ADVANTEST®

爱德万测试的 新一代车载芯片测试方案

Junlin Wang

Advantest China

BD&COE

Agenda

01   Introduction of Advantest

02   Trend and test challenges of New-Generation Automotive semiconductor

03   V93000 Solutions for Testing New-Generation Automotive Components

04   Solution Examples for New-Generation Automotive Components

Advantest at a Glance

A **global leader** in the ATE industry with a WW installed base of over 30,000 systems

Our nanotechnology products support leading-edge semiconductor processes at the **1Xnm node**

Our diverse workforce includes over **6,400 employees** from **50 countries**

Eco-friendly policies emphasize reduction of our carbon footprint

2018 THOMSON REUTERS
TOP 100
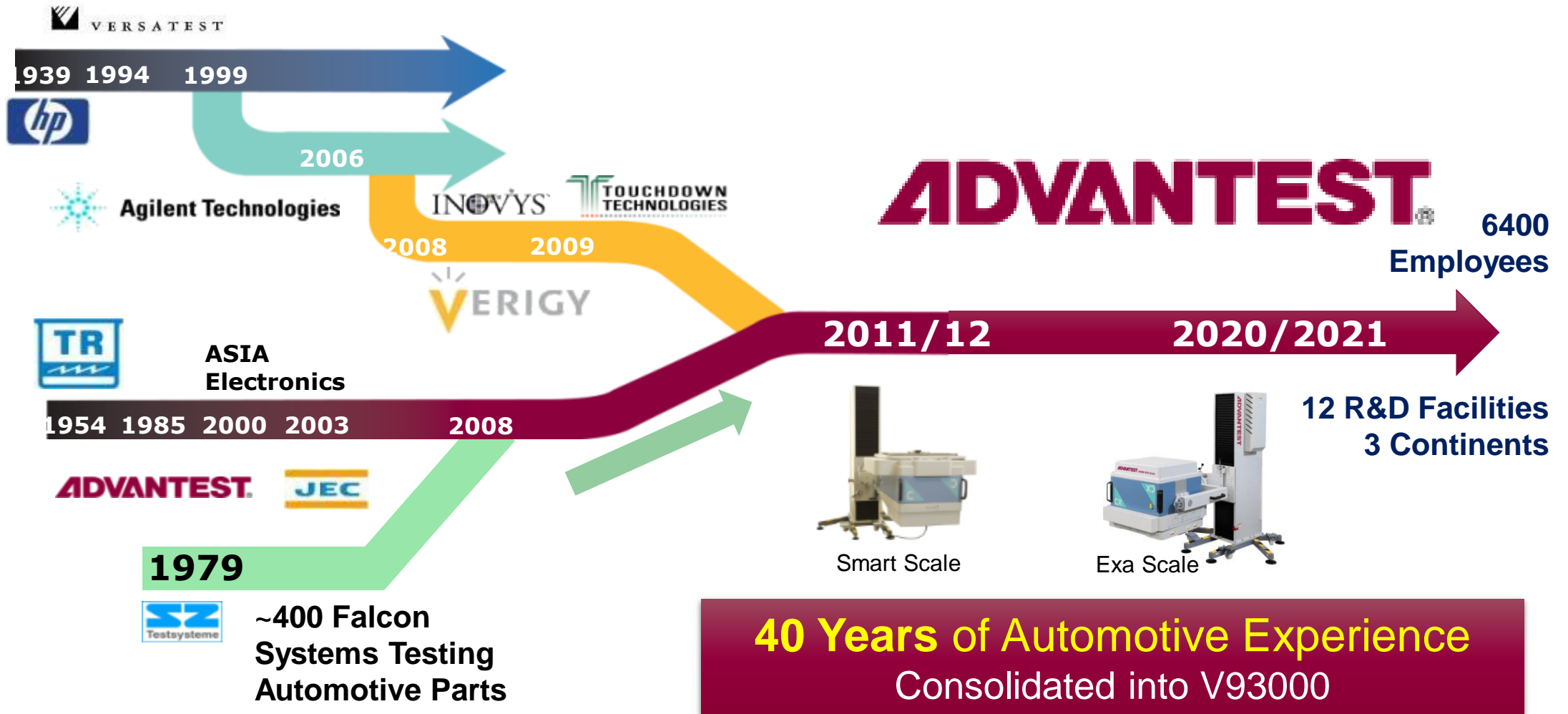**GLOBAL TECH LEADER**

2018 Global Technology Leader by Thomson Reuters

65+

Innovating in the measurement arena for **65+ years**

2022
RANKED 1ST SUPPLIERS
Tech Insights
CUSTOMER SATISFACTION

Named **THE #1** large supplier of chip making equipment for three consecutive years

A **10 BEST** supplier for **34** consecutive years

V93000 Heritage of Technical Excellence in Automotive

VERSATEST

1939 1994 1999

hp

2006

Agilent Technologies

INOVYS   TOUCHDOWN TECHNOLOGIES

2008   2009

VERIGY

ADVANTEST

6400 Employees

TR

ASIA Electronics

1954 1985 2000 2003   2008

ADVANTEST   JEC

2011/12   2020/2021

12 R&D Facilities
3 Continents

1979

SZ Testsysteme

~400 Falcon Systems Testing Automotive Parts

Smart Scale   Exa Scale

40 Years of Automotive Experience
Consolidated into V93000

V93000 is extending its automotive coverage.

Trend and test challenges of New-Generation Automotive semiconductor

Electrification(xEV), Autonomous Driving (ADAS, V2X)

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Trend of Automotive

Electrification

Autonomous Driving

- Zero Emission is driving xEV development. Advanced high power & battery technologies are required .

- Sensors & High-End Computing Technologies are Integrated by ADAS / Autonomous Applications.

Next-Generation Automotive Technologies

Electric Vehicles(EV), ADAS/ Autonomous, Connected Car etc.
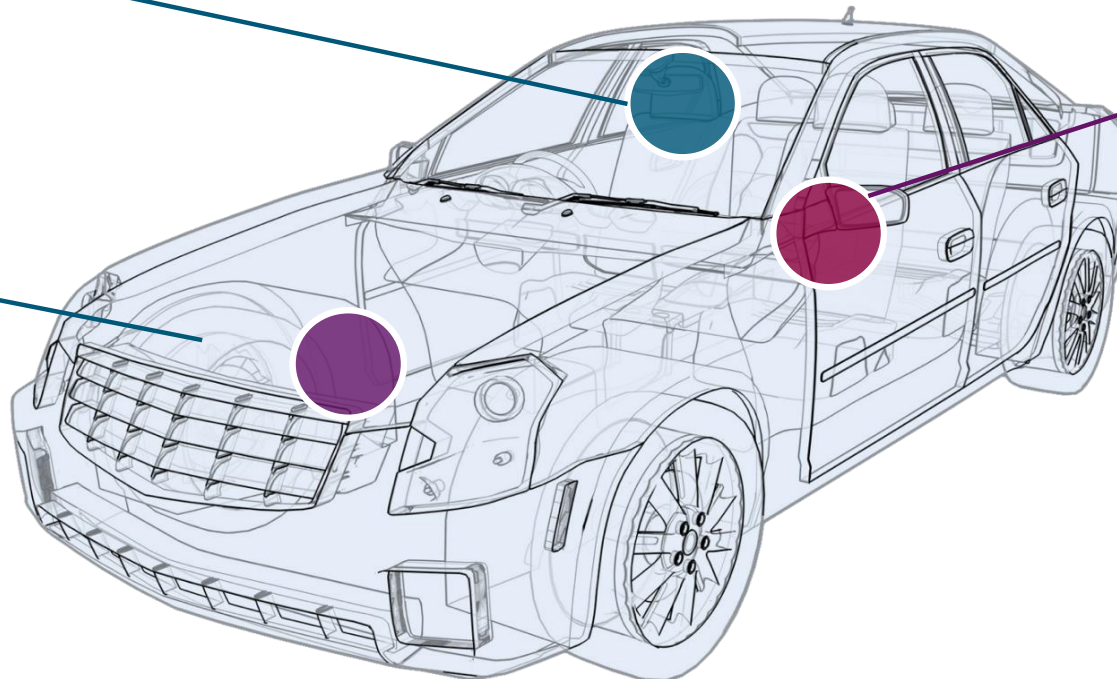
AUTONOMOUS CAR

