ISO-9001 CERTIFIED BY DSCC

M.S.KENNEDY CORP.

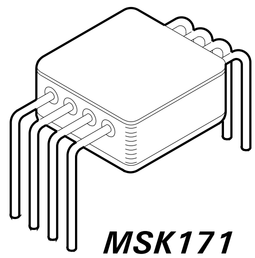
HIGH POWER DUAL OPERATIONAL AMPLIFIER 171/172

4707 Dey Road Liverpool, N.Y. 13088 (315) 701-6751

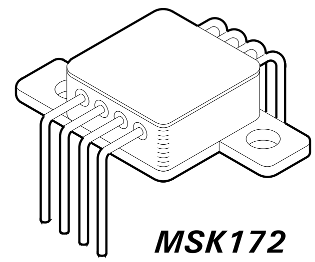
MIL-PRF-38534 QUALIFIED

FEATURES:

- Low Cost
- Wide Supply Voltage Range: 5V to 40V
- High Output Current: 3A Minimum
- High Efficiency: $|Vs\text{-}2.2V|$ at 2.5A
- Internal Current Limit
- Wide Common Mode Range (Includes Negative Supply Voltage)
- Low Distortion
- Internal Output Snubbers for Ultra-Stable Operation



MSK171

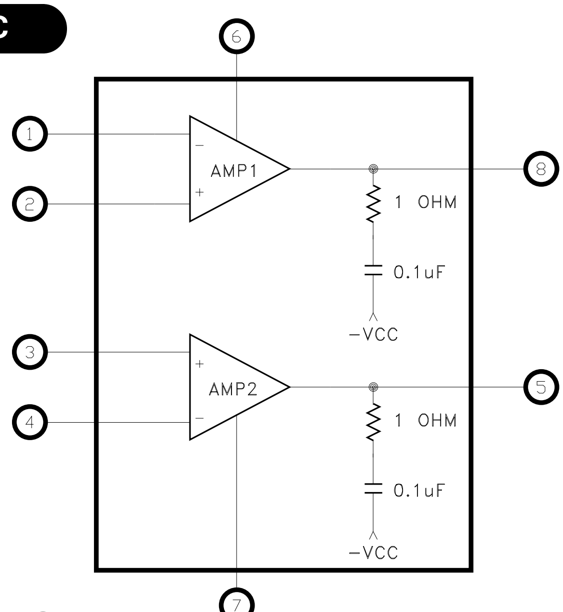


MSK172

DESCRIPTION:

The MSK 171/172 is a high power dual operational amplifier. Each amplifier is capable of delivering three amps of current to the load. The MSK 171/172 is an excellent low cost alternative for bridge mode configurations since both amplifiers are packaged together and will track thermally. The wide common mode range includes the negative rail, facilitating single supply applications. It is possible to have a "ground based" input driving a single supply amplifier with ground acting as the second or "bottom" supply of the amplifier. To maintain stability, output snubber networks have been internally connected to each op amp output (see "amplifier stability" in the attached application notes). The output stage is also current limit protected to approximately 3.0 amps. The MSK 171 is packaged in a space efficient 8-pin power dip while the MSK 172 is packaged in an 8-pin z-pack power dip with heat sink attach tabs. Consult factory for other packaging options if desired.

EQUIVALENT SCHEMATIC



TYPICAL APPLICATIONS

- Half and Full Bridge Motor Drives
- Audio Power Amplifiers
  - Bridge - 60W RMS Per Package
  - Stereo - 30W RMS Per Channel
- Ideal for Single Supply Systems
  - 5V - Peripheral
  - 12V - Automotive
  - 28V - Avionic

PIN-OUT INFORMATION

1	-Input 1	8	Output 1
2	+Input 1	7	-Vcc
3	+Input 2	6	+Vcc
4	-Input 2	5	Output 2

Rev. C 8/00

ABSOLUTE MAXIMUM RATINGS

V_{CC}	Total Supply Voltage	40V
$\pm I_{OUT}$	Output Current (within S.O.A.)	4A
V_{IND}	Input Voltage (Differential)	$\pm V_{CC}$
V_{IN}	Input Voltage (Common Mode)	$+V_{CC}$, $-V_{CC}$-0.5V
T_J	Junction Temperature	150°C
T_{ST}	Storage Temperature	-65°C to +150°C
T_{LD}	Lead Temperature	300°C
T_C	Case Operating Temperature (MSK171B/172B)	-55°C to +125°C
	(MSK171/172)	-40°C to +85°C
R_{TH}	Thermal Resistance (DC) Junction to Case	4.0°C/W

