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2021

Integrated BMS Test with Scalable ATE

Kun Xu, Junlin Wang
Advantest

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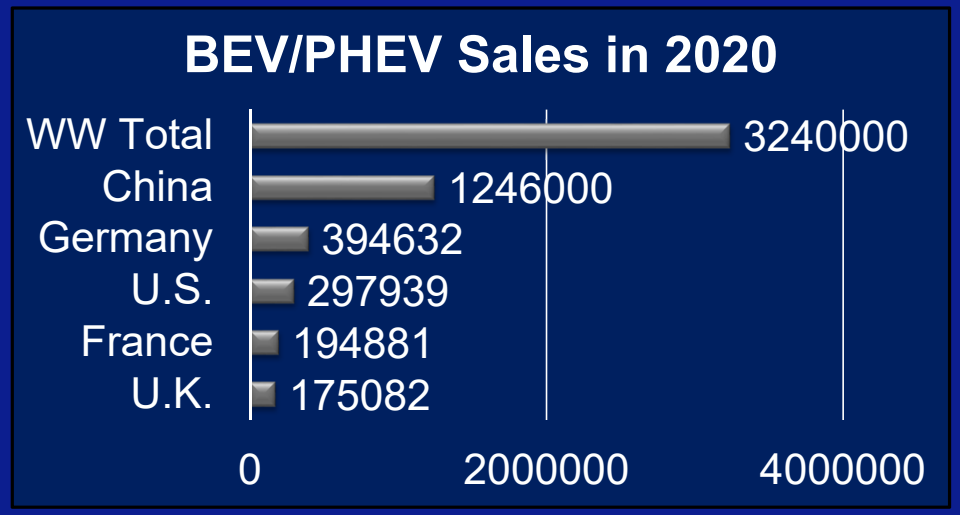
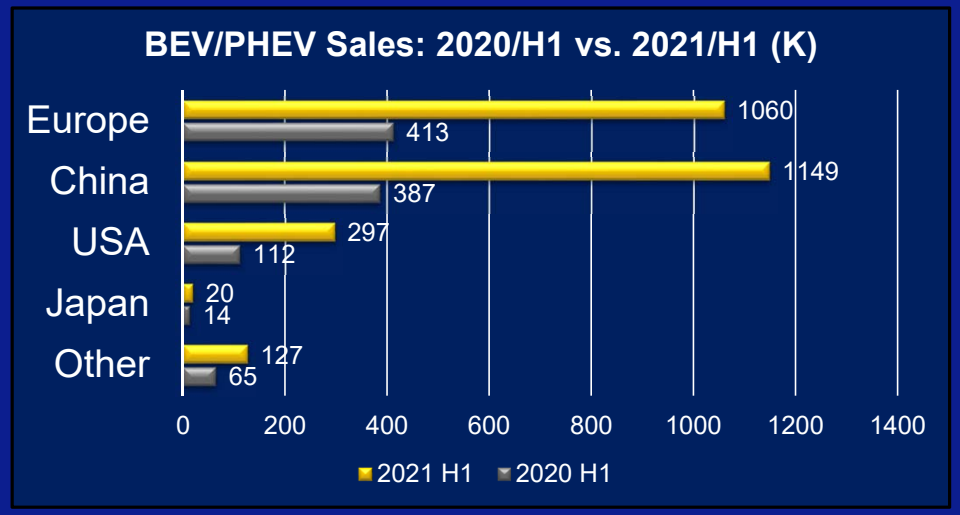
Virtual ▪ October 22-29, 2021

ADVANTEST

WW EV/HEV Sales





** Source from Wikipedia: Electric car use by country*

** Source from EV Volumes*

- As the mentioned by EV Volumes:
  - In 2020, the first wave of Covid-19 caused and unprecedented slump in car sales but also increasing support by policy makers.
  - 2021 is far from business as usual, but EV sales are back on track.

