REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED

Prepared in accordance with ASME Y14.24

Vendor item drawing

REV																					
PAGE																					
REV																					
PAGE																					
REV STATUS OF PAGES	**REV**																				
	PAGE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17			

PMIC N/A

PREPARED BY
RICK OFFICER

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

Original date of drawing
YY-MM-DD

12-12-05

CHECKED BY
RAJESH PITHADIA

APPROVED BY
CHARLES F. SAFFLE

TITLE

MICROCIRCUIT, LINEAR, ZERO DRIFT, DIGITALLY PROGRAMMABLE INSTRUMENTATION AMPLIFIER, MONOLITHIC SILICON

SIZE	CODE IDENT. NO.	DWG NO.
A	16236	V62/12646

REV

PAGE 1 **OF** 17

AMSC N/A

5962-V016-13

1. SCOPE

1.1 Scope. This drawing documents the general requirements of a high performance zero drift, digitally programmable instrumentation amplifier microcircuit, with an operating temperature range of -55°C to +125°C.

1.2 Vendor Item Drawing Administrative Control Number. The manufacturer's PIN is the item of identification. The vendor item drawing establishes an administrative control number for identifying the item on the engineering documentation:

V62/12646	-	01	X	E
Drawing number		Device type (See 1.2.1)	Case outline (See 1.2.2)	Lead finish (See 1.2.3)

1.2.1 Device type(s).

Device type	Generic	Circuit function
01	AD8231	Zero drift, digitally programmable instrumentation amplifier

1.2.2 Case outline(s). The case outline(s) are as specified herein.

Outline letter	Number of pins	JEDEC PUB 95	Package style
X	16	MO-220-VGGC	Lead frame chip scale quad package

1.2.3 Lead finishes. The lead finishes are as specified below or other lead finishes as provided by the device manufacturer:

Finish designator	Material
A	Hot solder dip
B	Tin-lead plate
C	Gold plate
D	Palladium
E	Gold flash palladium
Z	Other

1.3 Absolute maximum ratings. 1/

Supply voltage (V_S) ..... 6 V
Output short circuit current ..... Indefinite 2/
Input voltage (common mode) ..... $-V_S$ – 0.3 V to $+V_S$ + 0.3 V
Differential input voltage ..... $-V_S$ – 0.3 V to $+V_S$ + 0.3 V
Storage temperature range (T_{STG}) ..... -65°C to +150°C
Package glass transition temperature ..... 130°C
Junction temperature range (TJ) ..... 130°C
Electrostatic discharge (ESD):
  Human body model (HBM) ..... 1.5 kV
  Charged device model (CDM) ..... 1.5 kV
  Machine model (MM) ..... 0.2 kV

1.4 Recommended operating conditions. 3/

Operating free-air temperature range (T_A) ..... -55°C to +125°C

1.5 Thermal characteristics.

Thermal resistance, junction to case (θ_{JC}) ..... 6.3°C/W at the exposed pad
Thermal resistance, junction to ambient (θ_{JA}) :
  Thermal pad soldered to board ..... 54°C/W
  Thermal pad not soldered to board ..... 96°C/W

1/ Stresses beyond those listed under “absolute maximum rating” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
2/ For junction temperature between 105°C and 130°C, short circuit operation beyond 1000 hours can impact part reliability.
3/ Use of this product beyond the manufacturers design rules or stated parameters is done at the user’s risk. The manufacturer and/or distributor maintain no responsibility or liability for product used beyond the stated limits.

2. APPLICABLE DOCUMENTS

JEDEC PUB 95 – Registered and Standard Outlines for Semiconductor Devices

(Applications for copies should be addressed to the Electronic Industries Alliance, 2500 Wilson Boulevard, Arlington, VA 22201-3834 or online at http://www.jedec.org)

3. REQUIREMENTS

3.1 Marking. Parts shall be permanently and legibly marked with the manufacturer's part number as shown in 6.3 herein and as follows:

A. Manufacturer's name, CAGE code, or logo
B. Pin 1 identifier
C. ESDS identification (optional)

3.2 Unit container. The unit container shall be marked with the manufacturer's part number and with items A and C (if applicable) above.

3.3 Electrical characteristics. The maximum and recommended operating conditions and electrical performance characteristics are as specified in 1.3, 1.4, and table I herein.

