

Apéndice 1 Circuitos Integrados Utilizados



Low Cost Low Power Instrumentation Amplifier

AD620

FEATURES

Easy to use

- Gain set with one external resistor (Gain range 1 to 10,000)
- Wide power supply range (± 2.3 V to ± 18 V)
- Higher performance than 3 op amp IA designs
- Available in 8-lead DIP and SOIC packaging
- Low power, 1.3 mA max supply current

Excellent dc performance (B grade)

- 50 μ V max, input offset voltage
- 0.6 μ V/ $^{\circ}$ C max, input offset drift
- 1.0 nA max, input bias current
- 100 dB min common-mode rejection ratio (G = 10)

Low noise

- 9 nV/ $\sqrt{\text{Hz}}$ @ 1 kHz, input voltage noise
- 0.28 μ V p-p noise (0.1 Hz to 10 Hz)

Excellent ac specifications

- 120 kHz bandwidth (G = 100)
- 15 μ s settling time to 0.01%

APPLICATIONS

- Weigh scales
- ECG and medical instrumentation
- Transducer interface
- Data acquisition systems
- Industrial process controls
- Battery-powered and portable equipment

CONNECTION DIAGRAM

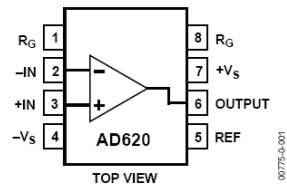


Figure 1. 8-Lead PDIP (N), CERDIP (Q), and SOIC (R) Packages

PRODUCT DESCRIPTION

The AD620 is a low cost, high accuracy instrumentation amplifier that requires only one external resistor to set gains of 1 to 10,000. Furthermore, the AD620 features 8-lead SOIC and DIP packaging that is smaller than discrete designs and offers lower power (only 1.3 mA max supply current), making it a good fit for battery-powered, portable (or remote) applications.

The AD620, with its high accuracy of 40 ppm maximum nonlinearity, low offset voltage of 50 μ V max, and offset drift of 0.6 μ V/ $^{\circ}$ C max, is ideal for use in precision data acquisition systems, such as weigh scales and transducer interfaces. Furthermore, the low noise, low input bias current, and low power of the AD620 make it well suited for medical applications, such as ECG and noninvasive blood pressure monitors.

The low input bias current of 1.0 nA max is made possible with the use of Super β processing in the input stage. The AD620 works well as a preamplifier due to its low input voltage noise of 9 nV/ $\sqrt{\text{Hz}}$ at 1 kHz, 0.28 μ V p-p in the 0.1 Hz to 10 Hz band, and 0.1 pA/ $\sqrt{\text{Hz}}$ input current noise. Also, the AD620 is well suited for multiplexed applications with its settling time of 15 μ s to 0.01%, and its cost is low enough to enable designs with one in-amp per channel.

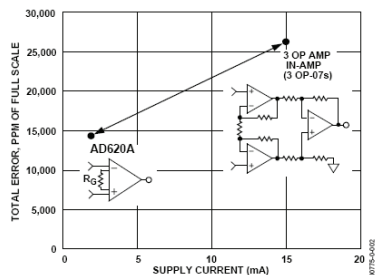


Figure 2. Three Op Amp IA Designs vs. AD620

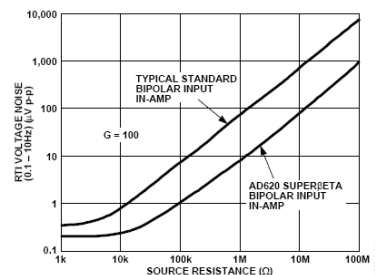


Figure 3. Total Voltage Noise vs. Source Resistance

Rev. G

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SPECIFICATIONS

Typical @ 25°C, $V_S = \pm 15$ V, and $R_L = 2$ k Ω , unless otherwise noted.

Table 1.

Parameter	Conditions	AD620A			AD620B			AD620S ¹			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
GAIN											
	$G = 1 + (49.4 \text{ k}\Omega/R_G)$	1			1			1			
Gain Range		10,000			10,000			10,000			
Gain Error ²	$V_{OUT} = \pm 10$ V										
G = 1		0.03 0.10			0.01 0.02			0.03 0.10			%
G = 10		0.15 0.30			0.10 0.15			0.15 0.30			%
G = 100		0.15 0.30			0.10 0.15			0.15 0.30			%
G = 1000		0.40 0.70			0.35 0.50			0.40 0.70			%
Nonlinearity											
	$V_{OUT} = -10$ V to $+10$ V										
G = 1–1000	$R_L = 10$ k Ω	10 40			10 40			10 40			ppm
G = 1–100	$R_L = 2$ k Ω	10 95			10 95			10 95			ppm
Gain vs. Temperature											
	G = 1	10			10			10			ppm/°C
	Gain > 1 ²	–50			–50			–50			ppm/°C
VOLTAGE OFFSET											
(Total RTI Error = $V_{OSI} + V_{OSO}/G$)											
Input Offset, V_{OSI}	$V_S = \pm 5$ V to ± 15 V	30 125			15 50			30 125			μ V
Overtemperature	$V_S = \pm 5$ V to ± 15 V	185			85			225			μ V
Average TC	$V_S = \pm 5$ V to ± 15 V	0.3 1.0			0.1 0.6			0.3 1.0			μ V/°C
Output Offset, V_{OSO}	$V_S = \pm 15$ V	400 1000			200 500			400 1000			μ V
Overtemperature	$V_S = \pm 5$ V	1500			750			1500			μ V
Average TC	$V_S = \pm 5$ V to ± 15 V	2000			1000			2000			μ V
Average TC	$V_S = \pm 5$ V to ± 15 V	5.0 15			2.5 7.0			5.0 15			μ V/°C
Offset Referred to the Input vs. Supply (PSR)											
	$V_S = \pm 2.3$ V to ± 18 V										
G = 1		80 100			80 100			80 100			dB
G = 10		95 120			100 120			95 120			dB
G = 100		110 140			120 140			110 140			dB
G = 1000		110 140			120 140			110 140			dB
INPUT CURRENT											
Input Bias Current		0.5 2.0			0.5 1.0			0.5 2			nA
Overtemperature		2.5			1.5			4			nA
Average TC		3.0			3.0			8.0			pA/°C
Input Offset Current		0.3 1.0			0.3 0.5			0.3 1.0			nA
Overtemperature		1.5			0.75			2.0			nA
Average TC		1.5			1.5			8.0			pA/°C
INPUT											
Input Impedance											
Differential		10 2			10 2			10 2			G Ω _pF
Common-Mode		10 2			10 2			10 2			G Ω _pF
Input Voltage Range ³	$V_S = \pm 2.3$ V to ± 5 V	$-V_S + 1.9$ $+V_S - 1.2$			$-V_S + 1.9$ $+V_S - 1.2$			$-V_S + 1.9$ $+V_S - 1.2$			V
Overtemperature		$-V_S + 2.1$ $+V_S - 1.3$			$-V_S + 2.1$ $+V_S - 1.3$			$-V_S + 2.1$ $+V_S - 1.3$			V
	$V_S = \pm 5$ V to ± 18 V	$-V_S + 1.9$ $+V_S - 1.4$			$-V_S + 1.9$ $+V_S - 1.4$			$-V_S + 1.9$ $+V_S - 1.4$			V
Overtemperature		$-V_S + 2.1$ $+V_S - 1.4$			$-V_S + 2.1$ $+V_S + 2.1$			$-V_S + 2.3$ $+V_S - 1.4$			V

