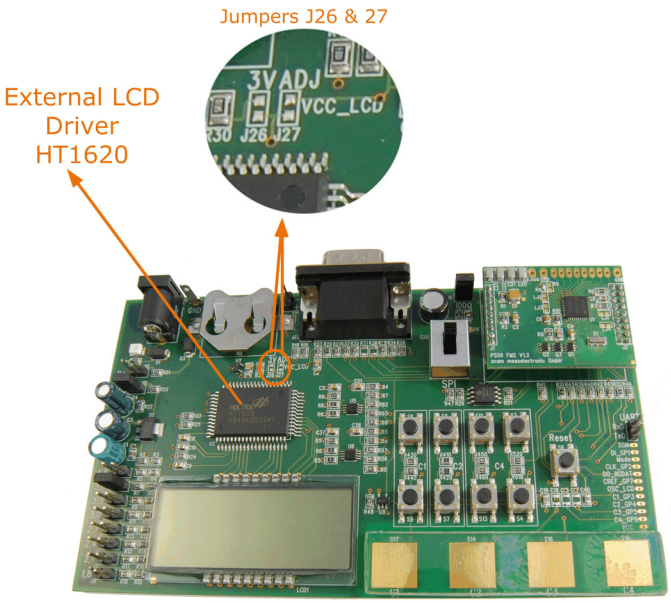


3.2 External LCD driver

PSØ9 offers the possibility to support an external LCD driver. Therefore a simplified SPI master mode is programmed in the PSØ9, especially adapted to Holtek HT1620 LCD driver. Three GPIOs of the PSØ9 are used to realize the SPI master interface to connect to the Holtek driver. The PSØ9 can generate a configurable 32 kHz clock needed to drive the HT1620 driver, thus avoiding the necessity of an external crystal oscillator for the LCD Driver. One GPIO is additionally used to for this clock.

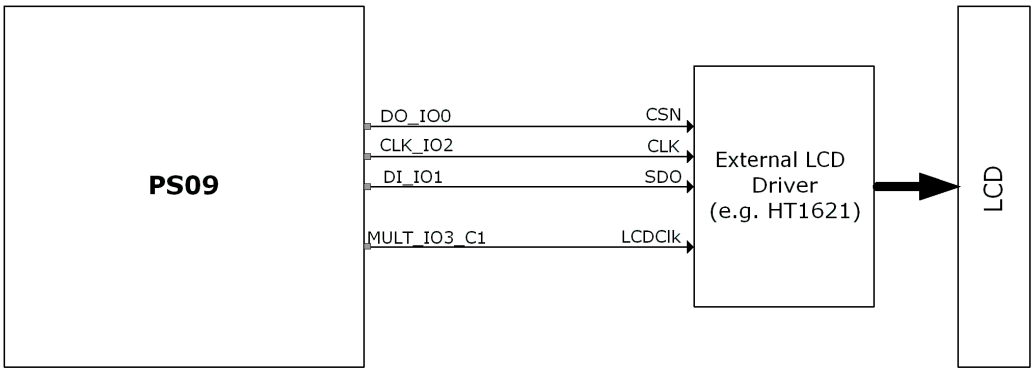
The LCD driver on the PSØ9 Motherboard can be powered by the output of a voltage regulator (fixed voltage of 3V). Optionally the LCD driver can be powered by the voltage selected by the on-board jumpers on the motherboard (voltage adjustable). The appropriate jumper (J26 (fixed) or J27 (adjustable)) has to be soldered in order to select the source of the LCD's power supply.

Figure 3-2: External LCD Driver



The following picture shows the connection of an external LCD driver circuit:

Figure 3-3: External LCD Driver Wiring



A flowchart showing the general sequence to program the PSØ9 in order to operate the external LCD driver is illustrated in Section 4.8 of the PSØ9 Data sheet. The flowchart is however based on the idea that GPIOs 5, 6, 7 would be used as the SPI communication lines. The PSØ9 EVA board supports communication to the Holtek driver only via GPIOs 0, 1, 2. Sample programs which use the LCD for display, along with the appropriate header files that are specific to the Holtek driver, HT1620 are available as part of the PSØ9 Assembler examples.

4 Load cell

The evaluation system is shipped with a ready made demonstration scale connected to the high resolution module. The load cell is model CZL601SE-10kg from Hua Lan Hai (http://www.chinesesensor.com/Single-point_Load_Cell.html).

