wireflow

AC0282-004, rev A

Battery Monitoring and Balancing System User Manual

WF 5218 - WF 5220 - WF 5221

Contents

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Support information

Technical support and Product information

www.wireflow.com

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

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Important information

Copyright

The WF 5218, WF 5220 and WF 5221 and accompanying software is Copyright ©2026, WireFlow AB.

Safety Guidelines

Operate the products only as described in this manual.

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

This symbol indicates important safety instructions. It alerts the user to potential hazards that could result in personal injury, electrical shock, or damage to the equipment.

Compliance

CE

The products meet the essential requirements of applicable European Directives, as follows:

- 2014/35/EU; Low-Voltage Directive (safety)
- Electromagnetic Compatibility (EMC) Directive 2014/30/EU [WF 5218/5221]
- Radio Equipment Directive (RED) 2014/53/EU [WF 5220]
- RoHS Directive 2011/65/EU
- EG 1907/2006 (REACH)
- 2012/19/EU (WEEE)

The products contain components with lead (CAS 7439-92-1) above 0.1 % w/w in accordance with REACH Article 33. The products can be handled safely under normal conditions and should be disposed of in accordance with local electronic waste (WEEE) regulations.

Please contact WireFlow to obtain the Declaration of Conformity or detailed REACH information for the WF 5218, WF 5220, or WF 5221 devices

Introduction

The Battery Monitoring and Balancing System from WireFlow includes a set of devices that can be used to build a battery cell monitoring and balancing system.

A typical setup is a system where a PC is used for supervision of all cell voltages in a large battery pack that does not include a BMS for cell monitoring. For this application a WireFlow WF522x gateway and a set of WF 5218 measurement nodes can be used together with the PC. It is also possible to use a PLC or other type of industrial controller since the Gateways uses standard types of interfaces and open communication protocols.

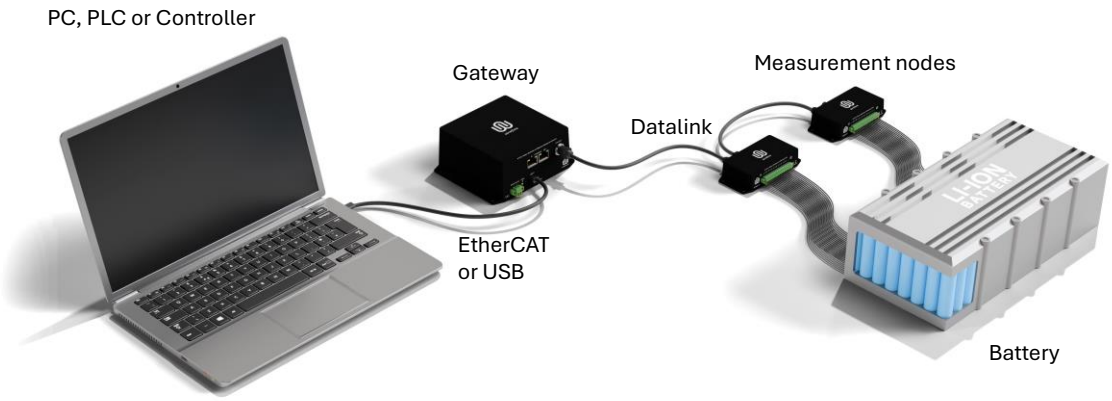

Figure 1 Typical setup of a WireFlow Battery Monitoring and Balancing system

WF 5218 node is a 12-channel battery monitoring and balancing device that includes a high voltage input multiplexer, ADC and balancing resistor for each battery cell. The module can measure up to 12 series-connected cells with a voltage up to 5V per cell. The WF 5218 also includes three measurement inputs for RTD temperatures sensors such as PT-100, NTC10k etc.

The WF 5220 gateway supports up to 16 WF 5218 nodes and communicates with the PC (or other type of computer) via USB. The communication is made with an open API based on the Modbus communication protocol. On the WireFlow homepage there is a LabVIEW driver, python examples and some user interface applications available for free download.

The WF 5221 is an alternative gateway that also supports up 16 WF 5218 nodes but it communicates with the main computer via EtherCAT fieldbus.

The module measurement circuitry in the WF 5218 node is galvanically isolated from the other devices in the system and provides a Double Insulation barrier of

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1 600 VDC channel-to-earth rated working voltage. This makes the device ideal for safe and accurate monitoring of large battery stacks. By using several WF 5218 nodes connected in series it is possible to monitor every cell in a long string of series-connected cells.

The 1600 VDC Double Insulation of the WF 5218 makes it very easy to make safe measurements on battery stack up to 1 600 VDC.

The WF 5218 node is powered by the cells connected between C0 to C12.

The Challenge with high common mode voltages

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 to 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.

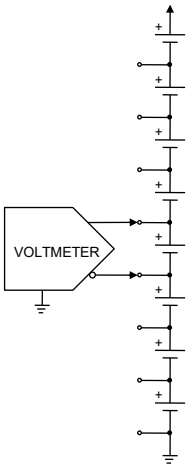

Figure 2 – Voltmeter on multiple cells

It is important to have good control over the grounds and different voltage potentials in the system to measure.

In a laboratory environment it is common practice to connect the minus pole of the bottom cell to protective ground. The measurement PC and other instrumentation is normally also connected to the protective earth. So the protective earth will in this case be used as the ground reference of the battery to measure on.

Another common practice used is to have the battery at a floating voltage potential. It will also be possible to use the WireFlow measurement system with a battery at floating potential. A method to make sure the floating battery is not at a total different potential when connecting the instrumentation is to connect a resistor with high resistance to protective earth, for example 100kΩ.

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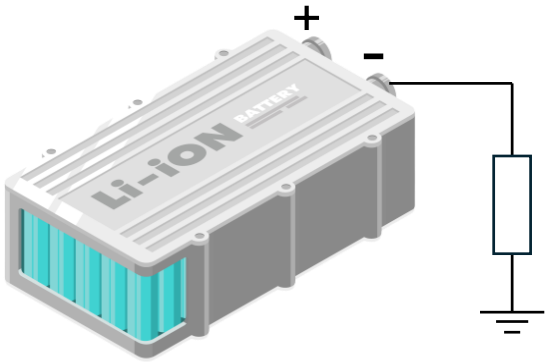

Figure 3 To avoid a floating battery to get an unknown voltage potential it is possible to connect the minus pole to protective earth via a high ohmic resistor

In field applications such in an electric car the grounding principles may be different. Whatever the grounding principles it is important to have a good understanding of the common mode voltages that will be used when doing measurements on the battery.

In this manual we will use the ground symbol ⏥ for representing the zero-volt potential reference used to illustrate the common mode voltage potentials at different locations of the system setup.

Understanding the isolation voltage of the different devices

The WF 5218 Battery Monitoring and Balancing Node has specified isolation voltages (rated working voltage) as follows:

- Double Insulation Channel-to-Link, Continuous: 1 600 VDC

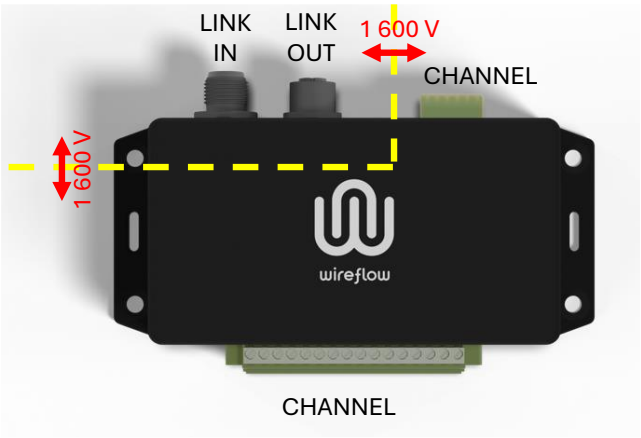

Figure 4 The WF 3168 double insulation barriers

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This means that the voltage potential difference between the measured cell voltages and temperature sensors towards the Link cables must not exceed 1 600 V.

For information there is also an galvanic isolation between the LinkIn and LinkOut signals as follows:

- Double Insulation LinkIn-to-LinkOut, Continuous: 80 VDC

The WF 522x Gateways have a specified isolation voltages (rated working voltage) as follows:

- WF 5220: Basic Insulation Link-to-GND, Continuous: 250 VDC
- WF 5221: Basic Insulation Link-to-GND, Continuous: 1 000 VDC

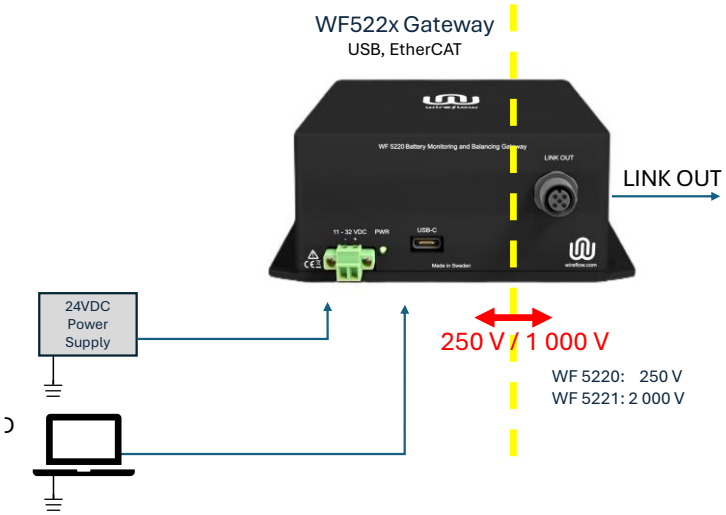

Figure 5 The WF 522x gateways have a Basic isolation

Please note that the ground of the WF522x 24VDC is connected to the USB ground inside the Gateway.

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Wiring

The 5218 node is designed to be wired to the cells within a battery module or pack. Each module has 12 cell voltage inputs. The module also has three temperature sensor inputs. The typical usage of these three inputs is to connect them to temperature sensors that are mounted inside the battery to measure.

Connecting cells to the WF 5218 node

A WF 5218 node can measure on up to 12 cells in series. The cell to measure on must be connected in series.

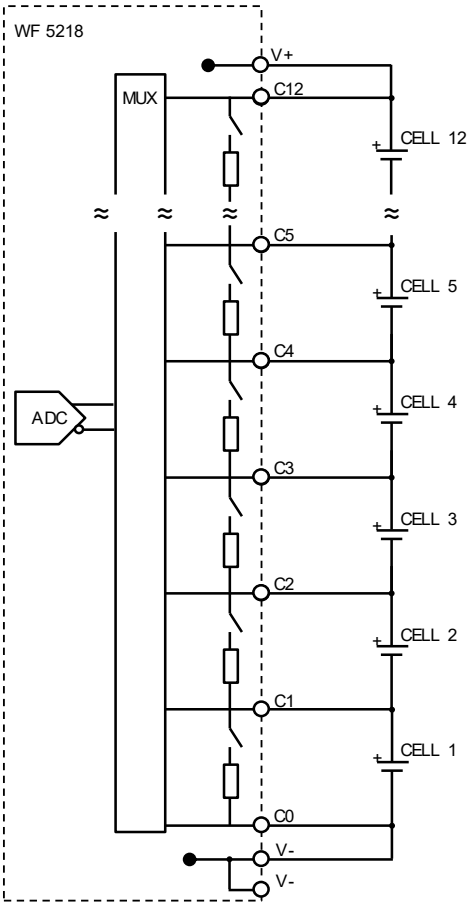

Figure 6 WF 5218 can measure on up to 12 series connected cells

The WF 5218 node is powered by the input pins V+ and V-. It is recommended to supply the WF 5218 from the battery stack and to use separate wires to the V+ and V- pins as seen in the illustration above. The reason for this is that there will be a small voltage drop on those wires due to the supply current that flows through these wires. By using separate wires for C0/V- and C12/V+ you avoid these voltage drops to affect the cell voltage measurements on Cell 1 and Cell 12.

