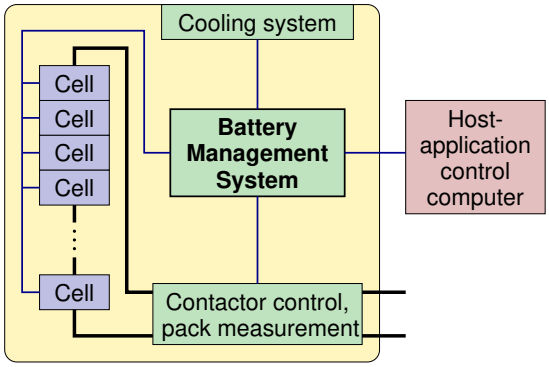
BMS requirement 3: Interface

- Have now looked at requirements 1 and 2 of a BMS, sensing and high-voltage control; protection
- In this topic, we consider requirement 3, ***interface***
  - Communications, charger control, data recording, range estimation

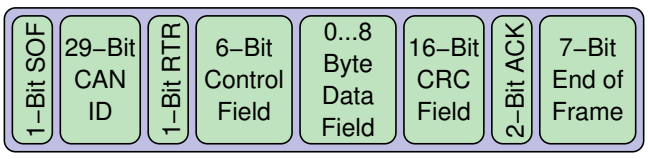


3a. Communication via CAN bus

- Control Area Network (CAN) bus is industry ISO standard for on-board vehicle communications
- Designed to provide robust communications in the very harsh automotive operating environments with high levels of electrical noise
- Two-wire serial bus designed to network intelligent sensors and actuators; can operate at two rates:
  - High speed (e.g., 1M Baud): Used for critical operations such as engine management, vehicle stability, motion control
  - Low speed (e.g., 100 kBaud): Simple switching and control of lighting, windows, mirror adjustments, and instrument displays (etc.)

Format of CAN-bus packet

- The protocol defines the following:
  - Method of addressing the devices connected to the bus
  - Data format (the “message”)
  - Transmission speed, priority settings, and sequence
  - Error detection and handling
  - Control signals



- Data frames are transmitted sequentially over the bus.

3b. Charger control

- Battery packs are charged in two ways:
  - Random: Charge delivered in unpredictable patterns; *e.g.*, regenerative braking
    - Control by providing inverter power limits
  - Plug-in: For EV/PHEV/E-REV
    - Control charger current, voltage, balancing
    - Often CP/CV; more exotic methods possible
    - Heating systems may be required

What limits fast charging?

- Passenger vehicles require approximately 200–300 Wh mile^{-1}
  - For 300 mile range, 60–90 kWh capacity, charge in 3 min. requires a rate of up to 1.8 MW!
  - Domestic 15 A, 110 V or 1.5 kW "level 1" service charges pack in 40–60 h
  - Domestic 30 A, 220 V or 6.6 kW "level 2" service charges pack in 10–15 h
  - DC "level 3" (CHAdeMO) fast charging, 500 V, 125 A can provide up to 80 % charge in 30 min
  - Tesla "level 3" fast charging for model S can provide 50 % charge in 20 min
  - So, limit is usually the electrical service, not the battery pack
- However, battery can limit charge rates at high SOC and low temperature

3c. Log book function

- For warrantee and diagnostic purposes, BMS must store a log of atypical/abuse events
  - Abuse type: out of tolerance, voltage, current, temperature
  - Duration and magnitude of abuse
- Can also store diagnostic information regarding
  - Number of charge/discharge cycles completed
  - SOH estimates at beginning of each driving cycle
  - And much more. . .
- Data stored in nonvolatile (*e.g.*, FLASH) memory and downloaded when required

3d. Range estimation

- How far can I drive before available energy is depleted?
- Heavily influenced by environmental factors:
  - What are the vehicle characteristics?
  - How is the vehicle being driven (gently/aggressively)?
  - Are there a lot of hills, a lot of wind?
  - Is it warm or cold out?
- At present, it appears that each OEM will have their own range algorithms
  - But, will look briefly at vehicle simulation in course 2
- Sufficient for now to produce inputs to those algorithms; esp. available energy

Summary

- BMS must communicate critical information to host application
- Often done via CAN-bus protocol
- Communication needs are application-specific, but often include
  - How to control charger to avoid safety hazards
  - Entries from logbook of atypical/abuse events
  - Range estimates (distance- or time-to-empty)
  - And of course, estimates of available energy and power, etc.
    - We consider what estimates a BMS must make in the next topic

Credits

Credits for photos in this lesson

- Tesla with supercharger on slide 4: Pixabay CC) license, `https://pixabay.com/en/tesla-tesla-model-x-charging-1738969/`
- Logbook on slide 6: Pixabay CC0 license, `https://pixabay.com/en/sketchbook-book-notes-calendar-156775/`