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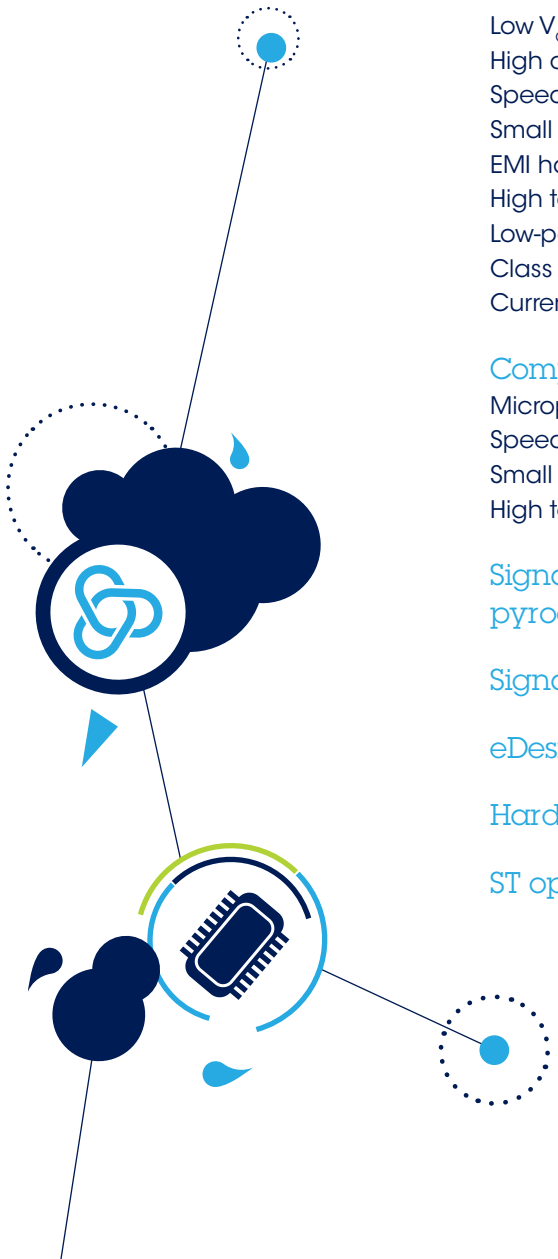
Operational amplifiers
Performance, robust and advanced technology

ST
Op Amps

Content



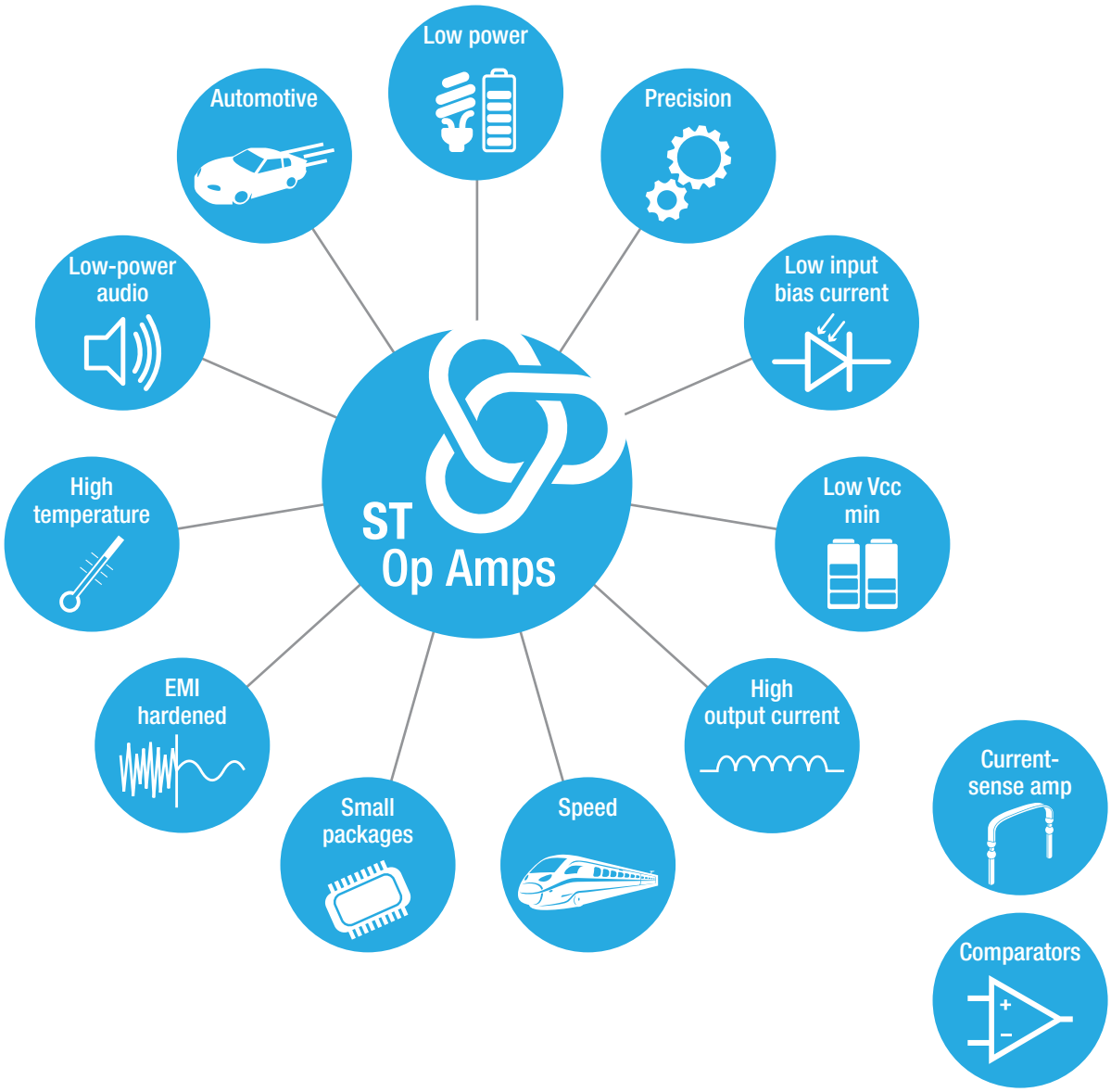
Introduction

STMicroelectronics offers a wide analog portfolio including high-performance amplifiers and comparators dedicated to the challenging industrial, automotive and consumer markets.

The product range is developed for various needs such as precision, low consumption, high speed, package form factor, audio and supply range, or cost-optimized bills of material.

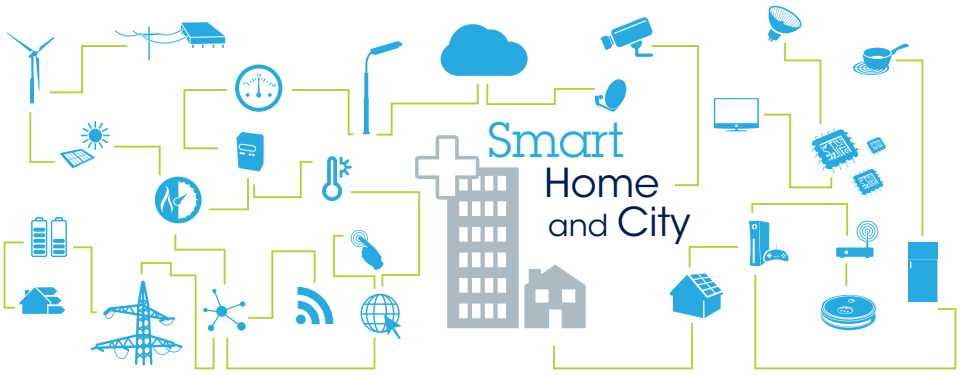
The range of products allows easy and fast integration of analog products inside signal conditioning, monitoring and control solutions.

ST's op amps enhance the signal chain by being the perfect companion chips for microcontrollers and analog sensors.

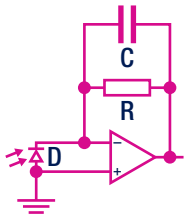


Application schematics

HOME



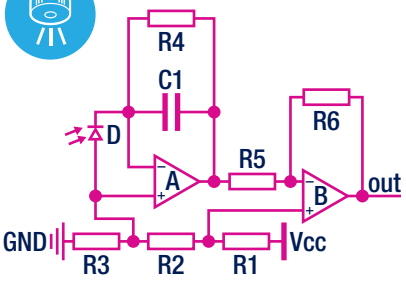
Photodiode current sensing



Featured products:

- TSU series
- TSX series
- TSV63 series

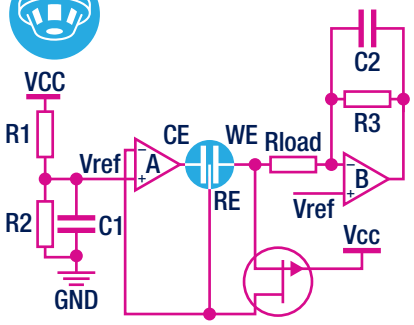
Smoke detector



Featured products:

- TSV629 series
- TSV5 series

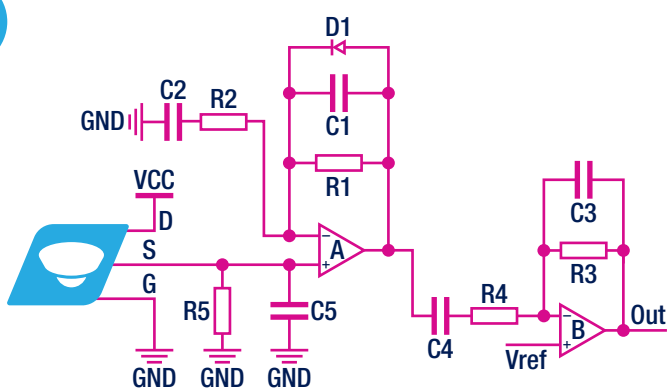
CO detector



Featured products:

- TSU series
- TSZ series

PIR detector



Featured products:

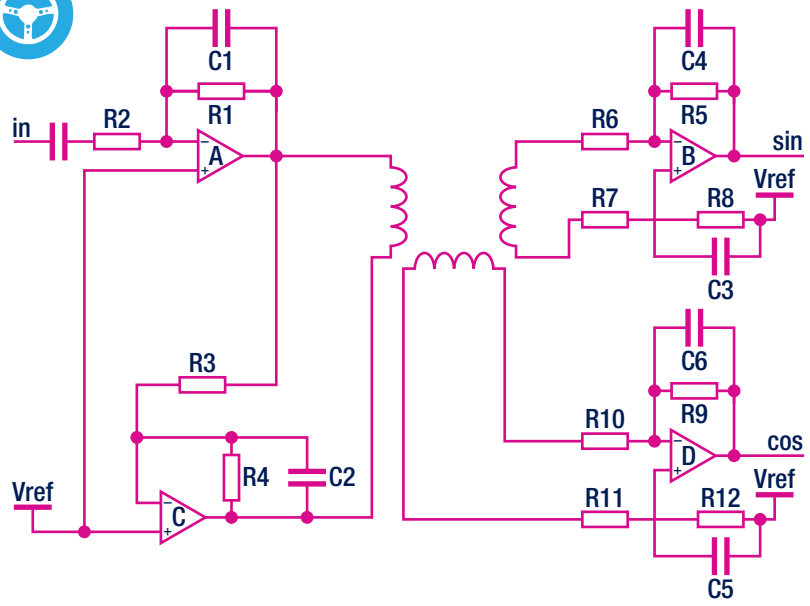
- TSU series

KEY PARAMETERS

- Precision
- Low input bias current
- Low power
- Small package

AUTOMOTIVE

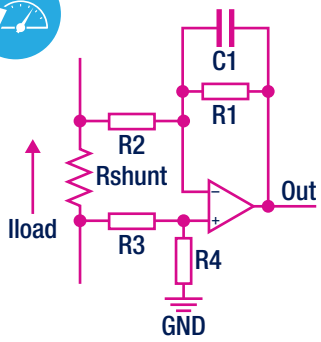
Steering angle sensor



Featured products:

- TSX564IYPT
- TSX922IYDT

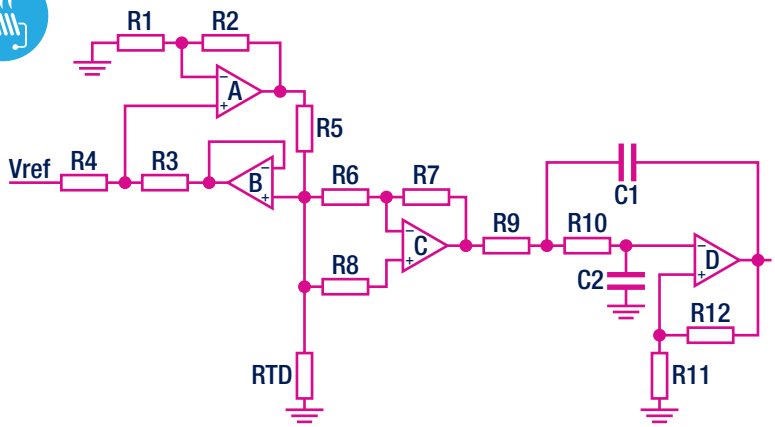
Current measurement



Featured products:

- TSX7191IYLT
- TSZ121IYLT
- TSX9291IYLT

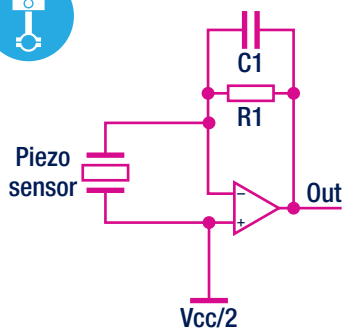
Resistance temperature detector



Featured products:

- TSZ124IYPT

Cylinder pressure sensor



Featured products:

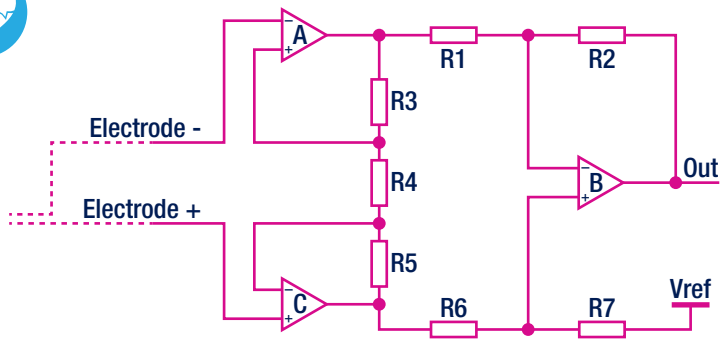
- TSX922IYDT
- TSV912HYDT

KEY PARAMETERS

- Precision
- Low power
- Speed
- High voltage
- Specific production flow

HEALTHCARE

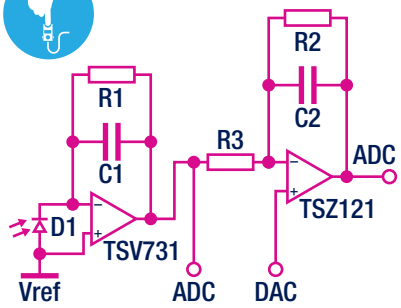
ECG electrocardiography



Featured products:

- TSZ series

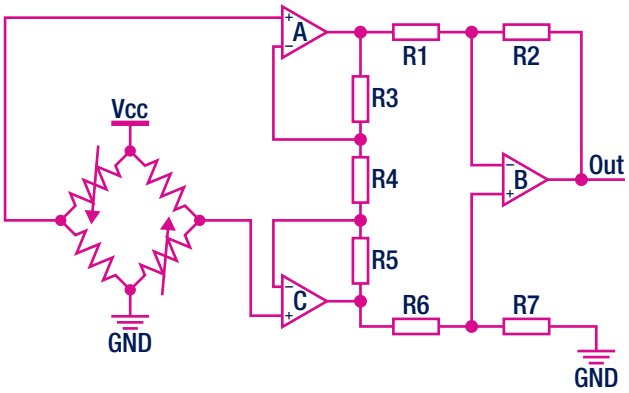
Pulse oximeter sensor



Featured products:

- TSZ series
- TSV7 series

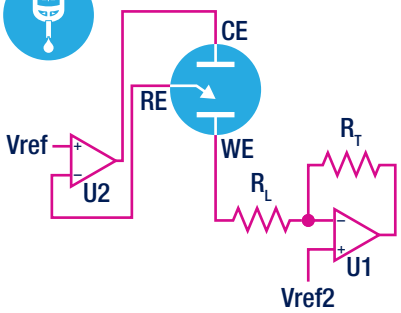
Blood pressure sensor



Featured products:

- TSV7 series
- TSZ series

Glucose meter



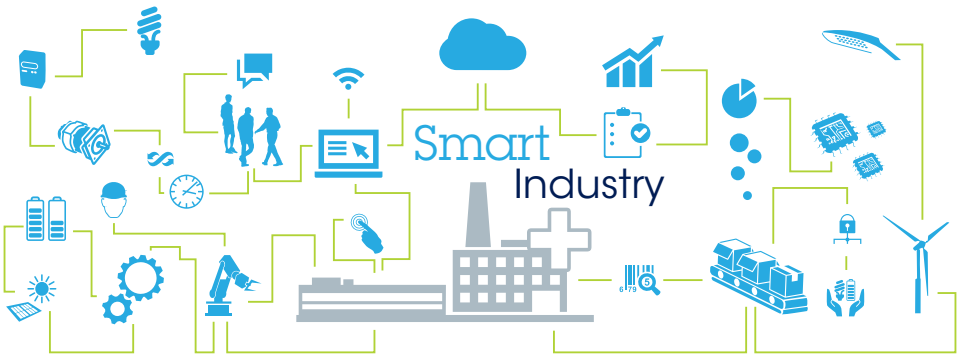
Featured products:

- TSV6 series
- TSV7 series

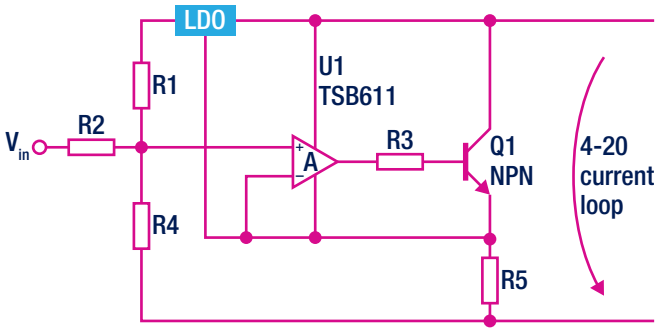
KEY PARAMETERS

- Precision
- Low input bias current
- Low power
- Small package

INDUSTRY



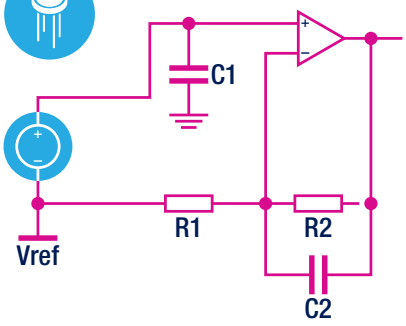
4-20 mA current loop



Featured products:

- TSB5 series
- TSB6 series
- TSX7 series

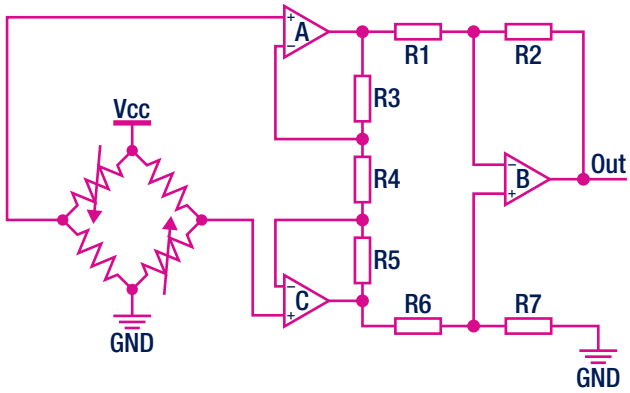
Thermopile



Featured products:

- TSZ series

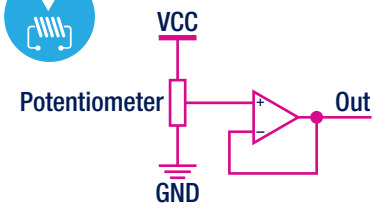
Force/pressure (strain gauge)



Featured products:

- TSV7 series
- TSX7 series
- TSZ series

Potentiometer



Featured products:

- TSV6 series
- TSX7 series

KEY PARAMETERS

- Precision
- Low power
- High voltage
- Small package

Operational amplifiers

LOW POWER

TSU101/2/4: 580 nA 1.5 to 5.5 V rail-to-rail input and output operational amplifiers

The TSU101, TSU102, and TSU104 operational amplifiers offer an ultra-low power consumption of 580 nA (typical) and 750 nA (maximum) per channel when supplied by 1.8 V. Combined with a supply voltage range of 1.5 to 5.5 V, these features allow the TSU10 series to be efficiently supplied by a coin type Lithium battery or a regulated voltage in low-power applications. Their 8 kHz gain bandwidth make them ideal for sensor signal conditioning, battery supplied and portable applications.

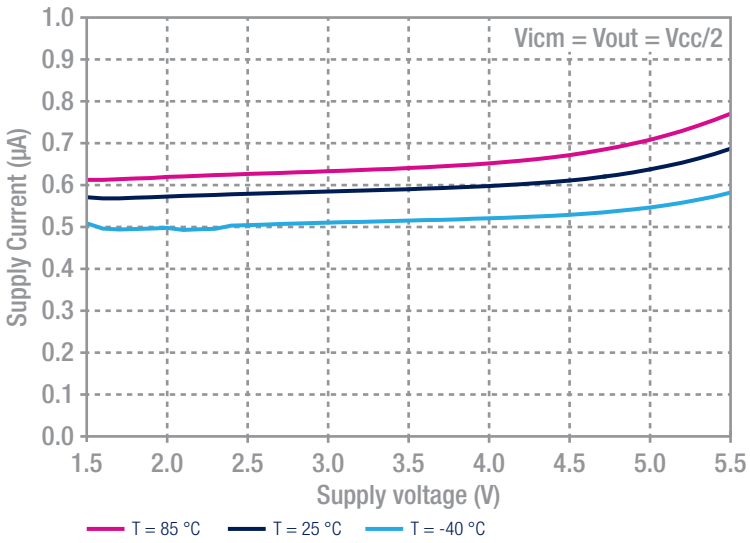
FEATURES

- 580 nA (typ.) per channel at 25 °C at V_{CC} = 1.8 V
- Low supply voltage: 1.5 to 5.5 V
- Rail-to-rail input and output
- Gain bandwidth product: 8 kHz (typ.)
- Low input bias current: 5 pA (max.) at 25 °C
- High tolerance to ESD: 2 kV HBM
- Industrial temperature range: -40 to +85 °C

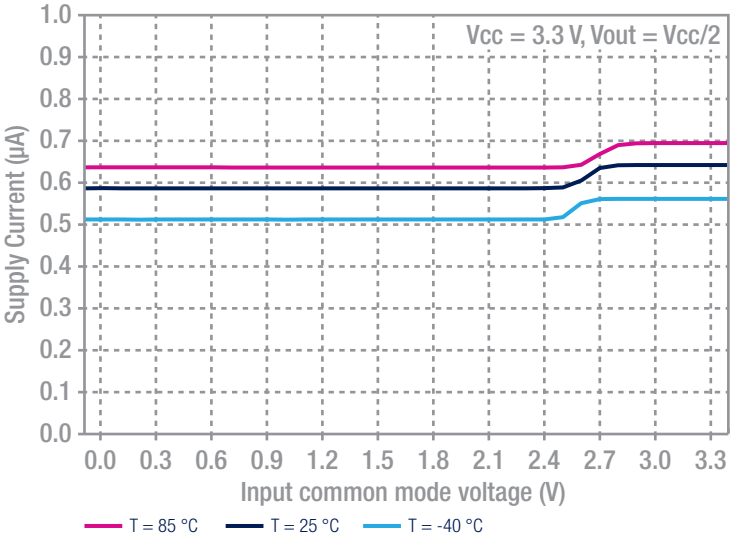
APPLICATIONS

- Ultra-long life battery-powered applications
- Power metering
- UV and photo sensors
- Electrochemical and gas sensors
- Pyroelectric passive infrared (PIR) detection
- Battery current sensing
- Medical instrumentation
- RFID readers

Supply current vs. supply voltage



Supply current vs. input common mode voltage



Part number	Typ. I_{cc} per channel (µA)	Min. V_{cc} (V)	Max. V_{cc} (V)	Typ. GBP (MHz)	Typ. SR (V/µs)	Max. V_{IO} @ 25 °C (µV)	Typ. I_{OUT} (mA)	Rail to rail		Single	Dual	Quad	Automotive grade
								In	Out				
Nanopower (I_{cc} ≤ 1 µA)													
TSU101/2/4	0.58	1.5	5.5	0.008	0.003	3000	5	Yes	Yes	•	•	•	
TSU111*	0.95	1.5	5.5	0.01	0.0035	150	10	Yes	Yes	•			
Micropower (1 µA < I_{cc} ≤ 35 µA)													
TS941A/2A/4A	1.2	2.5	10	0.01	0.045	5000	4.5	No	Yes	•	•	•	
TSV711/2/4	10	1.5	5.5	0.12	0.06	200	45	Yes	Yes	•	•	•	
TSV611A/2A	10.5	1.5	5.5	0.12	0.04	800	60	Yes	Yes	•	•		
TSV6191A/2A	10.5	1.5	5.5	0.45	0.08	800	60	Yes	Yes	•	•		
TS27L2/4A	10	3	16	0.1	0.04	5000	60	No	No		•	•	
TS931B/2B/4B	20	2.7	10	0.1	0.05	2000	5	No	Yes	•	•	•	✓
TSV621A/2A/4A	29	1.5	5.5	0.42	0.14	800	69	Yes	Yes	•	•	•	
TSV6291A/2A/4A	29	1.5	5.5	1.3	0.5	800	69	Yes	Yes	•	•	•	
TSZ121/2/4	31	1.8	5.5	0.4	0.19	5	17	Yes	Yes	•	•	•	✓
Low power (35 µA < I_{cc} < 1 mA)													
TSV521A/2A/4A	45	2.7	5.5	1.15	0.89	600	55	Yes	Yes	•	•	•	✓
TSX631A/2A/4A*	45	3.3	16	0.2	0.12	500	90	Yes	Yes	•	•	•	✓
TSV631A/2A/4A	60	1.5	5.5	0.88	0.34	500	69	Yes	Yes	•	•	•	✓
TSV6391A/2A/4A	60	1.5	5.5	2.4	1.1	500	69	Yes	Yes	•	•	•	
TSV731/2/4	60	1.5	5.5	0.9	0.35	200	52	Yes	Yes	•	•	•	
TSB611*	103	2.7	36	0.56	0.18	1000	60	No	Yes	•			✓
TS27M2B/M4	150	3	16	1	0.6	2000	60	No	No		•	•	
TS1851/2A/4A	162	1.8	6	0.65	0.25	1000	48	Yes	Yes	•	•	•	
TL061/2B/4	200	6	36	1	3.5	3000	N/A	No	No	•	•	•	
MC33171/2/4	200	4	44	2.1	2	4500	15	No	No	•	•	•	
TSX561A/2A/4A*	250	3	16	0.9	1.1	600	90	Yes	Yes	•	•	•	✓
TSB571/2*	380	4	36	2.5	1	1500	60	Yes	Yes	•	•		✓
TS912B/14A	400	2.7	16	1.4	1	2000	70	Yes	Yes		•	•	✓
TS1871A/2A/4A	400	1.8	6	1.8	0.6	1000	72	Yes	Yes	•	•	•	✓
TSV321A/358A/324A	500	2.5	6	1.4	0.6	1000	80	Yes	Yes	•	•	•	✓
TS512A/14A	500	6	30	3	1.5	500	23	No	No		•	•	✓
TS321A	600	3	30	0.8	0.4	2000	40	No	No	•			✓
TSX711A/12*	660	2.7	16	2.7	1.2	100	54	Yes	Yes	•	•		✓
TSX7191A/92*	660	2.7	16	8.5	2.4	100	70	Yes	Yes	•	•		✓
TSZ181/2*	700	2.2	5.5	3	4	15	17	Yes	Yes	•	•		✓
TSV911A/2A/4A	780	2.5	5.5	8	4.5	1500	35	Yes	Yes	•	•	•	✓
TS507	850	2.7	5.5	1.9	0.6	100	115	Yes	Yes	•			✓
TS9222/9224	900	2.7	12	4	1.3	500	80	Yes	Yes		•	•	✓
TS951/2/4	950	2.7	12	3	1	6000	22	Yes	Yes	•	•	•	✓
Amplifiers with standby pin													
TSX920/3*	2800	4	16	10	17.2	4000	62	Yes	Yes	•	•		
TSH73	9800	3	12	71	100	10000	55	No	Yes	3 channels			
TSV620A/3A/5A	29	1.5	5.5	0.42	0.14	800	69	Yes	Yes	•	•	•	
TSV6290A/3A/5A	29	1.5	5.5	1.3	0.5	800	69	Yes	Yes	•	•	•	
TSV630A/3A/5A	60	1.5	5.5	0.88	0.34	500	69	Yes	Yes	•	•	•	
TSV6390A/3A/5A	60	1.5	5.5	2.4	1.1	500	69	Yes	Yes	•	•	•	
TSV850A/3A/5A	130	2.3	5.5	1.3	0.7	800	56	No	Yes	•	•	•	
LMV820A/3A/5A	300	2.5	5.5	5.5	1.9	800	56	No	Yes	•	•	•	

Any non-automotive product may be eligible for AEC-Q100 qualification. Contact ST Sales representative for additional information.
Note: * New products

PRECISION

TSZ121/2/4: 5 V zero-drift rail-to-rail precision amplifiers (Vio ≤ 5 µV)

The TSZ operational amplifier series offer low-power, zero-drift operational amplifiers in space-saving packages. They use chopper-stabilized architecture that provides very low offset voltages (8 µV (max.) over the full operating temperature range) and near-zero drift. These miniature, ultra-precision and low quiescent current amplifiers offer high-impedance inputs that have a common-mode range of 100 mV beyond the rails and rail-to-rail outputs that swing within 50 mV of the rails. TSZ amplifiers are optimized for low-voltage operation with single or dual supplies as low as +1.8 V (±0.9 V) up to +5.5 V (±2.75 V). The chopper architecture rejects the high 1/f noise typically found in CMOS input op amps, making it suitable for a wide variety of low-frequency measurement applications.