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If you have fewer than 12 cells, then start adding cells from bottom (C0) and upwards. Leave the top inputs without any cells and instead short-circuit the unused Cx inputs where no cells are used to avoid having floating voltage measurements in your system and to keep the supply voltage to the V+ pin.

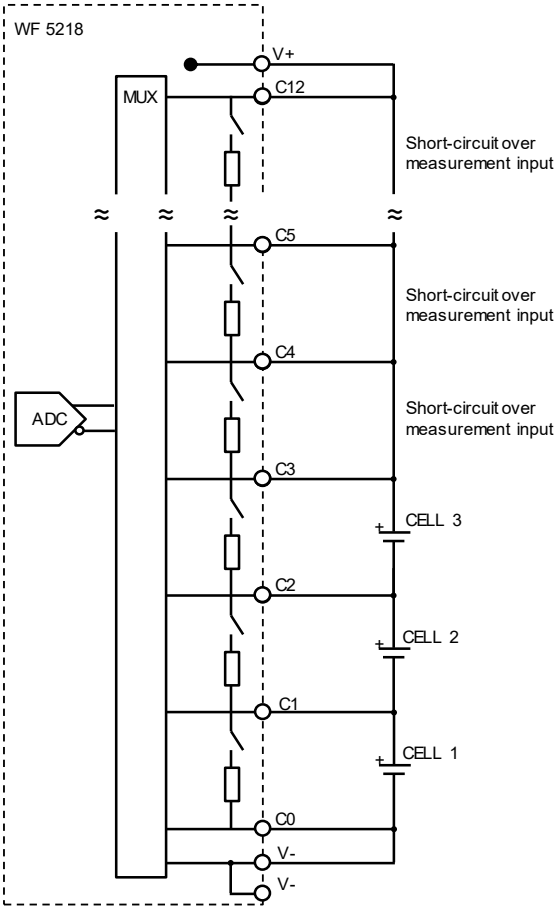

Figure 7 Recommended setup when measuring on fewer than 12 cells

Using multiple WF 5218 nodes in series

It is also possible to use several WF 5218 in series in case more than 12 cells shall be measured. There is no actual limit for how many WF 5218 nodes that can be connected in series. There is a limitation of max 16 nodes per gateway and a max isolation voltage that shall not be exceeded. But by using several gateways the maximum number of nodes can go beyond 16 pcs.

The extra C0* connector on the WF 5218 nodes may be used to make the wiring easier as shown in the illustration below.

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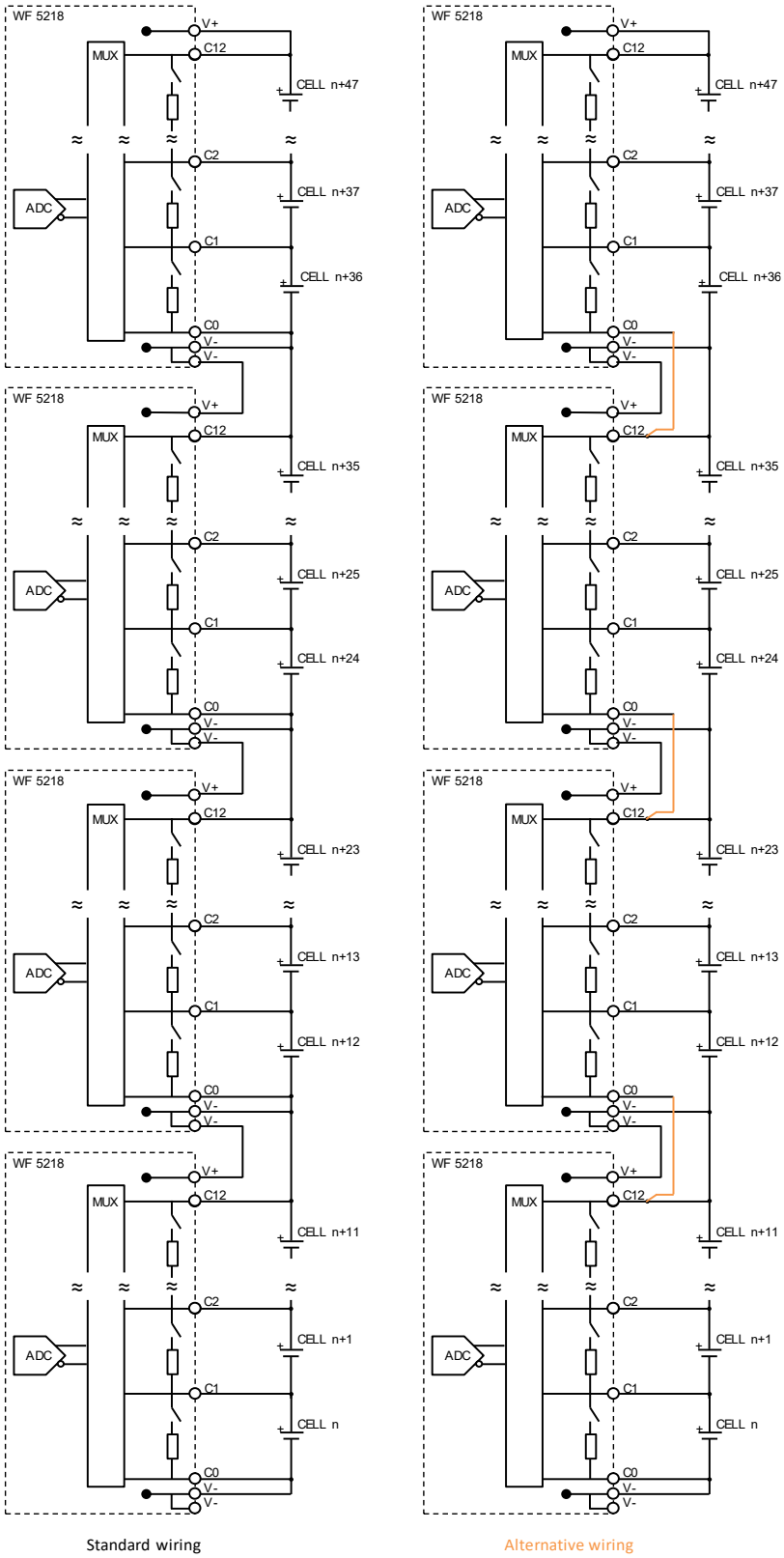

Figure 8 Connect WF 5218 in series to measure on "unlimited" no of cells

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Using external power supplies

It is also possible to power the WF5218 with an external power supply. It must however be at a floating potential, or with – at same potential as C0. There are also some crucial requirements for the + voltage that must be fulfilled as seen in the illustration below.

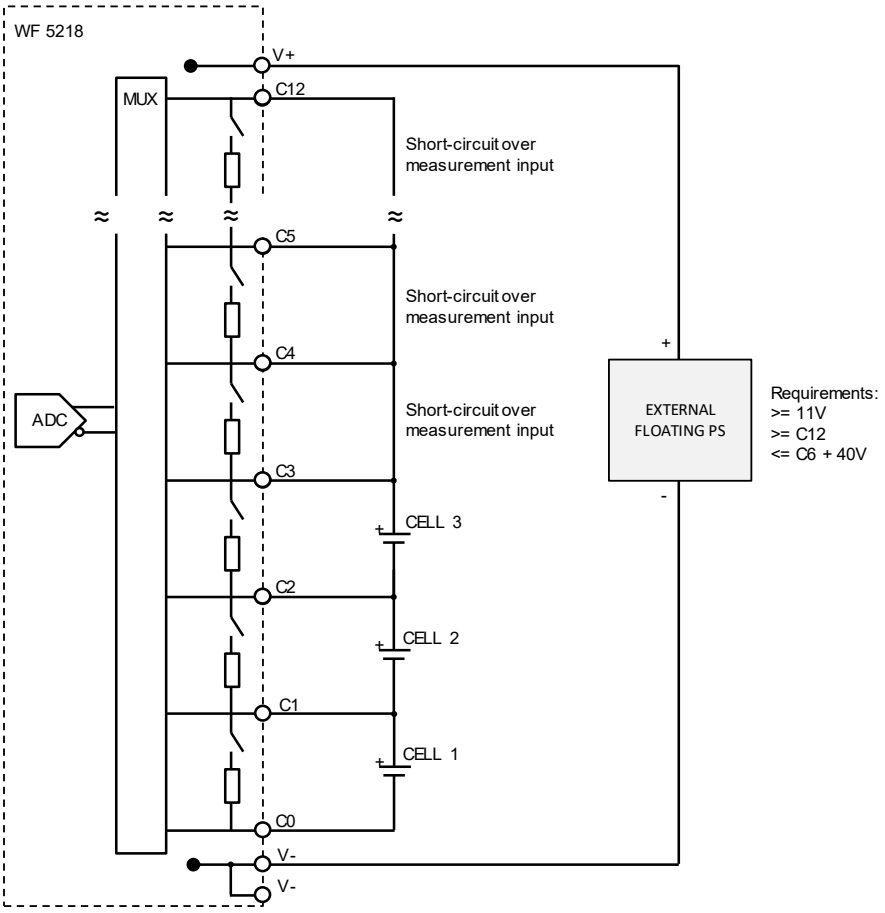

Figure 9 Setup with an external Power supply

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When using external power supplies for multiple WF 5218 nodes connected in series, please follow the setup illustrated below.

