X-SERIES BATTERY MANAGEMENT SYSTEM (BMS)

MODULE CONTROL UNIT – PASSIVE BALANCING (X-MCUP)

Data Sheet

12 Cell Battery Pack Monitoring and Control, Passive Cell Balancing, CAN, Auto CAN ID Assignment, Ultra-Low Power Dissipation with Hardware Interlock Safety Layer

1 FEATURES

- Measures 4 to 12 cell voltages in series
- Measures 4 to 12 cell temperatures
- Up to 300 mA Passive Cell Balancing
- Cell Capacity and DC Resistance calculations
- Cell over voltage, under voltage, and high temperature hardware interlock layer protection
- Isolated CAN to connect to X-BCU
- 24V Power received from X-BCU
- Automatic CAN Node ID assignment
- Additional Digital I/O
- Power, CAN, Node ID, and Hardware Interlock have In and Out wiring to allow simple wire harness
- Fault Management and Diagnostics
- Data Logging
- Ultra Low Power Dissipation
- Automotive Grade

2 DESCRIPTION

The X-Series Module Control Unit with Passive Balancing (X-MCUP) is part of the X-Series Battery Management System (BMS). Functioning as a slave controller, single or multiple X-MCUPs interface with the X-Series Battery Control Unit (X-BCU) to form a complete BMS.

The X-MCUPs are used to monitor cells in large battery packs with up to 240 cells in series in a distributed BMS. Each X-MCUP can be configured to monitor 4 to 12 cell voltages and temperatures. All cell measured voltages and temperatures are sent to the X-BCU. As well, the X-MCUP calculates the ESR and Capacity of each cell it is monitoring. All communication between controllers is over an isolated CAN bus.

The X-MCUPs balance the voltage and charge between all cells in a battery pack by removing energy from the highest charged cells, keeping the cells in a balanced state, and thus extending the life of your battery pack.

A total of four Digital I/O signals are equipped on X-MCUPs. Two of these signals are configurable as either Digital Inputs or outputs. Together with two more Digital Outputs, these four Digital I/O channels provide the design flexibility to accommodate additional digital feedbacks and/or controls that systems may require.

In addition to software monitoring and control, a hardware interlock layer triggers on hardware configurable thresholds for high cell voltage, low cell voltage, and high cell temperatures. The interlock signal is connected between single or multiple X-MCUPs to a single X-BCU controller. The X-BCU hardware will disconnect the battery pack from the vehicle by opening the battery safety relays in these extreme conditions to ensure safe operation. The hardware interlock layer acts as a redundant system to the software alarms and fault management to ensure 100% safe operation of the battery pack.

The X-MCUP controller is configurable for all lithium cell chemistries such as LFP, NMC, LMO, LTO and all cell form factors such as pouch, cylindrical, or prismatic form.

3 APPLICATIONS

- Electric, Hybrid, and Plug-In Hybrid Vehicles
- Industrial Battery Packs
- Backup and Standby Battery Systems
- Distributed Battery Packs with multiple modules or boxes

4 OPERATIONS

- Cell Voltage Monitoring of up to 12 cells. Cell voltage is sampled every 50ms, and reported through CAN to X-BCU every 100ms to ensure fast response in protecting cells from brief over and under voltage events. Cell monitoring has 0 to 5V range, 1.5mV resolution and less than 0.25% error.
- Temperature monitoring of up to 12 temperature sensors to ensure the safety of the battery pack is always maintained and the lifetime of the cells are maximized by avoiding high temperature events that will deteriorate the cell`s performance.
- State of Charge (SOC) dynamically calculated for each cell with advanced self-correcting model based algorithms. Less than 3 – 5% SOC error depending on the cell chemistry. SOC algorithms adapt to changing cell characteristics over time as the cells in the battery age.
- State of Health (SOH) continually calculated and monitored on each cell, and is based on the capacity fade and internal resistance increase over the lifetime of the cell. SOH of each cell allows weak cells that limit the performance of the entire battery to be detected and early identification of premature failure.
- Cell Internal DC Resistance calculated for each cell and determines the charge rate limits and available power forecasting.
- Cell Capacity calculated and allows high SOC accuracy.
- Passive Cell Balancing eliminates cell to cell imbalance by removing energy from the highest charged cell at 300 mA per cell. This extends the battery pack's effective lifetime.
- Cell voltage monitoring and passive balancing power isolated from the controller supply power, easily allowing multiple X-MCUPs to be connected together in battery packs up to 1000 VDC.
- Isolated CAN communication with X-BCU and other diagnostic equipment. 2.5 kV RMS signal and power isolation and > 25 kV/us common-mode transient immunity.
- Four additional Digital Outputs available of which two are configurable as Digital Inputs for flexibility in control and readback design.
- Fault Management: Over 20 fault conditions continually monitored and status reported over CAN. Multiple alarms levels: warning, soft shutdown, hard shutdown, sensor faults, and service alarms are all configurable. Alarms include under and over cell voltage, low and high cell temperature, over charge, over discharge, voltage and temperature sensor failures, faulty mechanical connections on bus bars or cell terminals, and others.
- Safety Hardware Interlocks: cell over voltage, cell under voltage, and cell high temperature will trigger the hardware interlock line that will cause the X-BCU hardware to open the safety relays independently of the software system. This safety-critical system eliminates any events that could cause financial damage, injury, or loss of life without relying on the complexities or timing delays of the software system. The

hardware system is designed for compatibility with IEC 61508 / ISO 26262.

The safety hardware interlock layer functions as a second layer to the software controls forming dual-channel architecture as required in safety-critical systems. This has the advantage of detecting faults or failures even if a systematic fault has occurred in the software controls. JTT's dual-channel architecture with hardware and software levels meets all safety critical system requirements. It minimizes controller cost and space when compared to other approaches used in other BMS systems where two independent but identical software systems are running in parallel.

- Battery Cell serial numbers can be set and stored in the controller during battery pack assembly, and useful for cell tracking for troubleshooting and warranty purposes
- Cell Lifetime Data Logging of each cell temperature, voltage, and SOC histograms useful for troubleshooting and warranty.
- Internal controller temperature monitoring.
- Cell balance circuitry has self-test capability to guarantee proper BMS operation and battery pack performance.
- CAN Node ID automatic assignment means all X-MCUPs in the battery are identical. There is no configuration necessary when swapping, replacing, or upgrading controllers. All X-MCU controllers in the distributed BMS can detect their position within the battery and are assigned a corresponding CAN Node ID.
- Ultra Low Cell Power Dissipation from voltage monitoring circuitry. The cell voltage monitoring and hardware interlock consumes 1.57 mA from the cells while the controller is actively monitoring cell voltages. The consumption is decreased to 35 µA leakage dissipation while controller is turned off.
- Reliable Power Supply Input with short circuit, reverse voltage, and surge protection. In addition, the X-MCUP power input is fed from the X-BCU regulated power output which has high voltage, low voltage, reverse voltage protection, high voltage transient immunity, load dump, and current injection immunity.
- Power, Ground, and Digital I/O available for connection to relays, optional driver board to control components such as fans, heaters, relays, or other devices if needed.
- In system firmware upgrading available through CAN.
- Battery and cell monitoring and diagnostics available in real-time trough diagnostic CAN to a laptop or PC with BMS LINK® software tool.
- In and out pins provided for power, ground, CAN, node id, and hardware interlock greatly simplify, reduce cost, and increase reliability of the BMS wire harness and removes the need for wire splicing.
- IP55 protection rating.
- Automotive grade electrical and mechanical components for temperature and vibration.

