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Standard analog products for automotive

General Purpose Analog

Signal conditioning and interface

April 2023

Index

ST provides a wide range of analog products dedicated to the challenging and demanding automotive market.

This presentation introduces an extended automotive high-performance analog portfolio of ST's products and solutions dedicated to signal amplification, current sensing, interface, reset, supervisors and automotive-grade logic ICs.

Thanks to innovative design techniques and a continuous focus on improving quality, ST offers high-performance devices that meet the specific requirements of the rigorous AEC-Q100 standard.

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Automotive standard analog portfolio

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Automotive signal conditioning

Extended automotive high-performance analog portfolio

- Operational amplifiers
- Comparators
- Current sense amplifiers
- Interfaces
- Reset and supervisors
- Automotive Logic

For all automotive applications

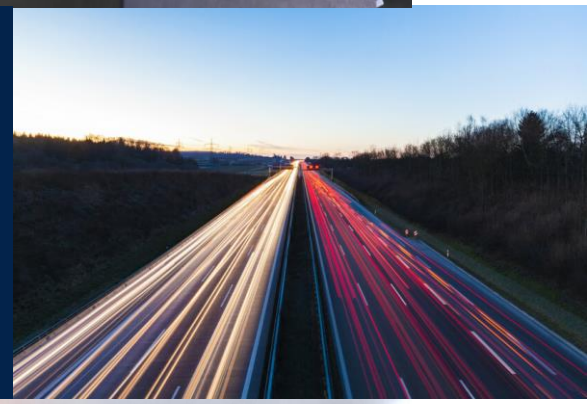
Operational amplifiers & comparators

LOW-POWER OPERATIONAL AMPLIFIERS

PRECISION OPERATIONAL AMPLIFIERS

HIGH OUTPUT CURRENT & CAPACITIVE LOAD OPERATIONAL AMPLIFIERS

FAST OPERATIONAL AMPLIFIERS



COMPARATORS

GRADE 0 (150°C) AMPLIFIERS & COMPARATORS

Current sense amplifiers

The main features of ST's portfolio of current sensing ICs ensure robustness and application safety:

- -20 to +70 V line monitoring
- Bidirectional or unidirectional current measurement.
- Integrated solutions for faster design time and reduced bill of materials
  - Integrated EMI filters
  - Pin selectable gain
  - Shutdown function
- Robust devices that do not require external protection
- Automotive-grade qualified

High-voltage

Precision / high-accuracy

Interfaces

USB Type C

STUSB1600
- USB Type-C r1.2
- DUAL ROLE
- AUTO-RUN
- QFN24 4x4

STUSB1700
- SOURCE only

STUSB1700Y
- SOURCE only

STUSB4500L
- Type C port controller
- SINK
- AUTO-RUN

USB Type C + PD PHY

STUSB1602
- USB Type-C r1.2 & PD r2.0
- DUAL ROLE
- Companion chip of STM32 MCU
- QFN24 4x4

STUSB1702Y
- SOURCE only

USB Type C Power Delivery

STUSB4700
- PD controller PD r2.0
- SOURCE
- AUTO-RUN
- QFN24 4x4

STUSB4710
- PD controller PD r2.0
- SOURCE
- AUTO-RUN
- QFN16 3x3 - SO-16

STUSB4700Y
- PD controller PD r2.0
- SOURCE
- AUTO-RUN

STUSB4500
- PD controller PD r2.0
- SINK
- AUTO-RUN

STUSB4761
- PD controller PD r3.0
- SOURCE
- AUTO-RUN with CC/CV
- 100W cable support

RS485

ST3485EIY
- 3.3 V powered
- 15 kV ESD protected
- up to 12 Mbps

STR485
- 3.3 V, selectable data rate (250 Kbps / 20 Mbps)
- 1.8 V to 3.3 V IO compatibility

ST485EIYDT
- 3.3 V powered
- 15 kV ESD protected
- up to 12 Mbps

RS485

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Production **Development**

Automotive grade version available

Watchdog, reset and supervisors ICs

STWD100:
watchdog timer circuit for automotive applications

The STWD100 watchdog timer circuits are self-contained devices which prevent system failures caused by certain types of hardware errors (including nonresponding peripherals and bus contention) or software errors (such as a bad code jump or code stuck in loop). A watchdog input (WDI) signal periodically resets the internal watchdog timer within a specified timeout period. If the system fails, the watchdog timer is not reset, a system alert is generated and the watchdog output is asserted.

Main applications

Advanced driver assistance systems (ADAS)

Infotainment

Telematics and connectivity

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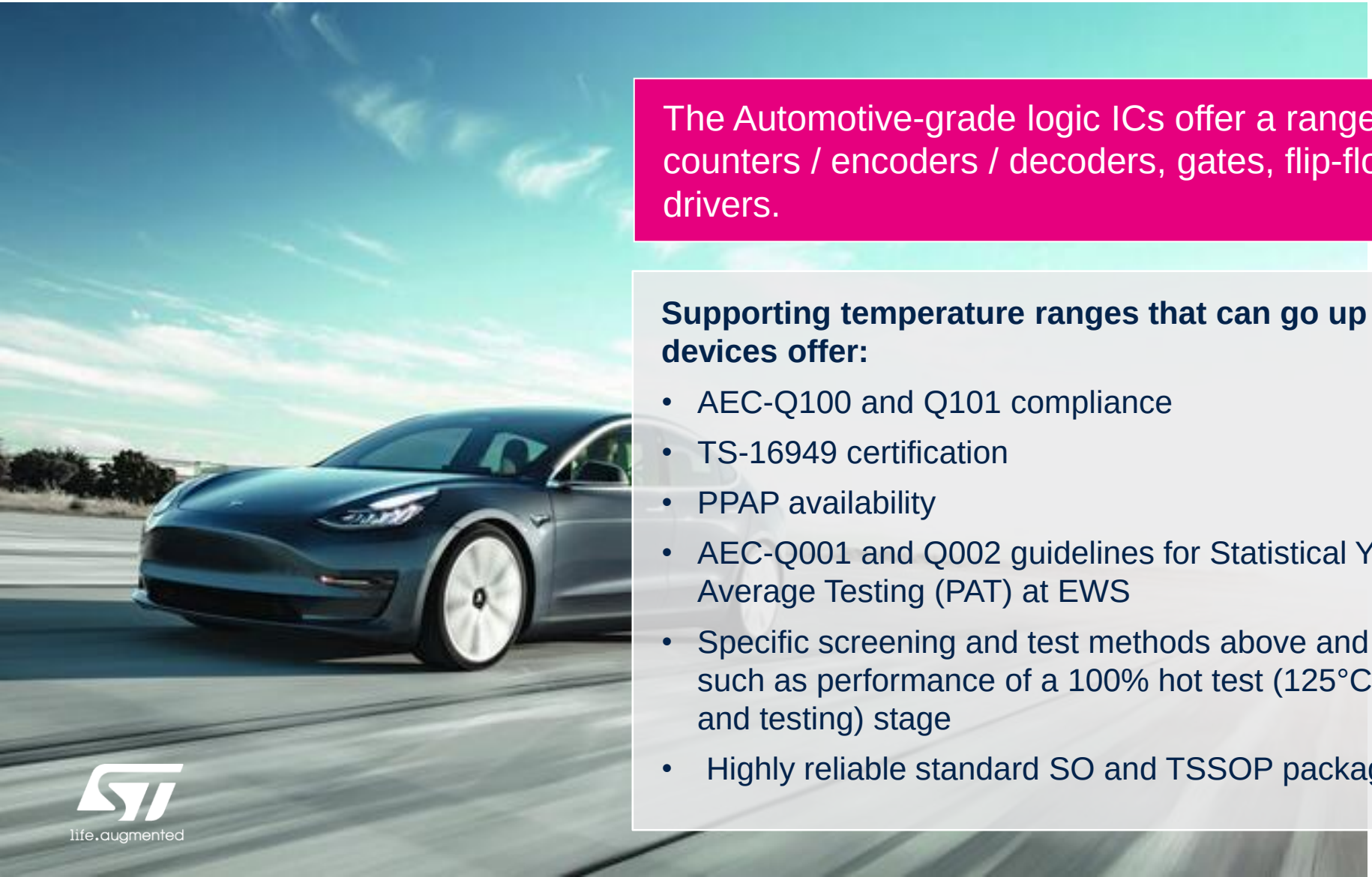
Automotive Logic ICs



The Automotive-grade logic ICs offer a range of products including counters / encoders / decoders, gates, flip-flop / registers and buffer drivers.

Supporting temperature ranges that can go up to 125°C, our automotive logic devices offer:

- AEC-Q100 and Q101 compliance
- TS-16949 certification
- PPAP availability
- AEC-Q001 and Q002 guidelines for Statistical Yield Analysis (SYA) and Part Average Testing (PAT) at EWS
- Specific screening and test methods above and beyond AEC-Q100 compliance, such as performance of a 100% hot test (125°C) during the back-end (packaging and testing) stage
- Highly reliable standard SO and TSSOP packages

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Automotive-grade standard logic

Function	Commercial product	Package	Description
Buffer	74LCX125YMTR + YTTR	SO14 + TSSOP14	Quad Bus Buffer (3-State)
Inverter	74VHC14YMTR + YTTR	SO14 + TSSOP14	Hex Schmitt Inverter
Buffer	74LCX07YMTR + YTTR	SO14 + TSSOP14	Hex Buffer
Gate	74LCX00YMTR + YTTR	SO14 + TSSOP14	Quad 2-Input NAND Gate
Schmitt Trigger	HCF40106YM013TR	SO14	Hex Schmitt Trigger
Buffer	HCF4010YM013TR	SO16	Hex Buffer/Converters noninverting
Flip-Flop	HCF4013YM013TR	SO14	Dual D Flip-Flop
Shift Register	HCF4021YM013TR	SO16	8-Stage Static Shift Register
Mux / Demux	HCF4051YM013TR	SO16	Single 8-Channel Analog Mux / Demux
Counter/Driver	HCF4060YM013TR	SO16	14-Stage Counter/Driver AND Oscillator
Inverter	HCF4069YUM013TR	SO14	Hex Inverter
Gate	HCF4070YM013TR	SO14	Quad Ex-OR Gate
Schmitt Trigger	HCF4093YM013TR	SO14	Quad 2-Input NAND Schmitt Trigger
Bus register	HCF4094YM013TR + YTTR	SO16	8-Stage Shift-AND-Store Bus Register
Mux / Demux	M74HC4851YRM13TR + YTTR	SO16 + TSSOP16	Single 8 Channel Analog Mux / Demux
Mux / Demux	M74HC4852YRM13TR	SO16	Dual 4 Channel Analog Mux / Demux
Inverter	M74HC04YRM13TR + YTTR	SO14 + TSSOP14	Hex Inverter
Gate	M74HC08YRM13TR + YTTR	SO14 + TSSOP14	Quad 2-Input AND Gate
Buffer	M74HC126YRM13TR+ YTTR	SO14 + TSSOP14	Quad Bus Buffer (3-State)
Gate	M74HC132YRM13TR + YTTR	SO14 + TSSOP14	Quad 2-Input Schmitt NAND Gate
Inverter	M74HC14YRM13TR + YTTR	SO14 + TSSOP14	Hex Schmitt Inverter
Multiplexer	M74HC151YRM13TR + YTTR	SO16 + TSSOP16	8-Channel multiplexer
Latch	M74HC259YRM13TR + YTTR	SO16 + TSSOP16	8 Bit Addressable Latch
Generator	M74HC280YRM13TR	SO14	9 Bit Parity Generator
Counter	M74HC4060YRM13TR + YTTR	SO16 + TSSOP16	14-Stage Binary Counter/Oscillator
Shift Register	M74HC4094YRM13TR + YTTR	SO16 + TSSOP16	8 Bit SIPO Shift Register Latch (3-State)
Shift Register	M74HC595YRM13TR + YTTR	SO16 + TSSOP16	8 Bit Shift Register Output Latch (3-State)
Inverter	M74HC365YRM13TR + YTTR	SO16 + TSSOP16	Hex Bus Buffer (3-State)

Quality, process, and packages

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Automotive grade qualification process

80%

of all innovations in the automotive industry today are enabled by electronics

- Very high level of in-house parametric testing equipment
- 100% electrical testing with very extensive coverage coupled with automatic visual inspection
- Part Average Testing (PAT) to detect and remove parts tested “pass” but potentially weak in reliability
- Hot test & Junction Verification Test (JVT) at Final test for SOT23, Mini-SO, SO, TSSOP, QFN/DFN
- A specific commercial product number

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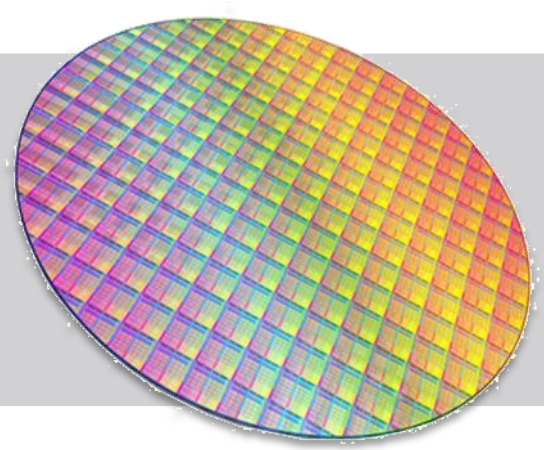
Automotive

