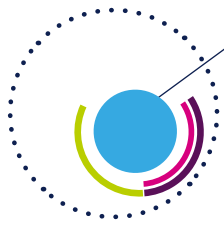




life.augmented

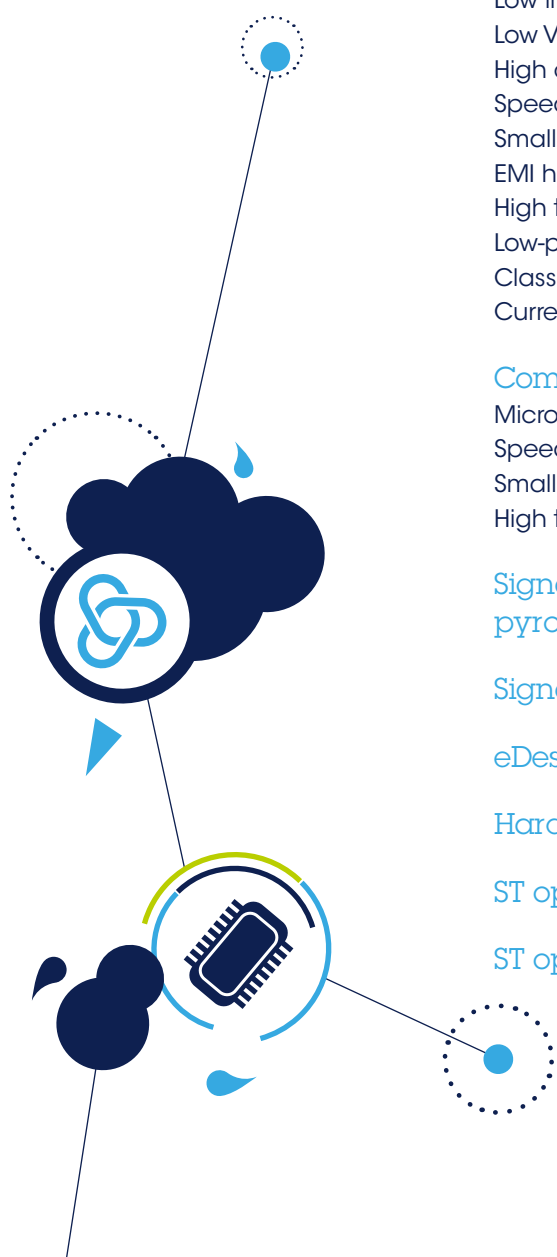
Amplifiers & Comparators Broaden Your Horizons





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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.

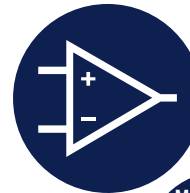
The range of products allows easy and fast integration of analog products inside signal conditioning, monitoring and control solutions.

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



Operational amplifiers

Low power 	Precision 	Low input bias current 	Low Vcc min
High output current 	Speed 	Small packages 	EMI hardened
High temperature 	Automotive 	Low-power audio 	Current-sense amp



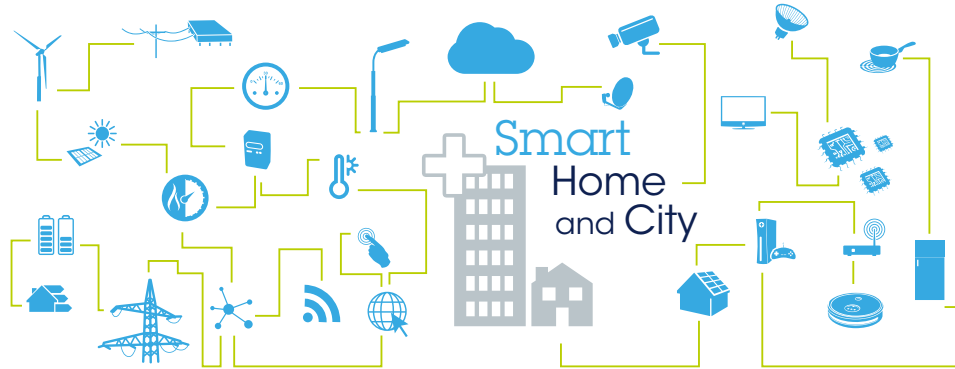
Comparators

Micropower 	Speed
Small packages 	High temperature
Automotive 	



Application schematics

HOME



4

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

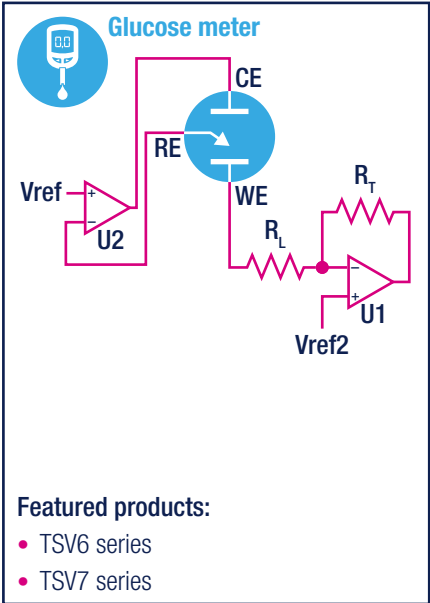
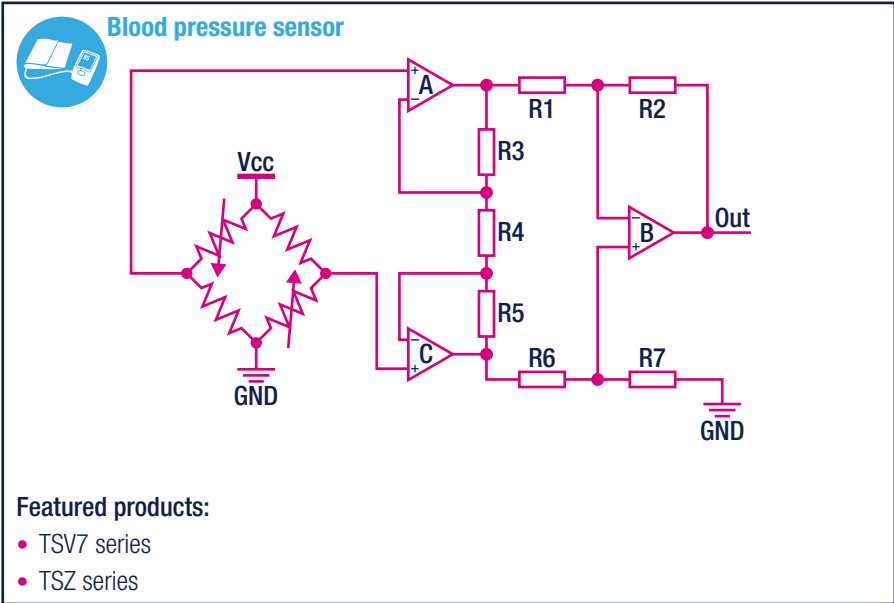
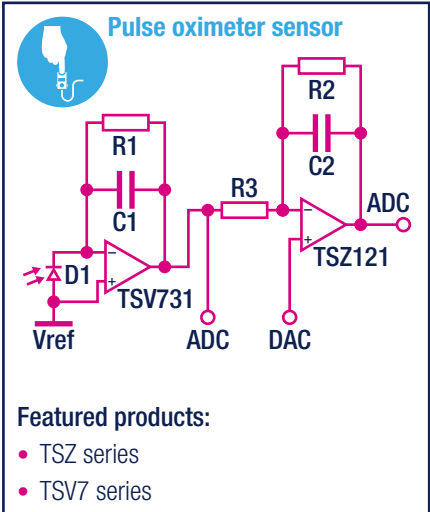
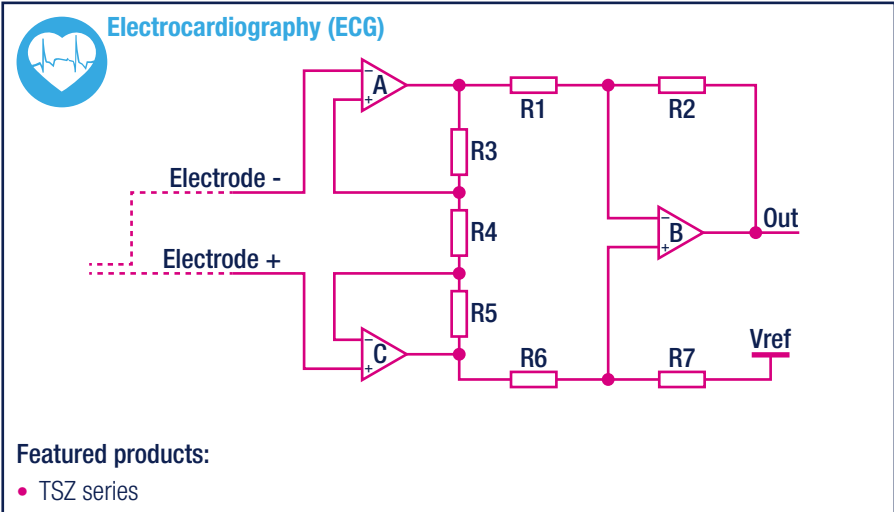
Featured products:

- TSX922IYDT
- TSV912HYDT

- ### KEY PARAMETERS
- Precision
 - Low power
 - Speed
 - High voltage
 - Specific production flow

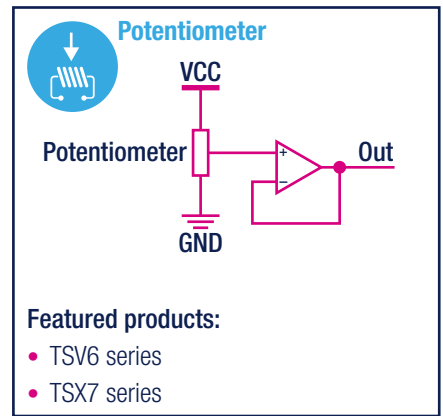
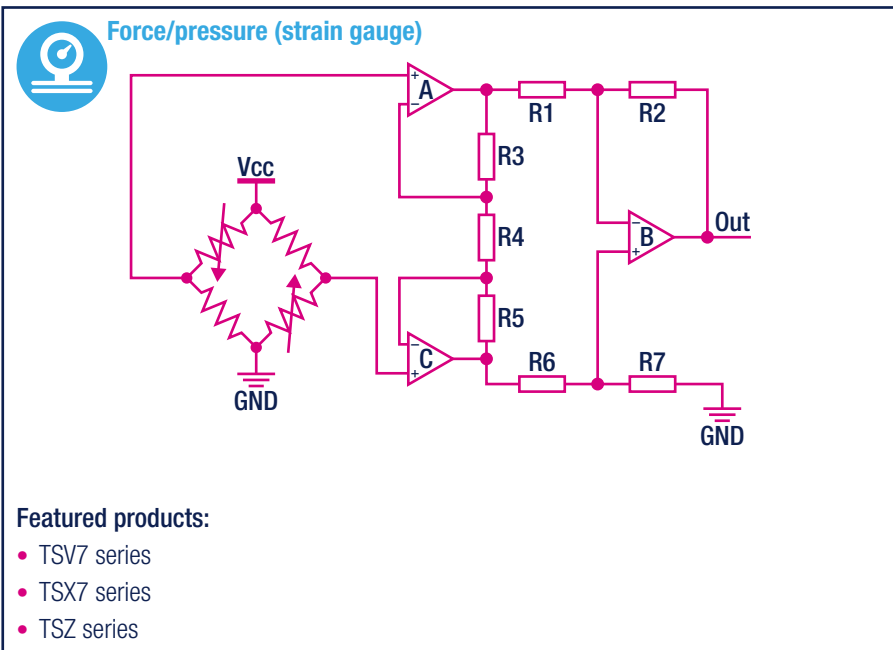
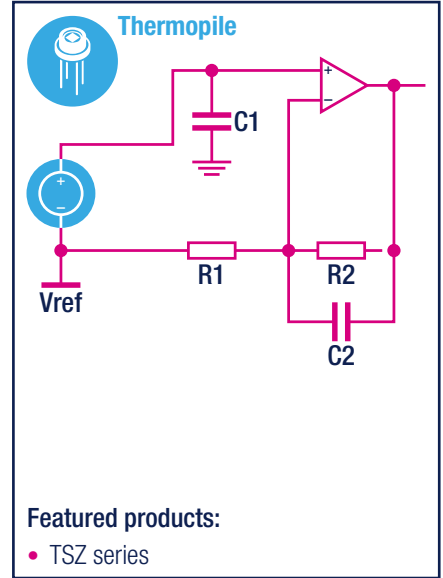
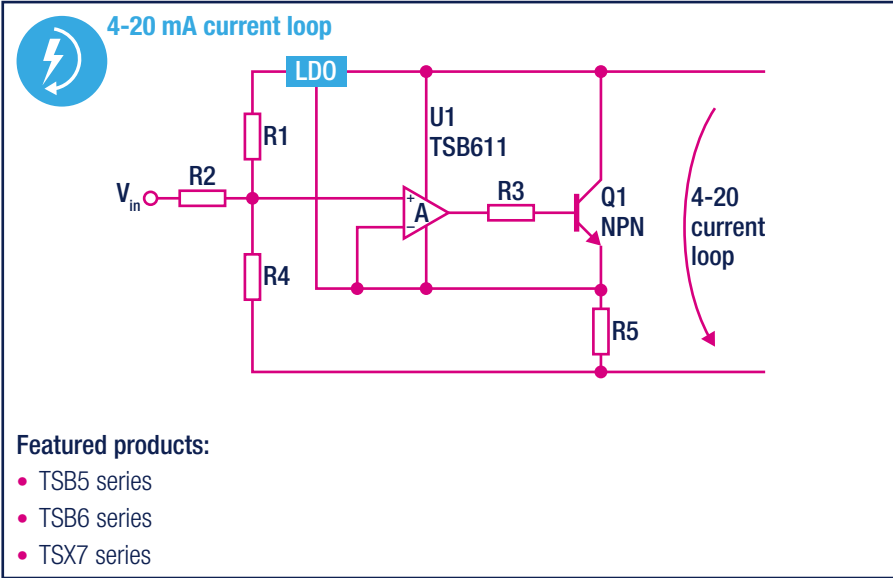


HEALTHCARE



- KEY PARAMETERS**
- Precision
 - Low input bias current
 - Low power
 - Small package

INDUSTRY



KEY PARAMETERS

- Precision
- Low power
- High voltage
- Small package



Operational amplifiers



LOW POWER

TSU series – Nanopower amplifiers with exceptionally low current consumption

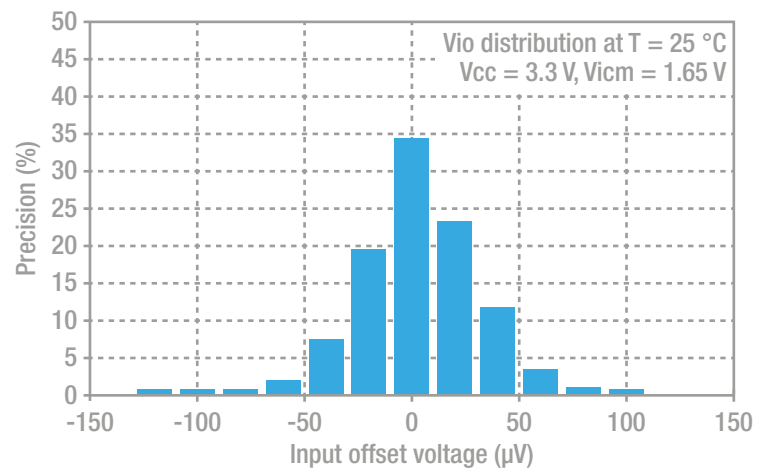
TSU111/2/4: Nanopower (900 nA), high accuracy (150 μ V) 5 V CMOS operational amplifier

The TSU111, TSU112 and the TSU114 operational amplifiers offer an ultra-low-power consumption per channel of 900 nA typical and 1.2 μ A maximum when supplied by 3.3 V. Combined with a supply voltage range of 1.5 to 5.5 V, these features allow the TSU11x to be efficiently supplied by a coin-type Lithium battery or a regulated voltage in low-power applications.

