



FTF 2016
TECHNOLOGY FORUM

BATTERY MANAGEMENT SOLUTIONS

FTF-AUT-N1822

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PUBLIC USE



AGENDA

- BMS market overview
- NXP's BMS portfolio
- BMS solutions for automotive
- BMS solutions for industrial
- Enablement



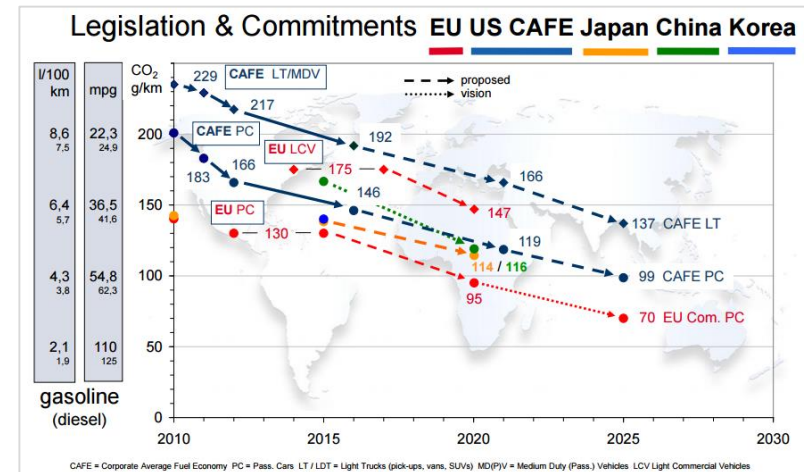
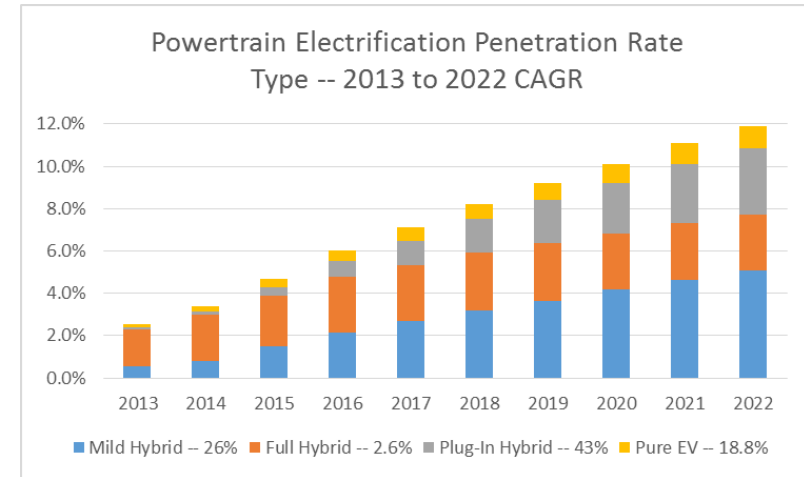
BMS Market



Profitable Growth Strategy – Battery Management Systems

Growing SAM, Market Share; Expanding Content Integration

- Growth drivers car electrification megatrend
 - Mandates for CO2 emission reduction & fuel efficiency
 - Diesel not viewed as clean & viable for CO2 reduction
- SAM growth
 - BCC for power train electrification and renewable energy adoption
 - 14 V BCC as Li-Ion replaces lead acid for car's main battery function
 - Lead acid battery sensor as start/stop function adoption increases for reduced emissions
- Key market sub-segments
 - Battery sensors: for 12 V Lead-Acid, 14 V Li-Ion batteries
 - Battery cell controllers: for 14 V, 48 V & HV Li-Ion batteries