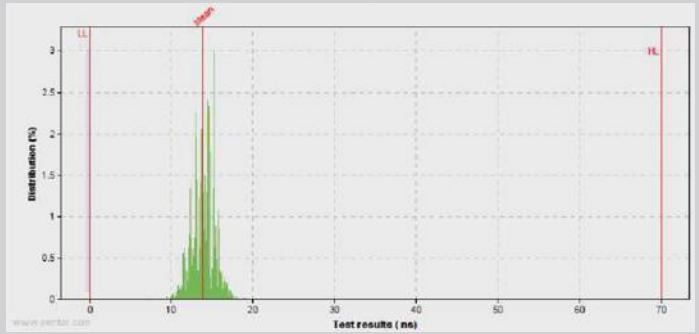
Automotive parts production process

Part number (example)	Grade	Process control T84	Visual inspection of wafers	EWS	PPAT GPAT	SBL SYL	Thermal cycles	Final electrical test	Junction verification test	PPAP report
TSZ181ILT	Non AG	Sampling	Sampling	Sampling	No	100%	No	25°C	No	No
TSZ181IYLT	AG Grade 1	100%	100%	100%	Yes	100%	Yes	25°C 125°C	125°C	Yes
TSZ181HYLT	AG Grade 0	100%	100%	100%	Yes	100%	Yes	25°C 150°C	150°C	Yes

125°C

150°C





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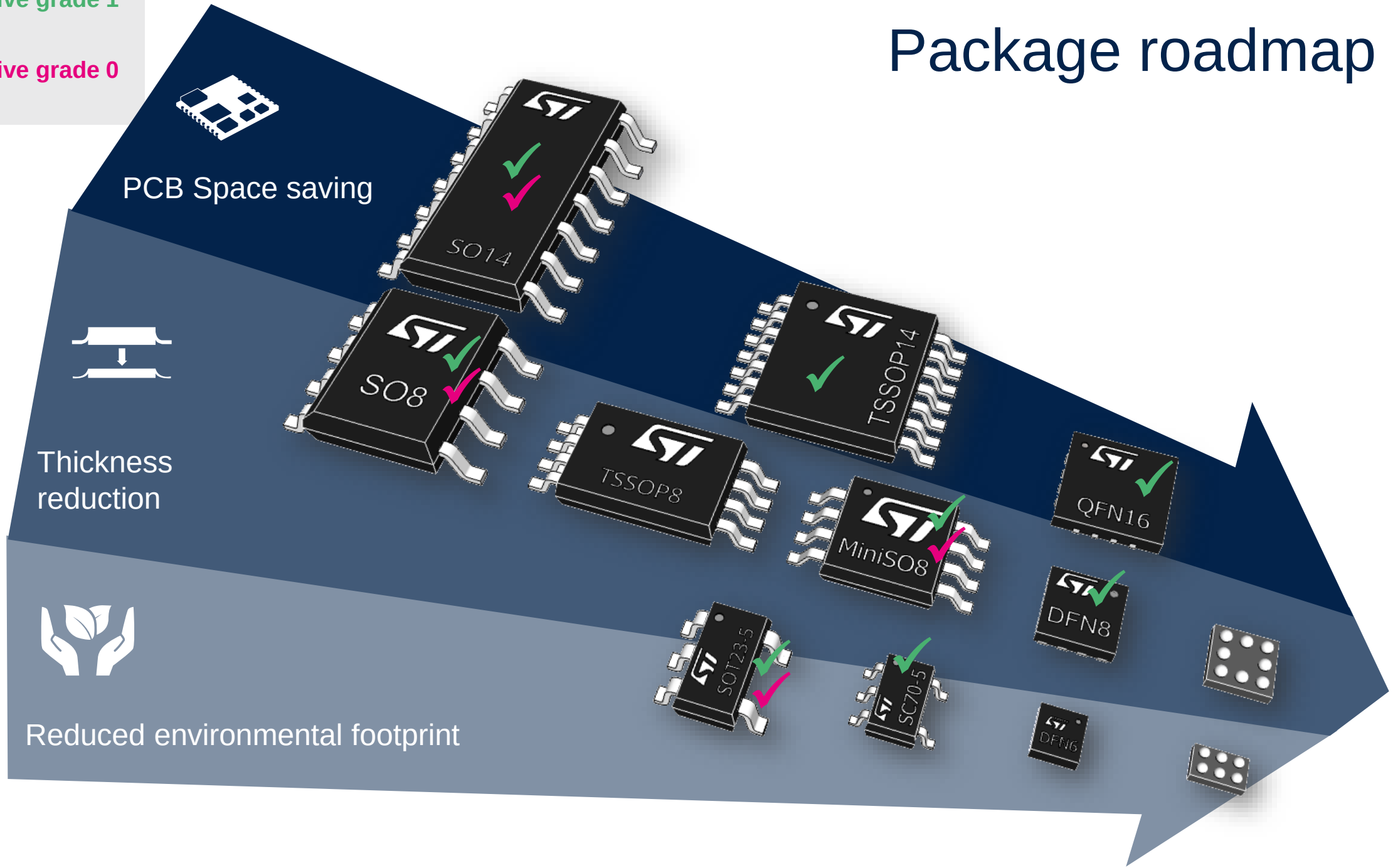
Package roadmap

- Automotive grade 1 (125°C)
- Automotive grade 0 (150°C)



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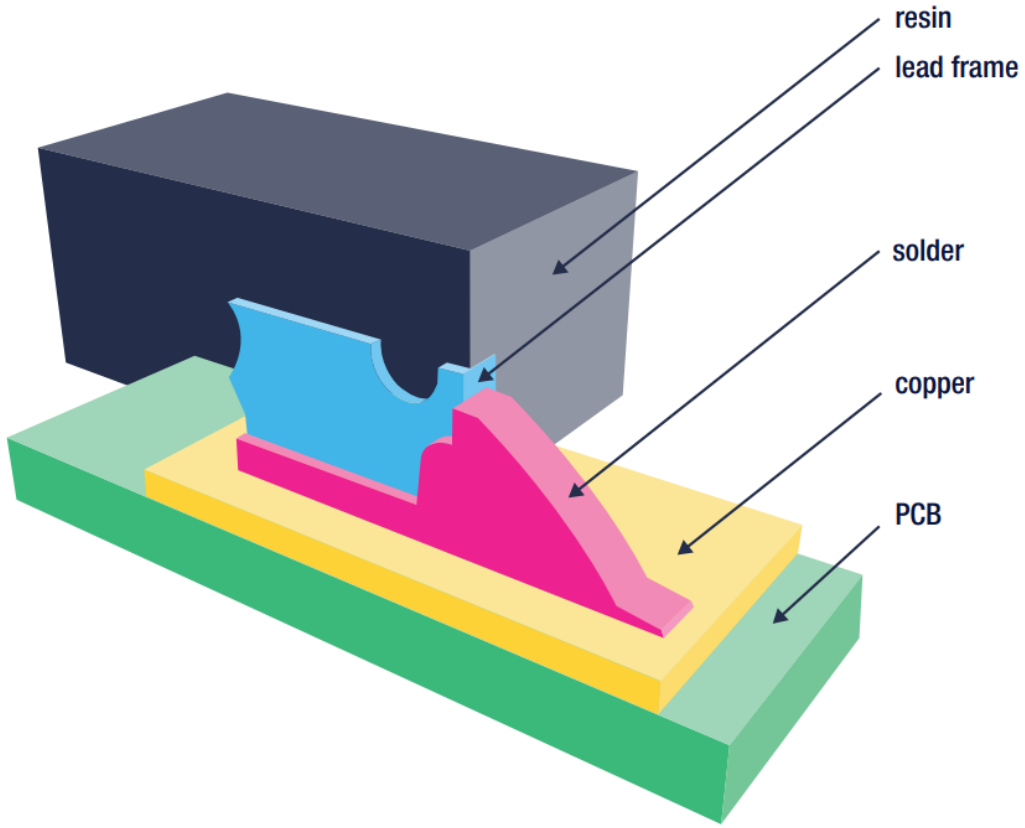
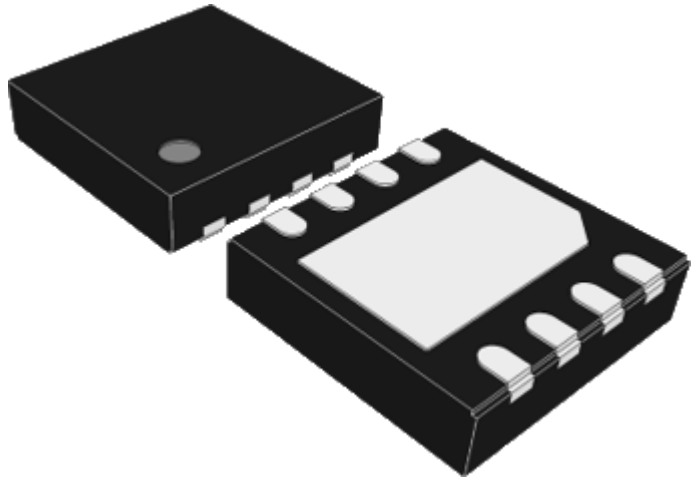
Automotive grade DFN packages

Wettable flanks for Automated Optical Inspection (AOI)



Wettable flanks package structure – internal layers



DFN8 3x3 EP WF

Immune to soldering crack for more than 2000 thermal cycles
-40 to 125 °C, 1 cycle per hour, 1.0 mm thick high Tg FR4 PCB

Product highlights

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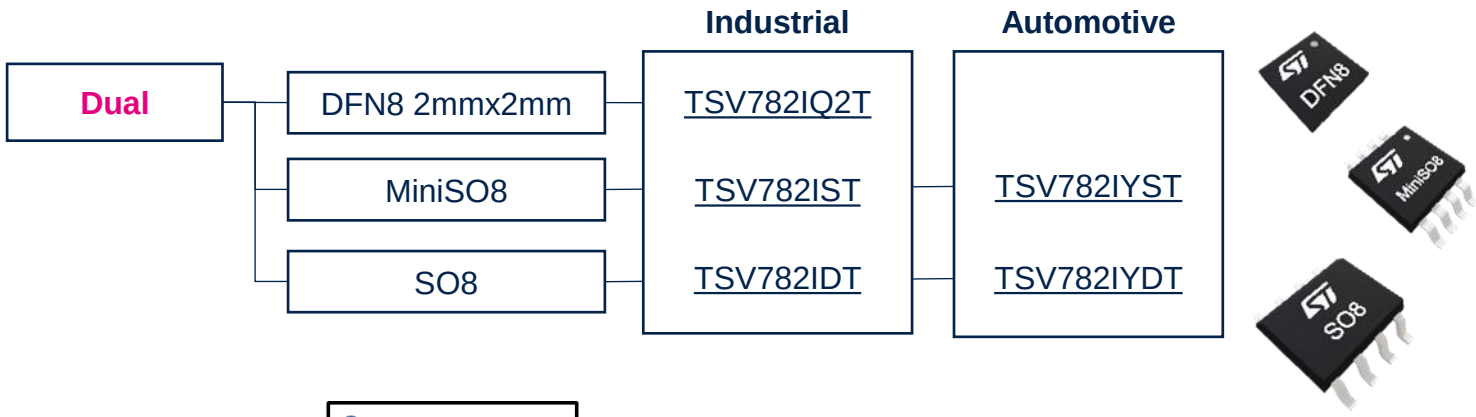
TSV782 overview

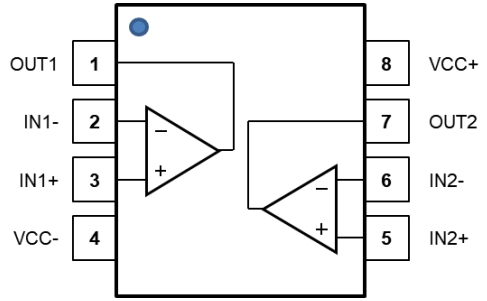
High bandwidth (30 MHz) Low offset (200 µV) Rail-to-rail 5 V op amp

KEY APPLICATIONS
- Industrial and Automotive
- Power management

KEY BENEFITS
- Accuracy virtually unaffected by noise or input bias current
- Signal conditioning for high frequencies

KEY FEATURES
- Gain bandwidth product 30 MHz, unity gain stable
- Slew rate 20V/µs
- Low input offset voltage: 50µV typ., 200 µV max.
- Low input bias current: 2 pA typ.
- Low noise : 7nV/√Hz
- Wide supply voltage range: 2.0 V to 5.5 V
- Rail-to-rail input and output





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TSV7721 TSV7722 TSV7723 overview

