Agenda

• Introduction
• Why BMS?
• Wired Systems
• BMS devices
• Wireless devices
• Wireless BMS system
NXP is Global #1 in Auto Semiconductors
With Secure End-to-end Hardware and Software Solutions

Technology Leadership + Applications Focus = #1 in Auto Semiconductors

#1 Auto Analog / RF / DSP
#1 Auto Microcontrollers (ex. Japan)
#1 Merchant Auto MEMS Sensors

#1 Car Infotainment
#1 Secure Car Access
#1 Body & In-Vehicle Networking
#1 Safety
#1 Powertrain

Innovation Leader ADAS
Innovation Leader Security

2017 Global Auto Semi Market: $34.5B
Automotive Global Megatrends
Driving the need for next generation silicon capabilities

Autonomy

Electrification

Connectivity

Safe and Secure Mobility / Zero Emissions
Automotive Battery Management Applications

- **Start-Stop**
  - 12V Pb Battery

- **Advanced Start-Stop**
  - 14V Li-ion Battery

- **48V Mild Hybrid**
  - 48V Li-ion Battery

- **EV/PHEV**
  - High Voltage Li-ion Battery

Level of Electrification

- CO2 -20%
- CO2 -100%
Vehicle Electrification Forecasts

Cars with High Voltage Electrification (HEV/EV)

- WW Full & Plug-in Hybrid / Full EV
  - 9-16 Mu in 2023
  - 14-26 Mu in 2026

Cars with Low Voltage Electrification

- WW Hybrid 48V
  - 12-14 Mu in 2026
- WW Hybrid 12V+12V
  - 10 Mu in 2026

Source: Strategy Analytics (2016)  Does not include vehicles with Start / Stop system.

- Bosch 12V Reku (Dual Battery)
- Bosch 48 V
- Valeo 12V Reku (Dual Battery)
- Valeo 48 V
- Conti 48 V
- Customer 1 12V
- Customer 2 12V
- Customer 3 48V
- Customer 1 48V
- Customer 2 48V

Production (K Mu)

- 2016 to 2028

Does not include vehicles with Start / Stop system.

11 Mu
Electrification Drivers

- Rising cost of complying with emissions regulations
- The falling cost of batteries
Lithium-Ion Batteries Performance

- **Common rechargeable batteries**
  - Lead-acid
  - NiCd
  - NiMH
  - Li-ion

- **Li-ion offers best general performance**

- **Rapidly growing volume of Li-ion:**
  - Significant drop in cell cost
    (10~14% per year till 2020) (JP Morgan & Morgan Stanley, June 2016)
  - Significant improvement in product maturity
Building a Li-Ion Battery Pack

- Nominal Lithium Cell Voltage = 3.6-3.8V
- Number of Cells in a Module varies by manufacturer/application
- Battery pack voltages and configurations vary by manufacturer/application

Example Battery Module
14 cells x 3.6V = 50.4 V

Example Battery Pack
8 modules x 50.4 V = 403 V

14 cells/module * 8 modules = 112 cells
Why Battery Management?

Design flaws led to 2013 lithium-ion battery fire in Boeing 787: U.S. NTSB

Samsung Galaxy Note 7 banned by more airlines over fire risk

Hoverboards recalled for fire and explosion risks — again

Faulty MacBook Pro Batteries Face FAA No-Fly Rule

Hazard to be mitigated is thermal runaway!
Why Battery Management?

The purpose of BMS is to:

- Provide Battery Module / Battery Pack **SAFETY** and **LONGEVITY**. *(Required for Li-ion!)*
- Provide **QUICK** and **RELIABLE** error monitoring and control. *(i.e. Over Temp, Under Temp, Over Volt, Under Volt, Over Current etc)*
- Estimate State-of-Charge (**SoC**)  
- Estimate State-of-Health (**SoH**) 
- Determine **CAPACITY** through precise **SoC** and **SoH** estimation. 
- Compensate for cell differences (Cell balancing)  
- Indicate end-of-life when the capacity falls below a target threshold.
Key BMS Functions

**Guarantee Safety**

- Over Voltage
- Under Voltage
- Cells Balanced

**Guarantee Performance**

- Guarantee
- Multi-cell Function

**Danger:**

- Over voltage
- Extra heat
- Unstable chemical stage
- Thermal runaway ->fire/explosion
- Low temperature charge