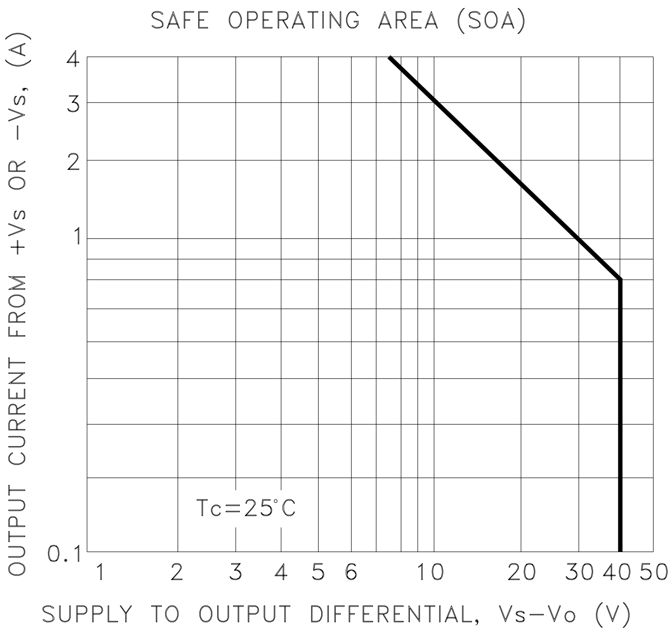
ELECTRICAL SPECIFICATIONS

Parameter		Test Conditions ①	Group A Subgroup	MSK171B/172B Min.	Typ.	Max.	MSK171/172 Min.	Typ.	Max.	Units
STATIC										
Supply Voltage Range ②		(Split Supply)	-	±2.5	±15	±20	±2.5	±15	±20	V
Quiescent Current		Total; V_{IN}=0V	1	-	±35	±75	-	±35	±75	mA
			2	-	±75	±105	-	-	-	mA
			3	-	±45	±75	-	-	-	mA
INPUT										
Offset Voltage		V_{IN}=0V	1	-	±0.5	±10	-	±2	±10	mV
Offset Voltage Drift ②		V_{IN}=0V	-	-	±20	±50	-	±20	-	μV/°C
Input Bias Current ②		V_{CM}=0V	-	-	±35	±500	-	±35	±1000	nA
		Full Temp.	-	-	±75	±1000	-	±75	-	nA
Power Supply Rejection ②		ΔV_{CC} = ±15V	-	60	80	-	60	80	-	dB
Common Mode Rejection ②		V_{CM} = ±10VDC	-	60	85	-	60	85	-	dB
Total Noise		R_L=500Ω A_V=1 C_L=1500pF	-	-	0.1	1.0	-	0.1	1.0	mV
OUTPUT										
Output Voltage Swing		(I_{OUT}= ±0.5A)	4	±14	±14.2	-	±14	±14.2	-	V
Output Current		V_{OUT}=MAX	4	±3.0	±4.0	-	±3.0	±4.0	-	A
Current Limit ②			-	-	±4.0	-	-	±4.0	-	A
Power Bandwidth ②		V_{OUT}=28V_{PP}	-	-	13.6	-	-	13.6	-	KHz
Crosstalk		I_{OUT}=1A f=1KHz	-	60	68	-	-	68	-	dB
Capacitive Load ②		A_V= +1V/V	-	-	0.22	-	-	0.22	-	μF
TRANSFER CHARACTERISTICS										
Slew Rate			4	0.5	1.2	-	0.5	1.2	-	V/μS
Open Loop Voltage Gain ②		F=10Hz R_L=500Ω	-	80	100	-	80	100	-	dB

NOTES:

① Unless otherwise noted $\pm V_{CC}$ = ±15VDC.
② Devices shall be capable of meeting the parameter, but need not be tested. Typical parameters are for reference only.
③ Industrial grade devices shall be tested to subgroups 1 and 4 unless otherwise requested.
④ Military grade devices ('B' suffix) shall be 100% tested to subgroups 1,2,3 and 4.
⑤ Subgroup 5 and 6 testing available upon request.
⑥ Subgroup 1,4 T_C = +25°C
Subgroup 2,5 T_C = +125°C
Subgroup 3,6 T_A = -55°C

SAFE OPERATING AREA (SOA)



Safe operating area curves are a graphical representation of all of the power limiting factors involved in the output stage of an operational amplifier. Three major power limiting factors are; output transistor wire bond carrying capability, output transistor junction temperature and secondary breakdown effects. To see if your application is meeting or exceeding the limitations of the safe operating area curves, perform the following steps:

1.) Find the worst case output power dissipation. For a split supply, purely resistive load application, this occurs when VOUT = 1/2 VCC.
2.) Take the values of (VCC-VOUT) and the corresponding output current and find their intersection on the safe operating area curves.
3.) Verify this point is below the safe operating area curves.

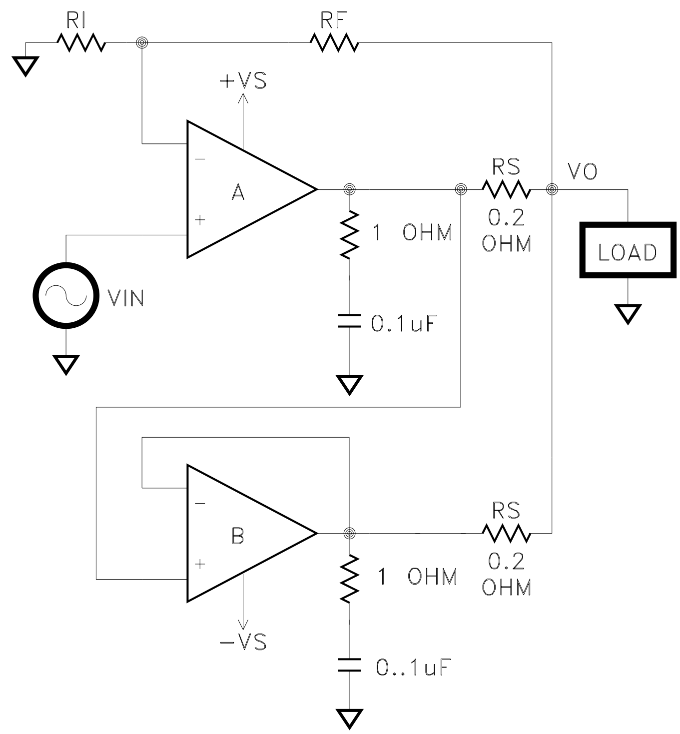
This is a simple task for purely resistive loads, for reactive loads the following table will save extensive analysis. Under transient conditions, capacitive and inductive loads up to the following maximum are safe.

± Vcc	Capacitive Load	Inductive Load
20V	200uF	7.5mH
15V	500uF	25mH
10V	5mF	35mH
5V	50mF	150mH

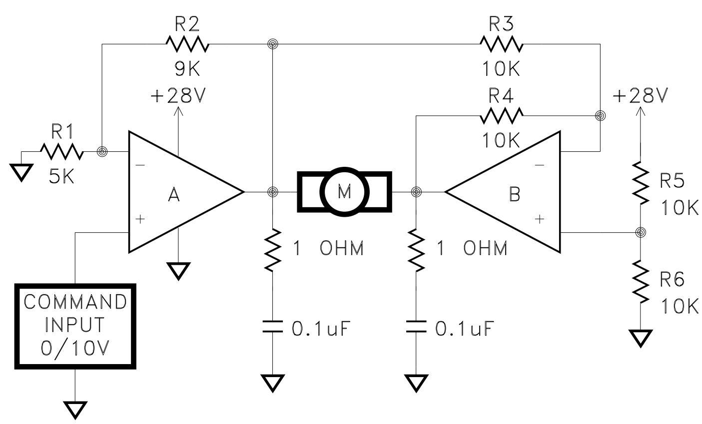
If the inductive load is driven near steady state conditions allowing the output to drop more than 6V below the supply rail while the amplifier is current limiting, the inductor should be capacitively coupled or the supply voltage must be lowered to meet the SOA criteria. It is a good practive to also connect reverse biased fast recovery diodes to the output for protection against sustained high energy flyback.