High bandwidth (22 MHz) Low offset (200 µV) Low-rail 5 V op amp

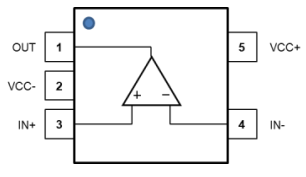
	20 MHz	30 MHz	50 MHz
rail-to-rail	TSV772	TSV782	TSV791 TSV792
low rail	**TSV7721 TSV7722 TSV7723**		

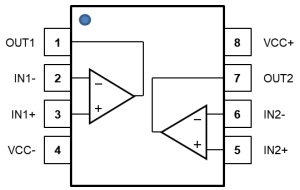
KEY APPLICATIONS
- Industrial and Automotive
- Telecom infrastructure

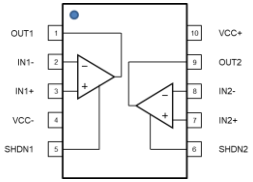
KEY BENEFITS
- Accuracy virtually unaffected by noise or input bias current
- Signal conditioning for high frequencies

KEY FEATURES
- Gain bandwidth product 22 MHz, unity gain stable
- Low input offset voltage 50 µV typ, 200 µV max
- Low input voltage noise density: 7 nV/√Hz
- Wide supply voltage range: 1.8 to 5.5 V
- Power saving: 1.7 mA typical, 2.5 nA in shut-down
- Output rail-to-rail
- Automotive grade and shut-down versions available

		Industrial	Automotive
Single	SOT23-5	TSV7721ILT	TSV7721IYLT
Dual	DFN8 2mmx2mm	TSV7722Q2T	
	MiniSO8	TSV7722IST	TSV7722IYST
	SO8	TSV7722IDT	TSV7722IYDT
Dual + Shut-down	MiniSO10	TSV7723IST	







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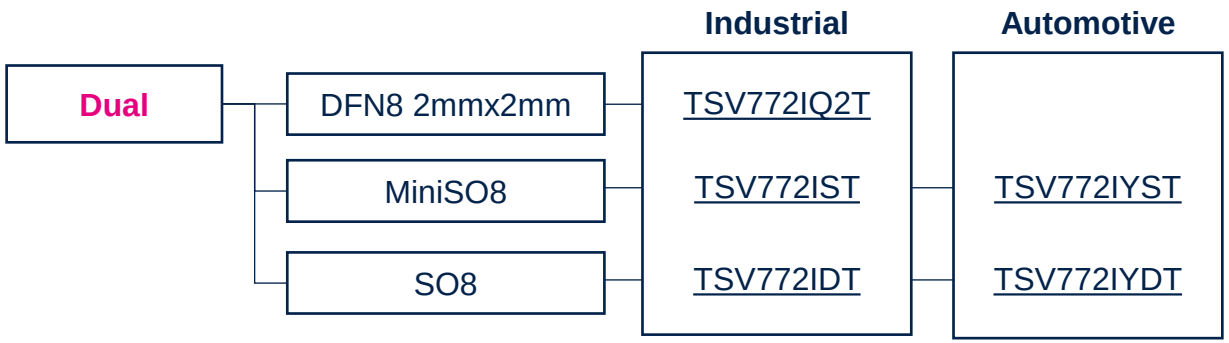
TSV772 overview

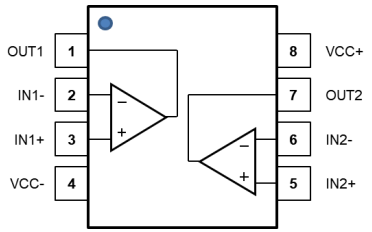
High bandwidth (20 MHz) Low offset (200 µV) Rail-to-rail 5 V op amp

KEY APPLICATIONS
- Industrial and Automotive
- Power management

KEY BENEFITS
- Accuracy virtually unaffected by noise or input bias current
- Signal conditioning for high frequencies

KEY FEATURES
- Gain bandwidth product 20 MHz, unity gain stable
- Low input offset voltage: 50 µV typ., 200 µV max.
- Low input bias current: 2 pA typ.
- Low noise: 7 nV/√Hz
- Slew rate: 10.5 V/µs
- Wide supply voltage range: 2.0 V to 5.5 V
- Rail-to-rail input and output





TSV791 TSV792 overview

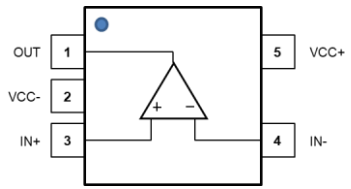
High bandwidth (50MHz) Low offset (200 µV) Rail-to-rail 5 V op amp

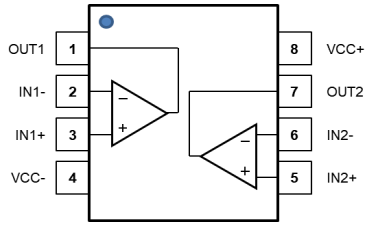
KEY APPLICATIONS
- Industrial and Automotive
- Power management

KEY BENEFITS
- Accuracy virtually unaffected by noise or input bias current
- Signal conditioning for high frequencies

KEY FEATURES
- Gain bandwidth product 50MHz, unity gain stable
- Slew rate 30V/µs
- Low input offset voltage 50µV typ, 200 µV max
- Low input voltage noise density 6.5nV/√Hz @10kHz
- Wide supply voltage range: 2.2 V to 5.5 V
- Rail-to-rail input and output
- Extended temperature range: -40 °C to +125 °C

		Industrial	Automotive
Single	SOT23-5	TSV791ILT	TSV791IYLT
Dual	DFN8 2mmx2mm	TSV792IQ2T	
	MiniSO8	TSV792IST	TSV792IYST
	SO8	TSV792IDT	TSV792IYDT





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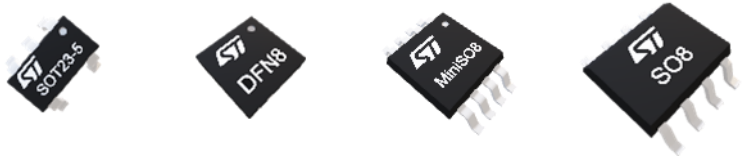
TSX9 overview

High bandwidth (10 to 16MHz) rail-to-rail 16V op amp

KEY APPLICATIONS
- Communications
- Process control

KEY BENEFITS
- Direct supply by +5V/-5V power lines
- Signal conditioning for high frequencies

KEY FEATURES
- Rail-to-rail input and output
- Gain bandwidth product 10 MHz (unity gain stable) or 16 MHz (stable for gain > 2)
- Low power consumption: 2.8 mA
- Low input bias current: 10 pA typ
- High tolerance to ESD: 4 kV HBM
- Automotive qualification



			Industrial	Automotive
10 MHz Unity gain stable	Single	SOT23-5	TSX921ILT	TSX921IYLT
	Single + Shut-down	SOT23-6	TSX920ILT	
	Dual	DFN8 2x2	TSX922IQ2T	
		MiniSO8	TSX922IST	TSX922IYST
		SO8	TSX922IDT	TSX922IYDT
	Dual + Shut-down	MiniSO10	TSX923IST	
16 MHz Stable for Gain >2	Single	SOT23-5	TSX9291ILT	TSX9291IYLT
	Dual	DFN8 2x2	TSX9292IQ2T	
		MiniSO8	TSX922IST	
		SO8	TSX9292IDT	TSX9292IYDT

TSX7 overview

High accuracy (Vio < 200 µV) rail-to-rail 16V op amp

KEY APPLICATIONS
- Instrumentation amplifier
- Active filtering

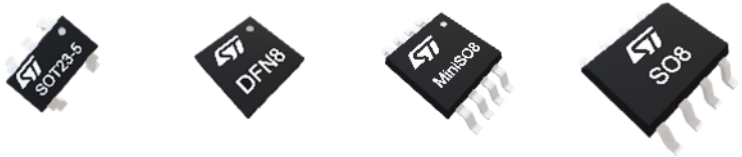
KEY BENEFITS
- Direct supply by +5V/-5V power lines
- High accuracy signal conditioning

KEY FEATURES

Low input offset voltage: 200 µV max

- Low input offset voltage: 100 µV max for “A” version
- Rail-to-rail input and output
- Gain bandwidth product 2.7 MHz (unity gain stable) or 9 MHz (stable for gain > 10)
- Low supply voltage: 2.7 - 16 V

				Industrial	Automotive
2.7 MHz Unity gain stable	Single Vio < 200µV	SOT23-5		TSX711ILT	TSX711IYLT
	Single Vio < 100µV	SOT23-5		TSX711AILT	TSX711AIYLT
	Dual	MiniSO8		TSX712IST	TSX712IYST
		SO8		TSX712IDT	TSX712IYDT
9 MHz Stable for Gain >10	Single Vio < 200µV	SOT23-5		TSX7191ILT	TSX7191IYLT
	Single Vio < 100µV	SOT23-5		TSX7191AILT	TSX7191AIYLT
	Dual	MiniSO8		TSX7192IST	TSX7192IYST
		SO8		TSX7192IDT	TSX7192IYDT



TSB7 overview

Low offset (300 µV), 6 MHz and 20 MHz, 36 V Rail-to-rail 36 V op amp

KEY APPLICATIONS
- Motor control
- Strain gauge

KEY BENEFITS
- Accuracy virtually unaffected by noise or input bias current
- Signal conditioning for high frequencies

KEY FEATURES
- Wide supply voltage range:
  - 2.7 to 36 V
- Gain bandwidth product:
  - 6 MHz (TSB71x, unity gain stable)
  - 22 MHz (TSB719x, stable for gain > 10)
- Rail-to-rail input and output
- Low offset voltage:
  - 300 µV maximum (A version)
  - 800 µV maximum (Standard)

			Industrial	Automotive
6 MHz Unity gain stable	**Single**	SOT23-5	TSB711AILT	TSB711AIYLT
			TSB711ILT	TSB711IYLT
	Dual	MiniSO8	TSB712AIST	TSB712AIYST
			TSB712IST	TSB712IYST
		SO8	TSB712AIDT	TSB712AIYDT
			TSB712IDT	TSB712IYDT
22 MHz Stable for Gain >10	**Single**	SOT23-5	TSB7191AILT	TSB7191AIYLT
			TSB7191ILT	TSB7191IYLT
	Dual	MiniSO8	TSB7192AIST	TSB7192AIYST
			TSB7192IST	TSB7192IYST
		SO8	TSB7192AIDT	TSB7192AIYDT
			TSB7192IDT	TSB7192IYDT

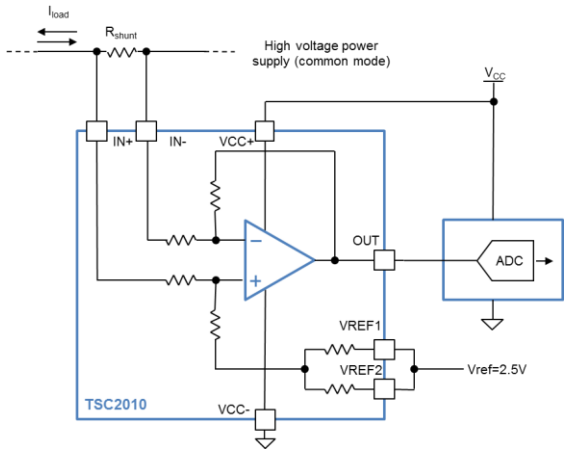
TSC2010 TSC2011 TSC2012 overview

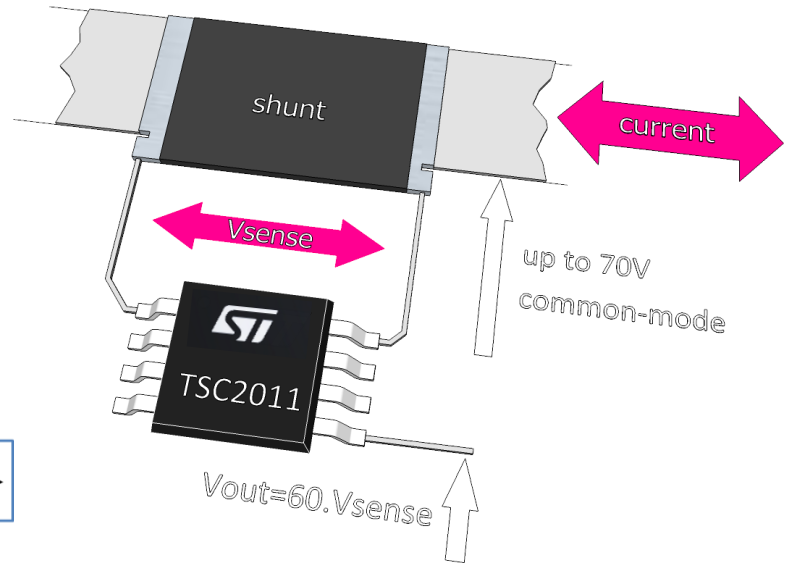
70 V bidirectional current sensing

KEY APPLICATIONS
- High-side current sensing
- Low-side current sensing
- Motor control

KEY BENEFITS
- High-side current measurement on high voltages
- Tolerant to voltage surge and battery reverse

