REVISIONS

LTR	DESCRIPTION	DATE (YR-MO-DA)	APPROVED
A	Add device type 02. - ro	15-10-21	C. SAFFLE
B	Sheet 3: Section 1.3: Change Power dissipation (P_D) limit to 333 mW. Section 1.4.1 Change input impedance differential to 4 kΩ. Sheet 16: Change: " This can be calculated by gain error (%) = 100 - (100 x (2kΩ / (2kΩ - R_{FILTER})))" to: "This can be calculated by gain error (%) = 100 - (100 x (4kΩ / (4kΩ + R_{FILTER})))". Editorial changes throughout. - jt	19-11-14	Jim R. Eschmeyer
C	Under Table I, Offset adjustment section, make correction to Accuracy referred to output test condition column by deleting V_S = 0.5 V to 5.5 V and replacing with V_S = 4.5 V to 5.5 V. - ro	21-04-21	James R. Eschmeyer
D	Delete Sensing input differential voltage parameter entirely from paragraph 1.3. Delete the words, "or with subsequent wafer lots" as specified in footnote 6/ of Table I and paragraph 4.4.1c. - ro	24-01-29	James R. Eschmeyer

Revision Status of Sheets

REV																						
SHEET																						
REV	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D						
SHEET	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16						

PMIC N/A

STANDARD
MICROCIRCUIT
DRAWING

THIS DRAWING IS AVAILABLE
FOR USE BY ALL DEPARTMENTS
AND AGENCIES OF THE
DEPARTMENT OF DEFENSE

PREPARED BY
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DRAWING APPROVAL DATE
14-02-20

DLA LAND AND MARITIME
COLUMBUS, OHIO 43218-3990
https://www.dla.mil/LandandMaritime

MICROCIRCUIT, LINEAR, HIGH VOLTAGE
BIDIRECTIONAL CURRENT SHUNT MONITOR,
MONOLITHIC SILICON

AMSC N/A

REVISION LEVEL
D

SIZE
A

CAGE CODE
67268

5962-12233

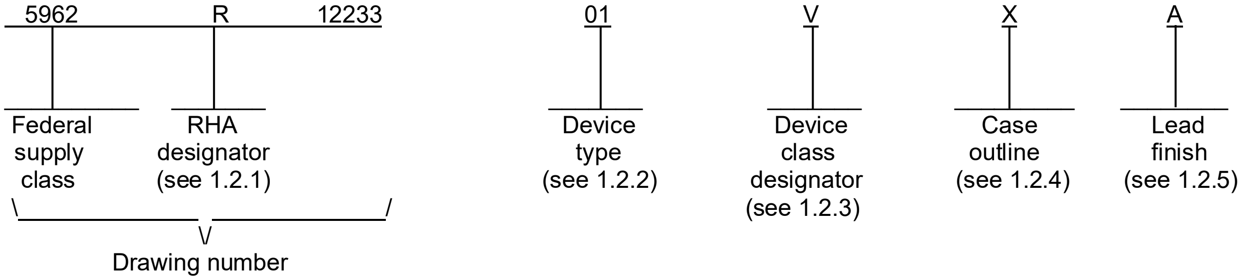
SHEET 1 OF 16

DISTRIBUTION STATEMENT A. Approved for public release. Distribution is unlimited.

1. SCOPE

1.1 Scope. This drawing documents two product assurance class levels consisting of high reliability (device class Q) and space application (device class V). A choice of case outlines and lead finishes are available and are reflected in the Part or Identifying Number (PIN). When available, a choice of Radiation Hardness Assurance (RHA) levels is reflected in the PIN.

1.2 PIN. The PIN is as shown in the following example:



1.2.1 RHA designator. Device classes Q and V RHA marked devices meet the MIL-PRF-38535 specified RHA levels and are marked with the appropriate RHA designator. A dash (-) indicates a non-RHA device.