FEATURES

- 900 nA per channel at 25 °C
- Low offset voltage:
 - 150 μ V (maximum) at 25 °C
 - 235 μ V (maximum) vs. T
- Low supply voltage: 1.5 to 5.5 V
- Rail-to-rail input and output
- Gain bandwidth product: 11.5 kHz

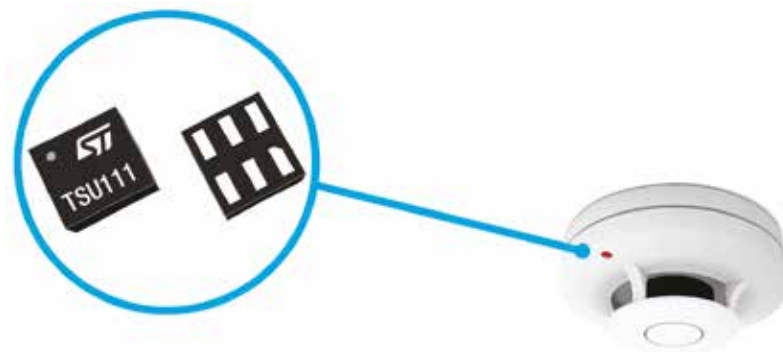
Input offset voltage distribution



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APPLICATIONS

- PIR and Gas sensors: CO, O₂, and H₂S
- Signal conditioning for energy harvesting



TSU101/2/4: Nanopower (580 nA), rail-to-rail input and output, 5 V CMOS 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.

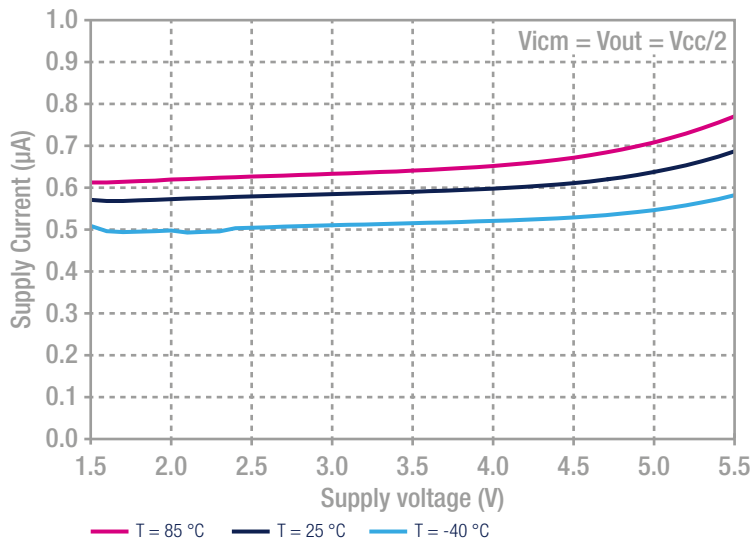
FEATURES

- 580 nA (typical) per channel at 25 °C
- Low supply voltage: 1.5 to 5.5 V
- Rail-to-rail input and output
- Gain bandwidth product: 8 kHz
- Low input bias current: 5 pA (maximum) at 25 °C

APPLICATIONS

- Ultra-long life battery-powered applications
- Power metering
- UV and photo sensors

Supply current vs. supply 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)	Rail to rail		Single	Dual	Quad	Automotive grade
							In	Out				
Nanopower ($I_{cc} \leq 1 \mu A$)												
TSU101/2/4	0.58	1.5	5.5	0.008	0.003	3000	Yes	Yes	•	•	•	
TSU111/2/4	0.9	1.5	5.5	0.0115	0.0027	150	Yes	Yes	•	•	•	
Micropower ($1 \mu A < I_{cc} \leq 35 \mu A$)												
TS941/2/4	1.2	2.5	10	0.01	0.0045	10000	No	Yes	•	•	•	
TS941A/2A/4A	1.2	2.5	10	0.01	0.0045	5000	No	Yes	•	•	•	
TSV611/2	10	1.5	5.5	0.12	0.04	4500	Yes	Yes	•	•		
TSV611A/2A	10	1.5	5.5	0.12	0.04	800	Yes	Yes	•	•		
TSV6191/2	10	1.5	5.5	0.45	0.08	4500	Yes	Yes	•	•		
TSV6191A/2A	10	1.5	5.5	0.45	0.08	800	Yes	Yes	•	•		
TSV711/2/4	10	1.5	5.5	0.12	0.06	200	Yes	Yes	•	•	•	
TS931/2/4	20	2.7	10	0.1	0.05	10000	No	Yes	•	•	•	
TS931A/4A	20	2.7	10	0.1	0.05	5000	No	Yes	•		•	
TSV621/2/4	29	1.5	5.5	0.42	0.14	4000	Yes	Yes	•	•	•	
TSV621A/2A/4A	29	1.5	5.5	0.42	0.14	800	Yes	Yes	•	•	•	
TSV6291/2/4	29	1.5	5.5	1.3	0.5	4000	Yes	Yes	•	•	•	
TSV6291A/2A/4A	29	1.5	5.5	1.3	0.5	800	Yes	Yes	•	•	•	
TSZ121/2/4	31	1.8	5.5	0.4	0.19	5	Yes	Yes	•	•	•	✓
Low power ($35 \mu A < I_{cc} < 1 mA$)												
TSV521/2/4	45	2.7	5.5	1.15	0.89	1000	Yes	Yes	•	•	•	
TSV521A/2A/4A	45	2.7	5.5	1.15	0.89	600	Yes	Yes	•	•	•	
TSX631/2/4	45	3.3	16	0.2	0.12	1000	Yes	Yes	•	•	•	✓
TSX631A/2A/4A	45	3.3	16	0.2	0.12	500	Yes	Yes	•	•	•	✓
TSV631/2/4	60	1.5	5.5	0.88	0.34	3000	Yes	Yes	•	•	•	✓
TSV631A/2A/4A	60	1.5	5.5	0.88	0.34	500	Yes	Yes	•	•	•	
TSV6391/2/4	60	1.5	5.5	2.4	1.1	3000	Yes	Yes	•	•	•	
TSV6391A/2A/4A	60	1.5	5.5	2.4	1.1	500	Yes	Yes	•	•	•	
TSV731/2/4	60	1.5	5.5	0.9	0.35	200	Yes	Yes	•	•	•	
TSB611	103	2.7	36	0.56	0.18	1000	No	Yes	•			✓
LMV321L/358L/324L	130	2.7	5.5	1.3	0.7	7000	No	Yes	•	•	•	
LMV321/358/324	145	2.7	6	1	0.35	3000	Yes	Yes	•	•	•	✓
TS1851/2/4	165	1.8	6	0.65	0.25	3000	Yes	Yes	•	•	•	
LMX321/358/324	180	2.5	5.5	1.3	0.7	4000	No	Yes	•	•	•	
TSV851/2/4	180	2.3	5.5	1.3	0.7	4000	No	Yes	•	•	•	✓
TSV851A/2A/4A	180	2.3	5.5	1.3	0.7	800	No	Yes	•	•	•	✓
TSX561/2/4	250	3	16	0.9	1.1	1000	Yes	Yes	•	•	•	✓
TSX561A/2A/4A	250	3	16	0.9	1.1	600	Yes	Yes	•	•	•	✓
LMV821/2/4	300	2.5	5.5	5.5	1.9	3500	No	Yes	•	•	•	✓

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)	Rail to rail		Single	Dual	Quad	Automotive grade
							In	Out				
Low power (35 µA < I_{cc} < 1 mA)												
TSB572	380	4	36	2.5	1	1500	Yes	Yes		•		✓
TS1871/2/4	400	1.8	6	1.8	0.6	3000	Yes	Yes	•	•	•	✓
TS1871A/2A/4A	400	1.8	6	1.8	0.6	1000	Yes	Yes	•	•	•	✓
TS912/4	400	2.7	16	1.4	1	10000	Yes	Yes		•	•	✓
TS912A/4A	400	2.7	16	1.4	1	5000	Yes	Yes		•	•	✓
LMC6482	500	2.7	16	2.7	1.4	2000	Yes	Yes		•		
TS512/4	500	6	30	3	1.5	2500	No	No		•	•	✓
TSV321/358/324	500	2.5	6	1.4	0.6	3000	Yes	Yes	•	•	•	✓
TSV358/324	500	2.5	6	1.4	0.6	3000	Yes	Yes		•	•	✓
TSX711/2	660	2.7	16	2.7	1.3	200	Yes	Yes	•	•		✓
TSX711A	660	2.7	16	2.5	1.5	100	Yes	Yes	•			✓
TSX7191/2	660	2.7	16	9	2.3	200	Yes	Yes	•	•		✓
TSX7191A	660	2.7	16	9	2.3	100	Yes	Yes	•			✓
TSV911/2/4	780	2.5	5.5	8	4.5	4500	Yes	Yes	•	•	•	✓
TSV911A/2A/4A	780	2.5	5.5	8	4.5	1500	Yes	Yes	•	•	•	✓
TSV912H	780	2.5	5.5	8	4.5	4500	Yes	Yes		•		✓
TSZ181/182	800	2.2	5.5	3	4.7	25	Yes	Yes	•	•		✓
TSV991/2/4	820	2.5	5.5	20	10	4500	Yes	Yes	•	•	•	✓
TSV991A/2A/4A	820	2.5	5.5	20	10	1500	Yes	Yes	•	•	•	✓
TS507	850	2.7	5.5	1.9	0.6	100	Yes	Yes	•			✓
TS9222/4	900	2.7	12	4	1.3	500	Yes	Yes		•	•	✓
TS951/952/954	900	2.7	12	3	1	6000	Yes	Yes	•	•	•	✓
TS9511	950	2.7	12	3	1	800	Yes	Yes	•			✓
Amplifiers with standby pin												
TSV620/3/5	29	1.5	5.5	0.42	0.14	4000	Yes	Yes	•	•	•	
TSV620A/3A	29	1.5	5.5	0.42	0.14	800	Yes	Yes	•	•		
TSV6290/3	29	1.5	5.5	1.3	0.5	4000	Yes	Yes	•	•		
TSV6290A/3A	29	1.5	5.5	1.3	0.5	800	Yes	Yes	•	•		
TSV630/3/5	60	1.5	5.5	0.88	0.34	3000	Yes	Yes	•	•	•	
TSV630A/3A/5A	60	1.5	5.5	0.88	0.34	500	Yes	Yes	•	•	•	
TSV6390/3/5	60	1.5	5.5	2.4	1.1	3000	Yes	Yes	•	•	•	
TSV6390A/3A	60	1.5	5.5	2.4	1.1	500	Yes	Yes	•	•		
TSV850/3	180	2.3	5.5	1.3	0.7	4000	No	Yes	•	•		
TSV850A/3A	180	2.3	5.5	1.3	0.7	800	No	Yes	•	•		
LMV820/3	300	2.5	5.5	5.5	1.9	3500	No	Yes	•	•		
LMV820A/3A	300	2.5	5.5	5.5	1.9	800	No	Yes	•	•		

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



PRECISION

TSZ series – Zero drift amplifiers: the paramount of accuracy for signal conditioning

TSZ181/2: 5 V zero-drift, very high accuracy $V_{io} \leq 25 \mu\text{V}$ operational amplifiers

The TSZ181, TSZ182 are single- and dual-channel operational amplifiers featuring very low offset voltages with virtually zero drift versus temperature changes.

The TSZ181, TSZ182 offer rail-to-rail input and output, excellent speed/power consumption ratio, and 3 MHz gain bandwidth product, while consuming just 1 mA at 5 V. The device also features an ultra-low input bias current.

These features make the TSZ18x ideal for high-accuracy high-bandwidth sensor interfaces.

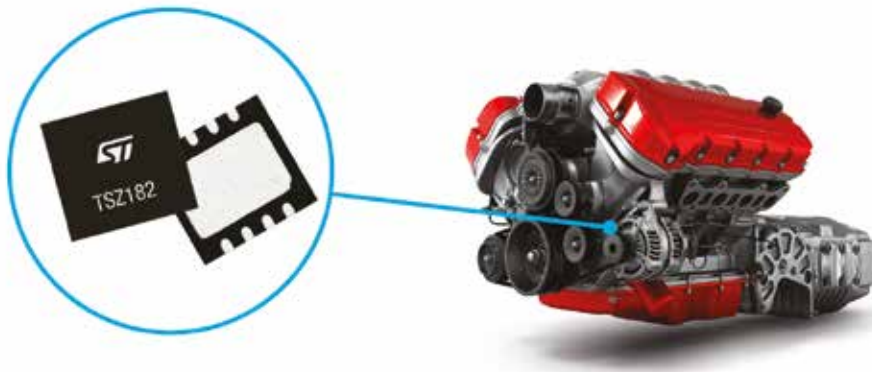
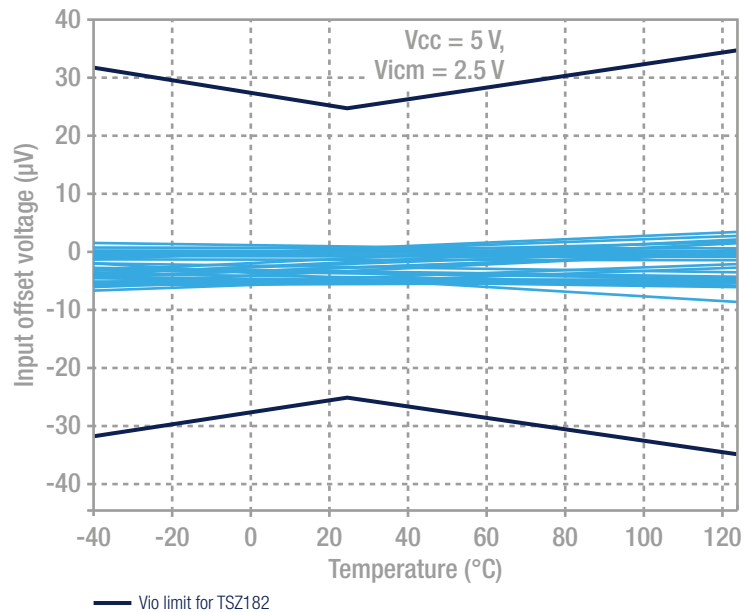
FEATURES

- Very high accuracy: $\pm 25 \mu\text{V}$ (maximum) at 25 °C
- Very good stability versus temperature: $\pm 35 \mu\text{V}$ (maximum) vs. T
- Gain bandwidth product: 3 MHz
- Low supply voltage: 2.2 to 5.5 V
- Low power consumption: 800 μA (typical)

APPLICATIONS

- High accuracy signal conditioning
- Automotive current measurement
- Battery-powered instrumentation

Input offset voltage vs. temperature



TSZ121/2/4: 5 V zero-drift rail-to-rail precision amplifiers ($V_{io} \leq 5 \mu\text{V}$)

The TSZ operational amplifier series offer low-power, zero-drift operational amplifiers in space-saving packages. They use a chopper-stabilized architecture that provides very low offset voltages $V_{io} < 8 \mu\text{V}$ over the full operating temperature 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.