AMPLIFIER STABILITY

Since both output transistors in this amplifier are NPN, consideration must be taken when stabilizing the output. A one ohm resistor, 0.1uF capacitor snubber network has been added internally from the output to -Vcc on each amplifier. This configuration minimizes local output stage oscillations. As always, adequate power supply bypassing is a necessity for amplifier stability. A parallel combination of a 4.7uF electrolytic (for every amp of output current) and a 0.01uF ceramic disc capacitor should be connected as close as possible to the package power supply pins to ground. The R-C snubber networks shown on the outputs of the amplifiers in the typical circuits are internal and should not be added externally.



PARALLEL CONNECTION
(yields single 6A amplifier)

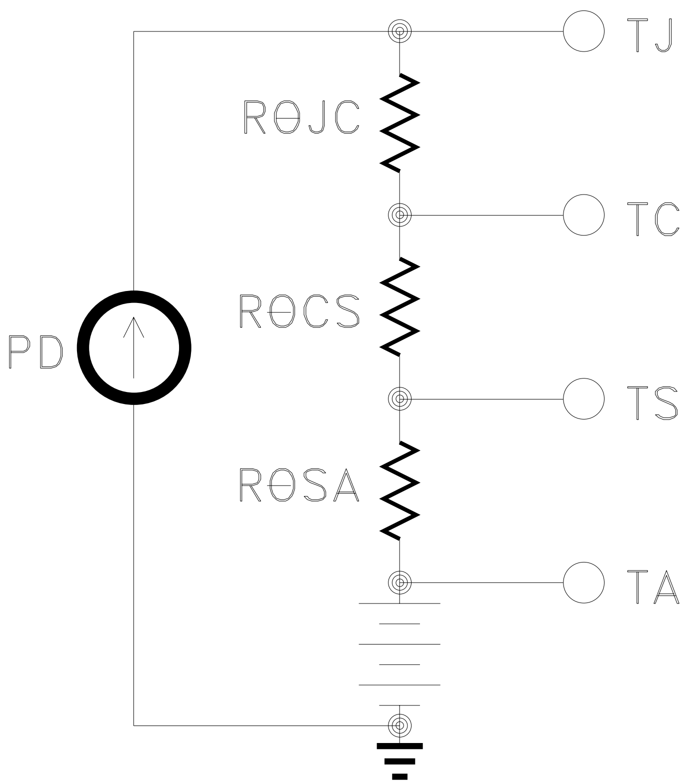


BIDIRECTIONAL MOTOR DRIVE

HEAT SINKING

To determine if a heat sink is necessary for your application and if so, what type, refer to the thermal model and governing equation below.

Thermal Model:



Governing Equation:

$T_J = P_D \times (R_{\theta JC} + R_{\theta CS} + R_{\theta SA}) + T_A$

Where

- T_J = Junction Temperature
- P_D = Total Power Dissipation
- $R_{\theta JC}$ = Junction to Case Thermal Resistance
- $R_{\theta CS}$ = Case to Heat Sink Thermal Resistance
- $R_{\theta SA}$ = Heat Sink to Ambient Thermal Resistance
- T_C = Case Temperature
- T_A = Ambient Temperature
- T_S = Sink Temperature

Example:

In our example the amplifier application requires each output to drive a 10 volt peak sine wave across a 20 ohm load for 0.5 amp of output current. For a worst case analysis we will treat the 0.5 amp peak output current as a D.C. output current. The power supplies are ±20VDC.

1.) Find Driver Power Dissipation
P_D = [(quiescent current) x (+V_{CC} - (-V_{CC}))] + [(V_{CC}-V_O) x I_{OUT}]
= (75mA) x (40V) + (10V) x (0.5A) + (10V) x (0.5A)
= 3W + 10W
= 13W

2.) For conservative design, set $T_J = +150°C$.