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Li-xx BMS Segments for Applications

Cell x1
BMS Voltage<4.5V

Cell x2~x4
BMS Voltage<18V

Cell x3~x5 per Pack
Pack x3~x4 up to 48V
BMS Voltage<18V

Cell x5~x16 per Pack
BMS Voltage<70V

Cell x16~x24 per Pack
Pack x4~x8 up to 400V
BMS Voltage<120V

Cell x16~x24 per Pack
Pack x8~xN up to 1200V
BMS Voltage<120V

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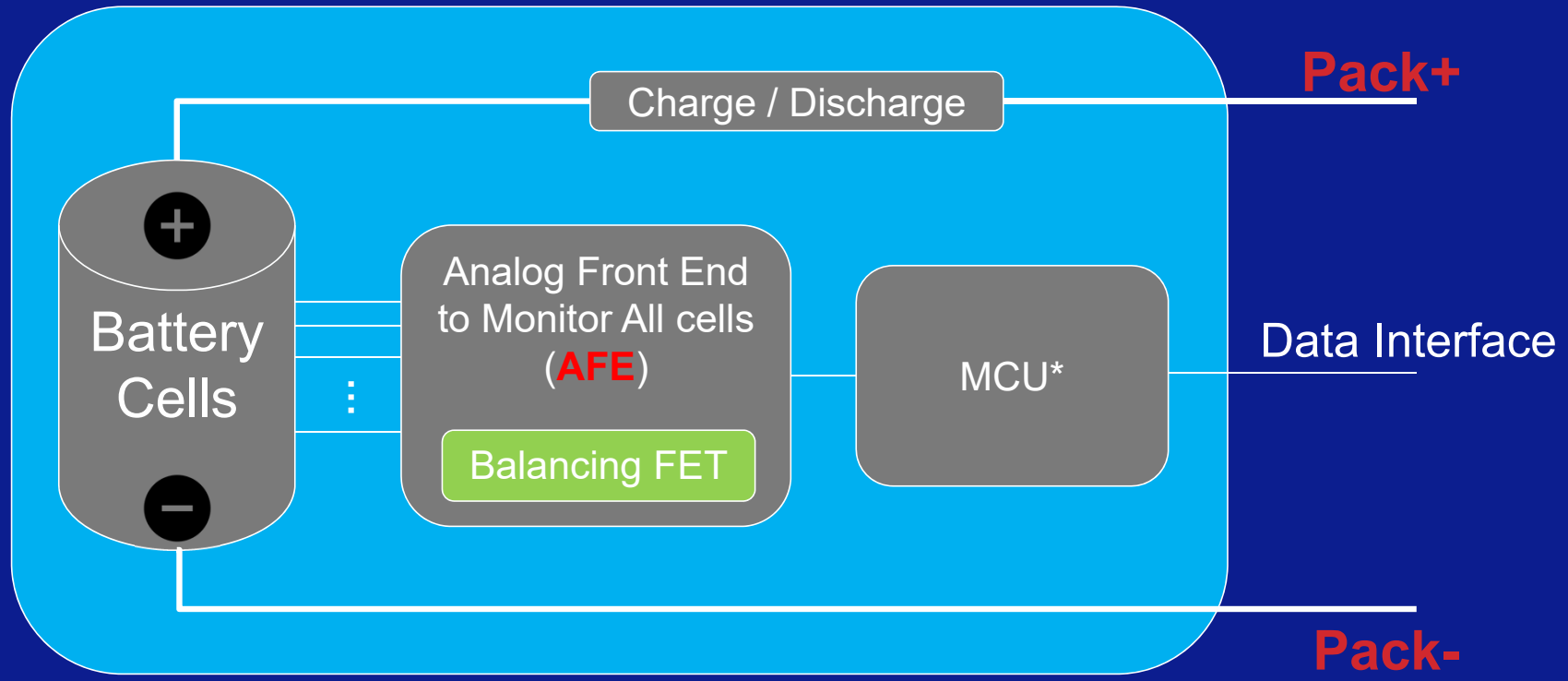
BMS and AFE in Power Battery Pack



- MCU: is used to calculate state-of-charge(SOC), state-of-health(SOH), cells balance, and communicate with other systems/equipment through bus