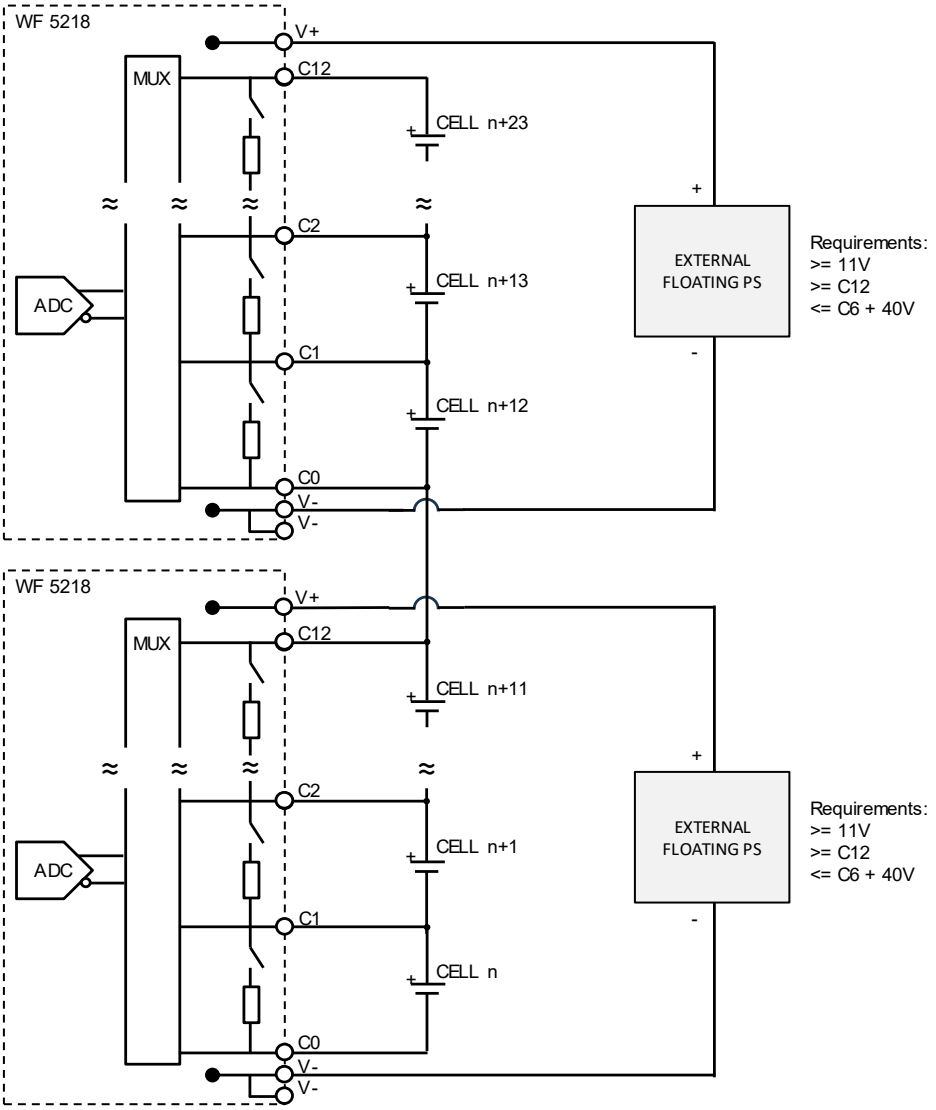

Figure 10 Setup with multiple external power supplies

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Using multiple gateways

If your battery has less than 192 cells, then you need only one gateway since each gateway supports up to 16 nodes and each node measures 12 cells.

If you have more than 192 cells, then you need multiple gateways. The illustration below shows how two gateways and 18 nodes can be used to measure a battery with 216 cells.

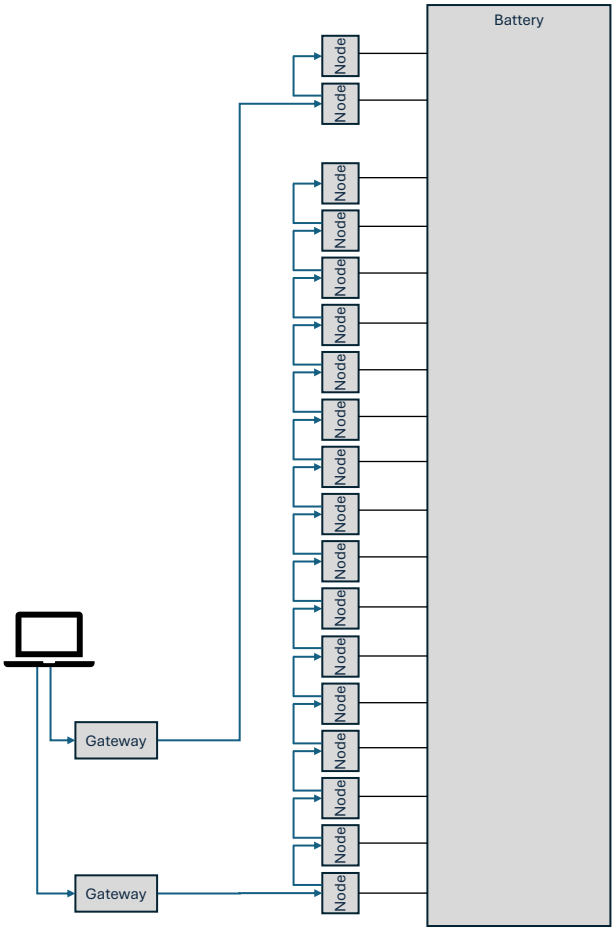

Figure 11 Usage of multiple gateways to go beyond 192 cells

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High voltage insulation and safety

- Each node has a Double insulation for 1600 VDC working voltage (continuously), between the Link cables and the battery.

Since the WF 5218 nodes are designed with Double insulation it is easy to setup a system with a high degree of safety for batteries with a maximum voltage of 1 600 VDC.

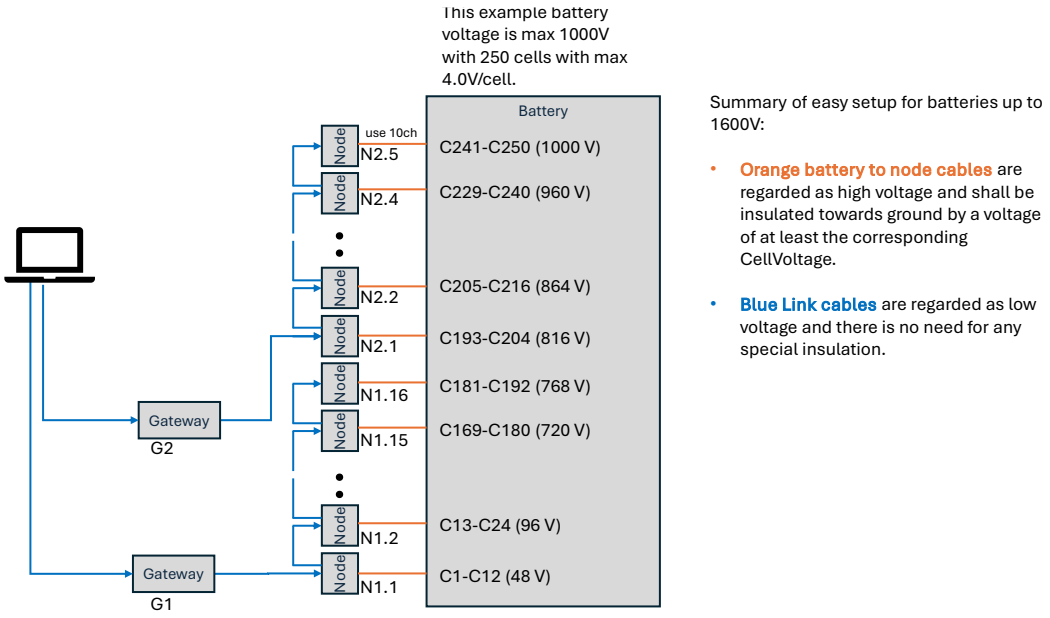

Figure 12 Easy and safe wiring for batteries up to 1 600 V

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Cables and wires

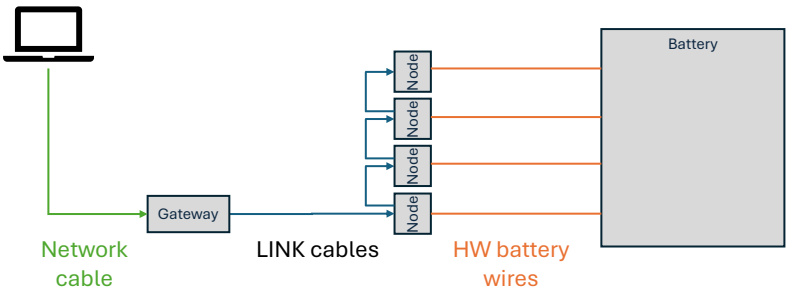

Figure 13 Cable types in the system

Network cables

Between the Gateways WF522x and the higher-level control computer standard network cables are used depending on the interface type used.

- USB
  For communication with the USB interface on the WF 522x please use a standard USB C cable.

- EtherCat
  For EtherCAT (WF5221) communication a standard Ethernet cable may be used.
  In the presence of strong electromagnetic disturbances it is recommended to use a shielded cable of type CAT6A with a length up to 3 m, To fully comply with the EMC Directive 2014/30/EU a ferrite must be used where the EtherCat cable must go two turns through the ferrite. Recommended ferrite models are WE 74271222 or WE 74271221.

Figure 14 EtherCAT cable goes two turns in the ferrite

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LINK cables

The Link cables are used to connect one or more WF 5218 nodes in a daisy chain topology. Each cable has one female connector in one side and one male connector on the other side.

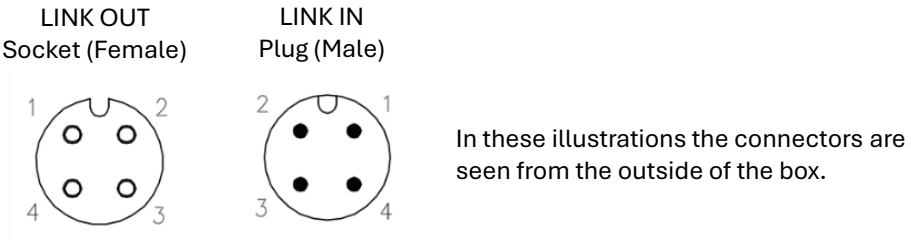

Figure 15 Pinout of the LINK OUT and LINK IN connectors

On the WF 522x gateways, there is a socket (female) LINK OUT connector used to transmit the LINK signal from the gateway. On the WF 5218 nodes, there are two connectors: one LINK IN and one LINK OUT.

The LINK connectors are M12, 4-position, A-coded connectors.

Pin 1. Data LINK M
Pin 2. Not used
Pin 3. Not used
Pin 4. Data LINK S

The cables can be supplied as ready-made assemblies. In this case, the cable model should be a male-to-female cable with M12, 4-position, A-coded connectors. For cables longer than one meter, the wires for pin 1 and pin 4 should be twisted inside the cable.

The maximum cable length depends on several factors. Testing has shown that cables up to about 50 meters can be used; however, to ensure stable communication in most situations, we recommend keeping cables no longer than 25 meters.

To fully comply with the EMC Directive 2014/30/EU regarding radiated emissions you should keep all cables 12 meters or shorter and for the first cable connected to the WF5221, limit the length to 3 meters.

WireFlow offers some standard cables and connectors. Please refer to the chapter at the end of this document for Ordering information.

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Recommended cables

Below is a list of cables that WireFlow has tested with good results.