5 BLOCK DIAGRAM

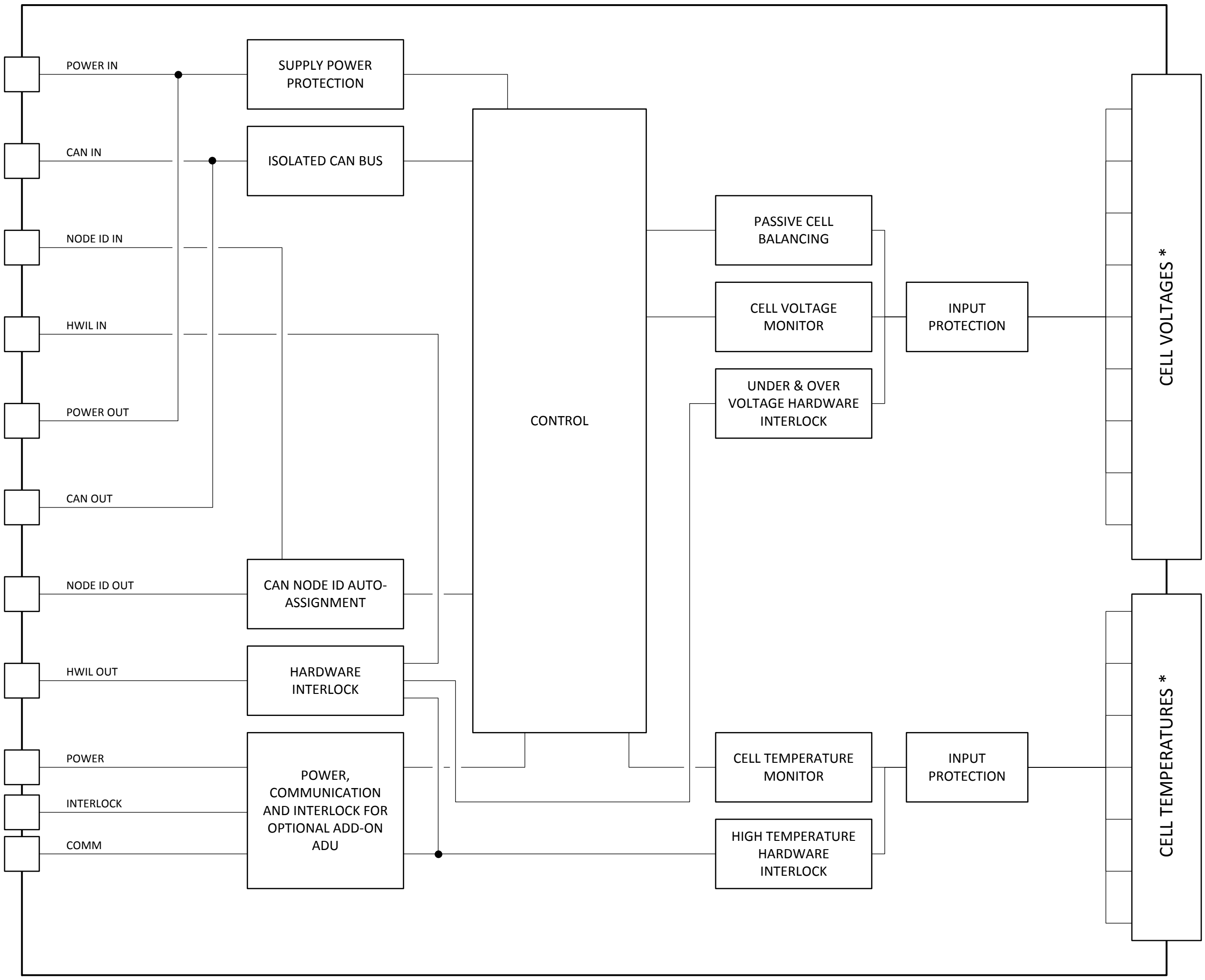


Figure 1. Controller Block Diagram

* Variable number of cell voltage and cell temperature inputs based on controller configuration

6 TYPICAL APPLICATION

The X-Series product line is typically used on medium to high voltage (200 to 1000V) battery packs that contain greater than 48 cells in series, in a distributed BMS setup. For battery packs 48 cells or less and less than 200V, the S-Series BMS controllers may be better suited.

Battery packs may be used for mobile applications, small passenger vehicles, industrial applications, backup power, or many others. Depending on the application the BMS will be configured differently. The most common accessories that may or may not be used in your application include, relays to isolate the battery pack from the system, LCD screen to display battery pack values, current sensor, fan, etc.

The following shows how the X-MCUP monitors a single module of 12 cells in a much larger battery pack. The CAN communication, power, ground, CAN Node ID auto-assignment, and hardware interlock wires come from another controller further up in the battery, go in and out of the X-MCUP controller and then continue down to the next controller in the battery pack.

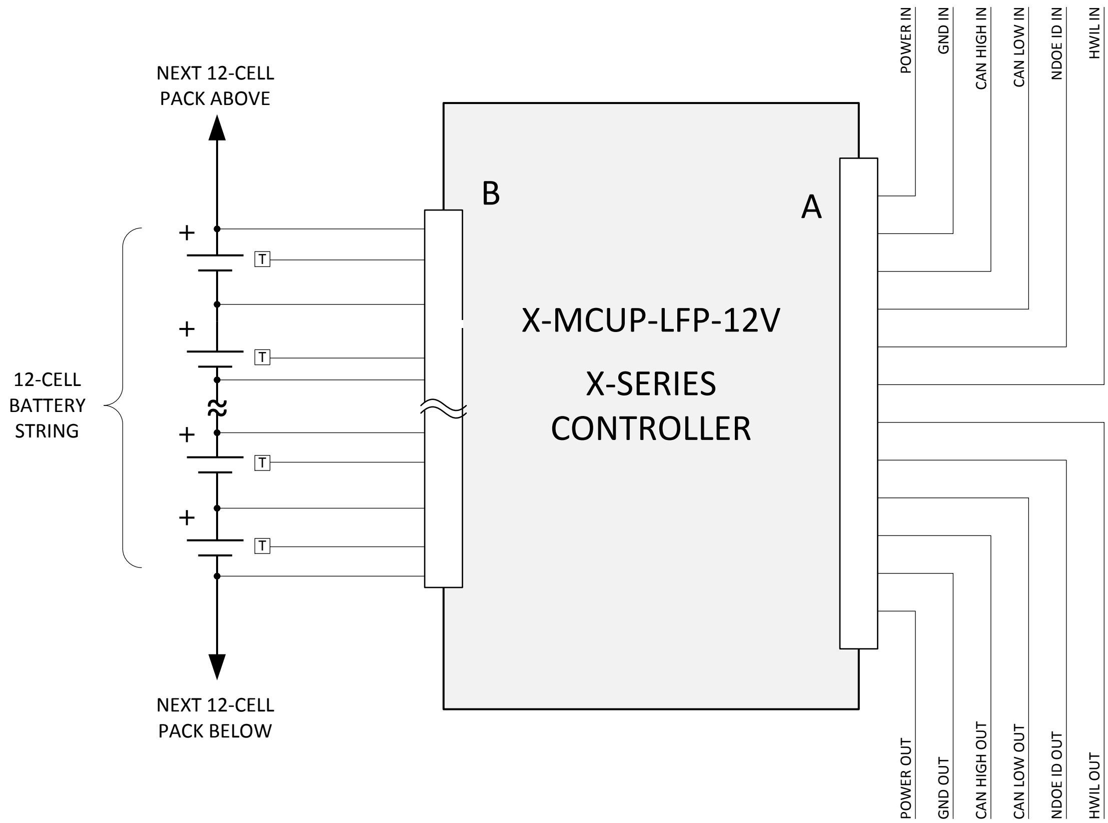


Figure 2. X-MCUP in Distributed BMS Setup

A complete distributed BMS for large battery packs is made up of multiple X-MCUs and a single X-BCU. The following shows how such an arrangement of controllers would look.