AD620

Parameter	Conditions	AD620A			AD620B			AD620S ¹			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Common-Mode Rejection											
Ratio DC to 60 Hz with 1 k Ω Source Imbalance	$V_{CM} = 0\text{ V to } \pm 10\text{ V}$										
G = 1		73	90		80	90		73	90		dB
G = 10		93	110		100	110		93	110		dB
G = 100		110	130		120	130		110	130		dB
G = 1000		110	130		120	130		110	130		dB
OUTPUT											
Output Swing	$R_L = 10\text{ k}\Omega$ $V_S = \pm 2.3\text{ V}$ to $\pm 5\text{ V}$	$-V_S + 1.1$	$+V_S - 1.2$		$-V_S + 1.1$	$+V_S - 1.2$		$-V_S + 1.1$	$+V_S - 1.2$		V
Overtemperature		$-V_S + 1.4$	$+V_S - 1.3$		$-V_S + 1.4$	$+V_S - 1.3$		$-V_S + 1.6$	$+V_S - 1.3$		V
Overtemperature	$V_S = \pm 5\text{ V}$ to $\pm 18\text{ V}$	$-V_S + 1.2$	$+V_S - 1.4$		$-V_S + 1.2$	$+V_S - 1.4$		$-V_S + 1.2$	$+V_S - 1.4$		V
Short Circuit Current		$-V_S + 1.6$	$+V_S - 1.5$		$-V_S + 1.6$	$+V_S - 1.5$		$-V_S + 2.3$	$+V_S - 1.5$		V
			± 18			± 18			± 18		mA
DYNAMIC RESPONSE											
Small Signal -3 dB Bandwidth											
G = 1			1000			1000			1000		kHz
G = 10			800			800			800		kHz
G = 100			120			120			120		kHz
G = 1000			12			12			12		kHz
Slew Rate		0.75	1.2		0.75	1.2		0.75	1.2		V/ μ s
Settling Time to 0.01%											
G = 1-100	10 V Step		15			15			15		μ s
G = 1000			150			150			150		μ s
NOISE											
Voltage Noise, 1 kHz											
$Total\ RTI\ Noise = \sqrt{(e_{ni}^2) + (e_{no}/G)^2}$											
Input, Voltage Noise, e_{ni}			9	13		9	13		9	13	nV/ $\sqrt{\text{Hz}}$
Output, Voltage Noise, e_{no}			72	100		72	100		72	100	nV/ $\sqrt{\text{Hz}}$
RTI, 0.1 Hz to 10 Hz											
G = 1			3.0			3.0	6.0		3.0	6.0	μ V p-p
G = 10			0.55			0.55	0.8		0.55	0.8	μ V p-p
G = 100-1000			0.28			0.28	0.4		0.28	0.4	μ V p-p
Current Noise											
0.1 Hz to 10 Hz	$f = 1\text{ kHz}$		100			100			100		fA/ $\sqrt{\text{Hz}}$
			10			10			10		pA p-p
REFERENCE INPUT											
R_{IN}			20			20			20		k Ω
I_{IN}	$V_{IN+}, V_{REF} = 0$		50	60		50	60		50	60	μ A
Voltage Range		$-V_S + 1.6$	$+V_S - 1.6$		$-V_S + 1.6$	$+V_S - 1.6$		$-V_S + 1.6$	$+V_S - 1.6$		V
Gain to Output		1 ± 0.0001			1 ± 0.0001			1 ± 0.0001			
POWER SUPPLY											
Operating Range ⁴											
		± 2.3	± 18		± 2.3	± 18		± 2.3	± 18		V
Quiescent Current	$V_S = \pm 2.3\text{ V}$ to $\pm 18\text{ V}$		0.9	1.3		0.9	1.3		0.9	1.3	mA
Overtemperature			1.1	1.6		1.1	1.6		1.1	1.6	mA
TEMPERATURE RANGE											
For Specified Performance			-40 to +85			-40 to +85			-55 to +125		$^{\circ}\text{C}$

¹ See Analog Devices military data sheet for 883B tested specifications.

² Does not include effects of external resistor R_G .

³ One input grounded. $G = 1$.

⁴ This is defined as the same supply range that is used to specify PSR.

ABSOLUTE MAXIMUM RATINGS

Table 2.

Parameter	Rating
Supply Voltage	± 18 V
Internal Power Dissipation ¹	650 mW
Input Voltage (Common-Mode)	$\pm V_s$
Differential Input Voltage	25 V
Output Short-Circuit Duration	Indefinite
Storage Temperature Range (Q)	-65°C to +150°C
Storage Temperature Range (N, R)	-65°C to +125°C
Operating Temperature Range	
AD620 (A, B)	-40°C to +85°C
AD620 (S)	-55°C to +125°C
Lead Temperature Range (Soldering 10 seconds)	300°C

Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

¹ Specification is for device in free air:
 8-Lead Plastic Package: $\theta_{JA} = 95^\circ\text{C}$
 8-Lead CERDIP Package: $\theta_{JA} = 110^\circ\text{C}$
 8-Lead SOIC Package: $\theta_{JA} = 155^\circ\text{C}$

ESD CAUTION

ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 4000 V readily accumulate on the human body and test equipment and can discharge without detection. Although this product features proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.



General purpose J-FET dual operational amplifiers

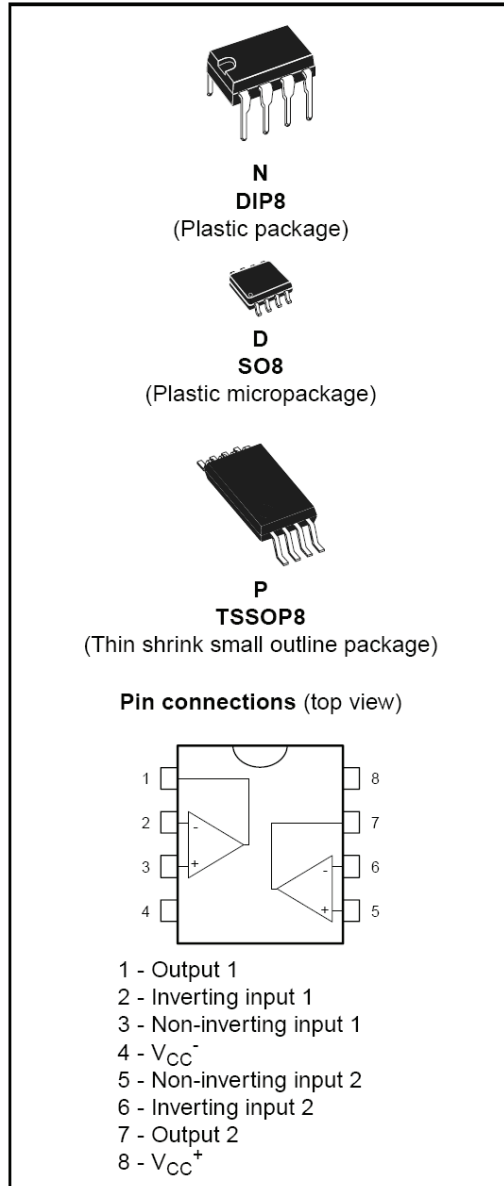
Features

- Wide common-mode (up to V_{CC}^+) and differential voltage range
- Low input bias and offset current
- Output short-circuit protection
- High input impedance J-FET input stage
- Internal frequency compensation
- Latch up free operation
- High slew rate: 16V/ μ s (typ)

Description

The TL082, TL082A and TL082B are high speed J-FET input dual operational amplifiers incorporating well matched, high voltage J-FET and bipolar transistors in a monolithic integrated circuit.