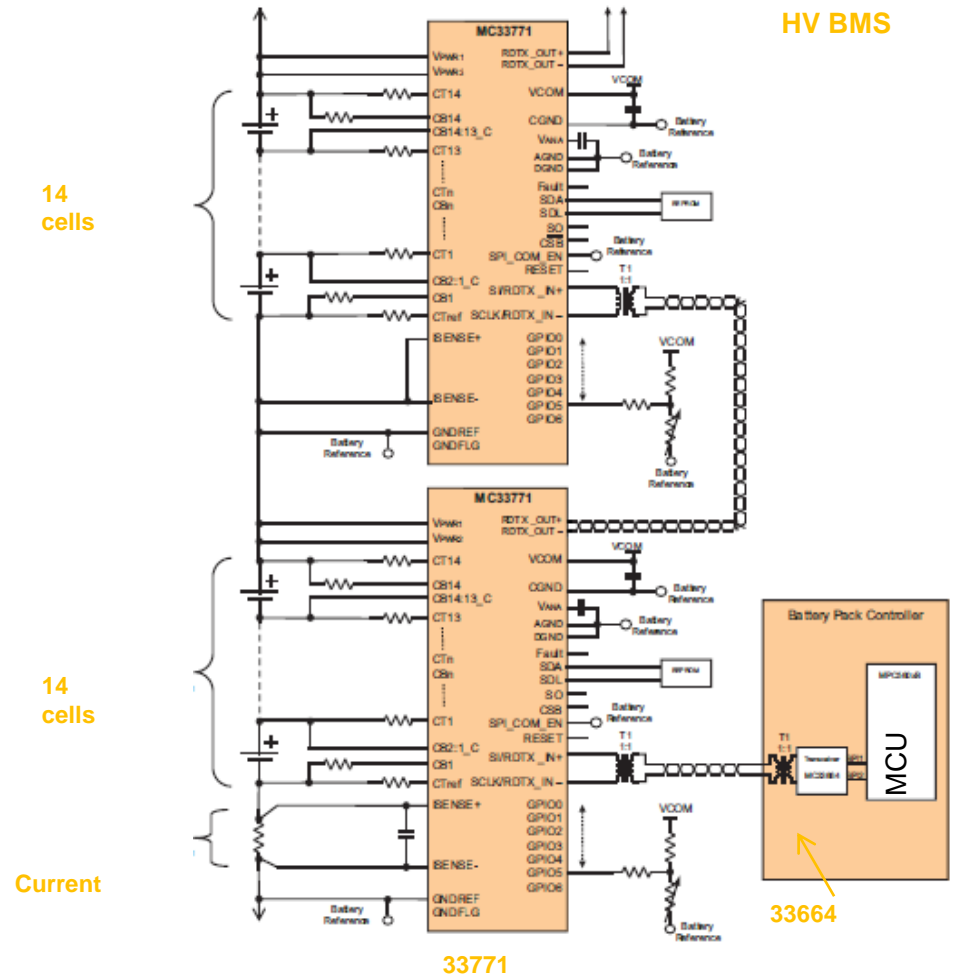
NXP's BMS Portfolio



MC3377x / MC33664 – Li-ion Battery Cell Controller Solution

Differentiating Points

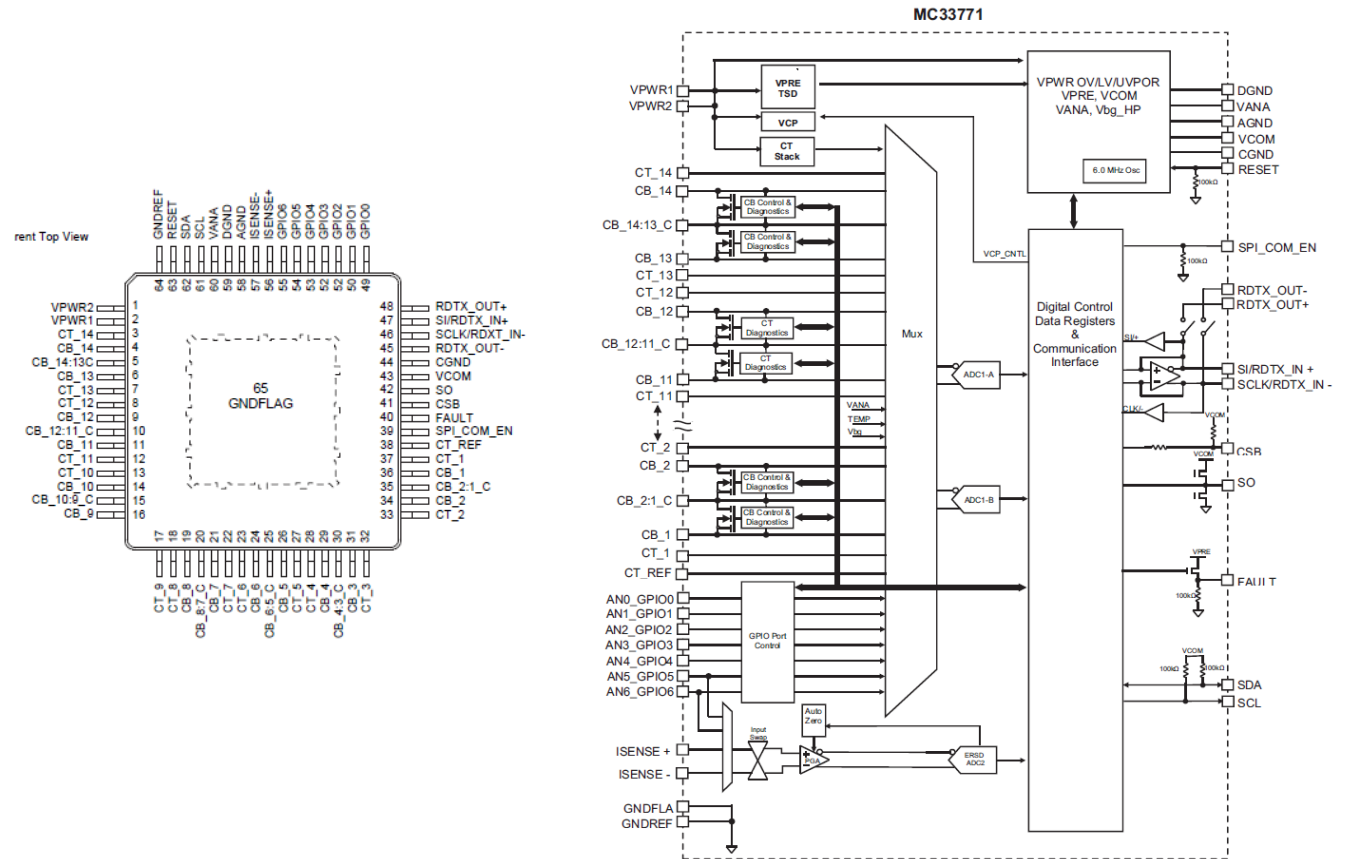
- **Battery Topology Flexibility**
 - Scalable SW & HW solution - 4 to 96 cells batteries
 - Supports centralized, distributed daisy chain, distributed CAN
- **High Integration**
 - Power supply
 - Current sensor (+/-1200A,) 0.5% accuracy with Coulomb Counter
 - Multiple programmable wake-up modes
 - MC33771: One Chip AFE for 48 V Li-ion BMS,
 - MC33772 : One Chip AFE for 14 V Li-Ion BMS
- **Fast Data acquisition and communication to pack controller**
 - 3.6 ms for pack controller to acquire conversions for 96 cells
 - Cell voltages & currents within same daisy chain measured within 100us
- **Superior Daisy Chain communication**
 - 2 Mbps comms speed, 100% differential, programmable address, bus wake-up
 - 3750 V Isolation with AEC-Q200 qualified external transformers
 - Automatic termination resistors, common mode noise immunity,
 - Receiver BCI tested (>200 mA)
- **System Diagnostics and functional safety supporting ISO26262 w/ single chip**
- **Automotive robustness: ESD, EMC, Hot Plug, AEC-Q 100**



MC33771 – 14 Cell Battery Cell Controller AFE

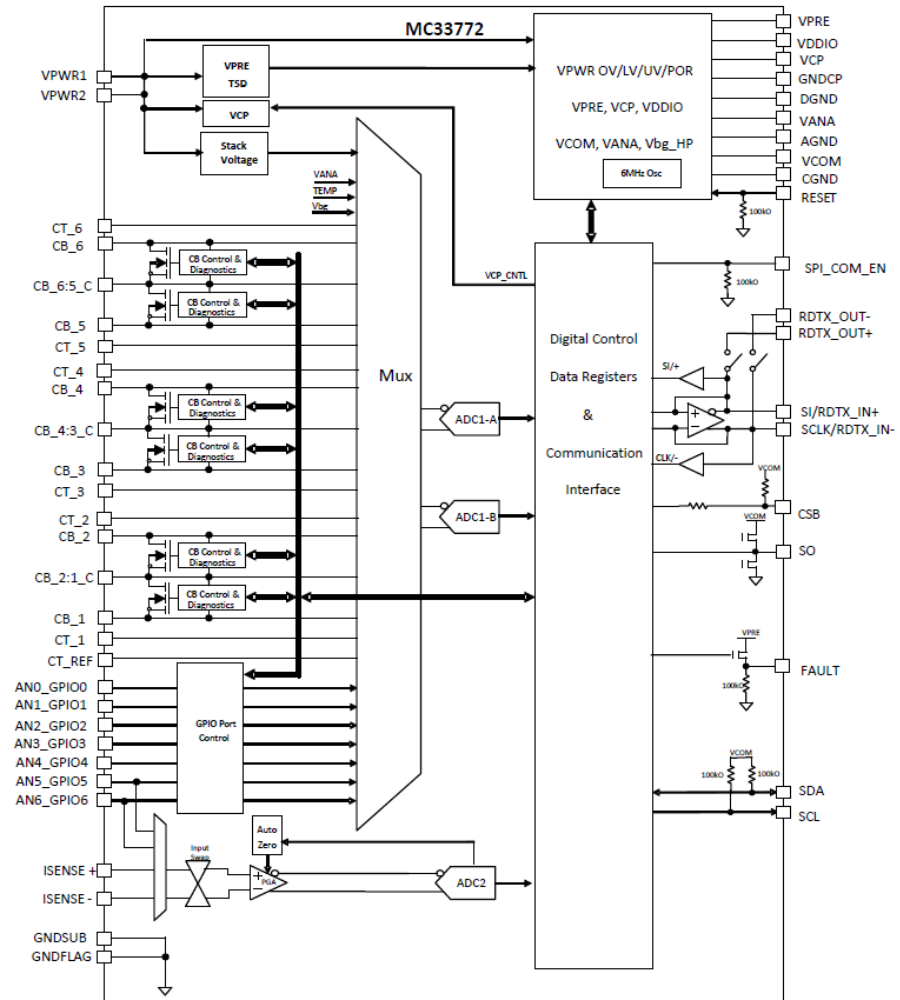
Features:

- $9.6\text{ V} \leq \text{VPWR} \leq 61.6\text{ V}$ operation, 70 V transient
- SPI or isolated 2 MHz differential communication
- 14 cell voltage measurement channels
- Total stack voltage measurement
- Current sensor with $\pm 0.5\%$ accuracy from milliamps to kiloamps
- Coulomb counter (also in low-power mode)
- 7 ADC/GPIO/temperature sensor inputs
- Addressable on initialization
- 5.0 V @ 5 mA reference supply output
- Integrated Sleep Mode over/under voltage & temperature monitoring
- Over/under voltage, over/under temperature Fault verification
- 14 Onboard 300mA passive cell balancing with diagnostics
- Open cell terminal detection
- Internal diagnostics
- Hot plug capable
- Low power modes of operation