1.2.2 Device type(s). The device type(s) identify the circuit function as follows:

Device type	Generic number	Circuit function
01	AD8210	High voltage bidirectional current shunt monitor
02	AD8210	High voltage bidirectional current shunt monitor

1.2.3 Device class designator. The device class designator is a single letter identifying the product assurance level as follows:

Device class	Device requirements documentation
Q or V	Certification and qualification to MIL-PRF-38535

1.2.4 Case outline(s). The case outline(s) are as designated in MIL-STD-1835 and as follows:

Outline letter	Descriptive designator	Terminals	Package style
X	CDFP3-F10	10	Flat pack

1.2.5 Lead finish. The lead finish is as specified in MIL-PRF-38535 for device classes Q and V.

1.3 Absolute maximum ratings. 1/

Supply voltage (V_S)	12.5 V
Continuous input voltage (V_{CM} on +INPUT, -INPUT)	-5 V to +68 V
Reverse supply voltage	0.3 V
Output short circuit duration	Indefinite
Power dissipation (P_D)	333 mW
Junction temperature range (T_J)	150°C
Lead temperature range (soldering, 10 seconds)	300°C
Storage temperature range (T_{STG})	-65°C to +150°C
Thermal resistance, junction to ambient (θ_{JC})	50°C/W 2/
Thermal resistance, junction to ambient (θ_{JA})	75°C/W 2/

1.4 Recommended operating conditions.

Supply voltage (V_S)	4.5 V to 5.5 V
Operating ambient temperature range (T_A)	-55°C to +125°C

1.4.1 Operating performance characteristics.

Input / output characteristics: (T_A = +25°C, +V_S = 5 V)	
Input impedance differential	4 kΩ
Input impedance common mode (V_{CM} on +INPUT,-INPUT = 5 V to 65 V)	5 MΩ
Input impedance common mode (V_{CM} on +INPUT,-INPUT = -2 V to 5 V)	1.5 kΩ
Output impedance	2 Ω
Input to output gain	20 V / V
Common mode rejection (f = 100 kHz, $V_{CM} < 5$ V, source imbalance < 2 Ω)	95 dB
Common mode rejection (f = 100 kHz, $V_{CM} > 5$ V, source imbalance < 2 Ω)	80 dB
Output offset adjustment range	0.05 V to 4.9 V
V_{REF} input voltage range	0 V to +V_S
V_{REF} divider resistor values	24 kΩ to 40 kΩ
Dynamic response: (T_A = +25°C, +V_S = 5 V) 3/	
Small signal bandwidth – 3 dB	575 kHz
Step response settling time positive current sense (within 1 % of true output)	3 µs
Step response settling time negative current sense (within 1% of true output)	6 µs
Noise performance: (T_A = +25°C, +V_S = 5 V)	
Voltage noise (referred to input (RTI), f = 0.1 Hz to 10 Hz)	7 µVp-p
Voltage noise (referred to input (RTI), special density, f = 1 kHz)	70 nV / $\sqrt{\text{Hz}}$

1/ Stresses above the absolute maximum rating may cause permanent damage to the device. Extended operation at the maximum levels may degrade performance and affect reliability.

2/ Measurement taken under absolute worst case condition. Data taken with a thermal camera for highest power density location. See MIL-STD-1835 for average package θ_{JC} thermal numbers.

3/ External input filtering should be considered to trade off desired dynamic response versus undesired response to system transients and electromagnetic interference (EMI). Refer to paragraph 6.7 for more information.

1.5 Radiation features.

Device type 01:
Maximum total dose available (dose rate = 50 – 300 rads(Si)/s) .... 100 krads(Si) 4/
Device type 02:
Maximum total dose available (dose rate ≤ 10 mrads(Si)/s) .... 50 krads(Si) 5/

2. APPLICABLE DOCUMENTS

2.1 Government specification, standards, and handbooks. The following specification, standards, and handbooks form a part of this drawing to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATION

MIL-PRF-38535 - Integrated Circuits, Manufacturing, General Specification for.

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-883 - Test Method Standard Microcircuits.
MIL-STD-1835 - Interface Standard Electronic Component Case Outlines.

DEPARTMENT OF DEFENSE HANDBOOKS

MIL-HDBK-103 - List of Standard Microcircuit Drawings.
MIL-HDBK-780 - Standard Microcircuit Drawings.

(Copies of these documents are available online at https://quicksearch.dla.mil/.)

2.2 Order of precedence. In the event of a conflict between the text of this drawing and the references cited herein, the text of this drawing takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

4/ Device type 01 may be dose rate sensitive in a space environment and may demonstrate enhanced low dose rate effects. For device type 01, radiation end point limits for the noted parameters are guaranteed only for the conditions specified in MIL-STD-883, method 1019, condition A.

5/ For device type 02, radiation end point limits for the noted parameters are guaranteed only for the conditions specified in MIL-STD-883, method 1019, condition D.