4.1 Technical Specification

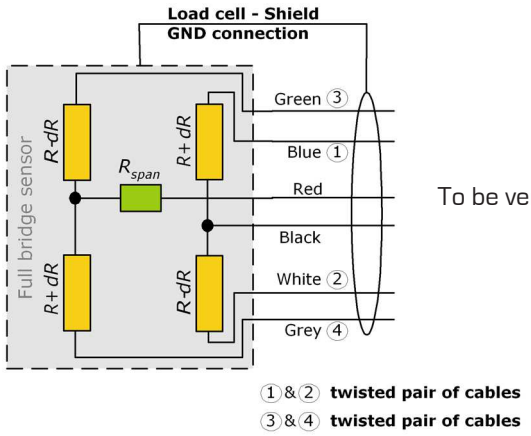
Table 4-1: Technical Spelcification

Maximum load	kg	10
Comprehensive error C2	%F.S.	0.02
Rated output	mV/V	typ. 1.85
Non-linearity	%F.S.	0.03
Hysteresis	%F.S.	0.03
Repeatability	%F.S.	0.02
Creep	%F.S./30min.	0.02
Resistance	Ohm	350 ± 5
Compensation resistor	Ohm	42 ± 5
Compensated temperature range	°C	-10 to +40
Operating temperature range	°C	-35 to +65
Safe overload	%F.S.	120
Ultimate overload	%F.S.	150

Mechanical dimensions:	
Base plate	200 mm x 100 mm
Weighing plate	90 mm x 90 mm
Total height	70 mm

4.2 Wiring diagram

Figure 4-2: Wiring diagram (to be verified)



To be verified

5 Evaluation Software 5-2

5.1 Installing the PSØ9-EVA Software 5-2
5.2 Running the Evaluation Software 5-3
5.2.1 Setup Page 5-3
5.2.2 Measurement Page 5-4
5.2.3 Graphic Page 5-5
5.2.4 Front-End Page 5-6
5.2.5 ALU Page 5-7
5.2.6 Expert Page 5-8
5.2.7 Memory Page 5-9
5.2.8 Interfaces Page 5-10
5.2.9 Temperature Compensation Page 5-11

5 Evaluation Software

5.1 Installing the PSØ9-EVA Software

The PSØ9-EVA software runs under the following operating systems

- Windows 2000
- Windows XP
- Windows Vista (please use the software/drivers for Windows 7)
- Windows 7

Please follow the described procedure to install the software and driver:

NOTE: Ensure that the Picoprog V2.0 programmer is disconnected before starting the procedure.

1. Install the device drivers by running setup.exe from Driver/PicoProg v2 Driver Installer Stand-Alone. Select the shown default paths and continue the setup procedure.
2. At the end of step 1, you will be asked in a separate window (batch-file) to connect the Picoprog V2.0 programmer. Please insert the PicoProg to your computer.
3. The driver is installed; a windows message may pop up asking you to install the driver though it is not signed. Please install it anyway.
4. The batch file asks you to plug in the programmer and it is now enumerated. Unplug and insert the Picoprog programmer.
5. Install the PSØ9 Assembler software from Software\PSØ9-Assembler-Software\XP-WIN7\Volume2-0-xx\setup.exe from the CD.
6. If required perform a system restart.
7. The assembler software is now ready to use. Open the PSØ9 Assembler software, the respective firmware is downloaded into the programmer automatically and the LED on the Picoprog programmer is illuminated.
8. You can test to find the programmer on the 'Download' page and press 'Get Device Info'.
9. Install the evaluation software now from Software\PSØ9-Evaluation-Software\Setup.exe
10. Once the software is installed, launch the application from the start menu. The software opens and a pop up window asks to select a firmware for Picoprog.
11. Select the hex-file (firmware) for Picoprog in the folder "data" The hex-file itself is named PSØ9_FWxx.hex
12. If everything is correctly installed, the USB identifier must be USB:: 0x194E:: 0x100F::NI-VISA.
13. Please confirm connection by clicking the button 'Verify Interface'. 'OK' should be shown in the pop-up window.