Phoenix Contact
Sensor/actuator cable

SAC-4P-M12MS/ x,x-PUR/M12FS where x,x is length of cable.
Available length: 0,3–0,6–1,0–1,5–2,0–3,0

Part no examples: 1668357 (30cm), 1668360 (60cm), 1699850 (1m), 1668373 (1,5m), 1693571 (2m), 1668386 (3m)

MOLEX
Micro-Change 120066 Series

Micro-Change (M12) Double-Ended Cordset with Knurled Hexnut, 4 Poles, A-Coded, Male (Straight) to Female (Straight), 22 AWG, Black TPU WSOR Cable

ENGINEERING No: 884030B30Mxxx where xxx is length in dm.
Available length [m]: 0.2, 0.3, 0.5, 0.6, 1, 1.5,2, 2.5, 3, 4, 5, 6, 7, 8, 10, 12, 14, 15, 16, 20, 25, 30, 40, 50

Part no examples: 1200669157 (20cm), 1200669480 (50cm), 1200668818 (1m), 1200668820 (3m), 1200668821 (5m), 1200668822 (10m), 1200669504 (12m)

Lumberg Automation
M12-Round-Plug Connector, Double-Ended Cordsets

RST 4-RKT 4-225/x M where x is length in meters; 0.3, 0.6, 1, 1.5, 2, 5

MUELLER ELECTRIC
M12 Cordset, 4 Position, 22 AWG Shielded, Male Straight to Female Straight

C4AC05UMxx where xxx is length in meters; 002, 005, 010 meters are standard

Recommended connectors

Below is a list of connectors that WireFlow has tested with good results. Use any twisted pair cable and make sure that signals DATA LINK M is twisted with DATA LINK S. A ethernet twisted pair cable can be used.

Hirschmann
Circular Connector, 4 Contacts, Cable, M12 Connector, IP67, E Series
Circular Connector, 4 Contacts, Cable, M12 Connector, IP67, E Series

Plug/Male: 933727100 ELST 4012 K PG7
Socket/Female: 933725100 ELKA 4012 K PG7

Another alternative from Hirschmann:
Straight cable plug, unassembled, strain relief by means of clamping cage, plastic coupling thread

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Plug/Male: ELST 4012 PG7
Socket/Female: ELKA 4012 PG7

TE Connectivity AMP Connectors
A coding – M12 Screw Connection, Straight, Unshielded

Plug/Male: T4111001041-000
Socket/Female: T4110001041-000

Phoenix Contact
Phoenix Contact Circular Connector, 4 Contacts, Cable Mount, M12 Connector, IP65, IP67, SACC Series

Plug/Male: 1424657
Socket/Female: 1424655

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HV Battery wires

The battery wires are connected between the WF 5218 node and the call connectors on the battery. There is virtually no current running through these wires so the core may be of small dimensions.

The wires should be regarded as High Voltage and care should be taken when choosing wires and also the placement of wires. Make sure that you understand how the voltage potential of each cell refers to ground and that the wire insulation is large enough for the planned placement.

The wires should be flame resistant according to IEC60332-x, VW-1, UL or similar.

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Device information

WF 5218 Battery Monitoring and Balancing Node

Figure 16 The WF 5218 Node

WF 5218 node can measure up to 12 series-connected cells with a voltage up to 5 Volt per cell. There is no ch-ch isolation since the device is designed for measuring on series-connected cells. The ch-gnd isolation is 1 600 Volt.

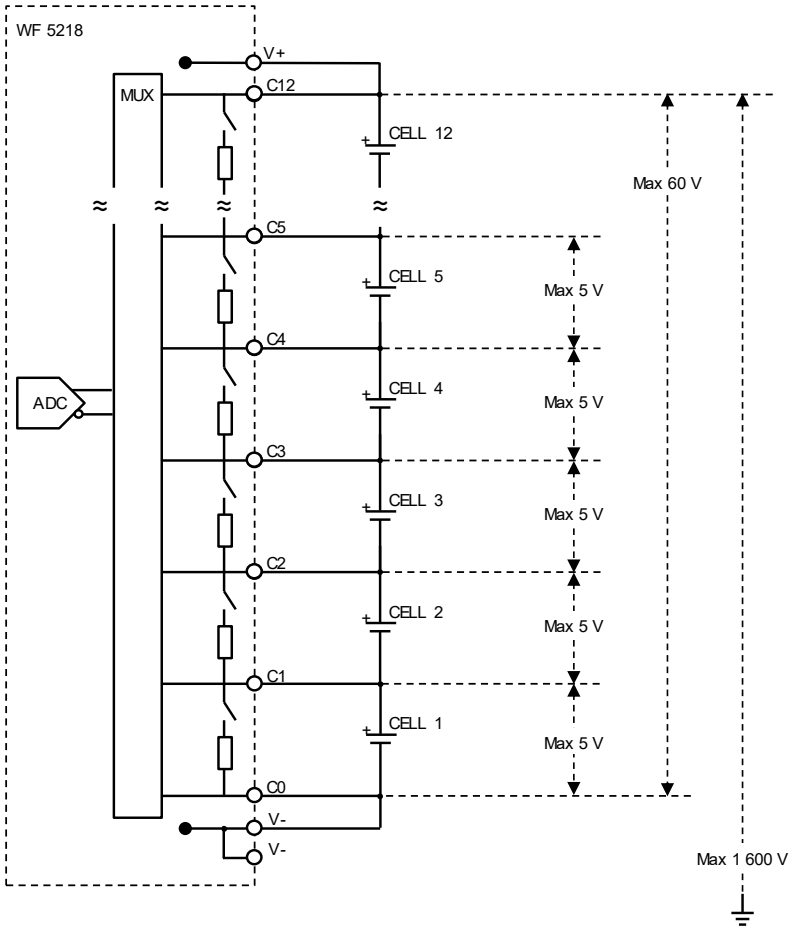

Figure 17 WF 5218 can measure up to 12 series connected cells with voltages up to 5V each

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Each input channel also includes functionality for passive balancing. A set of small MOSFET switches and balancing resistors are located inside WF 5218. By closing the switch, a small balancing current will be drawn from the actual battery cell and the cell will discharge through the small resistor.

The WF 5218 device is (normally) powered by the battery via the V+ and V- inputs. It is recommended to connect separate wires to the V+ and V- pins as seen in the illustration above to avoid voltage drops in cables affecting your measurements.

If your application requires that the WF 5218 is powered by a separate supply and not from the battery then this is possible, but there are several constraints that must be fulfilled which makes this method complicated:

- A separate supply must have minus at the same potential as cell input C0. So, connect the external supply minus to negative side of cell C1.
- V+ (C12*) must be
    - >=11V
    - >= C12
    - <= C6 + 40V
      In words: If number of cells are less than 12 pcs then short circuit the inputs on WF5218 for cells that do not exist. The V+ voltage must be the same or above the battery voltage AND must also always be above 11V AND must never be 40V above the voltage at C6. (Kind of complicated in other words. So, to make it easy just power the WF 5218 from the battery stack).

Please see chapter Connecting cells to the WF 5218 node on page 9 for some different connection examples.

The NTC measurement interface

The WF 5218 is designed to connect NTC sensors to the connector on the back of the module. Using the Gateway Configuration Software, you can configure the system for different types of NTC sensors, such as 10 kΩ, 50 kΩ, or 100 kΩ NTCs. The embedded software then uses this configuration to automatically calculate the correct temperature based on the sensor readings.

Alternatively, the system can be configured to return raw voltage values instead of temperature. In that case, you must calculate the temperature yourself using the voltage returned by the WF 5218. To perform this calculation, you need to understand the internal measurement circuit of the module.

The diagram below shows the internal circuit: the NTC sensor forms a voltage divider with an internal 10 kΩ resistor connected to a 3 V reference voltage.

Because of this design—and the ability to output raw voltage—the WF 5218 can also be used with other resistive sensors, not only NTCs. For example, you can

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connect a PT1000 sensor and perform your own temperature calculations based on the measured voltage.

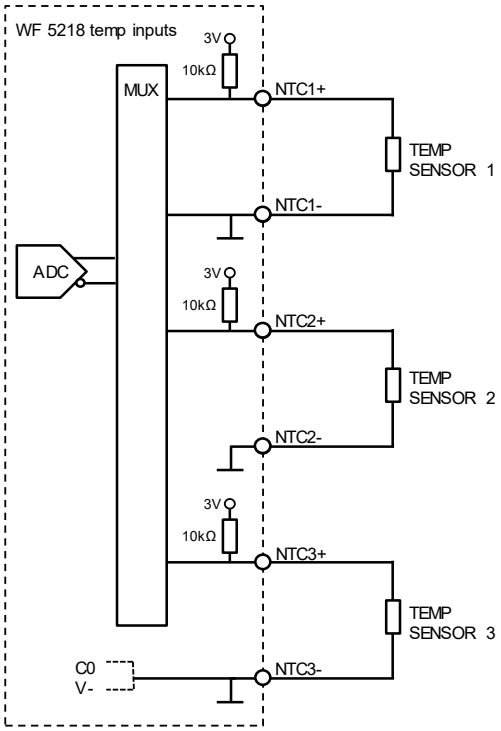

Figure 18 WF 5218 can measure on up to 3 resistive sensors

All three NTCx− connectors in the WF 5218 module are internally connected to each other. They are also internally connected to the same potential as the V− and CO pins on the front connector.

As long as the NTC sensors you are using are floating, the system will operate correctly. If your sensors are not floating, you must ensure that NTCx−, V−, and CO are at the same electrical potential.

Please note that this applies only within a single module. There is no electrical connection between pins on different modules, since each WF 5218 module is galvanically isolated from all others

The Data link interfaces

The WF 5218 nodes have one Link In connector and one Link Out connector. These connectors are used to connect several nodes to one Battery Monitoring and Balancing Gateway such as the WF 5220 or WF 5221. The Link cable contains two wires for data communication between the gateway and the nodes. These two communication wires should be twisted in the cables for optimal robustness.

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WF 5218 Specifications

Analog Input Characteristics	
Number of channels	12
Maximum voltage C_n to C_{n-1}	-0.3 to 8 V
Maximum voltage C_{12} to C_9	-0.3 to 21 V
Maximum voltage C_9 to C_6	-0.3 to 21 V
Maximum voltage C_6 to C_3	-0.3 to 21 V
Maximum voltage C_3 to C_0	-0.3 to 21 V
Measurement range C_n to C_{n-1}	0 to 5 V
Measurement resolution	0.1 mV
Measurement error	±1.0 mV typical *1 *2
Max sampling rate	66 Hz *3
Built in balancing resistor	150 Ω

Temperature input Characteristics	
Number of channels	3
Measurement resolution	0.1 mV
Measurement error	±1.3 mV typical*3
Voltage divider voltage	3 V ±5mV
Voltage divider resistor	10 kΩ ±1%
Max sampling rate	66 Hz *4

Power supply	
V^+ to V^- Supply Voltage	5-75 V (11-55 V for full meas. accuracy)
V^+ to C12 Voltage	Min -0.3V
V^+ to C6 Voltage	Max 40V
V^+ Current@sleep	6 uA
V^+ Current@measurement	16 mA
Rated power @sleep	30–450 uW (for 5–75 V supply voltage)
Rated power @measurement	80–1200 mW (for 5–75 V supply voltage)

Isolation Voltages (rated working voltage)		
Channel to channel	None	
Channel to Link, Continuous	1 600 V	Double Insulation
Link In to Link Out, Continuous	80 V	Double Insulation

Environmental	
Operating temperature	-20°C to 60°C
Indoor / Outdoor	Indoor use only

Mechanical	
Size (w x d x h)	137.54 x 63.32 x 31.00 mm
Weight	128 g

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Calibration	
Calibration Interval	No calibration needed

*[1] Accuracy specifications apply under DC steady-state conditions only. Measurements performed during active cell balancing or cell discharge are excluded. Specifications assume filtered ADC mode enabled. External wiring, connectors, and external sensors are not included in the accuracy specification.The product complies with EN 61326-1 and meets Performance Criterion B. During strong electromagnetic disturbances, temporary degradation of measurement performance may occur, potentially resulting in errors of several millivolts. Normal measurement performance is automatically restored once the disturbance subsides, without user intervention.