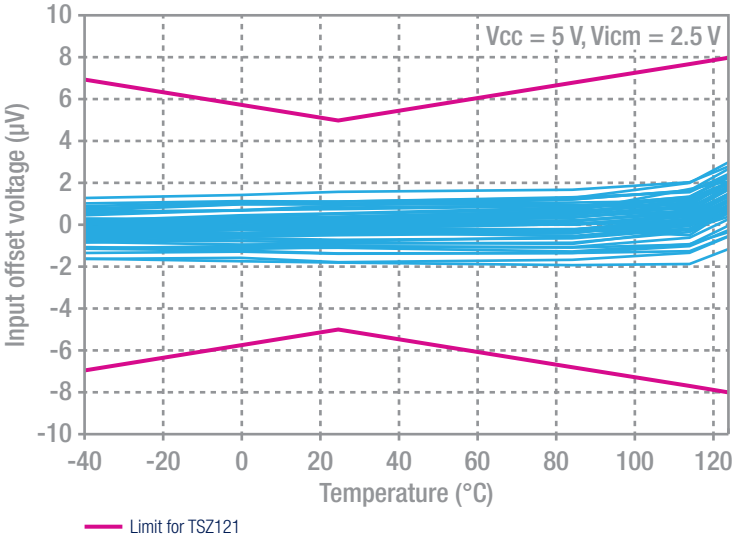
FEATURES

- Offset: ±1 µV (typ.), ±8 µV (worst case in temperature)
- Offset drift: 10 nV/ºC (typ.), 30nV/ºC (max.)
- 400 kHz GBP
- Low 28 µA (typ.) quiescent current
- Supply voltage: 1.8 to 5.5 V
- Extended temperature range: -40 to +125 °C
- Rail-to-rail input and output
- ESD: 4 kV HBM
- Qualified for automotive applications
- Available in tiny packages: SOT23 and DFN8 (2 x 2 mm)

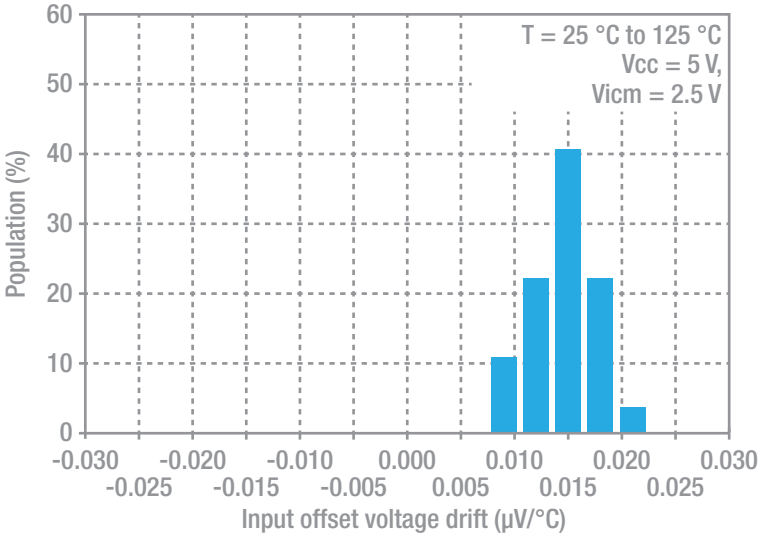
APPLICATIONS

- Portable instrumentation
- Battery-powered devices
- Mobile communications
- Sensor interfaces
- Medical instrumentation
- Electronic scales
- Temperature measurement

Input offset voltage vs. temperature



Vio temperature co-efficient distribution (25 °C to 125 °C)



Part number	Max. V_{IO} @ 25 °C (µV)	Typ. V_{IO} drift (µV/°C)	Max. Iib @ 25 °C (pA)	Min. V_{CC} (V)	Max. V_{CC} (V)	Typ. GBP (MHz)	Typ. SR (V/µs)	Typ. I_{CC} per channel (mA)	Typ. 1 kHz noise (nV/√Hz)	Rail to rail		Single	Dual	Quad	Automotive grade
										In	Out				
Low input offset															
TSZ121/2/4*	5	0.01	200	1.8	5.5	0.4	0.19	0.031	37	Yes	Yes	•	•	•	✓
TSZ181/2*	15	0.01	200	2.2	5.5	3	4	0.7	37	Yes	Yes	•	•		✓
TSX711A/12*	100	0.8	50	2.7	16	2.7	1.2	0.66	22	Yes	Yes	•	•		✓
TS507	100	1	70000	2.7	5.5	1.9	0.6	0.85	12	Yes	Yes	•			✓
TSU111*	150	0.5	5	1.5	5.5	0.01	0.0035	0.00095	240	Yes	Yes	•			
TSV711/2/4	200	3	10	1.5	5.5	0.12	0.06	0.01	100	Yes	Yes	•	•	•	
TSV731/2/4	200	2	10	1.5	5.5	0.9	0.35	0.06	35	Yes	Yes	•	•	•	
TSX7191A/2*	100	0.8	50	2.7	16	8.5	2.4	0.66	22	Yes	Yes	•	•		✓
TSV631A/2A/4A	500	2	10	1.5	5.5	0.88	0.34	0.06	60	Yes	Yes	•	•	•	✓
TSV6391A/2A/4A	500	2	10	1.5	5.5	2.4	1.1	0.06	60	Yes	Yes	•	•	•	✓
TSV630A/3A/5A	500	2	10	1.5	5.5	0.88	0.34	0.06	60	Yes	Yes	•	•	•	✓
TSV6390A/3A/5A	500	2	10	1.5	5.5	2.4	1.1	0.06	60	Yes	Yes	•	•	•	✓
TS9222/4	500	2	55000	2.7	12	4	1.3	0.9	9	Yes	Yes		•	•	✓
TS512A/4A	500	2	150000	6	30	3	1.5	0.5	8	No	No		•	•	✓
TSX561A/2A/4A*	600	2	100	3	16	0.9	1.1	0.25	48	Yes	Yes	•	•	•	✓
TSX631A/2A/4A*	700	1	100	3.3	16	0.2	0.12	0.045	60	Yes	Yes	•	•	•	✓
TS9511	800	2	70000	2.7	12	3	1	0.95	25	Yes	Yes	•			✓
TSV611A/2A	800	2	10	1.5	5.5	0.12	0.04	0.0105	105	Yes	Yes	•	•		
TSV6191A/2A	800	2	10	1.5	5.5	0.45	0.08	0.0105	105	Yes	Yes	•	•		
TSV621A/2A/4A	800	2	10	1.5	5.5	0.42	0.14	0.029	77	Yes	Yes	•	•	•	
TSV6291A/2A/4A	800	2	10	1.5	5.5	1.3	0.5	0.029	77	Yes	Yes	•	•	•	
TSV620A/3A/5A	800	2	10	1.5	5.5	0.42	0.14	0.029	77	Yes	Yes	•	•	•	
TSV6290A/3A/5A	800	2	10	1.5	5.5	1.3	0.5	0.029	77	Yes	Yes	•	•	•	
TSV521A/2A/4A	600	3	10	2.7	5.5	1.15	0.89	0.045	57	Yes	Yes	•	•	•	✓
TSV851A/2A/4A	800	1	60000	2.3	5.5	1.3	0.7	0.13	30	No	Yes	•	•	•	✓
LMV821A/2A/4A	800	1	120000	2.5	5.5	5.5	1.9	0.4	16	No	Yes	•	•	•	✓
TS522/4	850	2	750000	5	30	15	7	2	4.5	No	No		•	•	✓

Any non-automotive product may be eligible for AEC-Q100 qualification. Contact ST Sales representative for additional information.
Note: * New products

LOW INPUT BIAS CURRENT

TSX711/2: 2.7 – 16 V CMOS rail-to-rail 200 µV precision amplifiers

The TSX71 operational amplifier series offer high precision functioning with low input offset voltage down to a maximum of 200 µV at 25 °C. In addition, their rail-to-rail input and output functionality allow these products to be used on a full range of inputs and outputs without limitation. This is particularly useful for a low-voltage supply such as 2.7 V that the TSX71 is able to operate with. Thus, the TSX71 series have the significant advantage of offering a large span of supply voltages, ranging from 2.7 to 16 V. Low input bias current performance makes the TSX71 perfect when used for signal conditioning in sensor interface applications. In addition, low-side and high-side current measurements can be easily made thanks to rail-to-rail functionality, high ESD tolerance (4 kV HBM) and a wide temperature range are also good arguments to use the TSX71 in the automotive market segment.

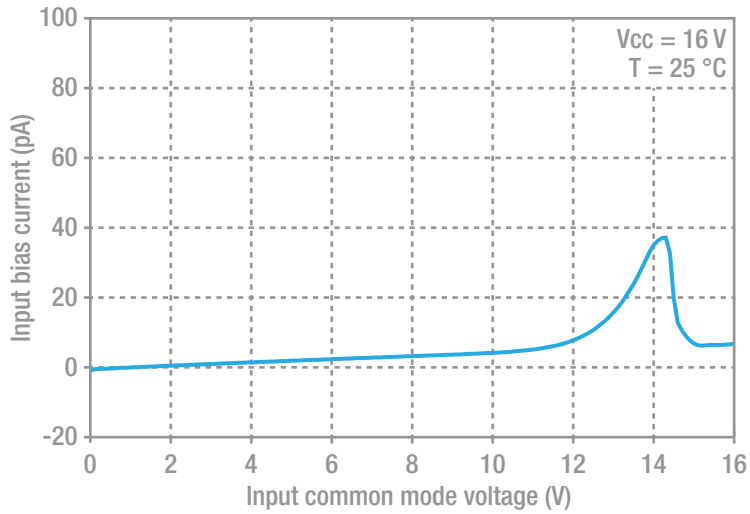
FEATURES

- Low input offset voltage: 200 µV (max.)
- Rail-to-rail input and output
- Low current consumption: 800 µA (max.)
- Gain bandwidth product: 2.7 MHz
- Low supply voltage: 2.7 to 16 V
- Low input bias current: 50 pA (max.)
- High ESD tolerance: 4 kV HBM
- AEC-Q100 qualified

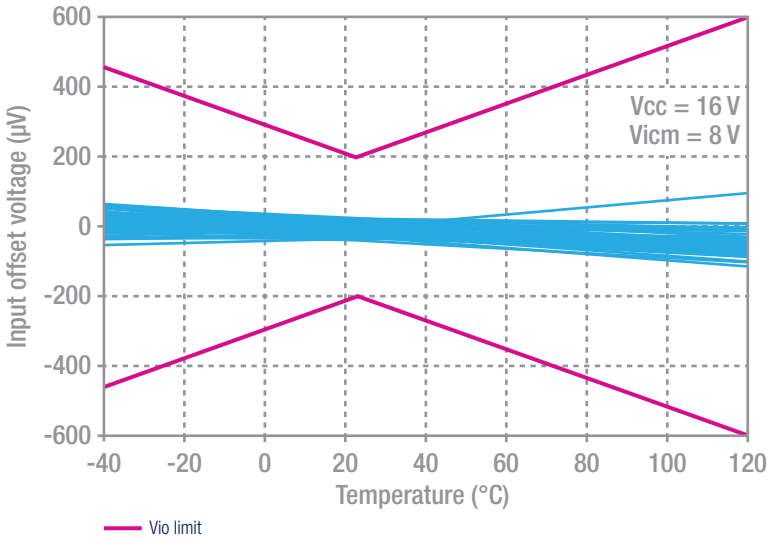
APPLICATIONS

- Battery-powered instrumentation
- Instrumentation amplifiers
- Active filtering
- DAC buffers
- High-impedance sensor interfaces
- Current sensing (high and low side)
- Automotive

Input common mode voltage (V)



Input offset voltage vs. temperature at Vcc = 16 V



Part number	Max. Iib @ 25 °C (pA)	Max. V_{IO} @ 25 °C (µV)	V_{IO} drift (µV/°C)	Min. V_{CC} (V)	Max. V_{CC} (V)	Typ. GBP (MHz)	Typ. SR (V/µs)	Typ. I_{CC} per channel (mA)	Typ. 1 kHz noise (nV/√Hz)	Rail to rail		Single	Dual	Quad	Automotive grade
										In	Out				
Low input bias current															
TSU101/2/4*	5	3000	2	1.5	5.5	0.008	0.003	580nA	265	Yes	Yes	•	•	•	
TSV911A/2A/4A	10	1500	5	2.5	5.5	8	4.5	0.78	27	Yes	Yes	•	•	•	✓
TSV611A/2A	10	800	2	1.5	5.5	0.12	0.04	0.0105	105	Yes	Yes	•	•		
TSV6191A/2A	10	800	2	1.5	5.5	0.45	0.08	0.0105	105	Yes	Yes	•	•		
TSV621A/2A/4A	10	800	2	1.5	5.5	0.42	0.14	0.029	77	Yes	Yes	•	•	•	
TSV6291A/2A/4A	10	800	2	1.5	5.5	1.3	0.5	0.029	77	Yes	Yes	•	•	•	
TSV631A/2A/4A	10	500	2	1.5	5.5	0.88	0.34	0.06	60	Yes	Yes	•	•	•	✓
TSV6391A/2A/4A	10	500	2	1.5	5.5	2.4	1.1	0.06	60	Yes	Yes	•	•	•	✓
TSU111*	10	150	0.5	1.5	5.5	0.01	0.0035	0.95	240	Yes	Yes	•			
TSV711/2/4	10	200	3	1.5	5.5	0.12	0.06	0.01	100	Yes	Yes	•	•	•	
TSV731/2/4	10	200	2	1.5	5.5	0.9	0.35	0.06	35	Yes	Yes	•	•	•	
TSV521A/2A/4A	10	600	3	2.7	5.5	1.15	0.89	0.045	57	Yes	Yes	•	•	•	✓
TSX921/2*	100	4000	2	4	16	10	17.2	2.8	16.5	Yes	Yes	•	•		✓
TSX9291/2*	100	4000	2	4	16	16	26	2.8	16.5	Yes	Yes	•	•		
TSX631A/2A/4A*	100	500	1	3.3	16	0.2	0.12	0.045	60	Yes	Yes	•	•	•	✓
TSX561A/2A/4A*	100	600	2	3	16	0.9	1.1	0.25	48	Yes	Yes	•	•	•	✓
TL071/2/4	100	3000	10	6	36	4	16	1.4	15	No	No	•	•	•	✓
TS931B/2B/4B	150	2000	3	2.7	10	0.1	0.05	0.02	76	No	Yes	•	•	•	✓
TS941A/2A/4A	150	5000	7	2.5	10	0.01	0.045	0.0012	/	No	Yes	•	•	•	
TS912B/4A	150	2000	5	2.7	16	1.4	1	0.2	30	Yes	Yes		•	•	✓
TS27M2B/4A	150	2000	2	3	16	1	0.6	0.15	38	No	No		•	•	
TSZ121/2/4*	200	5	0.01	1.8	5.5	0.4	0.19	0.031	37	Yes	Yes	•	•	•	✓
TL061/2B/4B	200	3000	10	6	36	1	3.5	0.2	42	No	No	•	•	•	
TL082B	200	3000	10	6	36	4	16	1.4	15	No	No	•	•	•	✓
TS27L2/4	150	5000	2	3	16	0.1	0.04	10	68	No	No		•	•	

Any non-automotive product may be eligible for AEC-Q100 qualification. Contact ST Sales representative for additional information.
Note: * New products

LOW V_{CC} MIN

TSV611/2: rail-to-rail input and output 5 V low-power CMOS amplifiers

The TSV61 family of single and dual operational amplifiers offers low voltage, low-power operation and rail-to-rail input and output. The devices also feature an ultra-low input bias current as well as a low input offset voltage. The TSV61 series have a gain bandwidth product of 120 kHz while consuming only 10 µA at 5 V and are able to work at very low supply voltage levels, down to 1.5 V. These features make the TSV61 family ideal for sensor interfaces, battery supplied and portable applications, as well as active filtering.

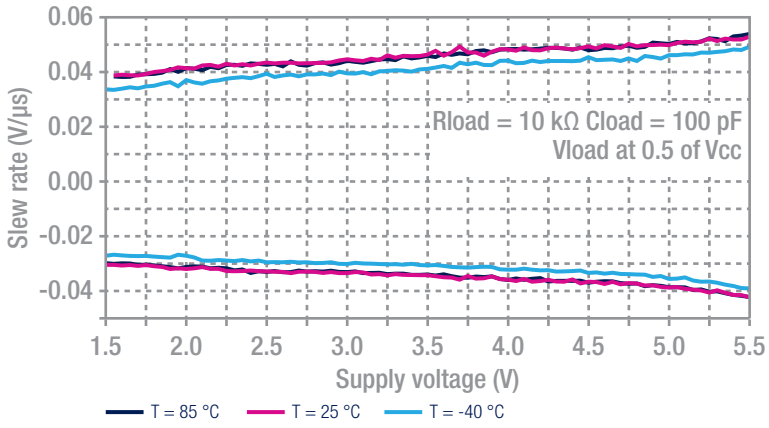
FEATURES

- Low input bias current: 1 pA (typ.)
- Low input offset voltage: 800 µV (max.) A version
- Rail-to-rail input and output
- Low supply voltage: 1.5 to 5.5 V
- Low power consumption: 10 µA (typ.) at 5 V
- Industrial temperature range: -40 to +85 °C
- Gain bandwidth product: 120 kHz (typ.)