**Requirements:**

- Safe & fast charging
- Discharge optimization
- State of charge (SOC) estimation
- State of health (SOH) estimation
- V - I - T measurement
- OV / UV / OT / UT detection
- Coulomb Counting
- Synchronization
- Internal Resistance Calculation

**Challenges:**

- Up to hundreds of cells
- Manufacture mismatch
- Capacity degradation
- Lifetime degradation
- Cell balancing
Typical BMS Applications for Automotive

14V, 48V, High Voltage
Typical 12-14V Li-Ion BMS Application

4-6 cells
Typical 48V Li-Ion BMS Application
Typical Distributed High Voltage BMS Application

**BMC:**
- Safety MCU - ASIL-D
- Control System / Safety
- Safety SBC - ASIL-D
- Isolated Communications

**Battery Pack**
- Cell Monitoring Circuit (CMC)
  - Temp
  - Cell Volts
  - Cell Balance
  - Comm
- Isolated Comm

**Battery Junction Box (BJB)**
- Analog Front End
- Monitor Contactor Voltages
- Control Contactors
- Measure Current
- Isolated Communications

**CMC**
- Analog Front End
  - Measure V – T
  - Cell Balance
  - Isolated Communications

**BJB:**
- Analog Front End
- Monitor Contactor Voltages
- Control Contactors
- Measure Current
- Isolated Communications
NXP Analog Front End Solutions
MC33771, MC33772, MC33664
NXP’s Scalable Battery Management Portfolio

- Addresses all BMS Applications
- Maximizes HW/SW reuse

- Intelligent Battery Sensor (IBS)
- Battery Cell Controller (MC33772)
- Battery Cell Controller (MC33771)
- Battery Cell Controller (n x MC3377x)

Level of Electrification

Start-Stop
12V Pb Battery

Advanced Start-Stop
14V Li-ion Battery

48V Mild Hybrid
48V Li-ion Battery

EV/PHEV
High Voltage Li-ion Battery

• Addresses all BMS Applications
• Maximizes HW/SW reuse

14xV
1xI
7xT
Digital
MCU
SBC

14xV
1xI
4xT
Digital
MCU
SBC

14xV
1xI
1xT
MCUSBC

Intelligent Battery Sensor (IBS)

12V

14V

48V

12V Pb Battery
14V Li-ion Battery
48V Li-ion Battery
High Voltage Li-ion Battery

CO2 -100%

CO2 -20%
NXP MC33771/2 Battery Cell Controller Solution

Battery Topology Flexibility
- Scalable SW & HW compatible BMS solution supporting **4 to 210 cells**
- MC33771 (7 to 14 cells) & MC33772 (3 to 6 cells) **fully compatible**
- Supporting Centralized, Distributed Daisy Chain, Distributed CAN

High integration level
- Integrated current Sensor (+-1200A)
- Integrated **Coulomb counter**
- Integrated **Balancing FETs** (300mA)
- Integrated Power Supply

High measurement accuracy
- ± 2~3 mV cell terminal (CT) voltage accuracy => accurate capacity prediction
- ± 0.5% accuracy integrated current sensor

Fast data acquisition and communication
- 3.6 ~ 4.1ms for sending command and read back **96 cell**

Superior daisy chain communication
- Low BOM with simple transformer only

System diagnostics and functional safety supporting ISO26262 w/ single chip
- Single chip **ASIL C** capable (**Easy ASIL D**)?

Automotive robustness
- ESD, EMC; Hot Plug, AEC-Q 100
MC33771 – 14 Cell Battery Cell Controller AFE

Features:

- Operating Voltage:
  - 9.6V ≤ VPWR ≤ 61.6V Operation, 70V Transient
- SPI or Isolated 2 MHz Differential Communication
- 14 Cell Voltage Measurement Channels
- Total Stack Voltage Measurement
- Current sensor with ±0.5% accuracy from milliamps to kiloamps
- Coulomb Counter (also in low-power mode)
- 7 ADC/GPIO/Temperature Sensor Inputs
- Addressable on Initialization
- 5.0V @ 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
- 64-LEAD LQFP-EP
- Temp range: -40°C to 105°C
- AEC-Q100 Automotive Qualified
- EMC/ESD Robustness
MC33772 – 6 Cell Battery Cell Controller AFE

Features:

• Operating Voltage:
  • 5V ≤ VPWR ≤ 30V Operation, 42V Transient (for SPI communication)
  • 7V ≤ VPWR ≤ 30V Operation, 42V Transient (for TPL communication)
• SPI or Isolated 2 MHz Differential Communication
• 6 Cell Voltage Measurement Channels
• Total Stack Voltage Measurement
• Current sensor with ±0.5% accuracy from mA to kA
• Coulomb Counter (also in Low-power mode)
• 7 ADC/GPIO/Temperature Sensor Inputs
• Addressable on Initialization
• 5.0V @ 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
• Temp range:
  - -40°C to 125°C (for SPI communication)
  - -40°C to 105°C (for TPL communication)
• AEC-Q100 Automotive Qualified
• EMC/ESD Robustness
MC33772xTC – Isolated Current Measurement IC

Features:

- Operating Voltage:
  - 5V ≤ VPWR ≤ 30V Operation, 42V Transient (for SPI communication)
  - 7V ≤ VPWR ≤ 30V Operation, 42V Transient (for TPL communication)
- SPI or Isolated 2 MHz Differential Communication
- 6 Cell Voltage Measurement Channels
- Total Stack Voltage Measurement
- Current sensor with ±0.5% accuracy from mA to kA
- Coulomb Counter (also in Low-power mode)
- ADC/GPIO/Temperature Sensor Inputs
- Addressable on Initialization
- 5.0V @ 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
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- Hot Plug Capable
- Operational Low Power Mode
- 48-LEAD LQFP-EP
- Temp range:
  - -40°C to 125°C (for SPI communication)
  - -40°C to 105°C (for TPL communication)
- AEC-Q100 Automotive Qualified
- EMC/ESD Robustness
MC33664ATL Transformer Physical Layer

Features:
• 2Mpbs Isolated Network Communication Rate
• Dual SPI Architecture for Message Confirmation
• Robust Conducted and Radiated Immunity with Wake-up
• 3.3V and 5.0V 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

Figure 3. MC33664ATL 16-Pin SOIC Narrow Body Pin Diagram
## Battery Management Portfolio

### Premium
- MC3377xBS (SPI comm)
- MC3377xBT (TPL comm)
  - Precise differential cell voltage measurement
  - Cell OV/UV
  - Synchronized current measurement
  - Coulomb Count
  - Cell balancing
  - Temp measurement, O/U temperature
  - Functional verification & diagnostics
  - Communication:
    - 2 MHz half duplex differential
    - SPI 4 MHz

### Advanced
- MC3377xBSA (SPI comm)
- MC3377xBT A (TPL comm)
  - Precise differential cell voltage measurement
  - Cell OV/UV
  - Synchronized current measurement
  - Coulomb Count
  - Cell balancing
  - Temp measurement, O/U temperature
  - Functional verification & diagnostics

### Basic
- MC3377xBT (TPL comm)
  - Precise differential cell voltage measurement
  - Cell OV/UV
  - Synchronized current measurement
  - Coulomb Count
  - Cell balancing
  - Temp measurement, O/U temperature
  - Functional verification & diagnostics

### Current
- MC3377xBTC (TPL comm)
  - Precise differential cell voltage measurement
  - Cell OV/UV
  - Synchronized current measurement
  - Coulomb Count
  - Cell balancing
  - Temp measurement, O/U temperature
  - Functional verification & diagnostics

### Half Duplex Differential PHY
- MC33664ATL1
  - Differential transformer driver / receiver
  - Bus and MCU wake-up
  - SAFE output (Fail-Safe implementation)
  - Operating voltage down to 3.5 V (cranking)
  - On-board oscillator
  - Analog bit filter

<table>
<thead>
<tr>
<th>Package</th>
<th>Temp range</th>
</tr>
</thead>
<tbody>
<tr>
<td>64/48-ld LQFP EP</td>
<td>-40 C to +105 C</td>
</tr>
<tr>
<td>16-ld LQFP EP</td>
<td>-40 C to +105 C</td>
</tr>
</tbody>
</table>

**Temp range:** -40 C to +105 C
Typical Battery Cell Controller / TPL Implementation
MC33771 Rev C
MC33771C – Device Level Changes

• **MC33771C** is a derivative of **MC33771B**, with improved TPL2 block.

• **MC33771C** has the same functionality as **MC33771B** with pinout/package compatibility.

• Only TPL & digital blocks are changed compared to **MC33771B**, other blocks are **FULLY compatible** with **MC33771B**.

• **Minimize** customer software change for **MC33771C** compared to **MC33771B**.