*[2] Accuracy depends on cell voltage. The table below shows the maximum measurement error at different cell voltages. For cell voltages below 2.5 V, the measurement error is lower than the value specified at 2.5 V. Similarly, for cell voltages above 4.1 V, the measurement error is lower than the value specified at 4.1 V. Therefore, the values in the table can be considered worst-case errors over the entire supported cell voltage range.

Cell Voltage	Typical Error @+20°C	Worst case Error over full temp range
2.5 V	±0.4 mV	±0.8 mV
3.3 V	±0.8 mV	±1.2 mV
4.1 V	±1.0 mV	±1.6 mV

At 5.0 V cell voltage, measurements at +20 °C show a typical error of approximately ±0.8 mV. No guaranteed worst-case specification is defined at 5.0 V.

*[3] Typical error at +20 °C: ±1.3 mV. Worst-case error over full temperature range: ±2.2 mV. Combined with the internal voltage reference and voltage divider, this corresponds to a worst-case temperature error of ±0.5 °C at 25 °C sensor temperature using an ideal NTC10k sensor.

*[4] The gateway initiates and collects measurements data from the WF 5218 node. This means that it is sample rate on a system level that is of interest. The system level sample decreases as more nodes are added. Please see data sheet for the gateway WF 522x model that you are using for more details.

WF 5218 Pinout

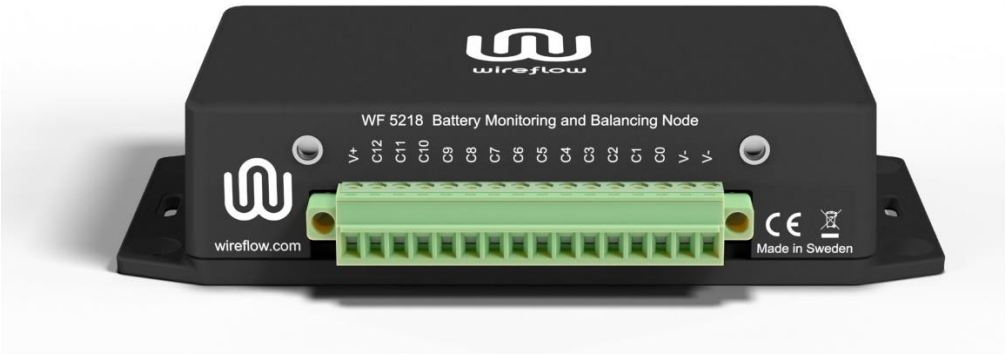

Figure 19 Pinout of the 16 pin Cell monitoring connector

On the front of the module is a 16-position pluggable terminal block with a 3.81 mm pitch. It accommodates conductor wires from 28 AWG to 16 AWG. If additional or spare terminal blocks are required, the recommended part is PHOENIX CONTACT 1827842.

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- V+ Positive Supply Pin
- Cx Battery cell connections. C0 is low voltage. C12 is high voltage
- V- Negative Supply Pin

Figure 20 Back side connectors of the WF 5218 module

On the back of the module is a 6- position pluggable terminal block with push-in spring connection. This terminal block comes with 2.5 mm pitch spacing and suitable for wire size ranging from 26 AWG to 20 AWG. If additional or spare terminal blocks are required, the recommended part is Phoenix Contact 1881367.

- NTCx+ Positive NTC sensor inputs
- NTCx- Negative NTC sensor inputs

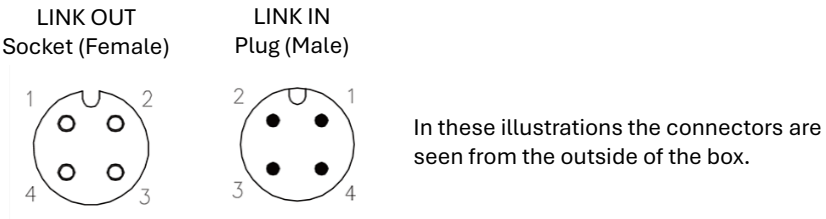

Figure 21 Pinout of the LINK OUT and LINK IN connectors

The LINK connectors are M12, 4-position, A-coded connectors. For recommended cables and connectors, refer to Chapter “LINK cables”.

Pin 1. Data LINK M
Pin 2. Not used
Pin 3. Not used
Pin 4. Data LINK S

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Dimensions

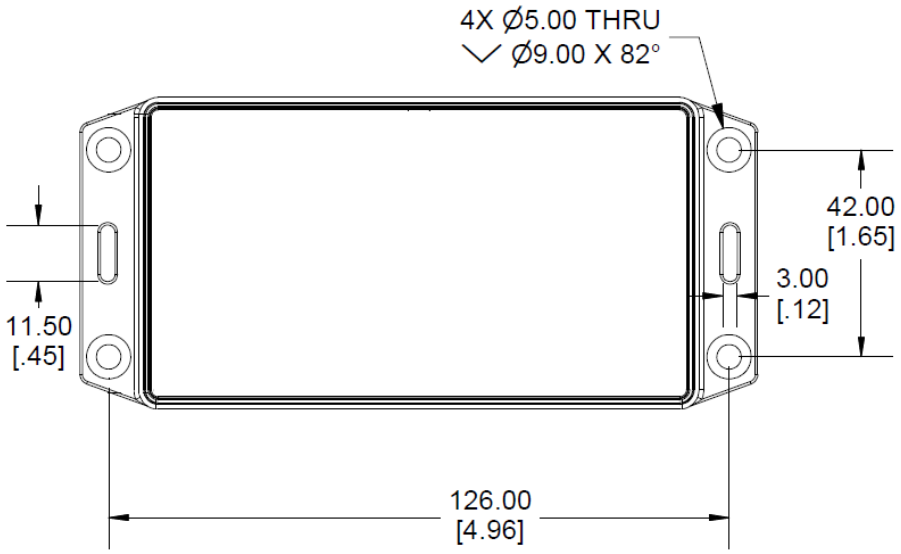

Figure 22 Mounting holes on WF 5218

Accessory for strain relief and contact protection

The Terminal Block Cover with Strain Relief for WF 5218 provides touch protection for the 16-pole terminal block and secure cable bundling with strain relief for reliable installations. Please refer to the chapter at the end of this document for Ordering information.

Key Features

- Provides touch protection for the 16-pole terminal block
- Enables secure cable bundling with cable ties
- Improves operator safety during installation and operation
- Designed specifically for use with the WF 5218 Battery Monitoring and Balancing Module

Figure 23 Terminal Block Cover for WF 5218

© WireFlow 2026

Accessory for DIN Rail mounting

The DIN Rail Adapter for WF 5218 provides a convenient way to mount the device on a 35 mm standard DIN rail. The adapter is designed so that the two flange lids are oriented horizontally toward the DIN rail. As a result, if the DIN rail is wall-mounted, the front of the WF 5218, with the cell connectors, will face upward, while the back of the WF 5218, with the LINK and temperature wires, will face downward. Please refer to the chapter at the end of this document for Ordering information.

Figure 24 Din rail mounting adapter for the WF 5218

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WF 5220 Battery Monitoring and Balancing Gateway

Figure 25 The WF 5218 Node

The WF 5220 Gateway acts as an interface between the WF 5218 Measurement Nodes and a PC or other type of control computer. It supports communication with the PC via USB, using an open API based on the Modbus protocol. This allows any programming language on the PC to be used to control and interact with the system.

The gateway includes a Link Out connector, which enables connection of up to 16 pieces of WF 5218 nodes in a daisy-chain configuration.

Power can be supplied to the gateway either via the dedicated DC input connector or through the USB port.

System configuration is performed via the USB interface using WireFlow's configuration software for PC.

For operation and monitoring, the gateway control can be achieved using WireFlow's PC software or custom user applications developed with the open API provided by the gateway.

WF 5220 Specifications

Communication interfaces	
Gateway to PC	USB
Gateway to WF 5218 nodes	LinkOut
Number of WF 5218 nodes	1-16

System functions and performance	
WF 5218 cell ADC modes	Filtered / Normal / Fast
WF 5218 NTC ADC modes	RAW / NTC (Beta/R25)
Max sampling rate with USB	66 Hz (1 node) to 13 Hz (16 nodes) *1 *2

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Power supply	
Voltage (DC input / USB port)	11-32 V (DC input) / 5V (USB port)
Rated power	0.77 W (DC input) / 0.61 W (USB port)

Isolation Voltages (rated working voltage)		
Link to GND, Continuous	250 VDC	Basic Insulation

Environmental	
Operating temperature	-20°C to 60°C
Indoor / Outdoor	Indoor use only

Mechanical	
Size (w x d x h)	147.36 x 123.50 x 59.90 mm
Weight	326 g

Calibration	
Calibration Interval	No calibration needed

*[1] The gateway collects data from all connected nodes. As more nodes are added, the maximum system sampling rate decreases. The specified maximum sampling rate refers to the system sampling rate, that is how quickly the master computer connected to the WF 5220 gateway can retrieve data from the attached nodes

*[2] The product complies with EN 61326-1 and meets Performance Criterion B. During strong electromagnetic disturbances, temporary degradation of performance may occur, the update rate may be reduced significantly. Normal performance is automatically restored after the disturbance, without any user intervention.

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WF 5220 Pinout

Figure 26 The front of the WF 5220 Gateway

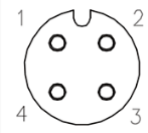
The DC input connector is a 2-position pluggable Terminal Block with M2 screw connection. It accepts 28 to 16AWG wire range.

If additional or spare terminal blocks are required, the recommended part is Phoenix Contact 1827703

- Negative terminal of the DC supply voltage
+ Positive terminal of the DC supply voltage

There is a standard USB-C connector on the front.

LINK OUT
Socket (Female)



In this illustration the connector is seen from the outside of the box.

Figure 27 Pinout of the LINK OUT connector

The LINK out connector is a M12, 4-position, A-coded connector. For recommended cables and connectors, refer to Chapter “LINK cables”.