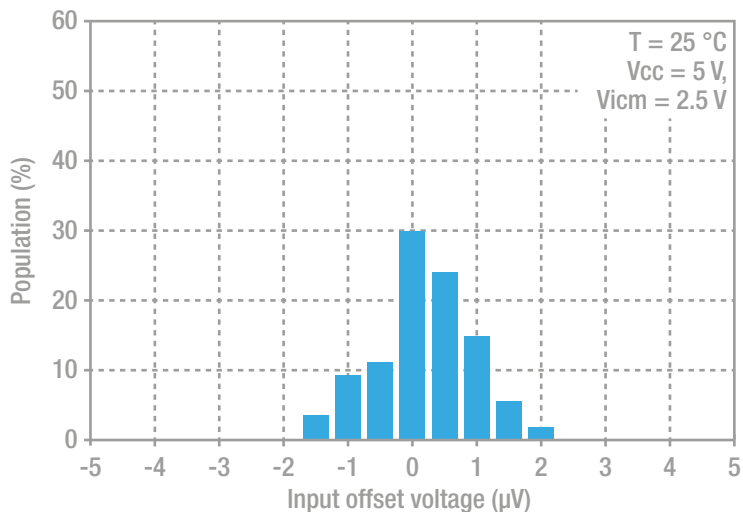
FEATURES

- Very high accuracy: $\pm 5 \mu\text{V}$ (maximum) at 25 °C
- Very good stability versus temperature: $\pm 8 \mu\text{V}$ (maximum) vs. T
- Gain bandwidth product 400 kHz
- Low power consumption 31 μA (typical)
- Supply voltage: 1.8 to 5.5 V

APPLICATIONS

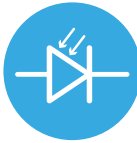
- Automotive signal conditioning
- Portable instrumentation
- High-accuracy current measurement

Input offset voltage distribution at $V_{CC} = 5 \text{ V}$



Part number	Max. V_{io} @ 25 °C (μV)	Typ. V_{io} drift ($\mu\text{V}/^\circ\text{C}$)	Max. lib @ 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/ $\sqrt{\text{Hz}}$)	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	31	37	Yes	Yes	•	•	•	✓
TSZ181/182	25	0.01	200	2.2	5.5	3	4.7	800	37	Yes	Yes	•	•		✓
TSX711A	100	0.8	50	2.7	16	2.5	1.5	660	20	Yes	Yes	•			✓
TSX7191A	100	0.8	50	2.7	16	9	2.3	660	22	Yes	Yes	•			✓
TS507	100	1	70000	2.7	5.5	1.9	0.6	850	12	Yes	Yes	•			✓
TSU111/2/4	150	0.5	5	1.5	5.5	0.0115	0.0027	0.9	265	Yes	Yes	•	•	•	
TSX711/2	200	0.8	50	2.7	16	2.7	1.3	660	22	Yes	Yes	•	•		✓
TSX7191/2	200	0.8	50	2.7	16	9	2.3	660	22	Yes	Yes	•	•		✓
TSV731/2/4	200	2	10	1.5	5.5	0.9	0.35	60	35	Yes	Yes	•	•	•	
TSV711/2/4	200	3	10	1.5	5.5	0.12	0.06	10	100	Yes	Yes	•	•	•	
TSB712A	300	1	900000	2.7	36	6	3	1800	12	Yes	Yes		•		✓
TSB7192A	300	1	900000	2.7	36	22	12	1800	12	Yes	Yes		•		✓
TSX631A/2A/4A	500	1	100	3.3	16	0.2	0.12	45	60	Yes	Yes	•	•	•	✓
TS9222/4	500	2	55000	2.7	12	4	1.3	900	9	Yes	Yes		•	•	✓
TSV630A/3A/5A	500	2	10	1.5	5.5	0.88	0.34	60	60	Yes	Yes	•	•	•	
TSV631A/2A/4A	500	2	10	1.5	5.5	0.88	0.34	60	60	Yes	Yes	•	•	•	
TSV6390A/3A	500	2	10	1.5	5.5	2.4	1.1	60	60	Yes	Yes	•	•		
TSV6391A/2A/4A	500	2	10	1.5	5.5	2.4	1.1	60	60	Yes	Yes	•	•	•	
TSV521A/2A/4A	600	2	10	2.7	5.5	1.15	0.89	45	57	Yes	Yes	•	•	•	
TSX561A/2A/4A	600	2	100	3	16	0.9	1.1	250	48	Yes	Yes	•	•	•	✓
LMV820A/3A	800	1	120000	2.5	5.5	5.5	1.9	300	16	No	Yes	•	•		
LMV821A/2A/4A	800	1	120000	2.5	5.5	5.5	1.9	300	16	No	Yes	•	•	•	✓
TSV850A/3A	800	1	60000	2.3	5.5	1.3	0.7	180	39	No	Yes	•	•		
TSV851A/2A/4A	800	1	60000	2.3	5.5	1.3	0.7	180	39	No	Yes	•	•	•	✓
TS9511	800	2	70000	2.7	12	3	1	950	25	Yes	Yes	•			✓
TSV611A/2A	800	2	10	1.5	5.5	0.12	0.04	10	105	Yes	Yes	•	•		
TSV6191A/2A	800	2	10	1.5	5.5	0.45	0.08	10	105	Yes	Yes	•	•		
TSV620A/3A	800	2	10	1.5	5.5	0.42	0.14	29	70	Yes	Yes	•	•		
TSV621A/2A/4A	800	2	10	1.5	5.5	0.42	0.14	29	70	Yes	Yes	•	•	•	
TSV6290A/3A	800	2	10	1.5	5.5	1.3	0.5	29	70	Yes	Yes	•	•		
TSV6291A/2A/4A	800	2	10	1.5	5.5	1.3	0.5	29	70	Yes	Yes	•	•	•	
TSB712	800	1	900000	2.7	36	6	3	1800	12	Yes	Yes		•		✓
TSB7192	800	1	900000	2.7	36	22	12	1800	12	Yes	Yes		•		✓

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



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 $^{\circ}\text{C}$. 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.

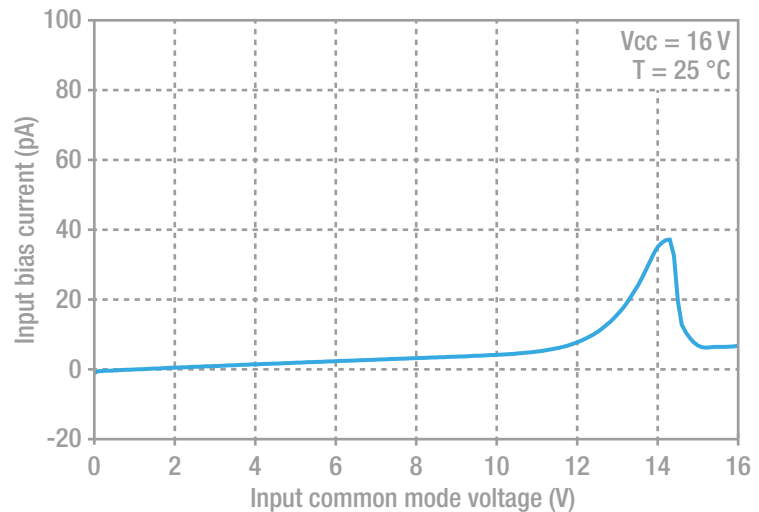
FEATURES

- 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

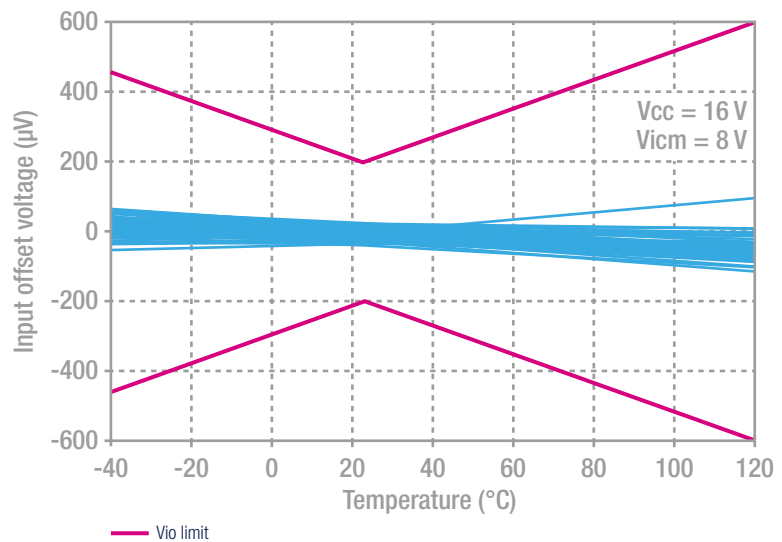
APPLICATIONS

- 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 $V_{CC} = 16\text{ V}$



Part number	Max. I _{lib} @ 25 °C (pA)	Max. V _{io} @ 25 °C (μV)	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	1.5	5.5	0.008	0.003	0.58	265	Yes	Yes	•	•	•	
TSU111/2/4	5	150	1.5	5.5	0.0115	0.0027	0.9	265	Yes	Yes	•	•	•	
TSV521/2/4	10	1000	2.7	5.5	1.15	0.89	45	57	Yes	Yes	•	•	•	
TSV521A/2A/4A	10	600	2.7	5.5	1.15	0.89	45	57	Yes	Yes	•	•	•	
TSV611/2	10	4500	1.5	5.5	0.12	0.04	10	105	Yes	Yes	•	•		
TSV611A/2A	10	800	1.5	5.5	0.12	0.04	10	105	Yes	Yes	•	•		
TSV6191/2	10	4500	1.5	5.5	0.45	0.08	10	105	Yes	Yes	•	•		
TSV6191A/2A	10	800	1.5	5.5	0.45	0.08	10	105	Yes	Yes	•	•		
TSV620/3/5	10	4000	1.5	5.5	0.42	0.14	29	70	Yes	Yes	•	•	•	
TSV620A/3A	10	800	1.5	5.5	0.42	0.14	29	70	Yes	Yes	•	•		
TSV621/2/4	10	4000	1.5	5.5	0.42	0.14	29	70	Yes	Yes	•	•	•	
TSV621A/2A/4A	10	800	1.5	5.5	0.42	0.14	29	70	Yes	Yes	•	•	•	
TSV6290/3	10	4000	1.5	5.5	1.3	0.5	29	70	Yes	Yes	•	•		
TSV6290A/3A	10	800	1.5	5.5	1.3	0.5	29	70	Yes	Yes	•	•		
TSV6291/2/4	10	4000	1.5	5.5	1.3	0.5	29	70	Yes	Yes	•	•	•	
TSV6291A/2A/4A	10	800	1.5	5.5	1.3	0.5	29	70	Yes	Yes	•	•	•	
TSV630/3/5	10	3000	1.5	5.5	0.88	0.34	60	60	Yes	Yes	•	•	•	
TSV630A/3A/5A	10	500	1.5	5.5	0.88	0.34	60	60	Yes	Yes	•	•	•	
TSV631/2/4	10	3000	1.5	5.5	0.88	0.34	60	60	Yes	Yes	•	•	•	✓
TSV631A/2A/4A	10	500	1.5	5.5	0.88	0.34	60	60	Yes	Yes	•	•	•	
TSV6390/3/5	10	3000	1.5	5.5	2.4	1.1	60	60	Yes	Yes	•	•	•	
TSV6390A/3A	10	500	1.5	5.5	2.4	1.1	60	60	Yes	Yes	•	•		
TSV6391/2/4	10	3000	1.5	5.5	2.4	1.1	60	60	Yes	Yes	•	•	•	
TSV6391A/2A/4A	10	500	1.5	5.5	2.4	1.1	60	60	Yes	Yes	•	•	•	
TSV711/2/4	10	200	1.5	5.5	0.12	0.06	10	100	Yes	Yes	•	•	•	
TSV731/2/4	10	200	1.5	5.5	0.9	0.35	60	35	Yes	Yes	•	•	•	
TSV911/2/4	10	4500	2.5	5.5	8	4.5	780	27	Yes	Yes	•	•	•	✓
TSV911A/2A/4A	10	1500	2.5	5.5	8	4.5	780	27	Yes	Yes	•	•	•	✓
TSV912H	10	4500	2.5	5.5	8	4.5	780	27	Yes	Yes		•		✓
TSV991/2/4	10	4500	2.5	5.5	20	10	820	27	Yes	Yes	•	•	•	✓
TSV991A/2A/4A	10	1500	2.5	5.5	20	10	820	27	Yes	Yes	•	•	•	✓
LMC6482	50	2000	2.7	16	2.7	1.4	500	22	Yes	Yes		•		
TSX711/2	50	200	2.7	16	2.7	1.3	660	22	Yes	Yes	•	•		✓
TSX711A	50	100	2.7	16	2.5	1.5	660	20	Yes	Yes	•			✓
TSX7191/2	50	200	2.7	16	9	2.3	660	22	Yes	Yes	•	•		✓
TSX7191A	50	100	2.7	16	9	2.3	660	22	Yes	Yes	•			✓
TSX561/2/4	100	1000	3	16	0.9	1.1	250	48	Yes	Yes	•	•	•	✓
TSX561A/2A/4A	100	600	3	16	0.9	1.1	250	48	Yes	Yes	•	•	•	✓
TSX631/2/4	100	1000	3.3	16	0.2	0.12	45	60	Yes	Yes	•	•	•	✓
TSX631A/2A/4A	100	500	3.3	16	0.2	0.12	45	60	Yes	Yes	•	•	•	✓
TSX920/923	100	4000	4	16	10	17.2	2800	16.5	Yes	Yes	•	•		
TSX921/922	100	4000	4	16	10	17.2	2800	16.5	Yes	Yes	•	•		✓
TSX9291/TSX9292	100	4000	4	16	16	26	2800	16.5	Yes	Yes	•	•		✓
TS912/4	150	10000	2.7	16	1.4	1	400	30	Yes	Yes		•	•	✓
TS912A/4A	150	5000	2.7	16	1.4	1	400	30	Yes	Yes		•	•	✓
TS931/2/4	150	10000	2.7	10	0.1	0.05	20	76	No	Yes	•	•	•	
TS931A/4A	150	5000	2.7	10	0.1	0.05	20	76	No	Yes	•		•	
TS941/2/4	150	10000	2.5	10	0.01	0.0045	1.2	330	No	Yes	•	•	•	
TS941A/2A/4A	150	5000	2.5	10	0.01	0.0045	1.2	330	No	Yes	•	•	•	
TSZ121/2/4	200	5	1.8	5.5	0.4	0.19	31	37	Yes	Yes	•	•	•	✓
TSZ181/182	200	25	2.2	5.5	3	4.7	800	37	Yes	Yes	•	•		✓

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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-channel 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 μ A 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.