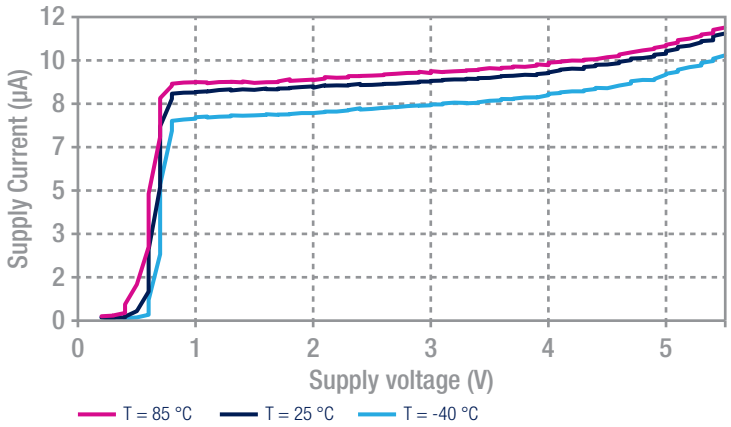
APPLICATIONS

- Battery-powered applications
- Smoke detectors
- Proximity sensors
- Portable devices
- Signal conditioning
- Active filtering
- Medical instrumentation

Slew rate vs. supply voltage



Supply current vs. supply voltage at Vicm = Vcc/2



Part number	Min. V_{CC} (V)	Max. V_{CC} (V)	Typ. GBP (MHz)	Typ. I_{CC} per channel (µA)	Max. V_{IO} @ 25 °C (µV)	Max. Iib @ 25 °C (pA)	Typ. 1 kHz noise (nV/√Hz)	Typ. I_{OUT} (mA)	Rail to rail		Single	Dual	Quad	Automotive grade
									In	Out				
Low voltage (V_{CC} min. ≤ 1.8 V)														
TSV611A/2A	1.5	5.5	0.12	10	800	10	105	60	Yes	Yes	•	•		
TSV6191A/2A	1.5	5.5	0.45	10	800	10	105	60	Yes	Yes	•	•		
TSV621A/2A/4A	1.5	5.5	0.42	29	800	10	77	69	Yes	Yes	•	•	•	
TSV6291A/2A/4A	1.5	5.5	1.3	29	800	10	77	69	Yes	Yes	•	•	•	
TSV631A/2A/4A	1.5	5.5	0.88	60	500	10	60	69	Yes	Yes	•	•	•	✓
TSV6391A/2A/4A	1.5	5.5	2.4	60	500	10	60	69	Yes	Yes	•	•	•	✓
TSU101/2/4	1.5	5.5	0.008	0.58	3000	5	265	5	Yes	Yes	•	•	•	
TSU111*	1.5	5.5	0.01	0.95	150	5	240	10	Yes	Yes	•			
TSV711/2/4	1.5	5.5	0.12	10	200	10	100	45	Yes	Yes	•	•	•	
TSV731/2/4	1.5	5.5	0.9	60	200	10	35	52	Yes	Yes	•	•	•	
TSZ121/2/4*	1.8	5.5	0.4	31	5	200	37	17	Yes	Yes	•	•	•	✓
TS1851A/2A/4A	1.8	6	0.65	162	1000	63000	40	48	Yes	Yes	•	•	•	
TS1871A/2A/4A	1.8	6	1.8	400	1000	130000	27	72	Yes	Yes	•	•	•	✓

Any non-automotive product may be eligible for AEC-Q100 qualification. Contact ST Sales representative for additional information.
Note: * New products

HIGH OUTPUT CURRENT & CAPACITIVE LOAD

TSX561/2/4: high merit factor 16 V with large output drive operational amplifiers

The TSX561/2/4 and TSX561A/2A/4A series of operational amplifiers benefit from ST's 16 V CMOS technology to offer state-of-the-art accuracy and performance in the smallest industrial packages. The TSX56 series offer a performing speed/power consumption ratio, 900 kHz gain bandwidth product while consuming only 250 µA at 16 V. Such features make the TSX56 series ideal for sensor interfaces and industrial signal conditioning. The wide temperature range and high ESD tolerance ease use in harsh automotive applications.

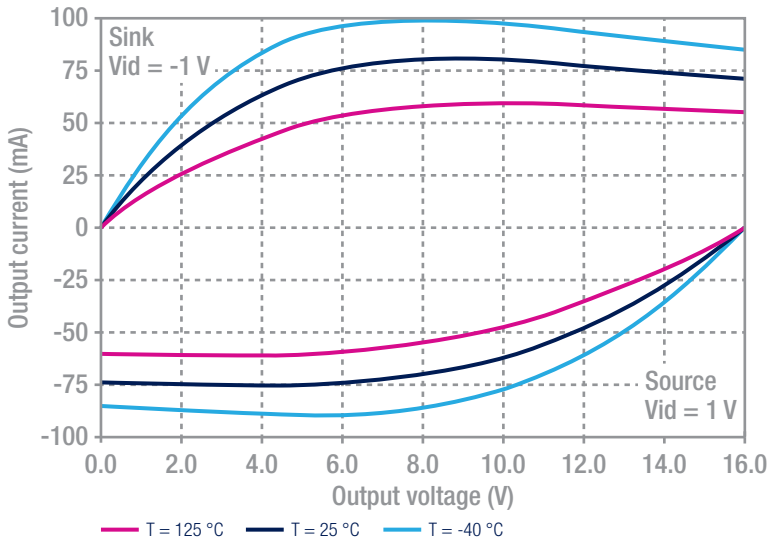
FEATURES

- Low power consumption: 235 µA (typ.) at 5 V
- Supply voltage: 3 to 16 V
- Gain bandwidth product: 900 kHz (typ.)
- Low input bias current: 1 pA (typ.)
- High tolerance to ESD: 4 kV
- 90mA output current capability under 16 V
- Low offset voltage
  - "A" version: 600 µV (max.)
  - Standard version: 1 mV (max.)
- Extended temperature range: -40 to +125 °C
- Automotive qualification
- Available in SOT23-5, DFN8 (2 x 2 mm), Mini-SO8, SO8, TSSOP14 and QFN16 (3 x 3 mm) packages

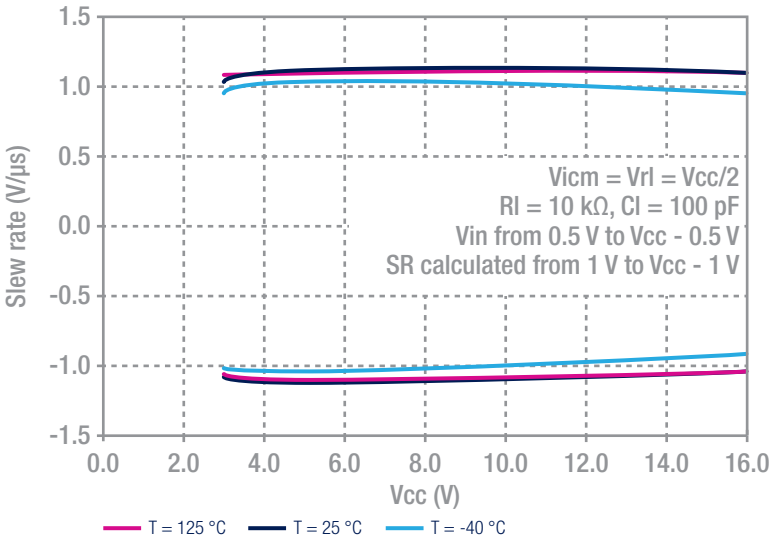
APPLICATIONS

- Industrial and automotive signal conditioning
- Active filtering
- Medical instrumentation
- High impedance sensors

Output current vs. output voltage at Vcc = 16 V



Slew rate vs. supply voltage



Part number	Typ. I_{OUT} (mA)	Min. V_{CC} (V)	Max. V_{CC} (V)	Typ. GBP (MHz)	Typ. SR (V/µs)	Typ. I_{CC} per channel (mA)	Rail to rail		Single	Dual	Quad	Automotive grade
							In	Out				
High output current (> 30 mA)												
TS921/2/4	80	2.7	12	4	1.3	1	Yes	Yes	•	•	•	✓
TSX561A/2A/4A*	90	3	16	0.9	1.1	0.25	Yes	Yes	•	•	•	✓
TSX631A/2A/4A*	90	3.3	16	0.2	0.12	0.045	Yes	Yes	•	•	•	✓
TS507	115	2.7	5.5	1.9	0.6	0.85	Yes	Yes	•			✓
TS982	200	2.5	5.5	2.2	0.7	5.5	Yes	Yes		•		✓
High capacitive load (cl > 500 pF)												
TS1851A/2A/4A	48	1.8	6	0.65	0.25	0.162	Yes	Yes	•	•	•	
TSV321A/358A/324A	80	2.5	6	1.4	0.6	0.5	Yes	Yes	•	•	•	✓
TS9222/4	80	2.7	12	4	1.3	0.9	Yes	Yes		•	•	✓

Any non-automotive product may be eligible for AEC-Q100 qualification. Contact ST Sales representative for additional information.
Note: * New products

SPEED

TSX9291: high-speed 16 V rail-to-rail I/O CMOS operational amplifier

The TSX9291 and TSX9292 operational amplifiers offer excellent AC characteristics such as 16 MHz gain bandwidth, 27 V/µs slew rate, and 0.0003% THD+N. They are decompensated amplifiers which are stable when used with a gain higher than 2 or lower than -1. The rail-to-rail input and output capability of these devices operates on a wide supply voltage range of 4 to 16 V. These last two features make the TSX929 series particularly well-adapted for a wide range of applications such as communications, I/V amplifiers for ADCs, and active filtering applications.

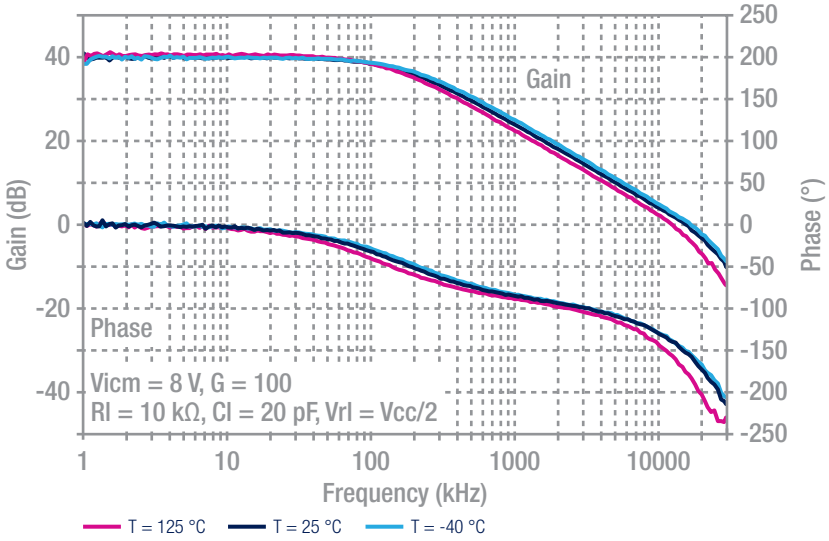
FEATURES

- Rail-to-rail input and output
- Wide supply voltage: 4 to 16 V
- Gain bandwidth product: 16 MHz (typ.) at 16 V
- Low power consumption: 2.8 mA (typ.) at 16 V
- Slew rate: 27 V/µs
- Stable when used in gain configuration
- Low input bias current: 10 pA (typ.)
- High tolerance to ESD: 4 kV HBM
- Extended temperature range: -40 to +125 °C
- Automotive qualification

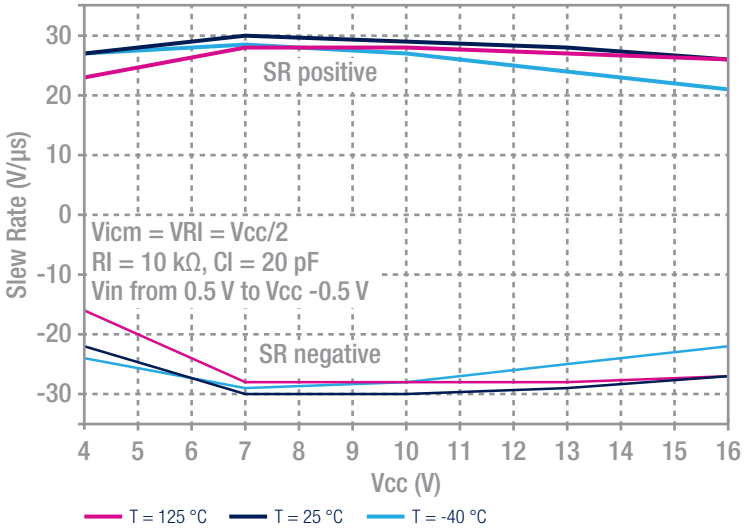
APPLICATIONS

- Communications
- Process control
- Active filtering
- Test equipment

Bode diagram vs. temperature for Vcc = 16 V



Slew rate vs. supply voltage and temperature



Part number	Typ. GBP (MHz)	Typ. SR (V(µS)	Min. V_{CC} (V)	Max. V_{CC} (V)	Typ. I_{CC} per channel (mA)	Max. V_{IO} @ 25 °C (µV)	Typ. 1 kHz noise (nV/√Hz)	Typ. I_{OUT} (mA)	Rail to rail		Single	Dual	Quad	Automotive grade
									In	Out				
Fast and high slew rate (GBP ≥ 4 MHz)														
TS921/2A/4A	4	1.3	2.7	12	1	900	9	80	Yes	Yes	•	•	•	✓
TL071/2/4	4	16	6	36	1.4	3000	15	40	No	No	•	•	•	✓
MC4558	5.5	2.2	4	40	1.15	5000	12	20	No	No		•		
TSV911A/2A/4A	8	4.5	2.5	5.5	0.78	1500	27	35	Yes	Yes	•	•	•	✓
TSX7191/2*	8.5	2.4	2.7	16	0.66	200	22	70	Yes	Yes	•	•		✓
TSX921/2*	10	17.2	4	16	2.8	4000	16.5	62	Yes	Yes	•	•		✓
TS461/2/4	12	4	2.7	10	2	5000	4	1.5	No	Yes	•	•	•	
TS971/2/4	12	4	2.7	10	2	5000	4	100	No	Yes	•	•	•	✓
MC33078/9	15	7	5	30	2	2000	4.5	30	No	No		•	•	✓
TS522/4	15	7	5	30	2	850	4.5	33	No	No		•	•	✓
TSX9291/2*	16	26	4	16	2.8	4000	16.5	62	Yes	Yes	•	•		
TSV991A/2A/4A	20	10	2.5	5.5	0.82	1500	27	35	Yes	Yes	•	•	•	✓
TSH22/4	25	15	3	30	2.15	2500	14	37	No	No		•	•	
TSH80/2	65	115	4.5	12	8.2	10000	11	55	No	Yes	•	•		✓
Video buffers														
TSH343 (6dB gain)	280	780	3	5.5	14.4	N/A	29	85	No	No	3 lines			
TSH122 (6dB gain)	9.5	x	2.25	5.5	2	N/A	51	75	No	No	•			
TSH73/74	70	100	3	12	9.8	10000	11	55	No	Yes	3 & 4 lines			

Any non-automotive product may be eligible for AEC-Q100 qualification. Contact ST Sales representative for additional information.
Note: * New products

SMALL PACKAGES

TSV630IQ2T: ultra-small DFN8 (2 x 2 mm), 5 V low-power rail-to-rail operational amplifier

The TSV630IQ2T is a single operational amplifier offering low voltage, low-power operation, and rail-to-rail input and output. It has a very low input bias current and a low offset voltage making it ideal for applications that require precision. It can operate at power supplies ranging from 1.5 to 5.5 V and is therefore very suitable for battery-powered devices, extending battery life. This offers an excellent speed/power consumption ratio, offering an 880 kHz gain bandwidth while consuming only 60 µA with a 5 V supply. It is also unity gain stable for capacitive loads up to 100 pF. The TSV630IQ2T is internally adjusted to provide very narrow dispersion of AC and DC parameters. The product provides a shutdown function. The DFN8 (2 x 2mm) micro package is guaranteed for industrial temperature ranges from -40 to +125 °C. These features combined make the TSV630IQ2T ideal for sensor interfaces, battery-supplied and portable applications, as well as active filtering. A DFN6 (1.2 x 1.3 mm) package is also available upon request. Please contact sales office for further information.