MC33772 – 6 Cell Battery Cell Controller AFE

- Operating voltage:
 - $5\text{ V} \leq \text{VPWR} \leq 30\text{ V}$ operation, 42 V transient (for SPI communication)
 - $7\text{ V} \leq \text{VPWR} \leq 30\text{ V}$ operation, 42V transient (for TPL communication)
- SPI ori2 MHz differential communication
- 6/4 cell voltage measurement channels
- Total stack voltage measurement
- Current sensor with $\pm 0.5\%$ accuracy from mA to kA
- Coulomb counter (also in Low-power mode)
- ADC/GPIO/temperature sensor inputs
- Addressable on initialization
- 5.0 V @ 5mA reference supply output
- Integrated sleep mode over/under voltage & temperature monitoring
- Over/under voltage, over/under temperature fault verification
- Onboard passive cell balancing with diagnostics and balancing timers
- Open cell terminal detection
- Internal diagnostics
- Hot plug capable
- Operational low power mode
- 48-LEAD LQFP-EP or 64-LEAD LQFP-EP
- Temp range: -40°C to 125°C
- AEC-Q100 automotive qualified
- EMC/ESD robustness

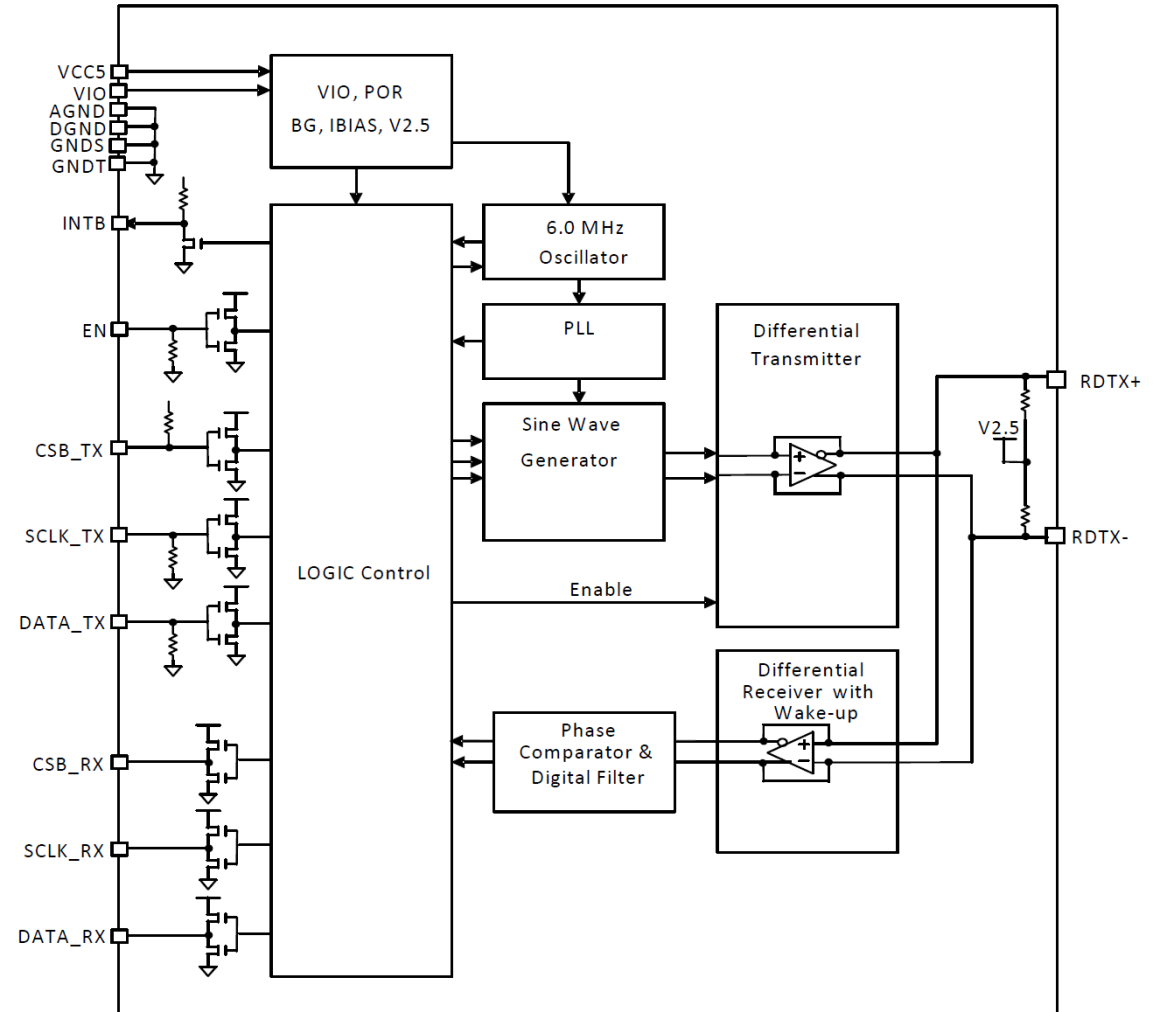
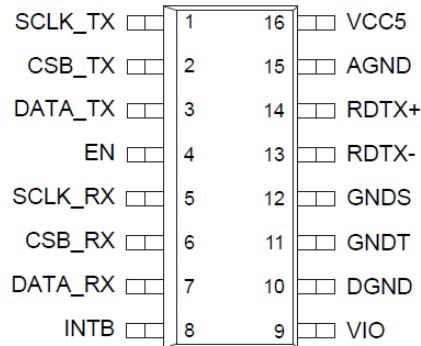


Information subject to change

MC33664ATL Transformer Physical Layer

Features

- 2 Mbps isolated network communication rate
- Dual SPI architecture for message confirmation
- Robust conducted and radiated immunity with wake-up
- 3.3 V and 5.0 V compatible logic thresholds
- Engineered for 5 meter, 15 node system
- Low current sleep mode with automatic wake-up
- Sine wave transmission for low radiated emission