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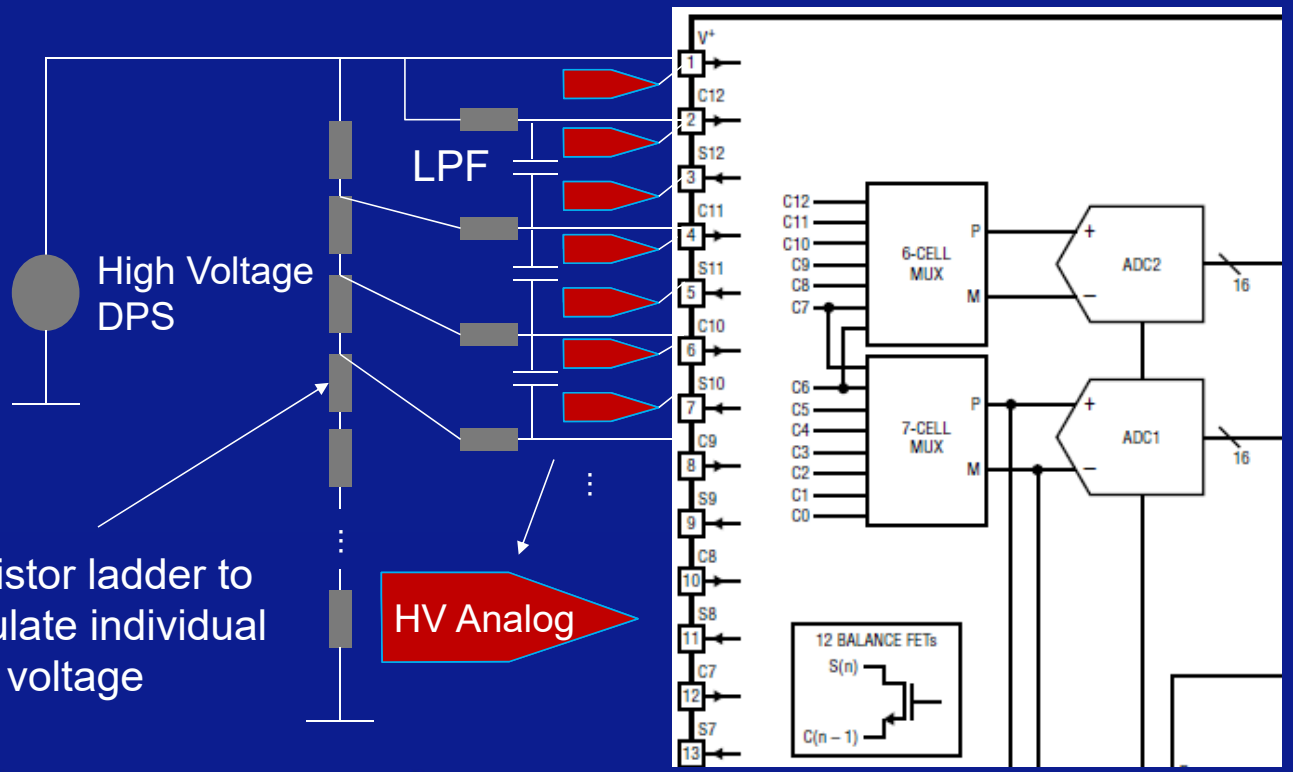
Typical BMS-AFE Test Circuit



- To monitor exact voltage between Cn & Cn-1
  - Each Cn should be assigned one analog channel
- High-Res **Diff-ADCs** are core modules in AFE
  - Both DC&AC test
  - AWG is required