3.4 Design, construction, and physical dimension. The design, construction, and physical dimensions are as specified herein.

3.5 Diagrams.

3.5.1 Case outline. The case outline shall be as shown in 1.2.2 and figure 1.

3.5.2 Terminal connections. The terminal connections shall be as shown in figure 2.

TABLE I. Electrical performance characteristics. 1/

Test	Symbol	Conditions V_S = 5 V, V_{REF} = 2.5 V, G = 1, R_L = 10 kΩ, unless otherwise specified	Temperature, T_A	Device type	Limits		Unit
					Min	Max	
Instrumentation amplifier.							
Input offset voltage	V_{OSI}	V_{OS} RTI = V_{OSI} + V_{OSO} / G	+25°C	01		15	µV
Offset voltage average temperature drift	$\Delta V_{OS}/\Delta T$	V_{OS} RTI = V_{OSI} + V_{OSO} / G	-55°C to +125°C	01		0.05	µV/°C
Output offset voltage	V_{OSO}	V_{OS} RTI = V_{OSI} + V_{OSO} / G	+25°C	01		30	µV
Offset voltage average temperature drift	$\Delta V_{OS}/\Delta T$	V_{OS} RTI = V_{OSI} + V_{OSO} / G	-55°C to +125°C	01		0.5	µV/°C
Input bias current	I_{IB}		+25°C	01		500	pA
			-55°C to +125°C			5	nA
Input offset current	I_{IO}		+25°C	01		100	pA
			-55°C to +125°C			0.5	nA
Gains.		1, 2, 4, 8, 16, 32, 64, or 128					
Gain error	AE	G = 1	+25°C	01		0.05	%
		G = 2 to 128				0.8	
Gain drift		G = 1 to 32	-55°C to +125°C	01		10	ppm/°C
		G = 64				20	
		G = 128				30	
Linearity		0.2 V to 4.8 V, 10 kΩ load	+25°C	01	3 typical		ppm
		0.2 V to 4.8 V, 2 kΩ load			5 typical		
Common mode rejection ratio	CMRR	G = 1	+25°C	01	80		dB
		G = 2			86		
		G = 4			92		
		G = 8			98		
		G = 16			104		
		G = 32			110		
		G = 64			110		
		G = 128			110		

See footnotes at end of table.

TABLE I. Electrical performance characteristics – Continued. 1/

Test	Symbol	Conditions V_S = 5 V, V_{REF} = 2.5 V, G = 1, R_L = 10 kΩ, unless otherwise specified	Temperature, T_A	Device type	Limits		Unit
					Min	Max	
Instrumentation amplifier – continued.							
Noise		en = $\sqrt{(e_{ni}^2 + (e_{no}/G)^2)}$, $+V_{IN}$, $-V_{IN}$ = 2.5 V					
Input voltage noise	e_{ni}	f = 1 kHz	+25°C	01	32 typical		nV / $\sqrt{Hz}$
		f = 1 kHz	-55°C		27 typical		
		f = 1 kHz	+125°C		39 typical		
		f = 0.1 Hz to 10 Hz	+25°C		0.7 typical		μVpp
Output voltage noise	e_{no}	f = 1 kHz	+25°C	01	58 typical		nV / $\sqrt{Hz}$
		f = 1 kHz	-55°C		50 typical		
		f = 1 kHz	+125°C		70 typical		
		f = 0.1 Hz to 10 Hz	+25°C		1.1 typical		μVpp
Current noise		f = 10 Hz	+25°C	01	20 typical		fA / $\sqrt{Hz}$
Other input characteristics.							
Common mode input impedance 2/			+25°C	01	10||5 typical		GΩ||pF
Power supply rejection ratio	PSRR		+25°C	01	100		dB
Input operating voltage range			+25°C	01	0.05	4.95	V
Reference input.							
Input impedance			+25°C	01	28 typical		kΩ
Voltage range			+25°C	01	-0.2	+5.2	V

See footnotes at end of table.