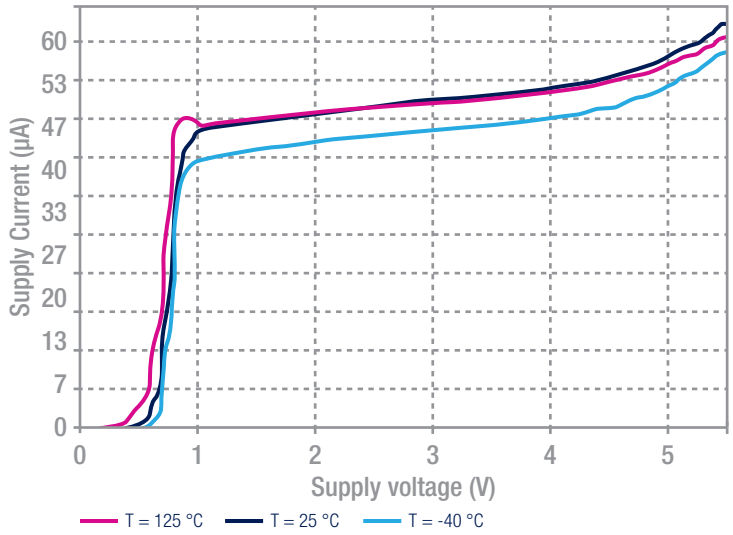
FEATURES

- Low offset voltage: 500 µV (max.) A version
- Low power consumption: 60 µA (typ.) at 5 V
- Low supply voltage: 1.5 to 5.5 V
- Gain bandwidth product: 880 kHz (typ.)
- Low power shutdown mode: 5 nA (typ.)
- High output current: 63 mA at V_{CC} = 5 V
- Low input bias current: 1 pA (typ.)
- Rail-to-rail input and output
- Extended temperature range: -40 to +125 °C
- Automotive qualification

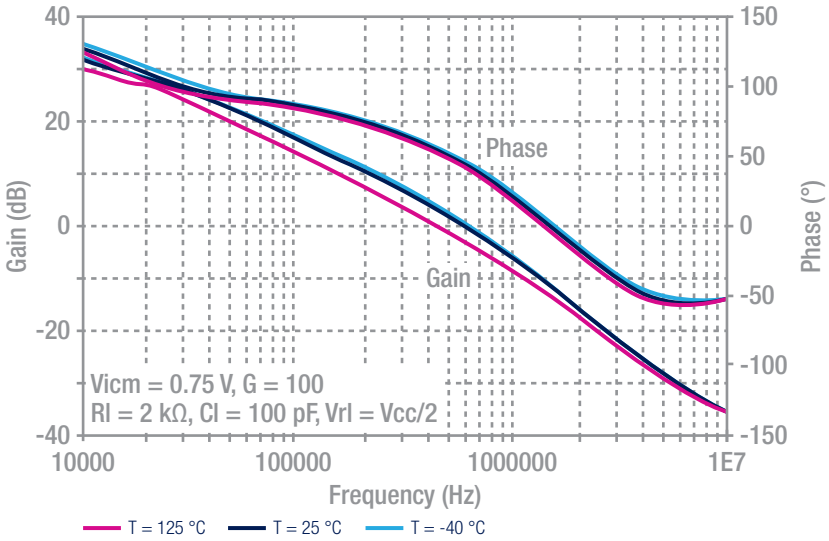
APPLICATIONS

- Battery-powered applications
- Portable devices
- Active filtering
- Medical instrumentation

Supply current vs. supply voltage at Vicm = Vcc/2



Voltage gain and phase vs. frequency at Vcc = 1.5 V



Part number	Package	Min. V_{CC} (V)	Max V_{CC} (V)	Typ. GBP (MHz)	Typ. SR (V/µs)	Typ. I_{CC} per channel (mA)	Max. V_{IO} @ 25 °C (µV)	Typ. I_{OUT} (mA)	Rail to rail		Single	Dual	Quad	Automotive grade
									In	Out				
Ultra small packages														
TSZ121/2/4*	SC70-5 2x2.1 pitch 0.65, DFN8 2x2 & QFN16 4x4 pitch 0.5	1.8	5.5	0.4	0.19	0.031	5	17	Yes	Yes	•	•	•	
TSV611A	SC70-5 2x2.1 pitch 0.65	1.5	5.5	0.12	0.04	0.0105	800	60	Yes	Yes	•			
TSV621A	SC70-5 2x2.1 pitch 0.65	1.5	5.5	0.42	0.19	0.029	800	69	Yes	Yes	•			
TSV631/2/4	SC70-5 2x2.1 pitch 0.65, DFN8 2x2 & QFN16 3x3 pitch 0.5	1.5	5.5	0.88	0.34	0.06	800	69	Yes	Yes	•	•	•	
TSV630	DFN8 2x2, DFN6 1.2x1.3 (under request)	1.5	5.5	0.88	0.34	0.06	3000	69	Yes	Yes	•			
TSV521A/2A/4	SC70-5 2x2.1 pitch 0.65, DFN8 2x2 & QFN16 3x3 pitch 0.5	2.7	5.5	1.15	0.89	0.045	600	30	Yes	Yes	•	•	•	
TSV711/2/4	SC70-5 2x2.1 pitch 0.65, DFN8 2x2 & QFN16 3x3 pitch 0.5	1.5	5.5	0.12	0.06	0.01	200	45	Yes	Yes	•	•	•	
TSV731/2/4	SC70-5 2x2.1 pitch 0.65, DFN8 2x2 & QFN16 3x3 pitch 0.5	1.5	5.5	0.9	0.35	0.06	200	52	Yes	Yes	•	•	•	
TSV991A	DFN6 1.3x1.6x0.55 pitch 0.4 x & DFN8 2x2 pitch 0.5	2.5	5.5	20	10	0.82	1500	35	Yes	Yes	•			
TSU101/2/4	SC70-5 2x2.1 pitch 0.65, DFN8 2x2 & QFN16 3x3 pitch 0.5	1.5	5.5	0.008	0.003	580nA	3000	5	Yes	Yes	•	•	•	
LMV321L	SC70-5 2x2.1 pitch 0.65	2.7	5.5	1.3	0.7	0.13	7000	58	No	Yes	•			
LMV821A/2A	SC70-5 2x2.1 pitch 0.65 & DFN8 2x2	2.5	5.5	5.5	1.9	0.3	800	56	No	Yes	•	•		
TS972	DFN8 3x3 pitch 0.5	2.7	10	12	4	2	5000	100	No	Yes		•		✓
TSX562/4*	DFN8 2x2 & QFN16 3x3 pitch 0.5	3	16	0.9	1.1	0.25	1000	90	Yes	Yes		•	•	
TSX632/4*	DFN8 2x2 & QFN16 3x3 pitch 0.5	3.3	16	0.2	0.12	0.045	1500	90	Yes	Yes		•	•	
TSX922*	DFN8 2x2 pitch 0.5	4	16	10	17.2	2.8	4000	62	Yes	Yes		•		
TSX9292*	DFN8 2x2 pitch 0.5	4	16	16	26	2.8	4000	62	Yes	Yes		•		
LM2904	DFN8 2x2 pitch 0.5	3	30	1.1	0.6	0.35	7000	30	No	No		•		
TSB611*	SOT23-5 2.8x2.9	2.7	36	0.56	0.2	0.1	1000	60	No	Yes	•			✓
TS321A	SOT23-5 2.8x2.9	3	30	0.8	0.4	0.6	2000	40	No	No	•			✓

Any non-automotive product may be eligible for AEC-Q100 qualification. Contact ST Sales representative for additional information.
Note: * New products

EMI HARDENED

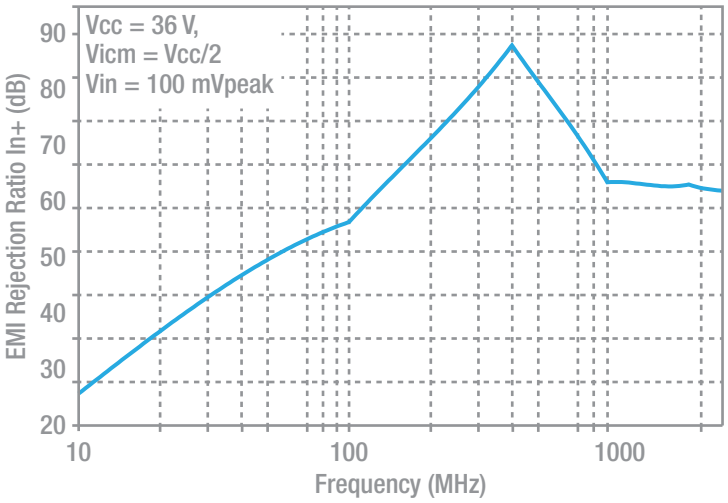
TSB572: low-power, 2.5 MHz, rail-to-rail input and output, 36 V operational amplifier

The TSB572 dual operational amplifier offers an extended voltage operating range from 4 to 36 V and rail-to-rail input/output. The TSB572 offers a very good speed/power consumption ratio with 2.5 MHz gain bandwidth product while consuming only 380 µA typically with a 36 V supply. Stability and robustness of the TSB572 make it an ideal solution for a wide voltage range of applications.

FEATURES

- Low-power consumption: 380 µA (typ.)
- Wide supply voltage: 4 to 36 V
- Rail-to-rail input and output
- Gain bandwidth product: 2.5 MHz
- Low input bias current: 30 nA (max.)
- High tolerance to ESD: 4 kV HBM
- Extended temperature range: -40 to +125 °C
- Automotive grade
- Small SMD packages

EMI rejection ratio Vcc = 36 V



APPLICATIONS

- Active filtering
- Audio systems
- Automotive
- Power supplies
- Industrial
- Low/High side current sensing

Part number	Min. V_{cc} (V)	Max. V_{cc} (V)	Typ. GBP (MHz)	Typ. SR (V/µs)	Typ. I_{cc} per channel (mA)	Max. V_{io} @ 25 °C (µV)	Typ. I_{out} (mA)	Rail to rail		Single	Dual	Quad	Automotive grade
								In	Out				
EMI hardened													
TSV711/2/4	1.5	5.5	0.12	0.06	0.01	200	45	Yes	Yes	•	•	•	
TSV731/2/4	1.5	5.5	0.9	0.35	0.06	200	52	Yes	Yes	•	•	•	
TSV632A/4A	1.5	5.5	0.88	0.34	0.06	500	69	Yes	Yes		•	•	✓
TSZ121/2/4*	1.8	5.5	0.4	0.19	0.031	5	17	Yes	Yes	•	•	•	✓
TSX561A/2A/4A*	3	16	0.9	1.1	0.25	600	90	Yes	Yes	•	•	•	✓
TSX631A/2A/4A*	3.3	16	0.2	0.12	0.045	500	90	Yes	Yes	•	•	•	✓
TSX711A/2*	2.7	16	2.7	1.2	0.66	100	54	Yes	Yes	•	•		✓
TSB571/2*	4	36	2.5	1	0.38	1500	60	Yes	Yes	•	•		✓

Any non-automotive product may be eligible for AEC-Q100 qualification. Contact ST Sales representative for additional information.
Note: * New products

HIGH OPERATING TEMPERATURE

TSV912H: high-temperature rail-to-rail input and output wide bandwidth operational amplifier

The TSV912H operational amplifier offers low-voltage operation and rail-to-rail input and output. The device features an excellent speed/power consumption ratio, offering an 8 MHz gain-bandwidth product while consuming only 1.1 mA (maximum) at 5 V. It is unity gain stable and features an ultra-low input bias current. The TSV912H is a high-temperature version of the TSV912, and can operate from -40 to +150 °C with unique characteristics. Its main target applications are automotive, but the device is also ideal for sensor interfaces, battery-supplied and portable applications, as well as active filtering.

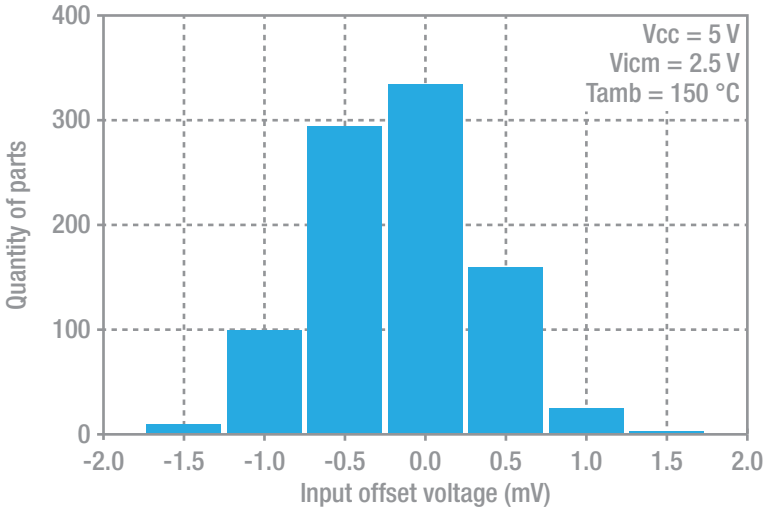
FEATURES

- Rail-to-rail input and output
- Wide bandwidth
- Low power consumption: 820 µA (typ.)
- High output current: 35 mA
- Supply voltage: 2.5 to 5.5 V
- Low input bias current: 1 pA (typ.)
- Ultra-high temperature range: -40 to +150 °C
- ESD internal protection ≥ 5 kV HBM
- SO8 package
- AEC-Q100 qualified

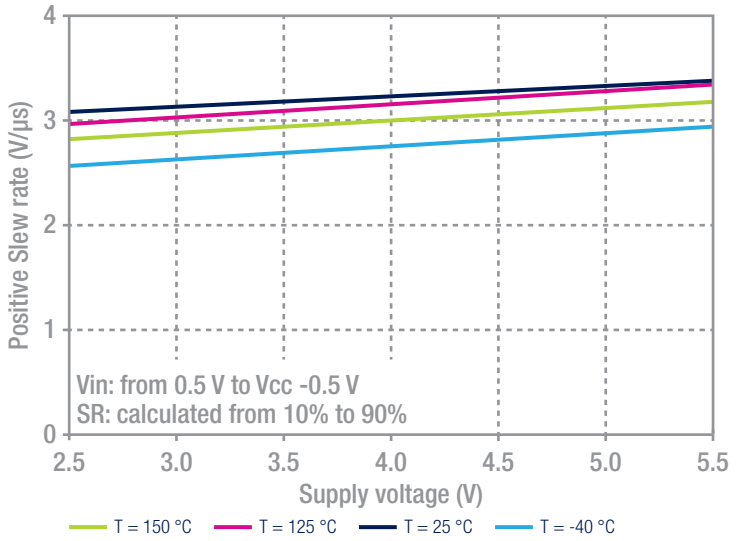
APPLICATION

- Automotive (gear box, exhaust, engine control, braking system,…)

Input offset voltage distribution at T = 150 °C



Positive slew rate



Part number	Typ. GBP (MHz)	Typ. SR (V/µs)	Min. V_{cc} (V)	Max. V_{cc} (V)	Typ. I_{cc} per channel (mA)	Rail to rail		Operating temperature range	Package	Dual	Automotive grade
						In	Out				
High temperature range amplifiers											
LM2904AH/WH	1.1	0.6	3	30	0.5	GND	No	-40 to +150 °C	TSSOP8, SO8, Mini-SO8	•	✓
TSV912H	8	4.5	2.5	5.5	0.82	Yes	Yes	-40 to +150 °C	SO8	•	✓

Any non-automotive product may be eligible for AEC-Q100 qualification. Contact ST Sales representative for additional information.

LOW-POWER AUDIO AMPLIFIERS

TS971/2/4: output rail-to-rail very low noise operational amplifier

The TS97 series of operational amplifiers operate with voltages as low as ±1.35 V and feature output rail-to-rail signal swing. The TS97 devices are particularly well suited for portable and battery-supplied equipment. Very low noise and low distortion characteristics make them ideal for audio pre-amplification. The TS97 devices are available in a variety of packages to suit all types of applications. For applications where space saving is critical, the SOT23-5 package (2.8 x 2.9 mm) or the DFN8 package (3 x 3 mm) simplify the board design because they can be placed anywhere on it.