** Block Diagram from BMS device datasheet of ADI*

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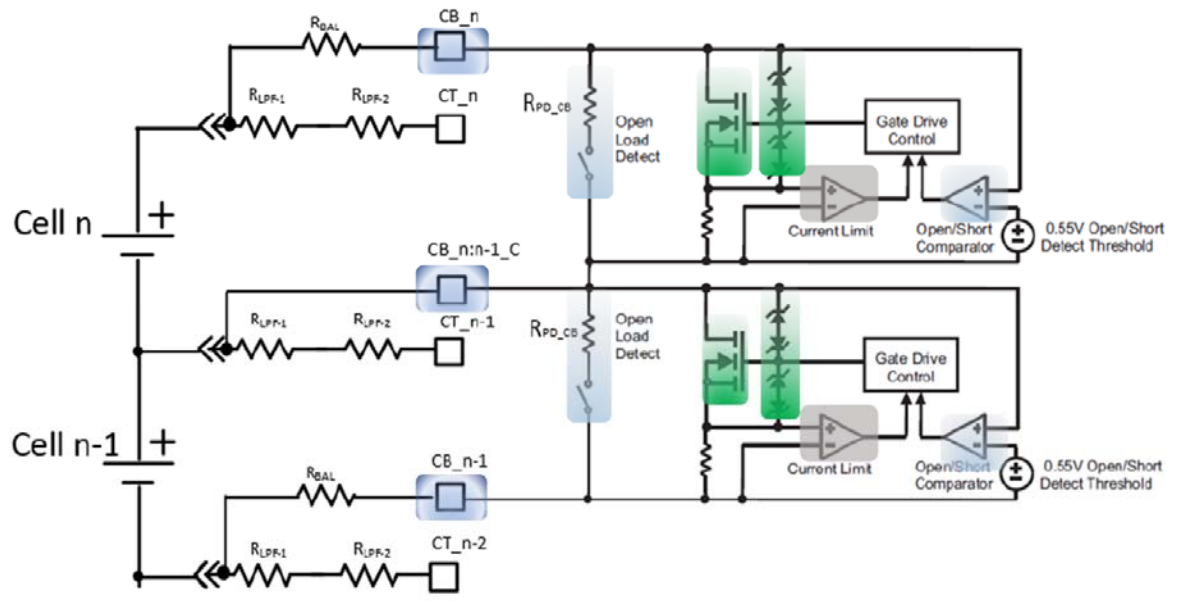
Cell Balancing

- Many BMS integrate FET for cell balancing, as shown in green blocks below
- FET's **Rds** must be tested with high current

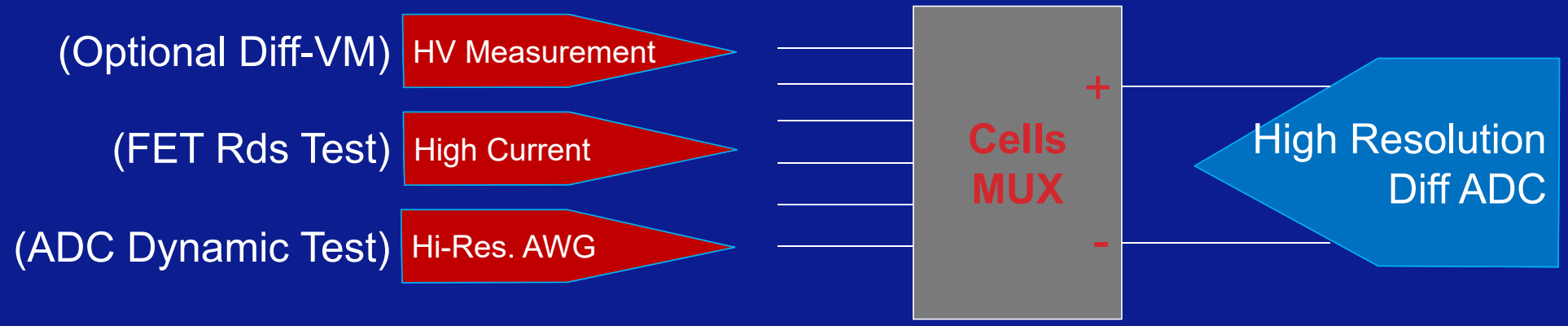


Rds Spec (ohm)	Vds Condition	Max Balance Current
5~10	3.2~4.5V	~1A
12~40	3.3~4.5V	~400mA
1~10	3.6V	~4A

Rds Test Condition by BMS customers

Test Challenge for BMS-AFE

- The cell monitor pins are tested on HV + HC + Dynamic
- AFE tests need more analog channels