TABLE I. Electrical performance characteristics – Continued. 1/

Test	Symbol	Conditions V_S = 5 V, V_{REF} = 2.5 V, G = 1, R_L = 10 kΩ, unless otherwise specified	Temperature, T_A	Device type	Limits		Unit
					Min	Max	
Instrumentation amplifier – continued.							
Dynamic performance.							
Bandwidth	BW	G = 1	+25°C	01	2.7 typical		MHz
		G = 2			2.5 typical		
Gain bandwidth	GBW	G = 4 to 128	+25°C	01	7 typical		MHz
Slew rate	SR		+25°C	01	1.1 typical		V/μs
Output characteristics.							
Output voltage high	V_{OH}	R_L = 100 kΩ to ground	+25°C	01	4.9		V
		R_L = 10 kΩ to ground			4.8		
Output voltage low	V_{OL}	R_L = 100 kΩ to 5 V	+25°C	01		100	mV
		R_L = 10 kΩ to 5 V				200	
Short circuit current	I_{SC}		+25°C	01	70 typical		mA
Digital interface.							
Input voltage low	V_{IL}		-55°C to +125°C	01		1.0	V
Input voltage high	V_{IH}		-55°C to +125°C	01	4.0		V
Setup time to $\overline{CS}$ high			-55°C to +125°C	01	50		ns
Hold time after $\overline{CS}$ high			-55°C to +125°C	01	20		ns
Operational amplifier.							
Input characteristics.							
Offset voltage	VOS		+25°C	01		15	μV
Offset voltage temperature drift	ΔVOS/ΔT		-55°C to +125°C	01		0.06	μV/°C
Input bias current	I_{IB}		+25°C	01		500	pA
			-55°C to +125°C			5	nA

See footnotes at end of table.

TABLE I. Electrical performance characteristics – Continued. 1/

Test	Symbol	Conditions V_S = 5 V, V_{REF} = 2.5 V, G = 1, R_L = 10 kΩ, unless otherwise specified	Temperature, T_A	Device type	Limits		Unit
					Min	Max	
Operational amplifier – continued.							
Input characteristics – continued.							
Input offset current	I_{IO}		+25°C	01		100	pA
			-55°C to +125°C			0.5	nA
Input voltage range	VINR		+25°C	01	0.05	4.95	V
Open loop gain	AOL		+25°C	01	100		V/mV
Common mode rejection ratio	CMRR		+25°C	01	100		dB
Power supply rejection ratio	PSRR		+25°C	01	100		dB
Voltage noise density			+25°C	01	20 typical		nV/$\sqrt{Hz}$
Voltage noise		f = 0.1 Hz to 10 Hz	+25°C	01	0.4 typical		μVp-p
Dynamic performance.							
Gain bandwidth product	GBWP		+25°C	01	1 typical		MHz
Slew rate	SR		+25°C	01	0.5 typical		V/μs
Output characteristics.							
Output voltage high	V_{OH}	R_L = 100 kΩ to ground	+25°C	01	4.9		V
		R_L = 10 kΩ to ground			4.8		
Output voltage low	V_{OL}	R_L = 100 kΩ to 5 V	+25°C	01		100	mV
		R_L = 10 kΩ to 5 V				200	
Short circuit current	I_{SC}		+25°C	01	70 typical		mA
Both amplifiers.							
Power supply.							
Quiescent current	IQ		+25°C	01		5	mA
Quiescent current (shutdown)			+25°C	01		1	μA

See footnotes at end of table.

TABLE I. Electrical performance characteristics – Continued. 1/

Test	Symbol	Conditions V_S = 3 V, V_{REF} = 1.5 V, G = 1, R_L = 10 kΩ, unless otherwise specified	Temperature, T_A	Device type	Limits		Unit
					Min	Max	
Instrumentation amplifier.							
Input offset voltage	V_{OSI}	V_{OS} RTI = V_{OSI} + V_{OSO} / G	+25°C	01		15	µV
Offset voltage average temperature drift	$\Delta V_{OS}/\Delta T$	V_{OS} RTI = V_{OSI} + V_{OSO} / G	-55°C to +125°C	01		0.05	µV/°C
Output offset voltage	V_{OSO}	V_{OS} RTI = V_{OSI} + V_{OSO} / G	+25°C	01		30	µV
Offset voltage average temperature drift	$\Delta V_{OS}/\Delta T$	V_{OS} RTI = V_{OSI} + V_{OSO} / G	-55°C to +125°C	01		0.5	µV/°C
Input bias current	I_{IB}		+25°C	01		500	pA
			-55°C to +125°C			5	nA
Input offset current	I_{IO}		+25°C	01		100	pA
			-55°C to +125°C			0.5	nA
Gains.		1, 2, 4, 8, 16, 32, 64, or 128					
Gain error	AE	G = 1	+25°C	01		0.05	%
		G = 2 to 128				0.8	
Gain drift		G = 1 to 32	-55°C to +125°C	01		10	ppm/°C
		G = 64				20	
		G = 128				30	
Common mode rejection ratio	CMRR	G = 1	+25°C	01	80		dB
		G = 2			86		
		G = 4			92		
		G = 8			98		
		G = 16			104		
		G = 32			110		
		G = 64			110		
		G = 128			110		

See footnotes at end of table.