The devices feature high slew rates, low input bias and offset current, and low offset voltage temperature coefficient.



2 Absolute maximum ratings and operating conditions

Table 1. Absolute maximum ratings

Symbol	Parameter	TL082M, AM, BM	TL082I, AI, BI	TL082C, AC, BC	Unit
V_{CC}	Supply voltage ⁽¹⁾	±18			V
V_i	Input voltage ⁽²⁾	±15			V
V_{id}	Differential input voltage ⁽³⁾	±30			V
P_{tot}	Power dissipation	680			mW
R_{thja}	Thermal resistance junction to ambient ⁽⁴⁾				°C/W
	SO-8	125			
	DIP8	85			
	TSSOP8	120			
R_{thjc}	Thermal resistance junction to case				°C/W
	SO-8	40			
	DIP8	41			
	TSSOP8	37			
	Output short-circuit duration ⁽⁵⁾	Infinite			
T_{stg}	Storage temperature range	-65 to +150			°C
ESD	HBM: human body model ⁽⁶⁾	1			kV
	MM: machine model ⁽⁷⁾	200			V
	CDM: charged device model ⁽⁸⁾	1500			V

- All voltage values, except differential voltage, are with respect to the zero reference level (ground) of the supply voltages where the zero reference level is the midpoint between V_{CC}^+ and V_{CC}^- .
- The magnitude of the input voltage must never exceed the magnitude of the supply voltage or 15 volts, whichever is less.
- Differential voltages are the non-inverting input terminal with respect to the inverting input terminal.
- Short-circuits can cause excessive heating. Destructive dissipation can result from simultaneous short-circuit on all amplifiers.
- The output may be shorted to ground or to either supply. Temperature and/or supply voltages must be limited to ensure that the dissipation rating is not exceeded.
- Human body model: 100pF discharged through a 1.5kΩ resistor between two pins of the device, done for all couples of pin combinations with other pins floating.
- Machine model: a 200pF cap is charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5Ω), done for all couples of pin combinations with other pins floating.
- Charged device model: all pins plus package are charged together to the specified voltage and then discharged directly to the ground.

Table 2. Operating conditions

Symbol	Parameter	TL082M, AM, BM	TL082I, AI, BI	TL082C, AC, BC	Unit
V_{CC}	Supply voltage	6 to 36			V
T_{oper}	Operating free-air temperature range	-55 to +125	-40 to +105	0 to +70	°C



3 Electrical characteristics

Table 3. $V_{CC} = \pm 15V$, $T_{amb} = +25^{\circ}C$ (unless otherwise specified)

Symbol	Parameter	TL082I,M,AC,AI,A M,BC,BI,BM			TL082C			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
V_{io}	Input offset voltage ($R_S = 50\Omega$) $T_{amb} = +25^{\circ}C$ TL082 TL082A TL082B		3 3 1	10 6 3		3	10	mV
	$T_{min} \leq T_{amb} \leq T_{max}$ TL082 TL082A TL082B			13 7 5			13	
DV_{io}	Input offset voltage drift		10			10		$\mu V/^{\circ}C$
I_{io}	Input offset current ⁽¹⁾ $T_{amb} = +25^{\circ}C$		5	100		5	100	pA nA
	$T_{min} \leq T_{amb} \leq T_{max}$			4			10	
I_{ib}	Input bias current $T_{amb} = +25^{\circ}C$		20	200		20	400	pA nA
	$T_{min} \leq T_{amb} \leq T_{max}$			20			20	
A_{vd}	Large signal voltage gain ($R_L = 2k\Omega$, $V_o = \pm 10V$) $T_{amb} = +25^{\circ}C$	50	200		25	200		V/mV
	$T_{min} \leq T_{amb} \leq T_{max}$	25			15			
SVR	Supply voltage rejection ratio ($R_S = 50\Omega$) $T_{amb} = +25^{\circ}C$	80	86		70	86		dB
	$T_{min} \leq T_{amb} \leq T_{max}$	80			70			
I_{CC}	Supply current, no load $T_{amb} = +25^{\circ}C$		1.4	2.5		1.4	2.5	mA
	$T_{min} \leq T_{amb} \leq T_{max}$			2.5			2.5	
V_{icm}	Input common mode voltage range	± 11	+15 -12		± 11	+15 -12		V
CMR	Common mode rejection ratio ($R_S = 50\Omega$) $T_{amb} = +25^{\circ}C$	80	86		70	86		dB
	$T_{min} \leq T_{amb} \leq T_{max}$	80			70			
I_{os}	Output short-circuit current $T_{amb} = +25^{\circ}C$	10	40	60	10	40	60	mA
	$T_{min} \leq T_{amb} \leq T_{max}$	10		60	10		60	
$\pm V_{opp}$	Output voltage swing $T_{amb} = +25^{\circ}C$	10	12		10	12		V
	$RL = 2k\Omega$	12	13.5		12	13.5		
	$RL = 10k\Omega$	10			10			
	$T_{min} \leq T_{amb} \leq T_{max}$	10			10			
SR	Slew rate ($T_{amb} = +25^{\circ}C$) $V_{in} = 10V$, $R_L = 2k\Omega$, $C_L = 100pF$, unity gain	8	16		8	16		V/ μs



Table 3. $V_{CC} = \pm 15V$, $T_{amb} = +25^{\circ}C$ (unless otherwise specified) (continued)

Symbol	Parameter	TL082I,M,AC,AI,A M,BC,BI,BM			TL082C			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
t_r	Rise time ($T_{amb} = +25^{\circ}C$) $V_{in} = 20mV$, $R_L = 2k\Omega$, $C_L = 100pF$, unity gain		0.1			0.1		μs
K_{ov}	Overshoot ($T_{amb} = +25^{\circ}C$) $V_{in} = 20mV$, $R_L = 2k\Omega$, $C_L = 100pF$, unity gain		10			10		%
GBP	Gain bandwidth product ($T_{amb} = +25^{\circ}C$) $V_{in} = 10mV$, $R_L = 2k\Omega$, $C_L = 100pF$, $f = 100kHz$	2.5	4		2.5	4		MHz
R_i	Input resistance		10^{12}			10^{12}		Ω
THD	Total harmonic distortion ($T_{amb} = +25^{\circ}C$), $f = 1kHz$, $R_L = 2k\Omega$, $C_L = 100pF$, $A_v = 20dB$, $V_o = 2V_{pp}$		0.01			0.01		%
e_n	Equivalent input noise voltage $R_S = 100\Omega$, $f = 1KHz$		15			15		$\frac{nV}{\sqrt{Hz}}$
ϕ_m	Phase margin		45			45		degrees
V_{o1}/V_{o2}	Channel separation $A_v = 100$		120			120		dB

1. The input bias currents are junction leakage currents which approximately double for every $10^{\circ}C$ increase in the junction temperature.

Apéndice 2 Transductores Utilizados

Model 141 High Output Linear Accelerometer For Vibration, Shock, Impact

Ranges from: $\pm 2g$ to $\pm 600g$
With External R_{cal} Calibration



The Model 141 is a linear accelerometer that produces a high level instantaneous DC output signal proportional to sensed accelerations (ranging from static acceleration up to 3000 Hz as indicated below).

Setra accelerometers are unique in their ability to withstand exceedingly high g overload without damage. The Model 141 incorporates the super-rugged Setra capacitance-type sensor and a miniaturized electronic circuit.

Its excellent dynamic response is maintained by air damping, which varies with temperature

approximately one-tenth as much as the best fluid damping.

