ST Analog Products
for Automotive applications

General Purpose Analog and RF
Added value for **SMART DRIVING**

- **Temperature measurement**
  - Op Amp TSZ124IYPT
  - [PPT](#)
  - [WWW](#)

- **Audio buffer**
  - Op Amp TS922IYPT
  - [PPT](#)
  - [WWW](#)

- **Headlight Levelling**
  - Op Amp TSB572IYST
  - [PPT](#)
  - [WWW](#)

- **Rain and Light sensor**
  - Op Amp TSV631IYLT
  - [PPT](#)
  - [WWW](#)

- **Power seat motor current control**
  - Current sensing TSC103IYPT
  - [PPT](#)
  - [WWW](#)

- **Pedal angle measurement**
  - Op Amp TSX922IYDT
  - [PPT](#)
  - [WWW](#)

- **Advanced driver assistance system**
  - Watchdog timer STWD100Y
  - [PPT](#)
  - [WWW](#)
Added value for **GREENER DRIVING**

- **Low-side current measurement for motor control**
  - Op Amp
  - TSZ124IYPT
  - [ppt](#) - [www](#)

- **Electric Power Steering angle measurement**
  - Op Amp
  - TSX564IYPT
  - [ppt](#) - [www](#)

- **NO\textsubscript{x} sensor for Selective Catalytic Reduction**
  - Op Amp
  - TSV912HYDT
  - [ppt](#) - [www](#)

- **O\textsubscript{2} sensor**
  - Op Amp
  - TSV522AIYST
  - [ppt](#) - [www](#)

- **Power switches for 48V battery applications**
  - Current sensing
  - TSC103IYPT
  - [ppt](#) - [www](#)
Headlight Levelling

**Context**

The headlight angle adjustment helps to compensate the car pitch angle, whatever the car loading or road conditions. The levelling becomes more and more critical as the headlight power increases, to prevent other drivers from 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 the battery voltage to the actuator.

**ST Offer**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage 36 V operating</td>
<td>Capability to provide control voltage proportional to battery</td>
</tr>
<tr>
<td>Supply voltage 40 V AMR</td>
<td>Reduces need of load dump clamping</td>
</tr>
<tr>
<td>Rail-to-rail input / output stage</td>
<td>No need for charge pump circuitry</td>
</tr>
</tbody>
</table>
Power switches for 48 V battery applications

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

Principle of operation

The current sense amplifier measures the current through a shunt resistor. If the current exceeds the programmed threshold, the microcontroller inhibits the gate drive.

ST Offer

- Input pins sustain: -16 to 75 V
  ESD 2.5 kV
- 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
Temperature measurement

Context

Temperature is measured to guarantee safe operation of motors, converters and electronic control units. In hybrid and electric vehicles, temperature measurement helps to monitor and maximize battery efficiency.

Principle of operation

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

ST Offer

<table>
<thead>
<tr>
<th>Feature</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input offset voltage $V_{\text{IO}} &lt; 5 \mu\text{V} @ 25^\circ\text{C}$  $V_{\text{IO}} &lt; 8 \mu\text{V} -40 \text{ to } 125 , ^\circ\text{C}$</td>
<td>Excellent measurement without trimming</td>
</tr>
<tr>
<td>Input offset voltage drift $\Delta V_{\text{IO}}/\Delta T$ 30 nV/°C (max.)</td>
<td>Stability of measurement versus temperature change</td>
</tr>
<tr>
<td>Input bias current $I_{\text{IB}} &lt; 200 \text{ pA}$</td>
<td>Compatible with high impedance sensor</td>
</tr>
</tbody>
</table>

Op Amp – Zero Drift
TSZ124IYPT
Electric Power Steering angle measurement

Electric Power Steering systems are replacing hydraulic systems in order to tailor steering-gear responses to driving conditions. In addition, EPS is a major contributor to fuel-saving efforts.

**Principle of operation**

The angle is measured by a resolver. The sine wave is amplified to the primary winding of a rotary transformer. The secondary side signal is modified by the angle.

**ST Offer**

- **Feature**: High output current $I_{OUT} = 90$ mA (typ.)
- **Benefit**: Capability to drive coils
- **Feature**: Slew rate 1.1 V/µs (typ.)
- **Benefit**: Enables high sampling frequency
- **Feature**: Supply voltage range 3 to 16 V
- **Benefit**: High-voltage biasing of the magnetic coil

Op Amp – 16V CMOS

TSX564IYPT
Rain and light sensors are widely used for the automatic mode of windscreen wipers and 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 an op amp.

**ST Offer**

- **Input bias current**
  - $I_{IB} < 10 \text{ pA} @ 25 \degree \text{C}$
  - $I_{IB} < 100 \text{ pA} @ 125 \degree \text{C}$

- **Supply voltage range**
  - 1.5 to 5.5 V

- **SOT23-5**

- **Maintains excellent accuracy by not affecting diode current**
- **Compatible with wide choice of supplies**
- **Micro package enhances sensor form factor**

**Context**

- AN4451: Signal conditioning for a UV sensor

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**Op Amp – Low Power**

TSV631IYLT
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.

**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**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variety of available watchdog timeout periods</td>
<td>Simple, robust and reliable implementation</td>
</tr>
<tr>
<td>Supply voltage range</td>
<td>Compatible with wide choice of supplies</td>
</tr>
<tr>
<td>2.7 to 5.5 V</td>
<td></td>
</tr>
<tr>
<td>SOT23-5</td>
<td>Micro package enhances sensor form factor</td>
</tr>
</tbody>
</table>
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 MOSFET bridge. The shunt resistor voltage drop is amplified by a high-accuracy op amp.

