



General Purpose Analog in AI Servers

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Key benefits of STEF48H28 hot-swap solution

First fully integrated protection for 48 V bus



Best-in-class power density: $>1 \text{ kW in } 7 \times 7 \text{ mm}^2$

Best-in-class On resistance: $< 2 \text{ m}\Omega$, minimizes power losses

High precision analog and digital (PMBUS) telemetry

Innovative (i x t) overcurrent protection: no oscillations

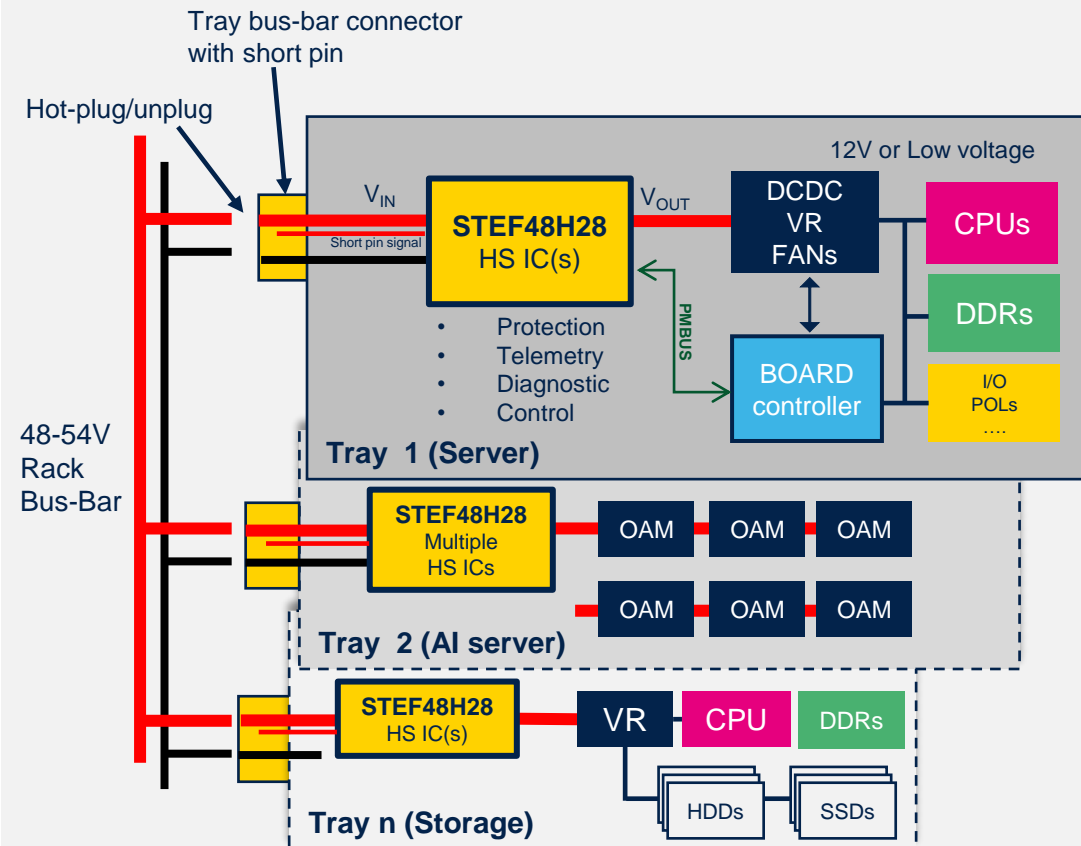
Noise immunity circuit: keeps system alive during line transients in the rack

Real-time thermal and SOA protection

One part number fits single and parallel operation:
Minimized test and qualification efforts

Hot-swap controller integrating low-Ron FET switch

eFuse/hot swap protection for IT trays (server, telecom, AI/ML, storage) on 48V DC power

