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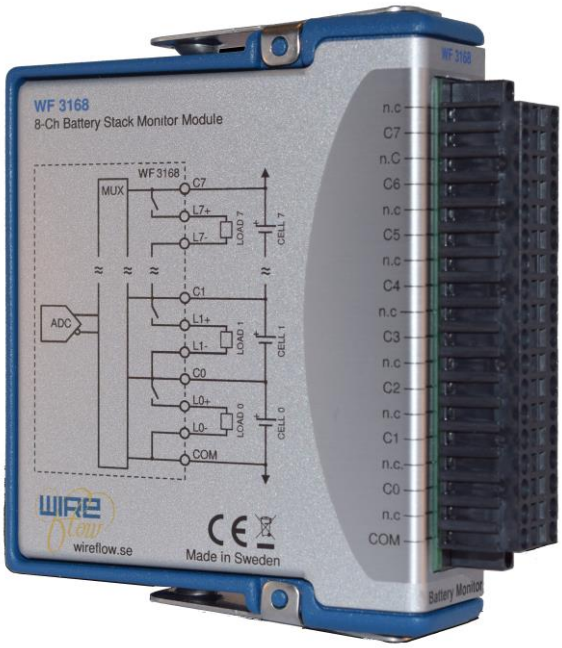
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wireflow

AC0094-009, rev C

WF 3168
User Manual



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Support information

Technical support and Product information

www.wireflow.se

WireFlow headquarters

WireFlow AB
Theres Svenssons gata 10
SE-417 55 Göteborg

Please see appendix “Technical support and Professional services” for more information.

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Important information

Copyright

The WF 3168 module and accompanying software driver is Copyright ©2018, WireFlow AB.

High risk activities

The software and hardware is not designed, manufactured or intended for use or resale as on-line control equipment in hazardous environments requiring fail-safe performance, such as in (but not limited to) the operation of nuclear facilities, aircraft navigation or communication systems, air traffic control, direct life support machines, or weapons systems, in which the failure of the Software could lead directly to death, personal injury, or severe physical or environmental damage ("High Risk Activities"). WireFlow and its suppliers specifically disclaim any express or implied warranty of fitness for High Risk Activities.

Safety Guidelines

Operate the WF 3168 only as described in this manual.



Make sure that installation and wiring is performed by qualified personnel according to the guidelines in this manual.



The module housing may be hot. The temperature may be higher than 65 °C.

CAUTIONS



Electrostatic discharge (ESD) can damage components.
Please wear an ESD wrist strap when handling the module.

Compliance

CE - European Union EMC and Safety Compliance CE

This product meets the essential requirements of applicable European Directives, as follows:

- 2014/35/EU; Low-Voltage Directive (safety)
- Electromagnetic Compatibility (EMC) Directive 2014/30/EU
- RoHS Directive 2011/65/EU

Please contact WireFlow to get a copy of the Declaration of Conformity for the WF 3168 module

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Device information

Introduction

The WF 3168 from WireFlow is an 8-channel battery monitoring and balancing device that includes a high voltage input multiplexer, ADC and balancing switches for each battery cell. The module can measure up to 8 series-connected cells with a voltage up to 15V per cell.

The module is designed for the CompactRIO platform from National Instruments.

The module measurement circuitry is galvanically isolated from the other modules in the system and provides up to 1000 VDC channel-to-earth rated working voltage, making the module ideal for accurately monitoring large battery stacks. By using several WF 3168 modules connected in series it is possible to monitor every cell in a long string of series-connected cells.

The challenge of measuring a battery stack is that the “voltmeter” used to measure the voltage over each cell must withstand a high “common mode” voltage relative the ground of the series connected battery stack. Also, the multiplexer that is used to move the voltmeter between the cells must withstand this high common mode voltage.