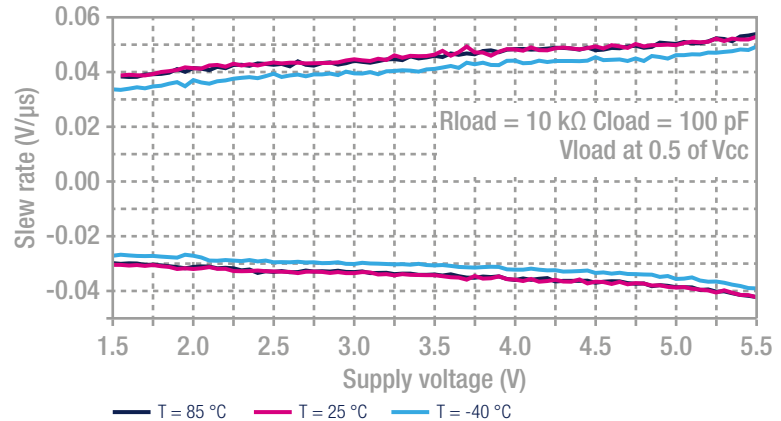
FEATURES

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

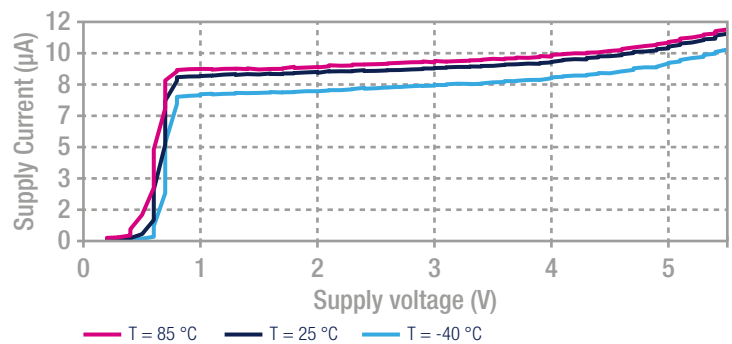
APPLICATIONS

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

Slew rate vs. supply voltage

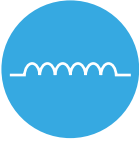


Supply current vs. supply voltage at $V_{icm} = V_{cc}/2$



Part number	Min. V_{CC} (V)	Max. V_{CC} (V)	Typ. GBP (MHz)	Typ. SR (v/ μ s)	Typ. I_{CC} per channel (μ A)	Max. V_{IO} @ 25 $^{\circ}$ C (μ V)	Max. I_{IB} @ 25 $^{\circ}$ C (pA)	Typ. 1 kHz noise (nV/ \sqrt Hz)	Typ. I_{OUT} (mA)	Rail to rail		Single	Dual	Quad	Automotive grade
										In	Out				
Low voltage (V_{CC} min. \leq 2.2 V)															
TSU101/2/4	1.5	5.5	0.008	0.003	0.58	3000	5	265	5	Yes	Yes	•	•	•	
TSU111/2/4	1.5	5.5	0.0115	0.0027	0.9	150	5	265	41	Yes	Yes	•	•	•	
TSV611/2	1.5	5.5	0.12	0.04	10	4500	10	105	60	Yes	Yes	•	•	•	
TSV611A/2A	1.5	5.5	0.12	0.04	10	800	10	105	60	Yes	Yes	•	•	•	
TSV6191/2	1.5	5.5	0.45	0.08	10	4500	10	105	60	Yes	Yes	•	•	•	
TSV6191A/2A	1.5	5.5	0.45	0.08	10	800	10	105	60	Yes	Yes	•	•	•	
TSV620/3/5	1.5	5.5	0.42	0.14	29	4000	10	70	69	Yes	Yes	•	•	•	
TSV620A/3A	1.5	5.5	0.42	0.14	29	800	10	70	69	Yes	Yes	•	•	•	
TSV621/2/4	1.5	5.5	0.42	0.14	29	4000	10	70	69	Yes	Yes	•	•	•	
TSV621A/2A/4A	1.5	5.5	0.42	0.14	29	800	10	70	69	Yes	Yes	•	•	•	
TSV6290/3	1.5	5.5	1.3	0.5	29	4000	10	70	69	Yes	Yes	•	•	•	
TSV6290A/3A	1.5	5.5	1.3	0.5	29	800	10	70	69	Yes	Yes	•	•	•	
TSV6291/2/4	1.5	5.5	1.3	0.5	29	4000	10	70	69	Yes	Yes	•	•	•	
TSV6291A/2A/4A	1.5	5.5	1.3	0.5	29	800	10	70	69	Yes	Yes	•	•	•	
TSV630/3/5	1.5	5.5	0.88	0.34	60	3000	10	60	69	Yes	Yes	•	•	•	
TSV630A/3A/5A	1.5	5.5	0.88	0.34	60	500	10	60	69	Yes	Yes	•	•	•	
TSV631/2/4	1.5	5.5	0.88	0.34	60	3000	10	60	69	Yes	Yes	•	•	•	✓
TSV631A/2A/4A	1.5	5.5	0.88	0.34	60	500	10	60	69	Yes	Yes	•	•	•	
TSV6390/3/5	1.5	5.5	2.4	1.1	60	3000	10	60	69	Yes	Yes	•	•	•	
TSV6390A/3A	1.5	5.5	2.4	1.1	60	500	10	60	69	Yes	Yes	•	•	•	
TSV6391/2/4	1.5	5.5	2.4	1.1	60	3000	10	60	69	Yes	Yes	•	•	•	
TSV6391A/2A/4A	1.5	5.5	2.4	1.1	60	500	10	60	69	Yes	Yes	•	•	•	
TSV711/2/4	1.5	5.5	0.12	0.06	10	200	10	100	45	Yes	Yes	•	•	•	
TSV731/2/4	1.5	5.5	0.9	0.35	60	200	10	35	52	Yes	Yes	•	•	•	
TS1851/2/4	1.8	6	0.65	0.25	165	3000	50000	40	48	Yes	Yes	•	•	•	
TS1871/2/4	1.8	6	1.8	0.6	400	3000	125000	27	72	Yes	Yes	•	•	•	✓
TS1871A/2A/4A	1.8	6	1.8	0.6	400	1000	125000	27	72	Yes	Yes	•	•	•	✓
TSZ121/2/4	1.8	5.5	0.4	0.19	31	5	200	37	17	Yes	Yes	•	•	•	✓
TSZ181/182	2.2	5.5	3	4.7	800	25	200	37	25	Yes	Yes	•	•	•	✓

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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.

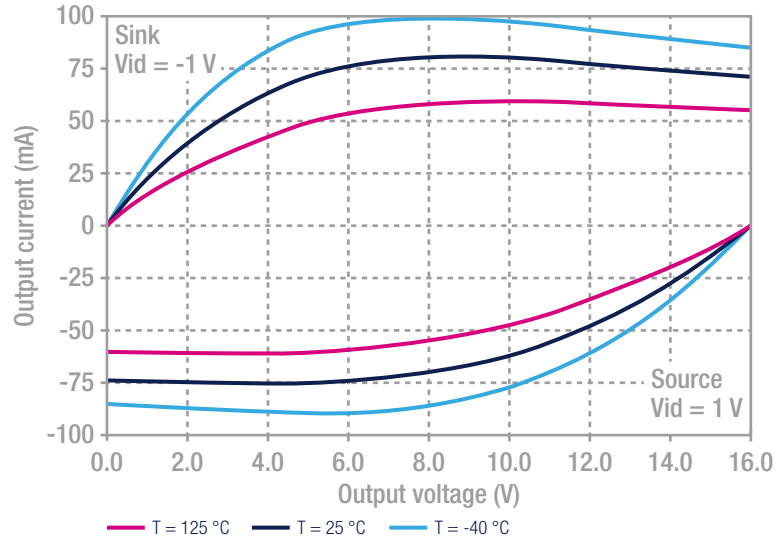
FEATURES

- 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 $^{\circ}\text{C}$
- Automotive qualification
- Available in SOT23-5, DFN8 (2 x 2 mm), Mini-SO8, SO8, TSSOP14 and QFN16 (3 x 3 mm) packages

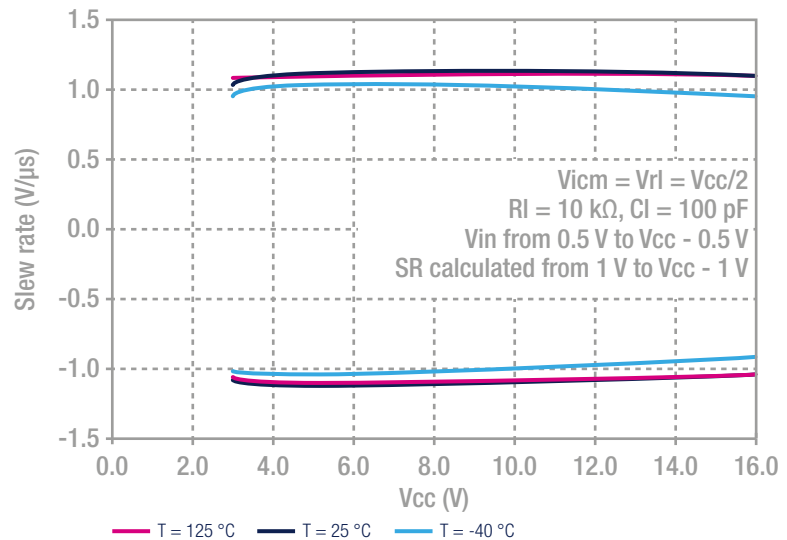
APPLICATIONS

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

Output current vs. output voltage at $V_{\text{CC}} = 16 \text{ V}$



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 ($C_L > 500 \text{ pF}$)												
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	•	•	•	✓
TS922/2/4	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.



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/ μ s 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.

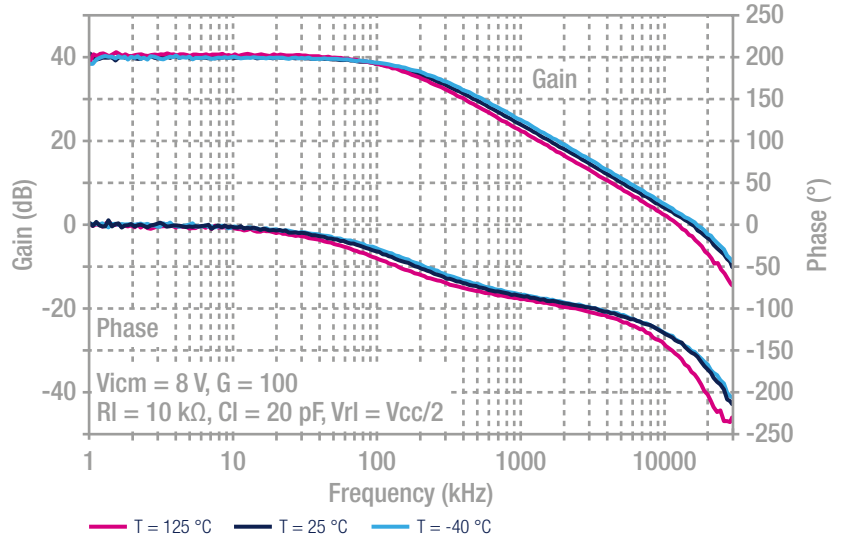
FEATURES

- 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/ μ s
- 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

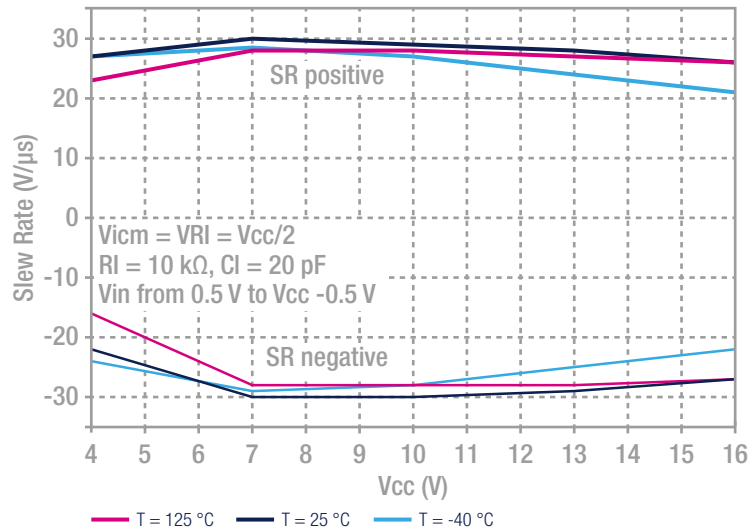
APPLICATIONS

- Communications
- Process control
- Active filtering
- Test equipment

Bode diagram vs. temperature for $V_{CC} = 16$ V

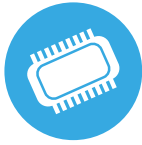


Slew rate vs. supply voltage and temperature



Part number	Typ. GBP (MHz)	Typ. SR (V/μs)	Typ. I _{cc} per channel (mA)	Min. V _{CC} (V)	Max. V _{CC} (V)	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 ≥ 3 MHz)														
TSB7192	22	12	1800	2.7	36	800	12	50	Yes	Yes		•		✓
TSB7192A	22	12	1800	2.7	36	300	12	50	Yes	Yes		•		✓
TSV991/2/4	20	10	820	2.5	5.5	4500	27	35	Yes	Yes	•	•	•	✓
TSV991A/2A/4A	20	10	820	2.5	5.5	1500	27	35	Yes	Yes	•	•	•	✓
TSX9291/TSX9292	16	26	2800	4	16	4000	16.5	62	Yes	Yes	•	•		✓
TS971/2/4	12	4	2000	2.7	10	5000	4	100	No	Yes	•	•	•	✓
TSX920/923	10	17.2	2800	4	16	4000	16.5	62	Yes	Yes	•	•		
TSX921/922	10	17.2	2800	4	16	4000	16.5	62	Yes	Yes	•	•		✓
TSX7191/2	9	2.3	660	2.7	16	200	22	50	Yes	Yes	•	•		✓
TSX7191A	9	2.3	660	2.7	16	100	22	50	Yes	Yes	•			✓
TSV911/2/4	8	4.5	780	2.5	5.5	4500	27	35	Yes	Yes	•	•	•	✓
TSV911A/2A/4A	8	4.5	780	2.5	5.5	1500	27	35	Yes	Yes	•	•	•	✓
TSV912H	8	4.5	780	2.5	5.5	4500	27	35	Yes	Yes		•		✓
TSB712	6	3	1800	2.7	36	800	12	50	Yes	Yes		•		✓
TSB712A	6	3	1800	2.7	36	300	12	50	Yes	Yes		•		✓
LMV820/3	5.5	1.9	300	2.5	5.5	3500	16	56	No	Yes	•	•		
LMV820A/3A	5.5	1.9	300	2.5	5.5	800	16	56	No	Yes	•	•		
LMV821/2/4	5.5	1.9	300	2.5	5.5	3500	16	56	No	Yes	•	•	•	✓
LMV821A/2A/4A	5.5	1.9	300	2.5	5.5	800	16	56	No	Yes	•	•	•	✓
TS921/2	4	1.3	1000	2.7	12	3000	9	80	Yes	Yes	•	•		
TS9222/4	4	1.3	900	2.7	12	500	9	80	Yes	Yes		•	•	✓
TSZ181/182	3	4.7	800	2.2	5.5	25	37	25	Yes	Yes	•	•		✓
TS512/4	3	1.5	500	6	30	2500	8	23	No	No		•	•	✓
TS951/952/954	3	1	900	2.7	12	6000	25	22	Yes	Yes	•	•	•	✓
TS952/4	3	1	900	2.7	12	6000	25	22	Yes	Yes		•	•	✓
TS9511	3	1	950	2.7	12	800	25	20	Yes	Yes	•			✓