TABLE I. Electrical performance characteristics – Continued. 1/

Test	Symbol	Conditions V_S = 3 V, V_{REF} = 1.5 V, G = 1, R_L = 10 kΩ, unless otherwise specified	Temperature, T_A	Device type	Limits		Unit
					Min	Max	
Instrumentation amplifier – continued.							
Noise		en = $\sqrt{(e_{ni}^2 + (e_{no}/G)^2)}$, $+V_{IN}$, $-V_{IN}$ = 2.5 V					
Input voltage noise	e_{ni}	f = 1 kHz	+25°C	01	40 typical		nV / $\sqrt{Hz}$
		f = 1 kHz	-55°C		35 typical		
		f = 1 kHz	+125°C		48 typical		
		f = 0.1 Hz to 10 Hz	+25°C		0.8 typical		μVpp
Output voltage noise	e_{no}	f = 1 kHz	+25°C	01	72 typical		nV / $\sqrt{Hz}$
		f = 1 kHz	-55°C		62 typical		
		f = 1 kHz	+125°C		83 typical		
		f = 0.1 Hz to 10 Hz	+25°C		1.4 typical		μVp-p
Current noise		f = 10 Hz	+25°C	01	20 typical		fA / $\sqrt{Hz}$
Other input characteristics.							
Common mode input impedance 2/			+25°C	01	10||5 typical		GΩ||pF
Power supply rejection ratio	PSRR		+25°C	01	100		dB
Input operating voltage range			+25°C	01	0.05	2.95	V
Reference input.							
Input impedance			+25°C	01	28 typical		kΩ
Voltage range			+25°C	01	-0.2	+3.2	V

See footnotes at end of table.

TABLE I. Electrical performance characteristics – Continued. 1/

Test	Symbol	Conditions V_S = 3 V, V_{REF} = 1.5 V, G = 1, R_L = 10 kΩ, unless otherwise specified	Temperature, T_A	Device type	Limits		Unit
					Min	Max	
Instrumentation amplifier – continued.							
Dynamic performance							
Bandwidth	BW	G = 1	+25°C	01	2.7 typical		MHz
		G = 2			2.5 typical		
Gain bandwidth	GBW	G = 4 to 128	+25°C	01	7 typical		MHz
Slew rate	SR		+25°C	01	1.1typical		V/μs
Output characteristics.							
Output voltage high	V_{OH}	R_L = 100 kΩ to ground	+25°C	01	2.9		V
		R_L = 10 kΩ to ground			2.8		
Output voltage low	V_{OL}	R_L = 100 kΩ to 3 V	+25°C	01		100	mV
		R_L = 10 kΩ to 3 V				200	
Short circuit current	I_{SC}		+25°C	01	40 typical		mA
Digital interface.							
Input voltage low	V_{IL}		-55°C to +125°C	01		0.7	V
Input voltage high	V_{IH}		-55°C to +125°C	01	2.3		V
Setup time to $\overline{CS}$ high			-55°C to +125°C	01	60		ns
Hold time after $\overline{CS}$ high			-55°C to +125°C	01	20		ns
Operational amplifier.							
Input characteristics.							
Offset voltage	VOS		+25°C	01		15	μV
Offset voltage temperature drift	ΔVOS/ ΔT		-55°C to +125°C	01		0.06	μV/ °C
Input bias current	I_{IB}		+25°C	01		500	pA
			-55°C to +125°C			5	nA

See footnotes at end of table.