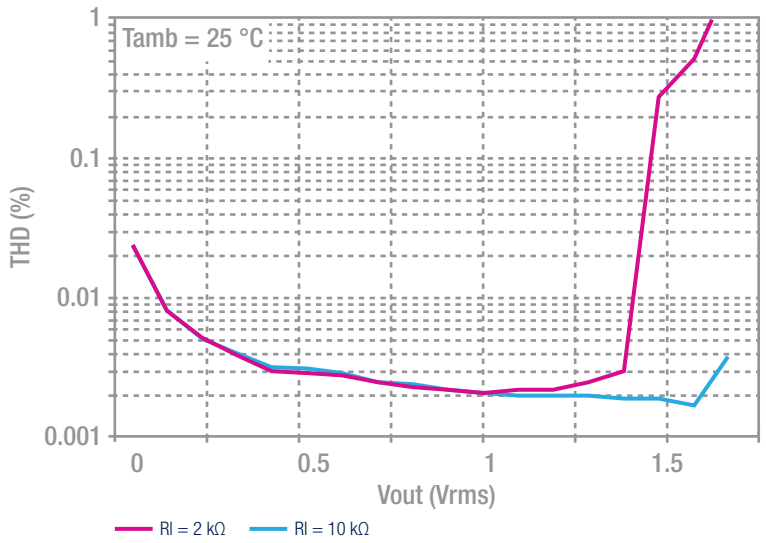
FEATURES

- Rail-to-rail output voltage swing ±2.4 V at V_{CC} = ±2.5 V
- Very low noise level: 4 nV/√Hz
- Ultra-low distortion: 0.003%
- High dynamic features: 12 MHz, 4 V/µs
- Supply voltage: 2.7 to 10 V
- ESD protection: 2 kV HBM
- Latch-up immunity (Class A)

APPLICATIONS

- Portable and handheld devices
- Instrumentation and sensing technology
- Professional audio circuits

THD vs Vout, Vcc = 5 V



Part number	Typ. GBP (MHz)	Typ. SR (V/µs)	Typ. THD @ 1 kHz (%)	Min. V_{CC} (V)	Max. V_{CC} (V)	Typ. I_{CC} per channel (mA)	Typ. A_{VD} (dB)	Single	Dual	Quad	Typ. 1 kHz noise (nV/√Hz)	Rail to rail Out	Package
Audio amplifiers													
TS461/2/4	12	4	0.003	2.7	10	2	80	•	•	•	4	Yes	SOT23-5, SO8, Mini-SO8, TSSOP8, SO14, TSSOP14
TS921/2A/4A	4	1.3	0.005	2.7	12	1	91	•	•	•	9	Yes	Flip-chip, SO8, TSSOP8, SO14, TSSOP14
TS971/2/4	12	4	0.003	2.7	10	2	80	•	•	•	4	Yes	SOT23-5, SO8, DFN8, TSSOP8, SO14, TSSOP14
MC33078/9	15	7	0.002	5	30	2	100		•	•	4.5	No	SO8, SO14

CLASS AB, CLASS D & HEADPHONE AMPLIFIERS

TS488: pop-free 120 mW stereo headphone amplifier

The TS488/9 is an enhancement of TS486/7 that eliminates pop and click noise and reduces the number of external passive components. The TS488 is a dual audio power amplifier capable of driving, in single-ended mode, either a 16 Ω or a 32 Ω stereo headset. Capable of descending to low voltages, it delivers up to 31 mW per channel (into 16 Ω loads) of continuous average power with 0.1% THD+N in the audio bandwidth from a 2.5 V power supply. An externally-controlled standby mode reduces the supply current to 10 nA (typ.). The unity gain stable TS488/9 is configured by external gain-setting resistors.

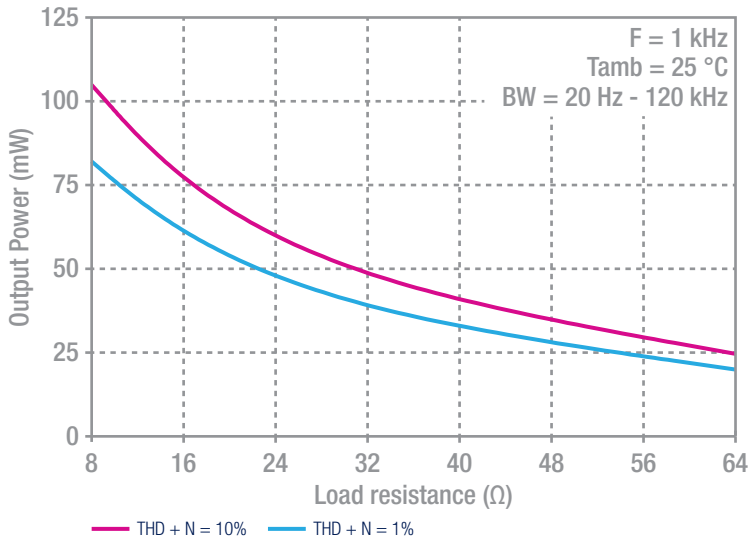
FEATURES

- Pop and click noise protection circuitry
- Operating range from V_{CC} = 2.2 to 5.5 V
- Output power:
  - 120 mW at 5 V, into 16 Ω with 0.1% THD+N (max.) (1 kHz)
  - 55 mW at 3.3 V, into 16 Ω with 0.1% THD+N (max.) (1 kHz)
- Low current consumption: 2.7 mA (max.) at 5 V
- Ultra-low standby current consumption: 10 nA (typ.)
- High crosstalk immunity: 102 dB (f = 1 kHz)
- Short-circuit protection circuitry
- DFN8 (2 x 2mm) package

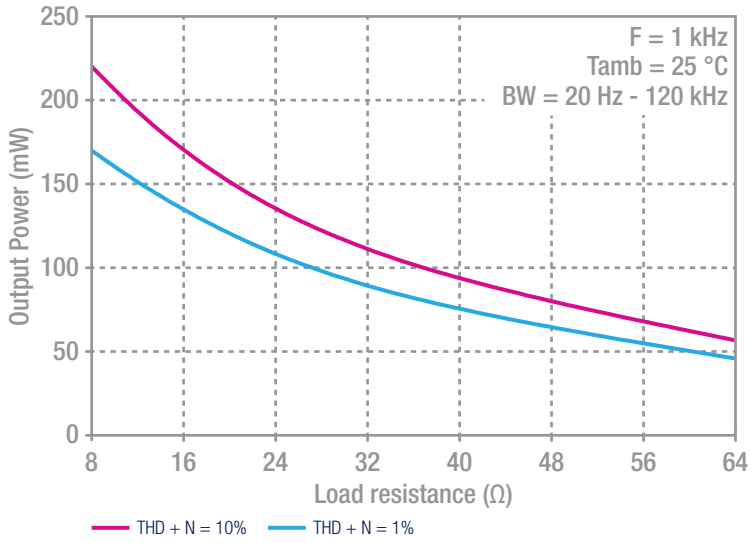
APPLICATIONS

- Headphone amplifiers
- Mobile phones, handheld devices and computer motherboards
- High-end TVs and portable audio players

Output power vs. load resistance Vcc = 3.3 V



Output power vs. load resistance Vcc = 5 V



Part number	Output Power per channel		Min. V_{CC} (V)	Max. V_{CC} (V)	Input	Mono/ Stereo	Typ. I_{CC} no load (mA)	Typ. SNR (dB)	Gain, control	Pop and noise cancellation	Max. Stdby I_{CC} (µA)	Package
	@ 1% THD V_{CC} max (W)	@ 10% THD V_{CC} max (W)										
Class AB audio Low power amplifiers												
TDA2822D	N/A	700 mW into 8 Ω 800 mW into 16 Ω	1.8	15	Single-ended	Bridge or Stereo	N/A	N/A	No	No	N/A	SO8
TS4871	1.28 W into 4 Ω 1 W into 8 Ω	2.08 W into 4 Ω 1.45 W into 8 Ω	2.5	5.5		Mono	6	97	No	Yes	1	SO8, Mini-SO8
TS4890	1.28 W into 4 Ω 1 W into 8 Ω	2.08 W into 4 Ω 1.45 W into 8 Ω	2.2	5.5			6	97	No		1	Mini-SO8
TS4990	1.2 W into 8 Ω 0.7 W into 16 Ω	1.5 W into 8 Ω 0.88 W into 16 Ω	2.2	5.5			3.7	103	No		1	Mini-SO8, DFN8 3x3, Flip-chip9
TS4994	1 W into 8 Ω 0.6 W into 16 Ω	1.48 W into 8 Ω 0.9 W into 16 Ω	2.5	5.5	Differential		4	100	No		1	DFN10 3x3, Mini-SO8
TS4994FC TS4995	1.2 W into 8 Ω 0.7 W into 16 Ω	1.5 W into 8 Ω 0.88 W into 16 Ω	2.5	5.5			4	100	No		1	Flip-chip9
TS4909	158 mW into 16 Ω 88 mW into 32 Ω	180 mW into 16 Ω 102 mW into 32 Ω	2.2	5.5	Single-ended	Stereo	2.1	105	External res		1	DFN10 3x3
TS4984	1 W into 8 Ω 0.65 W into 16 Ω	1.25 W into 8 Ω 0.8 W into 16 Ω	2.2	5.5			7.4	100	External res		1	QFN16 4x4
Headphone amplifiers												
TS419/21	295 mW into 16 Ω 207 mW into 32 Ω	367 mW into 16 Ω 258 mW into 32 Ω	2	5.5	Single-ended	Mono	1.8	98	External res	Yes	1	Mini-SO8, DFN8 3x3
TS482	107 mW into 16 Ω 67.5 mW into 32 Ω	131 mW into 16 Ω 82 mW into 32 Ω	2	5.5		Stereo	5.5	110	External res		N/A	SO8, Mini-SO8
TS488	120 mW into 16 Ω 80 mW into 32 Ω	160 mW into 16 Ω 100 mW into 32 Ω	2.2	5.5			2	105	External res		1	DFN8 2x2
TS4909	158 mW into 16 Ω 88 mW into 32 Ω	190 mW into 16 Ω 105 mW into 32 Ω	2.2	5.5			2.1	105	External res		1	DFN10 3x3
TS4621E/ML	65 mW into 16 Ω 43 mW into 32 Ω	92 mW into 16 Ω 58 mW into 32 Ω	2.3	4.8	Differential		1.2	100	I^2C		5	Flip-chip16
Microphone preamplifiers												
TS472	N/A	N/A	2.2	5.5	Differential	Differential	1.8	90	External res	N/A	1	QFN24 4x4, Flip-chip12
Class D audio low power amplifiers												
TS2007FC	2.3W into 4Ω 1.4W into 8Ω	3 W into 4 Ω 1.75 W into 8 Ω	2.4	5.5	Differential	Mono	2.5	93	6 dB, 12 dB	Yes	2	Flip-chip9
TS2012EI	1.85 W into 4 Ω 1.15 W into 8 Ω	2.5 W into 4 Ω 1.6 W into 8 Ω	2.5	5.5		Stereo	5	99	6,12, 8, 24 dB	Yes	2	Flip-chip16
TS4962/2M	2.2 W into 4 Ω 1.4 W into 8 Ω	2.8 W into 4 Ω 1.7 W into 8 Ω	2.4	5.5		Mono	2.3	85	External res	Yes	1	DFN8 2x2, Flip-chip9
TS4999	2.5 W into 4 Ω 1.35 W into 8 Ω	2.8 W into 4 Ω 1.7 W into 8 Ω	2.4	5.5		Stereo	5	99	3.5, 6, 9.5 and 12 dB	Yes	2	Flip-chip18

CURRENT-SENSE AMPLIFIERS

TSC103: high-voltage, high-side 70 V current-sense amplifier

The TSC103 measures a small differential voltage on a high-side shunt resistor and translates it into a ground-referenced output voltage. The gain is adjustable to four different values from 20 V/V up to 100 V/V by two selection pins. Wide input common-mode voltage range, low quiescent current, and tiny TSSOP8 packaging enable use in a wide variety of applications. The input common-mode and power-supply voltages are independent. The common-mode voltage can range from 2.9 to 70 V in the single-supply configuration or be offset by an adjustable voltage supplied on the VCC- pin in the dual-supply configuration. With a current consumption lower than 360 µA and a virtually null input leakage current in standby mode, the power consumption in the applications is minimized.

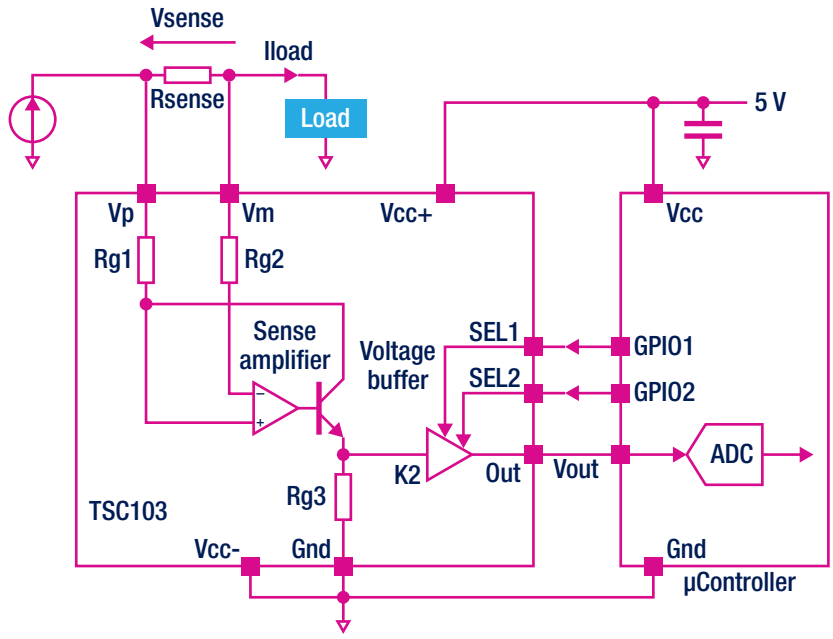
FEATURES

- Independent supply and input common-mode voltages
- Wide common-mode operating range: 2.9 to 70 V in single-supply configuration,-2.1 to 65 V in dual-supply configuration
- Wide common-mode surviving range: -16 to 75 V (reversed battery and load-dump conditions)
- Supply voltage range: 2.7 to 5.5 V in single-supply configuration
- Low current consumption: I_{CC} (max.) = 360 µA
- Pin selectable gain: 20 V/V, 25 V/V, 50 V/V or 100 V/V
- Buffered output
- SO8 & TSSOP8 packages
- AEC-Q100 qualified

APPLICATIONS

- Automotive current monitoring
- DC motor control
- Photovoltaic systems
- Battery chargers
- Precision current sources
- Current monitoring of notebook computers
- High-end power supplies

Common-mode voltage: 2.9 V to 70 V



Part number	Max. I_{CC} (µA)	Common mode operating range (V)		V_{CC} (V)		Voltage gain (V/V)	Operating temperature (°C)		Package	Automotive grade
		Min.	Max.	Min.	Max.		Min.	Max.		
Hide side current sensing										
TSC101	300	2.8	30	4	24	20, 50, 100	-40	125	SOT23-5	✓
TSC888	1000	2.8	24	4	24	20, 50, 100	-40	125	SOT23-5	
TSC102	420	2.8	30	3.5	5.5	Adjustable	-40	125	TSSOP8, SO8	✓
TSC1012	300	2.8	30	3.5	5.5	20, 50	-40	125	TSSOP8	✓
TSC103	360	2.9	70	2.7	5.5	20, 25, 50, 100	-40	125	TSSOP8, SO8	✓
TSC1031	360	2.9	70	2.7	5.5	50, 100	-40	125	TSSOP8, SO8	✓

Any non-automotive product may be eligible for AEC-Q100 qualification. Contact ST Sales representative for additional information.

EVALUATION BOARDS

Order code	Description	Reference
STEVAL-ISQ007V1	High-side current-sense amplifier demonstration board based on TSC101	AN2727
STEVAL-ISQ010V1	High-side current-sense amplifier demonstration board based on TSC102	DB0982
STEVAL-ISQ013V1	Low-side current sensing based on TS507	AN3222
STEVAL-ISQ014V1	Low-side current sensing based on TSZ121	UM1737

Comparators

MICROPOWER

TS881/2/4: 5 V Rail-to-rail nanopower comparators

The TS881, TS882 and the TS884 devices are single, dual and quad comparators featuring ultra-low supply current (220 nA typical per operator with output high, V_{CC} = 1.2 V, no load) with rail-to-rail input and output capability. The performance of these comparators allows them to be used in a wide range of portable applications. The TS882 and TS884 devices minimize battery supply leakage and therefore enhance battery lifetime and operating from a 1.1 to 5.5 V supply. The TS881 is able to operate down to the outstanding 0.85 V supply voltage. Their capability to withstand 8 kV HBM ESD level enable customers to use them in harsh conditions.