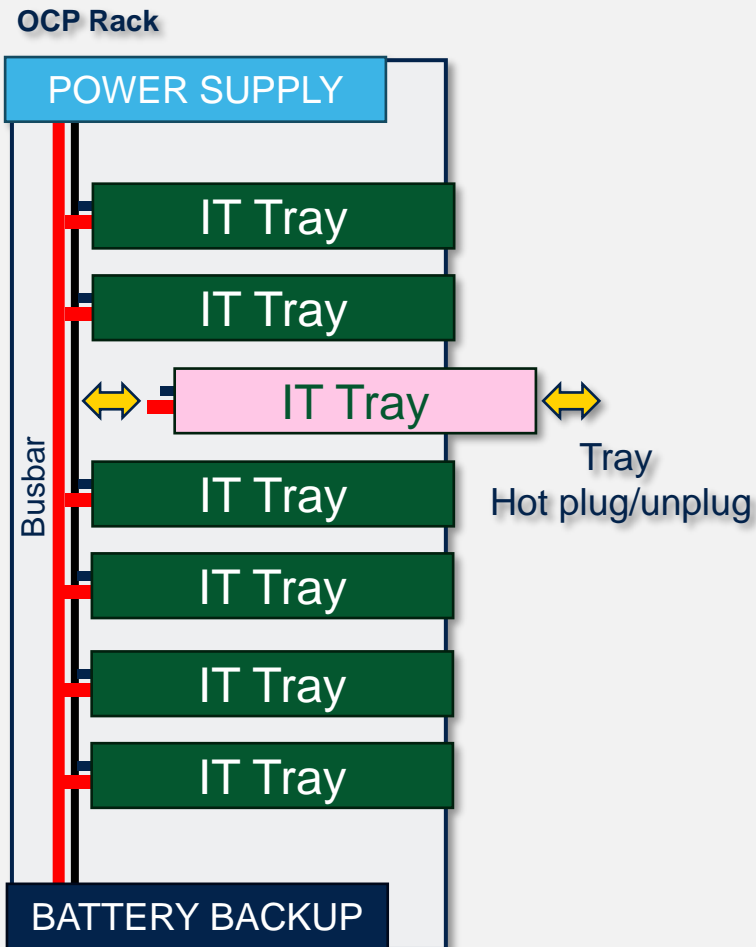


Function: main hot-swap protection/eFuse for 48V-54V DC

Features:

- Integrated Power MOSFET – 30A continuous current
- Internal current sensing – no shunt resistor
- Full set of configurable protections (UV, OV, OCP, SC, OT)
- Easily scalable by parallel configuration
- High immunity to busbar/line noise and steps
- Real-time analog and digital telemetry
- Integrated thermal sensors – real-time OT protection
- PMBUS interface

Context and requirements



Operating context

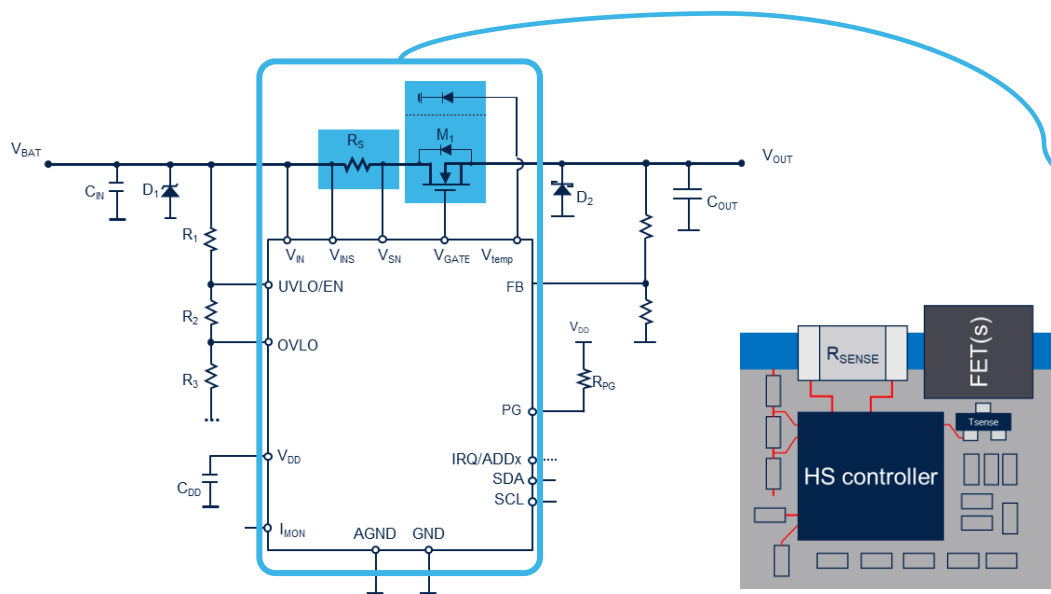
- +40V to + 59.5V DC
- Voltage spikes up to >90V
- 500W to multiple kW's power x tray
- Tray live hot-swap
- 100s nH to μ H input Busbar inductances
- Line transitions (PSU \leftrightarrow BBU)
- Line noise, EFT and surges

Requirements for the HS IC

- Over-Undervoltage protection
- Inrush-current control
- No input capacitor allowed
- Automatic IT gear restart
- Overcurrent protection
- Short circuit protection
- FET overtemperature protection
- FET short circuit detection
- FET SOA protection
- Immunity to line noise: avoid unwanted shutdowns