ADAS
- Sensors fusion
- V2X Communications
Autonomous Driving

ALTERNATE PROPULSION

Hybrid & EV
Rapid/wireless Charging
Charging/Refueling
Infrastructure

CONNECTED CAR

IoT & Connectivity
Infotainment
Telematics
Media Integration
Smartphone & Apps
Advertising
Navigation
Wearables
Cyber Security

Source: *IHS Markit Automotive Electronics & Semiconductor Market Trends*

Automotive Electronics to be tested

Traditional Automotive Semiconductor Segments:

Typical Automotive Applications:
Safety and Chassis
    ABS, ESC, Airbag…
Power Train
    Engine Management,
      injection, transmission…
Body comfort electronic
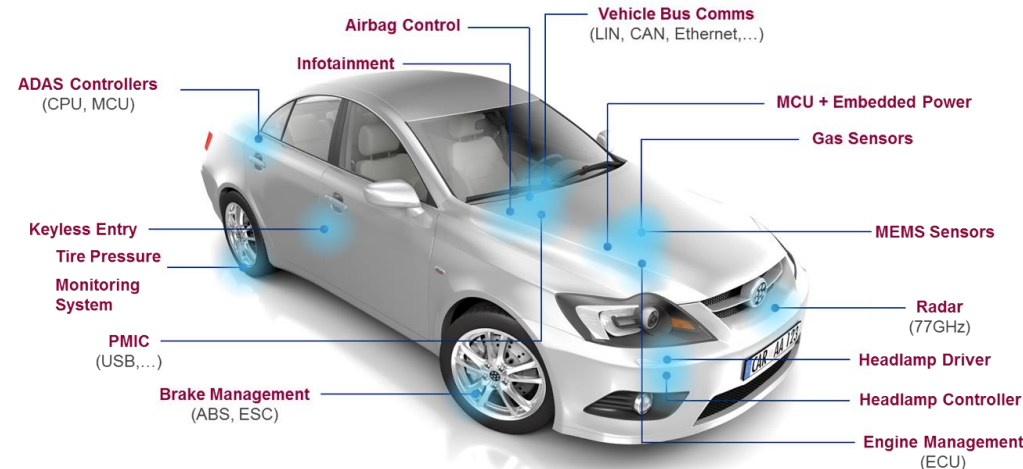   door/window/seat controls,
      LED lighting, wiper…)
Infotainment
    Audio, GPS…
Sensors
    Acceleration, gyro,
      pressure…

Multiple Technologies in new generation automotive:

New Generation Automotive:
Hybrid & Electric Vehicles (EV)
    Battery monitor, Battery
    Charger, balancing,
    Motor Driver/controller
    Switches (HS/LS, H-
    Bridges…)
ADAS system extends
    Lidar, Radar
    Digital Lighting
    Camera and Sensors
    High performance
    computing
V2X (vehicle to everything)
    5G, Cellular, Wi-Fi, BT,
    IoT,…

ADAS Controllers
(CPU, MCU)

Airbag Control

Infotainment

Vehicle Bus Comms
(LIN, CAN, Ethernet,…)

MCU + Embedded Power

Gas Sensors

Keyless Entry

Tire Pressure Monitoring System

MEMS Sensors

Radar
(77GHz)

PMIC
(USB,…)

Brake Management
(ABS, ESC)

Headlamp Driver

Headlamp Controller

Engine Management
(ECU)

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Test challenges for the new automotive semiconductors

Electrification

Zero Emission HV/ PHV/ EV

- Battery trends towards higher voltages (E-Mobility) for efficient motor drive
- Advanced High Power Technologies (SiC/GaN) bring higher switching frequencies, need higher force and measure accuracy to test low RDSON, increase voltages and currents

Networking

Connected Car

- Increasing wireless content in order to communicate outside the vehicle V2X,
- High frequency mmWave testing (OTA)
- challenging RF standards
- GPS location information
- Big data processing in the cloud

Automatic Operation

ADAS/ Autonomous Car

- Increase **in high-sensitivity sensors**
- Equipped with **advanced CPU**, Shrinking device voltages, precision force & measure
- Higher and higher speed interfaces, More scan vectors
- More complex APU and modems
- **Multiple technologies merging**:
- ✓ Car Radar / Lidar / High performance computing / High power / 5G / …

Safety & Security

Realization of Zero Defect

- Market failure zero
- In-process defects zero
- Long lifetime >10+ years
- Safety/Data encryption
- …

ADVANTEST®

Solution for Testing New-Generation Automotive Components

Solution for Testing Automotive Components

PS1600 Universal Pin
DC.. 1600Mbps
Digital, TMU, VI/PPMU, DPS
128 ch. per card

PS9G / PSSL
DC.... 8+Gbps / 16Gbps
Digital, TMU, PHY test

DPS128HC/HV, DPS64HC
-2.5V...7V (1A) / -6V..+15V (0.2A)
Precision HC/HV DPS, VI

DPS-UHC4T
+4V, 40A
160A/card
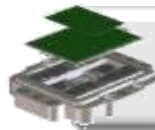
MBAV8+
LF (24bit) + HF (16bit)
4 AWG + 4 Digitizer

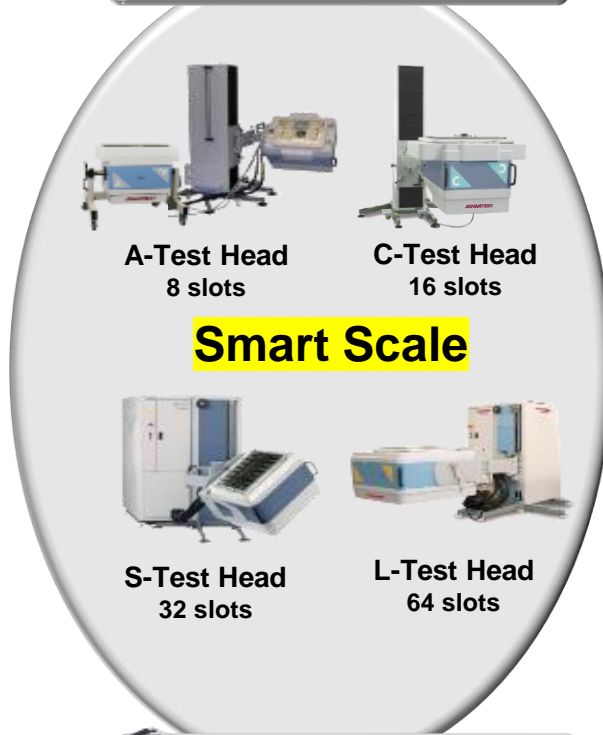**Wave Scale MX**
HS (16bit), HR (24bit)
16 AWG + 16 Digitizer