The electrical characteristics are compatible with conventional strain-gauge type signal conditioning, including the use of shunt R_{cal} over any selected range up to 100% full scale. The stainless steel case is O-ring sealed, has a well-defined base plane and is quite insensitive to mounting strain.

Cross axis interference is exceedingly low. The external easy-to-replace cable attachment facilitates installation and service.

Full Scale Ranges

For each of the available g ranges, the linearity is characterized by this range chart:
(Non-linearity as % full range, best straight line)

Nominal Range	Non-Linearity $\pm 1\%$	Natural Frequency (Nominal)	Flat Response (± 3 db) 0 Hz to:
$\pm 2g$	$\pm 2g$	300Hz	200Hz
$\pm 4g$	$\pm 4g$	440Hz	260Hz
$\pm 8g$	$\pm 8g$	570Hz	300Hz
$\pm 15g$	$\pm 15g$	840Hz	400Hz
$\pm 30g$	$\pm 30g$	1200Hz	700Hz
$\pm 60g$	$\pm 60g$	1560Hz	1000Hz
$\pm 150g$	$\pm 150g$	2600Hz	1600Hz
$\pm 600g$	$\pm 600g$	5000Hz	3000Hz

NOTE: Setra adheres to strict quality standards including ISO 9001 and ANSI-Z540-1. The calibration of this product is NIST traceable.

Features

- Excellent Static and Dynamic Response
- Temperature-Insensitive Gas Damping (0.7 Critical)
- High Output Signal
- High Overload Capability, (2000g static)
- Low Transverse Sensitivity (0.012 g/g)
- Wide-Range R_{cal} Type Calibration
- Easy-to-Replace Cable Attachment
- Compact, Lightweight
- Optional EMI Filter Upgrade
- Meets CE Conformance Standards

When it comes to a product to rely on, choose the Model 141.

When it comes to a company to trust, choose Setra .



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Model 141A and Model 141B Specifications

Performance Data

Non-Linearity (Best Fit Straight Line)	$\pm 1.0\%$ Full Scale
Hysteresis	0.10%
Non-Repeatability	0.05%
Transverse Acceleration Response	$< \pm 0.12$ g/g
Damping	Approximates second order system with 0.7 critical damping (Gas Squeeze-Film 0.7 ± 0.2 of critical at 77°F [25°C]). Damping ratio increases approximately 0.15%/°F.
Frequency Band	Flat from static to approx. 60% of natural frequency (all ranges)
Resolution	Infinite, limited only by output noise level
Thermal Effects	
Operating Temperature °F (°C)	-10 to +150 (-23 to +65)
Zero Shift	$< \pm 0.02\%$ Nominal Range/°F ($< \pm 0.36\%$ /°C)
Sensitivity Shift	$< \pm 0.02\%$ Nominal Range/°F ($< \pm 0.36\%$ /°C) Slightly higher thermal effects when 141A is operated at excitation voltage below 10 VDC
Zero G Output	$< \pm 25$ mV (factory calibrated at 10 VDC or 24 VDC excitation)
FS G Output	$< \pm 25\%$ of Nominal Output
Noise Level	$< \pm 0.01\%$ Nominal Range (RMS, in-band)

Performance Data (cont'd)

Calibration Data	Each unit is supplied with a computer generated plot of output vs. acceleration (centrifuge) at the specified excitation voltage.
Sensitivity	Reported at Nominal Range
Excitation Voltage	Model 141A calibrated at 10 VDC Model 141B calibrated at 24 VDC

Electrical Data

Electrical Circuit*	Three-Wire (Com. -Exc. -Out)
Isolation	100 M ohms
Internal Frequency	20 MHz approx.
Calibration Signal (R_{cal})	Available up to 100% Nominal Range by shunting external calibration resistor from calibration lead to -signal lead.
Excitation/Output**	141A 141B
Excitation Range	5-15 VDC 10-28VDC***
Excitation Voltage	10 VDC 24 VDC
Excitation Current	5 mA 10 mA
Nominal Output (open circuit)	± 500 mV ± 1000 mV
EMI/RFI Filtering	See Option 649

*Circuit is capacitively isolated from case. Power applied to output, or shorted output, will not damage unit. No reverse excitation protection.
 **Typical performance for nominal g range:
 Output is proportional to excitation voltage.
 Output impedance 9k ohms (nominal).
 ***Operable on 28 VDC aircraft power. (Recommend high voltage transient protection to prevent damage by emergency power conditions as defined in MIL-STD-704A, and voltage regulation to attain highest accuracy.)

Physical Description

Electrical Connection	2 foot multiconductor cable
Weight	30 grams (not including cable)
Case	Stainless steel, O-ring

Options

Option 620	Calibration at Special Excitation
Option 649	EMI/RFI Filter (MIL-STD-462)
Option 701	Wide Operating Temperature -65°F to +220°F (-54°C to +104°C)
Option 803-825	Up to 25 feet of cable can be supplied on your order; please specify cable length when ordering (e.g., 805 for 5ft. cable) Consult factory for cables longer than 25 feet.

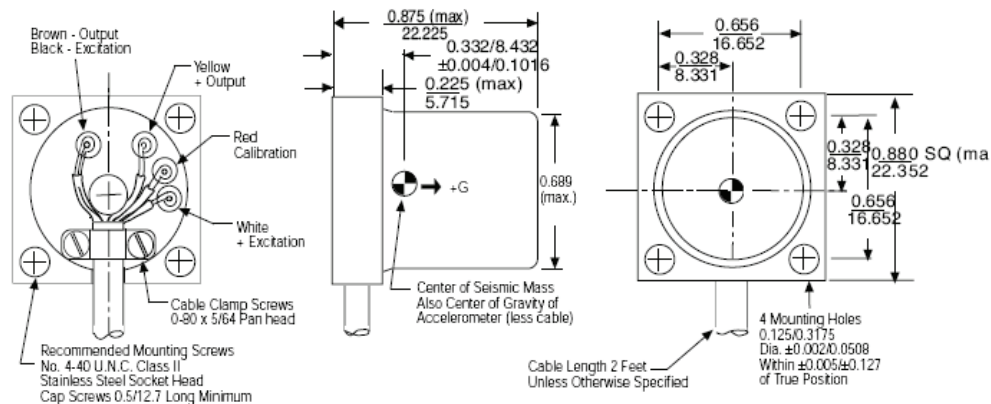
Ordering Information

Specify	Model 141A or Model 141B
Specify G Range	Nominal Range (\pm specific g)
Specify	Excitation voltage for calibration (if non-standard, use Option 620 at extra charge)

Specifications subject to change without notice.

Note: Setra adheres to strict quality standards including MIL-I-45208A and ANSI Z540-1. The calibration of this product is NIST traceable.

Outline Drawing



SSP0141 RevC 04/01

While we provide application assistance on all Setra products both personally and through our literature, it is the customer's responsibility to determine the suitability of the product in the application.

