ISO-9001 CERTIFIED BY DSCC

HIGH POWER DUAL OPERATIONAL AMPLIFIER 173/173-1

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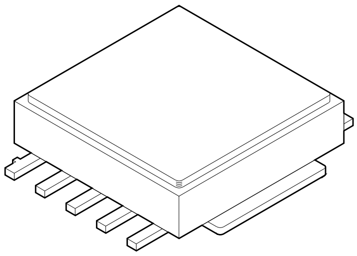
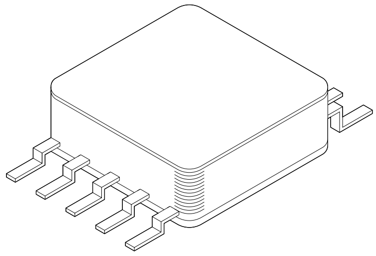
MIL-PRF-38534

FEATURES:

- Extremely Compact Surface Mount Package
- Low Cost Dual High Power Amplifier
- Wide Supply Voltage Range: 5V to 40V
- High Output Current: 2A
- High Efficiency: |Vs-2.2V| at 2A
- Internal Current Limit
- Wide Common Mode Range (Includes Negative Supply Voltage)
- Low Distortion



MSK173

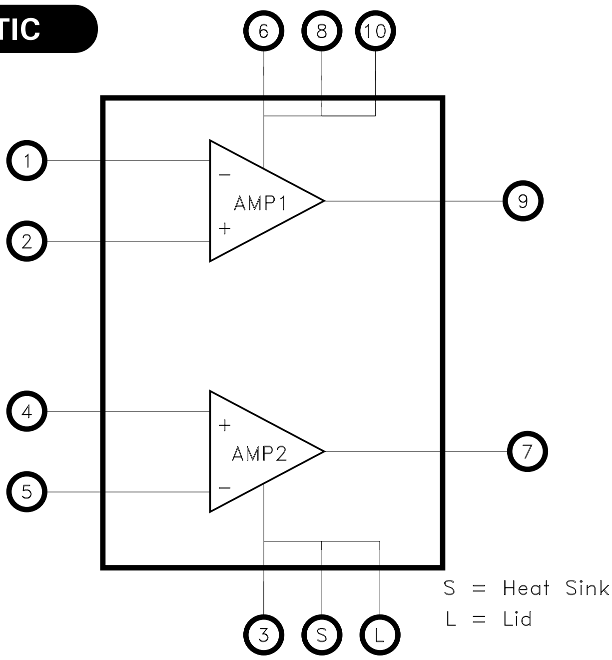


MSK173-1

DESCRIPTION:

The MSK 173 is a high power dual operational amplifier. Each amplifier is capable of delivering two amps of current to the load. The MSK 173 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. The output stage is current limit protected to approximately 4.0 amps. The MSK 173 is packaged in an extremely space efficient 10 pin power SOIC package. The MSK 173-1 is packaged in a 10 pin flatpack. Consult the factory for other packaging options if desired.

EQUIVALENT SCHEMATIC



All power pins must be electrically connected for proper operation.

TYPICAL APPLICATIONS

- Half and Full Bridge Motor Drives
- Audio Power Amplifiers
- Headphones
- Cellular Phones, PCMCIA, PDA
- Ideal for Single Supply Systems
  - 5V - Peripheral
  - 12V - Automotive
  - 28V - Avionic

PIN-OUT INFORMATION

1	-Input 1	10	+Vcc
2	+Input 1	9	Output 1
3	-Vcc	8	+Vcc
4	+Input 2	7	Output 2
5	-Input 2	6	+Vcc

HEAT SINK

The heat sink of the package and the lid are electrically connected to -Vcc. The heat sink tab must be connected to the system -Vcc.