TABLE I. Electrical performance characteristics – Continued. 1/

Test	Symbol	Conditions V_S = 3 V, V_{REF} = 1.5 V, G = 1, R_L = 10 kΩ, unless otherwise specified	Temperature, T_A	Device type	Limits		Unit
					Min	Max	
Operational amplifier – continued.							
Input characteristics – continued.							
Input offset current	I_{IO}		+25°C	01		100	pA
			-55°C to +125°C			0.5	nA
Input voltage range	VINR		+25°C	01	0.05	2.95	V
Open loop gain	AOL		+25°C	01	100		V/mV
Common mode rejection ratio	CMRR		+25°C	01	100		dB
Power supply rejection ratio	PSRR		+25°C	01	100		dB
Voltage noise density			+25°C	01	27 typical		nV/$\sqrt{Hz}$
Voltage noise		f = 0.1 Hz to 10 Hz	+25°C	01	0.6 typical		μVpp
Dynamic performance.							
Gain bandwidth product	GBWP		+25°C	01	1 typical		MHz
Slew rate	SR		+25°C	01	0.5 typical		V/μs
Output characteristics.							
Output voltage high	V_{OH}	R_L = 100 kΩ to ground	+25°C	01	2.9		V
		R_L = 10 kΩ to ground			2.8		
Output voltage low	V_{OL}	R_L = 100 kΩ to 3 V	+25°C	01		100	mV
		R_L = 10 kΩ to 3 V				200	
Short circuit current	I_{SC}		+25°C	01	40 typical		mA

See footnotes at end of table.

TABLE I. Electrical performance characteristics – Continued. 1/

Test	Symbol	Conditions V_S = 3 V, V_{REF} = 1.5 V, G = 1, R_L = 10 kΩ, unless otherwise specified	Temperature, T_A	Device type	Limits		Unit
					Min	Max	
Both amplifiers.							
Power supply							
Quiescent current	IQ		+25°C	01		4.5	mA
Quiescent current (shutdown)			+25°C	01		1	μA

1/ Testing and other quality control techniques are used to the extent deemed necessary to assure product performance over the specified temperature range. Product may not necessarily be tested across the full temperature range and all parameters may not necessarily be tested. In the absence of specific parametric testing, product performance is assured by characterization and/or design.

2/ The || symbolizes that the input impedance is being represented as the resistance value is in parallel with the capacitance.

Case X

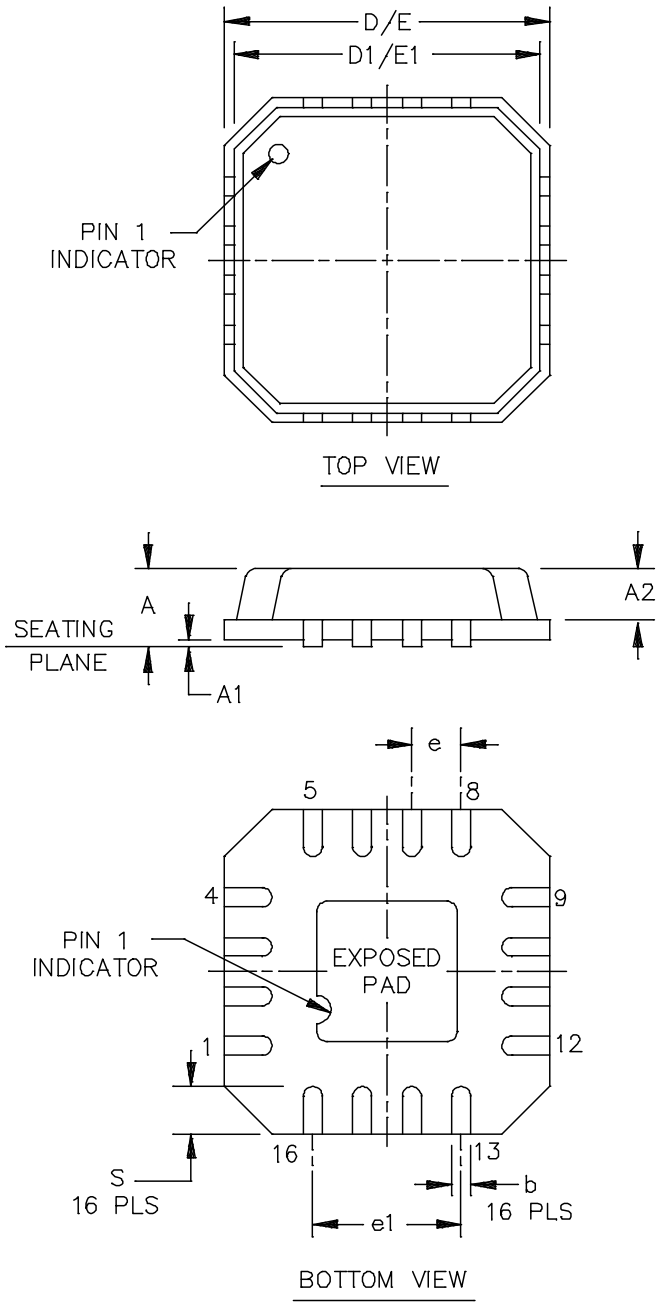

FIGURE 1. Case outline.