Optionally you can see a video-tutorial about the PS08 Assembler Software (which structurally the same as the PSØ9 Assembler) by watching the video from:

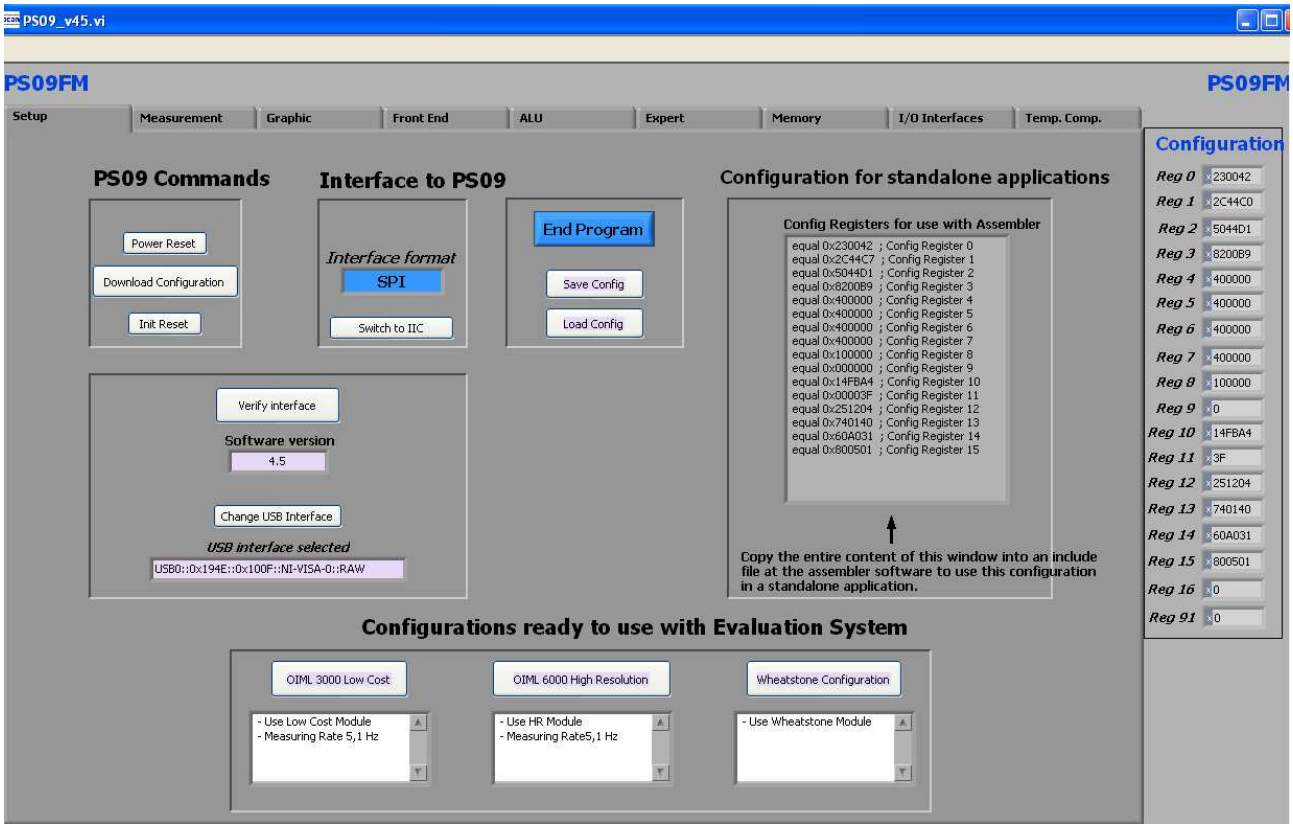
→ ASM-Screencast.exe in PS08-Assembler-Introduction\Flash folder.

5.2 Running the Evaluation Software

The software comes up with the following window:

5.2.1 Setup Page

Figure 5-1: Setup Page



Power Reset	Power reset of evaluation board
Download Configuration	Download the current configuration into the PSØ9
Init reset	Initialization of PSØ9 (keeps the configuration)
Verify Interface	Verifies the communication path between the PSØ9 and the PC
Switch to SPI	Establishes the communication mode between the Picoprog and the PSØ9 to SPI mode (Note: By default the communication mode set in the evaluation software is SPI)
Switch to IIC	Establishes the communication mode between the Picoprog and the PSØ9 to IIC mode