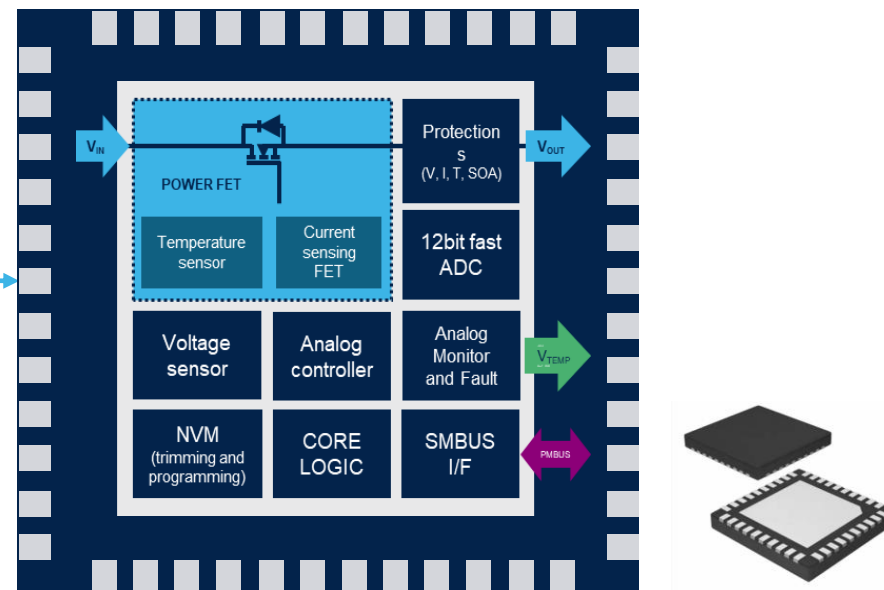
Integrating 48V hot-swap protection

Traditional hot-swap controller



External Rsense in series with the FET switch(es) and thermal sensor to be sized, compensated and tuned by the application designer.

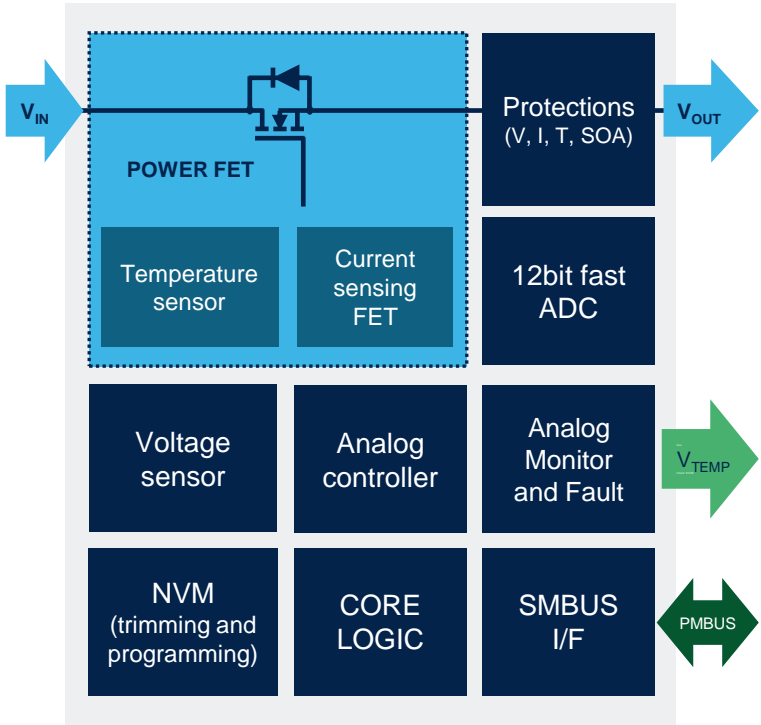
Integrated solution - STEF48H28



100V – 1.6mΩ FET with thermal and current sensor embedded. No external FET nor sense networks. Current and thermal sensor internally compensated and trimmed.

STEF48H28 features

48-54V electronic fuse/hot-swap with diagnostic features and PMBUS interface



Wide range of operation

- Input voltage range: **9 to 80V** (95V AMR, 100V transients)
- Adjustable UVLO/OVLO helps customizing the BUS protection

Efficient Power Integration:

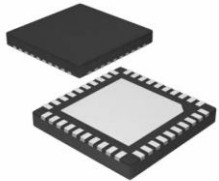
- Up to 30A Continuous current in a **7x7 mm² QFN**
- Up to **65% of area saving** vs space-wasting solutions with external MOSFETS and R-sense
- **1.6 m Ω Integrated smart FET** switch with current sensor minimizes power losses
- **Parallel configuration** protects High power systems

Accurate control and protection

- Programmable soft-start minimizes the in-rush current
- Enable, Power good and adjustable timers allow correct power ON/OFF sequences
- High Precision Adjustable **Current limit with (i x t) curve** accommodates load peaks (**GPU profile**)
- Fast, programmable Short circuit protection
- **Internal thermal and SOA protections** for the internal power switch
- **Noise immunity feature** allows smooth operation during hot-swaps

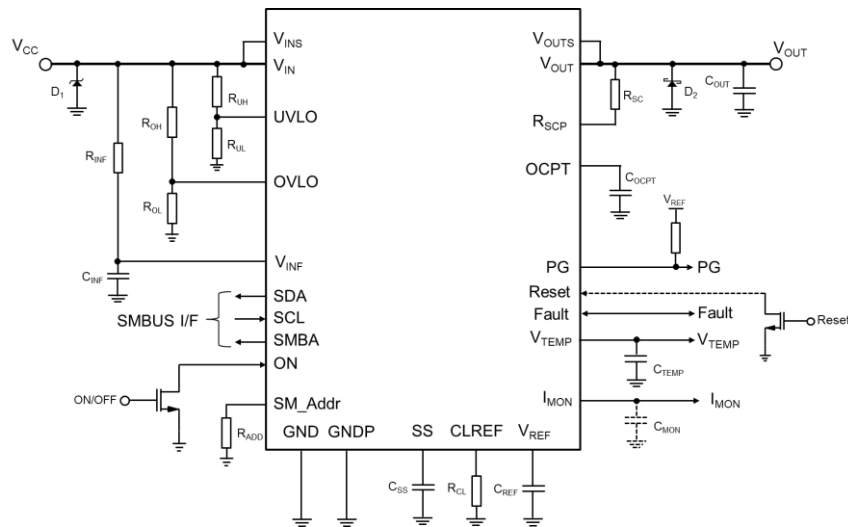
Remote monitor and diagnostics:

- **Precise analog current and temperature monitor** (I_{MON} , T_{MON})
- **PMBUS interface** with **V, I, T, E** and **Power telemetry** and address functions
- Reset and Fault flags for overload and protection intervention
- NVM and **black box**



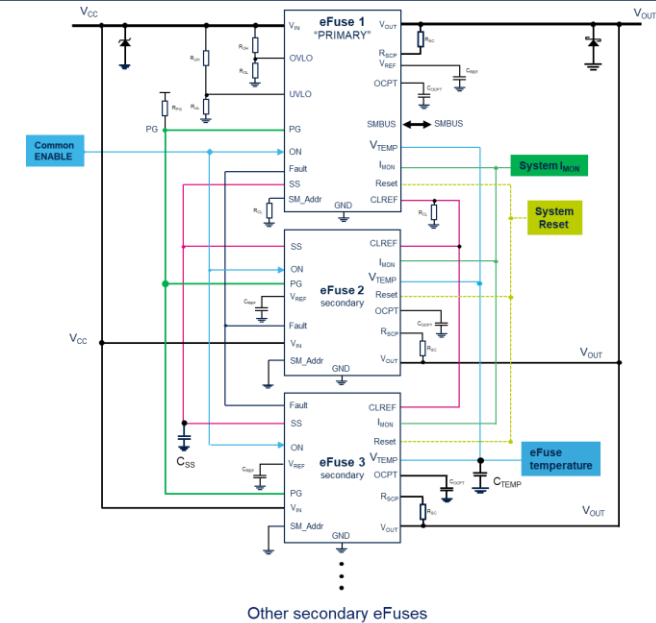
Device configuration

Single configuration (1-1.5 kW TDP, 2 kW peak)



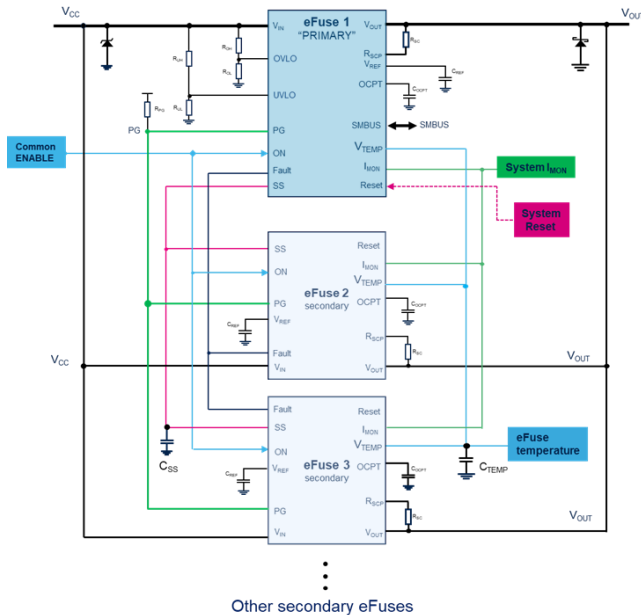
- One block handles 30A continuous current
- Analog I_{MON} , T_{MON}
- V, I, P, E and T telemetry on PMBUS

Parallel configuration, scalable power (>20kW)



- Only one device connected to PMBUS
- Same part number covers primary/secondary function
- System's I_{MON} and T_{MON} telemetry on analog pins
- Systems V, I, P, E and T telemetry on PMBUS

Parallel operation detail



System requirements

- Easy and reliable power scalability of the hot-swap function
- Inrush current control
- Safe and repeatable startup into the bulk capacitance
- No startup into leaky/shorted loads
- Fast and reliable ON/OFF synchronization
- Balanced current among the power devices
- Accurate system telemetry