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



SMALL PACKAGES

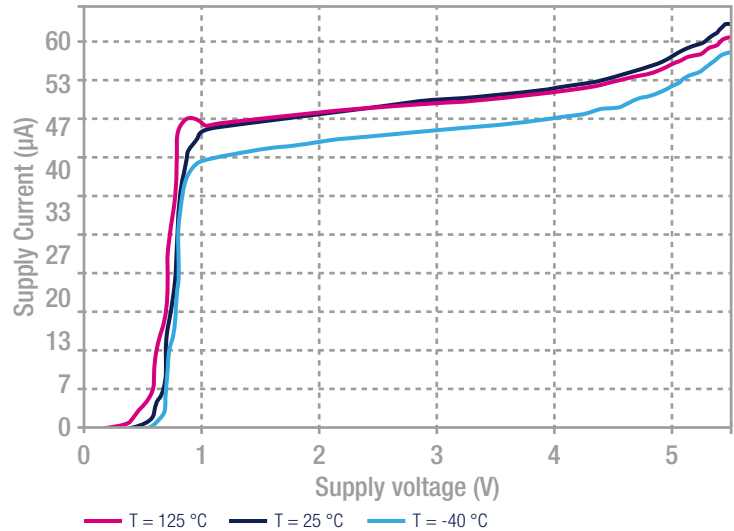
TSV630IQ2T: ultra-small DFN8 (2 x 2 mm), 5 V low-power rail-to-rail operational amplifier

The TSV630IQ2T is a single-channel 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 μ A 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 2 mm) micro package is guaranteed for industrial temperature ranges from -40 to +125 $^{\circ}$ 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.

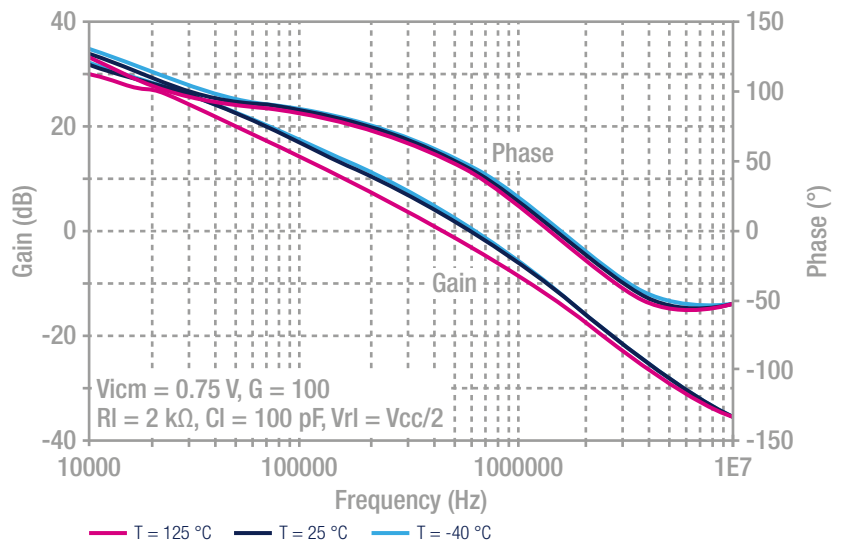
FEATURES

- Low offset voltage: 500 μ V (max.) A version
- Low power consumption: 60 μ A (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 $^{\circ}$ C
- Automotive qualification

Supply current vs. supply voltage at $V_{icm} = V_{cc}/2$



Voltage gain and phase vs. frequency at $V_{cc} = 1.5$ V



Part number	Package (mm)	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														
LMV321L/358L/324L	SC70-5	2.7	5.5	1.3	0.7	130	7000	58	No	Yes	•			
LMV821/2/4	SC70-5	2.5	5.5	5.5	1.9	300	3500	56	No	Yes	•	•	•	✓
LMV821A/2A/4A	SC70-5	2.5	5.5	5.5	1.9	300	800	56	No	Yes	•	•	•	✓
LMX321/358/324	SC70-5	2.5	5.5	1.3	0.7	180	4000	43	No	Yes	•			
TSB572	DFN8 3x3x0.8 WF	4	36	2.5	1	380	1500	60	Yes	Yes		•		✓
TSU101/2/4	SC70-5	1.5	5.5	0.008	0.003	0.58	3000	5	Yes	Yes	•	•	•	
TSU111/2/4	DFN6 1.2x1.3x0.5, SC70-5	1.5	5.5	0.0115	0.0027	0.9	150	41	Yes	Yes	•	•	•	
TSV521/2/4	SC70-5	2.7	5.5	1.15	0.89	45	1000	55	Yes	Yes	•	•	•	
TSV521A/2A/4A	SC70-5	2.7	5.5	1.15	0.89	45	600	55	Yes	Yes	•	•	•	
TSV611/2	SC70-5	1.5	5.5	0.12	0.04	10	4500	60	Yes	Yes	•	•		
TSV611A/2A	SC70-5	1.5	5.5	0.12	0.04	10	800	60	Yes	Yes	•	•		
TSV6191/2	SC70-5	1.5	5.5	0.45	0.08	10	4500	60	Yes	Yes	•	•		
TSV6191A/2A	SC70-5	1.5	5.5	0.45	0.08	10	800	60	Yes	Yes	•	•		
TSV620/3/5	SC70-6	1.5	5.5	0.42	0.14	29	4000	69	Yes	Yes	•	•	•	
TSV620A/3A	SC70-6	1.5	5.5	0.42	0.14	29	800	69	Yes	Yes	•	•		
TSV621/2/4	SC70-5	1.5	5.5	0.42	0.14	29	4000	69	Yes	Yes	•	•	•	
TSV621A/2A/4A	SC70-5	1.5	5.5	0.42	0.14	29	800	69	Yes	Yes	•	•	•	
TSV6290/3	SC70-6	1.5	5.5	1.3	0.5	29	4000	69	Yes	Yes	•	•		
TSV6290A/3A	SC70-6	1.5	5.5	1.3	0.5	29	800	69	Yes	Yes	•	•		
TSV6291/2/4	SC70-5	1.5	5.5	1.3	0.5	29	4000	69	Yes	Yes	•	•	•	
TSV6291A/2A/4A	SC70-5	1.5	5.5	1.3	0.5	29	800	69	Yes	Yes	•	•	•	
TSV630/3/5	DFN8 2x2, DFN6 1.2x1.3x0.5, SC70-6	1.5	5.5	0.88	0.34	60	3000	69	Yes	Yes	•	•	•	
TSV630A/3A/5A	SC70-6	1.5	5.5	0.88	0.34	60	500	69	Yes	Yes	•	•	•	
TSV631/2/4	SC70-5	1.5	5.5	0.88	0.34	60	3000	69	Yes	Yes	•	•	•	✓
TSV631A/2A/4A	SC70-5	1.5	5.5	0.88	0.34	60	500	69	Yes	Yes	•	•	•	
TSV6390/3/5	SC70-6	1.5	5.5	2.4	1.1	60	3000	69	Yes	Yes	•	•	•	
TSV6390A/3A	SC70-6	1.5	5.5	2.4	1.1	60	500	69	Yes	Yes	•	•		
TSV6391/2/4	SC70-5	1.5	5.5	2.4	1.1	60	3000	69	Yes	Yes	•	•	•	
TSV6391A/2A/4A	SC70-5	1.5	5.5	2.4	1.1	60	500	69	Yes	Yes	•	•	•	
TSV711/2/4	SC70-5	1.5	5.5	0.12	0.06	10	200	45	Yes	Yes	•	•	•	
TSV731/2/4	SC70-5	1.5	5.5	0.9	0.35	60	200	52	Yes	Yes	•	•	•	
TSV851/2/4	SC70-5	2.3	5.5	1.3	0.7	180	4000	56	No	Yes	•	•	•	✓
TSV851A/2A/4A	SC70-5	2.3	5.5	1.3	0.7	180	800	56	No	Yes	•	•	•	✓
TSV991/2/4	DFN8 2x2	2.5	5.5	20	10	820	4500	35	Yes	Yes	•	•	•	✓
TSV991A/2A/4A	DFN8 2x2, DFN6 1.3x1.6x0.55, DFN6 1.3x1.6x0.4	2.5	5.5	20	10	820	1500	35	Yes	Yes	•	•	•	✓
TSZ121/2/4	SC70-5	1.8	5.5	0.4	0.19	31	5	17	Yes	Yes	•	•	•	✓
TSZ181/182	DFN6 1.2x1.3x0.5	2.2	5.5	3	4.7	800	25	25	Yes	Yes	•	•		✓

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EMI HARDENED

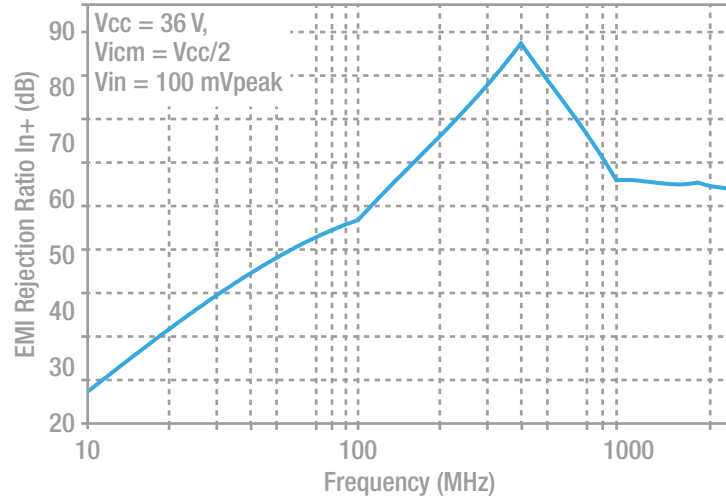
TSB572: low-power, 2.5 MHz, rail-to-rail input and output, 36 V operational amplifier

The TSB572 dual-channel 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 $^{\circ}\text{C}$
- Automotive grade
- Small SMD packages

EMI rejection ratio $V_{\text{CC}} = 36 \text{ V}$



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 $^{\circ}\text{C}$ (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	0.90	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	0.40	0.19	0.03	5	17	Yes	Yes	•	•	•	✓
TSZ181/182	2.2	5.5	3.00	4.70	0.80	25	25	Yes	Yes	•	•		✓
TSX561A/2A/4A	3.0	16.0	0.90	1.10	0.25	600	90	Yes	Yes	•	•	•	✓
TSX631A/2A/4A	3.3	16.0	0.20	0.12	0.05	500	90	Yes	Yes	•	•	•	✓
TSX711A/2	2.7	16.0	2.70	1.20	0.66	100	54	Yes	Yes	•	•		✓
TSB571/2	4.0	36.0	2.50	1.00	0.38	1500	60	Yes	Yes	•	•		✓

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



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.

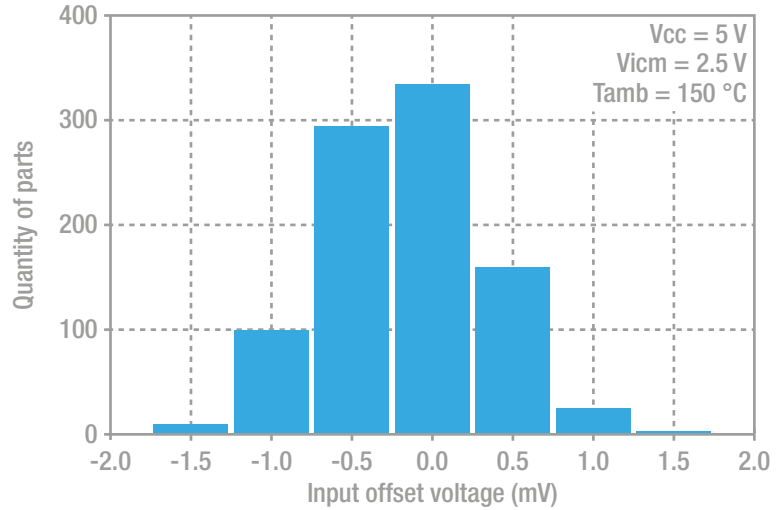
FEATURES

- Rail-to-rail input and output
- Wide bandwidth
- Low power consumption: 820 μ A (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 \geq 5 kV HBM
- SO8 package
- AEC-Q100 qualified

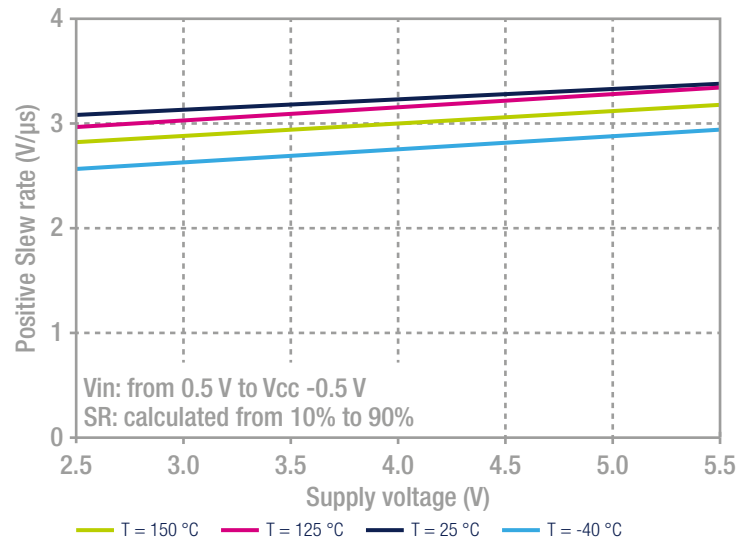
APPLICATION

- 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, S08, Mini-S08	•	✓
TSV912H	8	4.5	2.5	5.5	0.82	Yes	Yes	-40 to +150 °C	S08	•	✓

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.