3.) For this example, worst case $T_A = +25°C$

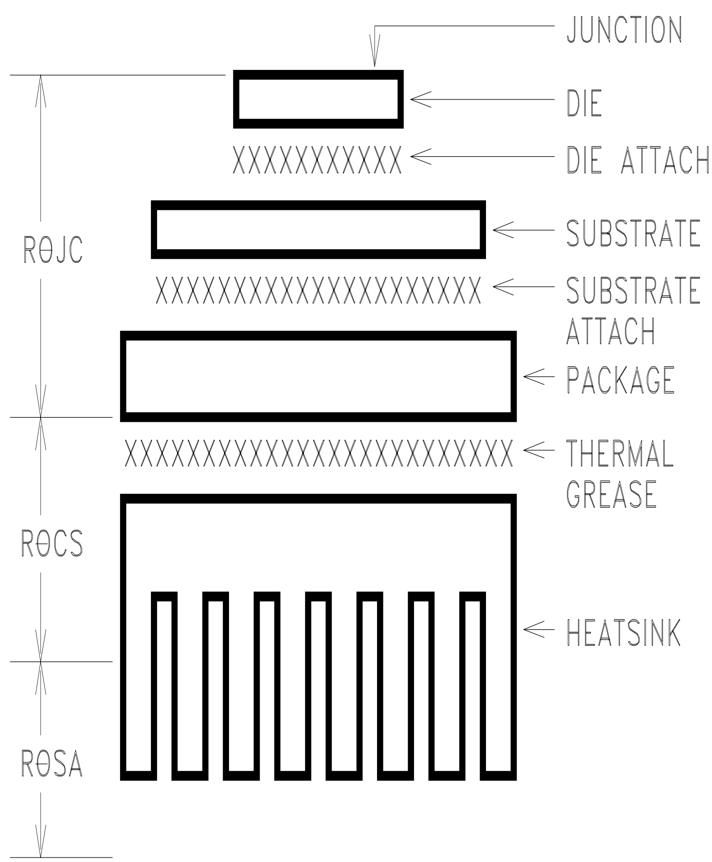
4.) $R_{\theta JC}$ = 4.0°C/W typically

5.) $R_{\theta CS}$ = 0.15°C/W for most thermal greases

6.) Rearrange governing equation to solve for $R_{\theta SA}$
$R_{\theta SA}$ = ((T_J - T_A)/P_D) - ($R_{\theta JC}$) - ($R_{\theta CS}$)
= ((150°C - 25°C) / 13W) - (4°C/W) - (.15°C/W)
≅ 5.5°C/W

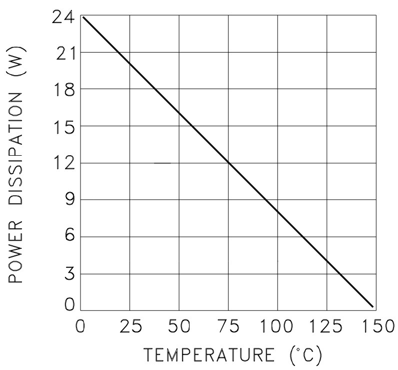
The heat sink in this example must have a thermal resistance of no more than 5.5°C/W to maintain a junction temperature of no more than +150°C.

Thermal Path:

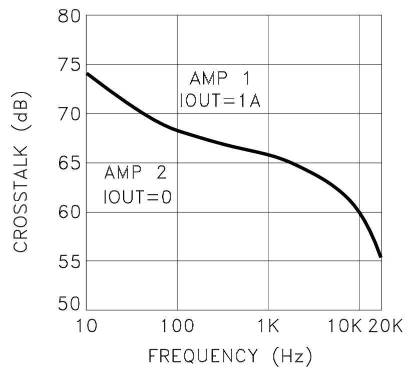


TYPICAL PERFORMANCE CURVES

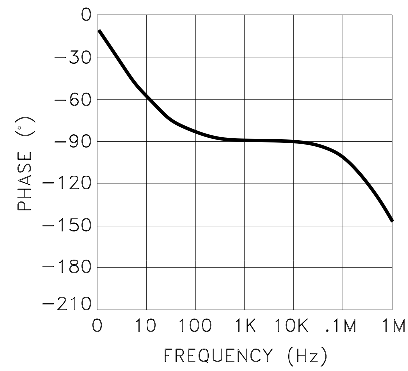
POWER DERATING



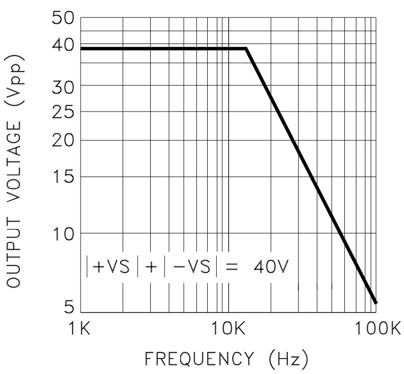
CROSSTALK vs FREQUENCY



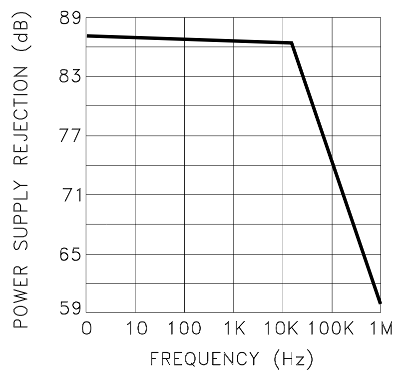
PHASE RESPONSE vs FREQENCY



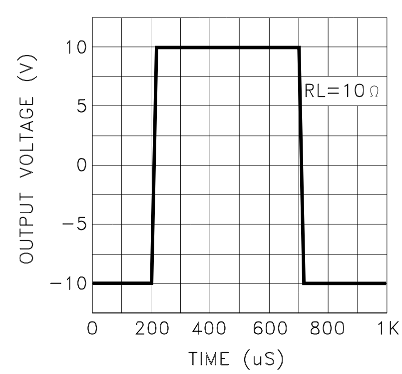
POWER RESPONSE vs FREQUENCY



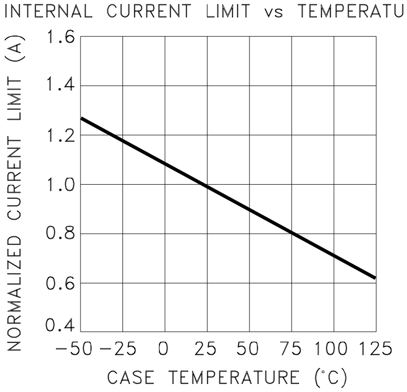
POWER SUPPLY REJECTION vs FREQUENCY



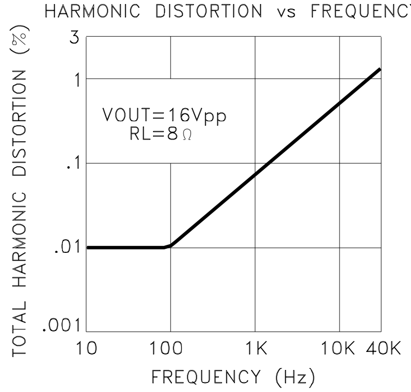
PULSE RESPONSE



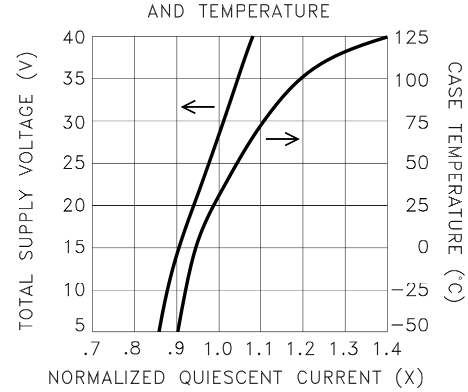
INTERNAL CURRENT LIMIT vs TEMPERATURE