*Updated blocks on MC33771C compared to MC33771B.*

Other blocks are identical between MC33771B and MC33771C.
**MC33771C** – Improved Daisy Chain

**MC33771C** TPL2 Improvements:
- Repeater structure in each TPL2 node
- Up to **63 nodes** in a single daisy chain
- **Inductive & capacitive** coupling support
- **Loopback** support
- Up to **20m** distance between nodes
- Compatible with MC33664
## MC3377xB/C – Comparison

<table>
<thead>
<tr>
<th>Parameter</th>
<th>MC33771B</th>
<th>MC33771C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage Channels</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Supply Vpwr Range (Max Transient)</td>
<td>9.6V..61.6V (75V)</td>
<td>9.6V..61.6V (75V)</td>
</tr>
<tr>
<td>Cell Terminal Input Voltage Range</td>
<td>-0.3V to 5V</td>
<td>-0.3V to 5V</td>
</tr>
<tr>
<td>Typical Measurement Error</td>
<td>± 0.8 mV</td>
<td>± 0.8 mV</td>
</tr>
<tr>
<td>Max Total Measurement Error (TME) for Cell Terminal Voltage (After aging: MLS3 &amp; 1000h HTOL)</td>
<td>± 3.9 mV</td>
<td>± 3.9 mV</td>
</tr>
<tr>
<td>Functional Safety</td>
<td>Single-chip ASIL C</td>
<td>Single-chip ASIL C</td>
</tr>
<tr>
<td>Isolated communication Speed</td>
<td>2 Mbps</td>
<td>2 Mbps</td>
</tr>
<tr>
<td>Communication Isolation</td>
<td>Inductive, Capacitive</td>
<td>Inductive, Capacitive</td>
</tr>
<tr>
<td>Max Nodes per Daisy Chain</td>
<td>15</td>
<td>63</td>
</tr>
<tr>
<td>CRC Bit</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Comms bit</td>
<td>40</td>
<td>48</td>
</tr>
<tr>
<td>Integrated Balancing</td>
<td>&lt;300 mA</td>
<td>&lt;300 mA</td>
</tr>
<tr>
<td>Balancing sleep mode</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Deep sleep mode</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>GPIO / Analog measurement inputs</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Current Channels</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Coulomb counter</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Package</td>
<td>64-pin LQFP-EP</td>
<td>64-pin LQFP-EP</td>
</tr>
</tbody>
</table>
Application Option: Loopback

- On system level, several looped daisy chains can be supported by writing a daisy chain address in the node. Thus, the node can always decode the chain address from the command and know if the message was intended for it.

- To support loopback, two TPL drivers (master nodes) are connected physically at different SPI ports of MCU at different ends of daisy chain.

- The MCU through these Master nodes can reach a node from both direction. Also, in case of broken link a node can always be addressable from the other side.
Wireless BMS

GFSK, BLE, Other?
Typical Battery Cell Controller / TPL implementation
Wireless Battery Management

- Battery Pack
  - MC33771
    - Temp
    - V sense
    - Balance
  - SPI

- Battery Junction Box
  - MC33772BTC
    - SPI
    - ASIL-D

- HV+ Contactor
- Pre-Charge Contactor
- Fuse
- 100μΩ Shunt

- Wireless Comm

- HV+ Contactor
- HV- Contactor

- NXP BMS Devices

- Wireless Battery Management Controller (BMC)
  - Safety MCU
    - ASIL-D
  - Safety SBC
    - ASIL-D

- 2.4G Radio (BLE?) on each CMC (Cell Monitoring Circuit)
- 2.4G Radio (BLE?) on BJB (Battery Junction Box)
- 2.4G Radio (BLE?) on BMC (Battery Management Controller)
Why Wireless BMS?

Drivers:
- Eliminates Isolation
- Simpler Assembly / Easier Maintenance
- Reduce Wiring / Connection Costs
- Reduce Failure Points
- Safer?
Wireless BMS Application

General BMS Application Requirements / Challenges

- Currently **2.4G technology** is seen as the **best choice**
  - Wireless BMS communication potentially **exposed** to public environment
  - External 2.4G devices will **impact** WBMS communication quality
  - Need **multiple** simultaneous **connections**
- **Tight air space** affecting RF communication?
- **Data polling time** should meet BMS application requirements
- **Network establishing time** should meet BMS application requirements
- **Synchronization** (Time Stamping) should meet BMS application requirements
- **Over-the-air (OTA)** firmware updates shall be possible
- **ASIL-D** from **BMC** - may **require redundant BLE masters**
- **EMI / EMC** is important
- **Low power consumption** is needed.