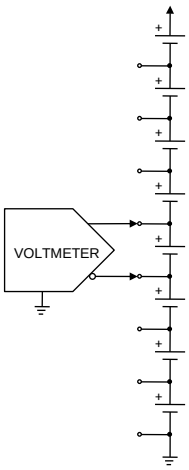


Figure 1 – Voltmeter on multiple cells

The minus pole of the bottom cell should always be connected to the chassis ground of the compact RIO chassis. Please note that the COM pin on the WF 3168 is isolated from chassis ground. So by connecting the lowest battery to chassis ground you will also connect the COM pin of the WF 3168 to chassis ground.

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The WF 3168 also provides eight balancing switches that can be used for passive balancing of the battery cells. If one battery cell becomes overcharged the corresponding balancing switch in the WF 3168 can be used to discharge that cell. An external resistor should be connected in series with the MOSFET switch that is located inside the WF 3168 to dissipate heat outside of the WF 3168 module as illustrated in the following figure:

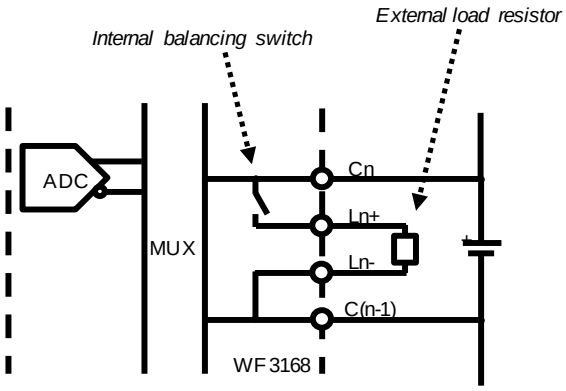


Figure 2 - External load resistor connection

Please note the maximum dissipation current allowed through the internal balancing switch when dimensioning the external dissipation resistor. There is no over-current protection on the internal switch so the circuit may be damaged if specified current is exceeded.

It is possible to measure on more than eight cells by using several WF 3168 modules connected in series. As always, the minus pole of the bottom cell should be connected to the chassis ground of the compact RIO chassis. By doing this you will connect the COM of the first WF 3168 to chassis ground.

The minus pole of the ninth cell (no 8) shall be connected to COM on the second WF 3168 and also to C7 of the first WF 3168. The illustration below shows an example where three WF 3168 are used to measure on 17 cells, (Cell0..Cell16). Cell17..Cell23 are unused.

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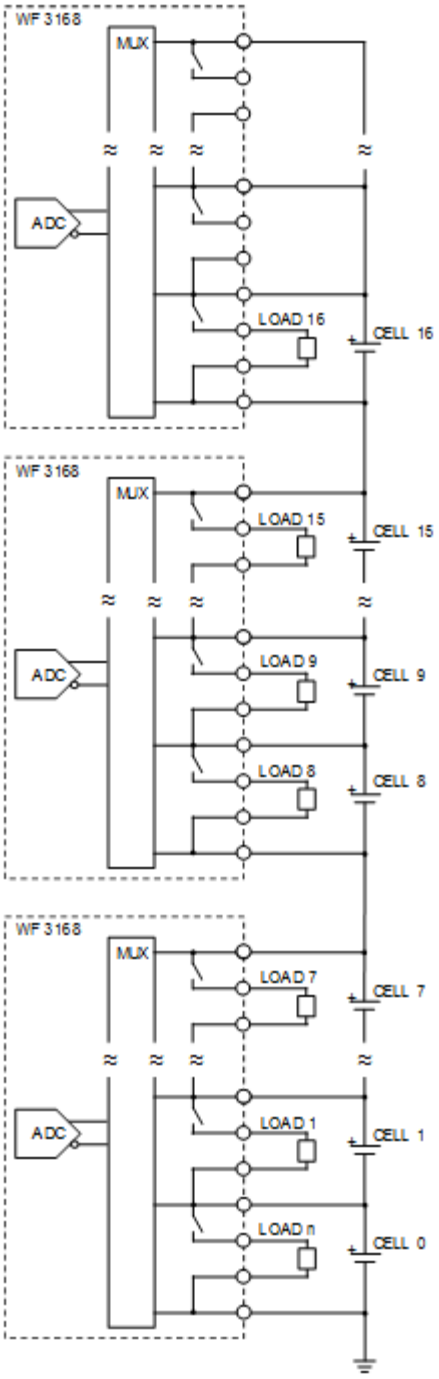