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 Toll Free: 800-257-3872; Fax: 978-264-0292; email: sales@setra.com

setra

Temposonics®

Magnetostrictive Linear-Position Sensors



E-Series Model ER Sensor
Analog and Digital Pulse Outputs

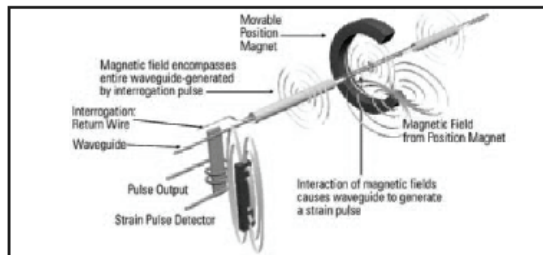
550996 C

Product Specification



Temposonics Model ER sensor

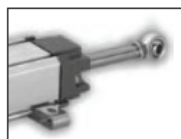
- Rugged industrial sensor
- Linear, absolute measurement
- Non-contact sensing technology
- Non-linearity less than 0.02 %
- Repeatability within 0.001 %
- EMI shielded and CE certified
- Analog output, (voltage or current)
- Start/Stop digital pulse output, (upload of sensor parameters available)



Model ER rod-and-cylinder sensor

The innovative Temposonics model ER sensor brings the proven benefits of magnetostrictive feedback to the versatile rod-and-cylinder sensor package. It is ideal for demanding industrial applications where high performance non-contact feedback is essential.

The model ER sensor's rod-and-cylinder design has a stainless steel "sensing rod" that can extend from the sensor housing. As the rod is extended and retracted, the sensing magnet remains completely contained



and protected at all times, ensuring reliable sensor performance in the toughest industrial environments.

The ER model sensor provides a very precise, durable and cost effective alternative to the wear problems associated with linear potentiometers.

The benefits of magnetostrictive sensing

Temposonics linear sensors use the time-based magnetostrictive position sensing principle developed by MTS. Within the sensing element, a sonic strain pulse is induced in a specially-designed magnetostrictive waveguide by the momentary interaction of two magnetic fields. One field comes from a movable permanent magnet that passes along the outside of the sensor. The other field comes from an "interrogation" current pulse applied along the waveguide. The resulting strain pulse travels at ultrasonic speed along the waveguide and is detected at the

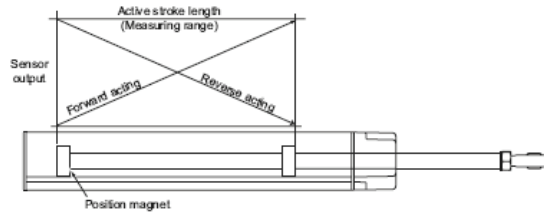
head of the sensing element. The position of the magnet is determined with high precision and speed by accurately measuring the elapsed time between the application of the interrogation pulse and the arrival of the resulting strain pulse with a high speed counter. Using the elapsed time to determine position of the permanent magnet provides an absolute position reading that never needs recalibration or re-homing after a power loss. Non-contact sensing eliminates wear, and guarantees the best durability and output repeatability.



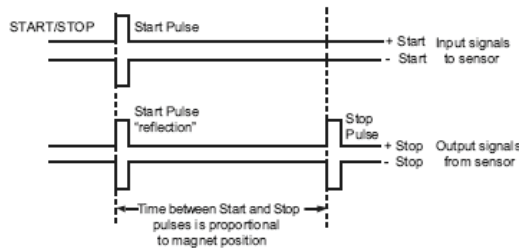
All specifications are subject to change. Please contact MTS for specifications that are critical to your needs.

Temposonics Model ER linear-position sensor

Temposonics E-Series model ER, rod-and-cylinder sensors are available with analog output or digital-pulse output. The analog outputs include voltage, (0 to 10 VDC, forward and reverse acting), and current, (4 to 20 mA, forward or reverse acting). Since the outputs are direct, no signal conditioning electronics are needed when interfacing with controllers or meters.



The available digital-pulse output is Start/Stop. Here the sensor requires a start signal from a controller or interface card to initiate the measurement cycle. The sensor generates a stop signal at the end of the measurement cycle that is used to stop the controller's counter clock. The elapsed time between the Start and Stop signals is directly proportional to the magnet's position within the sensor housing. The controller can calculate the absolute position of the magnet from the time value and the sensor's unique gradient value, (inverse of the average speed for the ultrasonic pulse traveling in the sensor's waveguide).



For applications using smart sensor interfaces the Start/Stop output, (option R3), can provide a sensor parameter upload ability. The following sensor parameters are available for upload:

- **Measuring range**
- **Offset**
- **Gradient** (Inverse speed of sensing pulse)
- **Status**
- **Manufacturer number**

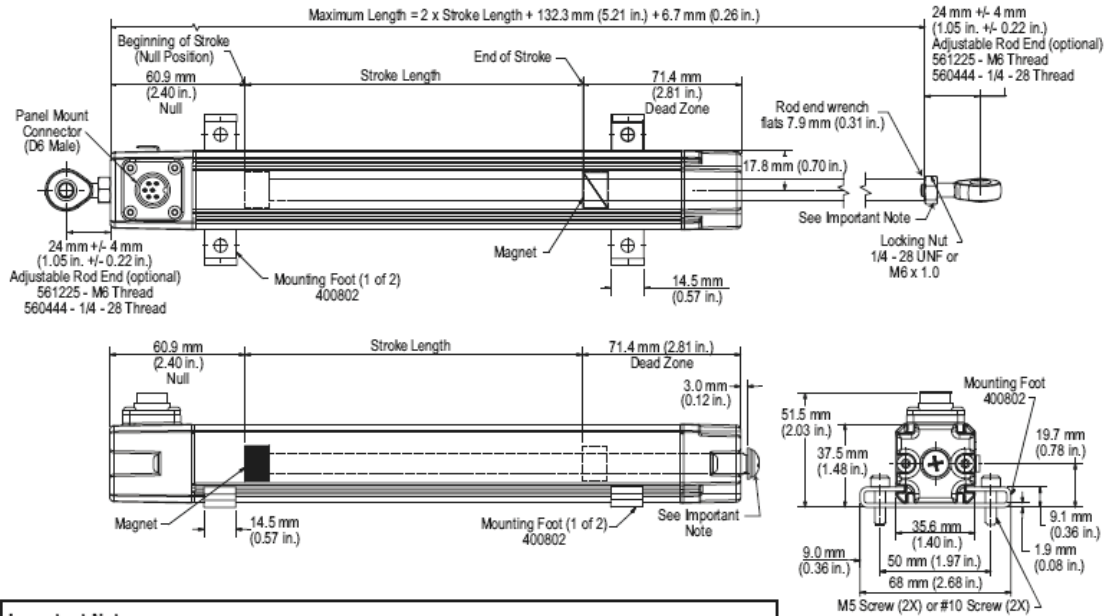
The sensor also features over-voltage protection to 36 Vdc and reverse polarity protection to 30 Vdc on input voltage connections. All outputs are absolute rather than incremental so that power-down situations do not require re-homing.

Parameters	Specification
Measured Variable:	Displacement
Resolution:	Analog: Infinite Digital: $1 \div [\text{gradient} \times \text{crystal freq. (MHz)} \times \text{circulation}]$; controller dependent.
Non-Linearity:	$< \pm 0.02\%$ Full stroke (minimum $\pm 60\mu\text{m}$)
Repeatability:	$< \pm 0.001\%$ Full stroke
Outputs:	Voltage: 0 to 10 Vdc and 10 to 0 Vdc (controller input resistance $R_L > 5k\Omega$) Current: 4 to 20 mA or 20 to 4 mA (min/max load: 0/500 Ω) Start/Stop: RS-422 differential signal (Serial parameter upload available for: measuring range, offset, gradient, status, and manufacturer number)
Update Frequency:	Voltage or Current: $> 1.5 \text{ kHz}$ Start/Stop: Controller dependent
Measuring Range:	75 to 1500 mm (3 to 60 in.) ER sensors standard stroke ranges are 3, 6, 9, 12, 15, 18, 21, 24, 30, 36, 42, 48, 54 and 60 inches (75, 100, 150, 200, 300, 400, 500, 600, 750, 1000, 1250, 1500 mm) Custom stroke lengths available.
Operating Conditions:	Temperature: - 40 to 75°C Relative humidity: 90% no condensation. Ingress protection: IP65 if mating cable connector is correctly fitted. Shock test: 100 g (single hit) IEC-Standard 68-2-27 Vibration rating: 10 g/10 - 2000 Hz IEC-Standard 68-2-6
EMC Test:	Electromagnetic emission EN 50081-1 Electromagnetic immunity EN 50082-2 EN 61000-4-2/3/4/6, Level 3/4, Criteria A, CE qualified
Operating Voltage:	+24 Vdc nominal (-15 or +20%) Polarity protection: up to -30 Vdc Overvoltage protection: up to 36 Vdc Current drain: Analog: 50 - 140 mA Start/Stop: 50 - 100 mA (stroke length dependent) Dielectric withstand voltage: 500 V, (DC ground to machine ground)
Connection type:	6-pin male D60 connector
Sensor housing:	Aluminum
Sensor rod:	Stainless steel type 303
Mounting:	Adjustable mounting feet or dual rod ends.