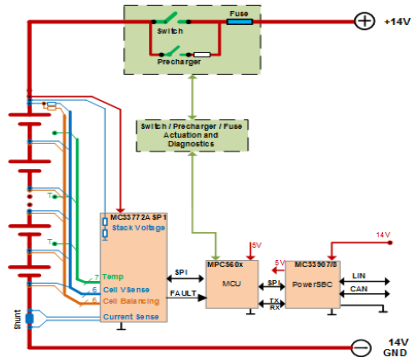
BMS Solutions for Automotive



NXP's Battery Management Solutions

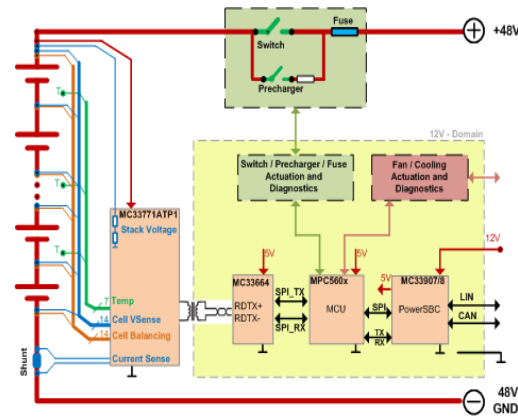
14 V Li-Ion BMS Chipset

MC33772ATP1, MPC5607B, MC33907/8 SBC



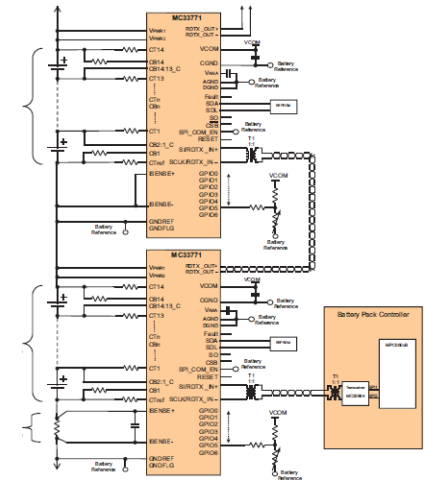
48 V Li-Ion BMS Chipset

MC33771ATP1, MC33664ATL1, MPC5607P, MC33907/8 SBC

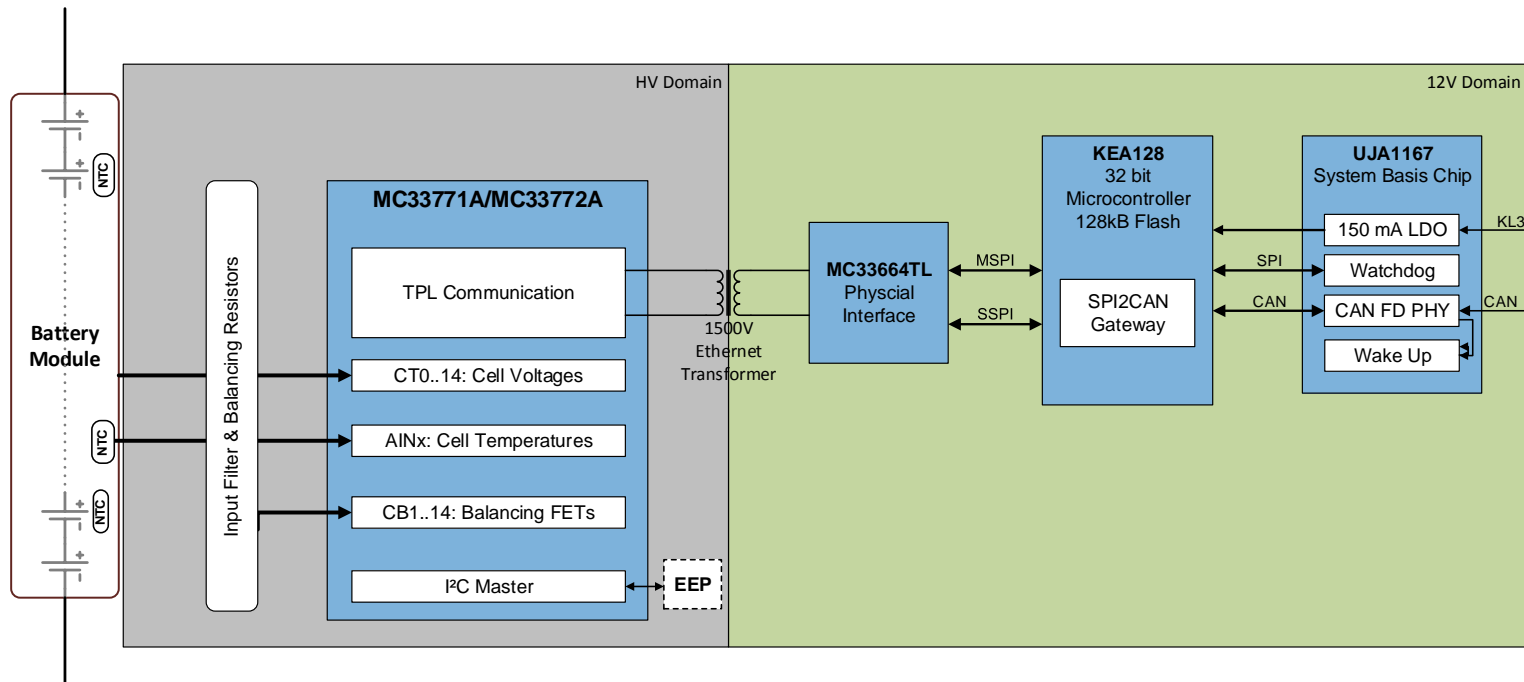


HV BMS Chipset

MC33771ATP1, MC33664ATL1, MPC5607P, MC33907/8 SBC

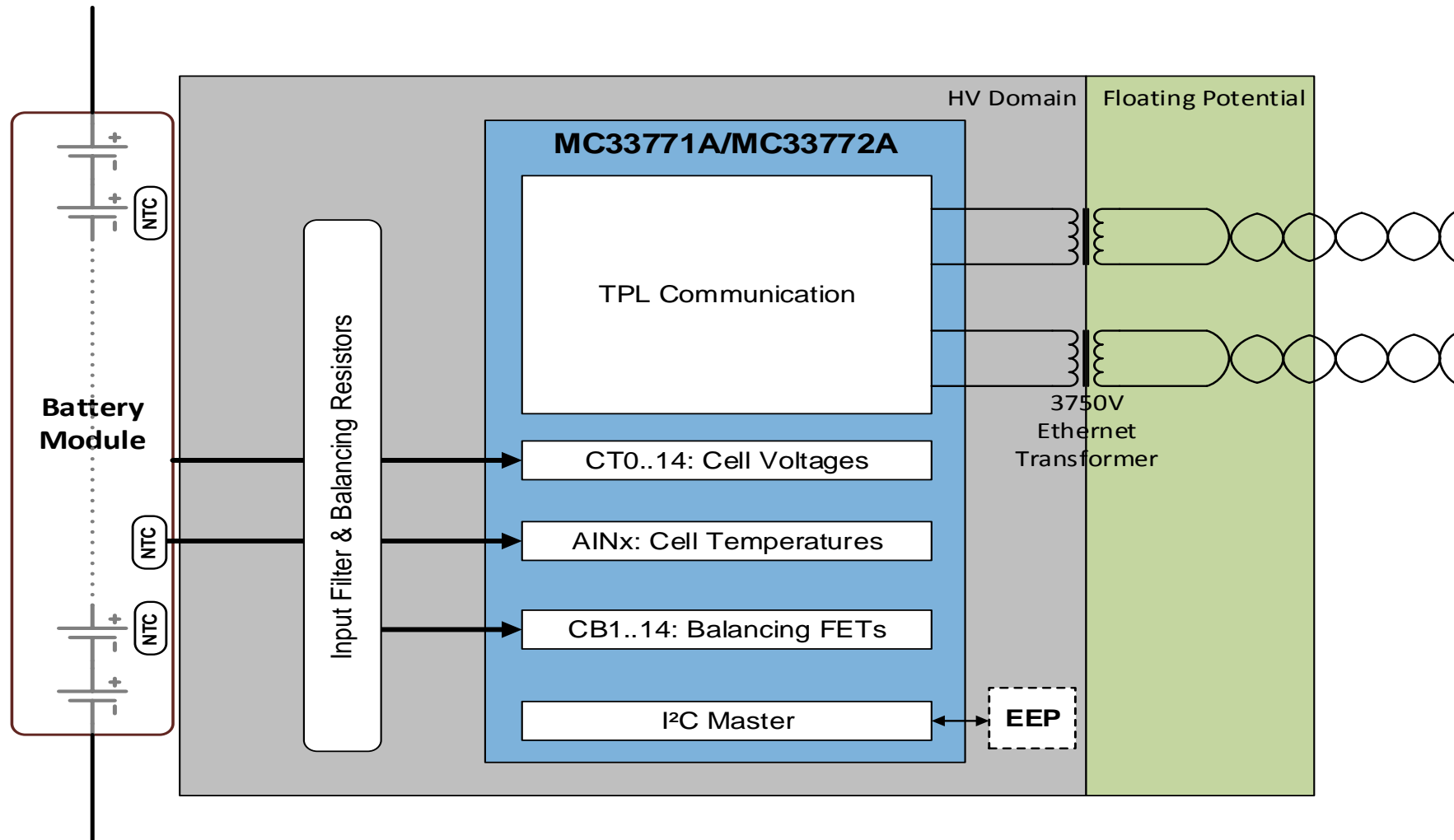


Typical HVBMS (CAN) Application