Same DUT Interface
Same loadboard across TH

A-Test Head
8 slots

C-Test Head
16 slots

Smart Scale
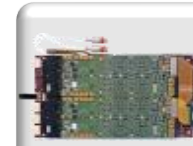
S-Test Head
32 slots

L-Test Head
64 slots

Direct Probe
High Accuracy & Parallelism

Single Scalable Platform

AVI64
64 high Precision VI, DIG IO,
AWG/DGT,TMU.
-40..+80V, ±4A pulsed

FVI16
16 floating high power VI channels
-60V..120V, 10A

PMUX
12 x 1:4 Kelvin multiplexers
(Up to 1536 DC switches)

Wave Scale RF 6/8
6/8GHz
200MHz BW

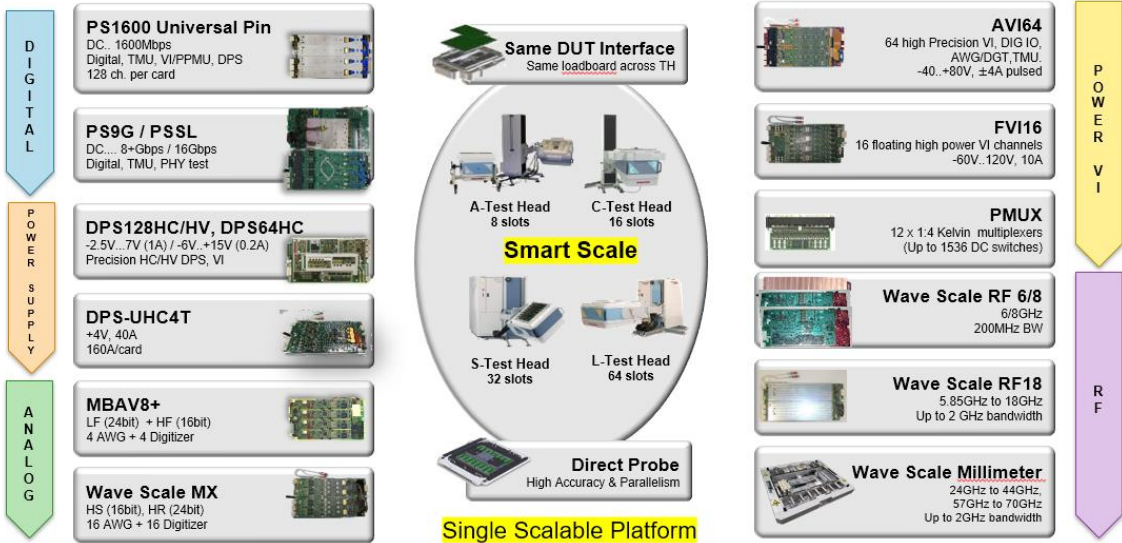**Wave Scale RF18**
5.85GHz to 18GHz
Up to 2 GHz bandwidth

Wave Scale Millimeter
24GHz to 44GHz,
57GHz to 70GHz
Up to 2GHz bandwidth

ADVANTEST®

V93000 EXA Scale Generation

Smart Scale Generation

DIGITAL

PS1600 Universal Pin
DC.. 1600Mbps
Digital, TMU, VI/PPMU, DPS
128 ch. per card

PS9G / PSSL
DC.... 8+Gbps / 16Gbps
Digital, TMU, PHY test

POWER SUPPLY

DPS128HC/HV, DPS64HC
-2.5V...7V (1A) / -6V..+15V (0.2A)
Precision HC/HV DPS, VI

DPS-UHC4T
+4V, 40A
160A/card

ANALOG

MBAV8+
LF (24bit) + HF (16bit)
4 AWG + 4 Digitizer

Wave Scale MX
HS (16bit), HR (24bit)
16 AWG + 16 Digitizer

Same DUT Interface
Same loadboard across TH

A-Test Head
8 slots

C-Test Head
16 slots

Smart Scale

S-Test Head
32 slots

L-Test Head
64 slots

Direct Probe
High Accuracy & Parallelism

Single Scalable Platform

POWER VI

AVI64
64 high Precision VI, DIG IO,
AWG/DGT,TMU.
-40..+80V, ±4A pulsed

FVI16
16 floating high power VI channels
-60V..120V, 10A

PMUX
12 x 1:4 Kelvin multiplexers
(Up to 1536 DC switches)

Wave Scale RF 6/8
6/8GHz
200MHz BW

RF

Wave Scale RF18
5.85GHz to 18GHz
Up to 2 GHz bandwidth

Wave Scale Millimeter
24GHz to 44GHz,
57GHz to 70GHz
Up to 2GHz bandwidth

V93000 EXA Scale

Universal Digital Pin
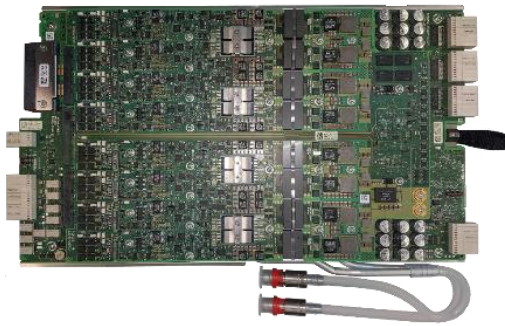
PS5000

+

XPS256

Power supply

Key automotive testing instuments

FVI16
Digital feedback designed
Floating High Power VI

- **16 channels per card**
- **Stacking up to ±200V**
- **Ganging up to 155A**

AVI64
Digital feedback designed
Universal Analog Pin
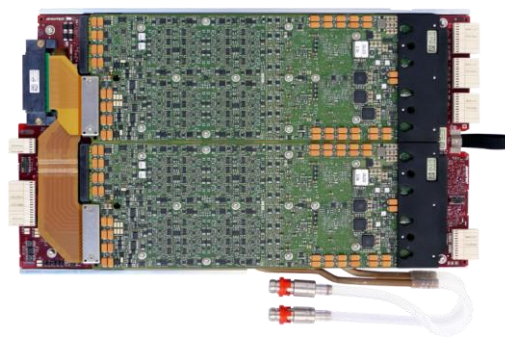
- **64 channels per card**
- **VI: -40V..+80V, 200mA / pin**
- **High Precision DC 100uV accuracy**
- **AWG / Digitizer / DiffVM / TMU / HV Digital IO**
- **Floating High Current Unit: 4A**

XPS256 [new]
Digital feedback designed
Power supply

- **256 pins with 1A**
- **Best Accuracy 150uV & Dynamic Response <40mV**
- **Unlimited & flexible ganging mA to >> 1000A**