KEY FEATURES
- Bidirectional current measurement
- Gain:
  - x20 (**TSC2010**) x60 (**TSC2011**)
  - x100 (**TSC2012**)
- V_{ICM} operating: -20 to 70 V surviving: -25 to 76 V
- V_{CC} 2.7 to 5.5 V
- V_{IO} max 700 µV
- Bandwidth:
  - 1 MHz (TSC2010) 750 kHz (TSC2011)
  - 300 kHz (TSC2012)
- Operating temperature -40 to 125°C, MiniSO8 SO8
- extended temperature range (-40 to 150 °C) : **TSC2010H**, **TSC2011H** and **TSC2012H.**





Link:

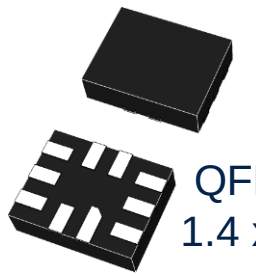
TSC210 TSC211 … TSC215 overview

26 V bidirectional current sensing

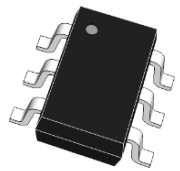
KEY APPLICATIONS
- Power management
- Battery chargers

KEY BENEFITS
- High-side current measurement on high voltages
- Tolerant to voltage surge and battery reverse

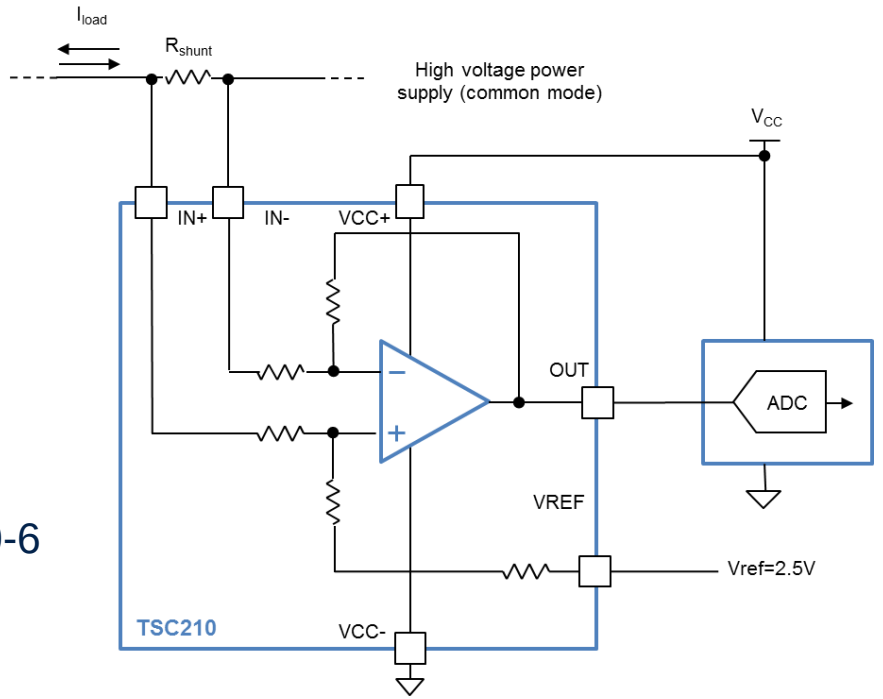
KEY FEATURES
- Bidirectional current measurement
- Gain selectable by part number option
  - x50 **TSC213** x75 **TSC215** x100 **TSC214**
  - x200 **TSC210** x500 **TSC211** x1000 **TSC212**
- V_{ICM} operating -0.3 to 26 V
- V_{CC} 2.7 to 26 V
- V_{IO} max 35 µV
- Bandwidth 16 kHz (TSC210)
- Operating temperature -40 to 125 °C



QFN10
1.4 x 1.8



SC70-6

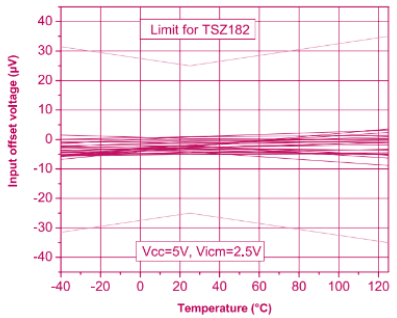


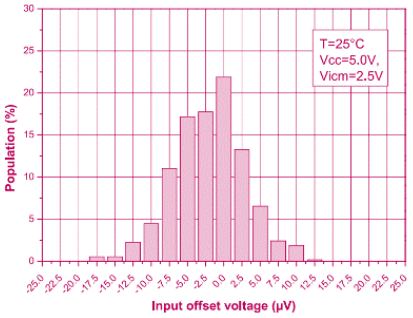
TSZ181, TSZ182 overview

3 MHz chopper op amp

KEY APPLICATIONS
- High accuracy signal conditioning
- Automotive current measurement and sensor signal conditioning

KEY BENEFITS
- Accuracy virtually unaffected by temperature change





KEY FEATURES
- Very high accuracy and stability:
  - 25 µV max at 25 °C,
  - 35 µV -40 °C to 125 °C
- Gain bandwidth product: 3 MHz
- Rail-to-rail input and output
- Low supply voltage: 2.2 - 5.5 V
- Low power consumption: 1 mA max. at 5 V
- extended temperature range (-40 to 150 °C): **TSZ181H, TSZ182H** and (-40 to 175 °C) : **TSZ181H1**, **TSZ182H1**

		Industrial	Automotive
Single	DFN6 1.2mm*1.3mm	TSZ181IQ1T	
	SOT23-5	TSZ181ILT	TSZ181IYLT
Dual	DFN8 2mmx2mm	TSZ182IQ2T	
	MiniSO8	TSZ182IST	TSZ182IYST
	SO8	TSZ182IDT	TSZ182IYDT

TSZ181H TSZ182H TSZ182H1 overview

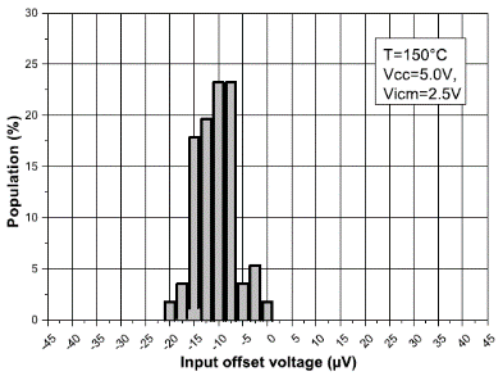
High temperature zero drift amplifier

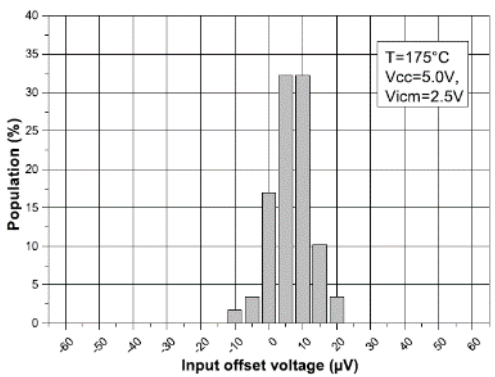
KEY APPLICATIONS
- High accuracy signal conditioning
- Current measurement
- Sensor signal conditioning

KEY BENEFITS
- Outstanding accuracy on an ultra wide temperature range
- Long mission profile

KEY FEATURES
- Very high accuracy and stability: V_{IO} 25 µV max
- Gain bandwidth product: 3 MHz
- Wide supply voltage range: 2.2 V to 5.5 V
- Rail-to-rail input and output
- Automotive grade
- High temperature range:
  - -40 °C to +150 °C (auto grade zero)
  - -40 °C to +175 °C (auto grade H1 version)

		Automotive Grade 0 150 °C	Automotive 175 °C
Single	SOT23-5	TSZ181HYLT	
Dual	SO8	TSZ182HYDT	TSZ182H1YDT





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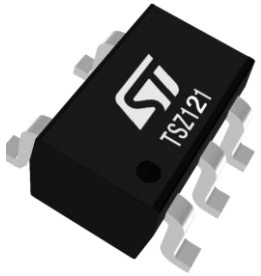
TSZ121 TSZ122 TSZ124 overview

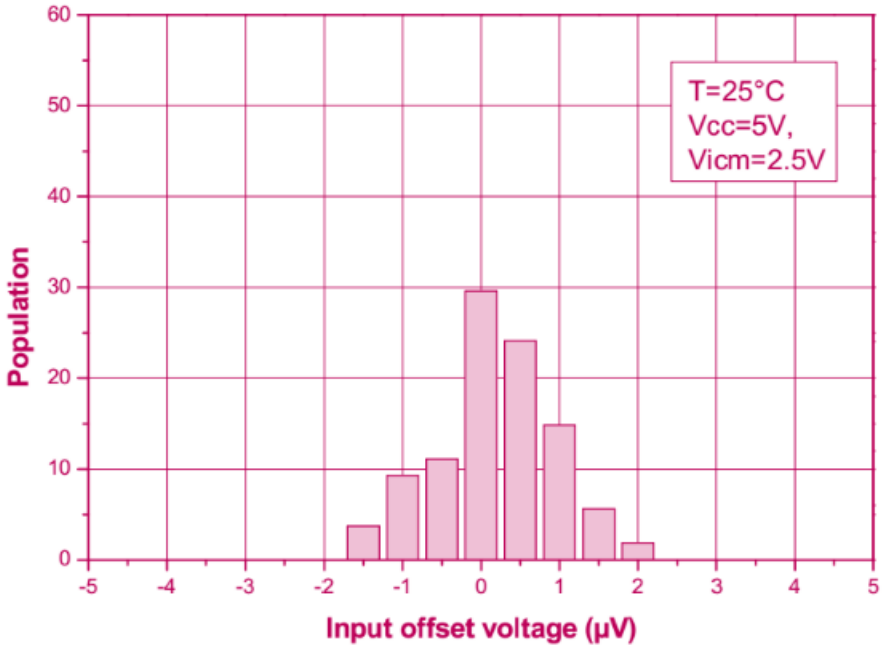
Zero-drift amplifiers

KEY APPLICATIONS
- Battery-powered applications
- Signal conditioning

KEY BENEFITS
- Accuracy virtually unaffected by temperature change

KEY FEATURES
- Very high accuracy (Vio)
- 5 µV max at 25 °C
- 8 µV max -40 °C to 125 °C
- dVIO/dT < 30 nV/°C
- Low supply voltage: 1.8 - 5.5 V
- Maximum supply current 40 µA
- Gain bandwidth product 400 kHz
- Automotive grade





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STWD100Y overview

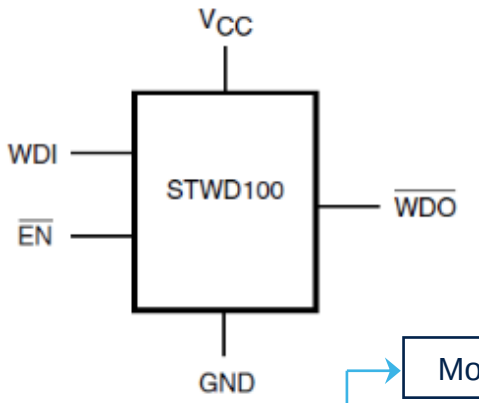
Standalone watchdog

KEY APPLICATIONS
- Industrial and automotive
- Telecommunications
- UPS (uninterruptible power supply)

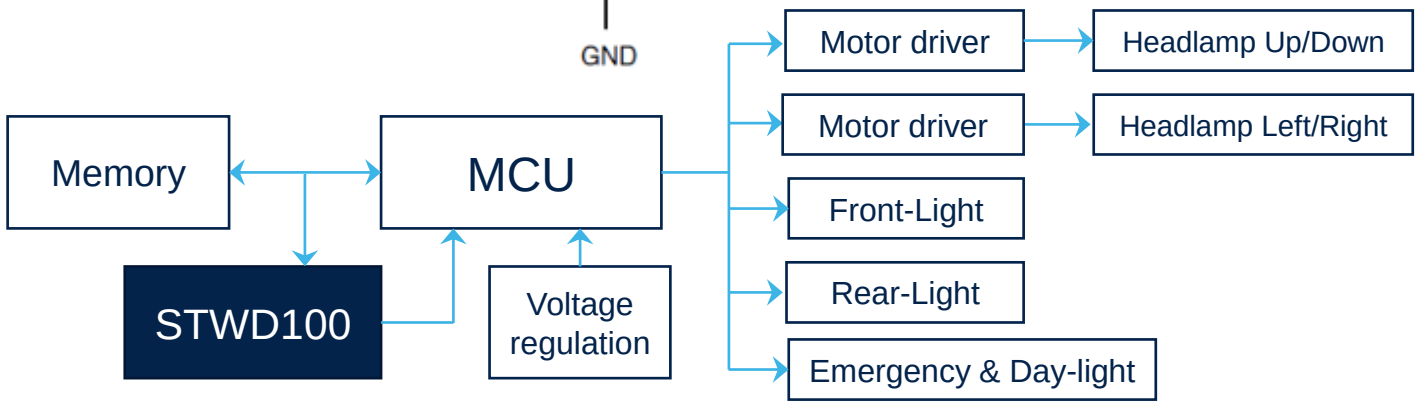
KEY BENEFITS
- Highest security level applications
- Robust and reliable
- Targeted applications: ADAS, front and rear LED lighting, mirror LED, emergency LED