Figure 3 - Using multiple WF 3168

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Specifications

Analog Input Characteristics	
Number of channels	8
Maximum voltage C_n to C_{n-1}	-0.9 to 24 V
Maximum voltage C_7 to C_3	-0.9 to 75 V
Maximum voltage C_3 to COM	-0.9 to 75 V
Measurement range C_n to C_{n-1}	0.1 to 15.1 V
Measurement resolution	0.1 mV *[1]
Measurement error (typical and (max))	6V: ±0.3mV (max ±2.4) 10V: ±0.6mV (max ±3.6) 12V: ±0.9mV (max ±4.8) 15V ±3.0mV (max ±8.4) *[4] *[5]
Max sampling rate	33 Hz
Input leakage current	10 nA typical
Input current when inputs are measured	±2 uA typical
Input impedance during measurements	300 kΩ *[3]

Balancing Switching Characteristics	
Maximum current, continuous	1.5 A
Max switching rate	45 Hz
Voltage drop	67 mV (@1.5A)

Power Requirements	
Power consumption from chassis	625 mW maximum
Thermal dissipation	625 mW maximum *[2]

Isolation Voltages (rated working voltage)	
Channel-to-channel	None
Channel-to-earth ground, Continuous	1000 V

Environmental	
Operating temperature	-40 °C to 70 °C *[2]
Storage temperature	-40 °C to 85 °C
Pollution	Degree 2
Maximum altitude	2000 m
Indoor / Outdoor	Indoor use only

Calibration	
Calibration Interval	No calibration needed

*[1] ADC readings are scaled from 0.1mV to FXP with 0.061 mV resolution by the LabVIEW driver.

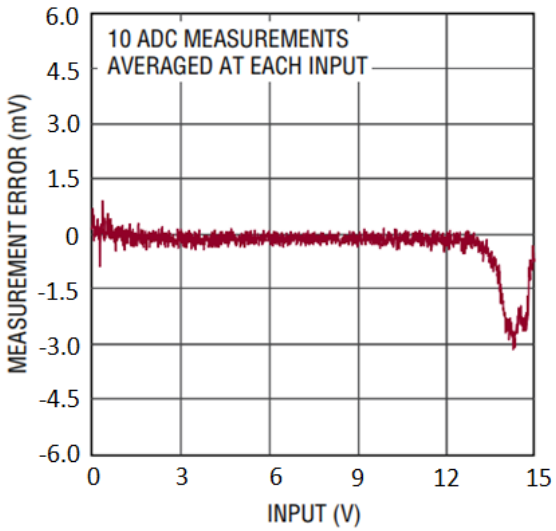
*[2] Max operating temperature and Thermal dissipation are affected when using the balancing function. Please see chapter *Thermal dissipation caused by balancing* for more information.

*[3] When doing measurement the impedance is lowered for a short while. Please see chapter *Impedance mode* for more information.

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*[4] Data is for Non noisy electromagnetic environments

*[5] Diagram below shows Measurement Error vs Input



Pinout

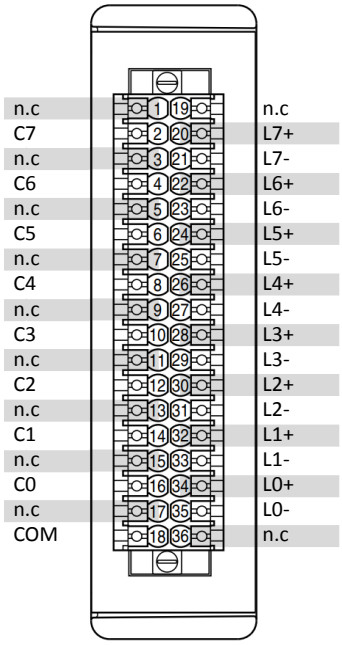


Figure 4 - Pinout on 36 pole spring-terminal

- COM Common reference connection to isolated ground
- Cx Analog input connections. For battery cells.
- Lx+ Balancing switch connections. For load resistors.
- Lx- Balancing return connections. Return for the load resistors.
- n.c No connections