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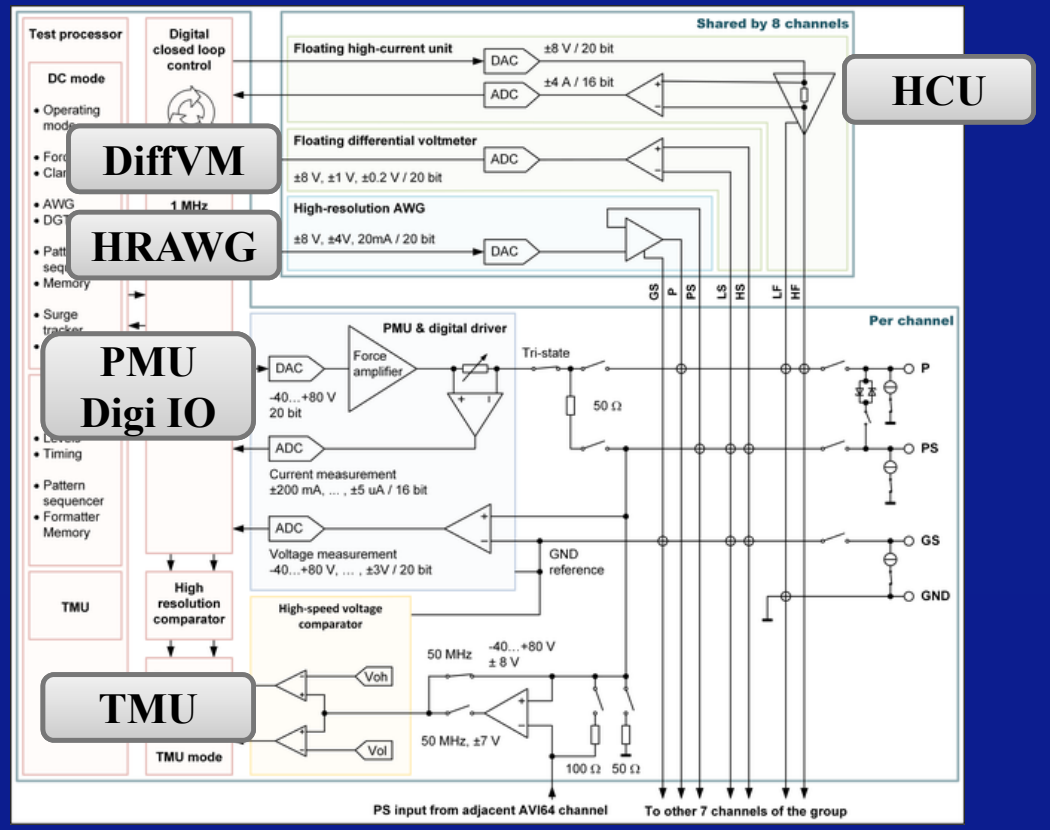
Solution Ideas

- Add relays to switch different analog channels
  - **Advantage**: Can use the most appropriate testing resources
  - **Disadvantage**:
    - DUT board is more complex from design to maintenance
    - May be limited parallel site count based on ATE framework
- Use universal analog channels
  - **Advantage**: Simplify DUT board, more site count
  - **Disadvantage**:
    - Higher performance requirement for analog channels, such as V/I range, features…

Test BMS-AFE with AVI64 of V93000

"General purpose" DCVI with Analog and High Voltage Digital capabilities (-40V~+80V)