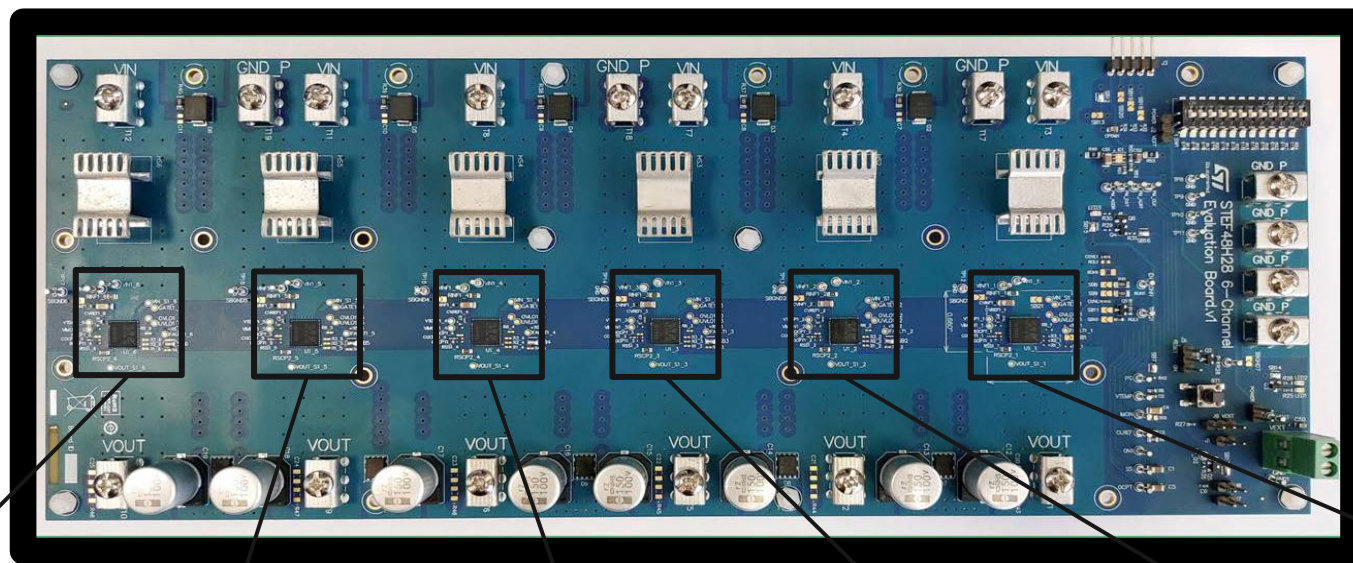
Implementation

- Parallel interconnection of multiple eFuses
- Controlled V_{OUT} ramp-up
- Multiple integrated protections (SOA, OT, OC) at startup
- Output status check with programmable timers and voltage thresholds
- Dedicated Fault propagation signal
- Current balancing circuit
- I, V, P, E and T telemetry with thermal compensation



Thermal analysis at full load parallel configuration

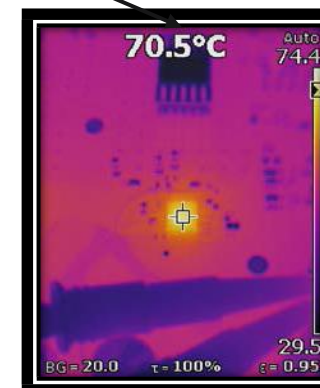
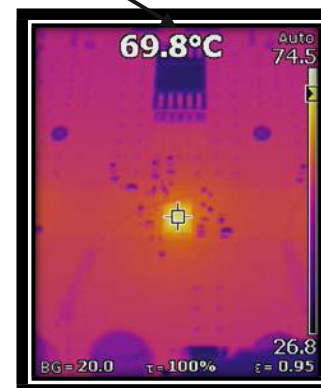
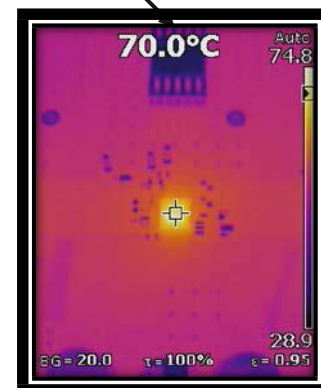
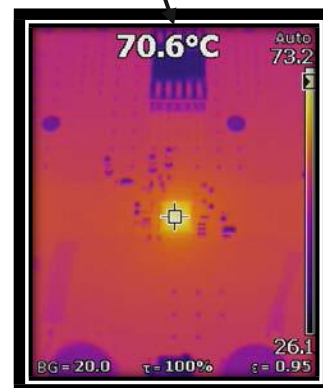
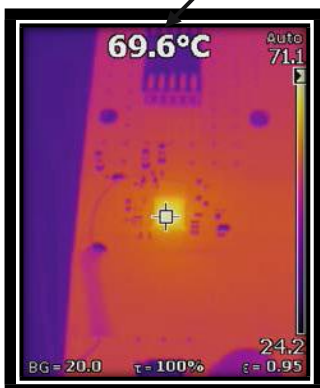
Test conditions:
EVb 6x eFuses,
 $V_{IN}=48\text{ V}$,
 $I_{OUT}=180\text{ A}$
(30 A per efuse),
 $T_{amb}=25^{\circ}\text{C}$.



Using a thermal imaging camera to show the temperature of each eFuse connected in a parallel architecture.