**Secure Connection / Communication is REQUIRED!**
Kinetis KW35A/36A MCU Family | Features – BLE 5 + GFSK

Core/Memory/System
- Arm® Cortex®-M0+ running up to 48 MHz
- KW35: 512kB (2x256kB, swappable) Program Flash with ECC; or
- KW36: 256kB Program Flash + 256kB FlexNVM both with ECC;
- 64 kB SRAM
- KW36: 8 kB of user-segment defined byte write/erase EEPROM
- Four independently programmable DMA controller channels

Radio
- Support for BLE v5.0 and Generic FSK
- Rx Sensitivity, -95 dBm BLE / -25 to +3.5 dBm programmable output power
- Increased coexistence performance; Radio I/O for Wi-Fi coexistence
- 6.8 mA Rx & 6.1mA Tx (0dBm) current target (DC-DC enabled)
- Integrated balun (~9% board area savings)
- Support for 8 concurrent connections

Communications/HMI/Timers
- 2xSPI, LP-UART with LIN, 2xI2C, CMT, GPIO with IRQ capability (KBI)
- KW36: CAN-FD and 2nd UART with LIN
- 3x FlexTimer (TPM) with PWM & quadrature decode support
- Low Power (LPTMR), Programmable Interrupt (PIT) and RTC timers

Analog
- 16-bit ADC with integrated temp sense and battery monitor
- 6-bit High-speed Analog Comparator

Security
- AES Accelerator and True Random Number Generator
- Advanced flash security

Integrated DC/DC Converter
- Normal: 1.71V to 3.6V / Buck : 2.1V to 4.25V

Unique Identifiers
- 80-bit device ID programmed at factory
- 40-bit unique number can be used for Bluetooth Low Energy

Production: Available Now

AEC Q100 Grade 2 (A version only)
Operating Range (Ambient): -40°C to +105°C
Kinetis KW37A/38/39A MCU Family | Block Diagram & IP Reuse

New IP vs KW36A

- Full Bluetooth LE 5.0 compliant GFSK PHY (Digital IP)
- Bluetooth LE 5.0 Link Layer (Digital IP)
- Localization: Enhanced Distance Estimation & Direction Finding support (i.e., improved DMA, antenna switching and time-stamping)

Modified IPs vs KW36A

- Increase output power to +5dBm (Analog IP, option already available in KW36A that need to be qualified)
- Enhanced Generic Link Layer (with early support of Bluetooth LE 5.1 compliant Direction Finding Packet)

Pin-to-pin compatible with KW36A

- 7x7 wettable flanks 48HVQFN

Changes from KW36

KW38 only

(48HVQFN Qualified Jul19)
## Summary of BLE 5 Features

<table>
<thead>
<tr>
<th>Version of Standard</th>
<th>Features</th>
<th>Description</th>
<th>Category</th>
<th>KW35/36A</th>
<th>KW37/38A</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Errata</strong></td>
<td>Core spec Errata of 4.2</td>
<td>Mandatory</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>5.0</td>
<td>LE 2M PHY</td>
<td>Higher data rate</td>
<td>Optional</td>
<td>x</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>LE coded PHY</td>
<td>Longer range, reduced data rate support of 125/500kbps. Only available on LE 1M PHY</td>
<td>Optional</td>
<td>x</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>LE advertising extensions</td>
<td>Enable longer advertising packet, more advertising channels, and more advertising type</td>
<td>Optional</td>
<td>x</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>High Duty Cycle Non-connectable Advertising</td>
<td>Reduced the minimum advertising interval for non-connectable advertising, enable high duty cycle beacon</td>
<td>Optional</td>
<td>x</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>LE Channel Selection Algorithm #2</td>
<td>Enable channel selection in sub-event</td>
<td>Optional</td>
<td>x</td>
<td>✓</td>
</tr>
</tbody>
</table>
Example Data to Transfer

CMC (~50 bytes)
- Fault Status (6 bytes)
- Up to 14 cells (28 bytes)
- Up to 7 Analog / GPIO inputs (14 bytes)
- IC temp (2 bytes)
- CRC-16 (2 bytes)
- Other Info?? (8 bytes)

BJB (~24 bytes)
- Fault Status (6 bytes)
- Stack Voltage (2 bytes)
- Pack Current (2 bytes)
- Coulomb Counter (4 bytes)
- CRC-16 (2 bytes)
- Other Info?? (8 bytes)

Low Data Rate Needed

Can LE coding be used to improve communication robustness?