KEY FEATURES
- Software code execution monitoring
- Hardware failure supervision
- System recovery

Watchdog timeout period	Output type	Chip enable	Icc (µA)
3.4 ms 6.3 ms 102 ms 1.6 s	open drain	yes	13



SOT23-5



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STUSB1700Y overview

Standalone USB Type-C controller

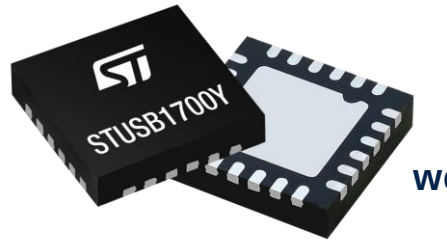
KEY APPLICATIONS
- USB car chargers
- Front seats and Rear seats charging
- Infotainment systems

KEY FEATURES
- Role: Source
- Configurable start-up profiles
- Integrated VCONN switch:
- Adjust. current limit (600mA max)
- OVP, OCP, UVP, short protection
- 22 V short-to-VBUS protection on CC
- Direct interface to MCU through I²C + IRQ
- Dual power supply capability:
- VBUS 4.1 V to 22 V - AMR = 28 V
- VSYS 3.0 V to 5.5 V

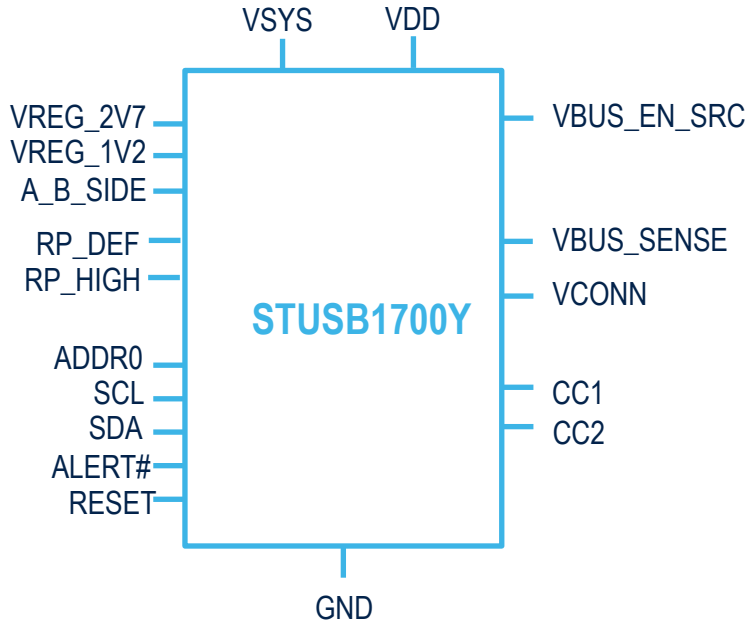
KEY BENEFITS
- Standalone IC (MCU optional)
- Plug & Play,
- Robustness to high voltage spikes
- Configurable and flexible
- Integrated solution (reduced PCB area and cost vs. discrete
- Type-C r1.2 compliant

Ideal solution for 15 W charging
(5V / 3A)
with or without USB DATA

Link on st.com



QFN24 4x4
wettable flanks



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STUSB4700Y overview

Stand-alone USB Type-C PD controller

KEY APPLICATIONS
- USB car chargers
- Front seats and Rear seats charging
- Infotainment systems

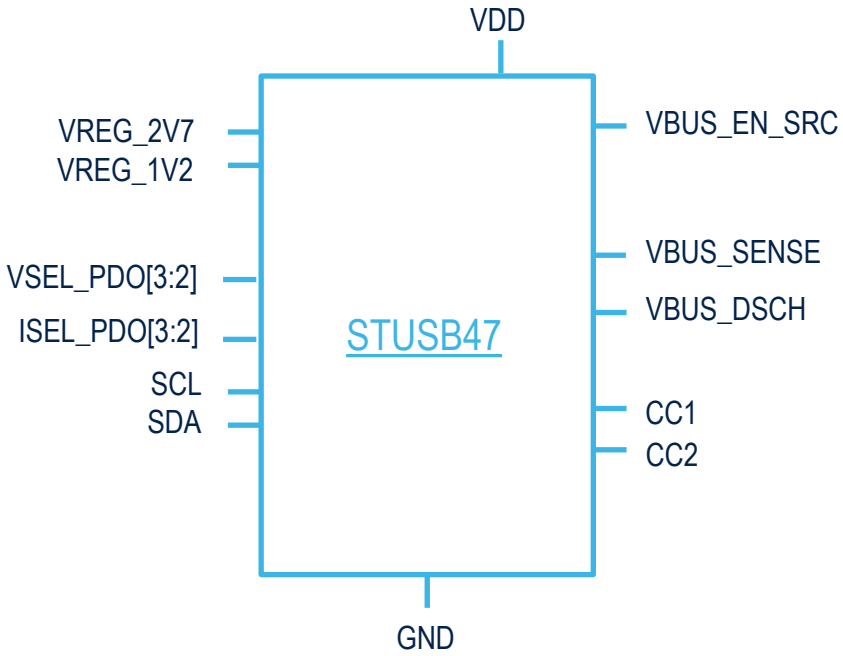
KEY FEATURES
- Role: Source
- Support all USB PD profiles
- Configurable start-up profiles
- Dedicated Voltage & Current control Interface
- Integrated Voltage monitoring
- High Voltage Protections on connector pins (including CC)
- Integrated VBUS discharge path
- Auto-run support
- Nominal power supply: VBUS 4.1 V to 22 V (AMR 28 V)

KEY BENEFITS
- Can run without MCU support
- Robustness to high voltage spikes
- Configurable and flexible
- Integrated solution (reduced PCB area and cost vs discrete)
- Low pin count
- Reference designs on request

Ideal solution for <60 W charging
(<20 V / 3 A)
with or without USB data
without infotainment (ALT MODE)

Link on st.com

QFN24 4x4 wettable flanks



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Automotive applications

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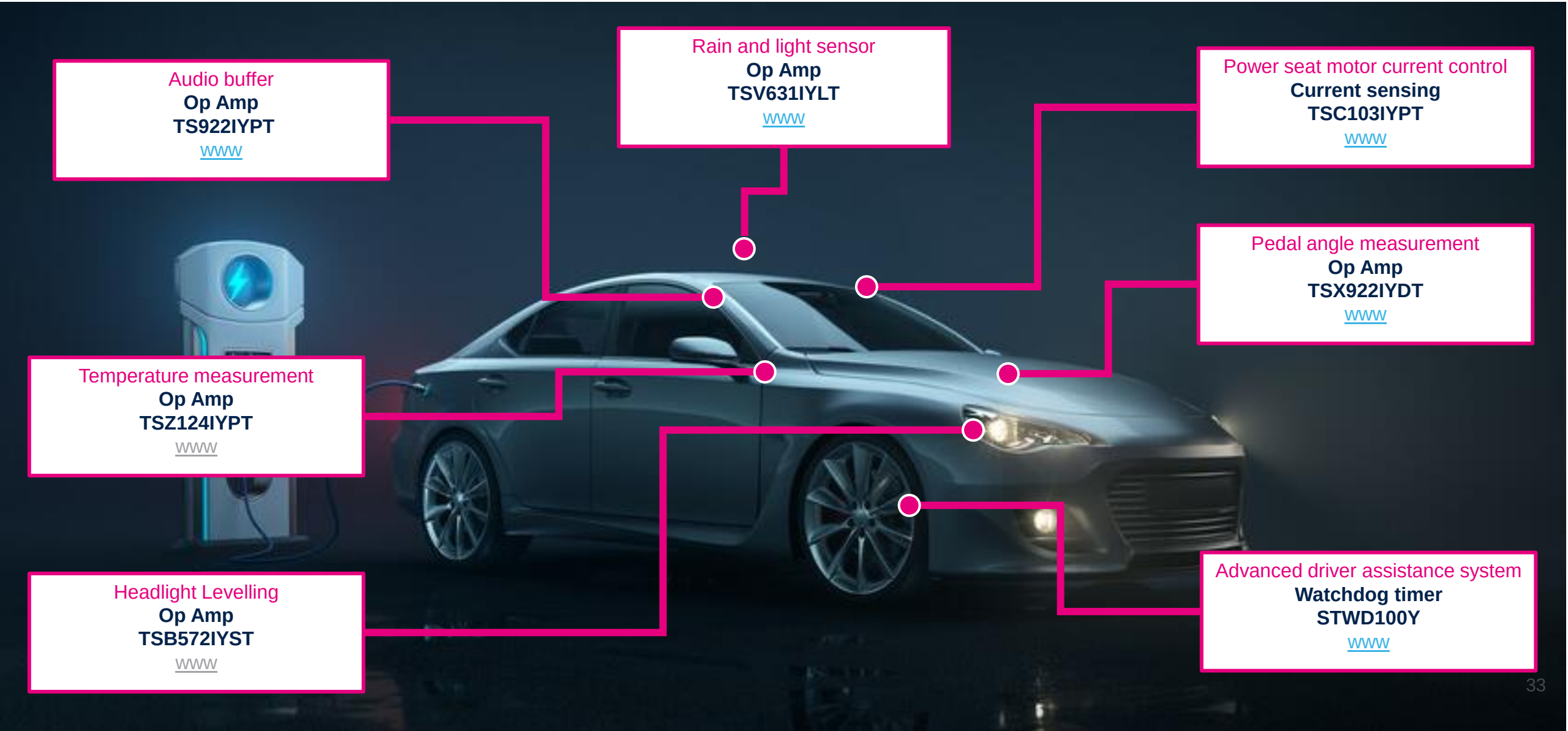
Added value for smart driving



Audio buffer
Op Amp
TS922IYPT
www

Rain and light sensor
Op Amp
TSV631IYLT
www

Power seat motor current control
Current sensing
TSC103IYPT
www

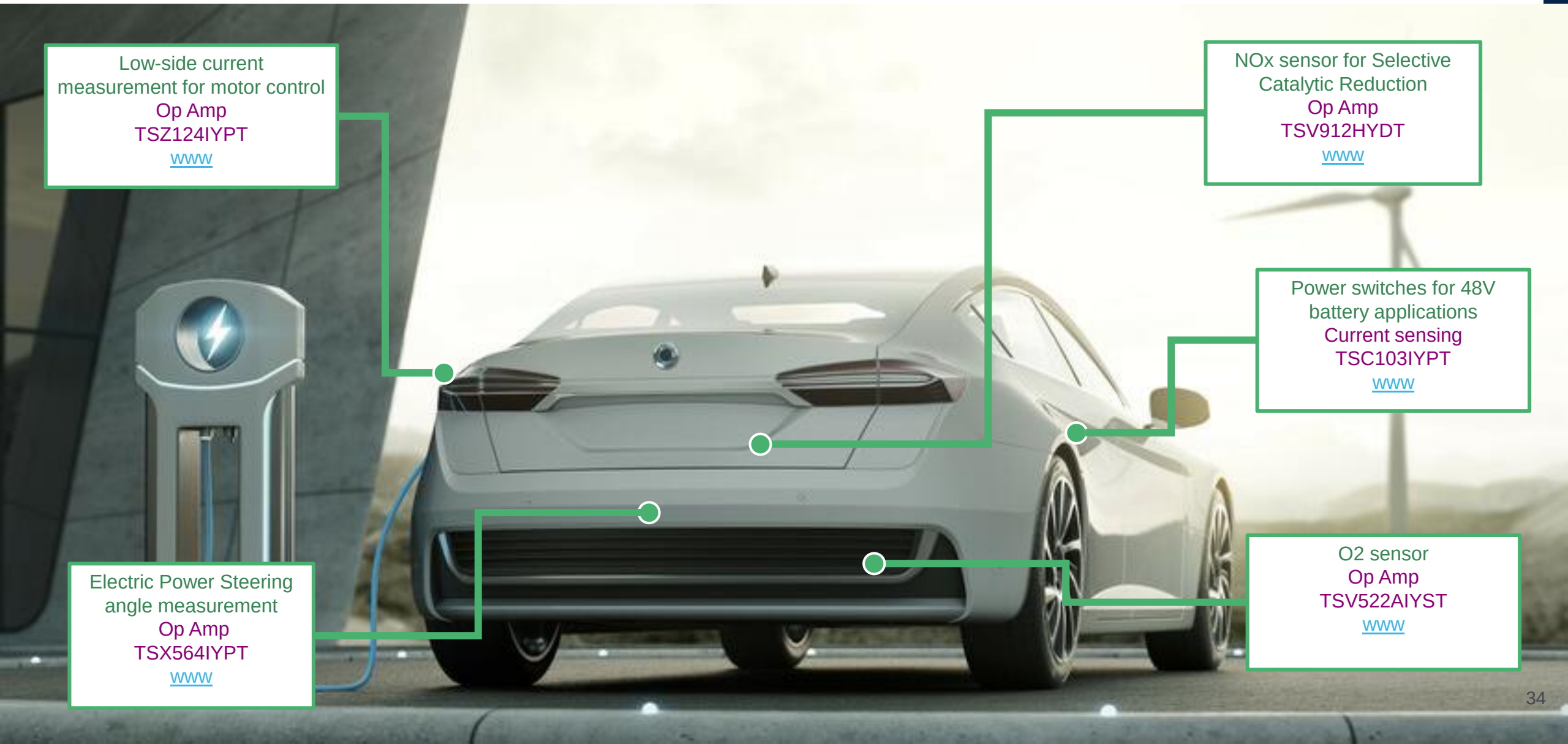
Pedal angle measurement
Op Amp
TSX922IYDT
www