3. REQUIREMENTS

3.1 Item requirements. The individual item requirements for device classes Q and V shall be in accordance with MIL-PRF-38535 as specified herein, or as modified in the device manufacturer's Quality Management (QM) plan. The modification in the QM plan shall not affect the form, fit, or function as described herein.

3.2 Design, construction, and physical dimensions. The design, construction, and physical dimensions shall be as specified in MIL-PRF-38535 and herein for device classes Q and V.

3.2.1 Case outline. The case outline shall be in accordance with 1.2.4 herein.

3.2.2 Terminal connections. The terminal connections shall be as specified on figure 1.

3.2.3 Block diagram. The block diagram shall be as specified on figure 2.

3.2.4 Radiation exposure circuit. The radiation exposure circuit shall be maintained by the manufacturer under document revision level control and shall be made available to the preparing and acquiring activity upon request.

3.3 Electrical performance characteristics and postirradiation parameter limits. Unless otherwise specified herein, the electrical performance characteristics and postirradiation parameter limits are as specified in table I and shall apply over the full ambient operating temperature range.

3.4 Electrical test requirements. The electrical test requirements shall be the subgroups specified in table IIA. The electrical tests for each subgroup are defined in table I.

3.5 Marking. The part shall be marked with the PIN listed in 1.2 herein. In addition, the manufacturer's PIN may also be marked. For packages where marking of the entire SMD PIN number is not feasible due to space limitations, the manufacturer has the option of not marking the "5962-" on the device. For RHA product using this option, the RHA designator shall still be marked. Marking for device classes Q and V shall be in accordance with MIL-PRF-38535.

3.5.1 Certification/compliance mark. The certification mark for device classes Q and V shall be a "QML" or "Q" as required in MIL-PRF-38535.

3.6 Certificate of compliance. For device classes Q and V, a certificate of compliance shall be required from a QML-38535 listed manufacturer in order to supply to the requirements of this drawing (see 6.6.1 herein). The certificate of compliance submitted to DLA Land and Maritime-VA prior to listing as an approved source of supply for this drawing shall affirm that the manufacturer's product meets, for device classes Q and V, the requirements of MIL-PRF-38535 and herein.

3.7 Certificate of conformance. A certificate of conformance as required for device classes Q and V shall be provided with each lot of microcircuits delivered to this drawing.

TABLE I. Electrical performance characteristics.

Test	Symbol	Conditions 1/ 2/ -55°C ≤ T_A ≤ +125°C V_S = V_{REF1} = + 5 V, V_{REF2} = GND, V_{CM} = -2 V and 65 V unless otherwise specified	Group A subgroups	Device type	Limits		Unit
					Min	Max	
Gain section.							
Gain accuracy	G_A	V_{OUT} ≥ 0.1 V dc,	1	01,02	-0.5	0.5	%
		V_{CM} = 0 V, 65 V, nominal gain = 20 V/V	2,3		-0.7	0.7	
		P, L, R	1	01	-0.5	0.5	
		P, L	1	02	-0.5	0.5	
Gain drift 3/	ΔG	V_{OUT} ≥ 0.1 V dc, V_{CM} = 0 V, 65 V, nominal gain = 20 V/V	1,2,3	01,02		20	ppm/°C
Voltage offset section.							
Offset voltage, referred to input	V_{OS}	V_{CM} = 0 V, 5 V	1,2,3	01,02	-1.8	1.8	mV
		P, L, R	1	01	-6	6	
		P, L	1	02	-6	6	
Offset voltage drift 3/	ΔV_{OS}	V_{CM} = 0 V, 5 V	1,2,3	01,02	-8	8	µV/°C
Input section.							
Common mode input voltage range	V_{ICM}	Continuous common mode	1,2,3	01,02	-2	65	V
		P, L, R	1	01	-2	65	
		P, L	1	02	-2	65	
Differential input voltage range	V_{ID}	4/	1,2,3	01,02	0	250	mV
		P, L, R	1	01	0	250	
		P, L	1	02	0	250	
Common mode rejection ratio	CMRR	V_{CM} ≥ 4 V	1,2,3	01,02	100		dB
		P, L, R	1	01	100		
		P, L	1	02	100		
		V_{CM} < 4 V 5/	1,2,3	01,02	80		
		P, L, R	1	01	80		
		P, L	1	02	80		

See footnotes at end of table.