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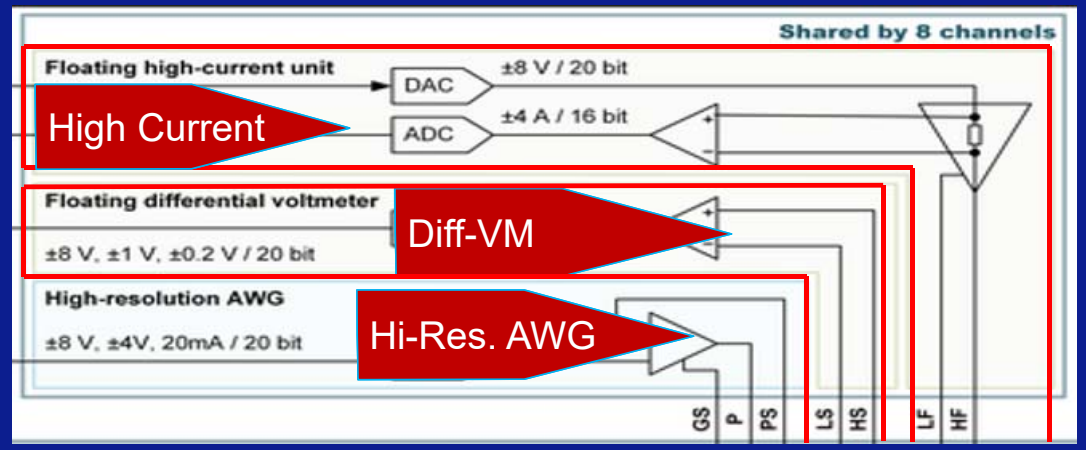
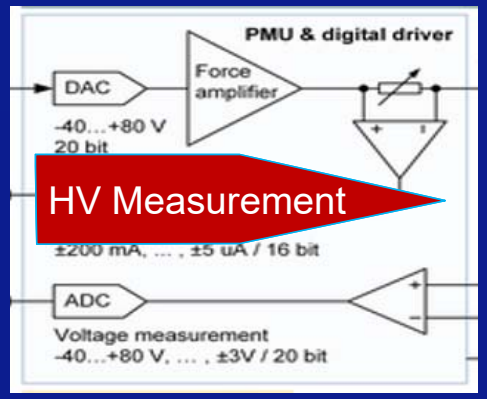
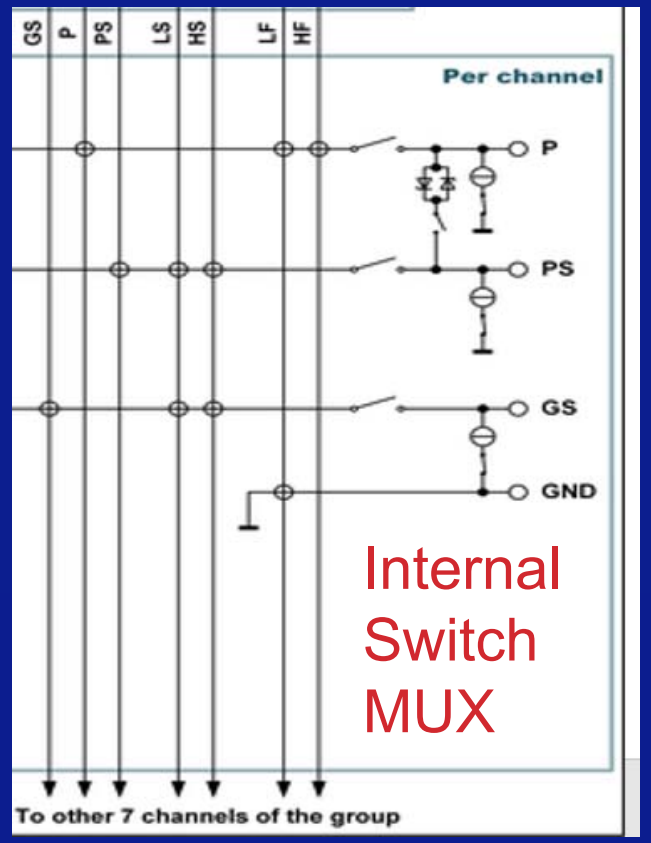
BMS-AFE Test Solution based on AVI64