DLA LAND AND MARITIME COLUMBUS, OHIO	SIZE A	CODE IDENT NO. 16236	DWG NO. V62/12646
		REV	PAGE 14

Symbol	Dimensions			
	Inches		Millimeters	
	Min	Max	Min	Max
A	.031	.039	0.80	1.00
A1	.0007	.001	0.02	0.05
A2	.025	.031	0.65	0.80
b	.009	.013	0.25	0.35
D/E	.157 BSC		4.00 BSC	
D1/E1	.147 BSC		3.75 BSC	
e	.025 BSC		0.65 BSC	
e1	.076	.088	1.95	2.25
s	.019	.029	0.50	0.75

NOTES:
1. Controlling dimensions are millimeter, inch dimensions are given for reference only.
2. For proper connection of the exposed pad, refer to the pin configuration and function descriptions section of the manufacturers datasheet.
3. Falls within reference to JEDEC MO-220-VGGC.

FIGURE 1. Case outline - Continued.

Device type	01	
Case outline	X	
Terminal number	Terminal symbol	Descriptive
1	NC	No connect. Do not connect to this pin.
2	-IN A (IN-AMP –IN)	Instrumentation amplifier negative input.
3	+IN A (IN-AMP +IN)	Instrumentation amplifier positive input.
4	NC	No connect. Do not connect to this pin.
5	$\overline{SDN}$	Shutdown.
6	+IN B	Operational amplifier positive input.
7	-IN B	Operational amplifier negative input.
8	OUT B (OP AMP OUT)	Operational amplifier output.
9	REF	Instrumentation amplifier reference pin. It should be driven with a low impedance. Output is referred to this pin.
10	OUT A (IN-AMP OUT)	Instrumentation amplifier output.
11	$-V_S$	Negative power supply. Connect to ground in single supply applications.
12	$+V_S$	Positive power supply.
13	$\overline{CS}$	Chip select. Enables digital logic interface.
14	A0	Gain settling bit (LSB).
15	A1	Gain settling bit.
16	A2	Gain setting bit (MSB).
	EPAD	Exposed pad. Can be connected to the negative supply ($-V_S$) or left floating.

FIGURE 2. Terminal connections.

4. VERIFICATION

4.1 Product assurance requirements. The manufacturer is responsible for performing all inspection and test requirements as indicated in their internal documentation. Such procedures should include proper handling of electrostatic sensitive devices, classification, packaging, and labeling of moisture sensitive devices, as applicable.

5. PREPARATION FOR DELIVERY

5.1 Packaging. Preservation, packaging, labeling, and marking shall be in accordance with the manufacturer's standard commercial practices for electrostatic discharge sensitive devices.

6. NOTES

6.1 ESDS. Devices are electrostatic discharge sensitive and are classified as ESDS class 1 minimum.

6.2 Configuration control. The data contained herein is based on the salient characteristics of the device manufacturer's data book. The device manufacturer reserves the right to make changes without notice. This drawing will be modified as changes are provided.

6.3 Suggested source(s) of supply. Identification of the suggested source(s) of supply herein is not to be construed as a guarantee of present or continued availability as a source of supply for the item. DLA Land and Maritime maintains an online database of all current sources of supply at http://www.landandmaritime.dla.mil/Programs/Smcr/.

Vendor item drawing administrative control number 1/	Device manufacturer CAGE code	Transport media, quantity	Vendor part number
V62/12646-01XE	24355	Reel, 1500	AD8231TCPZ-EP-R7

1/ The vendor item drawing establishes an administrative control number for identifying the item on the engineering documentation.

CAGE code	Source of supply
24355	Analog Devices Route 1 Industrial Park P.O. Box 9106 Norwood, MA 02062 Point of contact: Raheen Business Park Limerick, Ireland