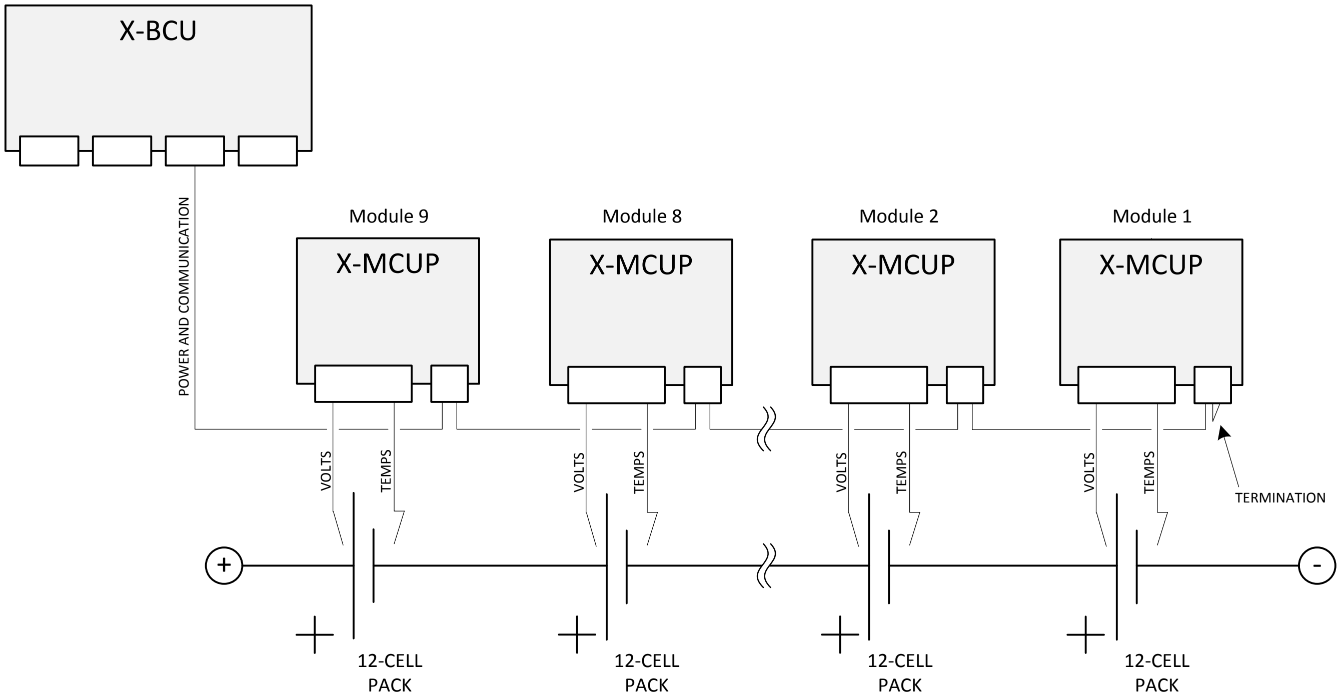


Figure 3. X-series Distributed BMS

7 CONFIGURATIONS AVAILABLE

The X-MCUP is available in several pre-set configurations, and may be customized for any application.

The configurations vary based on number of battery cells in series to monitor and which chemistry the battery cells are.

Each battery cell chemistry has different thresholds for cell under voltage and over voltage fault conditions which are set in the hardware interlock circuitry.

The X-MCUP hardware selected will work with any number of parallel cells, with any cell capacity selected, and any possible Digital I/O combinations as these only require a firmware configuration.

8 MODEL NUMBERING

X-MCUP-____-__V

Battery Cell Chemistry

LFP – Lithium Iron Phosphate
NMC – Nickel Manganese Cobalt
LMO – Lithium Manganese Oxide

Number of Cells in Series

X – Specify 4 to 12 cells

Example Model Number:

A controller configured for 10 LFP cells in series:

X-MCUP-LFP-10V

9 ELECTRICAL CHARACTERISTICS

PARAMETER	MIN	TYP	MAX	UNITS
Supply Power Specifications				
Supply Voltage (Vmain)		24	32	V
Supply Current, Normal Mode (@ 24 V)		60		mA
Cell Voltage Monitoring and Hardware Interlock Specifications				
Measurement Resolution		1.5		mV
Measurement Offset	-0.5		0.5	mV
Measurement Gain Error	-0.12		0.12	%
Cell Voltage Range	0		5	V
Cell Monitoring Current (In/Out Pins Cell 1 to Cell 12)				
Active Measuring	-20		20	µA
Leakage		2		nA
Supply Current (In Cell12 Out Cell 0)				
Active Measuring	1.24	1.55	2.02	mA
Leakage		35		µA
Measurement Period		50		ms
Hardware Interlock Detection Level Error	-0.8		0.8	%
Hardware Interlock Detection Period	13	15.5	19	ms
Cell Temperature Monitoring Specifications				
Measurement Resolution		0.1		°C
Measurement Accuracy		1.0		%
Cell Temperature Range	-100.0		100.0	°C

PARAMETER	MIN	TYP	MAX	UNITS
Cell Balancing Specifications				
Passive Balancing Current		250	300	mA
Isolated CAN Communication Specifications				
Isolation		2.5		kV rms
Common-mode Transient Immunity		25		kV/µs
Recessive Bus Voltage	2.0		3.0	V
CANH Output Voltage	2.75		4.5	V
CANL Output Voltage	0.5		2.0	V
Maximum Data Rate		500		Kbps
Digital I/O Specifications				
Low Side Digital Output Current Sink Per Channel			750	mA
Low Side Digital Output Current Sink All Channels			2	A
Low Side Digital Output Current Source per Channel		0		mA
Low Side Digital Output Switching Voltage			60	V
Digital Input Active Low Level	0		0.7	V

10 APPLICATION INFORMATION

CONNECTING TO OTHER CONTROLLERS

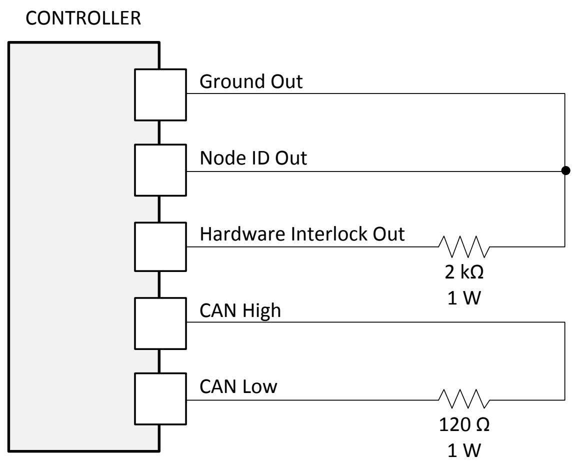
Several wires are required to be connected between an X-MCU and other X-MCUs or an X-BCU: power, ground, CAN high, CAN low, hardware interlock, and node ID. Each connection has an in and an out. The controller will not function properly if the in and the out connections are swapped by mistake.

The X-MCUP monitoring the cells at the highest potential in the battery pack will have its ins connected to the outs from an X-BCU. The outs from this X-MCU will then connect to the ins of the next X-MCU monitoring the cells at the next highest potential. The pattern of connecting the outs from one controller to the ins of the next lower controller will continue until the last controller which is monitoring the cells in the battery pack with the lowest potential. The last controller has the “termination” for the hardware interlock, node id, and CAN, connected to its outs. Refer to the next section for more information on the termination connection.

LAST CONTROLLER TERMINATION

The last controller in the in-out wire harness between multiple X-MCUs, which is monitoring the cells with the lowest potential in the battery pack, requires termination connections for the hardware interlock, CAN node ID wires, and CAN high and CAN low.

The Node ID out is connected to ground out. The hardware interlock out is connected to ground out with a 2 kΩ resistor. CAN High out is connected to CAN Low out with a 120 Ω resistor. Both resistors must be through-hole type, with a power rating of 1W or higher. This ensures that the resistor leads are durable enough to be soldered into a wire harness.