Temposonics Model ER linear-position sensor

A robust aluminum extrusion forms the sensor housing, containing the sensor rod, magnet, sensing element and electronics. The permanent magnet is mounted on a sliding carrier attached to the end of the stainless steel rod. As the rod moves in and out, the magnet travels above the sensing element inside the sensor housing.

Dimensions



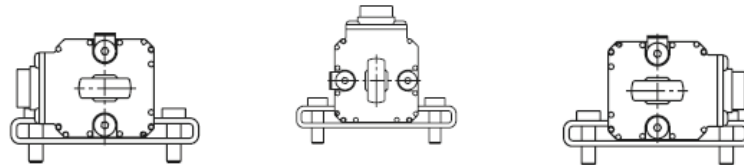
Important Note:

To avoid possible sensor damage, the washer, (or the locking nut for a rod end), must remain at the end of the rod to provide a mechanical stop when the rod is fully retracted.

Mounting

The ER sensors are designed for external installation on machines. The sensor housing is typically secured on the machine using the standard mounting feet and screws that can be easily adjusted. The rod end is then attached to the moving machine part.

Slots for the mounting feet are available on three sides of the sensor housing, allowing versatile mounting orientations for the sensor connector and extension cable.





Precision $\pm 1.7 g$ Single-/Dual-Axis iMEMS[®] Accelerometer

ADXL103/ADXL203

FEATURES

- High performance, single-/dual-axis accelerometer on a single IC chip
- 5 mm × 5 mm × 2 mm LCC package
- 1 mg resolution at 60 Hz
- Low power: 700 μA at $V_S = 5 V$ (typical)
- High zero g bias stability
- High sensitivity accuracy
- 40°C to +125°C temperature range
- X and Y axes aligned to within 0.1° (typical)
- BW adjustment with a single capacitor
- Single-supply operation
- 3500 g shock survival
- RoHS-compliant
- Compatible with Sn/Pb- and Pb-free solder processes

APPLICATIONS

- Vehicle dynamic control (VDC)/electronic stability program (ESP) systems
- Electronic chassis control
- Electronic braking
- Platform stabilization/leveling
- Navigation
- Alarms and motion detectors
- High accuracy, 2-axis tilt sensing

GENERAL DESCRIPTION

The ADXL103/ADXL203 are high precision, low power, complete single- and dual-axis accelerometers with signal conditioned voltage outputs, all on a single, monolithic IC. The ADXL103/ADXL203 measure acceleration with a full-scale range of $\pm 1.7 g$. The ADXL103/ADXL203 can measure both dynamic acceleration (for example, vibration) and static acceleration (for example, gravity).

The typical noise floor is 110 $\mu g/\sqrt{Hz}$, allowing signals below 1 mg (0.06° of inclination) to be resolved in tilt sensing applications using narrow bandwidths (<60 Hz).

The user selects the bandwidth of the accelerometer using Capacitor C_X and Capacitor C_Y at the X_{OUT} and Y_{OUT} pins. Bandwidths of 0.5 Hz to 2.5 kHz may be selected to suit the application.

The ADXL103 and ADXL203 are available in 5 mm × 5 mm × 2 mm, 8-pad hermetic LCC packages.

FUNCTIONAL BLOCK DIAGRAM

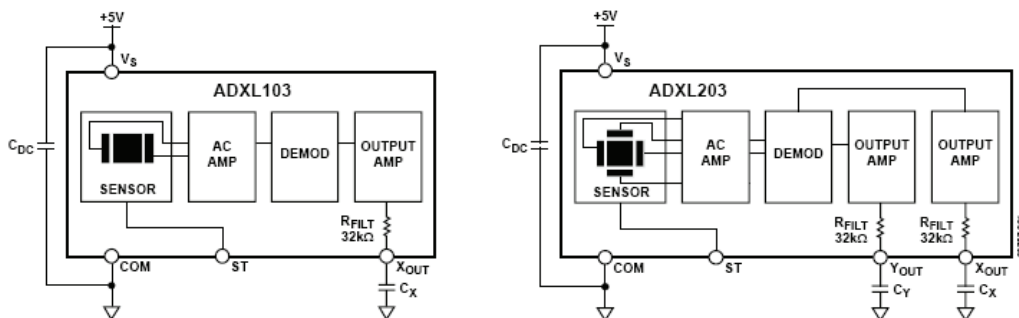


Figure 1.

Rev. A
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SPECIFICATIONS

T_A = -40°C to +125°C, V_S = 5 V, C_X = C_Y = 0.1 μF, acceleration = 0 g, unless otherwise noted.

Table 1.

Parameter	Conditions	Min ¹	Typ	Max ¹	Unit
SENSOR INPUT					
Measurement Range ²	Each axis	±1.7			g
Nonlinearity	% of full scale		±0.2	±1.25	%
Package Alignment Error			±1		Degrees
Alignment Error (ADXL203)	X sensor to Y sensor		±0.1		Degrees
Cross-Axis Sensitivity			±1.5	±3	%
SENSITIVITY (RATIOMETRIC)³					
Sensitivity at X _{out} , Y _{out}	Each axis V _S = 5 V	960	1000	1040	mV/g
Sensitivity Change Due to Temperature ⁴	V _S = 5 V		±0.3		%
ZERO g BIAS LEVEL (RATIOMETRIC)					
0 g Voltage at X _{out} , Y _{out}	Each axis V _S = 5 V	2.4	2.5	2.6	V
Initial 0 g Output Deviation from Ideal	V _S = 5 V, 25°C		±25		mg
0 g Offset vs. Temperature			±0.1	±0.8	mg/°C
NOISE PERFORMANCE					
Output Noise	<4 kHz, V _S = 5 V		1	3	mV rms
Noise Density			110		μg/√Hz rms
FREQUENCY RESPONSE⁵					
C _X , C _Y Range ⁶		0.002		10	μF
R _{FLT} Tolerance		24	32	40	kΩ
Sensor Resonant Frequency			5.5		kHz
SELF TEST⁷					
Logic Input Low				1	V
Logic Input High		4			V
ST Input Resistance to Ground		30	50		kΩ
Output Change at X _{out} , Y _{out}	Self Test 0 to Self Test 1	450	750	1100	mV
OUTPUT AMPLIFIER					
Output Swing Low	No load	0.05	0.2		V
Output Swing High	No load		4.5	4.8	V
POWER SUPPLY					
Operating Voltage Range		3		6	V
Quiescent Supply Current			0.7	1.1	mA
Turn-On Time ⁸			20		ms

¹ All minimum and maximum specifications are guaranteed. Typical specifications are not guaranteed.