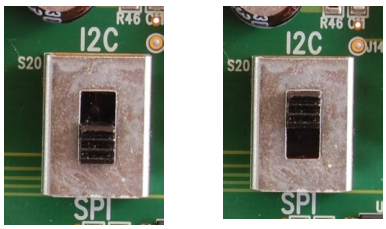


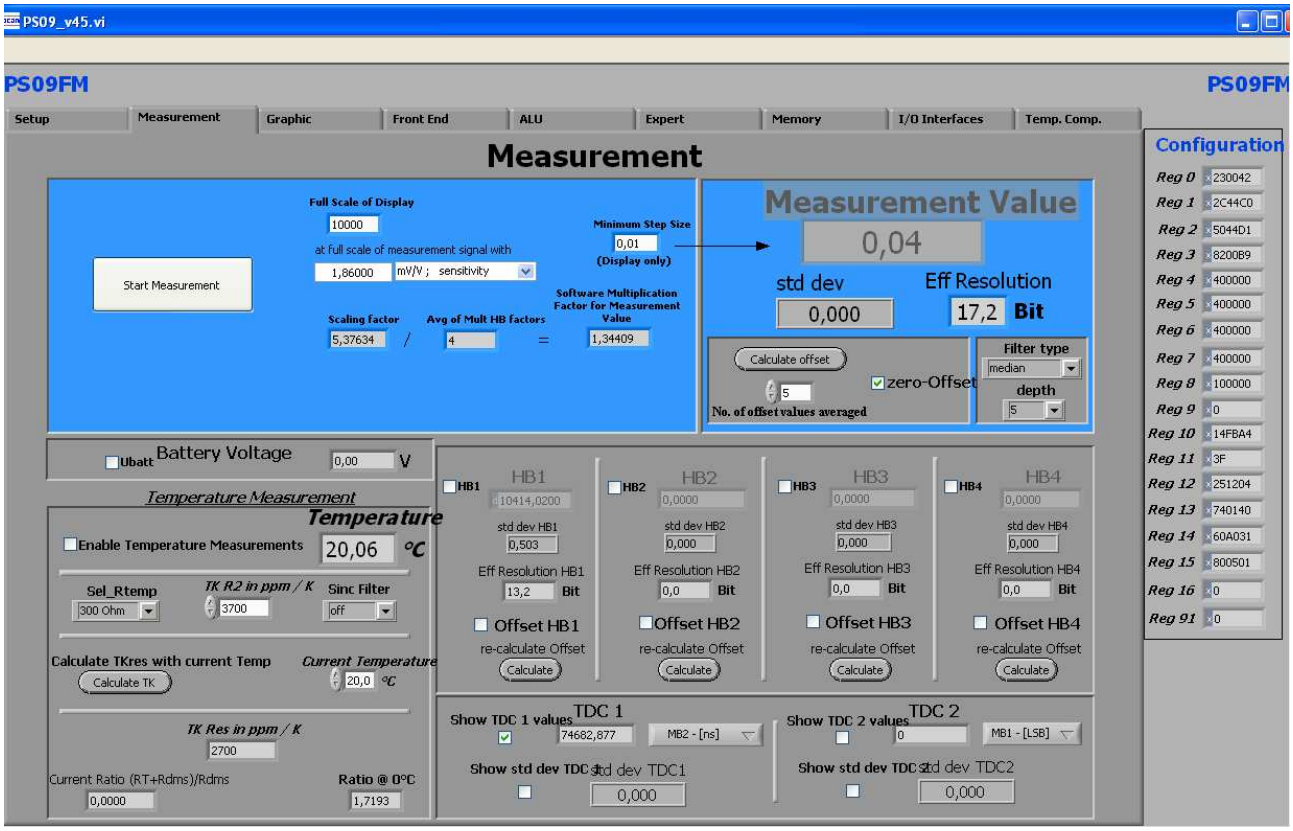
Figure 5-2: Switch IIC/SPI

Save Config	Save actual PSØ9 configuration to PC
Load Config	Load existing configuration from PC

1. It is recommended to start the PSØ9 evaluation by using the Ready-to-use configurations.
2. After loading a configuration please press ‚Power Reset' → ‚Download Configuration' → ‚Init Reset'
3. The communication to the chip is verified by pressing 'Verify Interface', the result is a pop up window with the software version, firmware version and the status of the PSØ9 communication interface.
4. Afterwards switch to the ‚Measurement' tab and press → ‚Start Measurement'