TABLE I. Electrical performance characteristics – continued.

Test	Symbol	Conditions 1/ 2/ -55°C ≤ T_A ≤ +125°C V_S = V_{REF1} = + 5 V, V_{REF2} = GND, V_{CM} = -2 V and 65 V unless otherwise specified		Group A subgroups	Device type	Limits		Unit
						Min	Max	
Output section.								
Output voltage range	V_{OUT}	R_L = 25 kΩ		1,2,3	01,02	0.05	4.9	V
			P, L, R	1	01	0.06	4.9	
			P, L	1	02	0.06	4.9	
Dynamic response section.								
Slew rate 3/ 6/	SR	100 mV input step, measured at 20 % to 80 % of output		4	01,02	2.4		V/µs
				5		2.8		
				6		1.8		
Offset adjustment section.								
Radiometric accuracy 7/	RAC	Divider to supplies, V_S = 5 V, V_{REF1} = 5 V and 0 V, V_{REF2} = 0 V and 5 V		1,2,3	01,02	0.499	0.501	V/V
			P, L, R	1	01	0.499	0.501	
			P, L	1	02	0.499	0.501	
Accuracy, referred to output	V_{OACC}	V_S = 4.5 V to 5.5 V		1,2,3	01,02	-0.6	0.6	mV/V
			P, L, R	1	01	-0.6	0.6	
			P, L	1	02	-0.6	0.6	

See footnotes at end of table.

TABLE I. Electrical performance characteristics – continued.

Test	Symbol	Conditions 1/ 2/ -55°C ≤ T_A ≤ +125°C V_S = V_{REF1} = + 5 V, V_{REF2} = GND, V_{CM} = -2 V and 65 V unless otherwise specified		Group A subgroups	Device type	Limits		Unit
						Min	Max	
Power supply, V_S								
Quiescent current	I_Q	V_{CM} > 5 V 8/		1,2,3	01,02		2	mA
			P, L, R	1	01		4	
			P, L	1	02		4	
		V_{CM} ≤ 5 V		1,2,3	01,02		7.6	
			P, L, R	1	01		9	
			P, L	1	02		9	
Power supply rejection ratio	PSRR	V_S = 4.5 V to 5.5 V		1,2,3	01,02	80		dB
			P, L, R	1	01	65		
			P, L	1	02	65		

1/ Device type 01 supplied to this drawing has been characterized through all levels P, L, and R of irradiation. Device type 02 supplied to this drawing has been characterized through all levels P and L of irradiation. However, device type 01 is only tested at the "R" level and device type 02 is only tested at the "L" level. Pre and Post irradiation values are identical unless otherwise specified in table I. When performing post irradiation electrical measurements for any RHA level, T_A = +25°C.

2/ Device type 01 may be dose rate sensitive in a space environment and demonstrate enhanced low dose rate effects. Radiation end point limits for the noted parameters are guaranteed only for the conditions as specified in MIL-STD-883, method 1019, condition A for device type 01 and condition D for device type 02. Device type 02 has been tested at low dose rate.

3/ Parameter not tested post irradiation.

4/ Differential input voltage range = ±125 mV with half scale output offset. Refer to paragraph 6.7 for more information.

5/ Source imbalance < 2 Ω.

6/ Parameter is guaranteed by engineering characterization, not production tested. Characterization repeated after major design or process changes.

7/ The offset adjustment is a ratio of the power supply when V_{REF1} and V_{REF2} are used as divider between the supplies.

8/ When the input common mode is less than 5 V, the supply current increases. This can be calculated with the following formula: I_Q (mA) = -0.7 * V_{CM} + 4.2. Refer to paragraph 6.7 for more information.

Device types	01, 02	
Case outline	X	
Terminal number	Terminal symbol	Description
1	NC/GND	Unused pin.
2	-INPUT	Sensing negative input voltage. Rshunt x Ishunt between INPUTs sets this voltage.
3	GND	Supply ground.
4	V_{REF2}	Low side output reference setting voltage input.
5	NC/GND	Unused pin.
6	OUT	Output voltage for sensed input. (+INPUT - -INPUT) x 20.
7	$+V_S$	Supply voltage.
8	V_{REF1}	High side output reference setting voltage input.
9	+INPUT	Sensing positive input voltage. Rshunt x Ishunt between INPUTs sets this voltage.
10	NC/GND	Unused pin.

FIGURE 1. Terminal connections.