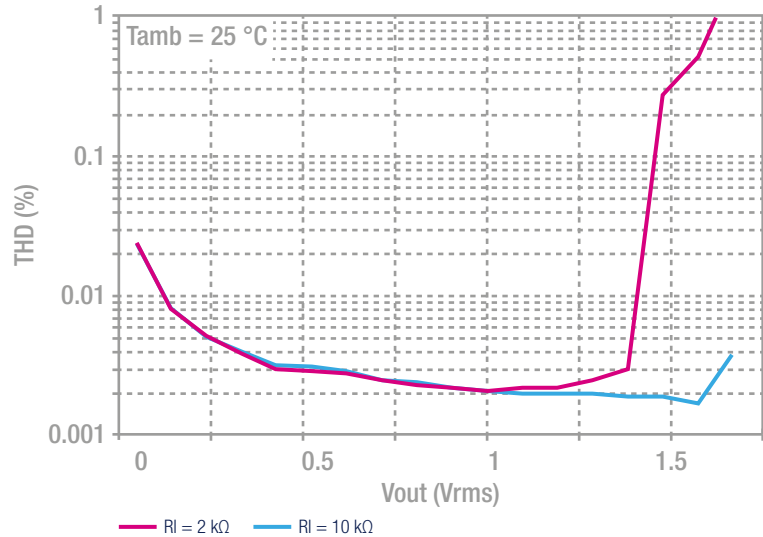
FEATURES

- Rail-to-rail output voltage swing ± 2.4 V at $V_{CC} = \pm 2.5$ V
- Very low noise level: 4 nV/ $\sqrt{\text{Hz}}$
- Ultra-low distortion: 0.003%
- High dynamic features: 12 MHz, 4 V/ μs
- Supply voltage: 2.7 to 10 V, ± 1.35 to 5 V
- ESD protection: 2 kV HBM
- Latch-up immunity (Class A)

APPLICATIONS

- Portable and handheld devices
- 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/ $\sqrt{\text{Hz}}$)	Rail to rail Out	Operating temp. Range (°C)	Package
Audio amplifiers														
TS461/2/4	12	4	0.003	2.7	10	2	80	•	•	•	4	Yes	-20 to 70	SOT23-5, S08, Mini-S08, TSSOP8, S014, TSSOP14
TS921/2A/4A	4	1.3	0.005	2.7	12	1	91	•	•	•	9	Yes	-40 to +125	Flip-chip, S08, TSSOP8, S014, TSSOP14
TS971/2/4	12	4	0.003	2.7	10	2	80	•	•	•	4	Yes	-40 to +125	SOT23-5, S08, DFN8, TSSOP8, S014, TSSOP14
MC33078/9	15	7	0.002	5	30	2	100		•	•	4.5	No	-40 to +125	S08, S014



CLASS AB, CLASS D & HEADPHONE AMPLIFIERS

TS488: pop-free 120 mW stereo headphone amplifier

The TS488 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 is configured by external gain-setting resistors.

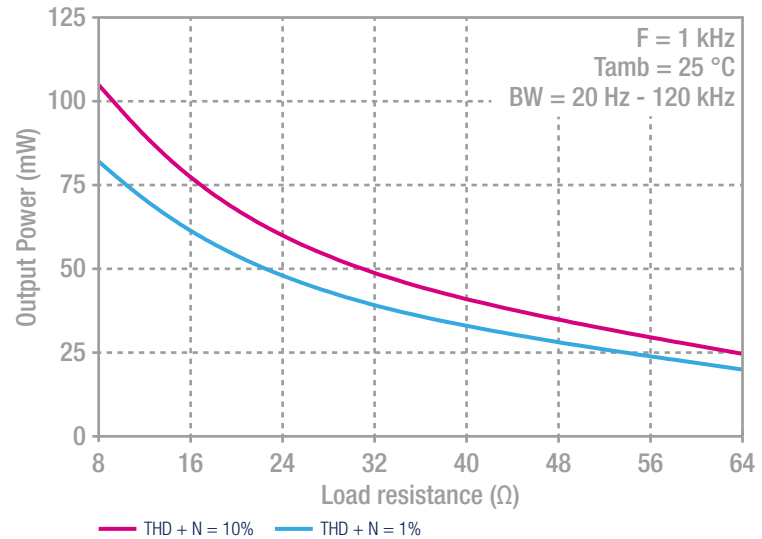
FEATURES

- 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 (1 kHz)
- Short-circuit protection circuitry
- DFN8 package

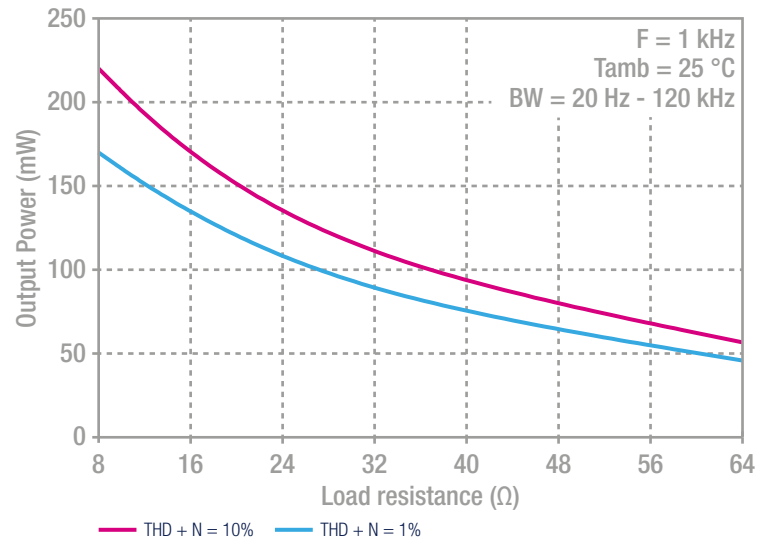
APPLICATIONS

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

Output power vs. load resistance $V_{CC} = 3.3$ V



Output power vs. load resistance $V_{CC} = 5$ 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. Stdbby I_{CC} (μ A)	Package
	@ 1% THD V_{CC} max (W)	@ 10% THD V_{CC} max (W)										
Class AB audio Low power amplifiers												
TS4871/ TS4890	1.28 W into 4 Ω 1 W into 8 Ω	2.08 W into 4 Ω 1.45 W into 8 Ω	2.5	5.5	Single-ended	Mono	6	97	External res	Yes	1	S08, Mini-S08
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	External res		1	S08, Mini-S08, 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	External res		1	DFN10 3x3, Mini-S08
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	External res/ 6 dB	1		Flip-chip9	
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	Single-ended	Stereo	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	6.0	98	External res	Yes	1	Mini-S08, 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		5.5	110	External res	N/A		S08, Mini-S08	
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		Stereo	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/ TS4621ML	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 ² C/ Dedicated pin		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	2.3 W into 4 Ω 1.4 W into 8 Ω	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, 18, 24 dB		2	Flip-chip16
TS4962	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		1	DFN8 2x2
TS4962M	2.3 W into 4 Ω 1.4 W into 8 Ω	3 W into 4 Ω 1.75 W into 8 Ω	2.4	5.5		Stereo	2.3	85	External res		2	Flip-chip9



CURRENT-SENSE AMPLIFIERS

TSC2011: high-voltage, precision, bidirectional current-sense amplifier

A precision bidirectional current sense amplifier, the TSC2011 can sense the current thanks to a shunt resistor over a wide range of common mode voltages, from -20 to +70 V, regardless of the supply voltage. It is available with an amplifier gain of 60 V/V.

It is able to sense very low drop voltages as low as 10 mV full scale minimizing the measurement error.

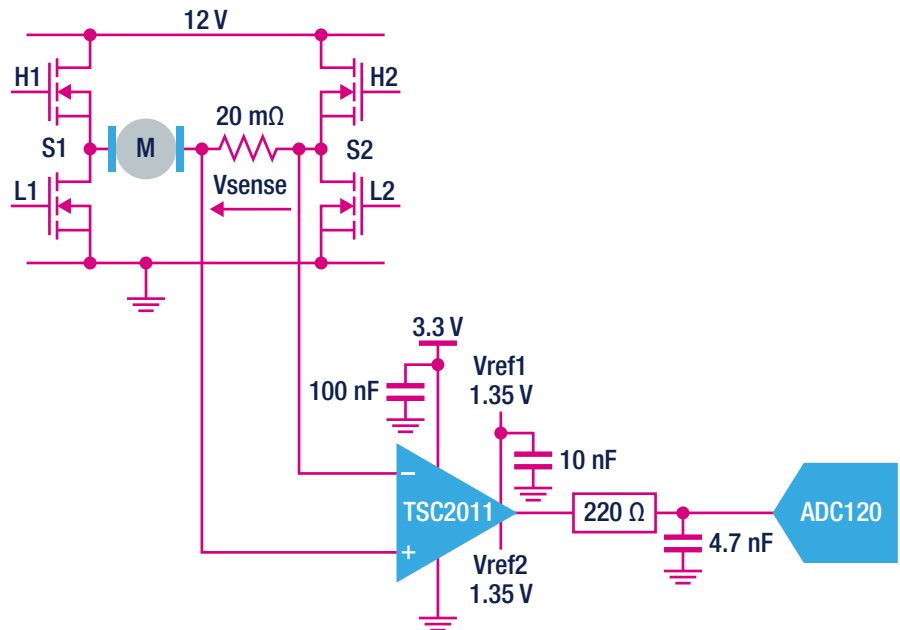
The TSC2011 can also be used in other functions including precision current measurement, overcurrent protection, current monitoring, and feedback loops.

FEATURES

- Wide common mode voltage: -20 to 70 V
- Offset voltage: $\pm 200 \mu\text{V}$ (maximum)
- 2.7 to 5.5 V supply voltage
- Gain: 60 V/V
- Gain error: 0.3% (maximum)
- Offset drift: $5 \mu\text{V}/^\circ\text{C}$ (maximum)
- Gain drift: 10 ppm/ $^\circ\text{C}$ (maximum)
- Quiescent current: 20 μA in Shutdown mode
- SO8 and Mini-SO8 package

APPLICATIONS

- Automotive current monitoring
- High-side current sensing
- Low-side current sensing
- Data acquisition and instrumentation
- Test and measurement equipment
- Industrial process control
- Motor control
- Solenoid control



Part number	Type	V _{io} (mV) Max.	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	Unidirectional	1.5	300	2.8	30	4	24	20, 50, 100	-40	125	SOT23-5	✓
TSC888	Unidirectional	-	1000	2.8	24	4	24	20, 50, 100	-40	125	SOT23-5	
TSC102	Unidirectional	1.5	420	2.8	30	3.5	5.5	Adjustable	-40	125	TSSOP8, S08	✓
TSC1021	Unidirectional	1.5	300	2.8	30	3.5	5.5	20, 50	-40	125	TSSOP8	✓
TSC103	Unidirectional	0.5	360	2.9	70	2.7	5.5	20, 25, 50, 100	-40	125	TSSOP8, S08	✓
TSC1031	Unidirectional	0.5	360	2.9	70	2.7	5.5	50, 100	-40	125	TSSOP8, S08	✓
TSC2011	Bidirectional	0.2	1500	-20.0	70	2.7	5.5	60	-40	125	S08, Mini-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
STEVAL-AETKT1V1	High-side current-sense amplifier demonstration board based on TSC2011	





Comparators



MICROPOWER

TS880/3: 0.9 V rail-to-rail nanopower comparators

The open-drain series of nanopower comparators integrates a single-channel TS880 and a dual-channel TS883. They feature an ultra-low supply current of 250 nA typical per operator with rail-to-rail input capability and open-drain output. The performance of these comparators allows them to be used in a wide range of portable applications. The TS880 and TS883 minimize battery supply leakage and therefore enhance battery lifetime.

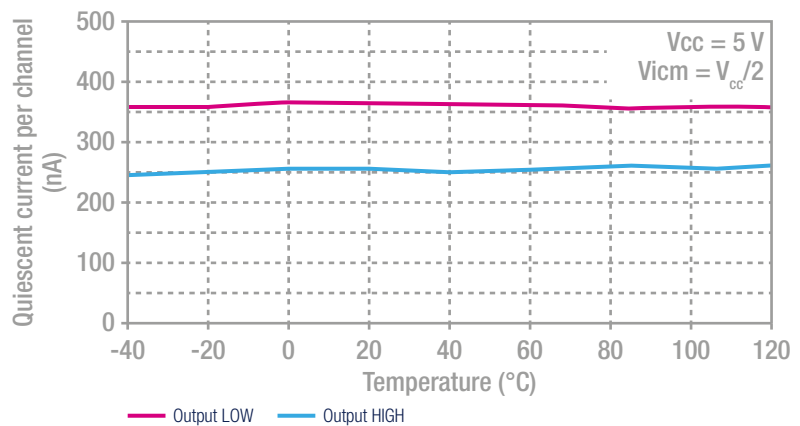
FEATURES

- 900 nA per channel at 25 °C
- Ultra low current consumption: 250 nA typ./op.
- Propagation delay: 2 μs (typical)
- Rail-to-rail inputs
- Open-drain outputs
- Supply operation from 0.9 to 5.5 V
- Wide temperature range: -40 to +125 °C
- ESD tolerance: 8 kV HBM
- Single version available in SC70-5 and SOT23-5 package
- Dual version available in Mini-SO8 and DFN8 2x2 mm package

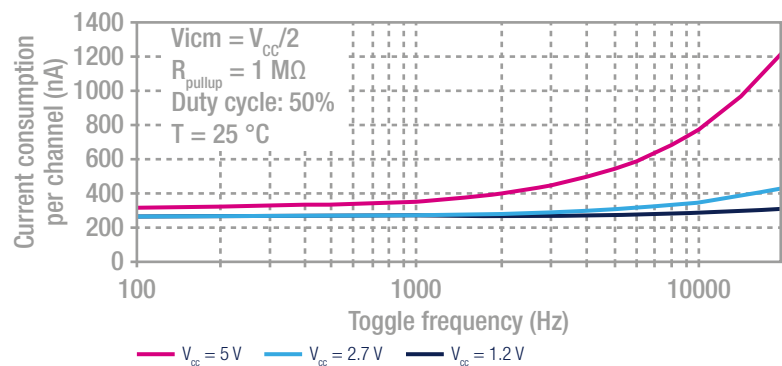
APPLICATIONS

- Portable systems
- Signal conditioning
- Medical

Current consumption vs. temperature



Current consumption 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	Temperature range (°C)	Rail to rail In	Output type	Input type	Single	Dual	Quad	Automotive grade
Nanopower												
TS881	0.21	0.85	5.5	2600	-40 to 125	Yes	Push-pull	CMOS	•			
TS882/4	0.21	1.1	5.5	2600	-40 to 125	Yes	Push-pull	CMOS			•	
TS880/3*	0.25	0.9	5.5	2000	-40 to 125	Yes	Open drain	CMOS	•	•		
Micropower												
TS331/2/4	20	1.6	5	270	-40 to 125	Yes	Open drain	BIP	•	•	•	✓
TS7211	6	2.7	10	400	-40 to 85	Yes	Push-pull	CMOS	•			
TS7221	6	2.7	10	400	-40 to 85	Yes	Open drain	CMOS	•			
TS861/2/4	6	2.7	10	400	-40 to 85	Yes	Push-pull	CMOS	•	•	•	
TSX3702/4	5	2.7	16	340	-40 to 125	No	Push-pull	CMOS		•	•	✓
TSX393/339	5	2.7	16	550	-40 to 125	No	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-channel 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 micropower 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.