BLE 5.0
- 2Mbps (same as TPL daisy chain but BCC comm happens concurrently)
- Overhead 22 bytes (includes CRC)
- Data Payload up to 244 bytes
- Connection intervals from 7.5ms to 4s (1.25ms increments)
NXP WBMS Demo (Based on MC33771B & KW36)

Wireless MCU:
- Lower power consumption
- **Customized BLE5.0** protocol for BMS
- OTA supported
- Up to 8 **concurrent connections** with 1 master
- Stable communication (Frequency hopping, repeat …)
- Security management (**AES-128**)  
  - Communication Distance < 30m
- Wireless link maintained by KW36 hardware.
- -25 to +3.5 dBm programmable output power
- Rx Sensitivity, -95 dBm BLE

**AFE:**
- 9.6 V ≤ VPWR ≤ 61.6 V operation, 75 V transient
- 7 to 14 cells management
- 4Mbps **SPI communication** with **MCU**
- 100mA cell balancing current, 300mA capability at max
- 6 channel external temperature sensing, 1 channel on board temperature sensing for cell balancing resistors.
- Full diagnostic functions
NXP WBMS Demo (Based on MC33771B & KW36)

- Star architecture – 1 master / 8 slaves

- Voltage measurement (14 channels / slave – 112 total)
- Temp Measurement (6 external + 1 on-board / slave)
- Cell Balancing – 100mA

- Wireless Baud Rate – 1Mbps
- Wireless Payload – 60 bytes (up to 255 bytes max)
- Wireless Security - AES-128
- Wireless Timestamp
- Polling time – 60ms
- Network establishing time – 120-500ms
- Functional Safety – ASIL D by BMC (ASIL-C/QM)
Enablement
MC3377xEVB, Battery Emulators, FRDM-KW36
Battery Cell Controller Enablement

MC33771 EVBs (14 cell)
- For TPL Communication
- For SPI Communication

MC33772 EVBs (6 cell)
- For TPL Communication
- For SPI Communication

FRDM-KW36A

14-Cell Emulator

6-Cell Emulator

14cell – AAA-PACK

FRDM-KW36 + MC3377xEVB
Summary

Wireless Communications can:
- Eliminate Isolation
- Provide Simpler Assembly / Easier Maintenance
- Reduce Wiring / Connection Costs
- Reduce Failure Points
- Safer?

Wireless Challenges:
- Secure Connections
- Secure Communications
- Robust Communications
- ASIL-D Conformance
- Cost ?? – Still need to do full system level cost analysis
# Tech Days Detroit 2019: Electrification Session

<table>
<thead>
<tr>
<th>Room</th>
<th>October 8</th>
<th>Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Galilee</td>
<td><strong>AMF-AUT-T3631</strong>&lt;br&gt;Scalable and Safe Power Management Solutions for Automotive Market</td>
<td>10:00AM-10:50AM</td>
</tr>
<tr>
<td></td>
<td><strong>AMF-AUT-T3832</strong>&lt;br&gt;Electrification Functional Safety Backbone Solutions to Attach with S32</td>
<td>11:10 AM – 11:50 AM</td>
</tr>
<tr>
<td>Samuel</td>
<td><strong>AMF-AUT-T3819</strong>&lt;br&gt;Entry-Level Solutions for EV/HEV Applications</td>
<td>10:10 AM – 10:50 AM</td>
</tr>
<tr>
<td></td>
<td><strong>AMF-AUT-T3626</strong>&lt;br&gt;Next-Generation Processor Solutions for Advanced H/Evs and Safety Domains Controllers</td>
<td>11:00 AM – 11:50 AM</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Room</th>
<th>October 9</th>
<th>Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nazareth</td>
<td><strong>AMF-AUT-T3827</strong>&lt;br&gt;Wireless BMS</td>
<td>11:00AM-11:50AM</td>
</tr>
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<td></td>
<td><strong>AMF-AUT-T3659</strong>&lt;br&gt;Functional Safety Concept of High-Voltage Traction Inverter</td>
<td>1:30PM-2:20PM</td>
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<tr>
<td>Wisdom</td>
<td><strong>AMF-AUT-T3828</strong>&lt;br&gt;BMS for Drones and Small Systems Incorporating Automotive Components</td>
<td>4:00PM-4:50PM</td>
</tr>
<tr>
<td>Samuel</td>
<td><strong>AMF-AUT-T3627</strong>&lt;br&gt;Cost-Optimized HV BMS Based on MC33771 revC</td>
<td>10:00AM-11:00AM</td>
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