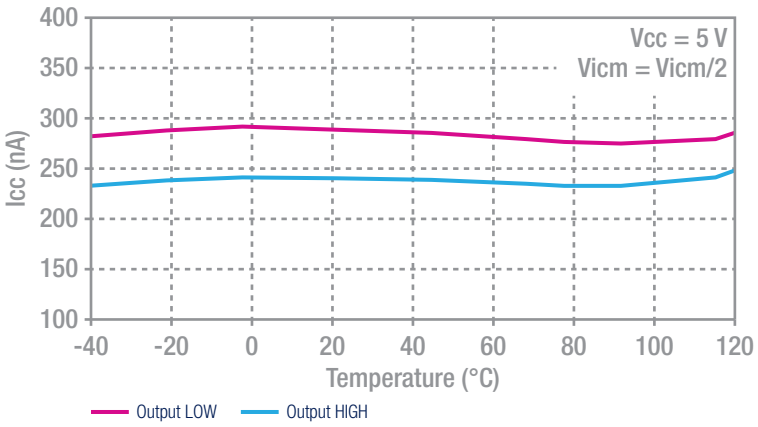
FEATURES

- Ultra-low current consumption: 220 nA (typ/ch.)
- Propagation delay: 2 µs (typ.)
- Rail-to-rail input, push-pull output
- Supply operation from 0.85 to 5.5 V (TS881)
- Supply operation from 1.1 to 5.5 V (TS882 & TS884)
- Extented temperature range: -40 to +125 °C
- ESD tolerance: 8 kV HBM/300 V MM
- Available in SC70-5, SOT23-5, Mini-SO8, DFN8 (2 x 2 mm), SO14, TSSOP14 and QFN16 (3 x 3 mm)

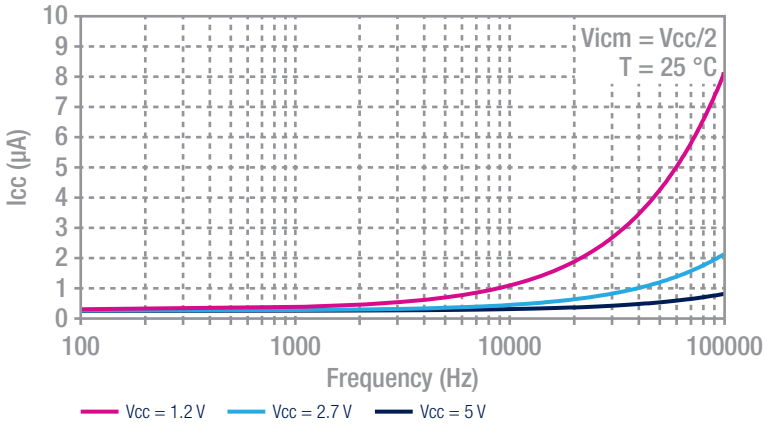
APPLICATIONS

- Portable systems
- Signal conditioning
- Medical

Current consumption per operator vs. temperature



Current consumption per operator vs. toggle frequency



Part number	Typ. I_{cc} per channel (µA)	Min. V_{cc} (V)	Max. V_{cc} (V)	Typ. response time (ns) 100 mV overdrive	Rail to rail In	Output type	Input type	Single	Dual	Quad	Automotive grade
Nanopower											
TS881	0.21	0.85	5.5	2600	Yes	Push-pull	CMOS	•			
TS882/4	0.21	1.1	5.5	2600	Yes	Push-pull	CMOS		•	•	
Micropower											
TS331/2/4	20	1.6	5	270	Yes	Open drain	BIP	•	•	•	✓
TS7211	6	2.7	10	400	Yes	Push-pull	CMOS	•			
TS7221	6	2.7	10	400	Yes	Open drain	CMOS	•			
TSX3702/4*	5	2.7	16	340	GND	Push-pull	CMOS		•	•	✓
TSX393/339*	5	2.7	16	550	GND	Open drain	CMOS		•	•	✓

Any non-automotive product may be eligible for AEC-Q100 qualification. Contact ST Sales representative for additional information.
Note: * New products

SPEED

TS3011: Rail-to-rail high-speed 5 V comparator

The TS3011 single comparator features a high-speed response time with rail-to-rail inputs. Specified for a supply voltage of 2.2 to 5 V, this comparator can operate over a wide temperature range from -40 to +125 °C. The TS3011 offers micro power consumption as low as a few hundred microamperes, thus providing an excellent ratio of power consumption current versus response time. The TS3011 includes push-pull outputs and is available in small packages (SMD): SOT23-5 and SC70-5.

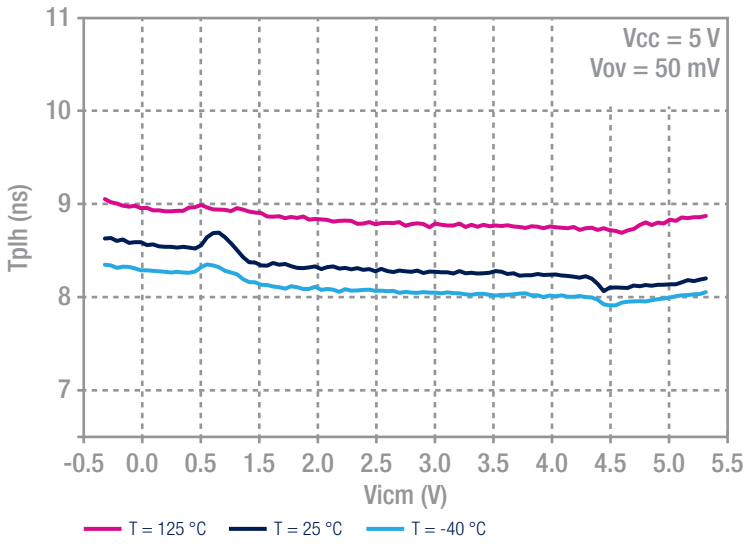
FEATURES

- Propagation delay: 8 ns
- Low current consumption: 470 µA (typ.) at 5 V
- Rail-to-rail input, push-pull output
- Supply operation from 2.2 to 5 V
- Extended temperature range: -40 to +125 °C
- ESD tolerance: 2 kV HBM/200 V MM
- SMD packages
- AEC-Q100 qualified

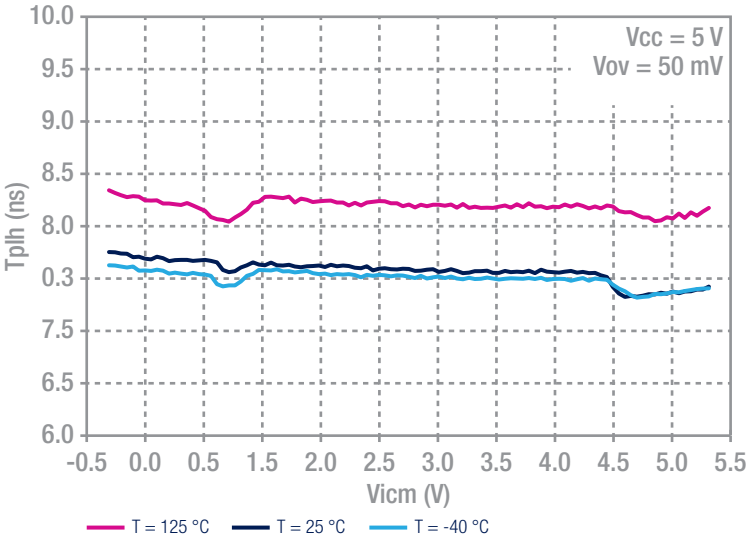
APPLICATIONS

- Telecoms
- Instrumentation
- Signal conditioning
- High-speed sampling systems
- Portable communication systems

Propagation delay vs. common mode voltage with negative transition



Propagation delay vs. common mode voltage with positive transition



Part number	Typ. I_{cc} per channel (µA)	Min. V_{cc} (V)	Max. V_{cc} (V)	Typ. response time (ns) 100 mV overdrive	Rail to rail In	Output type	Input type	Single	Dual	Quad	Automotive grade
Ultra high speed											
TS3011	470	2.2	5	8	Yes	Push-pull	CMOS	•			✓
High speed											
TS3021/2	73	1.8	5	42	Yes	Push-pull	BIP	•	•		✓

Any non-automotive product may be eligible for AEC-Q100 qualification. Contact ST Sales representative for additional information.

SMALL PACKAGES

TSX3702/4: 16 V dual and quad CMOS voltage comparators

The TSX3702 and TSX3704 are micro power CMOS dual and quad voltage comparators which exhibits a very low current consumption of 5 µA typical per comparator. These device have been designed as the improvement of the TS3704: it shows a lower current consumption, a better input offset voltage, and an enhanced ESD tolerance. The TSX3702 and TSX3704 are fully specified over a wide temperature range and are proposed in automotive grade for the TSSOP14 and SO8 packages. They are fully compatible with the TS3702 & TS3704 CMOS comparators and are available with similar packages. The new tiny package, QFN16 (3 x 3 mm), is also proposed for the TSX3704 thus allowing even more integration on applications. They are also available in open-drain output version, named TSX339 & TSX393.

FEATURES

- Low supply current: 5 µA (typ.) per comparator
- Wide single supply range 2.7 to 16 V or dual supply (±1.35 to ±8 V)
- Extremely low input bias current: 1 pA (typ.)
- Input common-mode voltage range includes ground
- Push-pull output
- High input impedance: 10^{12} Ω (typ.)
- Fast response time: 2.7 µs (typ.) for 5 mV overdrive
- ESD tolerance: 4 kV HBM, 200 V MM
- AEC-Q100 qualified

APPLICATIONS

- Automotive & industrial

Part number	Package	Typ. I_{cc} per channel (µA)	Min. V_{cc} (V)	Max. V_{cc} (V)	Typ. response time (ns) 100 mV overdrive	Rail to rail In	Output type	Single	Dual	Quad	Automotive grade
Small packages											
TS881	SC70-5	0.21	0.85	5.5	2600	Yes	Push-pull	•			
TS882/4	DFN8 2x2, QFN16 3x3	0.21	1.1	5.5	2600	Yes	Push-pull		•	•	
TS331/2/4	SC70-5, DFN6 1.2x1.3, DFN8 2x2, QFN16 3x3	20	1.6	5	270	Yes	Open drain	•	•	•	
TSX3702/4*	DFN8 2x2, QFN16 3x3	5	2.7	16	340	GND	Push-pull		•	•	
TSX393/339*	DFN8 2x2, QFN16 3x3	5	2.7	16	550	GND	Open drain		•	•	
TS985*	6-Bump CSP 1.2x0.8	13	1.8	5	420	Yes	Push-pull	•			
TS391	SOT23-5, DFN8 2x2	200	2	36	300	GND	Open collector	•			✓
TS3011	SC70-5	470	2.2	5	8	Yes	Push-pull	•			
TS3021	SC70-5	73	1.8	5	42	Yes	Push-pull	•			
LM2903/1	DFN8 2x2, QFN16 3x3	200	2	36	500	GND	Open collector		•	•	
LMV331	SC70-5	20	2.7	5	275	GND	Open drain	•			

Any non-automotive product may be eligible for AEC-Q100 qualification. Contact ST Sales representative for additional information.
Note: * New products

HIGH OPERATING TEMPERATURE

TS3021H: rail-to-rail 1.8 V high-speed comparator

The TS3021H single comparator features high-speed response time with rail-to-rail inputs. With a supply voltage specified from 2 to 5 V, this comparator can operate over an extended temperature range from -40 to 150 °C. The TS3021H comparator offers micropower consumption as low as a few tens of microamperes thus providing an excellent ratio of power consumption current versus 38 ns response time. The TS3021H includes push-pull outputs and is available in the small SOT23-5 package.

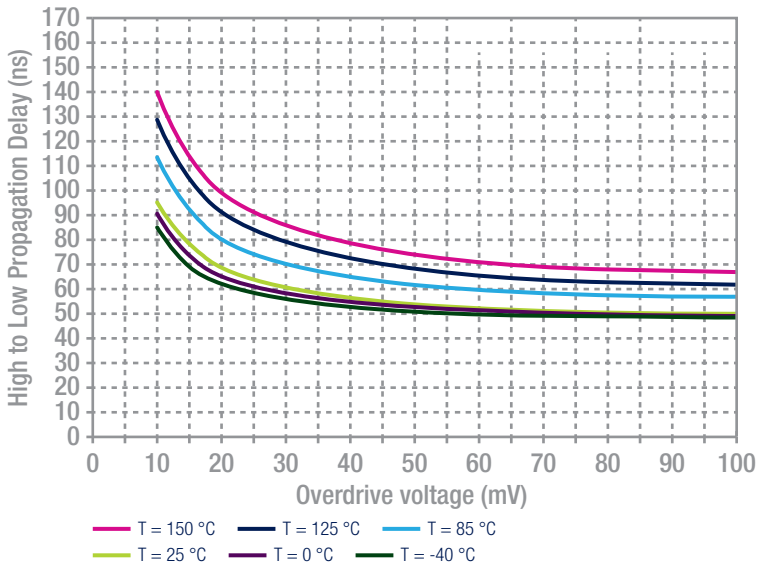
FEATURES

- Ultra-high temperature range: -40 to 150 °C
- Propagation delay: 38 ns
- Low current consumption: 73 µA
- Rail-to-rail input
- Push-pull output
- Supply operation from 1.8 to 5 V
- High ESD tolerance: 5 kV (HBM) and 300 V (MM)
- Latch-up immunity: 200 mA
- SMD package
- AEC-Q100 and Q003 qualified

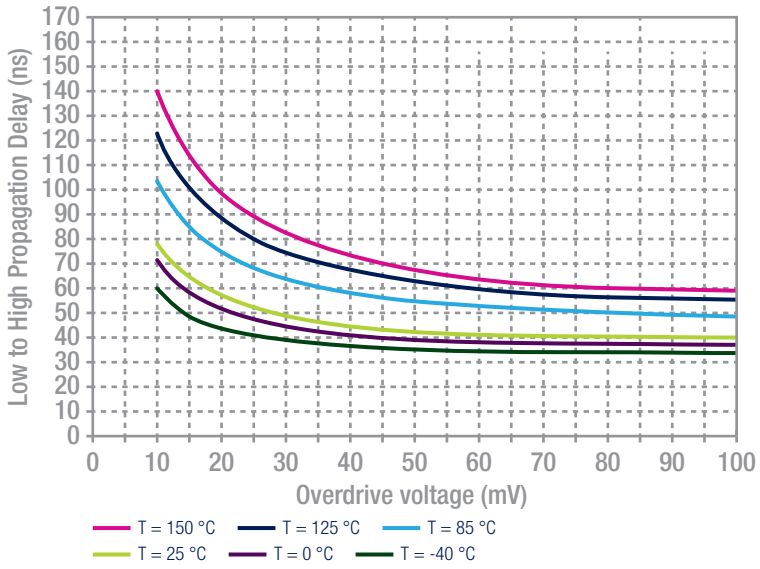
APPLICATIONS

- Automotive (gear box, exhaust, engine control, braking system,…)

Propagation delay (HL) vs. overdrive at Vcc = 5 V, Vicm = Vcc



Propagation delay (LH) vs. overdrive at Vcc = 5 V, Vicm = 0 V



Part number	Max. operating Temperature (°C)	Typ. I_{cc} per channel (µA)	Min. V_{cc} (V)	Max. V_{cc} (V)	Typ. response time (ns) 100 mV overdrive	Rail to rail In	Output type	Single	Dual	Quad	Automotive grade
High temperature											
TS3021H	150	73	1.8	5	42	Yes	Push-pull	•			✓
LM2903H/1H	150	200	2	36	300	GND	Open collector		•	•	✓

Any non-automotive product may be eligible for AEC-Q100 qualification. Contact ST Sales representative for additional information.

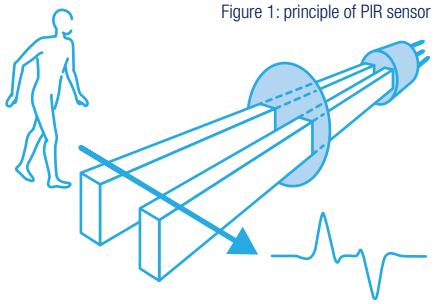
Signal conditioning for pyroelectric passive infrared sensors

APPLICATION NOTE AN4368 SUMMARY

Introduction to pyroelectric passive infrared sensors

Pyroelectric passive infrared (PIR) sensors are frequently used in the common life. They are a key component in the motion detection and can be used for security systems, automatic doors or automatic light. A common application is the human detection. When someone is detected in a specified area an action can be performed such as alarm triggering or room lighting for example.