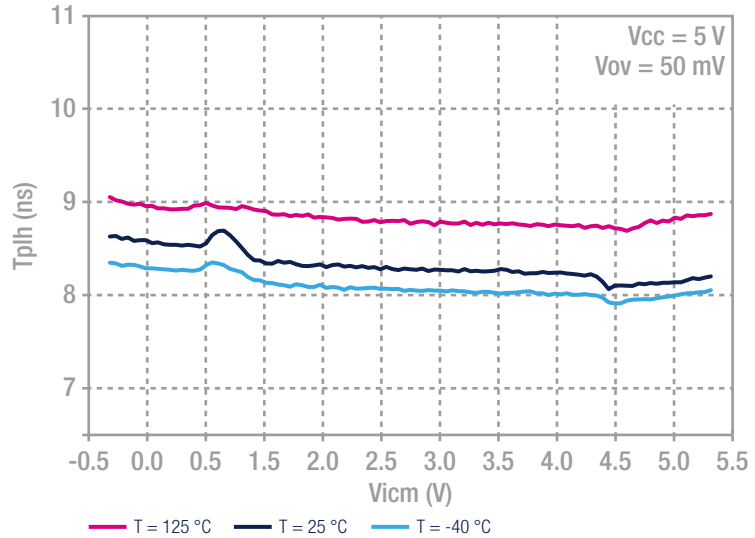
FEATURES

- 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

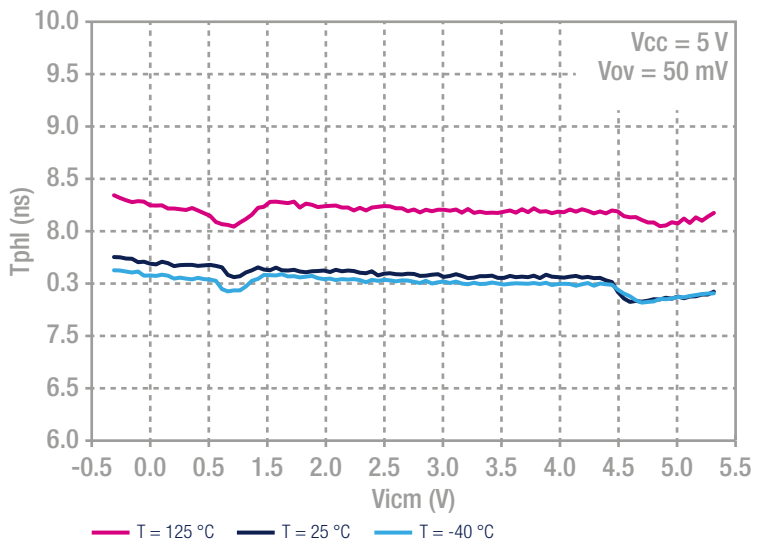
APPLICATIONS

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

Propagation delay vs. common mode voltage with negative transition

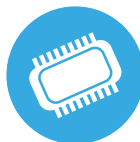


Propagation delay vs. common mode voltage with positive transition



Part number	Typ. I_{cc} per channel (μA)	Min. V_{cc} (V)	Max. V_{cc} (V)	Typ. response time (ns) 100 mV overdrive	Temperature range (°C)	Rail to rail In	Output type	Input type	Single	Dual	Quad	Automotive grade
Ultra high speed												
TS3011	470	2.2	5	8	-40 to 125	Yes	Push-pull	CMOS	•			✓
High speed												
TS3021/2	73	1.8	5	42	-40 to 125	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 micropower CMOS dual- and quad-channel voltage comparators which exhibit a very low current consumption of 5 μ A typical per comparator. With an improved design over the TS3704, these devices show 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 S08 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. Open-drain output versions are also available (TSX339 and TSX393).

FEATURES

- Low supply current: 5 μ A (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: $10^{12} \Omega$ (typ.)
- Fast response time: 2.7 μ s (typ.) for 5 mV overdrive
- ESD tolerance: 4 kV HBM, 200 V MM
- AEC-Q100 qualified

APPLICATIONS

- Automotive & industrial

Part number	Package (mm)	Typ. I_{cc} per channel (μ A)	Min. V_{cc} (V)	Max. V_{cc} (V)	Typ. response time (ns) 100 mV overdrive	Temperature range ($^{\circ}$ C)	Rail to rail In	Output type	Single	Dual	Quad	Automotive grade
Small packages												
TS881	SC70-5	0.21	0.85	5.5	2600	-40 to 125	Yes	Push-pull	•			
TS882/4	DFN8 2x2, QFN16 3x3	0.21	1.1	5.5	2600	-40 to 125	Yes	Push-pull		•	•	
TS880/3*	SC70-5, DFN8 2x2	0.25	0.9	5.5	2000	-40 to 125	Yes	Open drain	•	•		
TS331/2/4	SC70-5, DFN6 1.2x1.3, DFN8 2x2, QFN16 3x3	20	1.6	5	270	-40 to 125	Yes	Open drain	•	•	•	✓
TSX3702/4	DFN8 2x2, QFN16 3x3	5	2.7	16	340	-40 to 125	No	Push-pull		•	•	✓
TSX393/339	DFN8 2x2, QFN16 3x3	5	2.7	16	550	-40 to 125	No	Open drain		•	•	✓
TS985	6-Bump CSP 1.2x0.8	13	1.8	5	420	-40 to 85	Yes	Push-pull	•			
TS391	SOT23-5, DFN8 2x2	200	2	36	300	-40 to 125	No	Open collector	•			✓
TS3011	SC70-5	470	2.2	5	8	-40 to 125	Yes	Push-pull	•			✓
TS3021	SC70-5	73	1.8	5	42	-40 to 125	Yes	Push-pull	•			✓
LM2901/3	DFN8 2x2, QFN16 3x3	200	2	36	500	-40 to 125	No	Open collector		•	•	✓
LMV331	SC70-5	20	2.7	5	275	-40 to 85	No	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-channel 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.

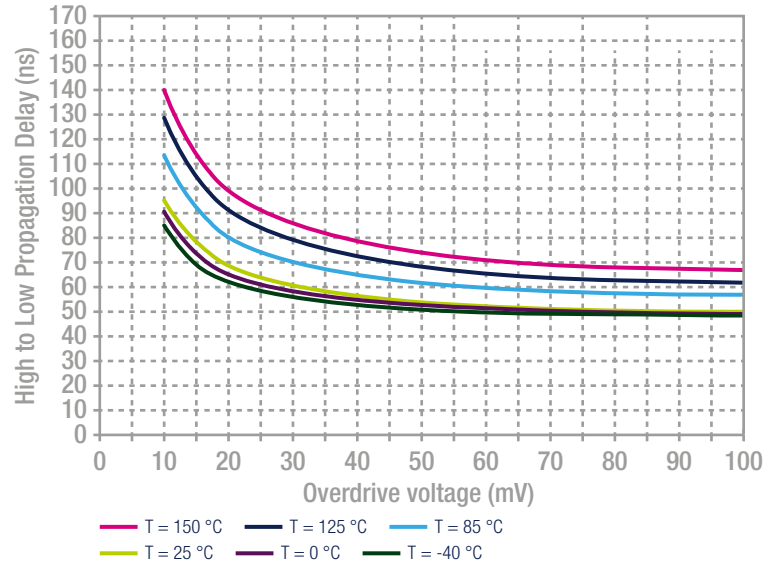
FEATURES

- Ultra-high temperature range: -40 to 150 °C
- Propagation delay: 38 ns
- Low current consumption: 73 μ A
- 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

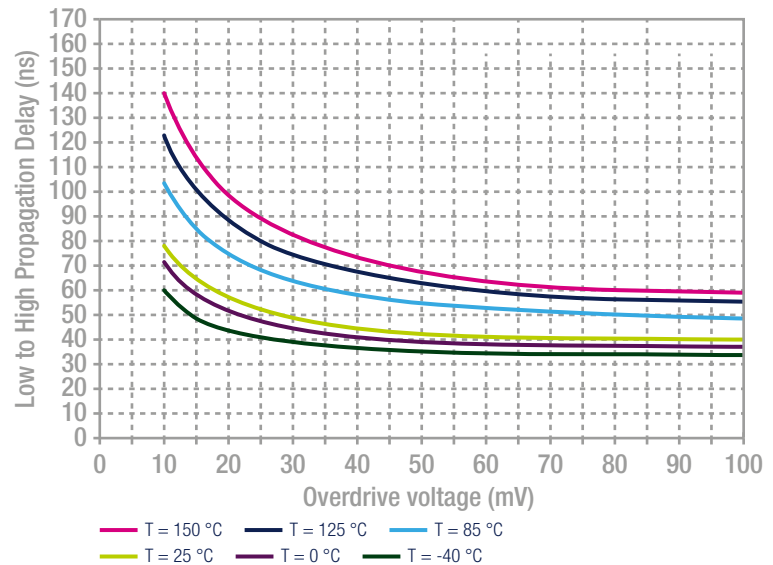
APPLICATIONS

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

Propagation delay (HL) vs. overdrive at $V_{cc} = 5$ V, $V_{icm} = V_{cc}$



Propagation delay (LH) vs. overdrive at $V_{cc} = 5$ V, $V_{icm} = 0$ V



Part number	Max. operating Temperature (°C)	Typ. I_{cc} per channel (μ A)	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	•			✓
LM2901H/3H	150	200	2	36	300	No	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 daily life. They are a key component for motion detection and can be used for security systems, automatic doors or automatic light. They are commonly used to detect humans. When someone is detected in a specified area, an action can be performed such as triggering an alarm or switching the lights on in a room, for example.

How does the sensor work?

The passive infrared sensors contain two parts that are sensitive to infrared. If both parts see the same amount of infrared light, the sensor won't detect anything. But, if one of these two parts detects more or less infrared light than the other, the sensor will trigger an output signal.

Figure 1 shows how the output voltage varies when a heat source enters or leaves an area protected by the sensor.

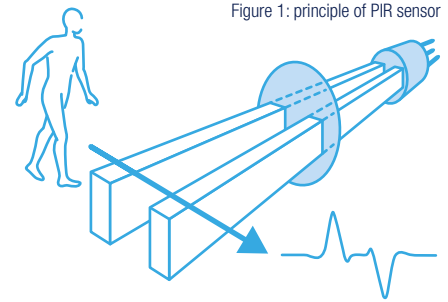


Figure 1: principle of PIR sensor

Sensor signal conditioning

When a body with a temperature different than the ambient moves within its field of detection, the PIR sensor triggers a small AC signal 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, noise filtering will also be helpful.

If we want to detect human motion, we have to consider frequencies from 0.5 to 5 Hz. In this article, the amplification and filtering of this frequency range is performed thanks to TSU102, a dual-channel op amp.

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's GBP must be greater than 2.7 kHz ($f_{max} \times gain \times 10 = 5 \times 53 \times 10 = 2.7 \text{ kHz}$). 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

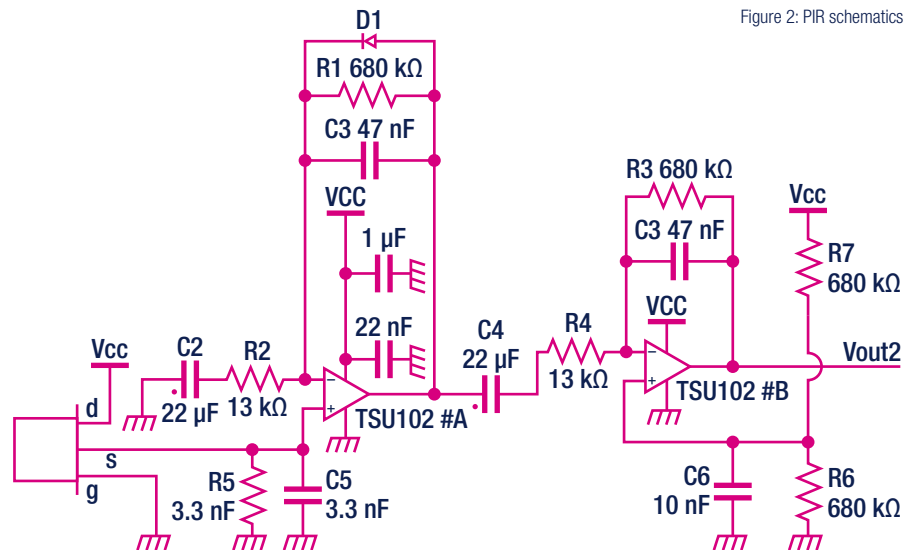


Figure 2: PIR schematics

requirement. In addition, since the DC is cancelled for motion detection, the op amp's accuracy, revealed thanks to V_{io} 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 all day. The schematic

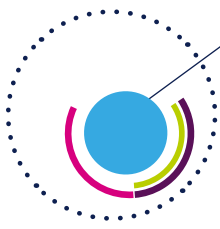
has been designed in order to optimize it. Here, the main consumption is the one due to the sensor. It consumes 19 μA . The rest of the application consumption is equal to 3.6 μA :

- 1.2 μA for the TSU102 op amp
- 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. A 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 can be used for a wide range of applications. Considered as piezoelectric elements, they are largely used in the consumer market as hard disk drive protection, but also used in the automotive sector for security, when window glass is hit and broken. These sensors can also be used for intelligent power management to maximize battery life for tire pressure monitoring system modules integrated in tire valves.