Temperature measurement
Op Amp
TSZ124IYPT
www

Headlight Levelling
Op Amp
TSB572IYST
www

Advanced driver assistance system
Watchdog timer
STWD100Y
www

Added value for greener driving



Low-side current measurement for motor control
Op Amp
TSZ124IYPT
www

NOx sensor for Selective Catalytic Reduction
Op Amp
TSV912HYDT
www

Power switches for 48V battery applications
Current sensing
TSC103IYPT
www

Electric Power Steering angle measurement
Op Amp
TSX564IYPT
www

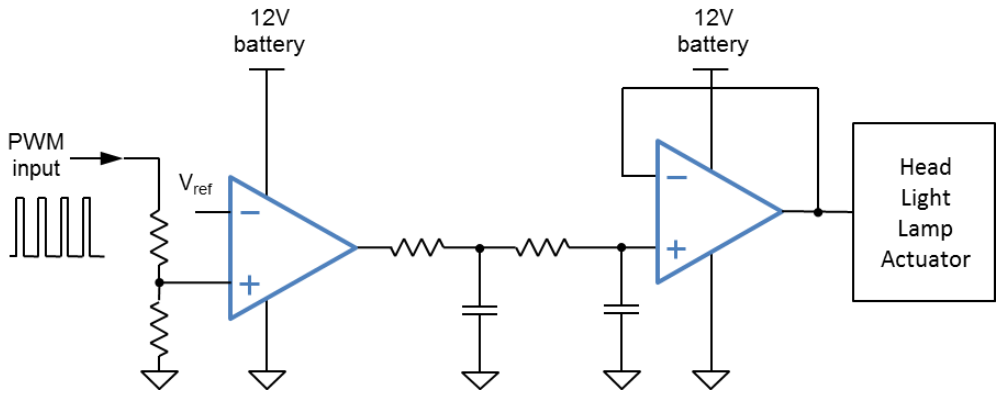
O2 sensor
Op Amp
TSV522AIYST
www

Head light levelling

Context

Adjustment of headlight angle helps to compensate the car pitch angle, whatever the car loading or road conditions. The levelling becomes more and more critical as the headlights power increases, to prevent other drivers being dazzled.

Principle of operation



The ECU provides a PWM signal proportional to the desired headlight angle. The first op amp acts as a level shifter, and the second as a low pass filter in order to provide a voltage proportional to battery voltage to the actuator.

ST Offer

Feature	Benefit
Supply voltage 36V operating	Capability to provide control voltage proportional to battery
Supply voltage 40V AMR	Reduce need of load dump clamping
Rail-to-rail input / output stage	No need for charge pump circuitry

Op Amp – 36V

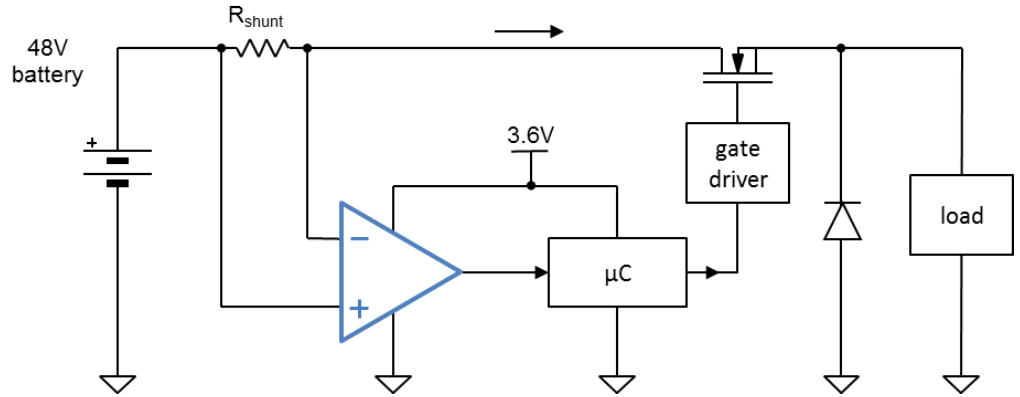
TSB572IYST

Power switches for 48 V battery applications

Context

The automotive industry is committed to meet future emission regulations, and the implementation of intermediate battery voltage of 48 V appears as a very promising solution.

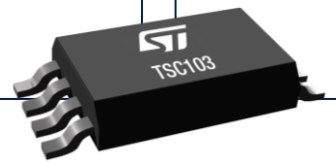
Principle of operation



The current sense amplifier measures the current through a shunt resistor. In case the current would exceed the programmed threshold, the microcontroller would inhibit the gate drive.

ST Offer

Feature	Benefit
Input pins sustain: -16 to 75V ESD 2.5kV	No protection needed for: Load dump, reversed battery, ESD surges
Output voltage accuracy: ±2.5% @25°C ±4% from -40 to 125°C	Minimizes shunt value and cost



Current sense amplifier

TSC103IYPT

AN4909: Intelligent power switches for 48 V battery applications

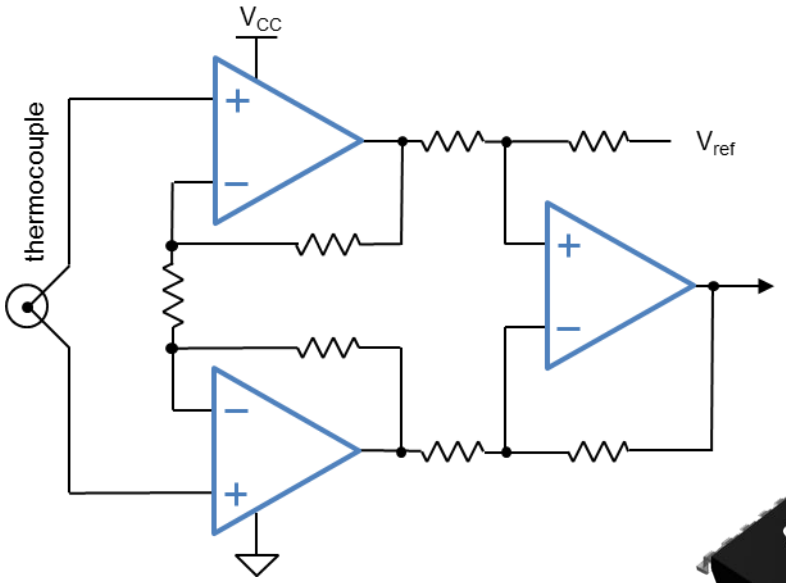
Temperature measurement

Context

Temperature is measured to guarantee safe operation of Motors, Converters and electronic control units. In Hybrid and Electric vehicle temperature measurement helps to monitor and maximize battery efficiency.

Principle of operation

The thermocouple probe creates a reference voltage proportional to temperature, amplified by high accuracy op amp in differential amplifier configuration.



ST Offer

Feature	Benefit
Input offset voltage Vio < 5 µV @25°C Vio < 8 µV -40 to 125°C	Excellent measurement without trimming
Input offset voltage drift ΔVio/ΔT 30nV/°C max	Stability of measurement versus temperature change
Input bias current Iib < 200 pA	Compatible with high impedance sensor

Op Amp – Zero Drift

TSZ124IYPT

life.augmented

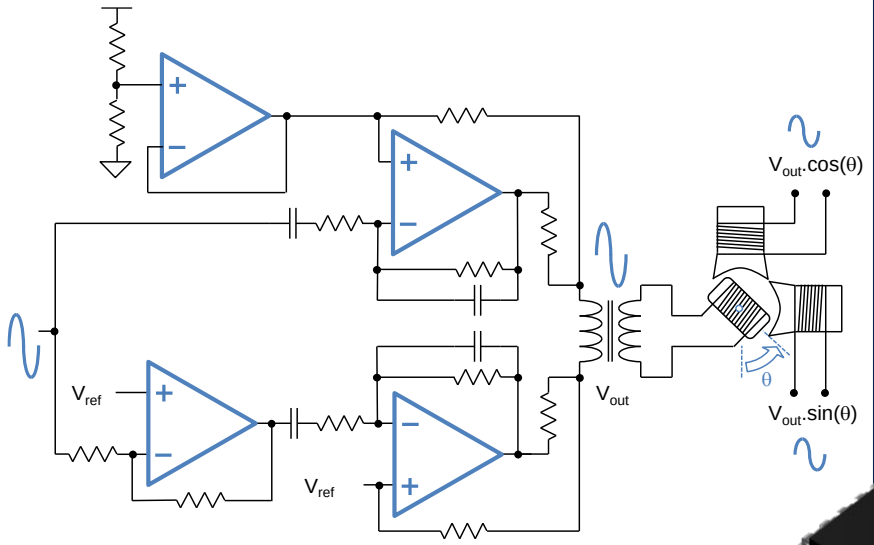
Electric power steering angle measurement

Context

Electric Power Steering is replacing hydraulics system due to the possibility to tailor steering-gear response according to driving conditions. In addition, EPS is a major contributor to fuel-saving efforts.

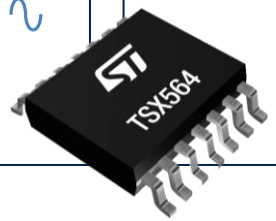
Principle of operation

Angle is measured by a resolver. Sine wave is amplified to primary winding of a rotary transformer. Secondary side signal is modified by angle.



ST Offer

Feature	Benefit
High output current Iout = 90mA typ	Capability to drive coils
Slew rate 1.1V/µs typ	Enables high sampling frequency
Supply voltage range 3 to 16V	High voltage biasing of the magnetic coil



Op Amp – 16V CMOS

TSX564IYPT

life.augmented

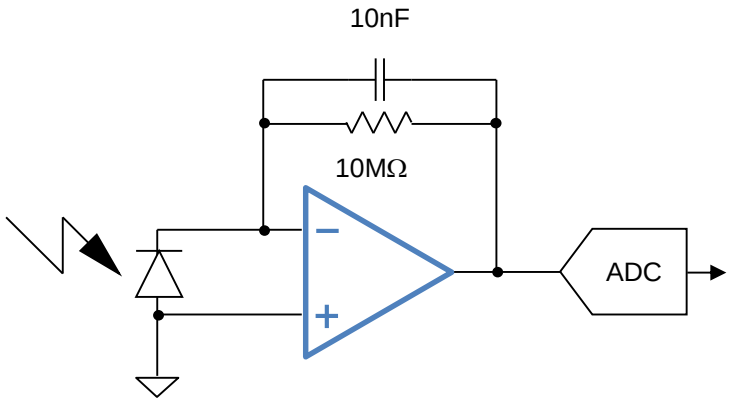
Rain and light sensor

Context

Rain and light sensors are widely used for automatic mode of windscreen wipers and automatic lights. Further applications can include the automatic closing of electric roof and windows or adjustment of dashboard backlight.

Principle of operation

The photodiode generates a reverse current proportional to the amount of light. This current is converted into voltage and amplified by op amp.



ST Offer

Feature	Benefit
Input bias current Iib < 10pA @ 25°C Iib < 100pA @ 125°C	Maintains excellent accuracy by not affecting diode current
Supply voltage range 1.5 to 5.5V	Compatible with wide choice of supplies
SOT23-5	Micro package enhances sensor form factor

AN4451: Signal conditioning for a UV sensor

Op Amp – Low Power

TSV631IYLT

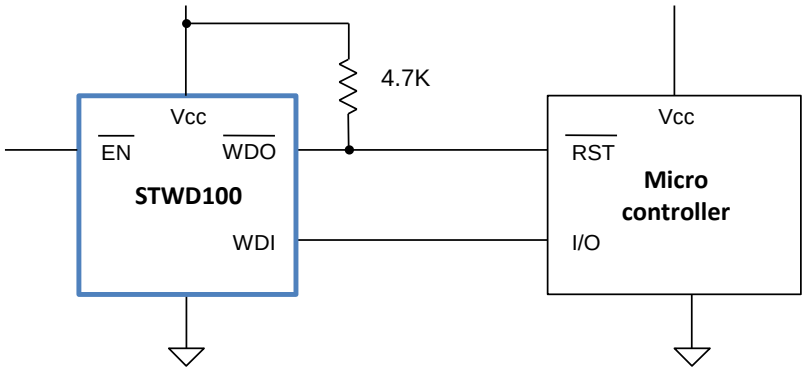
Advanced driving assistance system

Context

Watchdog ICs improve system reliability by monitoring the system for software code execution errors and hardware failures. This is specially critical for Advanced Driving Assistance Systems paving the way to autonomous vehicles.