PS5000 [new]
Fastest general purpose
Universal Digital Pin

- **256 pins with 5Gbps**
- **3.5Gvec / per pin, 896Gvec one pin via Xtreme pooling™**
- **Digital, TMU, VI, AWG/DGT, DPS/ganging**
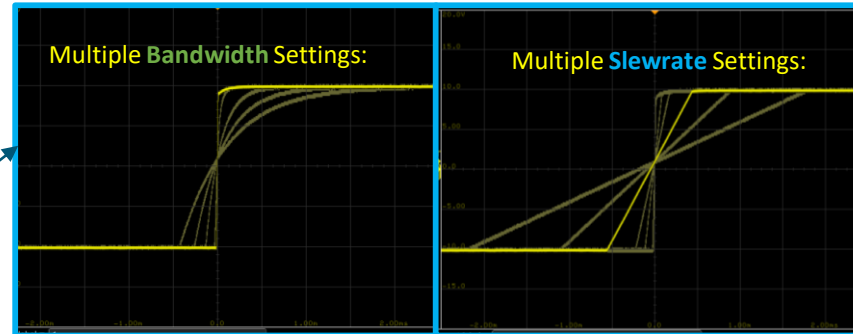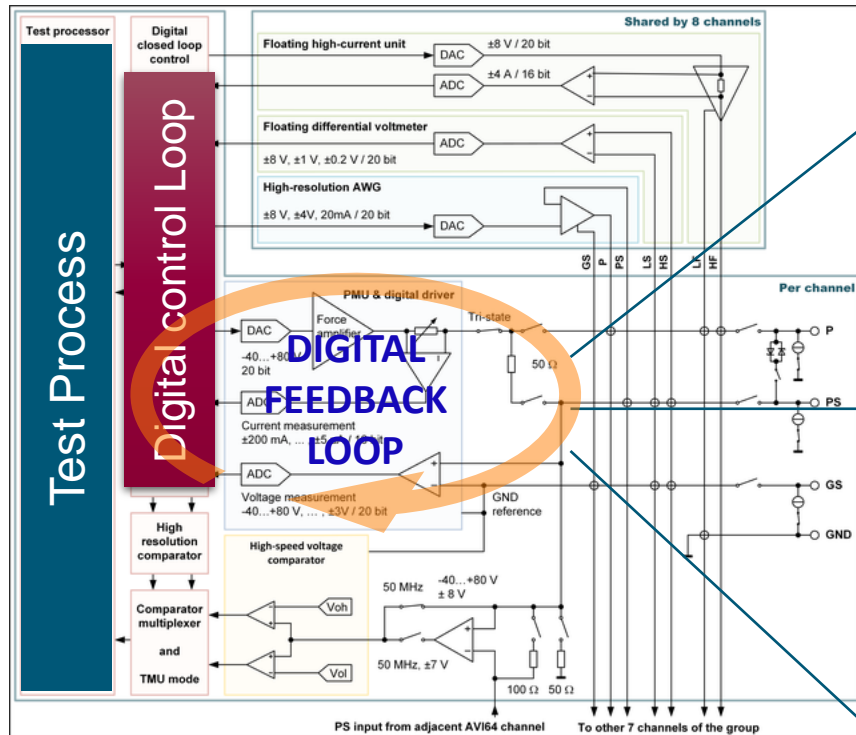
Why Digital Feedback Closed-Loop?

high reliability and quality Automotive testing required:

- **Glitch free connection/ transient** to avoid DUT damage, latch up, overstress (electrical, thermal or mechanical) ➔ high quality requirements of test ➔ **AEC-Q100 zero defects**
- **Avoid connection issues** experienced during power test development
- Faster test development time ➔ **higher productivity**
  - Less debugging effort
  - No need of hand crafted connection sequence
    - Min. 5ms (manual prg.) vs. ~1ms (automated sequence) for each connect
- spike check before product release (**Automotive requirement**)


AEC - Q004 - Rev- February 26, 2020

AUTOMOTIVE ZERO DEFECTS FRAMEWORK

ZD
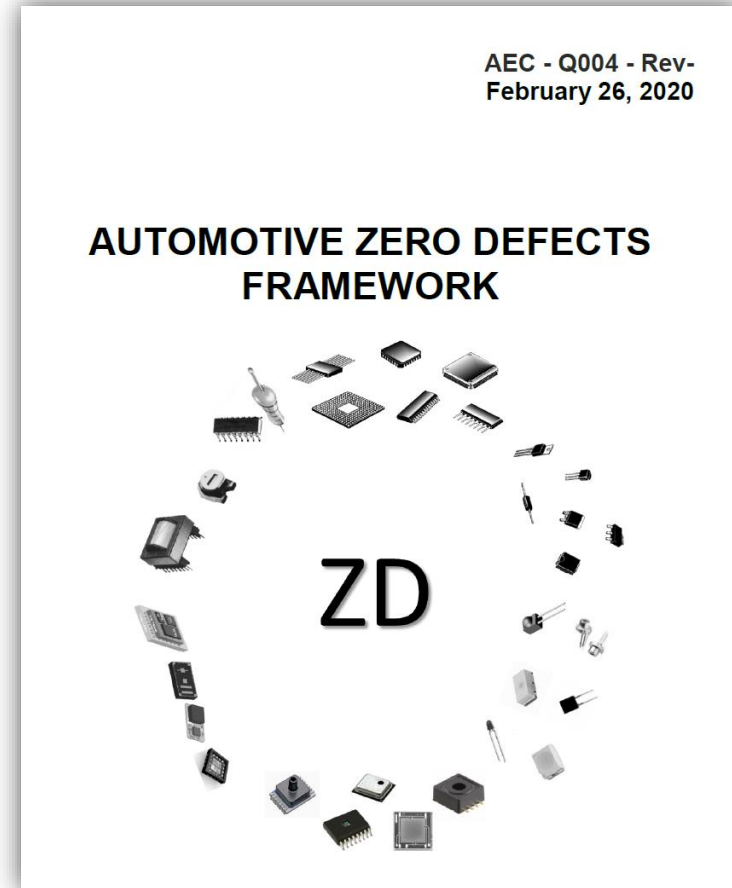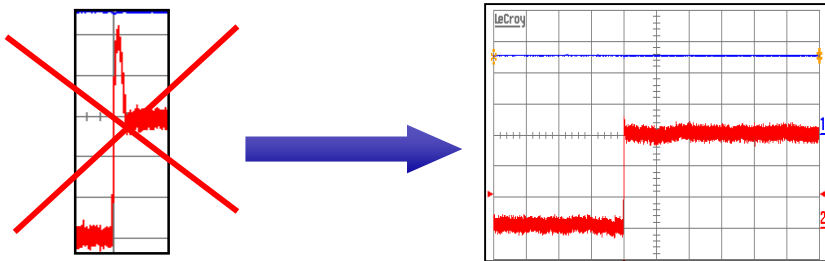
Why Digital Feedback Closed-Loop?