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External wiring of battery cells

You can connect the battery cells like this:

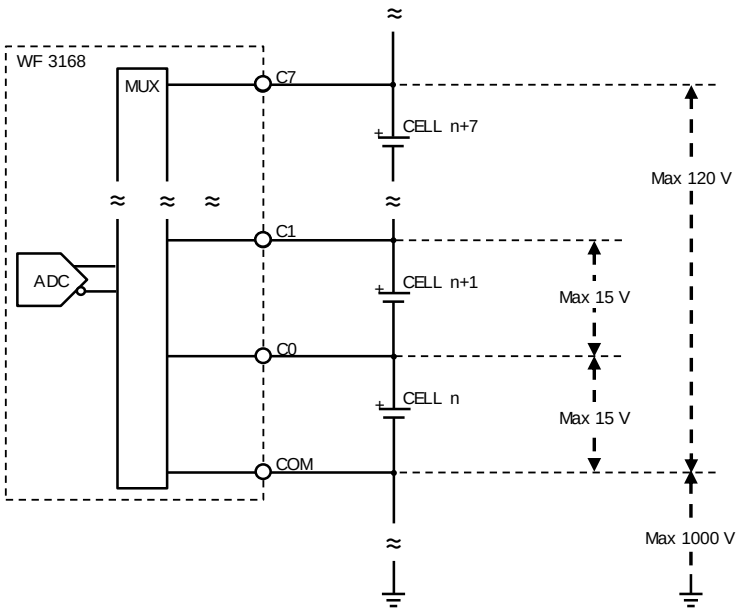


Figure 5 - External wiring of battery cells

If you have more inputs on your WF 3168 module(s) than you have cells then it is recommended to start adding cells from bottom (COM) and upwards. Leave the top inputs without any cell. The recommendation is to short-circuit the unused Cx inputs where no cells are used.

The recommendation is to connect the minus pole of the CELL 0 to chassis ground on the compactRIO. It shall also be connected to the COM connector on the WF 3168.

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External wiring of balancing loads

If you want to use the balancing switch feature of the WF 3168 you should connect external dissipation resistor loads to the Lx+ and Lx- connectors of the WF 3168. If you don't want to use the balancing function you should leave the Lx+ and Lx- connections unconnected.

Balancing loads should be connected like this:

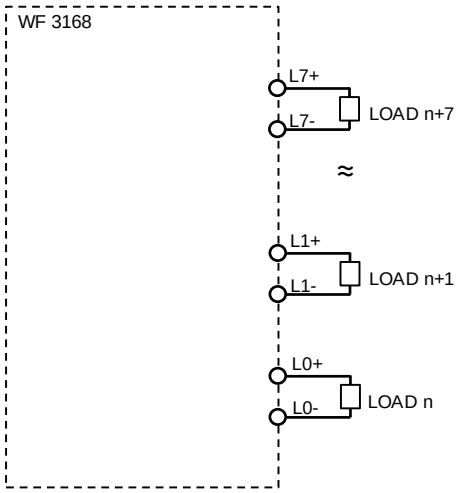


Figure 6 - External wiring of balancing loads

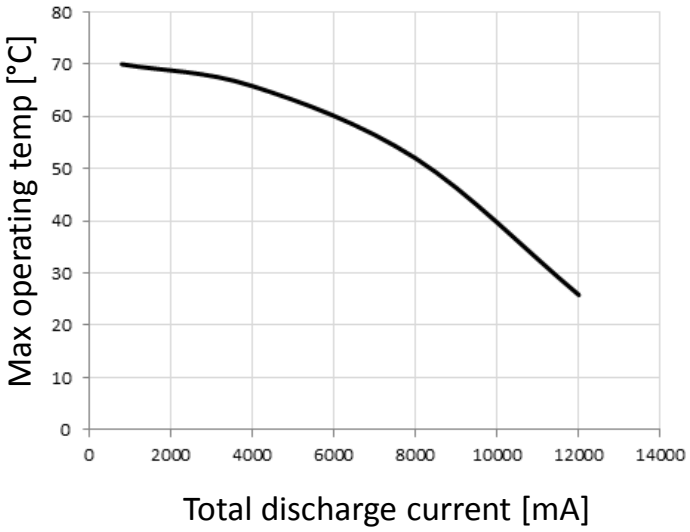
Please note the maximum dissipation current allowed through the internal balancing switch when dimensioning the external dissipation resistor. There is no over-current protection on the internal switches so the circuit may be damaged if specified current is exceeded.

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Thermal dissipation caused by balancing

As mentioned earlier external load resistors shall be used when using the balancing function of the WF 3168. The reason for using external resistors is to avoid thermal dissipation inside the module. Even if external resistors are used there will be some thermal dissipation inside the module caused by voltage drop over the FET switches etc. inside the module. The graph below shows how the module max operating temperature deteriorates with the total discharge current.

To obtain full discharge functionality in an ambient temperature that is higher than can be derived out the graph below, active cooling will be required.



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Impedance mode

The module is normally in a high impedance mode to make sure to minimize current being drawn from the batteries. When a measurement is taken the module automatically changes to a low impedance mode during the measurement. After the measurement is taken the module automatically returns to the high impedance mode.

If measurements are taken faster than 1 Hz then the module will be kept in low impedance mode to make it possible to measure at a high sampling rate without being forced to toggle between the different impedance modes.

The timing thresholds used for impedance mode switching makes it impossible to use a sampling rate between 1 to 1.5 Hz.

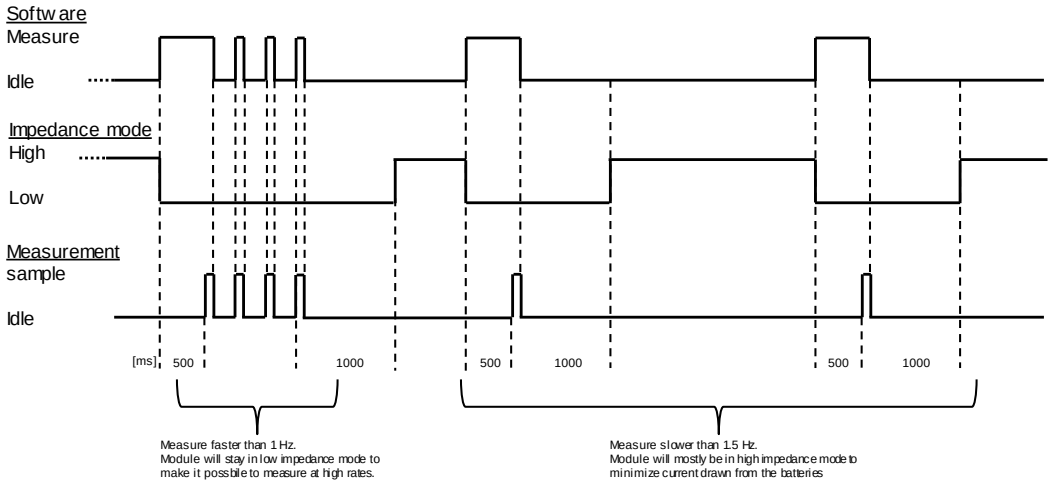


Figure 7 - Impedance mode during measurements

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Software

The WF 3168 is delivered with a LabVIEW driver to manage the module using FPGA property nodes and IO nodes. This chapter describes the installation, requirements and basic usage.