Principle of operation

When operating correctly, a vehicle's systems regularly reset the STWD100 watchdog timer. If the timer exceeds the specified timeout period, an alert is triggered.



ST Offer

Feature	Benefit
Variety of available watchdog timeout periods	Simple, robust and reliable implementation
Supply voltage range 2.7 to 5.5V	Compatible with wide choice of supplies
SOT23-5	Micro package enhances sensor form factor

Watchdog timer

STWD100Y

life.augmented

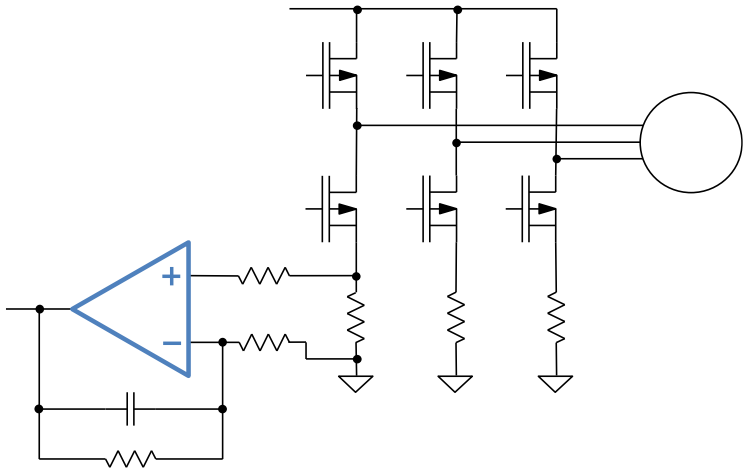
Low-side current measurement for motors

Context

The pervasion of brushless DC motors in automotive leads to removal of energy-wasting belts for the transmission of power to sub-systems.

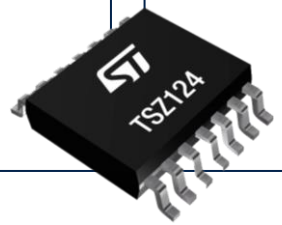
Principle of operation

The current is measured in each branch of the 3-phase Mosfets bridge. Shunt resistor voltage drop is amplified by high accuracy op amp.



ST Offer

Feature	Benefit
Input offset voltage Vio < 5 µV @25°C Vio < 8 µV -40 to 125°C	Minimizes shunt resistor value and cost
TSSOP14	Facilitates integration



UM1737: How to use the product evaluation board STEVAL-ISQ014V1 for low-side current sensing with the TSZ121 operational amplifier

Op Amp – Zero Drift

TSZ124IYPT

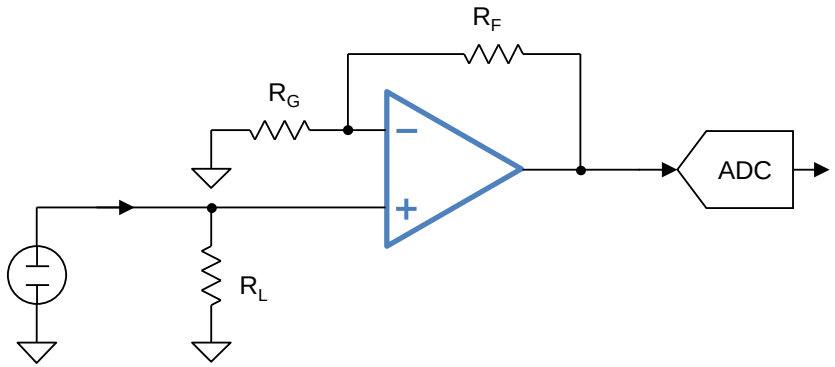
O_2 sensors

Context

Measurement of exhaust or inlet gas concentration of oxygen enables emission control by adjustment of combustion. Other applications include measurement of the partial pressure of oxygen in passengers breathing gas.

Principle of operation

O2 level is translated into current by the electrochemical sensor. Current is converted into voltage and amplified by op-amp in trans-impedance configuration.



ST Offer

Feature	Benefit
Input offset voltage Vio < 800 µV	Excellent measurement without trimming
Input bias current Iib < 10 pA	Compatible with high impedance sensor
MiniSO8	Micro package enhances sensor form factor

Op Amp – Low Power

TSV522AIYST

AN4348: Signal conditioning for electrochemical sensors

life.augmented

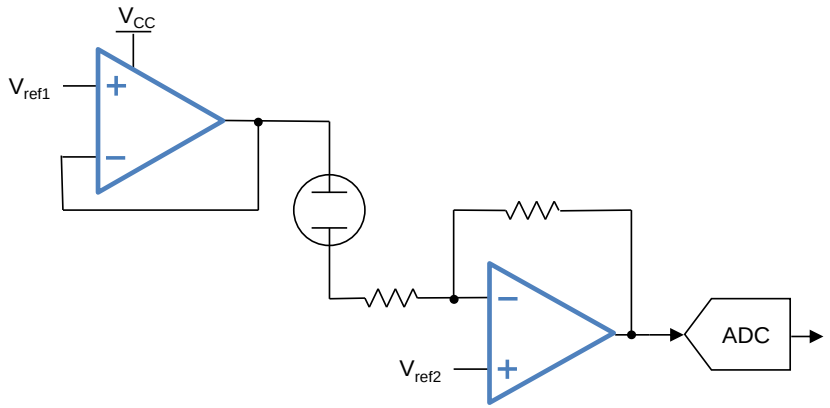
NO_x sensors for SCR

Context

Vehicle have to comply with environmental regulations requiring dramatic reduction of Nitrogen Dioxides emissions (NO_x and NO_2). This pressure implies new technologies such as real-time measurement of NO_x and selective catalytic reduction (SCR).

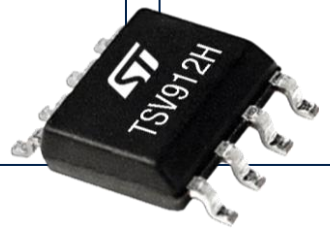
Principle of operation

The NOx is measured in the exhaust gas by amperometric or potentiometric method.
Aqueous ammonia (also named urea) is injected in the catalyst in order to transform NO_x into N_2 and water.



ST Offer

Feature	Benefit
Low input bias current Iib < 10pA	Maintains sensor accuracy
Operating temperature -40 to 150°C	Compatible with extreme working conditions
ESD HBM 5kV	Increased reliability in assembly line and during lifetime



Op Amp
TSV912HYDT

AN4348: Signal conditioning for electrochemical sensors

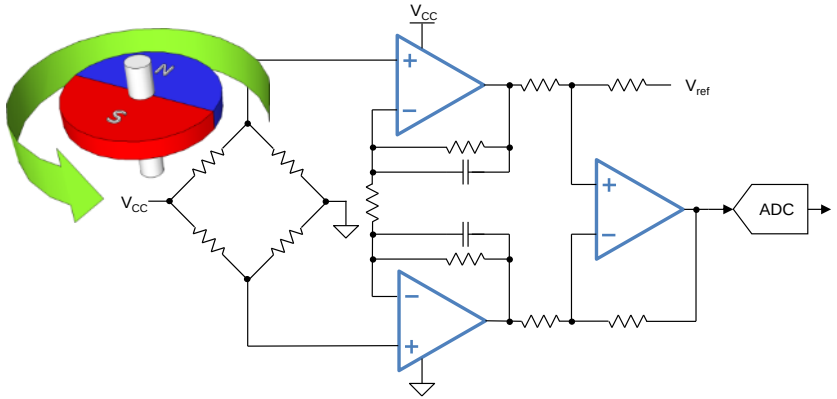
life.augmented

Pedal angle measurement

Context

Measurement of pedal position is mandatory to drive-by-wire, enabling new features as adaptive cruise control. Other applications include throttle valve angle measurement, windows wipers control.

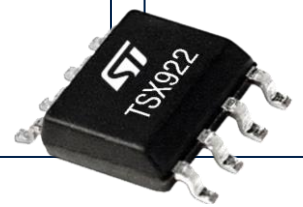
Principle of operation



The magnetic field created by a permanent magnet is measured by Anisotropic Magneto Resistor included in Wheatstone bridge. Electrical signal is amplified by op amp in difference amplifier configuration.

ST Offer

Feature	Benefit
High Gain Bandwidth Product: 10 MHz	Minimum phase shift between sensor and ADC
Supply voltage range 4 to 16V	Compatible with high voltage sensor



Op Amp – 16V CMOS

TSX922IYDT

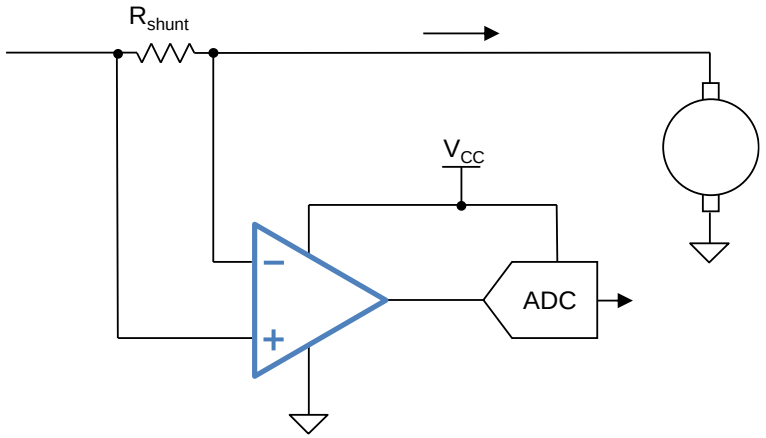
life.augmented

Power seat current control

Context

Power seat allows the user to fine tune the seat position using a joystick. Advanced feature can include automatic recall of user-customized settings. Modern cars can use 3 to 6 motors per seat for position adjustment.

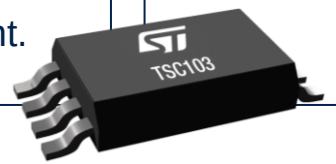
Principle of operation



The current flowing to the motor is measured through a shunt resistor. The current sense amplifier is directly connected to the shunt, and thanks to internal gain the output pin feedbacks current.

ST Offer

Feature	Benefit
Input pins sustain: -16 to 75V ESD 2.5kV	No protection needed for: Load dump, reversed battery, ESD surges
Output voltage accuracy: ±2.5% @25°C ±4% from -40 to 125°C	Minimizes shunt value and cost



Current sense amplifier

TSC103IYPT

AN4304: How to filter the input of a high-side current sensing
AN4366: Compensate the input offset of a high-side current sensing
AN4369: Adjustable gain with a current sensing

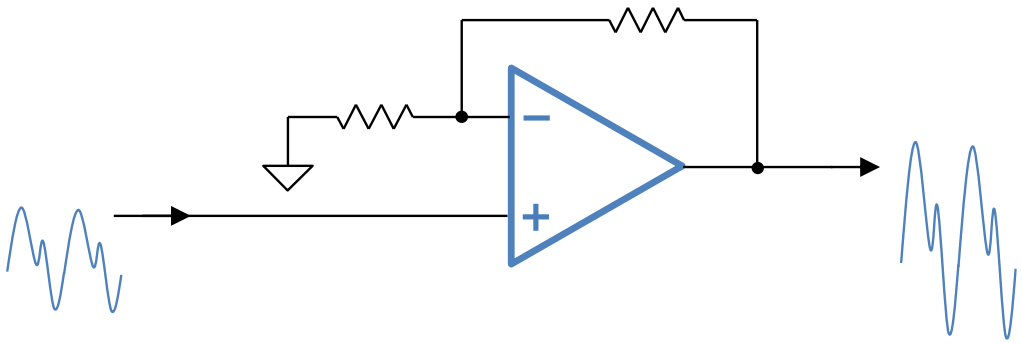
life.augmented

Audio buffer

Context

Audio quality has direct impact on the end-user perception of quality of the vehicle. Audio is now required not only for music, but also for navigation and user vocal interface.

Principle of operation



The amplifier is used to buffer and amplify the audio signal. Amplifiers with good audio performances are required.