AVI64 Block diagram example

Multiple **Bandwidth** Settings:

Multiple **Slewrate** Settings:

iForce

vForce

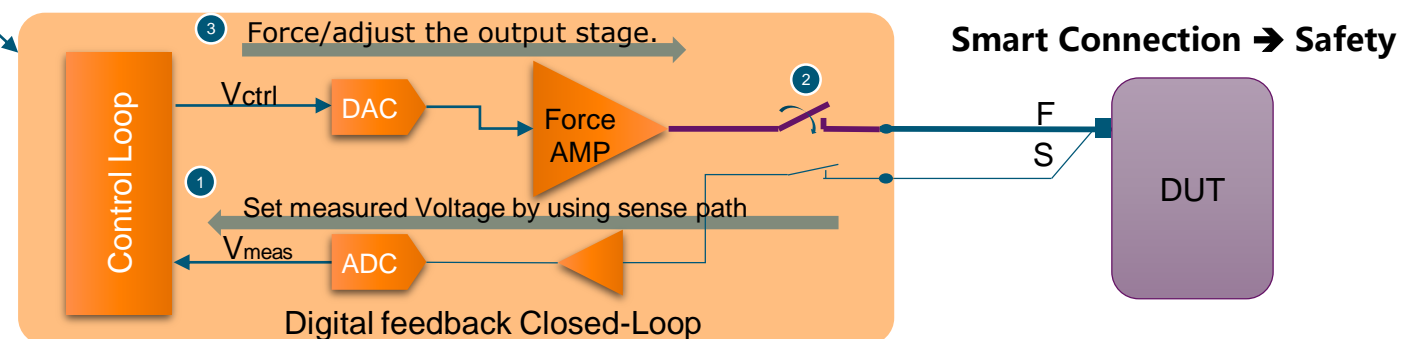*vForce*

Seamless adjustment of bandwidth and slewrate

→ **Adapt to various load conditions (resistive, capacitive, inductive) to optimize settling times and overshoot, High quality of test, no overshoots which can lead to device latchup, etc.**
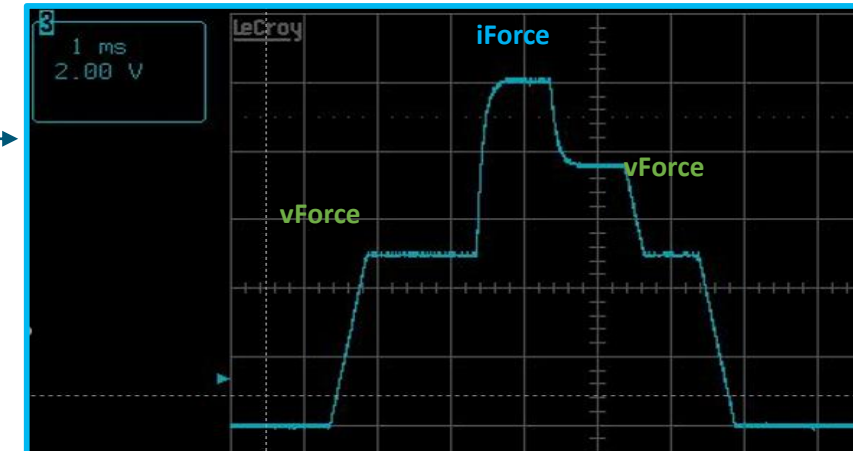
Seamless mode change between vForce to iForce

→ No disconnect needed
→ Fast test times
  e.g for regulator testing load and line regulation in one sequence

AVI64/FVI16 Adopting Advantest Power design technology already validated on Automotive applications in the world's top automotive semiconductor companies

③ Force/adjust the output stage.

Control Loop

Vctrl → DAC → Force AMP ② F / S → DUT

① Set measured Voltage by using sense path

Vmeas ← ADC ←

Digital feedback Closed-Loop

Smart Connection → Safety

Solution Examples for New-Generation Automotive Components

Solution Examples for New-Generation Automotive Components

Multiple Technologies in new generation automotive:

New Generation Automotive:
Hybrid & Electric Vehicles (EV)
  Battery monitor, Battery Charger, balancing, Motor Driver/controller Switches (HS/LS, H-Bridges…)
ADAS system extends
  Lidar, Radar
  Digital Lighting
  Camera and Sensors
  High performance computing, Soc/GPU/CPU
V2X (vehicle to everything)
  5G, Cellular, Wi-Fi, BT, IoT,…

followed slides will show you test solutions for:

Battery Management System IC

Digital Light

Lidar Technology solution

Autonomous Systems

Vehicle to Everything

ADVANTEST®
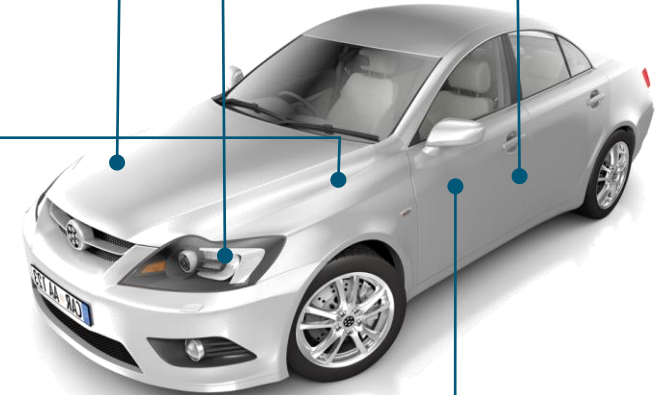
Electrification: Battery Management System IC

With the shift to HV/ PHV/ EVs, the market for battery monitoring ICs will expand to maximize the use of battery capacity.

→ The demand for **"Testing Battery Monitoring ICs with High Precision"** will increase.

V93000 PAC

16xModules, 7104x 18650 cells connected in serial (~4.2 V max @ 100% SOC), to reach 400V package voltage
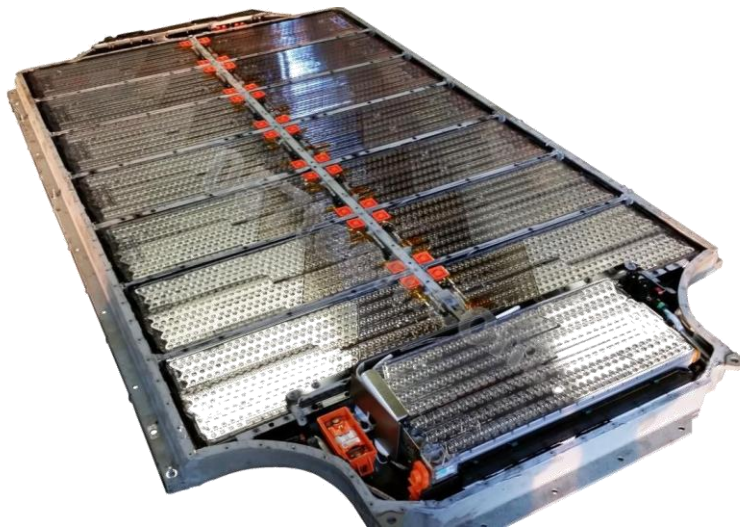
(Used in early Tesla S Models **Tesla 84 kWh / 400 V Battery**)

Features of a BMS chips:
1. Dynamic Monitoring in real time.
   - Acquisition battery cell V, T, I.
   - Battery cell state monitor (e.g OV/UV).
2. Balancing control.
3. communication SPI / GPIO between communicating devices or other nodes (T, I).