8-Pins Share Functions



Per-Pin Functions



Internal Switch MUX

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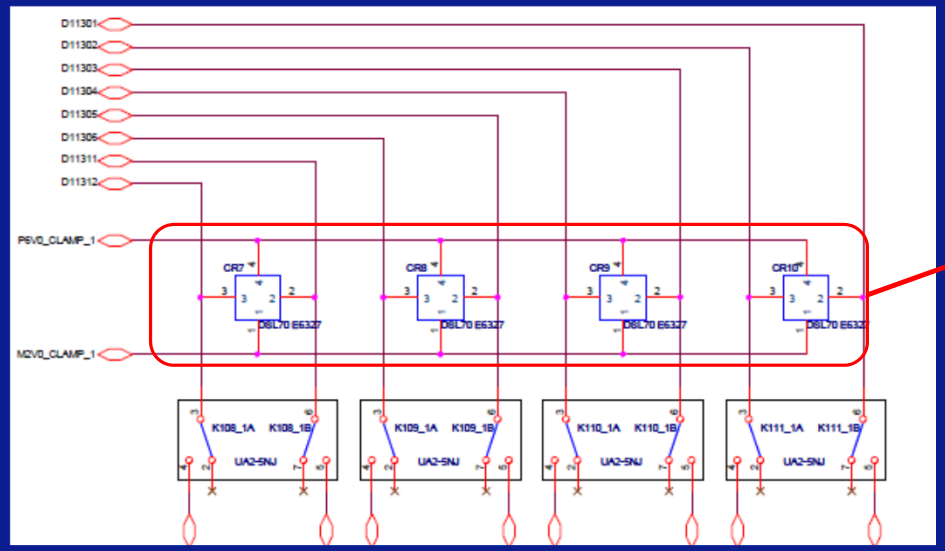
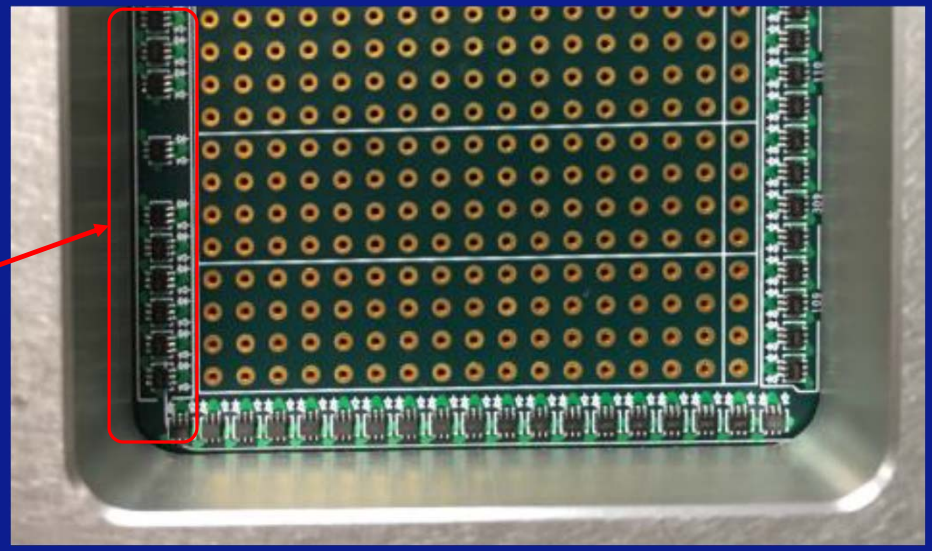
Isolate LV & HV