Pin 1. Data LINK M
Pin 2. Not used
Pin 3. Not used
Pin 4. Data LINK S

© WireFlow 2026

Dimensions

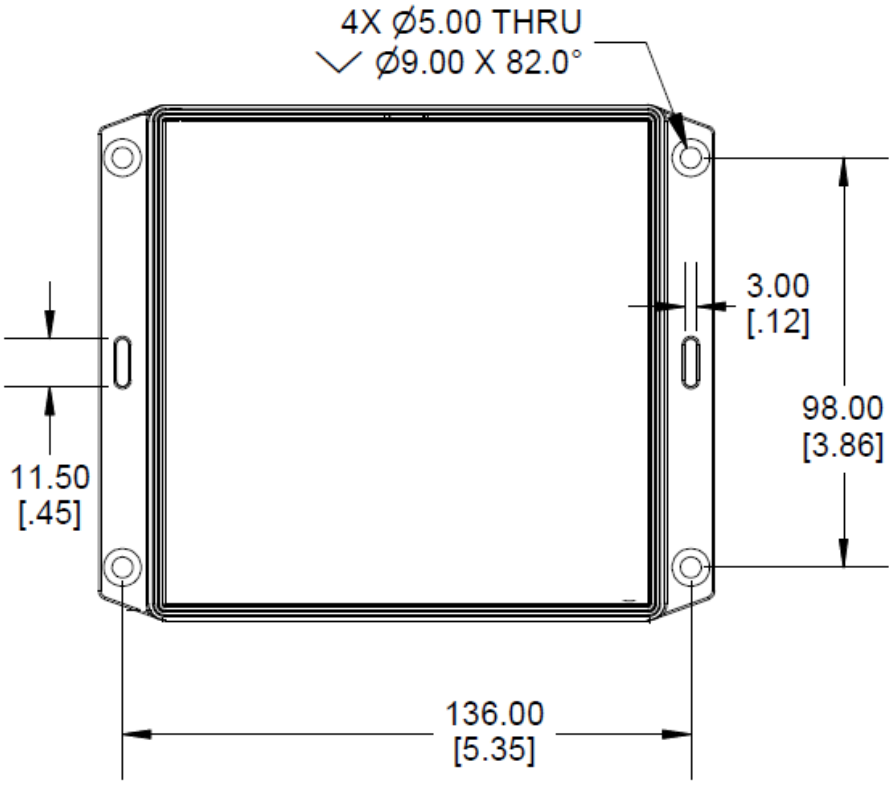


Figure 28 Mounting holes on WF 5220

Accessory for DIN Rail mounting

The DIN Rail Adapter for WF 522x provides a convenient way to mount the device on a 35 mm standard DIN rail. The adapter is designed so that the two flange lids are oriented vertically toward the DIN rail. As a result, if the DIN rail is wall-mounted, the front of the WF 5220, with the connectors, will face to the front. Please refer to the chapter at the end of this document for Ordering information.

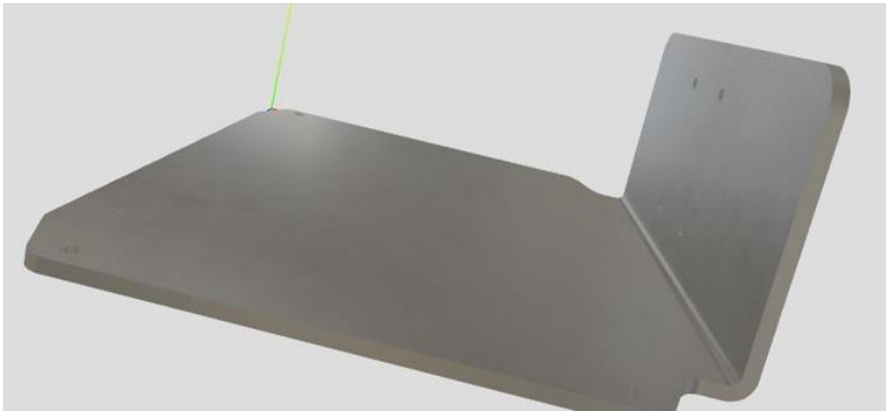


Figure 29 Din rail mounting adapter for the WF 5220

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WF 5221 Battery Monitoring and Balancing Gateway for EtherCAT

Figure 30 The WF 5218 Node

The WF 5221 Gateway acts as an interface between the WF 5218 Measurement Nodes and a PC or other type of control computer. It supports communication with the PC via EtherCAT. The Gateway acts as a EtherCAT slave and have two connectors for EtherCat in and out.

The gateway includes a Link Out connector, which enables connection of up to 16 pieces of WF 5218 nodes in a daisy-chain configuration.

Power can be supplied to the gateway either via the dedicated DC input connector or through the USB port.

System configuration is performed via the USB interface using WireFlow's configuration software for PC.

For operation and monitoring, the gateway can be accessed via the EtherCAT interface. Control can be achieved using any type of EtherCAT master PC software.

WF 5221 Specifications

Communication interfaces	
Gateway to PC	EtherCAT
Gateway to WF 5218 nodes	LinkOut
Number of WF 5218 nodes	1-16

System functions and performance	
WF 5218 cell ADC modes	Filtered / Normal / Fast
WF 5218 NTC ADC modes	RAW / NTC (Beta/R25)
Max sampling rate with EtherCAT	66 Hz (1 node) to 40 Hz (16 nodes) *1 *2

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Power supply	
Voltage (DC input / USB port)	11-32 V (DC input) / 5V (USB port)
Rated power	1.7 W (DC input) / 1.4 W (USB port)

Isolation Voltages (rated working voltage)		
Link to GND, Continuous	1 000 V	Basic Insulation

Environmental	
Operating temperature	-20°C to 60°C
Indoor / Outdoor	Indoor use only

Mechanical	
Size (w x d x h)	147.36 x 123.50 x 59.90 mm
Weight	375 g

Calibration	
Calibration Interval	No calibration needed

*[1] The gateway collects data from all connected nodes. As more nodes are added, the maximum system sampling rate decreases. The specified maximum sampling rate refers to the system sampling rate, that is how quickly the master computer connected to the WF 5221 gateway can retrieve data from the attached nodes

*[2] The product complies with EN 61326-1 and meets Performance Criterion B. During strong electromagnetic disturbances, temporary degradation of performance may occur, the update rate may be reduced significantly. Normal performance is automatically restored after the disturbance, without any user intervention.

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WF 5221 Pinout

Figure 31 The front of the WF 5221 Gateway

The DC input connector is a 2-position pluggable Terminal Block with M2 screw connection. It accepts 28 to 16AWG wire range.

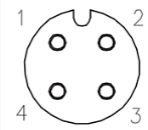
If additional or spare terminal blocks are required, the recommended part is Phoenix Contact 1827703

- Negative terminal of the DC supply voltage
+ Positive terminal of the DC supply voltage

There is a standard USB-C connector on the front.

The two RJ45 connectors are standard EtherCAT IN and OUT connectors.

LINK OUT
Socket (Female)



In this illustration the connector is seen from the outside of the box.

Figure 32 Pinout of the LINK OUT connector

The LINK out connector is a M12, 4-position, A-coded connector. For recommended cables and connectors, refer to Chapter “LINK cables”.

Pin 1. Data LINK M
Pin 2. Not used
Pin 3. Not used
Pin 4. Data LINK S

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Dimensions

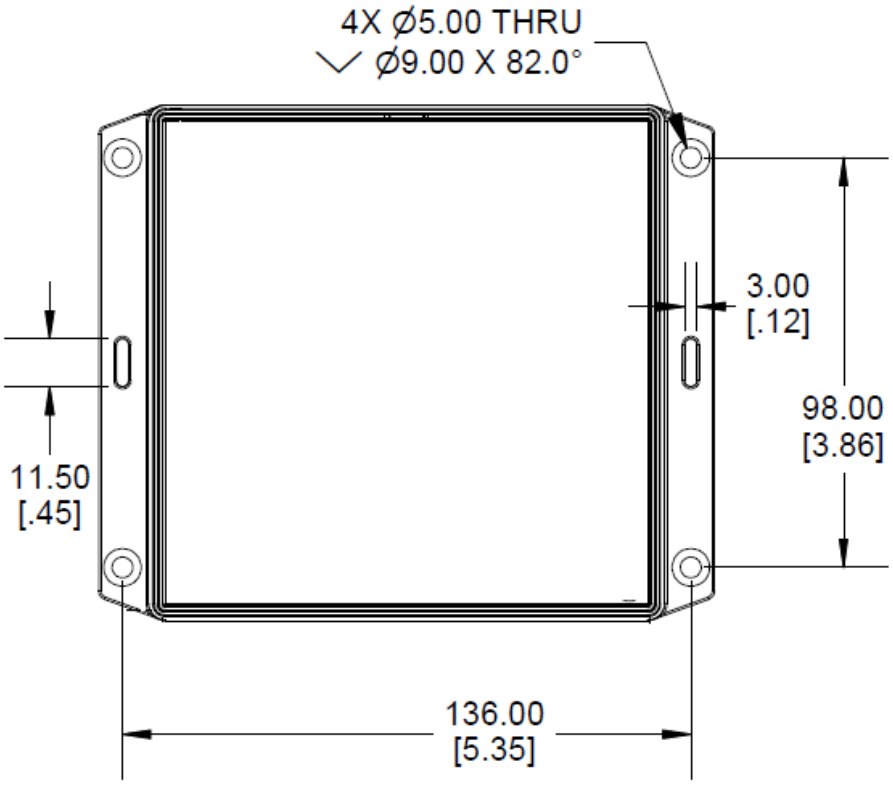

Figure 33 Mounting holes on WF 5221

Accessory for DIN Rail mounting

The DIN Rail Adapter for WF 522x provides a convenient way to mount the device on a 35 mm standard DIN rail. The adapter is designed so that the two flange lids are oriented vertically toward the DIN rail. As a result, if the DIN rail is wall-mounted, the front of the WF 5221, with the connectors, will face to the front. Please refer to the chapter at the end of this document for Ordering information.

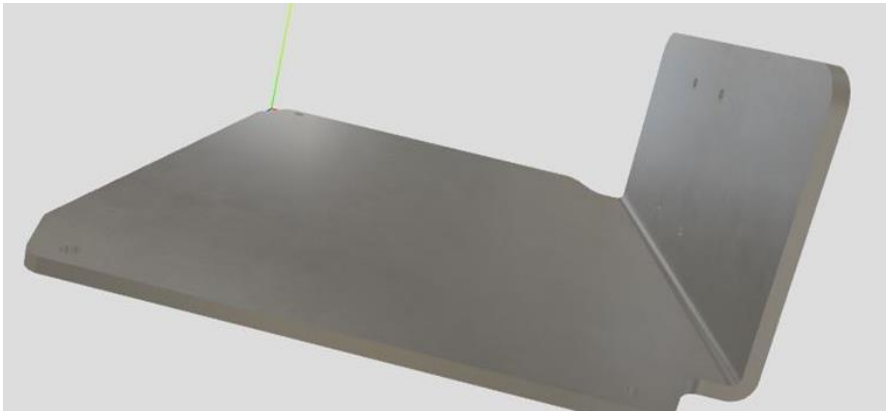

Figure 34 Din rail mounting adapter for the WF 5221

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Software

The system includes two types of software: **configuration software** and **operational software**. WireFlow provides ready-to-use applications for both. In addition, thanks to the system's open API, users can develop their own custom software tailored to specific needs.