Requirements

- LabVIEW Full (version >= 2017 SP1*)
- LabVIEW FPGA module
- NI-RIO (version >= 17.6)
- VIPM 2017 or higher

* Previous version of this driver (v1.0.0) is available on www.wireflow.se and supports LabVIEW 2014.

The WF 3168 driver currently requires the LabVIEW FPGA toolkit. The software for the WF 3168 is delivered as a VIPM packet (.vip) and requires the free version of VI Package Manager (VIPM) to be installed (available at jki.net or from ni.com).*

Installation

The easiest way to install/update the WF 3168 software is (when VIPM is already installed);

1. Double click the *.vip package
2. Follow the instructions in VIPM to select LabVIEW version where to install the driver
3. Restart LabVIEW

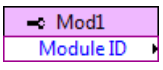
Once installed the necessary files should be installed in the LabVIEW application folders, see the API section for details.

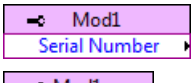
Supported Platforms

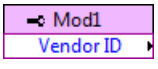
The WF 3168 module can be used in any C Series chassis, with LabVIEW FPGA programming enabled. This currently excludes the CompactDAQ series of chassis, but includes cRIO, EtherCAT and FPGA expansion chassis.

API

Once the WF 3168 module has been added to the project the module can be controlled using property nodes and I/O nodes. The property nodes return information about the current firmware, the information returned is;

- 

This is the identification number of the WF 3168 module
- 

Serial number of the module
- 

Vendor identification number (in this case WireFlow)

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Voltage is read from the cells using IO nodes. The WF 3168 provides eight IO nodes for reading the voltage from each individual cell. IO node AI0..AI7 corresponds to Cell0..Cell7. The voltage reading is only performed during IO node execution.

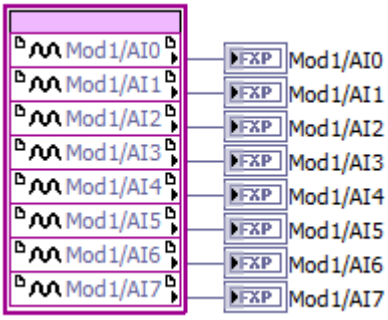


Figure 8 – IO node reading the voltages from Cell0..Cell7

The balancing switches are controlled from IO nodes as well. DO0..DO7 corresponds to the switches for Cell0..Cell7. By setting the balancing switch value to true, the switch is enabled and a current can flow through the balancing resistor if one is connected to the terminals.

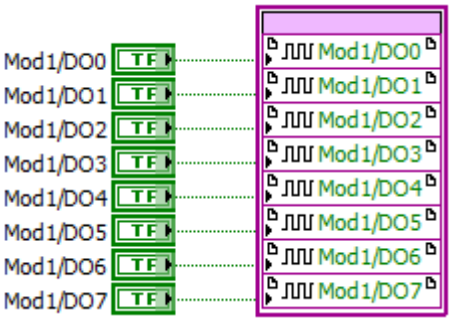


Figure 9 – IO node controlling balancing loads for Cell0..Cell7

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Examples

The shipping example demonstrate the basic usage of the API driver methods. To find the example, open LabVIEW example finder and search for the WF 3168.