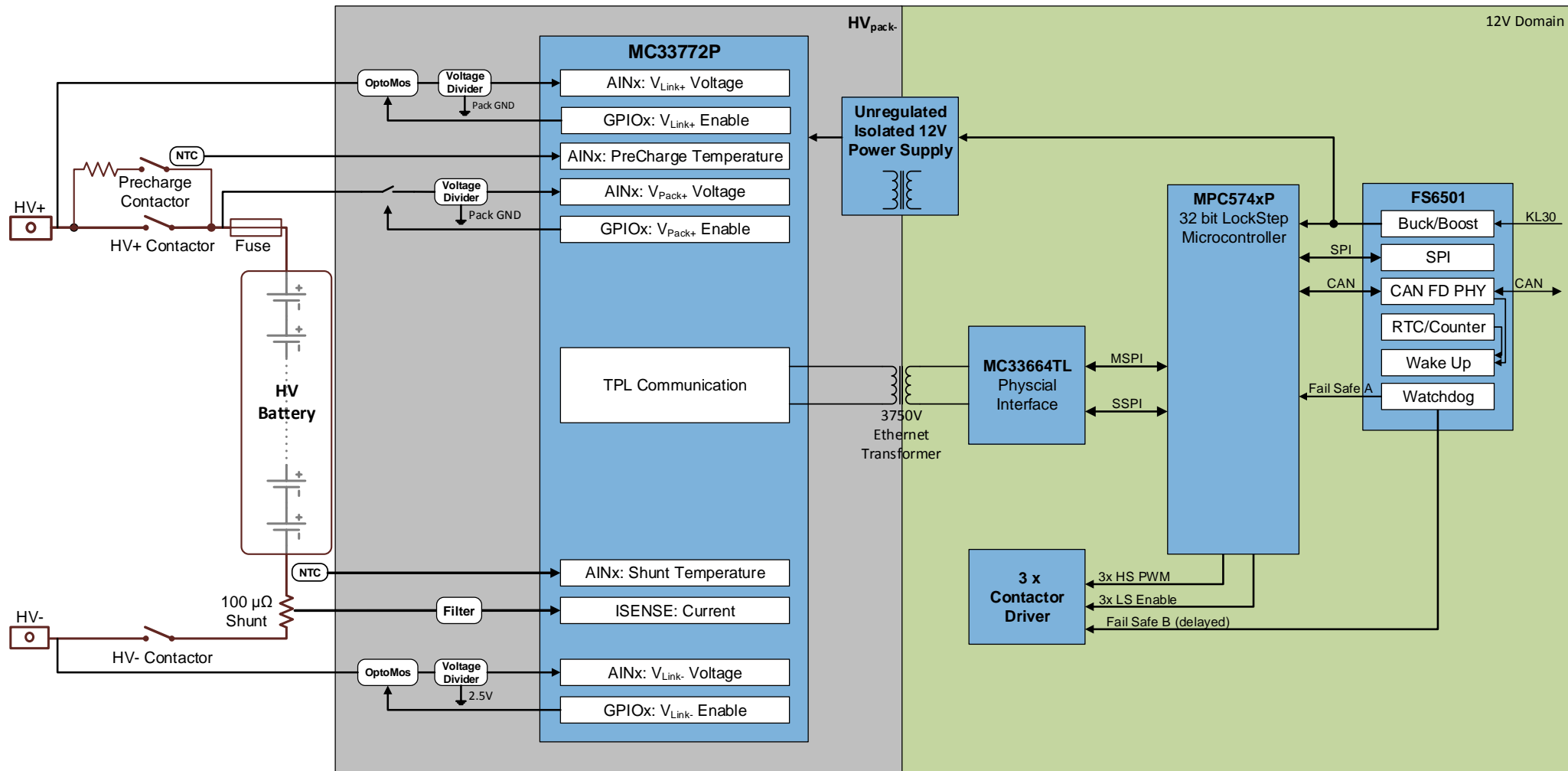


		MC33771	MC33772
Operating Voltage	(SPL)	9.6 V ... 61.6 V	5 V ... 30 V
	(TPL)	9.6 V ... 61.6 V	7 V ... 30 V
Transient Voltage		70 V	42 V
Power supply		Integrated	Integrated
# Cell Voltages (2mV)		14	6
# Balancing FETs (300mA)		14	6
# Balancing timers (up to 8hrs)		14	6
# Current Sensor w/ PGA		1	1
# Coulomb Counter		1	1
# Temperature Inputs /GPIOs		7	7
Package		64 LQFP-EP	48 LQFP-EP

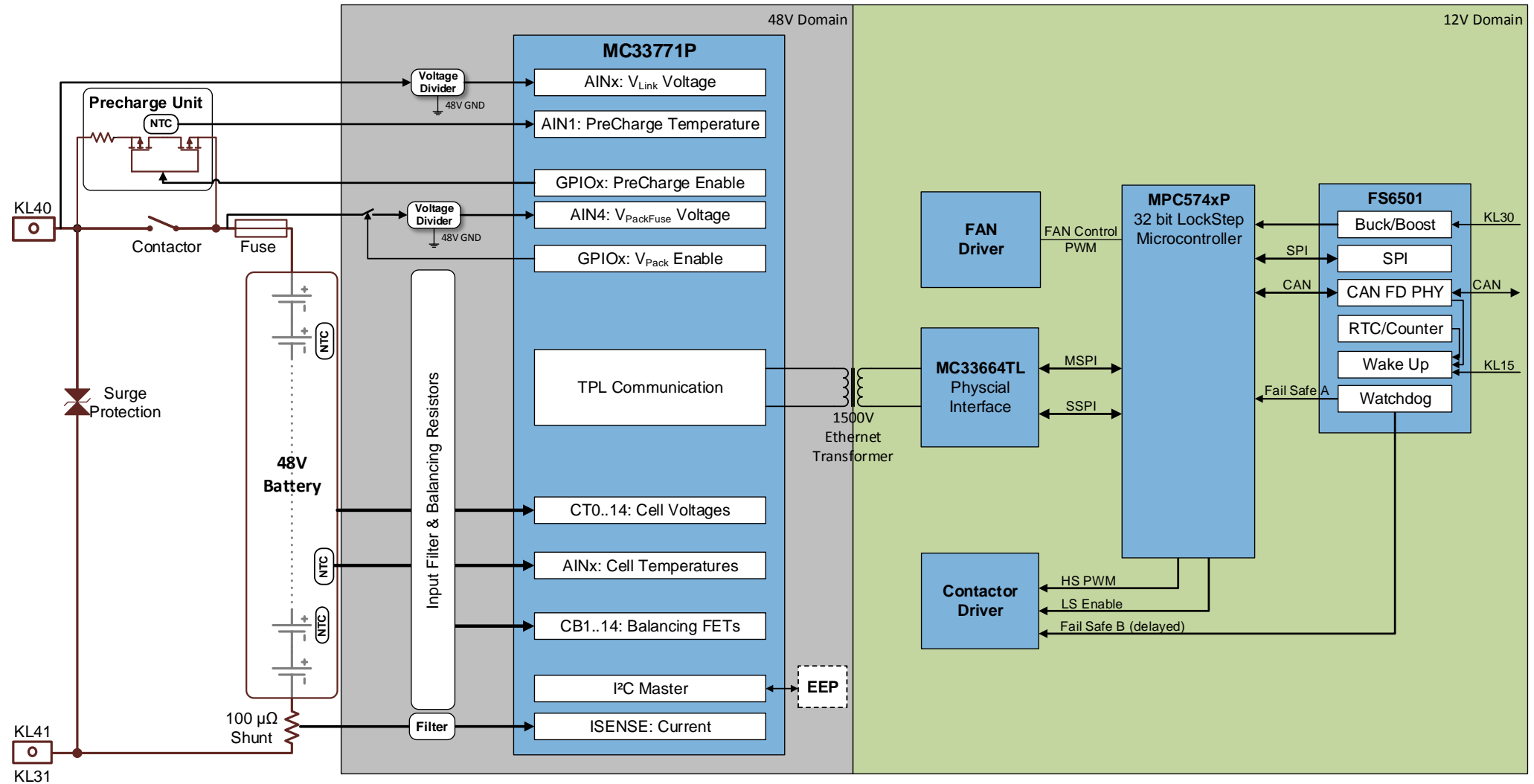
Typical HV Battery Cell Supervising Circuit (TPL)