BMS Chip
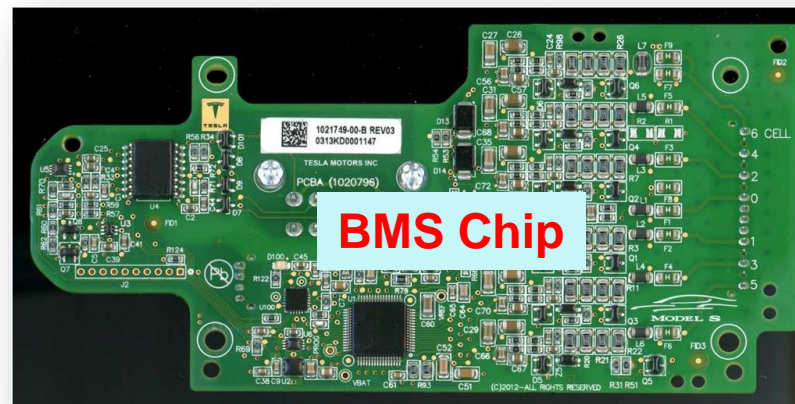
Older Tesla S BMS PCB (1 of 16)
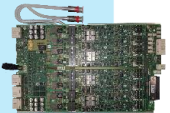
PS1600 Universal Pin
DC.. 1600Mbps
Digital, TMU, VI/PPMU, DPS
128 channels per card

FVI16
floating high Power VI
16x ch. -60V...+120V, 10A
Power VI, HV-DPS, AWG/DGT,TMU
200V stacking, 155A ganging

AVI64
Universal Analog Pin
64xch -40V...+80V, 200mA VI
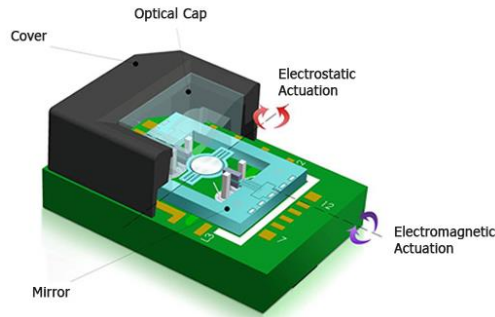Precision DC, 100uV accuracy
TMU, AWG/DGT, HV Digital IO

PMUX
12 x 1:4 Kelvin multiplexers
(Up to 1536 DC switches)

Lidar Technology solution

Mechanical Lidar

- MEMS mirror based or rotating optics
- Cost intensive. less reliable

6 Lidars per car for full 360° view
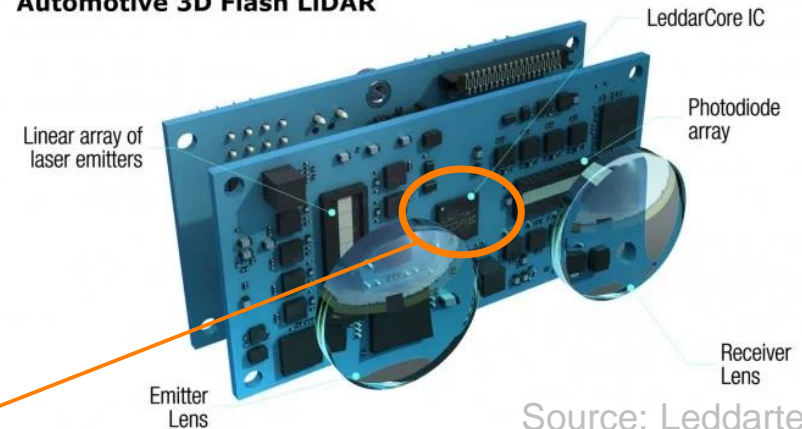
Source: Leddartech

Solid State Lidar

- Robust, no more moving parts
- 3D scanning capability by laser and photo diode arrays
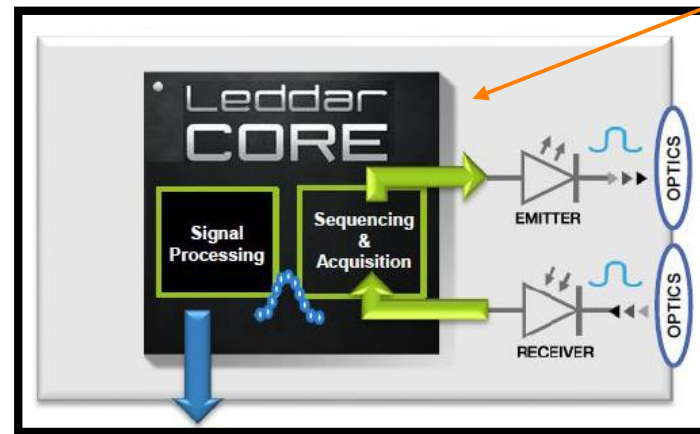- Cost down   < 100 USD

Automotive 3D Flash LiDAR

Source: Leddartech

PS1600 Universal Pin
DC.. 1600Mbps
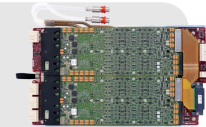Digital, TMU, VI/PPMU, DPS
128 channels per card

for digital tests of signal processing chain

AVI64
Universal Analog Pin
-40V...+80V, 200mA VI, accuracy 100uV
Precision DC, TMU, AWG/DGT, Digital
64 channels per card

for precicion parametric tests on analog frontend

Digital Light – Future Headlamp Technology

High speed data interface for individual real time LED control …

Supply LED chip with >50W of DC power…

PS1600 Universal Pin
DC.. 1600Mbps
Digital, TMU, VI/PPMU, DPS
128 channels per card

DPS128 HC
-2.5V...7V, 1A max (-6V...+15V HV)
Precision DC, DPS, VI
128 channels per card

Pin Scale 5000
256 pins at 5000Mbps
Advanced Universal pin

DC Scale XPS256
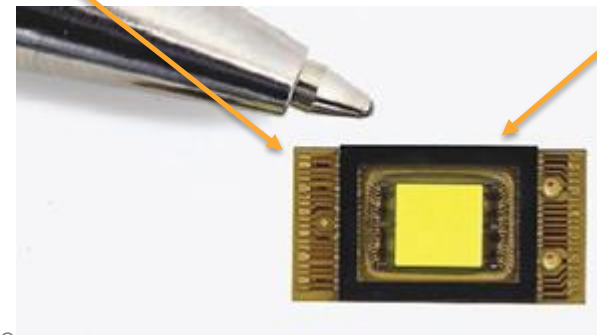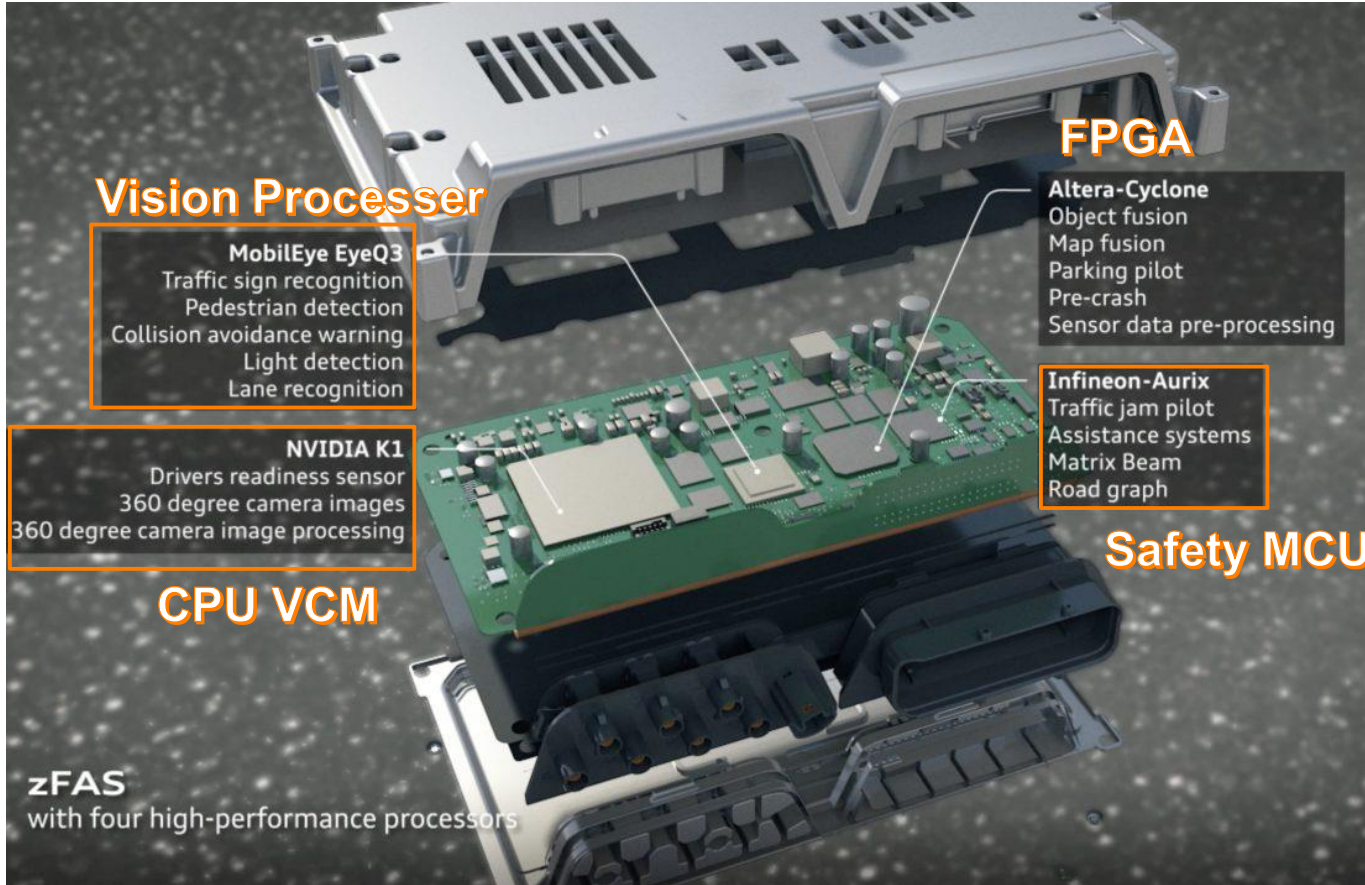256x 1A, unlimited ganging
< 40mV droop,