Configuration Software Options

- Ready-to-use software
  - WF522x Configuration Tool (AC0279 by WireFlow)
- Custom-made software in any programming language
  - Developed using the open Modbus API described in this manual
- Custom-made software in C#
  - Using the AC0279 source code as a starting point, source code available at www.wireflow.com from product page

Operational Software Options (WF 5220)

- Ready-to-use software
  - WF5220 Instrument Panel (AC0307 by WireFlow)
- Custom-made software in any programming language
  - Developed using the open Modbus API described in this manual
- Custom-made software in C#
  - Using the AC0307 source code as a starting point, source code available at www.wireflow.com from product page
- Custom-made software in LabVIEW
  - WF5220 LabVIEW Modbus Driver (AC0280 by WireFlow)

Operational Software Options (WF 5221)

- Ready-to-use software
  - Several EtherCAT master software solutions are available, including both open-source libraries and commercial products. These can be used together with the EtherCAT descriptor XML file provided by WireFlow.
- Custom-made software in any programming language
  - Custom applications can be developed using one of the many available EtherCAT master libraries. These should also be used together with the EtherCAT descriptor XML file provided by WireFlow

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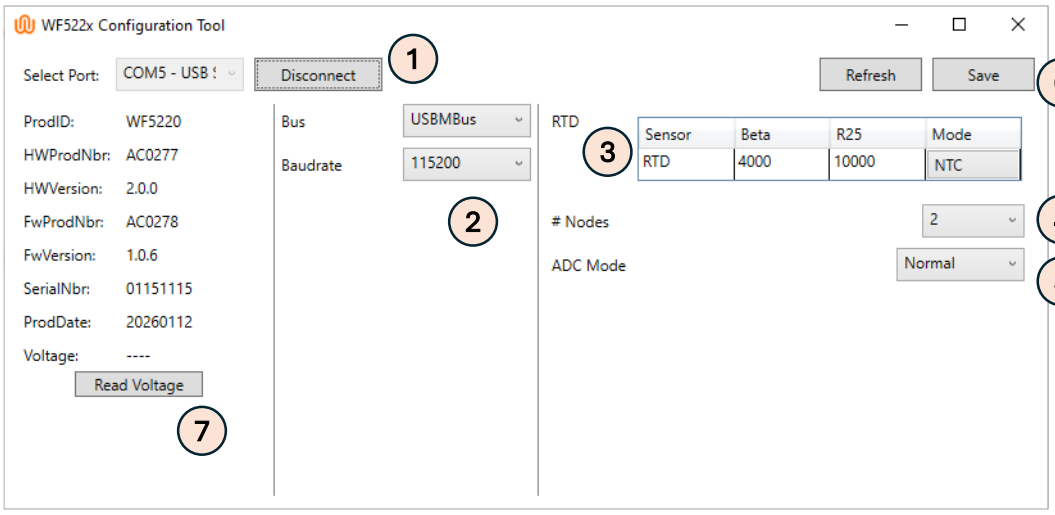
WF522x Configuration Tool



1. The available COM ports in the drop-down menu will be COM ports that are associated with WF522x Gateway. Clicking Connect will read the information from the gateway and populate the fields in the application with the current settings.

2. Here it is possible to configure the communications bus between gateway and host. The available bus types depend on the gateway model.

3. This field is used to configure the built in temperature sensors. In RAW mode the Beta and R25 coefficients are N/A. For information about R25 and Beta coefficients please refer to documentation about NTC temperature sensors.

4. This setting controls how many nodes the gateway reads values from.

5. This setting controls the ADC conversion settings of the node. Sampling rate is affected by the selection of the mode.

6. Pressing save will send the configuration to the gateway and trigger a restart of the gateway to reload with the new settings.

7. This button can be used to read the internal supply voltage of the gateway, the result will show just above the button.

It is always possible to set a higher number of nodes than connected, this will not impact measurements of connected nodes, but it will impact sampling rate since the gateway will still try to read from all specified nodes.

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ADC Mode

The ADC mode is a setting that is used in the nodes, it tells the node how to perform the sampling. There are three modes FILTERED, NORMAL and FAST. The selection of the mode here will affect accuracy of the sample and the sampling frequency.

- **Filtered**
  Applies increased filtering to smooth the signal and suppress short-term fluctuations. Suitable for noisy conditions or when stable readings are required.

- **Normal**
  Uses moderate filtering to balance signal stability and response time. Recommended for most operating conditions.

- **Fast**
  Uses minimal filtering to provide the fastest possible response to changes in the signal. Best for monitoring rapid variations.

Supported Platforms

The application was created to work on Windows operating system using .NET 10 or later.

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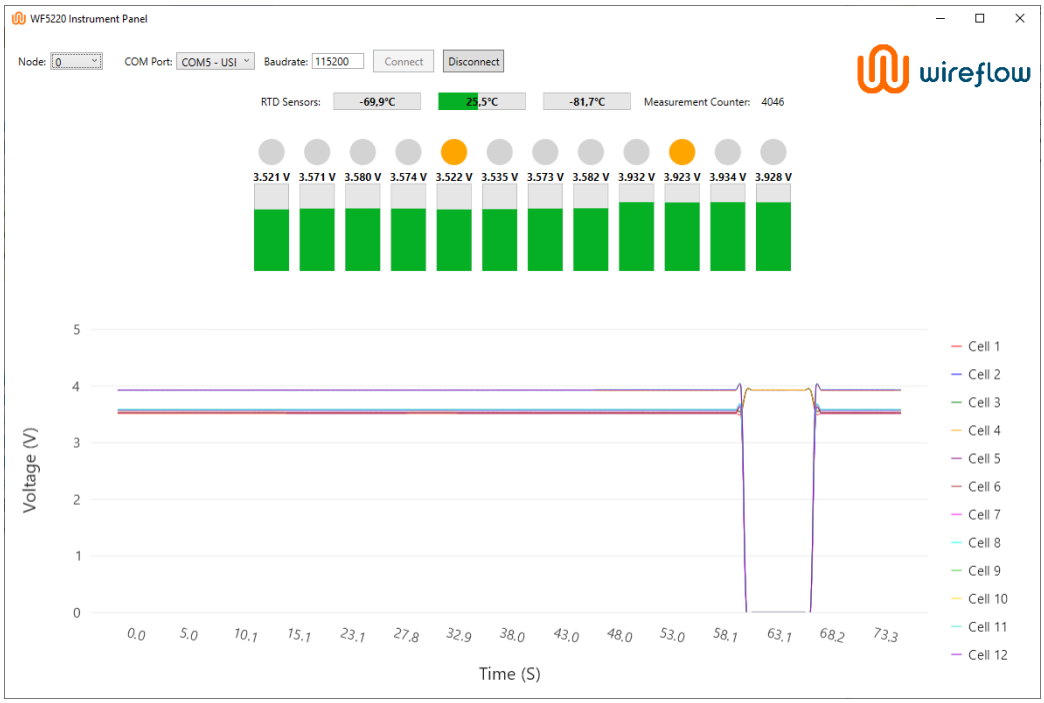
WF5220 Instrument Panel



Before starting the application make sure the WF5220 is connected to the computer through a USB cable. If a gateway is connected the COM port for this device will show in the COM Port drop-down.

When the correct COM port has been selected press Connect and wait for connection. When a connection is established measurement data will begin to populate in the graph and cell indicators.

If multiple nodes are connected to the gateway it is possible to select which node to display data from in the Node drop-down. The numbering here is related to in which order the nodes are connected. So Node 0 is always the node closest to the gateway and counting up from there.

Above the cell indicators is the discharge control, if it is gray then discharge is disabled and if it is orange then discharge is enabled for that cell.

Data is updated in batches of two seconds and each individual measurement point can be viewed by hovering over the graph.

If a node higher than the number configured in the gateway is selected then the application will only read out zero values.

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WF5220 LabVIEW Modbus Driver

The WF5220 comes with a LabVIEW Modbus driver that can be used to implement an application or used as an example for getting started with the Modbus interface.

Installation

The LabVIEW driver is supplied as a *.vip package and requires the user to have VIPM (Vi Package Manager) installed, which can be obtained from www.ni.com.

To install the package, follow these steps:

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

The supplied Modbus driver implements the basic functionality and can be used for simpler applications, for high performance applications it is recommended to use the Modbus specification and implement using the preferred LabVIEW Modbus library.

API

Init.vi

Initialize a connection to a WF5220 battery gateway via a virtual COM port. It also returns the number of nodes that are configured in the system (by the Configuration tool).

Close.vi

Closes the connection to WF5220.

Clear_Error.vi

The devices contain an error register that can show internal errors, to clear this error code call this function.

Clear_Warning.vi

Clear the PEC Error Counter, PEC errors are seen as warning since this will occur naturally if less nodes than configured are connected in the system.

Get_NumberOfNodes.vi

Returns the number of nodes that are configured in the system (by the Configuration tool).

Read_AllRegisters.vi

Function is used to read all registers from a node, this includes cell measurements, RTC measurements and VREF. Selecting a node is done by inputting a number in the range of 0-15 based on the number of nodes in the system (<0 will read all nodes).

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Read_CellValues.vi

This function is used to read only cell voltages from a node. Selecting a node is done by inputting a number in the range of 0-15 based on the number of nodes in the system (<0 will read all nodes).

Read_Counter.vi

In the gateway there is a counter that can be used to ensure that the read data is a new value. This counter will increase by one for each iteration of the measurement loop on the gateway.

Read_Discharge.vi

This function is used to read the current discharge register. This is a 12-bit bit pattern, 0 means no discharge and 1 means that the discharge for that cell is active.

Read_Error.vi

Returns an error code if one is active, 0 means no error code.

Read_Temperatures.vi

This function is used to read only RTC data from a node. Selecting a node is done by inputting a number in the range of 0-15 based on the number of nodes in the system (<0 will read all nodes).

Read_Warning.vi

Returns a PEC Error Counter, PEC errors are seen as warning since this will occur naturally if less nodes than configured are connected in the system.

Set_Discharge vi

This function is used to set the discharge parameters of a node, this is done through a 12-bit bit pattern. Selecting a node is done by inputting a number in the range of 0-15 based on the number of nodes in the system.

SW-Trig vi

If the WF5220 API is running in "SW timed" mode, this VI triggers a sample from all nodes. In other modes, this VI does nothing.

If "Wait for new sample" is TRUE, the VI checks the Gateway sample count, and waits for this to be updated. before returning the new counter value (Normally not necessary)

Examples

An example file can be opened from either the NI example finder, or from VIPM.

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Modbus API

The Modbus protocol is a request-response based protocol where a master device (typically a PC) sends a *request message* to a slave device (the Gateway WF 522x (5220 or 5221)), which replies with a *response message*.

This way, the master can read or write data from/to the slave. Data is organized in 16-bit registers which are used for control, measurement and configuration of the slave.

The Modbus protocol specification is available for download at https://modbus.org/specs.php under *MODBUS protocol specification.*

The WF 522x uses the Modbus RTU implementation which is the serial line version of the Modbus protocol. This implementation adds a *Unit ID* and *error check* to each message.

The Modbus over serial line specification is available for download at https://modbus.org/specs.php under *Modbus Serial Line Protocol and Implementation Guide V1.02.*

Unit ID

The WF 522x uses a virtual COM port for communication, hence it will be the only slave on that COM port. The unit ID is therefore fixed and set to 1.