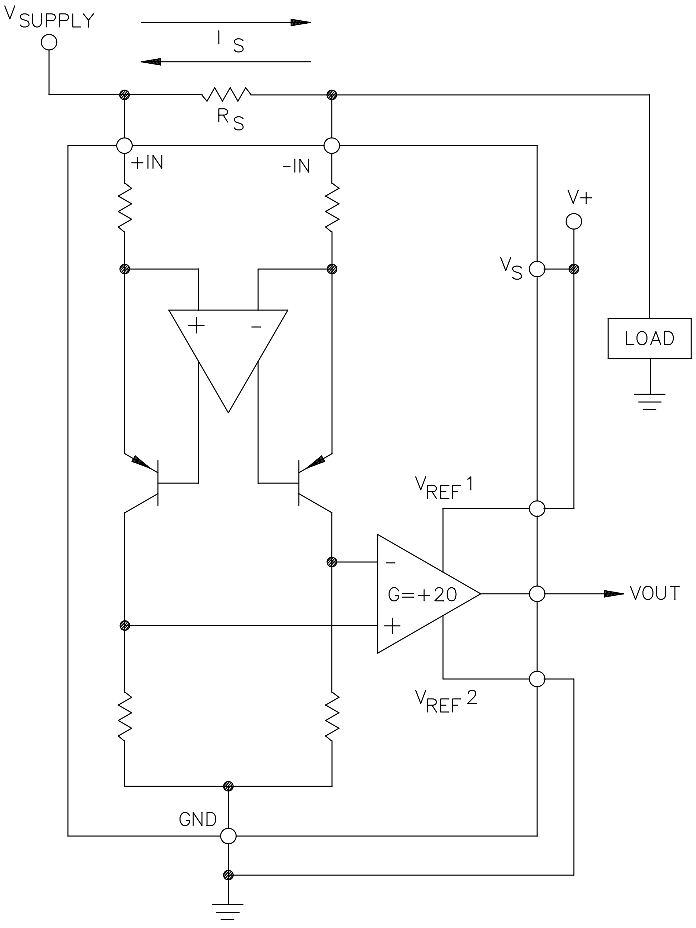


FIGURE 2. Block diagram.

4. VERIFICATION

4.1 Sampling and inspection. For device classes Q and V, sampling and inspection procedures shall be in accordance with MIL-PRF-38535 or as modified in the device manufacturer's Quality Management (QM) plan. The modification in the QM plan shall not affect the form, fit, or function as described herein.

4.2 Screening. For device classes Q and V, screening shall be in accordance with MIL-PRF-38535, and shall be conducted on all devices prior to qualification and technology conformance inspection.

4.2.1 Additional criteria for device classes Q and V.

a. The burn-in test duration, test condition and test temperature, or approved alternatives shall be as specified in the device manufacturer's QM plan in accordance with MIL-PRF-38535. The burn-in test circuit shall be maintained under document revision level control of the device manufacturer's Technology Review Board (TRB) in accordance with MIL-PRF-38535 and shall be made available to the acquiring or preparing activity upon request. The test circuit shall specify the inputs, outputs, biases, and power dissipation, as applicable, in accordance with the intent specified in method 1015 of MIL-STD-883.

b. Interim and final electrical test parameters shall be as specified in table IIA herein.

c. Additional screening for device class V beyond the requirements of device class Q shall be as specified in MIL-PRF-38535, appendix B.

4.3 Qualification inspection for device classes Q and V. Qualification inspection for device classes Q and V shall be in accordance with MIL-PRF-38535. Inspections to be performed shall be those specified in MIL-PRF-38535 and herein for groups A, B, C, D, and E inspections (see 4.4.1 through 4.4.4).

4.4 Conformance inspection. Technology conformance inspection for classes Q and V shall be in accordance with MIL-PRF-38535 including groups A, B, C, D, and E inspections, and as specified herein.

4.4.1 Group A inspection.

a. Tests shall be as specified in table IIA herein.

b. Subgroups 7, 8, 9, 10, and 11 in table I, method 5005 of MIL-STD-883 shall be omitted.

c. Subgroups 4, 5, 6 are tested as part of device initial characterization and after design and process changes as indicated in table I.

4.4.2 Group C inspection. The group C inspection end-point electrical parameters shall be as specified in table IIA herein.