NEW

NEW

Enables next step of safety:
- Display warnings on pavement
- Display traffic lanes
- Blank out faces of pedestrians
- Intelligent high beam
- And much more…

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CONFIDENTIAL
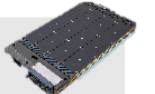
Autonomous Systems – AUDI A8 ADAS module (level 3)

AUDI A8 ADAS module (level 3)

Source: Audi

Vision Processer

FPGA

MobilEye EyeQ3
Traffic sign recognition
Pedestrian detection
Collision avoidance warning
Light detection
Lane recognition

Altera-Cyclone
Object fusion
Map fusion
Parking pilot
Pre-crash
Sensor data pre-processing

NVIDIA K1
Drivers readiness sensor
360 degree camera images
360 degree camera image processing

Infineon-Aurix
Traffic jam pilot
Assistance systems
Matrix Beam
Road graph

CPU VCM

Safety MCU

zFAS
with four high-performance processors

➢ **Multiple SoCs** from different vendors on the same board

PS1600 Universal Pin
DC.. 1600Mbps
Digital, TMU, VI/PPMU, DPS
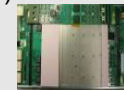**128 channels per card**

Pin Scale 5000
256 pins at 5000Mbps
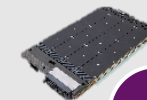3.5GVec per pin scan memory
Advanced Universal pin
NEW

Digital

DPS128 HC/HV
-2.5V...7V, 1A max (-6V...+15V HV)
Precision DC, DPS, VI
128 channels per card

DC Scale XPS256
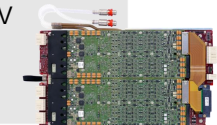256x 1A, unlimited ganging
< 40mV droop,
NEW

Power

AVI64
Universal Analog Pin
-40V...+80V, 200mA VI, accuracy 100uV
Precision DC, TMU, AWG/DGT, Digital
64 channels per card

Analog

ADVANTEST

V2X - Vehicle to Everything enhances ADAS

- Do not pass warning
- Collision/queue warning
- Blind intersection detection
- Cruise control & platooning
- …

- Traffic signal priorities
- Emergency vehicle alert
- Discover parking/charging
- …

- Alerts
- Vulnerable road user
- …

- SW updates
- Service Notifications
- ..

Vehicle

Vehicle

V2V

V2P

V2I

V2N

Pedestrian / VRU
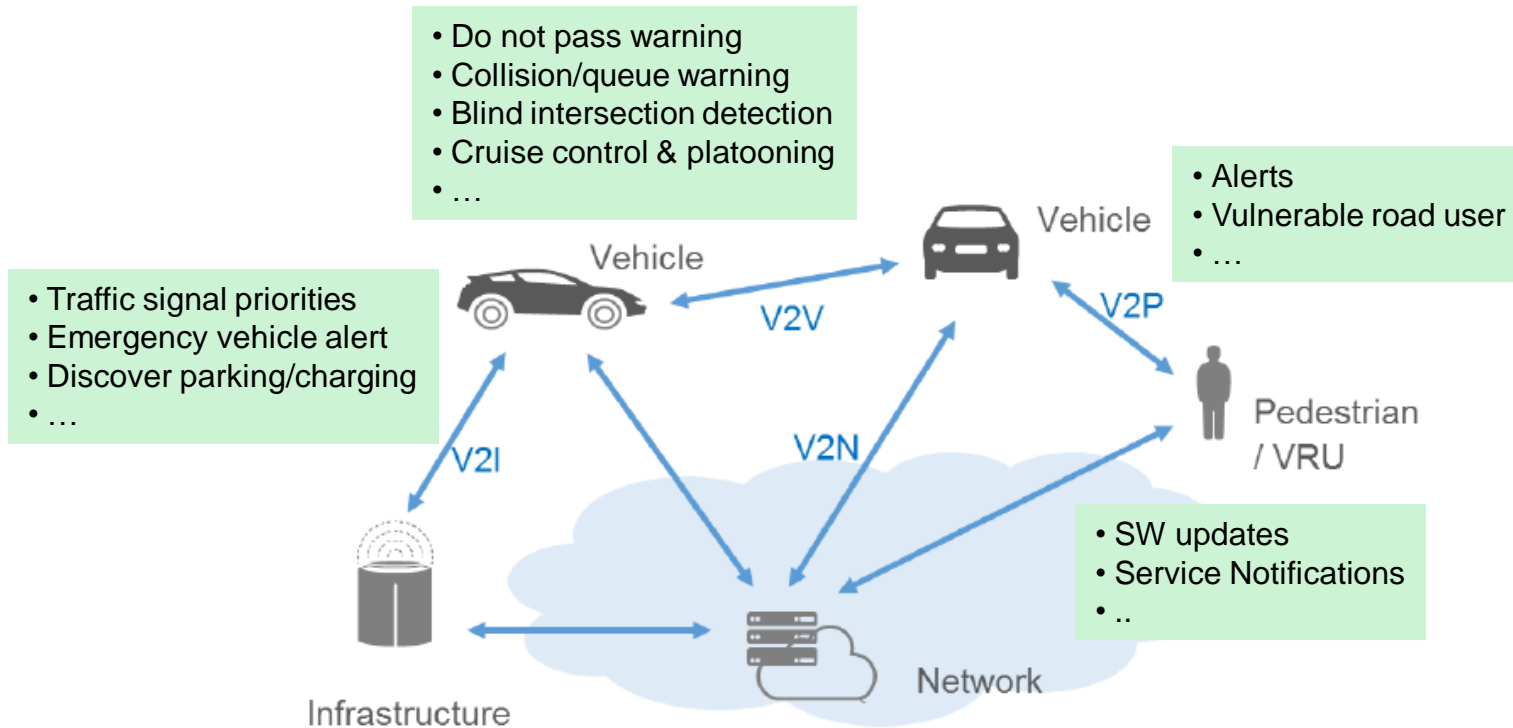
Infrastructure

Network

Figure 1: V2X Types.