NUMBER OF CELLS AND TEMPERATURE SENSORS

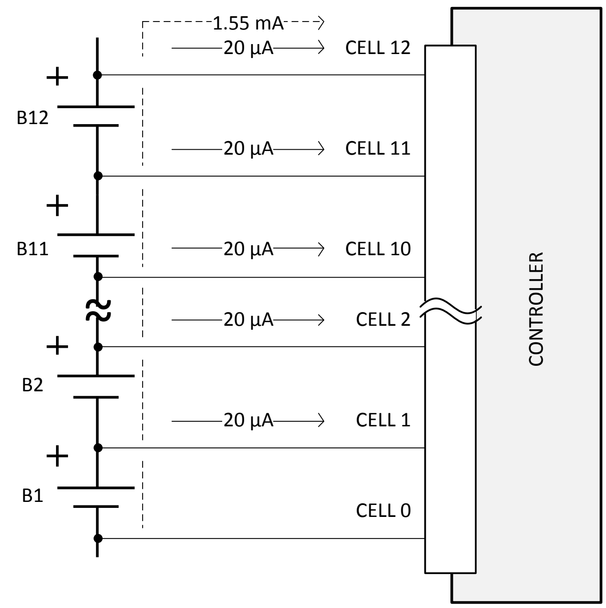
An X-MCUP controller must be used with the same number of cells in series, and same number of temperature sensor for which it was configured for. The controller model number specifies how many cells and how many temperatures it is set up for. For more information on the model number, see the previous section on model numbering.

CELL MEASUREMENT

Cell voltage measurement is one of the most important parts of the X-Series BMS. Although the voltage does not indicate the state of charge (SOC) in a lithium battery the voltage is critical to calculating the SOC. The X-MCUP has cell voltage monitoring with a resolution of 1.5mV, with ±0.5mV offset, and only ±0.12% error.

The X-MCUP is designed for minimal cell energy dissipation from the cell voltage monitoring and the cell voltage hardware interlock circuitry. Cell voltage measurement and hardware interlocks are done through the Cell 0 to Cell 12 pins. While cell voltage monitoring is active, each cell input, pins Cell 1 to Cell 12, are consuming only 20 µA. When the controller is powered off each pin consumes only 2 nA.

The cell monitoring and hardware interlock circuitry is isolated from the rest of the controller circuitry to allow multiple X-MCUPs to monitor different groups of cells, at different relative potentials, within the same battery pack. The power for the cell monitoring circuitry comes from the battery cells. The power path is in through Cell 12 pin (or the highest cell if less than 12 are being monitored) and out through the Cell 0 pin. The typical current consumption for the monitoring and hardware interlock circuitry is 1.55mA. When the controller is powered off the consumption in this path is down to 35 µA.



CELL INPUT PROTECTION

The cell voltage monitoring inputs (Cell 0 to Cell 12) are capable of measuring 0 – 5 volts. However the inputs have added protection to both protect the BMS controller and to ensure that connected cells are not discharged in the event that some of the voltage inputs are miss-wired. Each cell input has reverse voltage and high voltage protection in case two wires are swapped.

If a wiring miss-match does occur, and the cell input protection is tripped, the protection will automatically reset itself once the cell input connector is unplugged and the abnormal voltage is removed from the input pins. Extreme care must be taken to ensure that all cell voltage inputs are wired correctly.

PASSIVE CELL BALANCING

The X-Series BMS with X-MCUPs utilizes passive cell balancing to keep all cells within the battery pack equally charged. This is achieved by discharging energy from the highest charged cells. This ensures that cells that have slightly weaker performance are not degraded further by over-charging or over-discharging them during operation. A well balanced battery pack will have a higher capacity and a longer lifetime than an unbalanced one.

Depending on cell voltage the passive balance circuitry will discharge a balancing cell between 200 and 300 mA. The cell balancing is based on the amount of charge in each cell and not on the cell voltage. This means that balancing is active all the time unlike other BMS systems where balancing is only enabled while the battery is idle. The controller also monitors the internal balance circuitry temperature and may limit the number of balancing cells when operating in extreme ambient temperatures.

CELL VOLTAGE AND TEMPERATURE HARDWARE INTERLOCKS

Cell hardware interlocks based on cell over voltage, cell under voltage, and high cell temperature will trigger the hardware interlock and open the safety relays independently of the software system. This safety-critical system eliminates any events that could cause financial damage, injury, or loss of life without relying on the complexities or timing delays of the software system. The hardware system is designed for compatibility with IEC 61508 / ISO 26262.

The safety hardware interlock layer functions as a second layer to the software controls forming dual-channel architecture as required in safety-critical systems. This has the advantage of detecting faults or failures even if a systematic fault has occurred in the software controls. JTT's dual-channel architecture with hardware and software levels meets all safety critical system requirements. It minimizes controller cost and space when compared to other approaches used in other BMS systems where two independent but identical software systems are running in parallel.

The X-MCUP hardware interlock circuit works in combination with an X-BCU. The X-BCU generates and monitors the hardware interlock signal that travels in and out of all X-MCUPs in the BMS. If any X-MCUP hardware interlock occurs then it will trip the hardware interlock signal from the X-BCU. The X-BCU hardware will detect this and automatically open the battery safety relays.

CAN BUS

Isolated controller area network (CAN) bus compatible with SAE J1939 and ISO 11898 goes in and out. It is configured to run at 500 kbps. This CAN bus is for internal communication between X-MCUs, X-BCU and the BMS Link monitoring tool. All communication on this CAN bus is encrypted.

To comply with SAE J1939 and ISO 11898 termination resistors are required at either end of the bus. At the one end of the bus, the X-BCU has internal CAN termination. At the other end, at the last X-MCU in the BMS, external termination is required between CAN High out and CAN Low out. Refer to the previous section on Last Controller Termination.

Each X-MCU is added on the internal CAN bus as a node. It has over 2kΩ of resistance split between the incoming CAN high and CAN low to reduce electromagnetic emission and increase bus noise immunity.

For the CAN bus physical layer it is recommended to use shielded twisted pair cables with the shield terminated at one end. For all other physical layer recommendations please consult SAE J1939 and ISO 11898.

ALARM DEFINITIONS AND REPORTING

Over 20 alarms are being evaluated at over 10 times a second to ensure safe battery operation, and to maximize the battery pack performance and lifetime. The list of alarms is configured for different battery cell types, and battery applications.

There are multiple levels of alarms depending on the severity. Alarms can be warning, soft shut down, hard shut down, service, or sensor fault alarms. A warning alarm means that the BMS will not take any action but there is some abnormal performance in the battery that may be the early signs of a problem.

A soft shutdown alarm means that something in the battery or in the system's operation of the battery is well outside of the normal operating window and the battery pack must be disconnected from the system. Once a soft shutdown alarm has occurred the battery safety relays will automatically open after 20 seconds has passed.

A hard shutdown alarm means that something in the battery or in the system's operation of the battery is causing a safety hazard and immediate action must be taken. Once a hard shutdown alarm occurs the battery safety relays will open automatically after 2 seconds have passed.

A service alarm indicates that something in the battery pack may need to be serviced in the near future. It is not causing any immediate safety issues or performance loss but it may be soon. One example of a service alarm may be that the cells temperature difference may be high, because an air inlet filter may need to be changed.

A sensor fault alarm means that a sensor in the battery pack is no longer operating within its specified function. And will need to be serviced and possible replaced. One faulty temperature sensor on a pack will not cause any immediate danger, so the battery pack is still operational, and the battery pack control can continue without that sensor. However the senor should be serviced and replaced if needed.