5.2.2 Measurement Page

Figure 5-3; Measurement Page

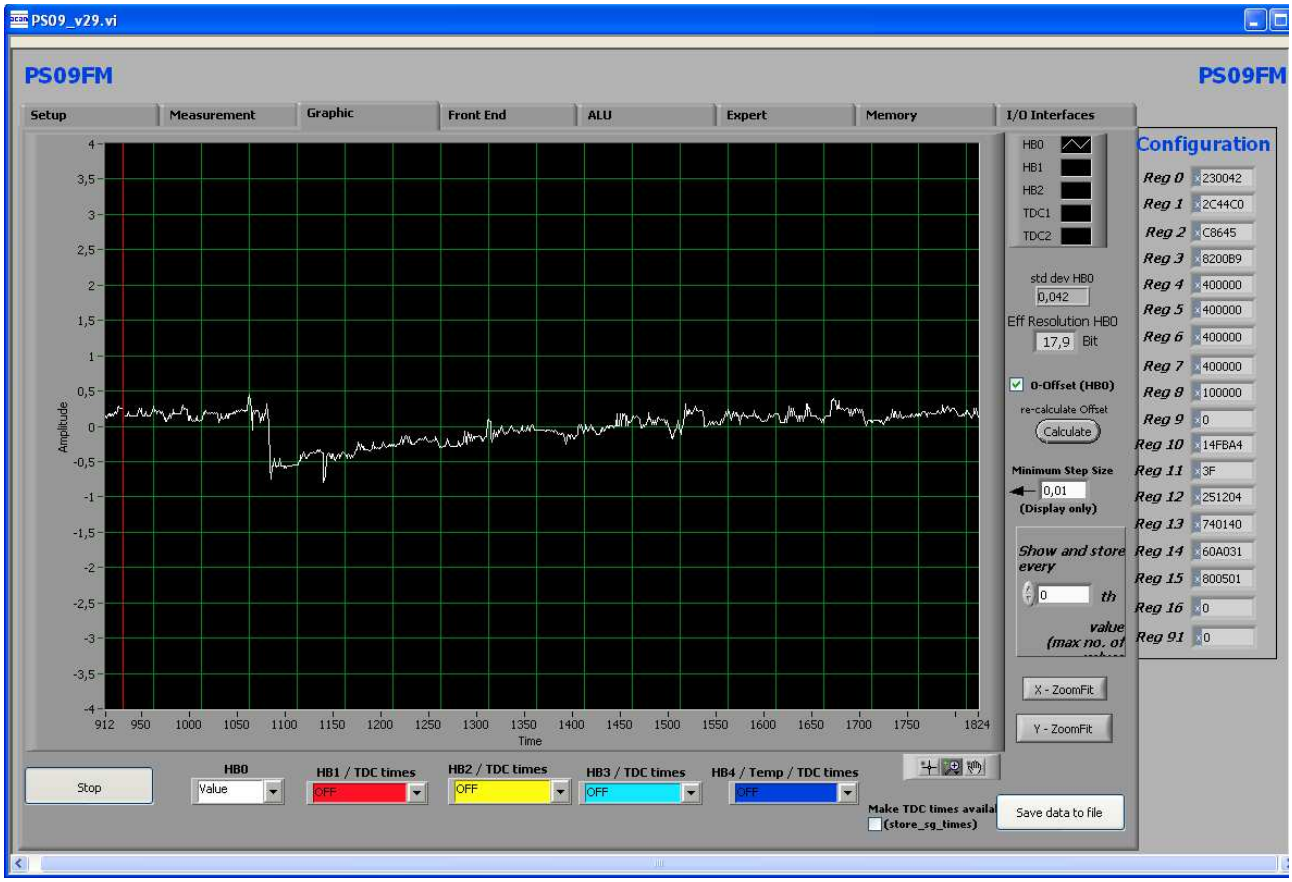


Full Scale of Display	Value that shall be displayed at maximum load at full scale of measurement...
	Sensitivity of sensor, output at maximum load
Minimum step size	Minimum step size of displayed result
Measurement value	Display of HB0 result using the software filters set under „Filter".
Eff. Resolution	Effective resolution with respect to maximum output
Filter	Selection of various software filters like SINC (rolling average) and Median (non-linear filter).

depth	Depth of the filter
re-calculate Offset	Software recalculates the offset, sets back the display to 0.
Ubat	Include voltage measurement, display in V.
Temperature Measurement	To enable the temperature measurement to be performed on chip.
Sel_Rtemp	Select the value of the internal temperature measurement resistance to be used for measurement.
HB1 ... HB4	Display the results of the half bridges (works only if Single Conversion Mode is configured)
Show TDC1 values	Shows the discharge time
Show TDC2 values	Shows resolution of TDC