ST Offer

Feature	Benefit
Low noise: 9 nV/√ Hz	Maintain audio quality
High output current: 80 mA	Ability to drive 32 Ω loads
Supply voltage range 2.7 to 12 V	High level of signal ensures disturbance rejection

Op Amp

TS922IYPT

Promotion tools

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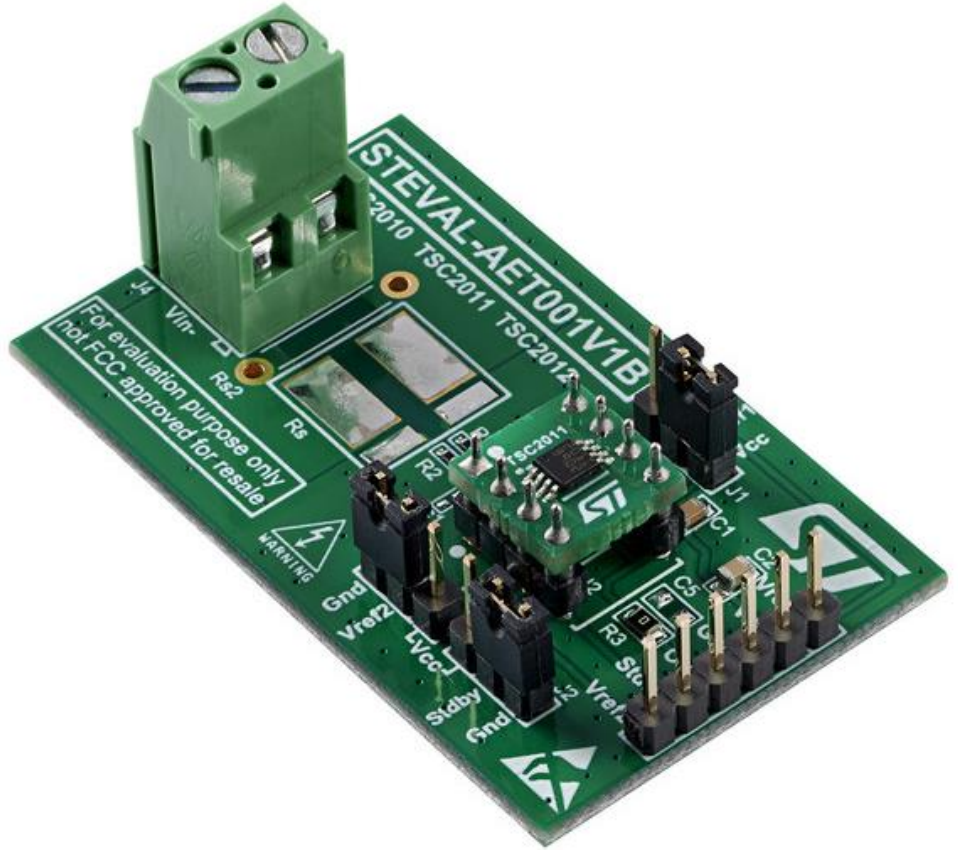
TSC2010 TSC2011 TSC2012 evaluation board
STEVAL-A1ETKT1V2

Motherboard

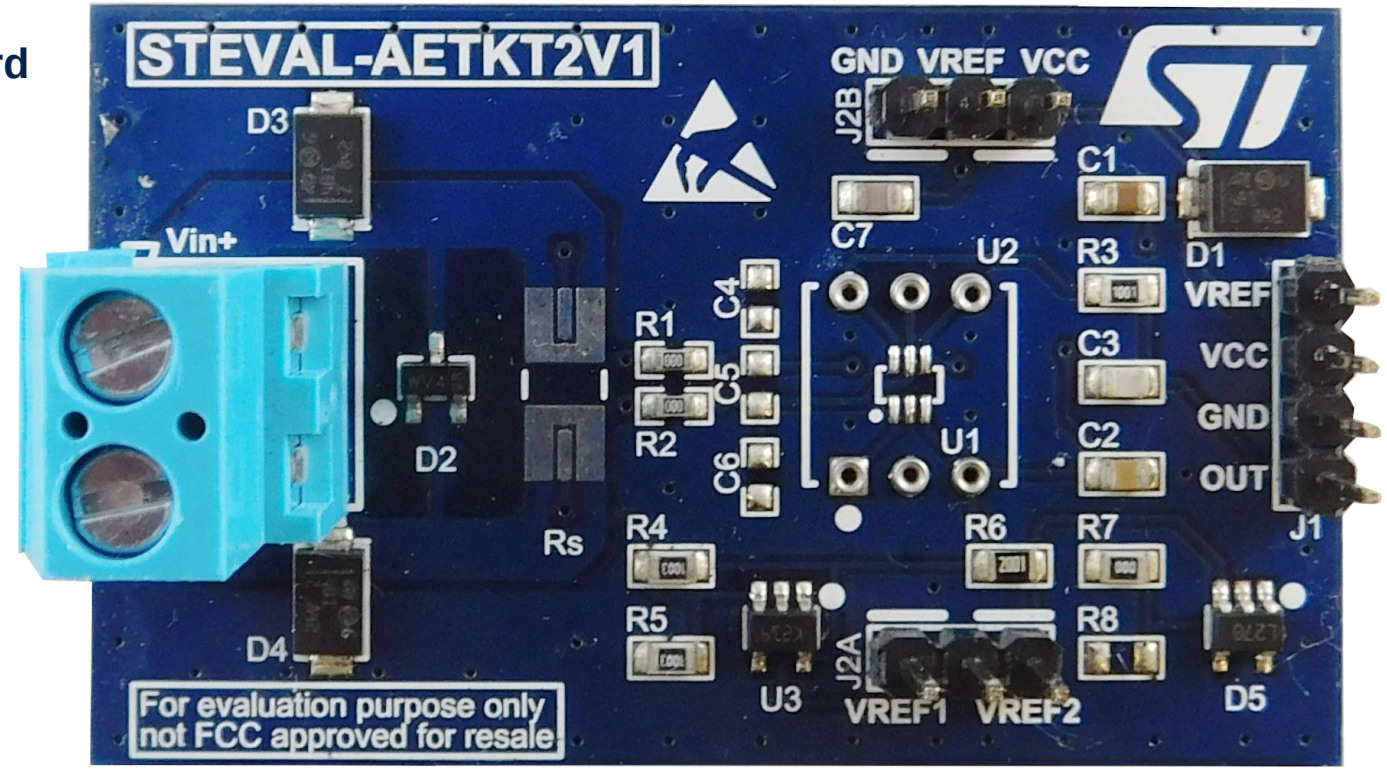


Daughter boards:
TSC2010, TSC2011, TSC2012.

Link

TSC210/211/212/213/214/215 demo board
STEVAL-AETKT2V1

Motherboard



Daughter boards:
TSC210, TSC213

Link

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Product	Description	Package
Operational amplifiers		
LM2904WHYST	30 V, low-power dual bipolar, 150 °C op amp	Mini SO8
TSB572IYQ2T	36 V, low-power dual rail-to-rail BiCMOS op amp in side-wettable flanks	DFN8 3x3
TSB611IYLT	36 V, low-power, rail-to-rail output, op amp	SOT23-5
TSB712IYST	36 V, precision, 6 MHz, rail-to-rail I/O, BiCMOS op amp	Mini SO8
TSV911IYLT	5 V, wide bandwidth 8 MHz, single rail-to-rail I/O CMOS op amp	SOT23-5
TSV912HYDT	5 V, wide bandwidth 8 MHz, 150 °C, dual rail-to-rail I/O CMOS op amp	SO8
TSX921IYLT	16 V, wide bandwidth 10 MHz, single rail-to-rail I/O CMOS op amp	SOT23-5
TSZ182IYST	5 V, very-high-accuracy, zero drift, CMOS op amp	Mini SO8
Comparators		
LM2903YQ3T	36 V, low-power dual bipolar comparator in side-wettable flanks	DFN8 2x2
TS3011IYQ3T	5 V, rail-to-rail, high-speed comparator in side-wettable flanks	DFN8 2x2
TS3021HIYLT	1.8 V, rail-to-rail, high-speed, 150 °C comparator	SOT23-5
TS3022IYST	5 V, rail-to-rail, high-speed micropower comparator	Mini SO8
TSX3702IYDT	16 V, micropower dual CMOS push-pull comparator	SO8
Current sensing		
TSC101CIYLT	High-side current sense amplifier	SOT23-5
TSC103IYPT	High-voltage high-side current sense amplifier	TSSOP8

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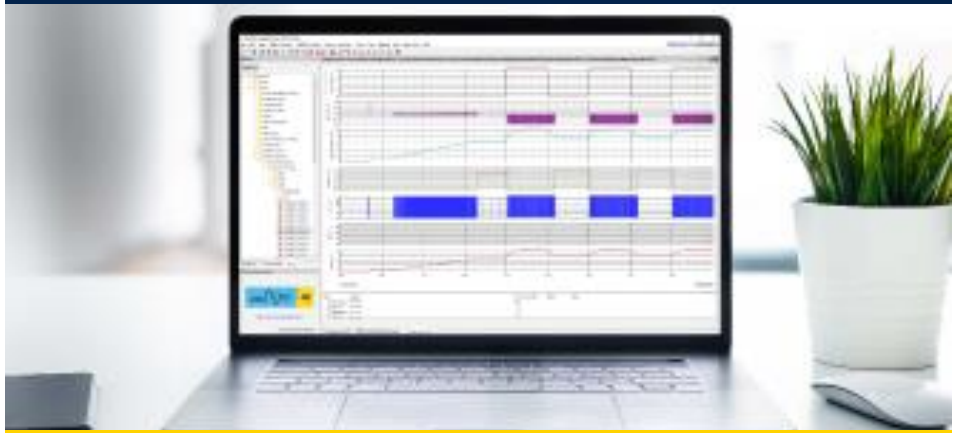

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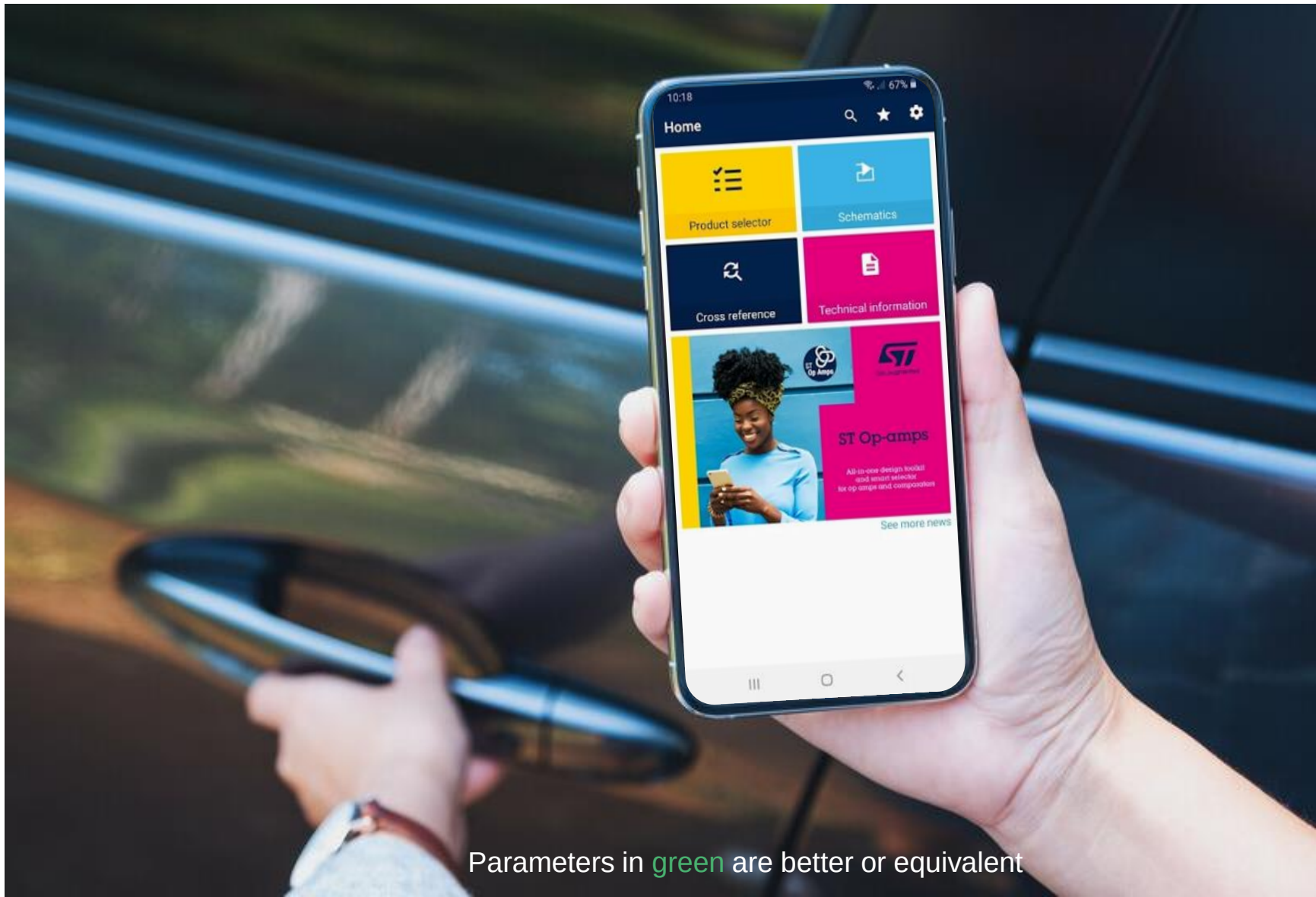

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