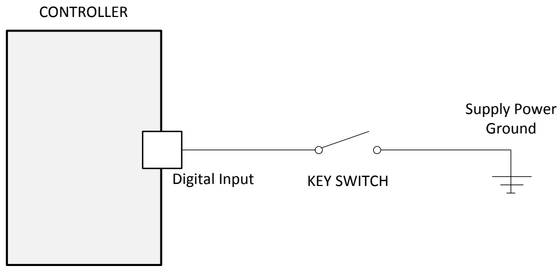
Alarms may be standard set or customized for your application. X-MCUP alarm status is communicated over CAN to the X-BCU which then acts on the alarms and/or communicates it to the vehicle.

DIGITAL I/O

There are four general purpose Digital I/O ports. Two of them are software configurable to be used as either digital inputs or digital outputs, while the other two are digital outputs.

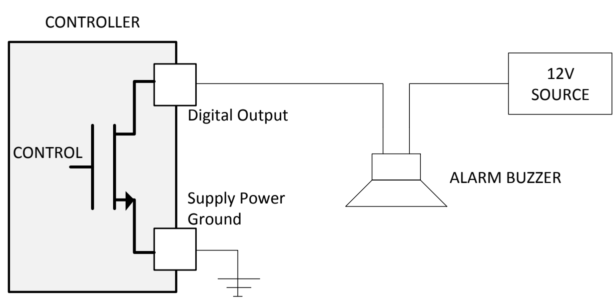
DIGITAL INPUTS

Digital inputs are active low inputs, meaning that if left floating or disconnected the input has an internal pull-up to a high level and will be considered off. To turn the input on, connect the input to system ground. The on condition is true when the input voltage is from 0 – 0.7 V. The inputs are typically used for a key switch status, charger connected status, or operator push buttons.



DIGITAL OUTPUTS

The digital outputs are implemented as low side sinking digital outputs. This means that the power for the device that the digital output is controlling is wired to a constant power source and the ground of the device is wired to the digital output. When the digital output is turned on then the ground of the device is connected to the supply power ground of the BMS, and the device will turn on. Each digital output is capable or sinking 750 mA. In total all digital outputs can sink up to a maximum of 2 Amps. The maximum switching voltage is 60 V. Digital outputs can be used to control fans, relays, heaters, LCD screen power or other components.



DATA LOGGING

The lifetime histograms of temperature, voltage and current of every cell monitored by the controller are logged in the controller memory. This data can be useful for troubleshooting and warranty purposes.

Battery cell serial numbers can be set and stored in the controller during pack assembly and used for cell tracking.

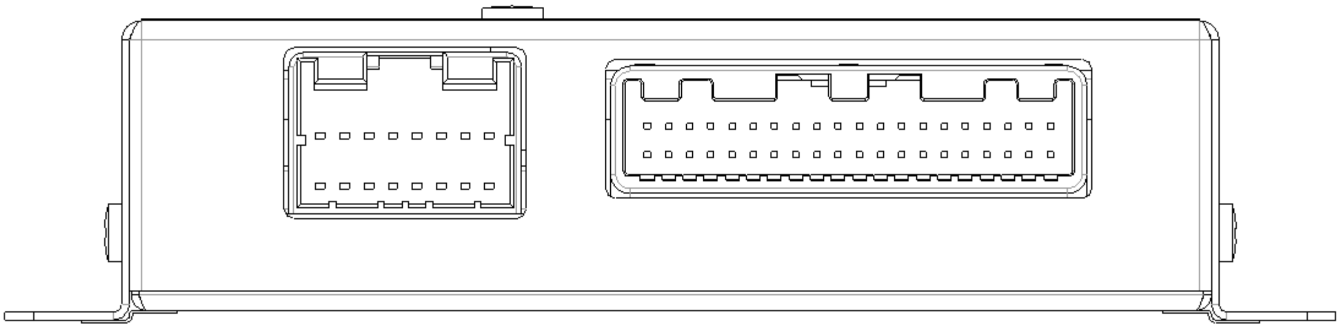
FIRMWARE UPGRADING

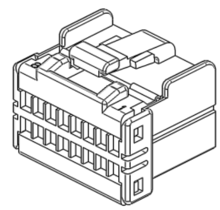
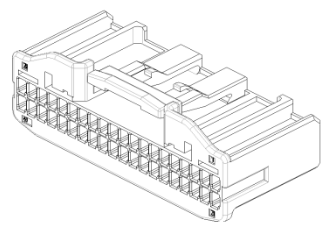
Firmware upgrading can be completed from a laptop or PC connected to the CAN bus with a CAN-USB tool, and the JTT Firmware Loader® software.

BATTERY PACK MONITORING

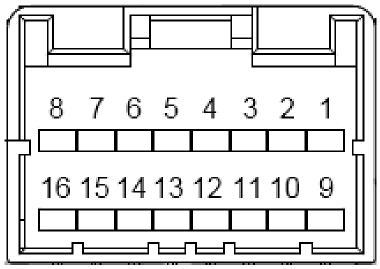
Battery pack monitoring can be done in real time with a laptop or PC connected to the CAN bus with a CAN-USB tool and the JTT BMS LINK®.

11 CONNECTORS AND PIN OUT



Connector	TE Connector P/N	TE Socket P/N	TE Hand Crimp Tool	
A	174046-2	175062-1 (loose) 173681-1 (strip) (22-20 AWG)	90652-1	
B	1318389-2	1123343-1 (strip) 1318143-1 (loose) (24-20 AWG)	1276652-1	

Connector A – Power and Communication



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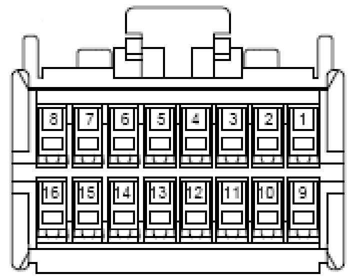
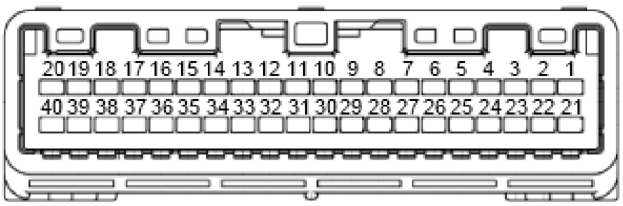


Plug

Wire insulation must be 1.8 - 2.0 mm diameter

Pin	Tag	AWG	Description
1	DO1	18	Digital output 1
2	DO2	18	Digital output 2
3	DO3 / DI1	18	Configurable digital output 3 or digital input 1
4	DO4 / DI2	18	Configurable digital output 4 or digital input 2
5	CAN_H_IN	20	CAN High communication Input
6	CAN_H_OUT	20	CAN High communication Output
7	Vsupply_IN	18	+24V Power Supply Input
8	Vsupply_OUT	18	+24V Power Supply Output
9	HWIL_IN	20	Hardware Interlock Status Input
10	HWIL_OUT	20	Hardware Interlock Status Output
11	NODE_ID_IN	20	CAN Node ID auto assignment Input
12	NODE_ID_OUT	20	CAN Node ID auto assignment Output
13	CAN_L_IN	20	CAN Low communication Input
14	CAN_L_OUT	20	CAN Low communication Output
15	GND_IN	18	+24V Power Supply Ground Input
16	GND_OUT	18	+24V Power Supply Ground Output