² Guaranteed by measurement of initial offset and sensitivity.

³ Sensitivity is essentially ratiometric to V_S. For V_S = 4.75 V to 5.25 V, sensitivity is 186 mV/V/g to 215 mV/V/g.

⁴ Defined as the output change from ambient-to-maximum temperature or ambient-to-minimum temperature.

⁵ Actual frequency response controlled by user-supplied external capacitor (C_X, C_Y).

⁶ Bandwidth = 1/(2 × π × 32 kΩ × C). For C_X, C_Y = 0.002 μF, bandwidth = 2500 Hz. For C_X, C_Y = 10 μF, bandwidth = 0.5 Hz. Minimum/maximum values are not tested.

⁷ Self-test response changes cubically with V_S.

⁸ Larger values of C_X, C_Y increase turn-on time. Turn-on time is approximately 160 × C_X or C_Y + 4 ms, where C_X, C_Y are in μF.

ADXL103/ADXL203

ABSOLUTE MAXIMUM RATINGS

Table 2.

Parameter	Rating
Acceleration (Any Axis, Unpowered)	3500 g
Acceleration (Any Axis, Powered)	3500 g
Drop Test (Concrete Surface)	1.2 m
V _s	-0.3 V to +7.0 V
All Other Pins	(COM - 0.3 V) to (V _s + 0.3 V)
Output Short-Circuit Duration (Any Pin to Common)	Indefinite
Temperature Range (Powered)	-55°C to +125°C
Temperature Range (Storage)	-65°C to +150°C

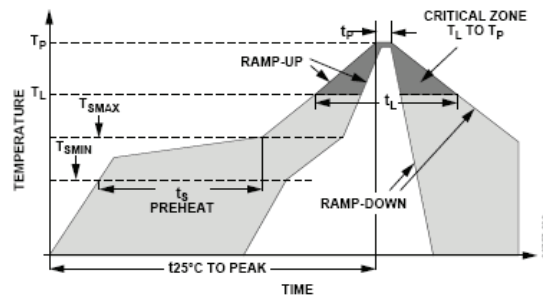
Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Table 3. Package Characteristics

Package Type	θ_{JA}	θ_{JC}	Device Weight
8-Lead CLCC	120°C/W	20°C/W	<1.0 gram

ESD CAUTION

ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 4000V readily accumulate on the human body and test equipment and can discharge without detection. Although this product features proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.



Profile Feature	Condition	
	Sn63/Pb37	Pb-Free
Average Ramp Rate (T _L to T _P)	3°C/second max	
Preheat		
• Minimum Temperature (T _{SMIN})	100°C	150°C
• Maximum Temperature (T _{SMAX})	150°C	200°C
• Time (T _{SMIN} to T _{SMAX}) (t _s)	60 to 120 seconds	60 to 150 seconds
T _{SMAX} to T _L		
• Ramp-Up Rate	3°C/second	
Time Maintained above Liquidous (T _L)		
• Liquidous Temperature (T _L)	183°C	217°C
• Time (t _L)	60 to 150 seconds	60 to 150 seconds
Peak Temperature (T _P)	240°C + 0°C/-5°C	260°C + 0°C/-5°C
Time Within 5°C of Actual Peak Temperature (t _p)	10 to 30 seconds	20 to 40 seconds
Ramp-Down Rate	6°C/second max	
Time 25°C to Peak Temperature	6 minutes max	8 minutes max

Figure 2. Recommended Soldering Profile

PIN CONFIGURATIONS AND FUNCTION DESCRIPTIONS

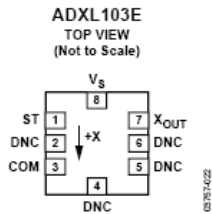


Figure 3. ADXL103 Pin Configuration

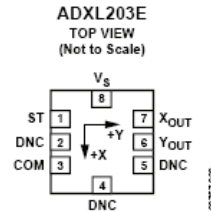


Figure 4. ADXL203 Pin Configuration

Table 4. ADXL103 Pin Function Descriptions

Pin No.	Mnemonic	Description
1	ST	Self Test
2	DNC	Do Not Connect
3	COM	Common
4	DNC	Do Not Connect
5	DNC	Do Not Connect
6	DNC	Do Not Connect
7	X _{OUT}	X Channel Output
8	V _S	3 V to 6 V

Table 5. ADXL203 Pin Function Descriptions

Pin No.	Mnemonic	Description
1	ST	Self Test
2	DNC	Do Not Connect
3	COM	Common
4	DNC	Do Not Connect
5	DNC	Do Not Connect
6	Y _{OUT}	Y Channel Output
7	X _{OUT}	X Channel Output
8	V _S	3 V to 6 V