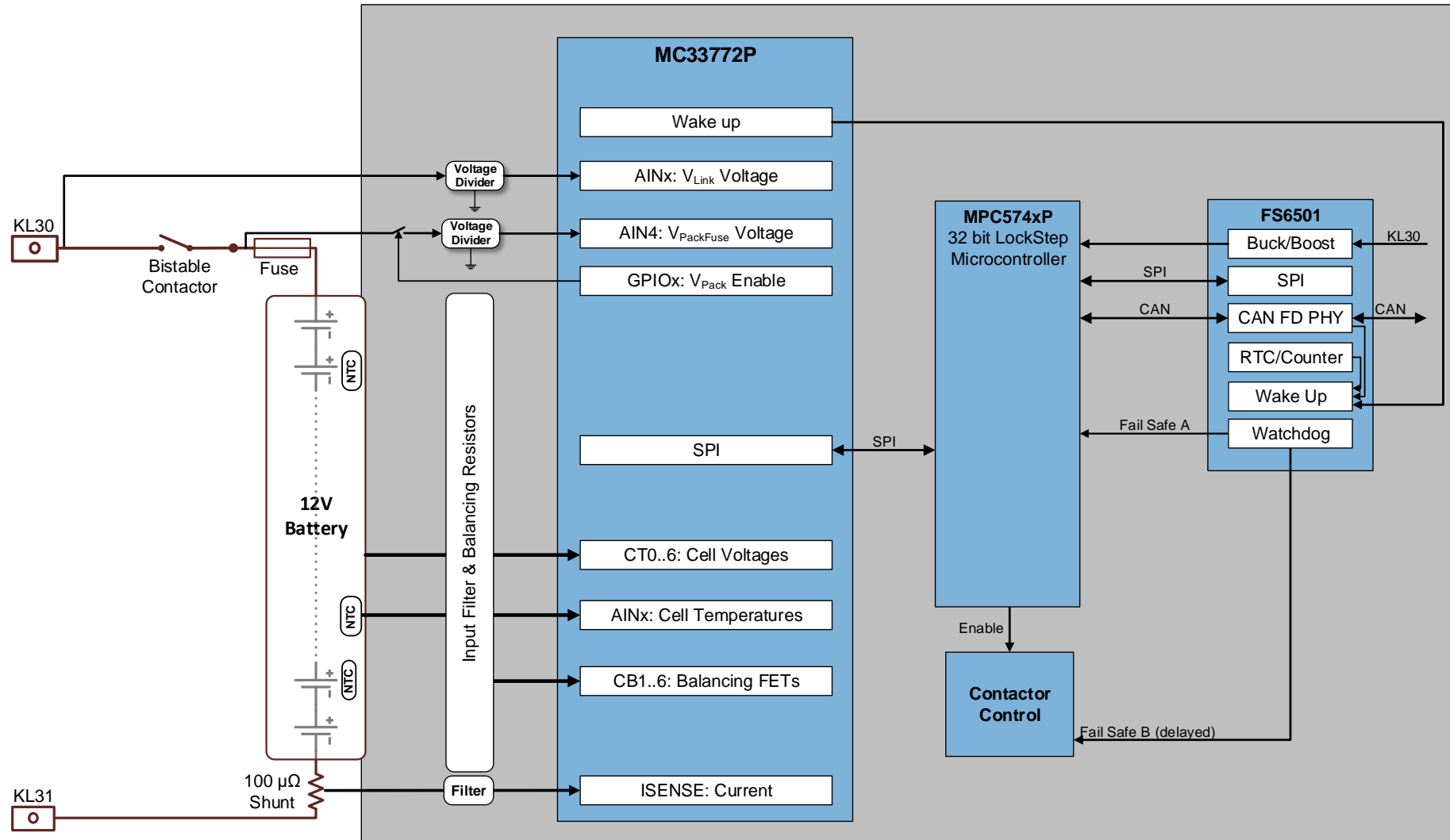
Typical HV Battery Switch Box Controller