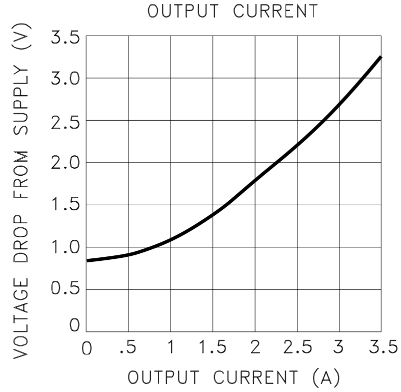
HARMONIC DISTORTION vs FREQUENCY



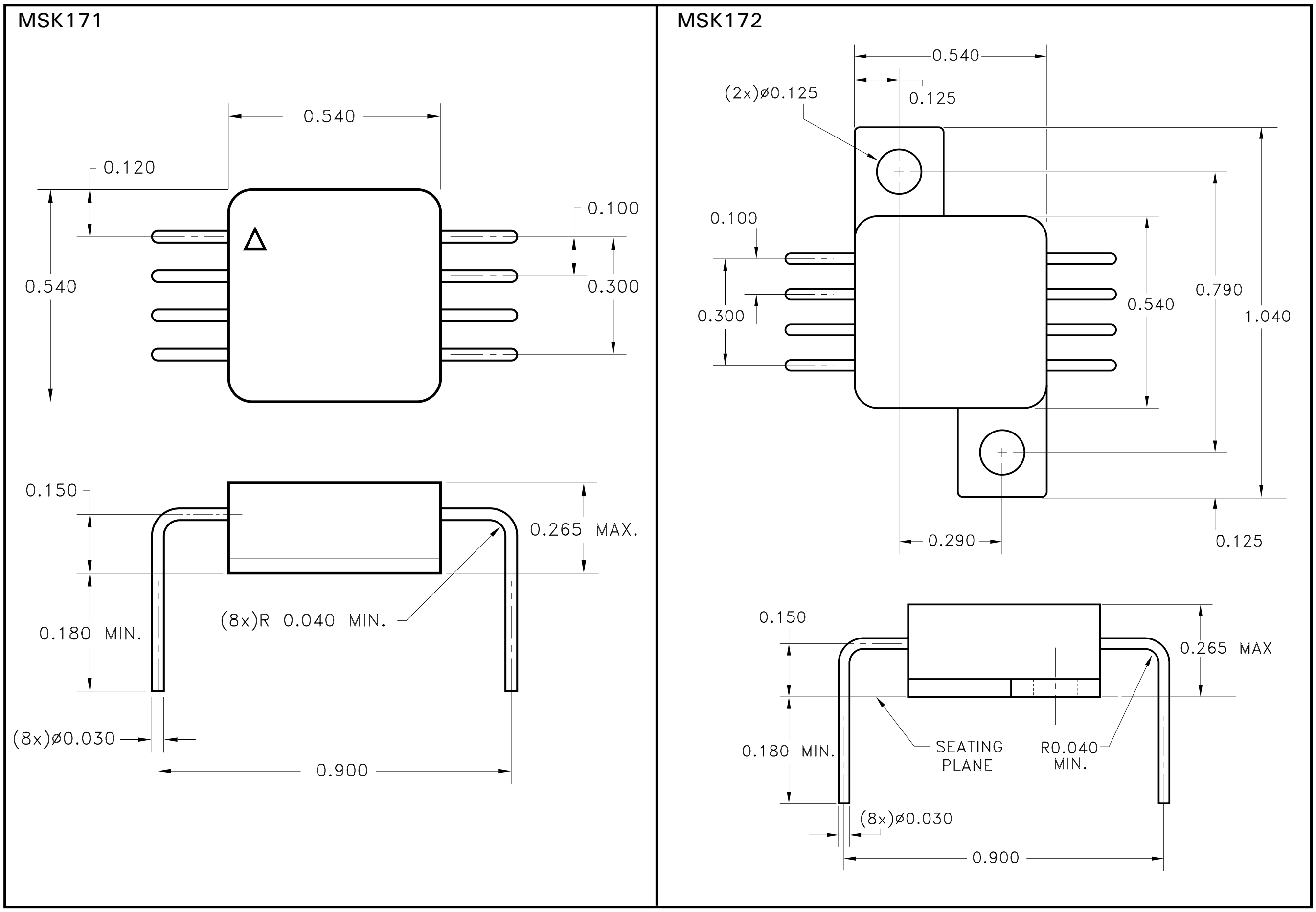
QUIESCENT CURRENT vs SUPPLY VOLTAGE
AND TEMPERATURE



OUTPUT VOLTAGE SWING vs
OUTPUT CURRENT



MECHANICAL SPECIFICATIONS



ESD TRIANGLE INDICATES PIN 1.
ALL DIMENSIONS ARE ±0.010 INCHES UNLESS OTHERWISE LABELED.

ORDERING INFORMATION

Part Number	Screening Level
MSK171	Industrial
MSK171B	Military-Mil-PRF-38534
MSK172	Industrial
MSK172B	Military-Mil-PRF-38534

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