Source: The 3G4G Blog

1. Improve active safety
2. Better traffic efficiency
3. Increase situational awareness

Wave Scale RF – ready for upcoming V2X test challenges

Wave Scale RF 6/8

6/8GHz,
200MHz bandwidth

Wave Scale RF18

5.85GHz to 18GHz
Up to 2 GHz bandwidth

Wave Scale Millimeter

24GHz to 44GHz, 57GHz to 70GHz
Up to 2GHz bandwidth

All functionality controlled through HW sequencer
Best throughput and highest repeatability

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Automotive Electronics tested on V93000

Traditional Automotive Semiconductor Segments:

Multiple Technologies in new generation automotive:
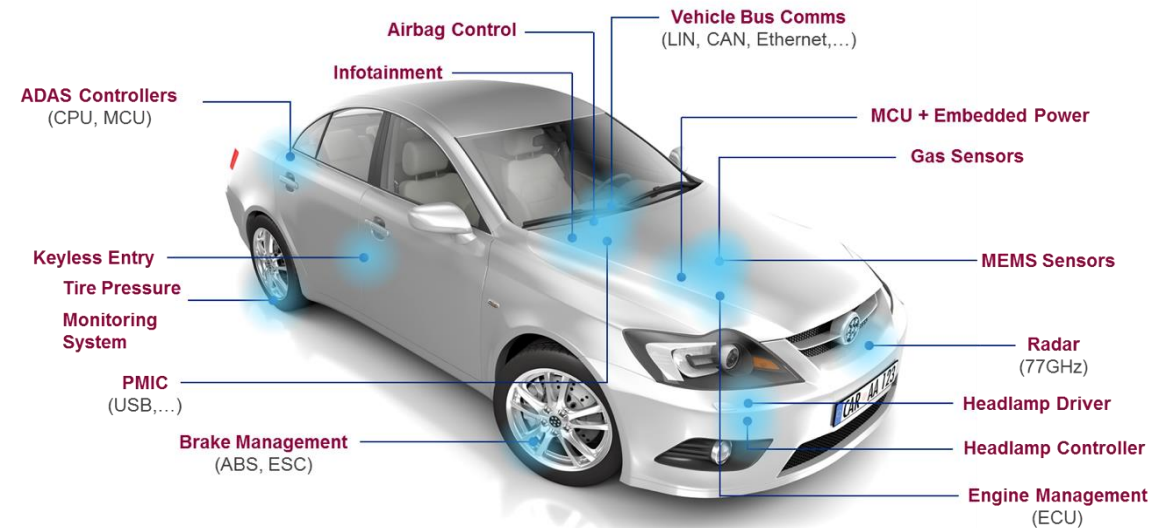
Typical Automotive Applications:
- Safety and Chassis
    - ABS, ESC, Airbag…
- Power Train
    - Engine Management, injection, transmission…
- Body comfort electronic
    - door/window/seat controls, LED lighting, wiper…)
- Infotainment
    - Audio, GPS…
- Sensors
    - Acceleration, gyro, pressure…
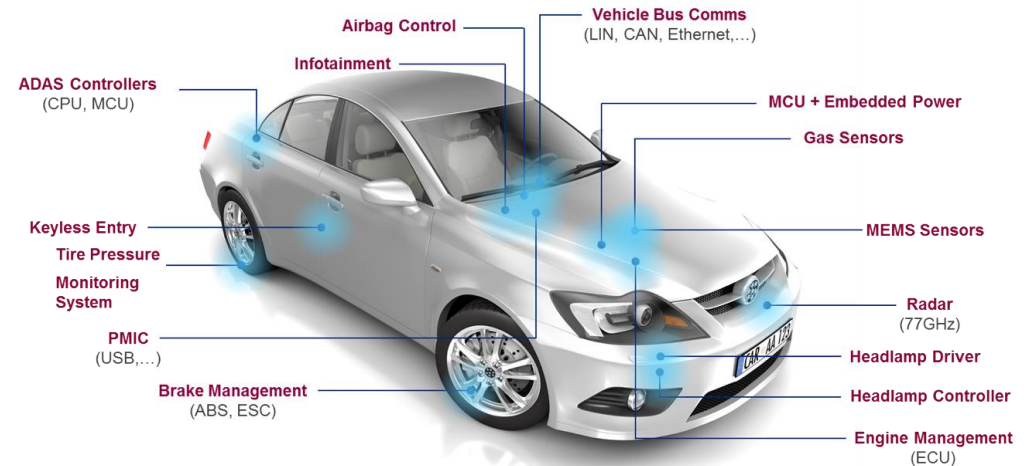
New Generation Automotive:
- Hybrid & Electric Vehicles (EV)
    - Battery monitor, Battery Charger, balancing,
    - Motor Driver/controller
    - Switches (HS/LS, H-Bridges…)
- ADAS system extends
    - Lidar
    - Digital Lighting
    - Camera and Sensors
    - High performance computing, Soc/GPU/CPU
- V2X (vehicle to everything)
    - 5G, Cellular, Wi-Fi, BT, IoT,…

Automotive Electronics tested on V93000

Airbag Control

Vehicle Bus Comms
(LIN, CAN, Ethernet,…)

Infotainment

ADAS Controllers
(CPU, MCU)

MCU + Embedded Power

Gas Sensors

Keyless Entry

MEMS Sensors

Tire Pressure

Monitoring System

PMIC
(USB,…)

Radar
(77GHz)

Brake Management
(ABS, ESC)

Headlamp Driver

Headlamp Controller

Engine Management
(ECU)

Summary

- **Electrification and Autonomous Driving** need more and more new semiconductor technologies to support them.

  ✓ Battery technologies trend towards higher voltages for efficient motor drive. Advanced High Power Technologies (SiC/GaN) bring higher switching frequencies, need higher force/measure accuracy to test low RDSON, increase voltages /currents requirements.

  ✓ ADAS need multiple Technologies to realize autonomous driving, like Sensors, High-End Computing, 5G. Test techniques need the know-how of Power, Analog, Digital, Mixed Signal, and RF. **ATE meets challenges for more and more channels per system, higher performance & reliability** due to new technologies.

- Advantest V93000 provides **complete solutions** to address next-generation automotive testing.

- V93000 digital feedback control loop technology provides high quality test signal for automotive ICs testing, help you to realize the goal of **Zero-defect strategy.**

Airbag Control

Vehicle Bus Comms (LIN, CAN, Ethernet,…)

Infotainment

ADAS Controllers (CPU, MCU)

MCU + Embedded Power

Gas Sensors

Keyless Entry
Tire Pressure
Monitoring System

MEMS Sensors

Radar (77GHz)

PMIC (USB,…)

Headlamp Driver

Brake Management (ABS, ESC)

Headlamp Controller

Engine Management (ECU)

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