Typical 48 V Li-Ion BMS Application



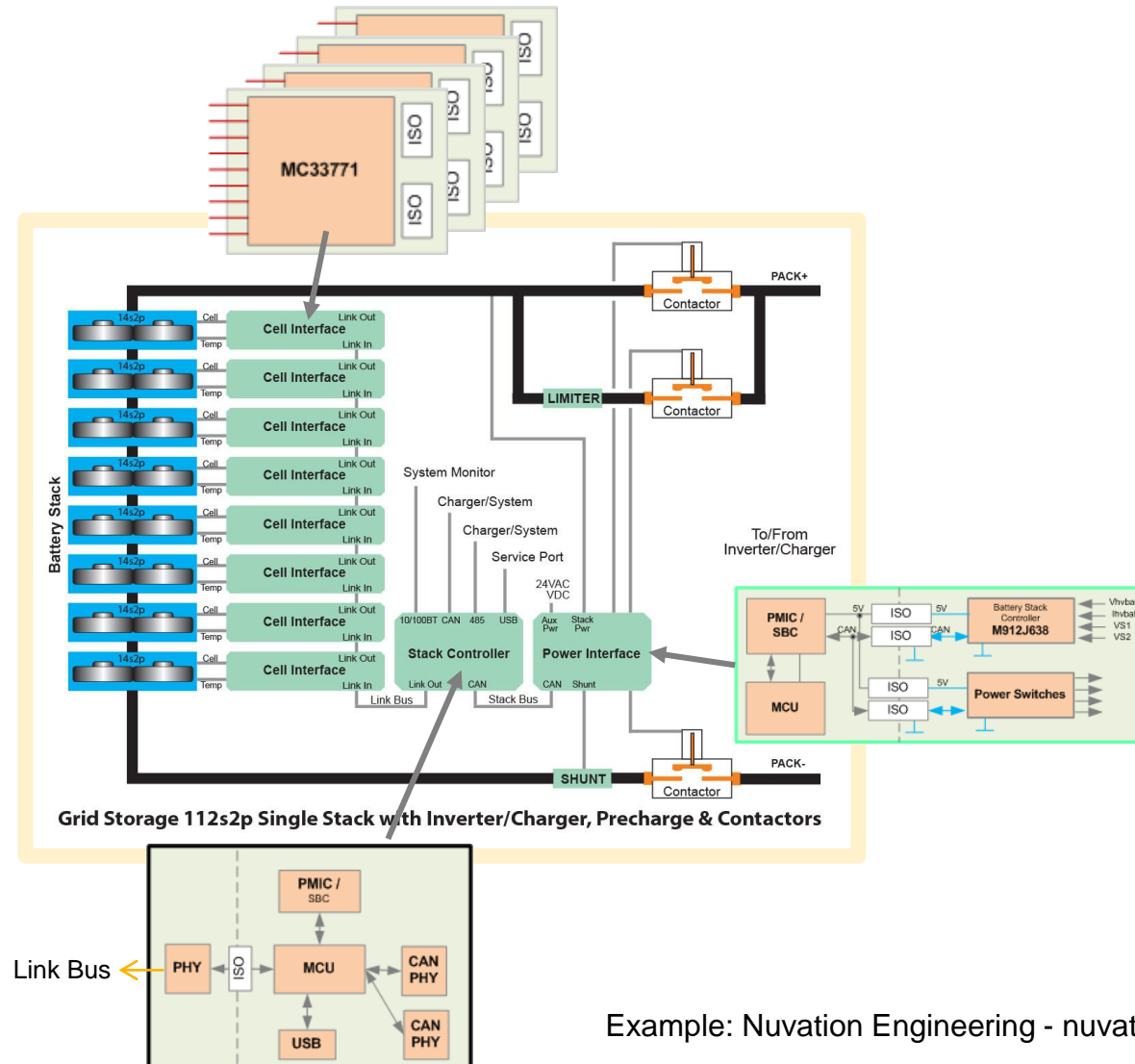
Typical 14 V Li-Ion BMS Application



BMS Solutions for Industrial

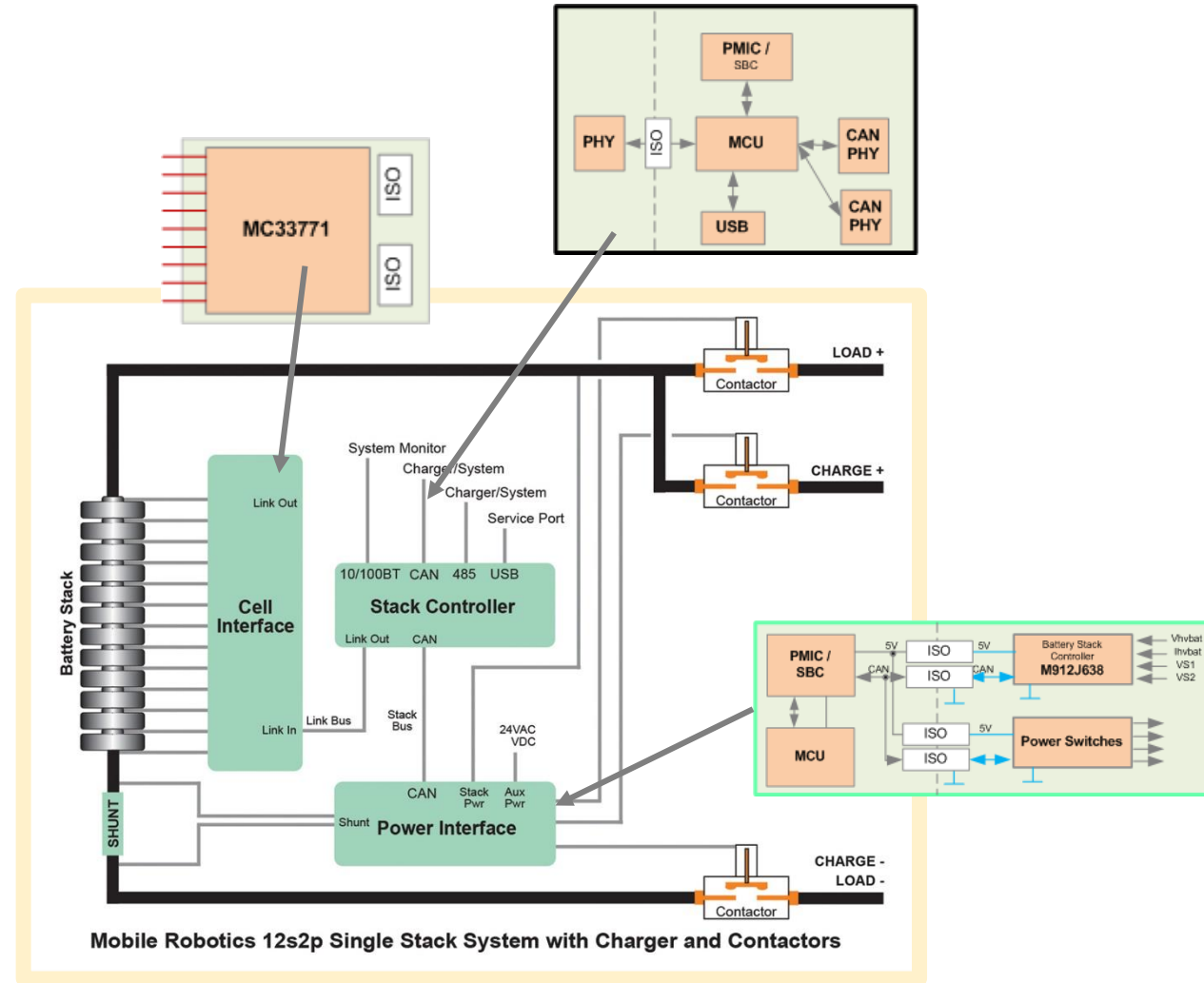


A Typical BMS For Grid Energy Storage Systems



Example: Nuvation Engineering - nuvationbms.com

A Typical BMS for Mobile Robotics



Example: Nuvation Engineering - nuvationbms.com

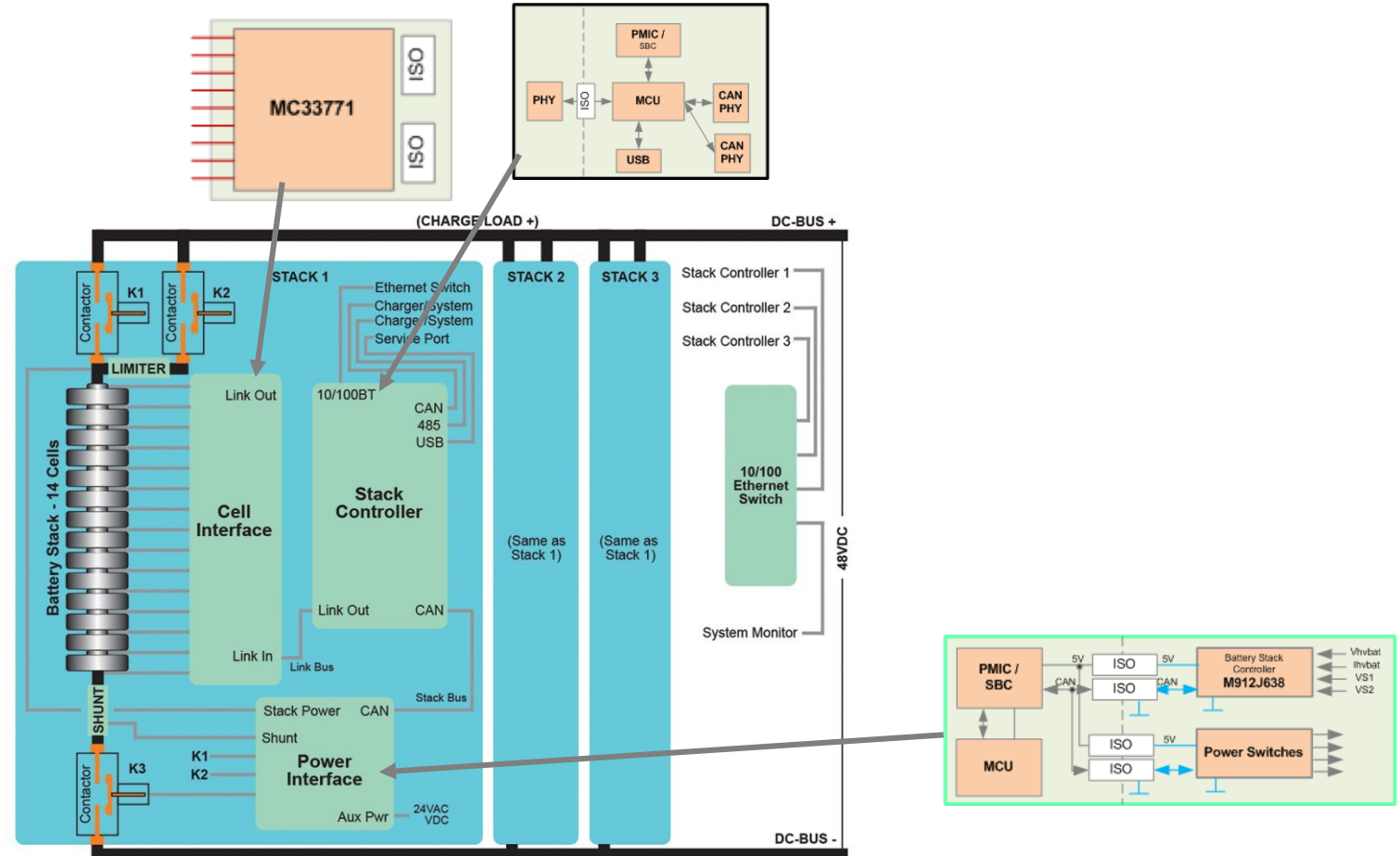
Amazon: Wheeled Robot (Kiva)