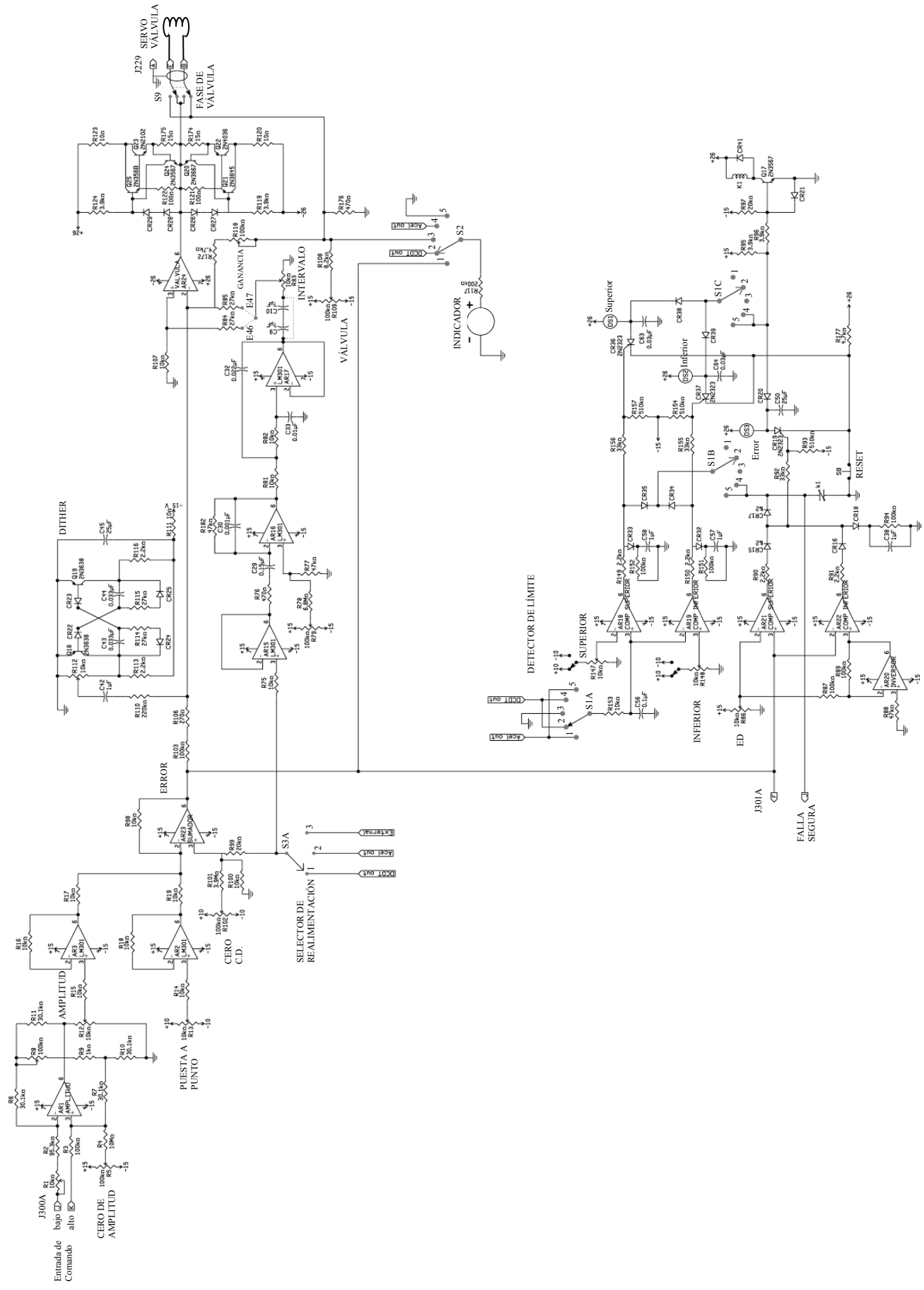


Diagrama acondicionador del transductor magnetostriectivo

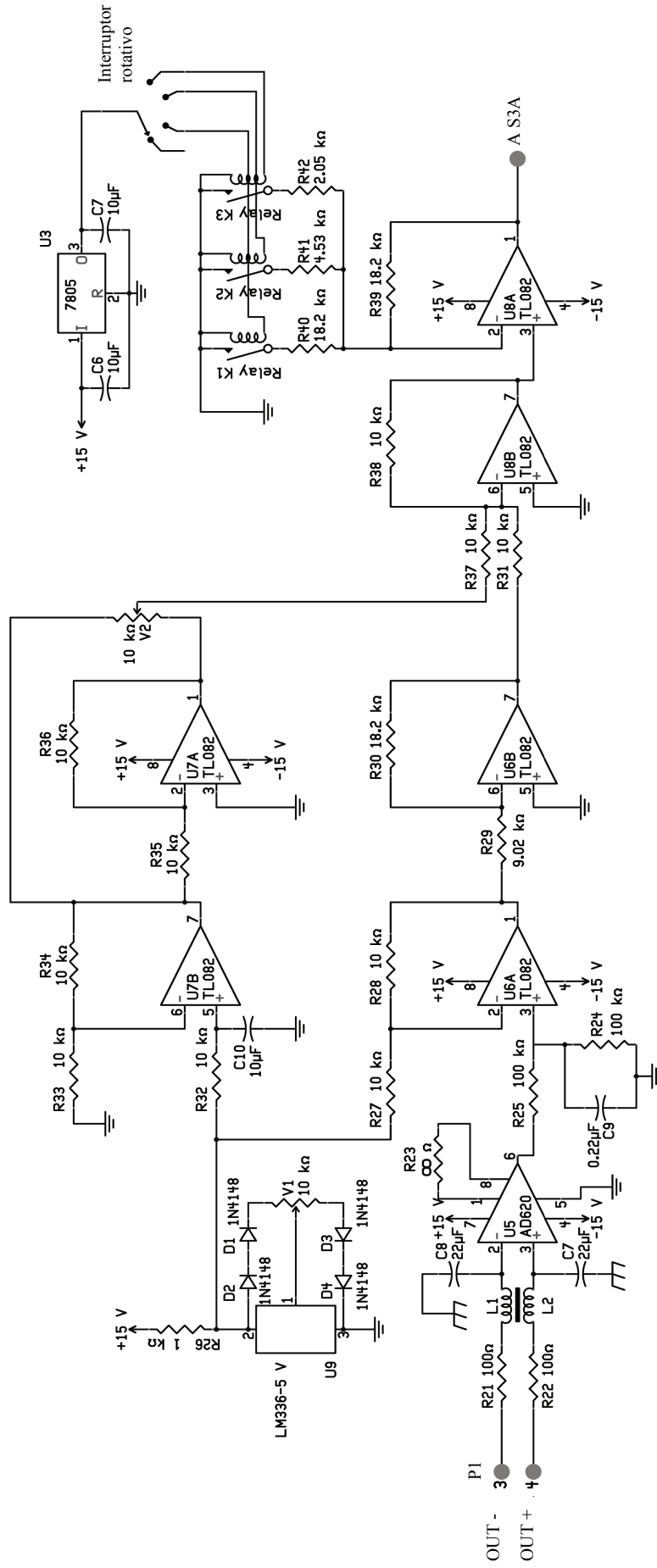
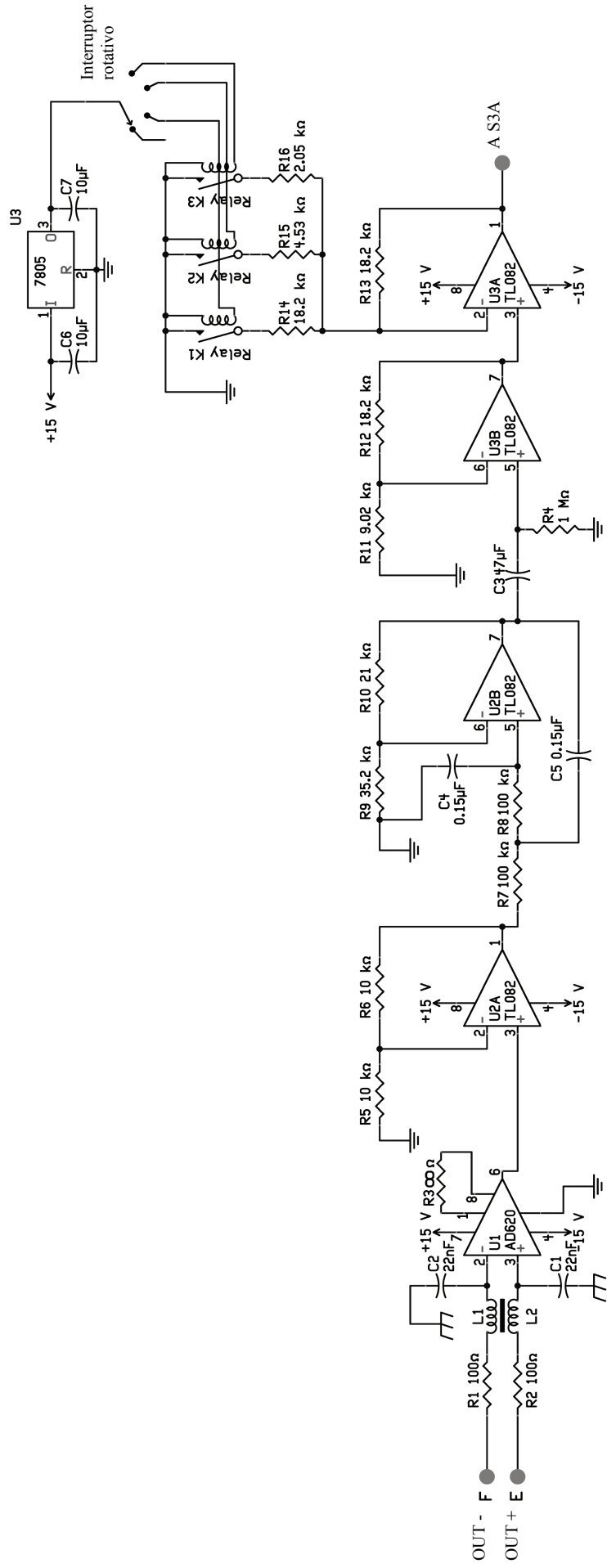


Diagrama del acondicionador del acelerómetro



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