The test was carried out at room temperature and an output power of 1.5 kW per eFuse. The temperature of each eFuse is close to the others confirming the great thermal performance of the device (R_{THJA}) and a good EVb design. The results are in line with the telemetry data.

eFuse-to-eFuse delta $T < 1^{\circ}\text{C}$


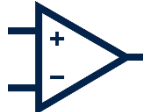








General-purpose analog products

Power management

 DC+	DC-DC converters	 LDO	LDO regulators	 Battery Chargers	Battery Chargers
 Voltage Reference	Voltage Reference	 LED Drivers	LED Drivers	 STPMIC	PMIC
 eFuse	Electronic Fuses	 Real Time Clocks	Real Time Clocks	 Space	Space

Signal conditioning and interface

 ST Op Amps	Operational amplifiers	 Comparators	Comparators	 Current-sense amplifiers	Current-sense amplifiers
 Audio ICs	Audio ICs	 Battery Monitoring	Battery Monitoring	 ADC	ADC
 STUSB	USB	 Interfaces	Interfaces		

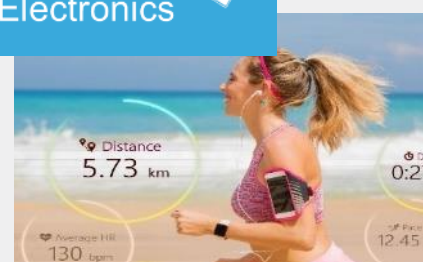
Industrial



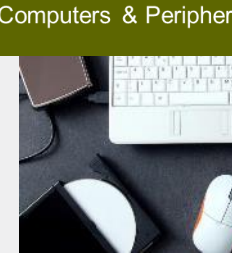
Automotive



Personal Electronics

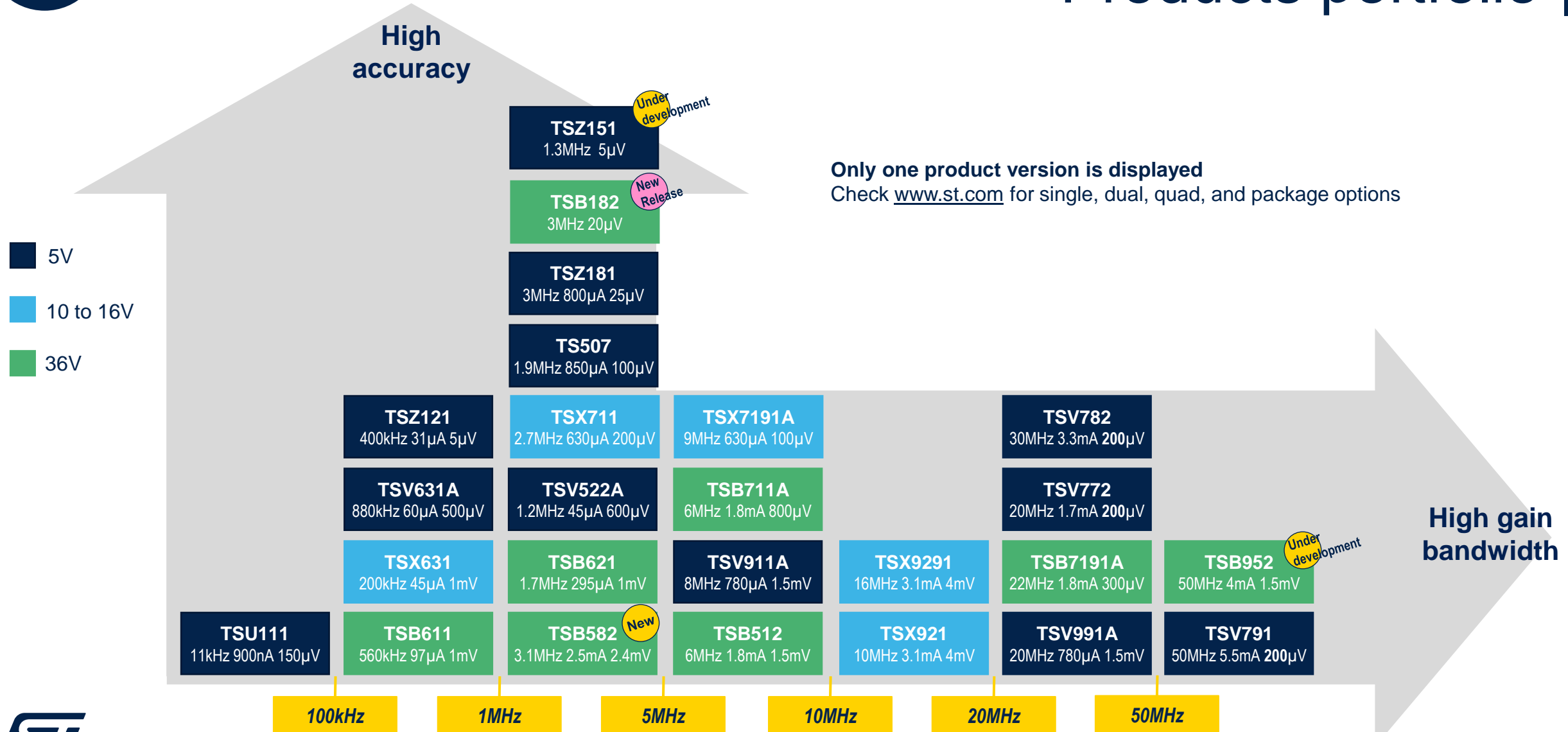


Communications Equipment, Computers & Peripherals





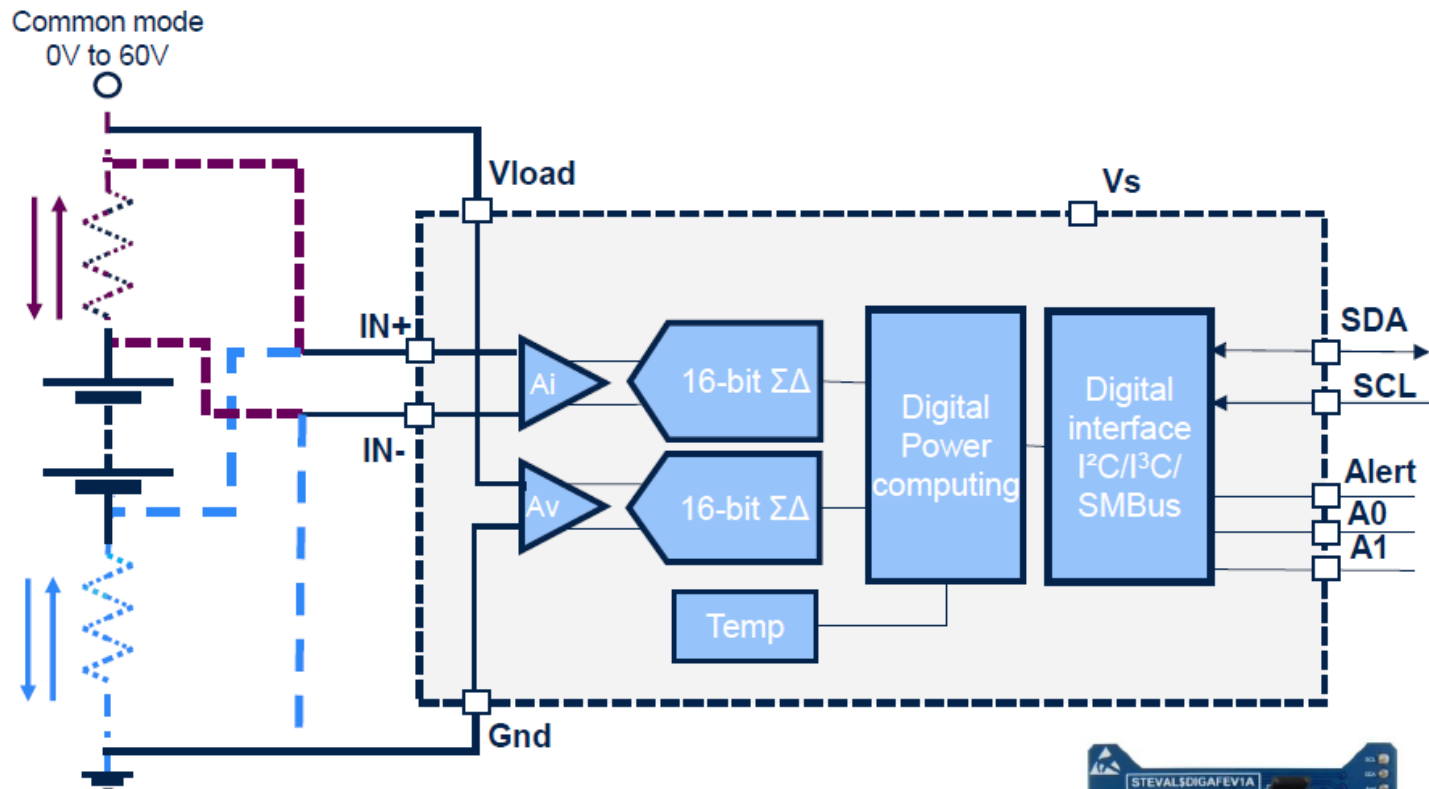
Operational Amplifiers Products portfolio





NEW

Digital DC current sense AFE



DFN10 3x3 mm



Key features

- Monitors current, DC voltage up to 60V, temperature and performs DC power computing
- Current measurement can be high-side low side and bidirectional
- **Alerts can be raised if over/under voltage, current power and temperature**
- 2.7V to 5.5V power supply
- Integrated dual-channel 16-bit sigma-delta
- Conversion rate from 128µs to 31.768ms
- **Bus interface: MIPI I3C, I²C/SMBus**