Figure 1: principle of PIR sensor



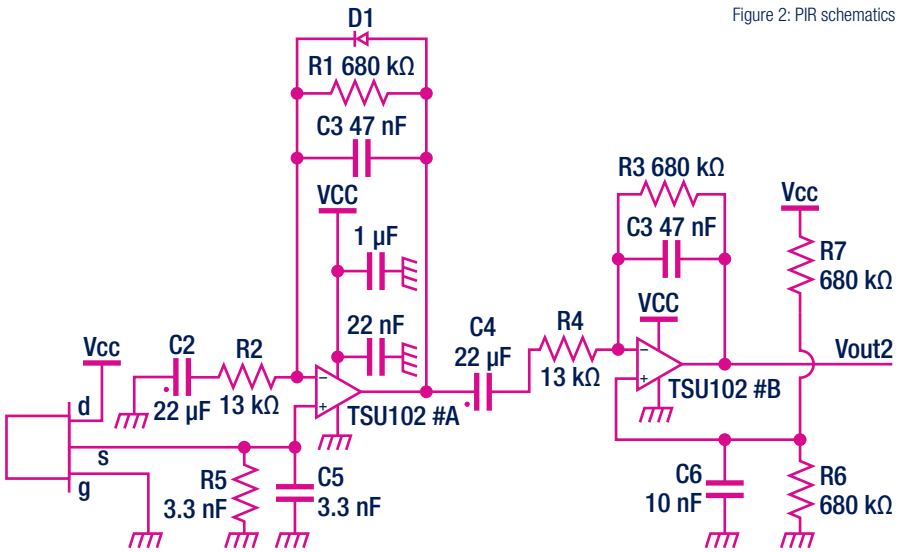
How does the sensor work?

The passive infrared sensors contain two parts that are sensitive to infrared. If both parts are seeing the same amount of infrared, the sensor won't detect anything. But, if one of these two parts is seeing more or less infrared than the other part, the output of the sensor will vary.
The figure 1 shows how the output voltage varies when a heat source goes in or out of the area protected by the sensor.

Sensor signal conditioning

When a body with a temperature different than the ambient is moving in its field of detection, the PIR sensor is providing a small AC signal which is in the range of 1 mVpp. Moreover this small voltage is around a DC signal that may significantly vary from one sensor to the other. Thus it is mandatory to cancel the DC part of the signal and to amplify only the AC part. As this signal will be disturbed by the environment, a noise filtering will also be helpful.
If we want to detect human motion, we have to consider frequencies from 0.5 Hz to 5 Hz. In this article, the amplification and filtering of this frequency range is performed thanks to TSU102, a dual op amp.
Schematic is shown on figure 2.

Figure 2: PIR schematics



The AC signal generated by the PIR sensor is amplified by 69 dB: 35 dB thanks to the first stage and 34 dB on the second one.
The op-amp GBP must be bigger than 2.7 kHz (fmax x gain x 10 = 5 x 53 x 10 = 2.7 kHz). The factor 10 has been taken into consideration in order to have some margin and to be sure not to be limited by the GBP.

Almost all GBP amplifiers will fit this GBP requirement. In addition, since the DC is cancelled for motion detection, the op-amp accuracy, revealed thanks to Vio parameter, has no importance.
Finally, if we are dealing with portable applications, consumption is a key feature. Especially, since this kind of application is supplied during all day. The schematic has been designed in order to optimize it.
Here, the main consumption is the one due to the sensor. It consumes 19 µA. The rest of the application consumption is equal to 3.6 µA:

- 1.2 µA for the TSU102 op-amps
- 2.4 µA due to the divider bridge composed by R6 and R7

Conclusion

Passive InfraRed sensors are widely used and require some op-amps to amplify and to filter the signal they generate which is noisy and has a very small amplitude. Comparator can also be added to compare the amplified signal with threshold voltages before going into an I/O of the microcontroller (no need for ADC). Thanks to the TSU102, you can design an application compliant with 3.3 V microcontrollers with an optimized current consumption.
For more details, please download AN4368 document from www.st.com

Signal conditioning for shock sensors

APPLICATION NOTE AN4708 SUMMARY

Introduction

Shock sensors considered as piezoelectric element can be used for a wide range of applications. It is largely used in the consumer market as hard disk drive protection, but also used in the automotive range for example for security, when window glass is hit and broken. Or it enabling intelligent power management to maximize battery life for tire pressure monitoring system modules integrated in tire valves.

Charge amplifier configuration

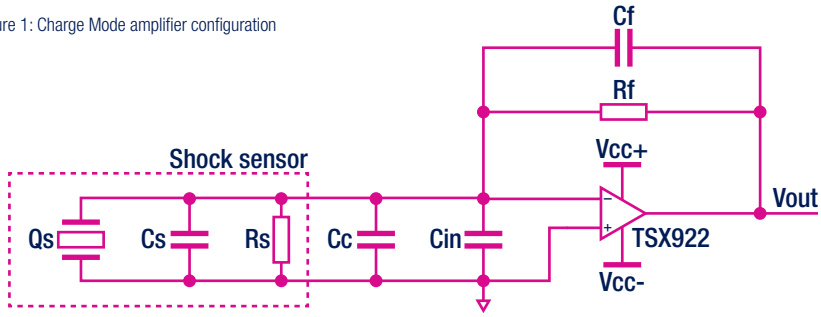
Charge mode sensors are typically used when the electronics are connected far from the sensor. In this case, we can use the configuration shown in Figure 1. The charge amplifier requires a low bias input current as it does not charge and discharge the gain capacitor, Cf, at high currents. Consequently, it is extremely important to choose a CMOS op amp such as the TSX922 which presents a very low input current, lib, of 10 pA @ 25 °C. If any charge coming from the piezoelectric sensor "tries" to charge the capacitance of the sensor, the cable, or the input capacitance of the amplifier, a voltage is created between the input pin of the amplifier. As the amplifier has a very high gain (90 dB), this voltage is immediately nulled by sourcing or pulling the same amount of charge through the feedback capacitance, Cf, and the resistance, Rf. The input charge, Qs, is applied to the inverting input of the amplifier. It is distributed to the cable capacitance, Cc, the amplifier input capacitance, Cin, and the feedback capacitor, Cf.

$$Qs = QCc + QCin + QCf \quad (1)$$

By considering that Q = CV we can write

$$Qs = Vin(Cc + Cin) + Vf.Cf \quad (2)$$

Figure 1: Charge Mode amplifier configuration



Where Vin is the differential Voltage of the Op amp and Vf the Voltage in the feedback loop. Thanks to the large gain of the op amp (AVD), and as Vout =-Vf equation 2 can be simplified as equation 3:

$$Vout = -\frac{Qs}{Cf} \quad (3)$$

From the equation (3) we can see that charge amplifier gain is independent of input capacitance, therefore system sensitivity is unaffected by changes in input, cable length or type.

Voltage amplifier configuration

For the voltage mode amplifier the induced voltage is presented to the high impedance non inverting input and then amplified by the op amp. The main advantage of the voltage mode configuration is that the gain is set accurately with resistors rather than with a small capacitor.
The configuration is described figure 2:
In a frequency range, all the charges generated by the sensor are transferred into Cs and Cc. The op amp amplifies this voltage as shown in Equation 4.

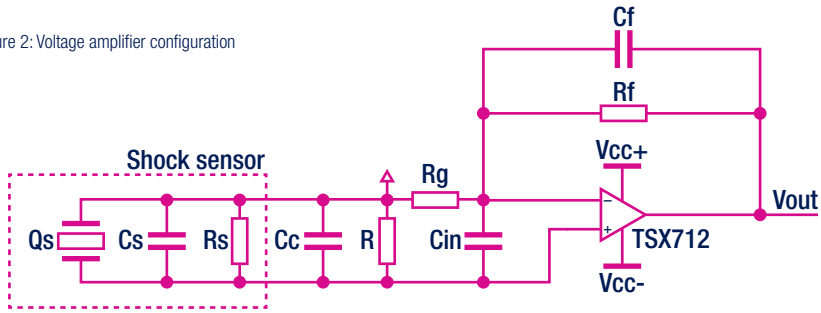
$$Vout = -\frac{Qs}{Cs + Cc} * \left(1 + \frac{Rf}{Rg}\right) \quad (4)$$

As the gain is related to the amount of capacitance seen by the sensor, the shock sensor must be connected as close as possible to the op amp in this configuration. This is because the parasitic capacitance of the cable, Cc, affects the actual gain (and the longer the cable, the higher this capacitance). R ensure that the DC correctly biases the op amp.

Conclusion

Piezo electric accelerometer as shock sensor can be used either with a charge mode configuration thanks to the TSX922 or voltage mode configuration thanks to the TSX712.
For more details, please download AN4708 document from www.st.com

Figure 2: Voltage amplifier configuration



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THE SMART WAY TO DESIGN YOUR APPLICATION

STMicroelectronics eDesignSuite is a smart simulation tool that greatly simplifies the task of engineers working on various application types. To use the eDesignSuite you must first register on MyST at **https://my.st.com/analogsimulator.**

STEP 1 Select the Signal Conditioning module

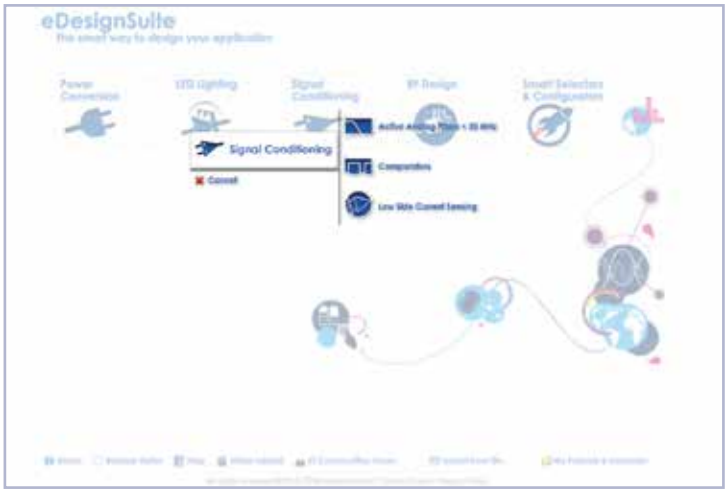
STEP 2 Select the type of product family (active analog, comparators or low side current sensing)

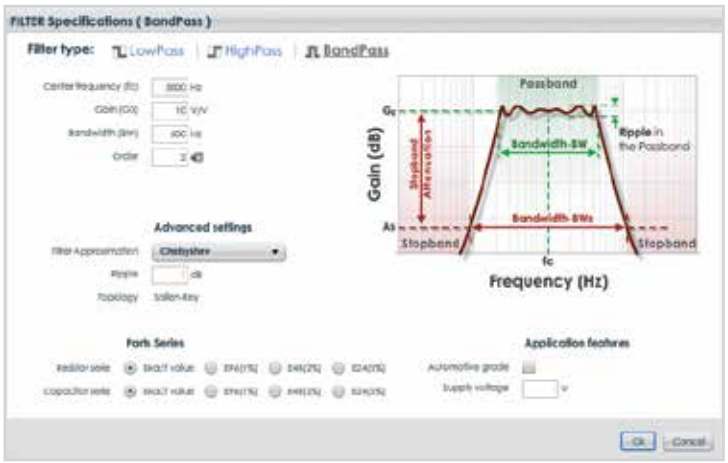
STEP 3 Select the desired filter performance (low pass/high pass/band pass)

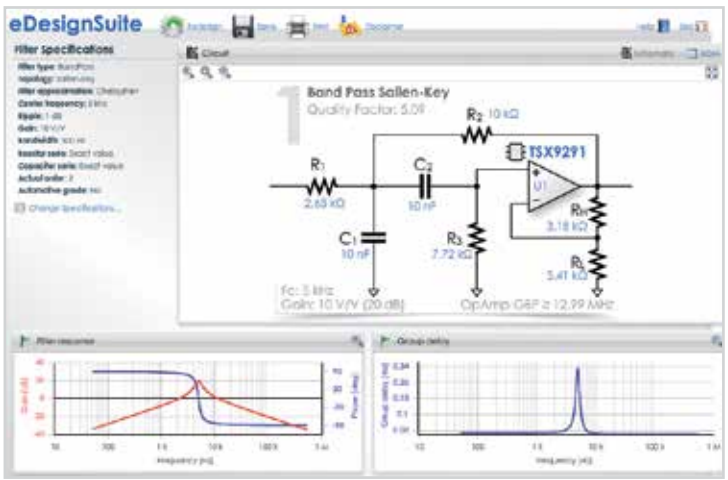
STEP 4 Adjust your choice (center frequency, bandwidth…)

…you can then

- Get the suggested schematics with op amps, resistors and capacitors
- Get the bill of material
- Get the gain, phase and group delay charts of the filter response in order to analyze your filter easily
- Datasheet
- Product folder







Hardware and software utilities

The STM32 Open Development Environment is a fast and affordable way to develop and prototype innovative devices and applications with state-of-the-art ST components leveraging the STM32 32-bit microcontroller family and a comprehensive set of functions for sensing, connectivity, power, audio, motor control and more.The combination of a broad range of expandable boards based on leading-edge commercial products and modular software, from driver to application level, enables fast prototyping of ideas that can be smoothly transformed into final designs.

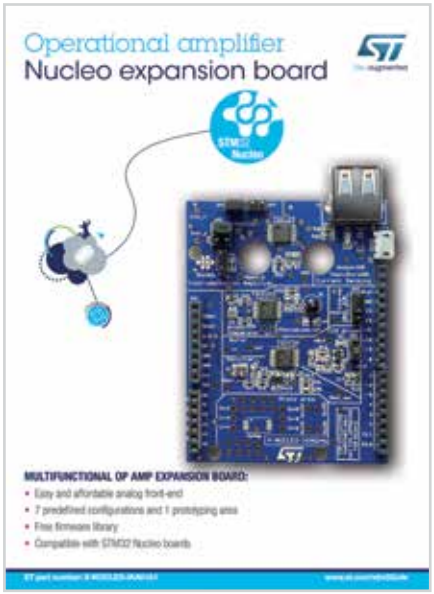
OP AMP NUCLEO EXPANSION BOARD

Use the X-NUCLEO-IKA01A1 multifunctional op amp expansion board for STM32 Nucleo

The board contains seven predefined configurations based on three different operational amplifiers.

- A TSZ124 for instrumentation amplifiers and current sensing configurations
- A TSU104 for a window comparator function or for photodiode or UV sensor configurations
- A TSV734 for LED driver and buffer configurations

Information on how to obtain the board can be found at www.st.com/x-nucleo under the reference X-NUCLEO-IKA01A1.



STM32 DEVELOPMENT SOFTWARE

Use THE X-CUBE-ANALOG1 multifunctional software expansion for STM32CUBE

The X-CUBE-ANALOG1 is an expansion software package for STM32Cube. The software runs on the STM32 microcontroller and is used for reading and configuring various analog functions such as instrumentation amplifier, current sensing, LED driver, photodiode/UV and window comparator operational amplifier drivers using the TSZ124, TSV734 and TSU104 devices running on an STM32 microcontroller.
It is compatible with the X-NUCLEO-IKA01A1 expansion board plugged to a NUCLEO-F401RE, NUCLEO-F103RB, NUCLEO-L053R8 or NUCLEO-L476RG board.

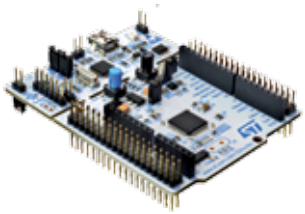
ALL THAT YOU NEED

Hardware

Multifunctional expansion board

Multifunctional expansion board based on operational amplifiers

X-NUCLEO-IKA01A1



STM32 Nucleo-64 development board

STM32F4 MCU

NUCLEO-F401RE

Software
(Free of charge)

Multifunctional
software expansion
X-CUBE-ANALOG1

STM32Cube

ST op amps application

THE ST OP AMPS APP MAKES SELECTING THE BEST COMPONENT FOR YOUR APPLICATION EASY!

The ST op amps app is available free from App Store and Google Play to help engineers develop circuits using operational amplifiers and comparators which are frequently designed into audio, control, monitoring, automotive and communication systems.

With reference schematics and guides built in, the ST op amps app provides an intuitive, mobile design assistant accessible at any time or place. It features touch-sensitive menus and scrollable pages for simple navigation.

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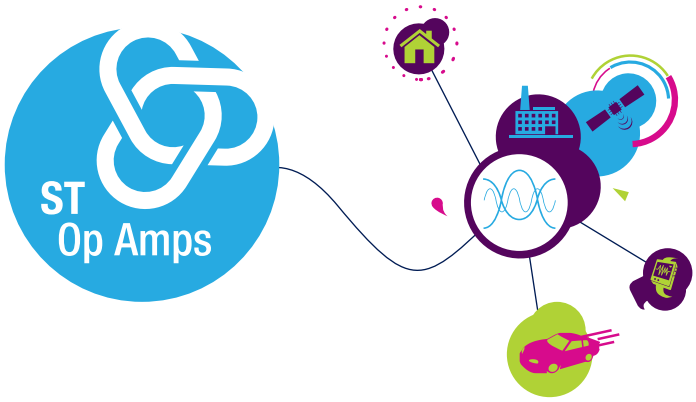

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