Connector B – Cell Voltages and Temperature Sensors



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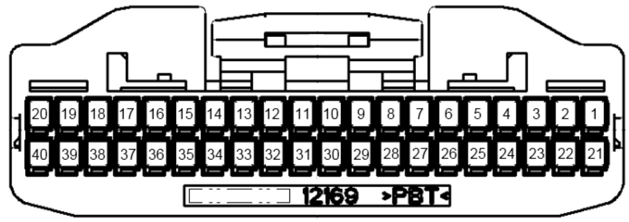
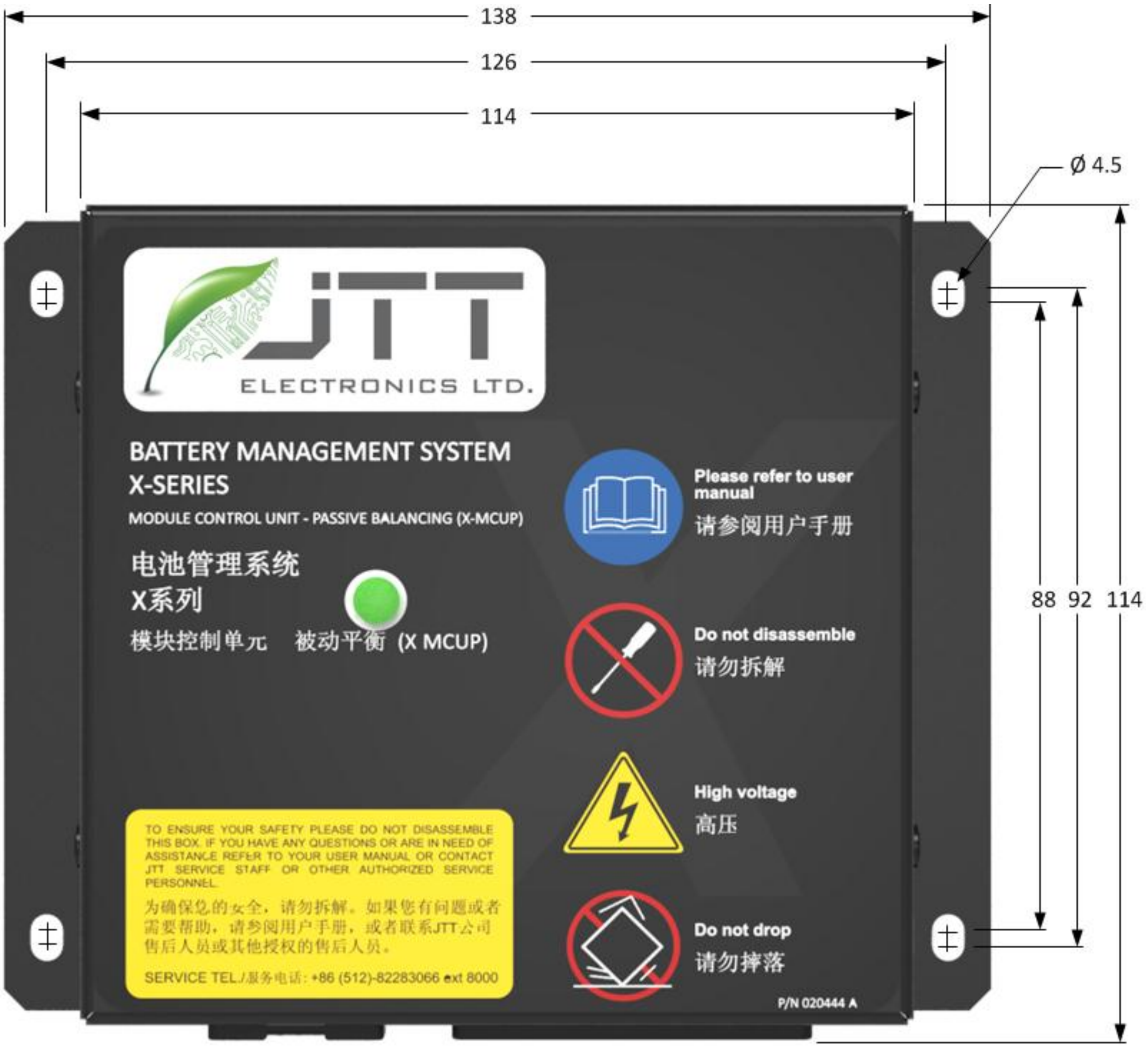


Plug

Wire insulation must be 0.95 - 1.7 mm diameter.

Pin	Tag	AWG	Description
1	Cell 6	22	Cell 6 Positive Terminal Voltage Input
2	Cell 7	22	Cell 7 Positive Terminal Voltage Input
3	Cell 8	22	Cell 8 Positive Terminal Voltage Input
4	Cell 9	22	Cell 9 Positive Terminal Voltage Input
5	Cell 10	22	Cell 10 Positive Terminal Voltage Input
6	Cell 11	22	Cell 11 Positive Terminal Voltage Input
7	Cell 12	22	Cell 12 Positive Terminal Voltage Input
8	N/C	22	
9	TS1	22	Return for temperature sensor 1
10	TS2	22	Return for temperature sensor 2
11	TS3	22	Return for temperature sensor 3
12	TS4	22	Return for temperature sensor 4
13	TS5	22	Return for temperature sensor 5
14	TS6	22	Return for temperature sensor 6
15	TS7	22	Return for temperature sensor 7
16	TS8	22	Return for temperature sensor 8
17	TS9	22	Return for temperature sensor 9
18	TS10	22	Return for temperature sensor 10
19	TS11	22	Return for temperature sensor 11
20	TS12	22	Return for temperature sensor 12
21	Cell 5	22	Cell 5 Positive Terminal Voltage Input
22	Cell 4	22	Cell 4 Positive Terminal Voltage Input
23	Cell 3	22	Cell 3 Positive Terminal Voltage Input
24	Cell 2	22	Cell 2 Positive Terminal Voltage Input
25	Cell 1	22	Cell 1 Positive Terminal Voltage Input
26	Cell 0 (Cell GND)	22	Cell Ground Input (Cell 1 Negative Terminal)
27	N/C		
28	N/C		
29	TS1_5V	22	5V supply out for temperature sensor 1
30	TS2_5V	22	5V supply out for temperature sensor 2
31	TS3_5V	22	5V supply out for temperature sensor 3
32	TS4_5V	22	5V supply out for temperature sensor 4
33	TS5_5V	22	5V supply out for temperature sensor 5
34	TS6_5V	22	5V supply out for temperature sensor 6
35	TS7_5V	22	5V supply out for temperature sensor 7
36	TS8_5V	22	5V supply out for temperature sensor 8
37	TS9_5V	22	5V supply out for temperature sensor 9
38	TS10_5V	22	5V supply out for temperature sensor 10
39	TS11_5V	22	5V supply out for temperature sensor 11
40	TS12_5V	22	5V supply out for temperature sensor 12

12 SIZE AND MOUNTING



All dimensions are in mm.