Status

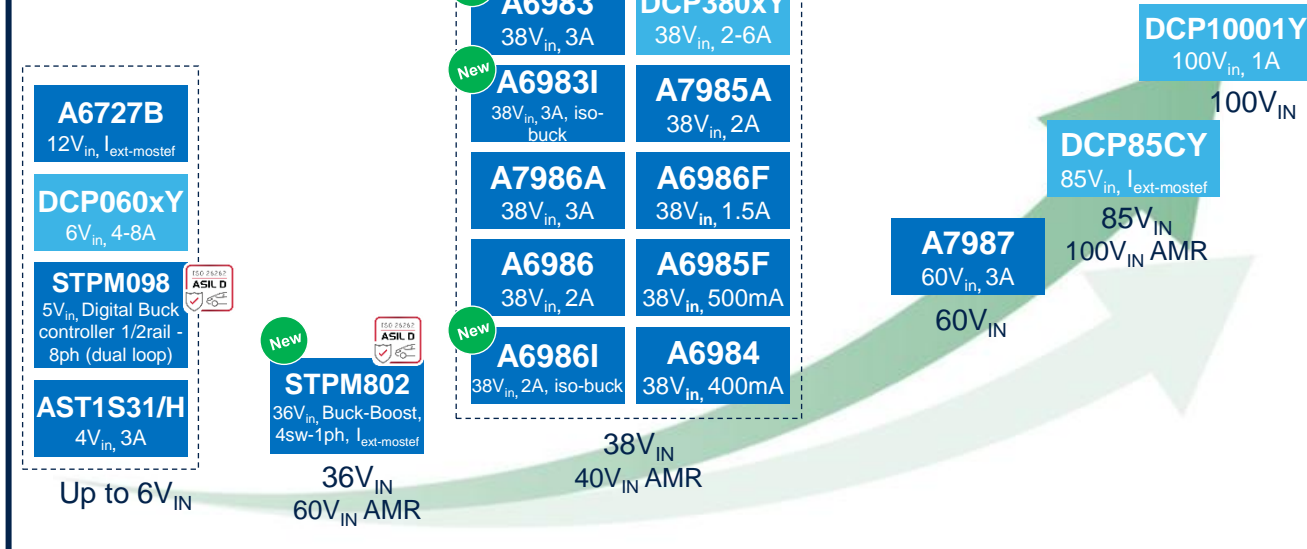
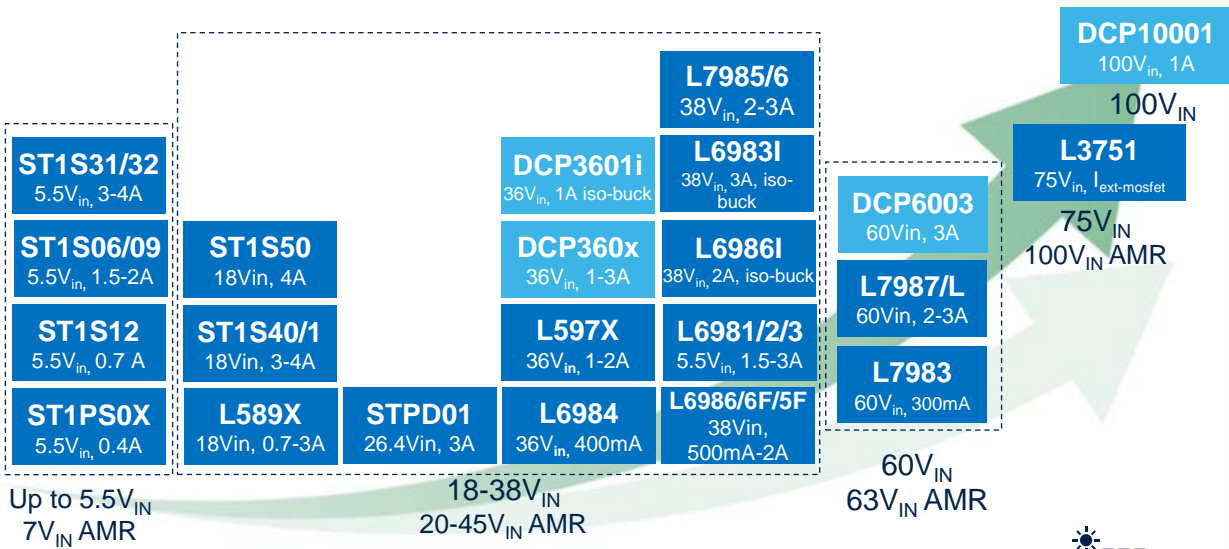
- Mass production
- Evaluation board: **STEVAL-DIGA FEV1**



Switching regulators application segment

Industrial

Automotive



3.3/5 V



12-24V_{BUS}



48V_{BUS}



3.3/5 V_{BUS}



12V_{BATT} Car



24V_{BATT}



48V Boardnet



Available Under development



High-performance LDOs by feature


Miniaturization

LDBL20: world's smallest LDO
LD56020: best featured in CSP
LD39020/39030: DFN4-1x1mm²




Tiny package

Low consumption

STLQ020: 200 mA, 0.3 μA I_Q LDO
LD39130S: 300 mA, 1 μA I_Q LDO
LDQ40/LDL40: 250mA, 2 μA I_Q , AG 

Ultralow I_Q

Low power dissipation

LD59150: 1.5 A, 65 mV drop LDO, AG
LD39200: 2 A, 130 mV drop LDO
LD56050: 0.5 A, 80 mV drop LDO
LD57100: 1 A, 50 mV drop LDO
LDO40L: 0.4 A, 140 mV drop LDO, AG 

Ultralow dropout



LDO

Standard V_{REG} & Power packages

L78/L79, LM317, LD1117



From the leader in industry standard and power packages

Noise sensitive environments

LD56100: 1 A, 13 μV_{RMS} , Low noise, low drop
LDLN025: 250 mA, 6.5 μV_{RMS}
LDLN030: 300 mA, 7.5 μV_{RMS} , 80dB PSRR
LD56020: 200 mA, 8.8 μV_{RMS} , 90dB PSRR Low Vin

Low noise High PSRR



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