- A Kiva robot drive unit is seen, foreground, before it moves under a stack of merchandise pods, seen on a tour of one of Amazon's newest distribution centers in Tracy, California. This Amazon Fulfillment Center opened in 2013 and was refitted to use new robot technology in the summer of 2014. All year Amazon has been investing in ways to make shipping faster and easier to prepare for this holiday season. At this Northern California warehouse the company is employing robotics and other new technology to help workers process the annual onslaught of shopping orders.



A Typical BMS for 48 VDC

Telecommunications Power Back-up Systems



Telecom Backup 3 Stack 14s1p 48VDC System with Charger and Contactors

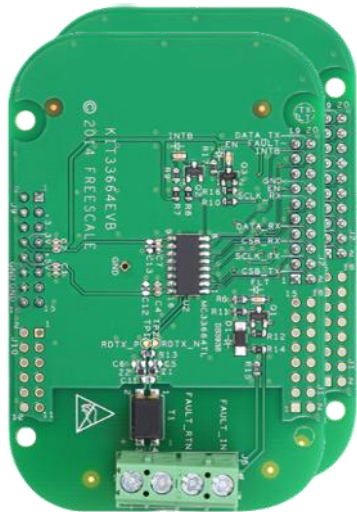
Example: Nuvation Engineering - nuvationbms.com

Enablement



Battery Cell Controller Evaluation Boards

MC33664 Evaluation Kit

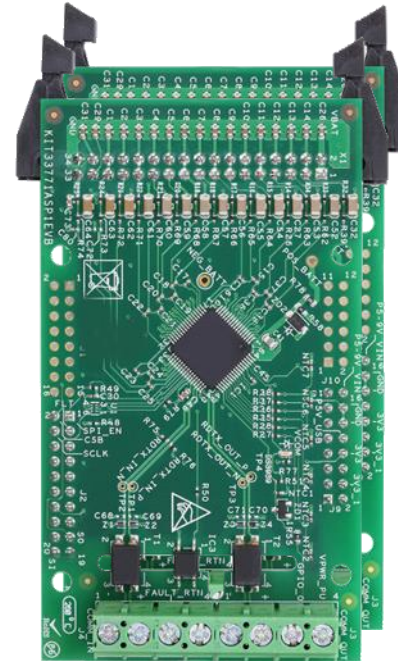


**Freedom Board
with MC33664**



**MC33771 Evaluation Kits
(14 cell)**

- For TPL Communication
- For SPI Communication



**MC33772 Evaluation Kits
(6 Cell)**

- For TPL Communication
- For SPI Communication



Battery Pack Evaluation Boards

14-Cell AA Battery Pack
(compatible with 6-Cell)



14-Cell AAA Battery Pack
(compatible with 6-Cell)



14-Cell slider emulator
(compatible with 6-Cell)



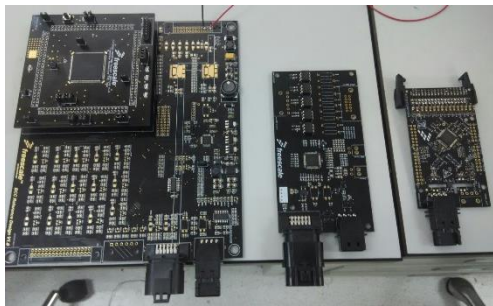
14-Cell Isolated Pack emulator
(in Development)



Battery Cell Controllers Reference Designs

High Voltage Battery Pack Controller

- Full featured Hardware + Software set
- Complete system with Microcontroller + PowerSBC + BCC + TPL
- Easily scalable from 1 to 15 MC33771 devices
- Configurable MC33771 communication: SPI or TPL
- Supports PowerPC and Kinetis uC families
- Easy microcontroller swap through uC daughtercard
- Supports CAN communication with Master ECU



Electric Bike Pack

- 36 V – 10-cell pack – 1 BCC14
- Kinetis KE06
- Charging control
- Monitors voltage, current, temperature
- Passive cell balancing
- Estimation of SOC, SOH
- Communication with LIN, CAN

(under development)



14 V Li-Ion Auto Battery

- 14 V – 6-cell pack – 1xBCC6
- Safety features

(under planning)



Centralized High Voltage Battery Pack Controller

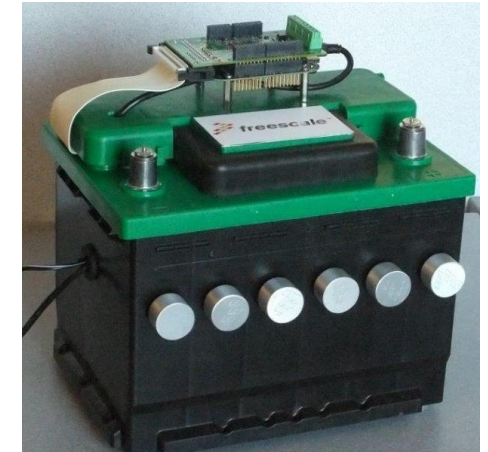
- 98 Cell pack controller – 7xBCC14
- Centralized system
- Micro controller
- Safety features



Battery Cell Controller Demos



Safety Demo With Fault Injection



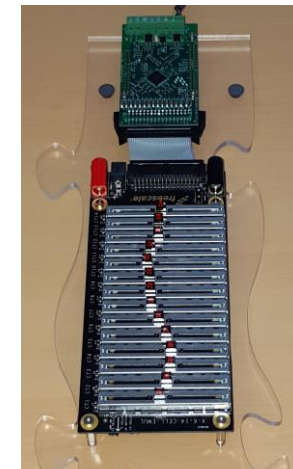
14 V Lilon Auto Battery



SWT Truck BCC14 Demo



CEAC Dual BCC14 Demo



BCC6 Demo



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