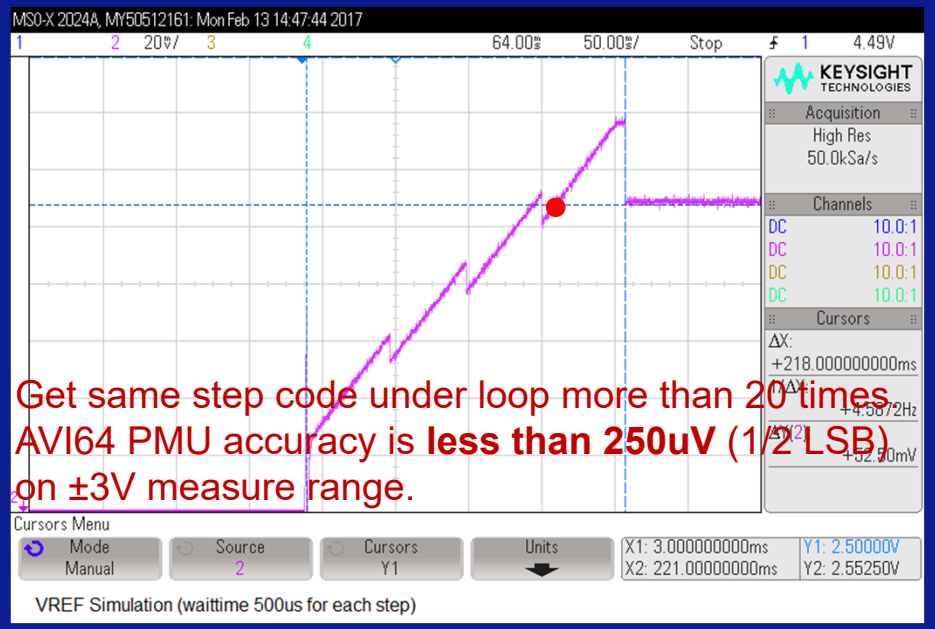
- BMS-AFE works with battery high voltage, but its outputs are low voltage signal, especially for digital communication with MCU
- The isolation between LV and HV is required on DUT board





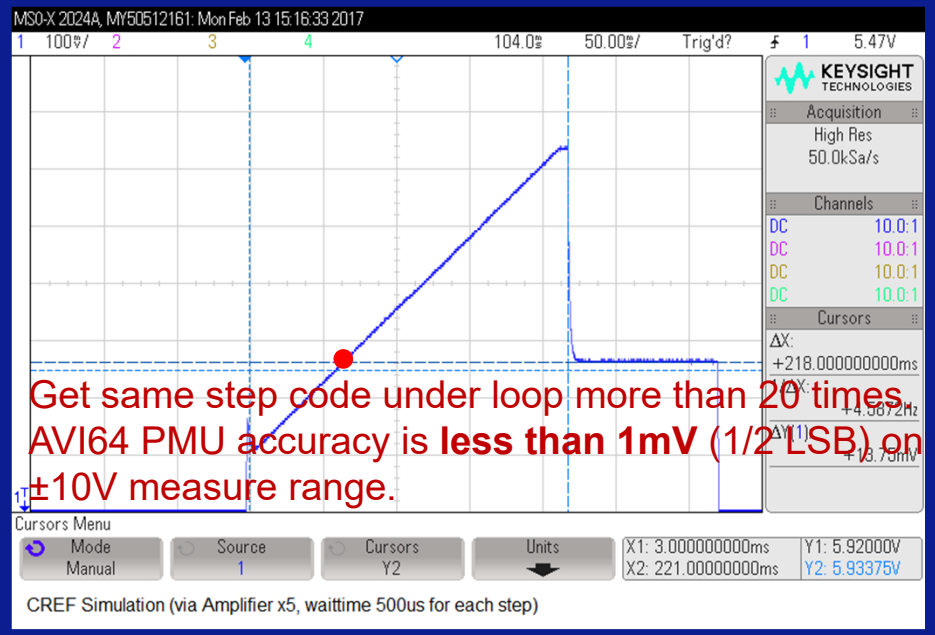
BMS-AFE Test Examples with AVI64

- VREF Trim Testing:
- 256 steps ramp wave, 1 step: ~ 0.5 mV
- Find step code on 2.5 V



Get same step code under loop more than 20 times, AVI64 PMU accuracy is **less than 250uV** (1/2 LSB) on ±3V measure range.

- CREF Trim Testing:
- 256 steps ramp wave, 1 step: ~ 0.4x5 mV
- Find step code on 5.920V (Amplifier x5)



Get same step code under loop more than 20 times, AVI64 PMU accuracy is **less than 1mV** (1/2 LSB) on ±10V measure range.

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Summary

- Power battery is an essential part of BEV and BMS is the brain of battery pack.
- BMS-AFE is required to monitor more and more series cells, from x16 to x24, even more.
- That means HV + HC test challenge will get higher and higher.
- Choose ATE rationally according to the characteristics of chip.
- Advantest still focuses on the newest testing technology to support Power/Analog/Controller area.

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