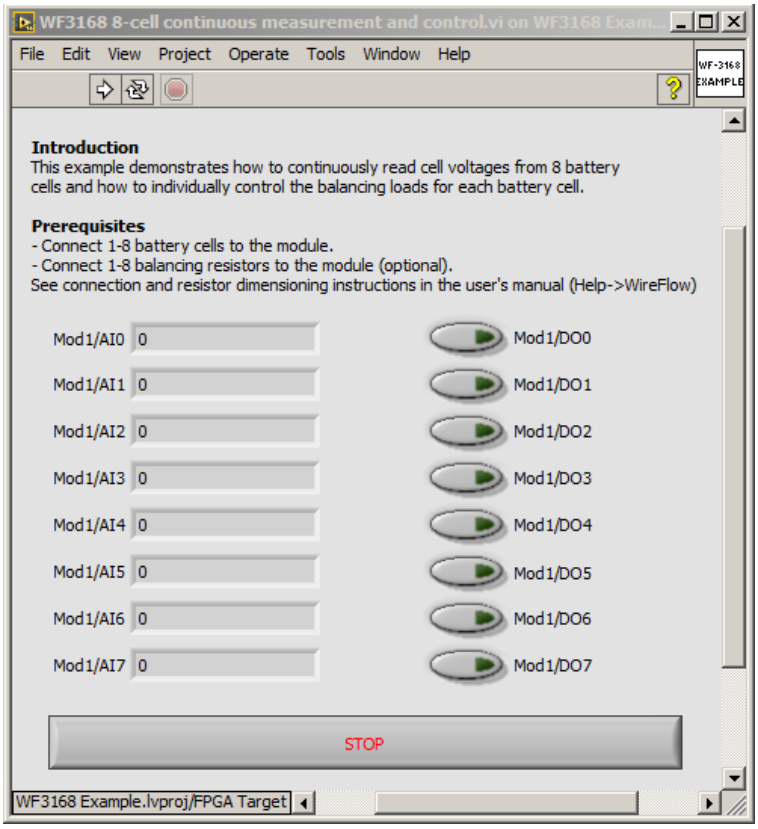


Figure 10 – 8-cell continuous measurement and control front panel

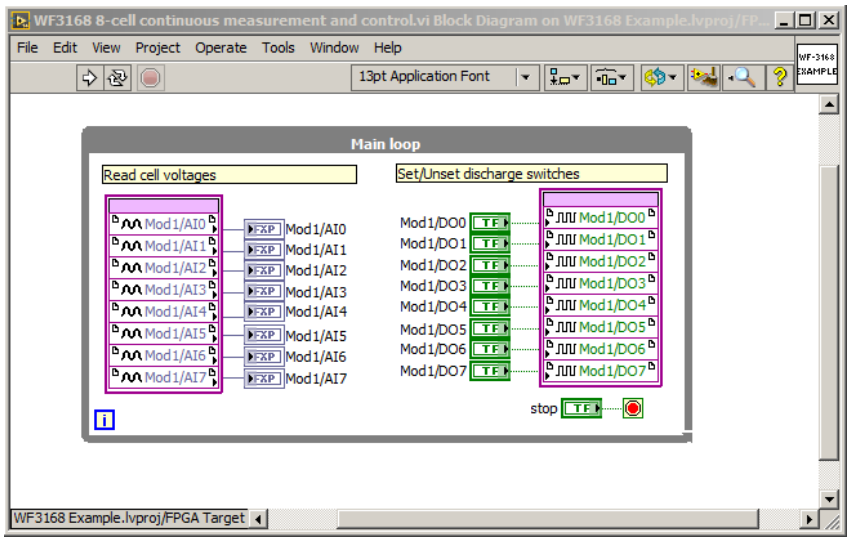


Figure 11 – 8-cell continuous measurement and control block diagram

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Technical support and Professional services

If you need to contact support please include the following information for faster handling

- Product number
  printed on the side of the module, ACxxxx
- Serial number
  printed on the side of the module, s/n XXXXXX
- HW version
  printed on the side of the module, vX.X.X
- Driver version (as indicated in VIPM)
- LabVIEW version
- NI-RIO version
- NI-FPGA version
- Target platform
- General description of the problem.

If possible, please include sample code that exemplifies the problem.

Please send support questions to support@wireflow.se, and set the subject to "Support WF 3168

Waste Electrical and Electronic Equipment (WEEE)



EU Customers At the end of the product life cycle, all products must be sent to a WEEE recycling center. For more information about how to, visit www.wireflow.se/weee.

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