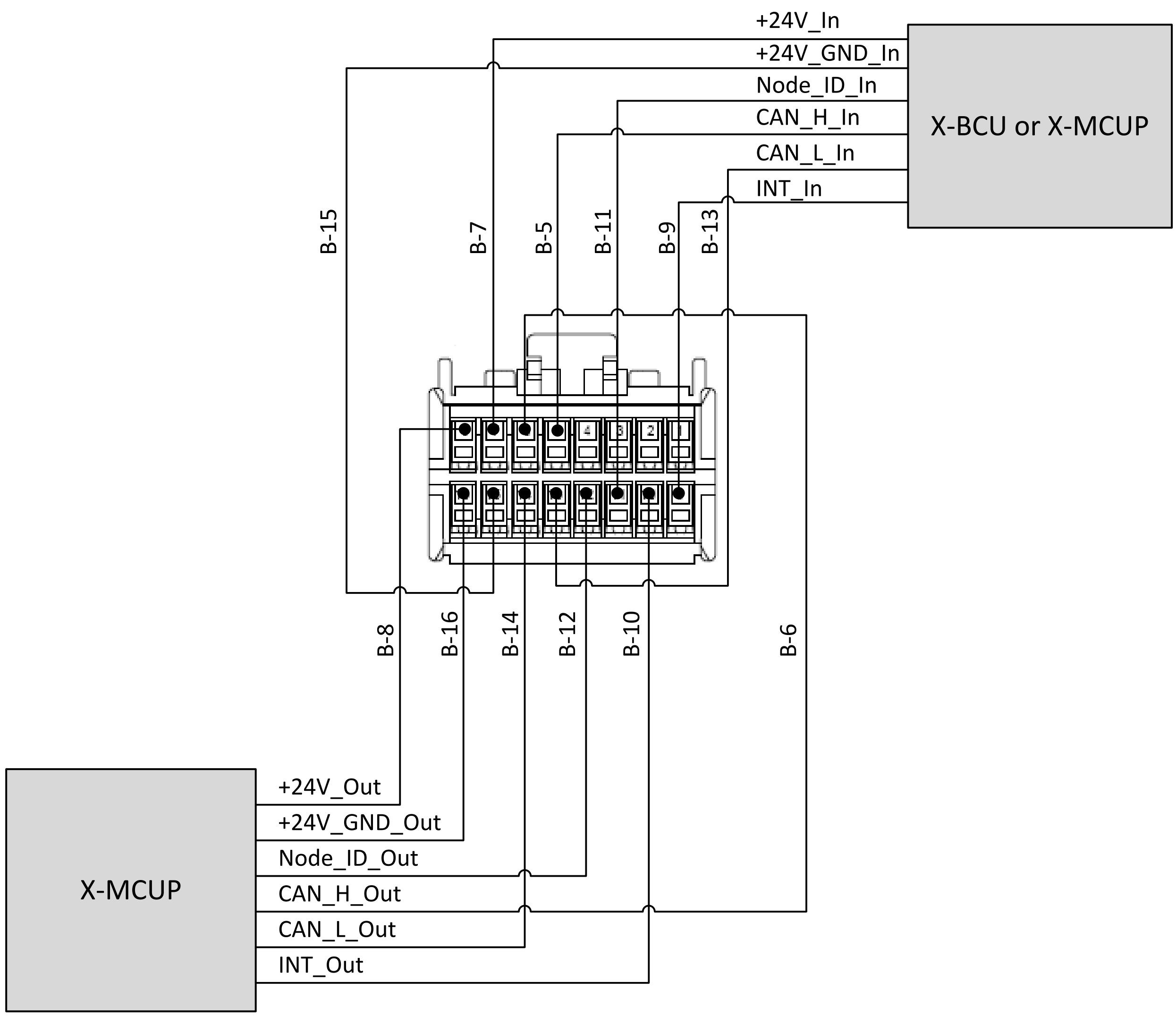
13 BMS Link – Monitor and Diagnose Your Battery Pack

- Monitor and Diagnose problems in the Battery Pack from your PC or Laptop in real time.
- BMS Link is compatible with all JTT BMS products
- The most comprehensive, battery integrated monitoring, logging and control software
- Windows (XP, 7)
- Multi-page layout for displaying battery data in numerical and graphical form.
- Cell voltages, temperatures, SOC, SOH, cell DCRs, balancing status, alarm status, battery voltage, battery current, and more available in real time.
- Service Mode available for additional data, and forcing all battery components such as fans, heaters, relays, cell balancing on and off.
- Controller identification by serial number and firmware version.
- Cell identification and tracking by serial number and cell lifetime data for warranty and troubleshooting.
- Record, save, and analyze data log files
- Updates with all cell and battery pack information every 100ms
- Alarm status information for all controllers within the battery

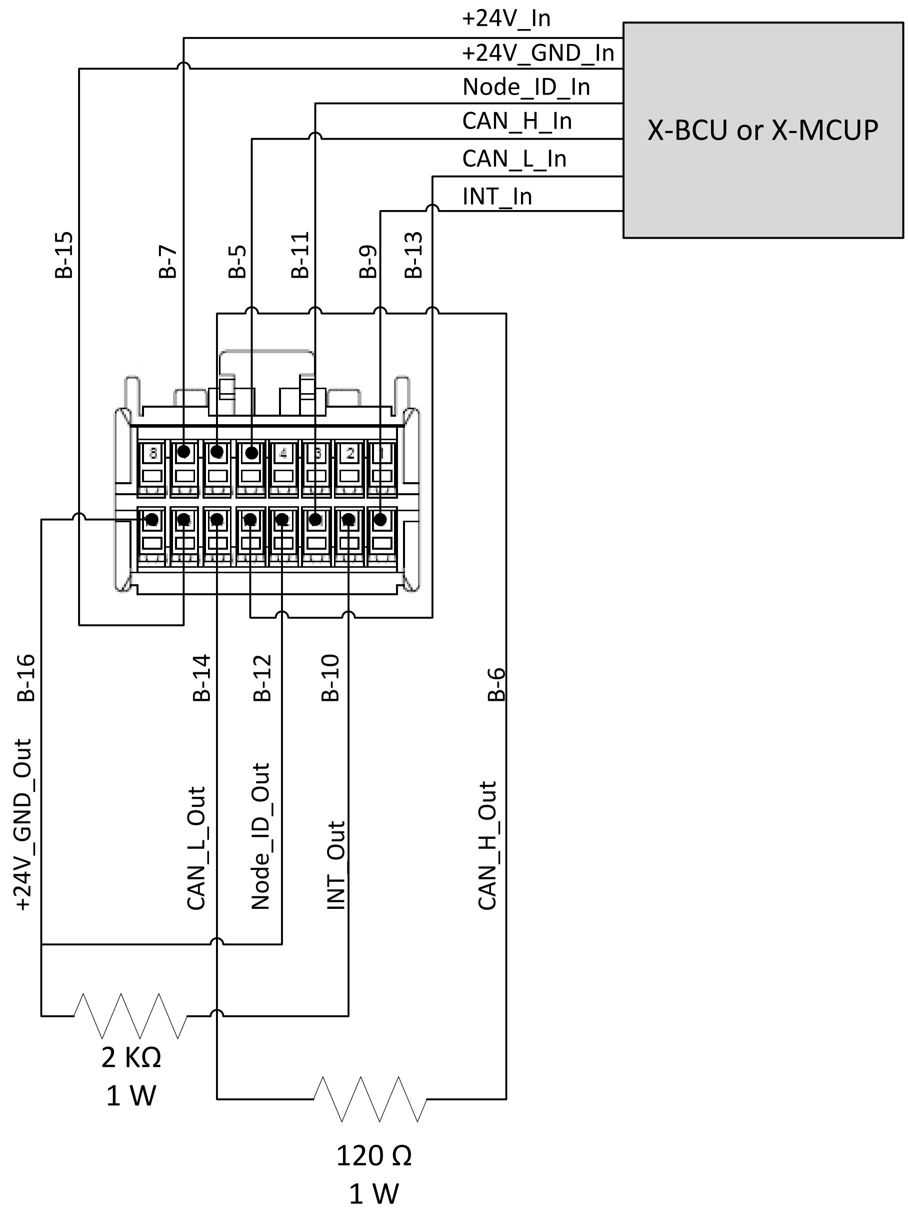
14 TYPICAL WIRING

Power and Communication

The following diagram shows the wiring for power, CAN, hardware interlock, and CAN node ID in and out of the X-MCUP. The In connections come from an X-BCU or another X-MCUP, and the Out connections either go to another X-MCUP or are terminated when the controller is the last one in the daisy chain as in the two pictures below. Please see the X-BCU product specification document for more details on wiring and pin out of the X-BCU.