Serial Settings

The WF522x uses the following serial settings:

Parameter	Value
Baudrate	115200
Stop bits	1
Parity	None
Data bits	8

Function Codes

The WF522x supports the following function codes:

Function	Code
Read Coils	0x01
Read Holding Registers	0x03
Read Input registers	0x04
Write single coil	0x05
Write single register	0x06
Write multiple coils	0x0F
Write Multiple Registers	0x10

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Registers

Name	Address	Data Type	Description
Coils			
Clear Warning	19	-	Clear Warning register
Clear Error	20	-	Clear Error register
Input registers			
Measurement Counter Lo	0	U32.Lo	Measurement loop counter
Measurement Counter Hi	1	U32.Hi	
Node0_Cell0 volt	2	U16	Voltage in 0.1mV
Node0_Cell1 volt	3	U16	Voltage in 0.1mV
Node0_Cell2 volt	4	U16	Voltage in 0.1mV
Node0_Cell3 volt	5	U16	Voltage in 0.1mV
Node0_Cell4 volt	6	U16	Voltage in 0.1mV
Node0_Cell5 volt	7	U16	Voltage in 0.1mV
Node0_Cell6 volt	8	U16	Voltage in 0.1mV
Node0_Cell7 volt	9	U16	Voltage in 0.1mV
Node0_Cell8 volt	10	U16	Voltage in 0.1mV
Node0_Cell9 volt	11	U16	Voltage in 0.1mV
Node0_Cell10 volt	12	U16	Voltage in 0.1mV
Node0_Cell11 volt	13	U16	Voltage in 0.1mV
Node0_NTC0	14	U16	NTC-Mode = mC°, RAW=0.1mV
Node0_NTC1	15	U16	NTC-Mode = mC°, RAW=0.1mV
Node0_NTC2	16	U16	NTC-Mode = mC°, RAW=0.1mV
Node0_VREF	17	U16	Voltage in 0.1mV
Node1_Cell0 volt	18	U16	Voltage in 0.1mV
...			
Node15_Cell0 volt	242	U16	Voltage in 0.1mV
Node15_Cell1 volt	243	U16	Voltage in 0.1mV
Node15_Cell2 volt	244	U16	Voltage in 0.1mV
Node15_Cell3 volt	245	U16	Voltage in 0.1mV
Node15_Cell4 volt	246	U16	Voltage in 0.1mV
Node15_Cell5 volt	247	U16	Voltage in 0.1mV
Node15_Cell6 volt	248	U16	Voltage in 0.1mV
Node15_Cell7 volt	249	U16	Voltage in 0.1mV
Node15_Cell8 volt	250	U16	Voltage in 0.1mV
Node15_Cell9 volt	251	U16	Voltage in 0.1mV
Node15_Cell10 volt	252	U16	Voltage in 0.1mV
Node15_Cell11 volt	253	U16	Voltage in 0.1mV
Node15_NTC0	254	I16 (NTC) U16 (RAW)	NTC-Mode = 0.01C°, RAW=0.1mV
Node15_NTC1	255	I16 (NTC) U16 (RAW)	NTC-Mode = 0.01C°, RAW=0.1mV
Node15_NTC2	256	I16 (NTC) U16 (RAW)	NTC-Mode = 0.01C°, RAW=0.1mV
Node15_VREF	257	U16	Voltage in 0.1mV

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Warning code	322	U16	
Error code	323	U16	
Holding registers			
Loop Time	0	U16	0=OFF, 1.. = mS
Discharge Node0	1	U16	Bit pattern; bit0=cell1, bit11=cell12
Discharge Node1	2	U16	Bit pattern; bit0=cell1, bit11=cell12
Discharge Node2	3	U16	Bit pattern; bit0=cell1, bit11=cell12
Discharge Node3	4	U16	Bit pattern; bit0=cell1, bit11=cell12
Discharge Node4	5	U16	Bit pattern; bit0=cell1, bit11=cell12
Discharge Node5	6	U16	Bit pattern; bit0=cell1, bit11=cell12
Discharge Node6	7	U16	Bit pattern; bit0=cell1, bit11=cell12
Discharge Node7	8	U16	Bit pattern; bit0=cell1, bit11=cell12
Discharge Node8	9	U16	Bit pattern; bit0=cell1, bit11=cell12
Discharge Node9	10	U16	Bit pattern; bit0=cell1, bit11=cell12
Discharge Node10	11	U16	Bit pattern; bit0=cell1, bit11=cell12
Discharge Node11	12	U16	Bit pattern; bit0=cell1, bit11=cell12
Discharge Node12	13	U16	Bit pattern; bit0=cell1, bit11=cell12
Discharge Node13	14	U16	Bit pattern; bit0=cell1, bit11=cell12
Discharge Node14	15	U16	Bit pattern; bit0=cell1, bit11=cell12
Discharge Node15	16	U16	Bit pattern; bit0=cell1, bit11=cell12
NbrNodes	5105	U16	Number of configured nodes

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Automatic read with specified loop time vs. polled read

In the WF5221 Gateway, the firmware continuously reads all nodes at a fixed interval defined by the “Loop Time” parameter, and updates the EtherCAT data at the same rate.

For Modbus communication used on the WF5220, we generally recommend using a polled read in all situations except when the absolute highest sampling rate is required.

When the best possible sampling sate is needed

To achieve the maximum sampling rate:

1. Configure the system to do Fast mode sampling
2. Set the Modbus register “Measurement Counter” to 10 ms.
3. Read the Modbus data registers as quickly as possible.
4. Verify that the value of “Measurement Counter” has changed since the previous read to ensure that the data is fresh.

Recommended method when maximum sampling rate is not required

When ultra-fast sampling is unnecessary, we recommend a polled read procedure to ensure fresh data while avoiding unnecessary complexity:

1. Set the “Measurement Counter” register to 10 000 ms.
2. Set the “Measurement Counter” register again to 0 ms (to stop automatic sampling)
3. Read the desired data registers.

This sequence forces the gateway to perform exactly one read cycle from the node(s). It also guarantees that the Modbus registers contain updated data before the read in step 3 is executed.

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WF 5221 EtherCAT interface

WF5221 utilizes the EtherCAT interface and can be used together with an EtherCAT master. WireFlow provides several ESI-files for the gateway based on performance and setup criteria of the customer. By the default the WF5221 is delivered with an ESI setup for 4 nodes, there are other available options that can be used for optimizing the data gathering.

It is important to note that a system needs to have an ESI installed that supports a larger number of nodes than configured in the AC0279 WF522x Configuration Tool, but it is allowed to configure a lower number of nodes than the ESI specifies.

On the WireFlow WF5221 product page it is possible to download the complete ESI-package that can be installed on the gateway using the AC0314-005 EtherCAT_ProdTool.

Registers

The EtherCAT interface Node cell and RTC measurements, including the V_{ref} signal. It also supports the LoopTime and Discharge parameters for control of the node. The data format for all these signals is the same as for Modbus.

Program EtherCAT

Start the application EEPROM Programmer.exe. This application can be found here:

AC0314-005 EtherCAT_ProdTool.zip

1. Connect the WF5221 with both USB and an ethernet cable to the computer.
2. Under the menu Slaves, press Scan.
3. Then select Ethernet. (This could vary if you have some sort of adapter between the computer and ethernet cable.)
4. The application will then find the device.

5. Then open a file named WF522x-Y.xml, where Y represents the number of nodes specified in the ESI. These files can be found in the ESI package:
    - AC0314-006 EtherCAT_AppFiles

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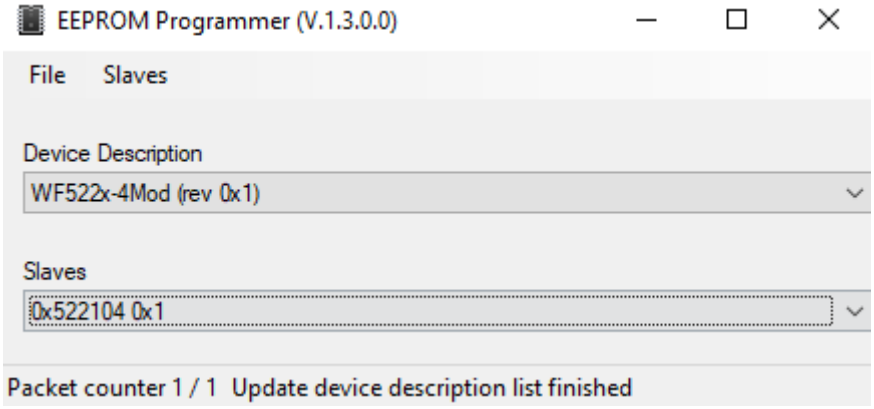
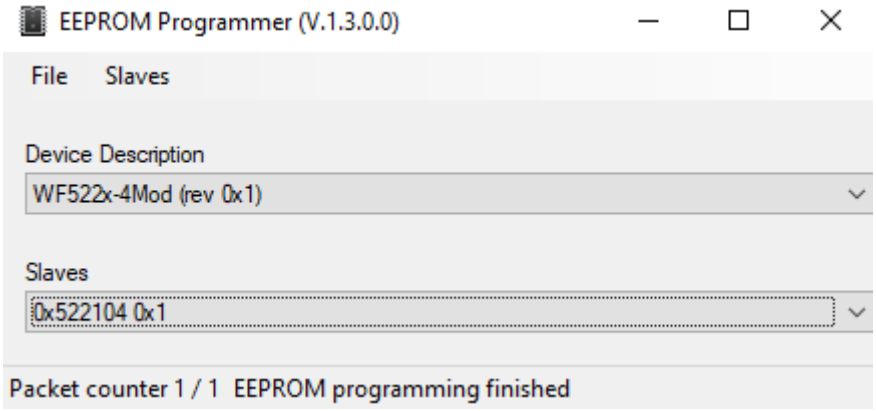


6. Then press Program Selected under the menu Slaves and wait until the program is finished.



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Technical support and Professional services

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

- Description of your configuration.
  What WireFlow devices are used in your application and how are they interconnected. For example, One Gateway of type WF5220 and three WF 5218 nodes connected to one battery module/pack with 32 cells according to attached sketch.
- General description of the problem.
- Product number, hardware version and serial numbers of the nodes and isolator blocks if used.
  Can be find on a label on the devices. (ACxxxx, v xxx, s/n xxxxxx)
- Product number, hardware version and serial number of the gateway.
  Can be find on a label on the devices. (ACxxxx, v xxx, s/n xxxxxx) or by using the WF522x Configuration Tool
- Product number and version of the gateway firmware
  Can be found by using the WF522x Configuration Tool (ACxxxx, v xxx)

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 xxxx” (where xxx is the model number, for example WF 5221)

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.

Revision history

Rev A	2026-05-18	First issue

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Ordering information

Article no	Product	p/n
AE0043	WF 5218 Battery Monitoring and Balancing Node	AC0275
AE0044	WF 5220 Battery Monitoring and Balancing Gateway	AC0277
AE0045	WF 5221 Battery Monitoring and Balancing Gateway for EtherCAT	AC0291
	Accessories:	
AE0048	Terminal Block Cover for WF 5218	AC0310
AE0049	DIN Rail Adapter for WF 5218	AC0289
AE0050	DIN Rail Adapter for WF 522x	AC0290
AE0052	M12 connector 4-pos Plug-Male A-coded	
AE0053	M12 connector 4-pos Socket-Female A-coded	
AE0054	M12 cable 30cm 4-pos Straight Male to Female A-coded	
AE0055	M12 cable 3m 4-pos Straight Male to Female A-coded	

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