4.4.2.1 Additional criteria for device classes Q and V. The steady-state life test duration, test condition and test temperature, or approved alternatives shall be as specified in the device manufacturer's QM plan in accordance with MIL-PRF-38535. The test circuit shall be maintained under document revision level control by the device manufacturer's TRB in accordance with MIL-PRF-38535 and shall be made available to the acquiring or preparing activity upon request. The test circuit shall specify the inputs, outputs, biases, and power dissipation, as applicable, in accordance with the intent specified in method 1005 of MIL-STD-883.

4.4.3 Group D inspection. The group D inspection end-point electrical parameters shall be as specified in table IIA herein.

TABLE IIA. Electrical test requirements.

Test requirements	Subgroups (in accordance with MIL-PRF-38535, table III)	
	Device class Q	Device class V
Interim electrical parameters (see 4.2)	1	1
Final electrical parameters (see 4.2)	1, 2, 3, 1/ 3/ 4, 5, 6	1, 2, 3, 1/ 2/ 3/ 4, 5, 6
Group A test requirements (see 4.4)	1, 2, 3, 3/ 4, 5, 6	1, 2, 3, 3/ 4, 5, 6
Group C end-point electrical parameters (see 4.4)	1,2,3	1, 2, 3 2/
Group D end-point electrical parameters (see 4.4)	1,2,3	1,2,3
Group E end-point electrical parameters (see 4.4)	---	1

1/ PDA applies to subgroup 1.
2/ Delta limits as specified in table IIB shall be required where specified, and the delta limits shall be completed with reference to the zero hour electrical parameters (see table I).
3/ See table I for parameters tested or characterized for subgroups 4, 5, 6.

TABLE IIB. Burn-in and operating life test delta parameters. T_A = +25°C. 1/ 2/

Parameters	Symbol	Delta limits	Unit
Quiescent current	I_Q	±0.1	mA
Offset voltage	V_{OS}	±0.5	mV
Gain accuracy	G_A	±0.1	%

1/ If device is tested at or below delta limit in table, no deltas are required. Deltas are performed at room temperature.
2/ Delta parameters are performed per table I conditions.

4.4.4 Group E inspection. Group E inspection is required only for parts intended to be marked as radiation hardness assured (see 3.5 herein).

a. End-point electrical parameters shall be as specified in table IIA herein.

b. For device classes Q and V, the devices or test vehicle shall be subjected to radiation hardness assured tests as specified in MIL-PRF-38535 for the RHA level being tested. All device classes must meet the postirradiation end-point electrical parameter limits as defined in table I at T_A = +25°C ±5°C, after exposure, to the subgroups specified in table IIA herein.

4.4.4.1 Total dose irradiation testing. Total dose irradiation testing shall be performed in accordance with MIL-STD-883, method 1019 condition A for device type 01 and condition D for device type 02 and as specified herein.

5. PACKAGING

5.1 Packaging requirements. The requirements for packaging shall be in accordance with MIL-PRF-38535 for device classes Q and V.

6. NOTES

6.1 Intended use. Microcircuits conforming to this drawing are intended for use for Government microcircuit applications (original equipment), design applications, and logistics purposes.

6.1.1 Replaceability. Microcircuits covered by this drawing will replace the same generic device covered by a contractor prepared specification or drawing.

6.2 Configuration control of SMD's. All proposed changes to existing SMD's will be coordinated with the users of record for the individual documents. This coordination will be accomplished using DD Form 1692, Engineering Change Proposal, or email communication.

6.3 Record of users. Military and industrial users should inform DLA Land and Maritime when a system application requires configuration control and which SMD's are applicable to that system. DLA Land and Maritime will maintain a record of users and this list will be used for coordination and distribution of changes to the drawings. Users of drawings covering microelectronic devices (FSC 5962) should contact DLA Land and Maritime-VA, telephone (614) 692-8108.

6.4 Comments. Comments on this drawing should be directed to DLA Land and Maritime-VA, Columbus, Ohio 43218-3990, or telephone (614) 692-0591.

6.5 Abbreviations, symbols, and definitions. The abbreviations, symbols, and definitions used herein are defined in MIL-PRF-38535 and MIL-HDBK-1331.

6.6 Sources of supply.

6.6.1 Sources of supply for device classes Q and V. Sources of supply for device classes Q and V are listed in MIL-HDBK-103 and QML-38535. The vendors listed in MIL-HDBK-103 and QML-38535 have submitted a certificate of compliance (see 3.6 herein) to DLA Land and Maritime-VA and have agreed to this drawing.