ST Offer

Input offset voltage
- $V_{IO} < 5 \mu V \ @ \ 25 ^\circ C$
- $V_{IO} < 8 \mu V \ (-40 \ to \ 125^\circ C)$

Minimizes shunt resistor value and cost

TSSOP14

Facilitates integration

Op Amp – Zero Drift

TSZ124IYPT
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 air breathed by passengers.

**Principle of operation**

The O\textsubscript{2} level is translated into current by the electrochemical sensor. The current is converted into voltage and amplified by the op amp in a trans-impedance configuration.

**ST Offer**

- **Input offset voltage** $V_{\text{IO}} < 800 \mu\text{V}$
  - Excellent measurement without trimming
- **Input bias current** $I_{\text{IB}} < 10 \text{ pA}$
  - Compatible with high impedance sensor
- **MiniSO8**
  - Micro package enhances sensor form factor

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*Op Amp – Low Power*

**TSV522AIYST**

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*AN4348: Signal conditioning for electrochemical sensors*
NO\textsubscript{x} sensors for SCR

**Context**
Vehicles must comply with environmental regulations that require a dramatic reduction of Nitrogen Dioxide emissions (NO\textsubscript{x} and NO\textsubscript{2}). This pressure implies new technologies such as real-time measurement of NO\textsubscript{x} and selective catalytic reduction (SCR).

**Principle of operation**
NO\textsubscript{x} is measured in the exhaust gas using an amperometric or potentiometric method. Aqueous ammonia (also named urea) is injected in the catalyst in order to transform NO\textsubscript{x} into N\textsubscript{2} and water.

**ST Offer**
- **Low input bias current** $I_{IB} < 10$ pA
  - Maintains sensor accuracy
- **Operating temperature** -40 to 150 °C
  - Compatible with extreme working conditions
- **ESD HBM** 5 kV
  - Increased reliability in assembly line and during lifetime

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**Op Amp**
**TSV912HYDT**

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**Feature**
- AN4348: Signal conditioning for electrochemical sensors
Pedal angle measurement

Measurement of pedal position is mandatory for drive-by-wire systems, enabling new features such as adaptive cruise control. Other applications include throttle valve angle measurement and windscreen wiper control.

Context

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

Principle of operation

The Op Amp – 16V CMOS TSX922IYDT offers high gain bandwidth at 10 MHz with a minimum phase shift between sensor and ADC. It is compatible with high voltage sensors, operating within a supply voltage range of 4 to 16 V.
Power seat current control

Context

Power seat controls allow the user to fine-tune the seat position using a joystick. Advanced features 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 the internal gain, the output pin feedbacks current.

ST Offer

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

Current sense amplifier

TSC103IYPT

ST offer

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

**Context**

**Principle of operation**

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

**ST Offer**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low noise: 9 nV/√ Hz</td>
<td>Maintain audio quality</td>
</tr>
<tr>
<td>High output current: 80 mA</td>
<td>Ability to drive 32 Ω loads</td>
</tr>
<tr>
<td>Supply voltage range</td>
<td>High level of signal ensures disturbance rejection</td>
</tr>
<tr>
<td>2.7 to 12 V</td>
<td></td>
</tr>
</tbody>
</table>
Support tools
Automotive op amps sample kit 2017

Order information

Order code: KITAUTOPAMP02
Order by multiples of 20

Featured products

<table>
<thead>
<tr>
<th>Product Code</th>
<th>Description</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSC101AIYLT</td>
<td>High-side current sense amplifier</td>
<td>SOT23-5</td>
</tr>
<tr>
<td>TSC1031IYPT</td>
<td>High-voltage high-side current sense amplifier</td>
<td>TSSOP8</td>
</tr>
<tr>
<td>TSC1031IYPT</td>
<td>High-voltage high-side current sense amplifier</td>
<td>TSSOP8</td>
</tr>
<tr>
<td>LM2904WHYDT</td>
<td>32 V, low-power dual bipolar high temperature (150 °C) op amp</td>
<td>SO8</td>
</tr>
<tr>
<td>LM2903HYDT</td>
<td>36 V, low-power dual bipolar high temperature (150 °C) comparator</td>
<td>SO8</td>
</tr>
<tr>
<td>TSB572IYQ2T</td>
<td>36 V, low-power dual rail-to-rail BiCMOS op amp</td>
<td>DFN8</td>
</tr>
<tr>
<td>TSV631IYLT</td>
<td>5.5 V, low-voltage, micropower single rail-to-rail I/O CMOS op amp</td>
<td>SOT23-5</td>
</tr>
<tr>
<td>TSV912AIYST</td>
<td>5 V, wide bandwidth dual rail-to-rail I/O CMOS op amp</td>
<td>MiniSO8</td>
</tr>
<tr>
<td>TSZ121IYLT</td>
<td>5 V, 400 KHz, very high accuracy (5µV) zero drift rail-to-rail I/O CMOS op amp</td>
<td>SOT23-5</td>
</tr>
<tr>
<td>TSZ182IYST</td>
<td>5 V, 3 MHz, very high accuracy (25µV) zero drift rail-to-rail I/O CMOS op amp</td>
<td>MiniSO8</td>
</tr>
</tbody>
</table>
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Comparators
Current sensing

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