Charge amplifier configuration

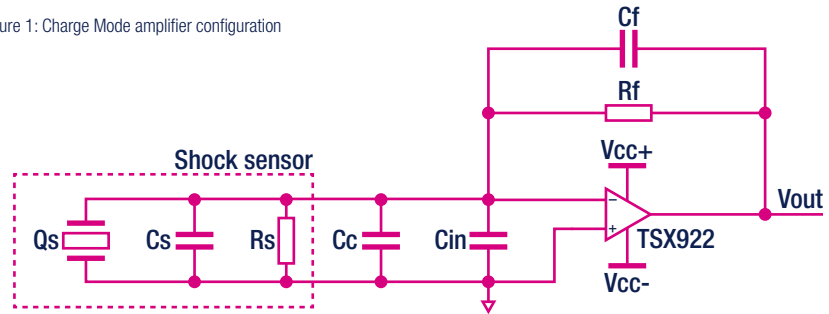
Charge mode sensors are typically used when the electronics are connected far from the sensor. In this case, we can use the configuration shown in Figure 1. The charge amplifier requires a low bias input current as it does not charge and discharge the gain capacitor, C_f , at high currents. Consequently, it is extremely important to choose a CMOS op amp such as the TSX922 which presents a very low input current, I_{in} , 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, C_f , and the resistance, R_f . The input charge, Q_s , is applied to the inverting input of the amplifier. It is distributed to the cable capacitance, C_c , the amplifier input capacitance, C_{in} , and the feedback capacitor, C_f .

$$Q_s = Q_{C_c} + Q_{C_{in}} + Q_{C_f} \quad (1)$$

By considering that $Q = CV$ we can write

$$Q_s = V_{in}(C_c + C_{in}) + V_f.C_f \quad (2)$$

Figure 1: Charge Mode amplifier configuration



Where V_{in} is the differential voltage of the op amp and V_f the voltage in the feedback loop. Thanks to the large gain of the op amp (AVD), and as $V_{out} = -V_f$, Equation 2 can be simplified as Equation 3:

$$V_{out} = -\frac{Q_s}{C_f} \quad (3)$$

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 C_s and C_c . The op amp amplifies this voltage as shown in Equation 4.

$$V_{out} = -\frac{Q_s}{C_s + C_c} * \left(1 + \frac{R_f}{R_g}\right) \quad (4)$$

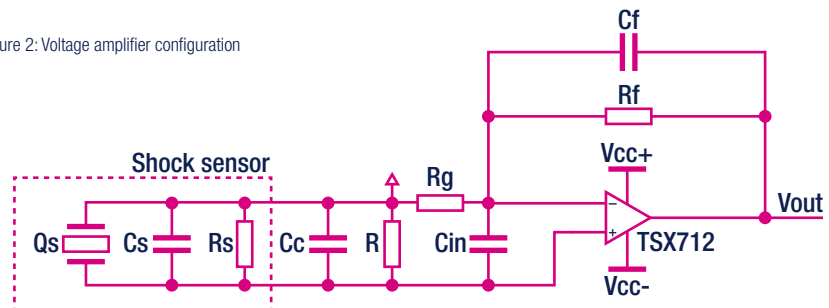
As the gain is related to the amount of capacitance seen by the sensor, the shock sensor must be connected as close as possible to the op amp in this configuration. This is because the parasitic capacitance of the cable, C_c , affects the actual gain (and the longer the cable, the higher this capacitance).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

Conclusion

A piezo electric accelerometer can be used as a shock sensor with either 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





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)

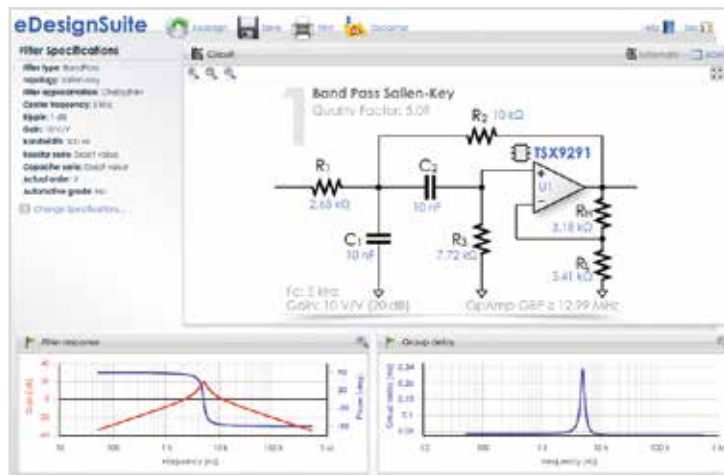
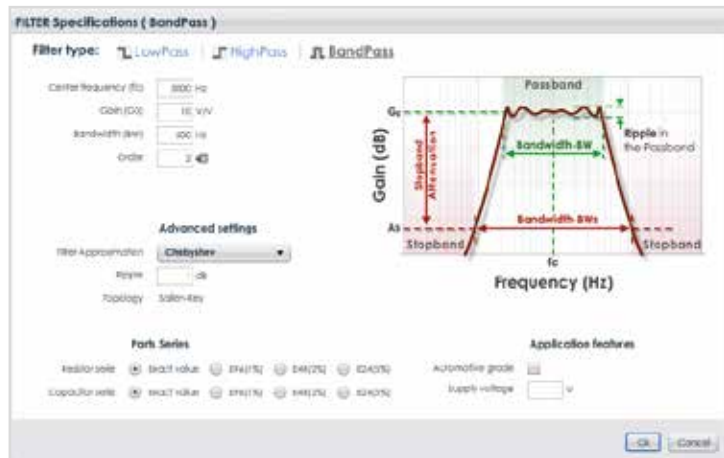
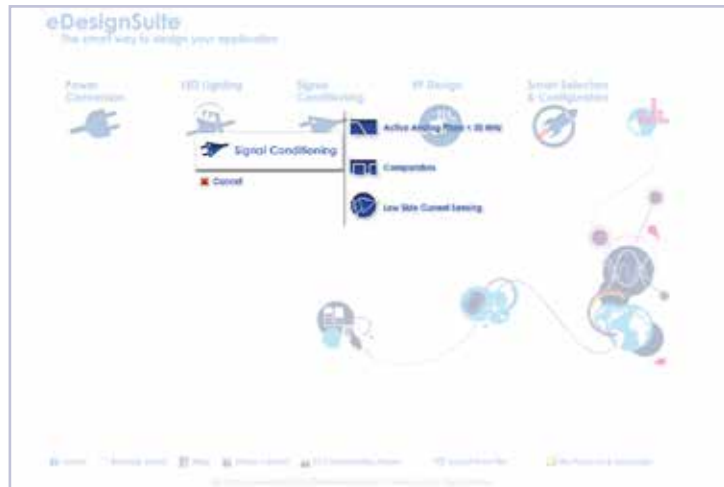
STEP 3 Select the desired filter performance (low pass/high pass/band pass)

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.

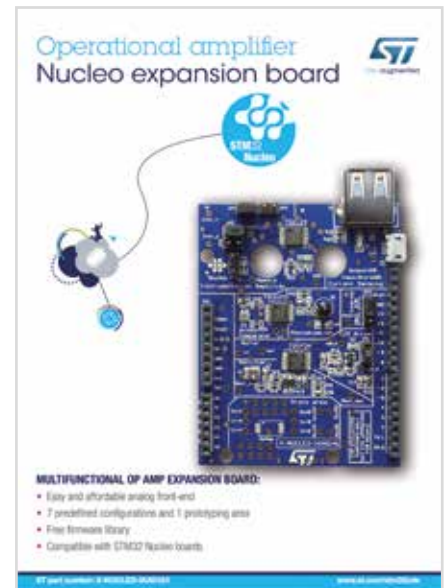
OP AMP NUCLEO EXPANSION BOARD

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



ELECTROCHEMICAL TOXIC GAS SENSOR EXPANSION BOARD

Get started with the P-NUCLEO-IKA02A1 for electrochemical toxic gas sensing

Tasteless and odorless, carbon monoxide is a highly toxic inhalant that can be lethal, which is why we need detectors to prevent intoxication risks. The P-NUCLEO-IKA02A1 pack is a ready-to-use CO detector including an STM32 Nucleo expansion board based on two TSU111 operational amplifiers and a Figaro TGS5141 CO sensor. Two TSU111 op amps provide signal conditioning; they are ideal for electrochemical sensing thanks to their high precision and low power consumption.

Information on how to obtain the board can be found at www.st.com/x-nucleo under the reference P-NUCLEO-IKA02A1.



BARE EVALUATION BOARDS

Designed for use with our dual-channel op amps, this collection of bare PCB evaluation boards lets you quickly prototype new circuits and reduce design time.

Get started with our **current sensing amplification stage configuration design tool** and **eDesignSuite smart simulator and system design engine**.

Order code	Description	Reference
STEVAL-CCA057V1	Evaluation board for dual-channel op amps in a S08 package	AN4495
STEVAL-CCA057V2	Evaluation board for dual-channel op amps in a Mini-S08 package	AN4574
STEVAL-CCA057V3	Evaluation board for dual-channel op amps in a Mini-S010 package	AN4575
STEVAL-CCA057V4	Evaluation board for dual-channel op amps in a DFN8 with exposed pad package	AN4576
STEVAL-CCA057V5	Evaluation board for dual-channel op amps in a DFN8 package	AN4577



ST op amps application

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



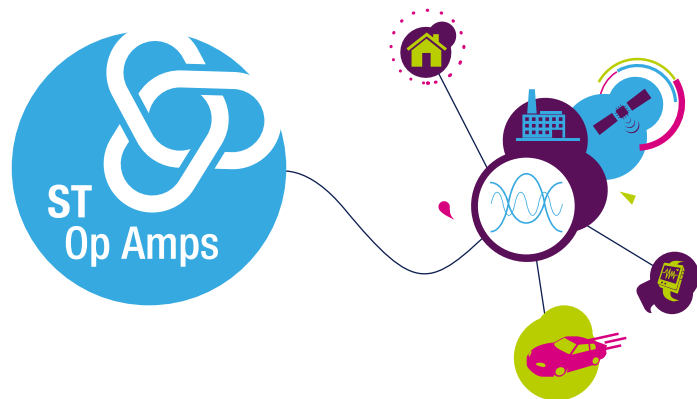
The (ST-OPAMPS-APP) is available free from App Store and Google Play to help engineers develop circuits using operational amplifiers and comparators which are frequently designed into audio, control, monitoring, automotive and communication systems.

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.

DOWNLOAD FROM THE APP STORE OR GOOGLE PLAY

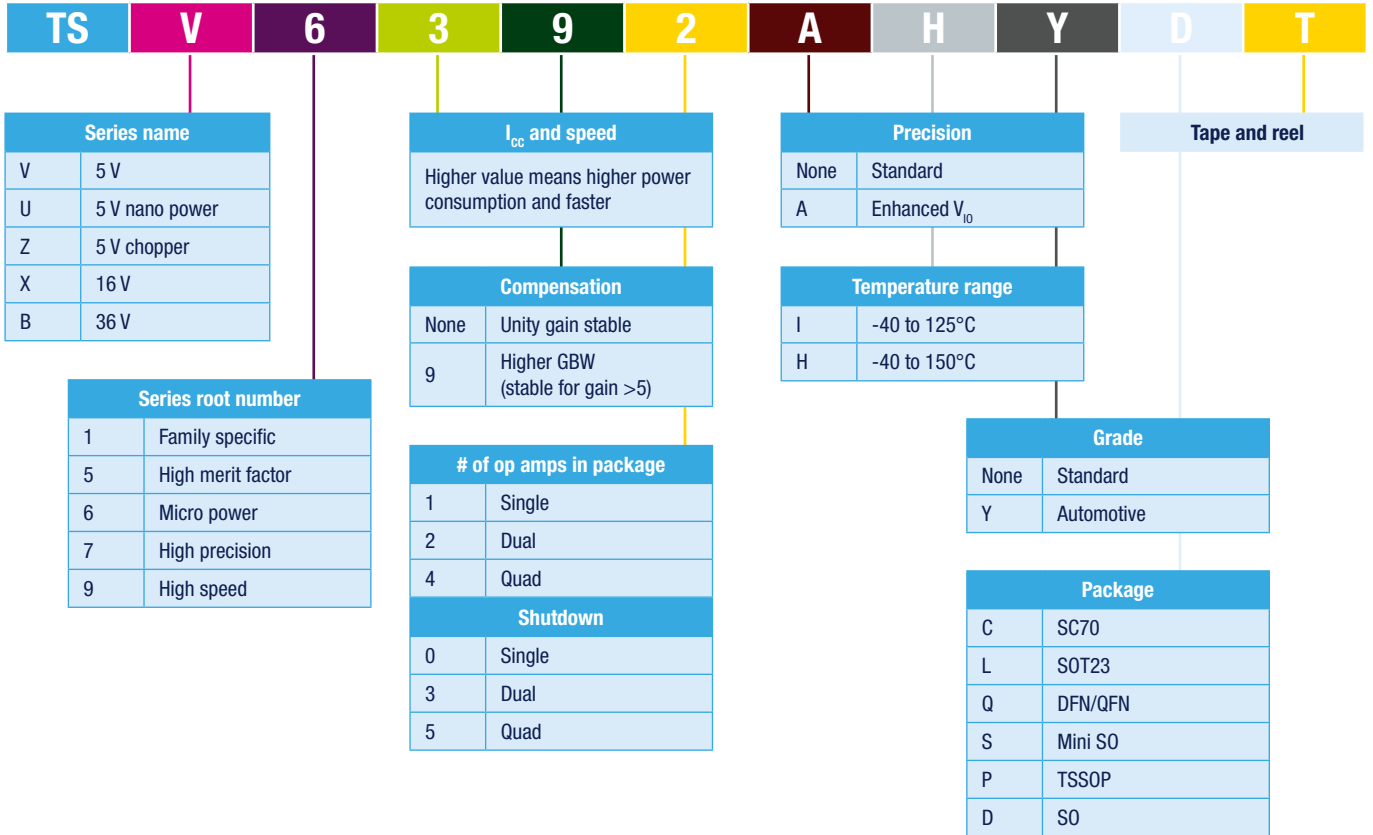


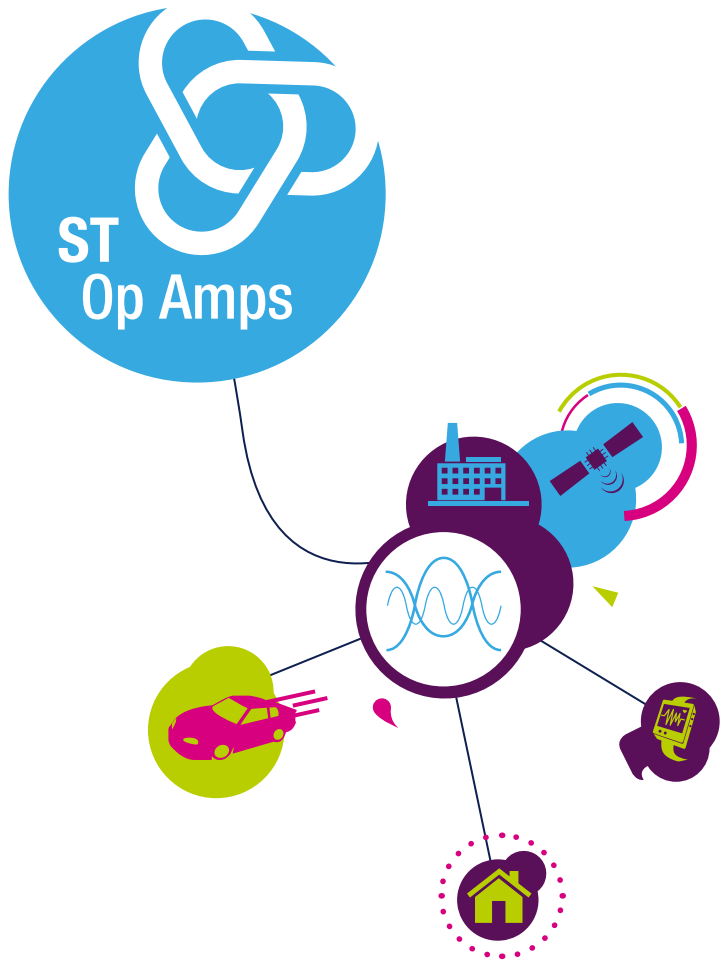
The ST Op Amps is available on Google Play and App Store www.st.com/opamps-app





ST op amps naming





life.augmented



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