6.7 Application notes.

6.7.1 Normal operation (-2 V to 65 V supply range). In normal applications, the device amplifies a small differential input voltage generated by the load current flowing through a shunt resistor. The device rejects high common-mode voltages (up to 65 V) and provides a ground referenced buffered output that interfaces with an analog-to-digital converter (ADC).

The device is comprised of two main blocks, a differential amplifier and an instrumentation amplifier. A load current flowing through the external shunt resistor produces a voltage at the input terminals of the device. The input terminals are connected to the differential amplifier (A1) by R1 and R2. A1 nulls the voltage appearing across its own input terminals by adjusting the current through R1 and R2 with Q1 and Q2. When the input signal to the device is 0 V, the currents in R1 and R2 are equal. When the differential signal is nonzero, the current increases through one of the resistors and decreases in the other. The current difference is proportional to the size and polarity of the input signal.

The differential currents through Q1 and Q2 are converted into a differential voltage by R3 and R4. A2 is configured as an instrumentation amplifier. The differential voltage is converted into a single-ended output voltage by A2. The gain is internally set with precision-trimmed, thin film resistors to 20 V/V.

The output reference voltage is easily adjusted by the V_{REF1} pin and the V_{REF2} pin. In a normal configuration, V_{REF1} is connected to V_{CC} while V_{REF2} is connected to GND. In this case, the output is centered at $V_{CC}/2$ when the input signal is 0 V.
The device can be adjusted for unidirectional or bidirectional operation.

6.7.2 Unidirectional operation. Unidirectional operation allows the device to measure currents through a resistive shunt in one direction. The basic modes for unidirectional operation are ground referenced output mode and $+V_S$ referenced output mode. In unidirectional operation, the output can be set at the negative rail (near ground) or at the positive rail (near $+V_S$) when the differential input is 0 V. The output moves to the opposite rail when a correct polarity differential input voltage is applied.
In this case, full scale is approximately 250 mV. The required polarity of the differential input depends on the output voltage setting. If the output is set at ground, the polarity needs to be positive to move the output up as shown in table III.

TABLE III. Reference output. $+V_S = 5$ V

V_{IN} (referred to –INPUT)	V_{OUT}
0 V	4.9 V
-125 mV	2.5 V
-250 mV	0.05 V

If the output is set at the positive rail, the input polarity needs to be negative to move the output down as shown in table IV.

TABLE IV. Bidirectional operation. $+V_S = 5$ V

V_{IN} (referred to –INPUT)	V_{OUT}
+125 mV	4.9 V
0 V	2.5 V
-125 mV	0.05 V

6.7.3 Ground referenced output. When using the device in the mode, both reference inputs are tied to ground, which causes the output to sit at the negative rail when the differential input voltage is zero as shown in table V.

TABLE V. Ground reference output. $+V_S = 5$ V

V_{IN} (referred to –INPUT)	V_{OUT}
0 V	0.05 V
+125 mV	2.5 V
+250 mV	4.9 V

6.7.4 $+V_S$ referenced output. This mode is set when both reference pins are tied to the positive supply. It is normally used when the diagnostic scheme requires detection of the amplifier and wiring before power is applied to the load. See table III.

6.7.5 Bidirectional operation. Bidirectional operation allows the device to measure currents through a resistive shunt in two directions. The output offset can be set anywhere within the output range. Normally, it is set at half scale for equal measurement range in both directions. In some cases, however, it is set at a voltage other than half scale when the bidirectional current is nonsymmetrical. Adjusting the output can also be accomplished by applying voltage(s) to the reference inputs.

6.7.6 External referenced output. Tying both V_{REF} pins together to an external reference produces an output offset at the reference voltage when there is no differential input. The external reference replaces tying both to $+V_S$. The external reference value must be between 0 V and $+V_S$. When the input is negative relative to the −INPUT pin, the output moves down from the reference voltage. When the input is positive relative to the −INPUT pin, the output increases.

6.7.7 Splitting an external reference. In this case, an external reference is divided by two with an accuracy of approximately 0.2% by connecting one V_{REF} pin to ground and the other V_{REF} pin to the reference voltage. The external reference value must be between 0 V and $+V_S$. Note that pin V_{REF1} and pin V_{REF2} are tied to internal precision resistors that connect to an internal offset node. There is no operational difference between the pins.