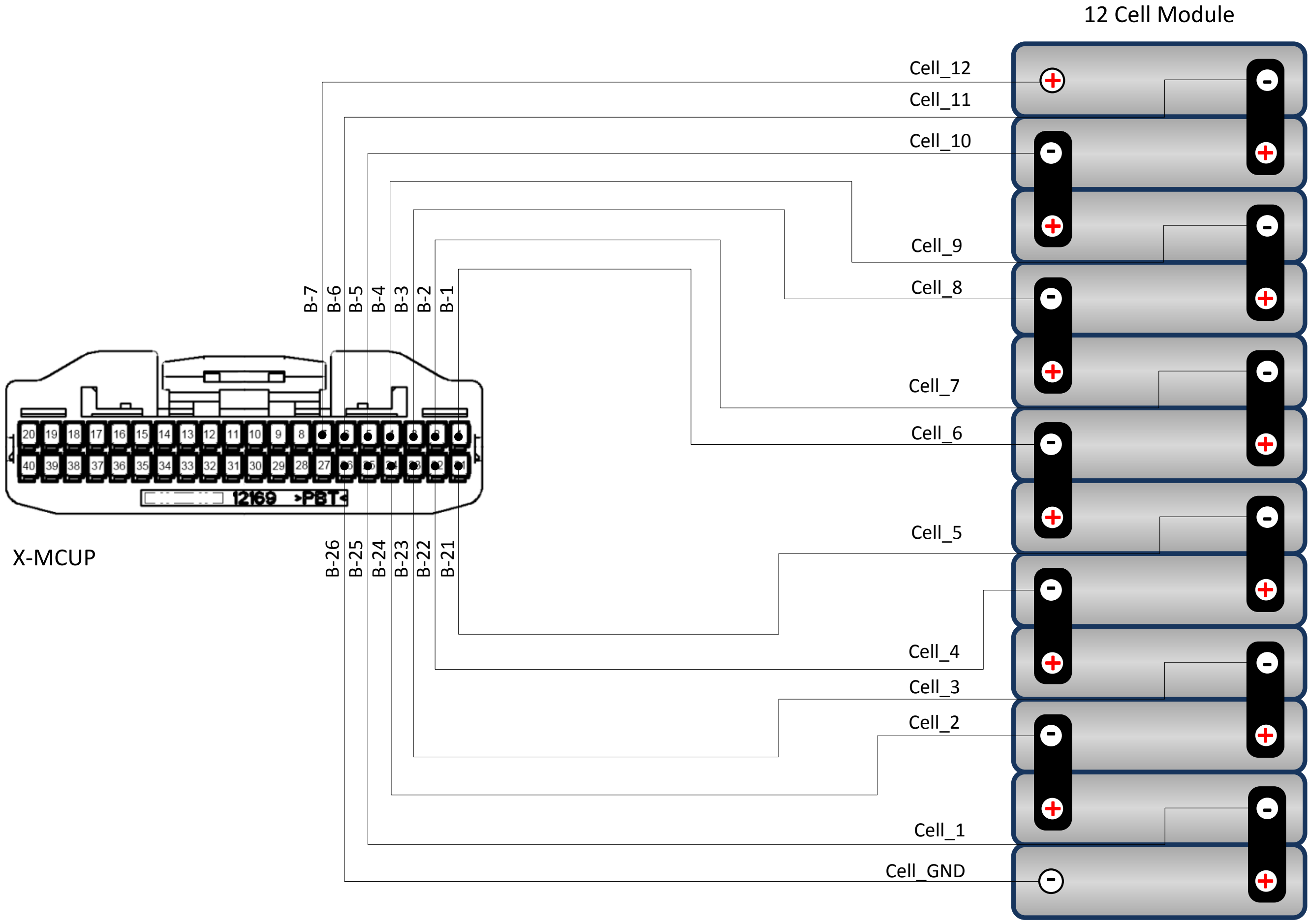
Power and Communication Wiring



Power and Communication Termination Wiring

Cell Voltage Wiring

The following is an example of how the cell voltage wiring is done with 10 cells in series.

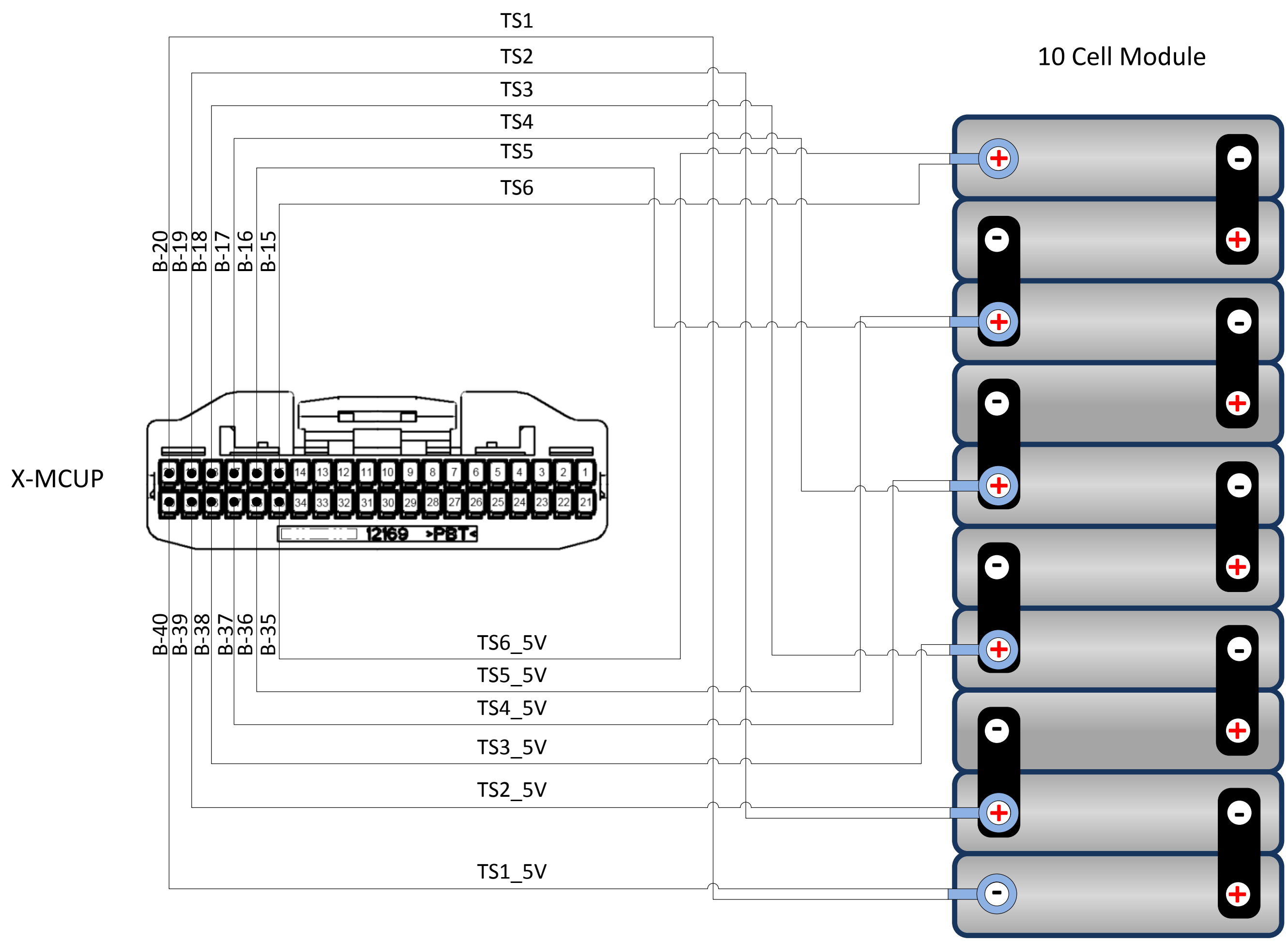


Cell Voltage Wiring

Note: All cell voltage sensing wires should have a voltage rating higher than the maximum battery voltage.

Temperature Sensor Wiring

Temperature sensors can be mounted to the packaging or body of the cell, to cell terminals, or cell bus bars. The following is a wiring example of where 6 temperature sensors are mounted to cell terminals in a 10 cell module.



Temperature Sensor Wiring