5.2.3 Graphic Page

Figure 5-4: Graphic Page

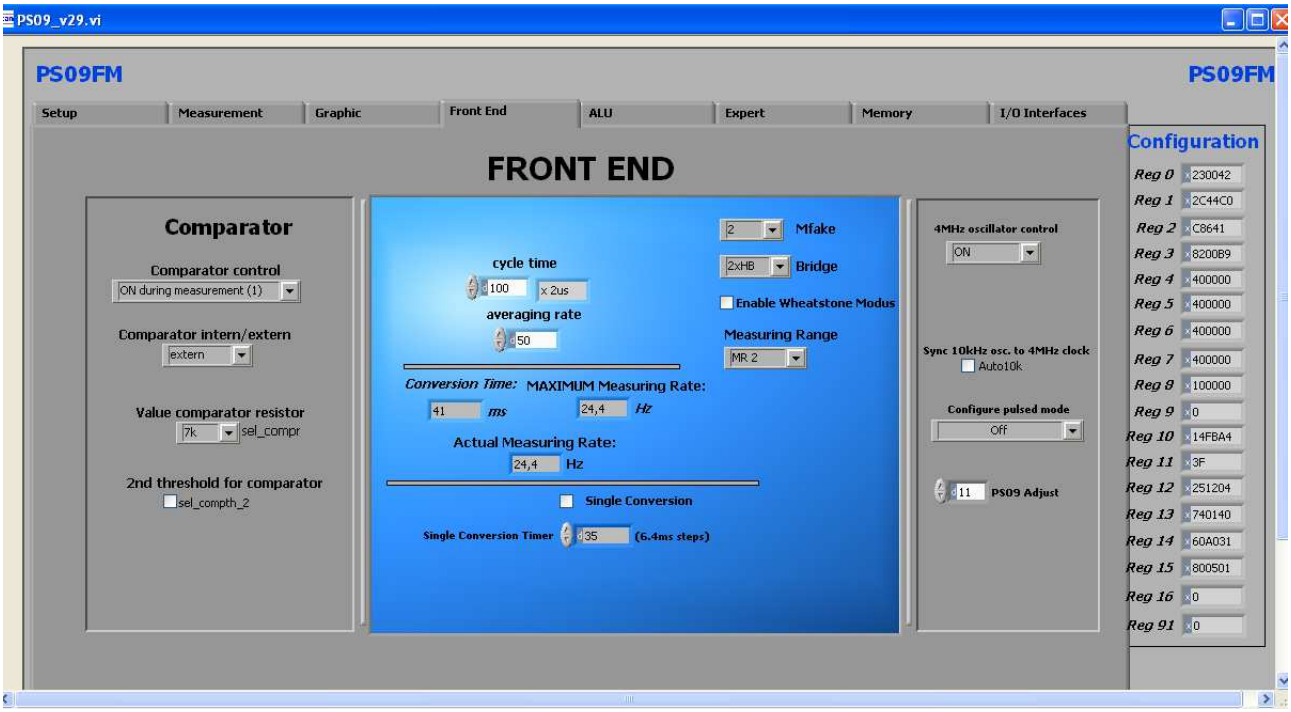


Graphical display of the results. The consolidated result HB0 as well as the separate half bridge results can be displayed. Additionally, Temperature can also be graphically displayed.

Pressing the → ‚Save data to file' button stores the data in a text file. The size is limited to 32k values. For long term drift investigations it is possible to store not each value. The number between values to be stored can be set.

5.2.4 Front-End Page

Figure 5-5: Front-End Page



Comparator control	= con_comp: Sets the switch on behaviour of the comparator
Comparator intern/external	= sel_compint: Selection between internal comparator (LC module) and external bipolar comparator (High resolution module)
Comparator resistor value	= sel_compr: Select comparator working resistor
Sel_cmp_thr2	= Selects the second threshold for the comparator
Cycle time	= cytime: Set the cycle time (see section 9.2.3 of PSØ9 datasheet)
Averaging rate	= avrate: Set the internal averaging rate
Single conversion	= single_conversion: Selects single conversion modes. The timer defines the time interval between conversions.
Mfake	= mfake: Sets number of fake measurements.
Bridge	= bridge: Selects the number of half bridges
Enable Wheatstone	= en_wheatstone: Selects Wheatstone mode
Measurement range	= messb2: Standard is measurement range 2. Option to select range 1.
4 MHz oscillator control	= sel_start_osz: Sets the switch on control for the 4 MHz oscillator