For proper operation, the device output offset should not be set with a resistor voltage divider. Any additional external resistance could create a gain error. A low impedance voltage source should be used to set the output offset of the device.

6.7.8 Splitting the supply. By tying V_{REF1} to $+V_S$ and V_{REF2} to the GND pin, the output is set at mid-supply when there is no differential input. This mode is beneficial because no external reference is required to offset the output for bidirectional current measurement. This creates a midscale offset that is in ratio to the supply, meaning that if the supply increases or decreases, the output still remains at half scale. For example, if the $+V_S$ supply = 5.0 V, the output is at half scale or 2.5 V.
If the supply increases by 10% (to 5.5 V), the output also increases by 10% (2.75 V).

6.7.9 Input filtering. In some applications, filtering at the input of the device can be beneficial in reducing differential noise, as well as transients and current ripples flowing through the input shunt resistor. An input low-pass filter can be implemented as shown in figure 3.

The 3 dB frequency for this filter can be calculated by using: 1 / (2π x 2 x RFILTER x CFILTER)

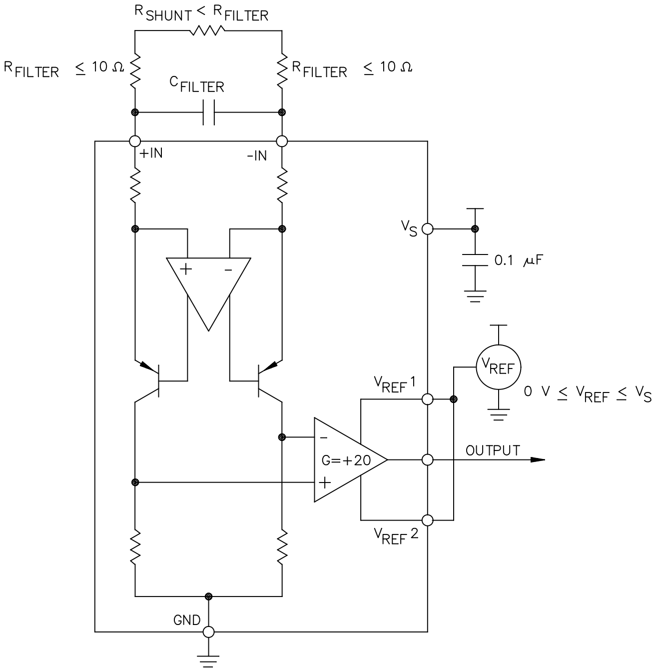


FIGURE 3. Input low pass filtering.

Adding outside components, such as RFILTER and CFILTER, introduces additional errors to the system. To minimize these errors as much as possible, it is recommended that RFILTER be 10 Ω or lower. By adding the RFILTER in series with the 4 kΩ internal input resistors of the device, a gain error is introduced.

This can be calculated by gain error (%) = 100 - (100 x (4 kΩ / (4 kΩ + RFILTER))).

STANDARD MICROCIRCUIT DRAWING BULLETIN

DATE: 24-01-29

Approved sources of supply for SMD 5962-12233 are listed below for immediate acquisition information only and shall be added to MIL-HDBK-103 and QML-38535 during the next revision. MIL-HDBK-103 and QML-38535 will be revised to include the addition or deletion of sources. The vendors listed below have agreed to this drawing and a certificate of compliance has been submitted to and accepted by DLA Land and Maritime-VA. This information bulletin is superseded by the next dated revision of MIL-HDBK-103 and QML-38535. DLA Land and Maritime maintains an online database of all current sources of supply at https://landandmaritimeapps.dla.mil/programs/smcr/.

Standard microcircuit drawing PIN 1/	Vendor CAGE number	Vendor similar PIN 2/
5962R1223301VXA	24355	AD8210AF/QMLR
5962L1223302VXA	24355	AD8210AF/QMLL

1/ The lead finish shown for each PIN representing a hermetic package is the most readily available from the manufacturer listed for that part. If the desired lead finish is not listed contact the vendor to determine its availability.

2/ Caution. Do not use this number for item acquisition. Items acquired to this number may not satisfy the performance requirements of this drawing.

Vendor CAGE number	Vendor name and address
24355	Analog Devices Route 1 Industrial Park P.O. Box 9106 Norwood, MA 02062 Point of contact: 7910 Triad Center Greensboro, NC 27409-9605