ABSOLUTE MAXIMUM RATINGS

V_{CC}	Total Supply Voltage	40V
$\pm I_{OUT}$	Output Current (within S.O.A.)	3A PK
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	
	(MSK173B,173B-1 ④)	-55°C to +125°C
	(MSK173,173-1)	-40°C to +85°C
R_{TH}	Thermal Resistance (DC) Junction to Case	
	MSK 173	3.0°C/W
	MSK 173-1	12.0°C/W

ELECTRICAL SPECIFICATIONS

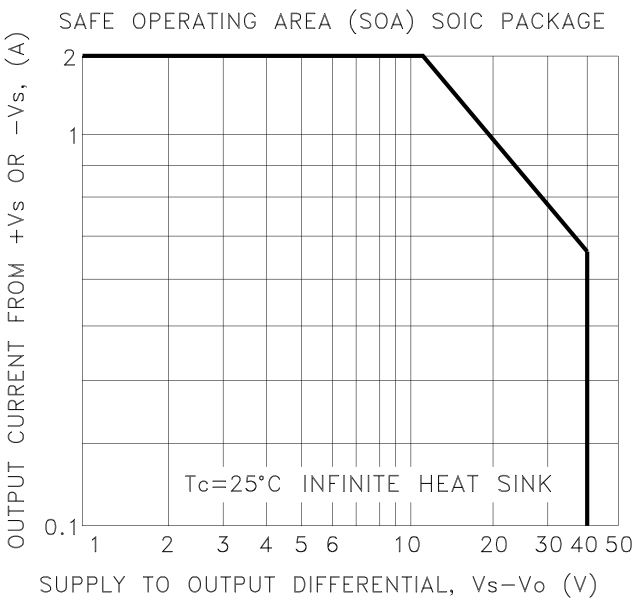
Parameter	Test Conditions ①	Group A Subgroup	MSK173B ④ MSK173B-1 Min.	Typ.	Max.	MSK173 MSK173-1 Min.	Typ.	Max.	Units
STATIC									
Supply Voltage Range ②	(Split Supply)	-	±2.5	±15	±20	±2.5	±15	±20	V
Quiescent Current	Total; V_{IN}=0V	1	-	±35	±50	-	±35	±60	mA
		2	-	±50	±75	-	-	-	mA
		3	-	±30	±50	-	-	-	mA
INPUT									
Offset Voltage	V_{IN}=0V	1	-	±0.5	±10	-	±2	±15	mV
		2, 3	-	±2.0	±15	-	-	-	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		4	±14	±14.2	-	±14	±14.2	-	V
Output Current Peak ②	V_{OUT}=MAX	-	±2.0	±3.0	-	±2.0	±3.0	-	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. Consult factory for availability of military grade devices.
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

APPLICATION NOTES

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 $V_{OUT} = 1/2\ V_{CC}$.
2. Take the values of (V_{CC}-V_{OUT}) 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.

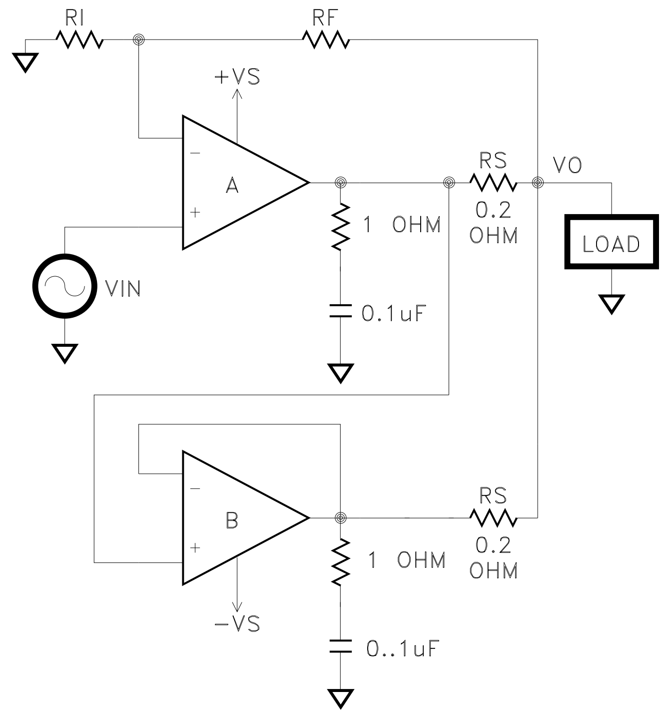
This is a simple task for purely resistive loads, for reactive loads the following table will save extensive analysis. Under transient conditions, capacitive and inductive loads up to the following maximum are usually safe.

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

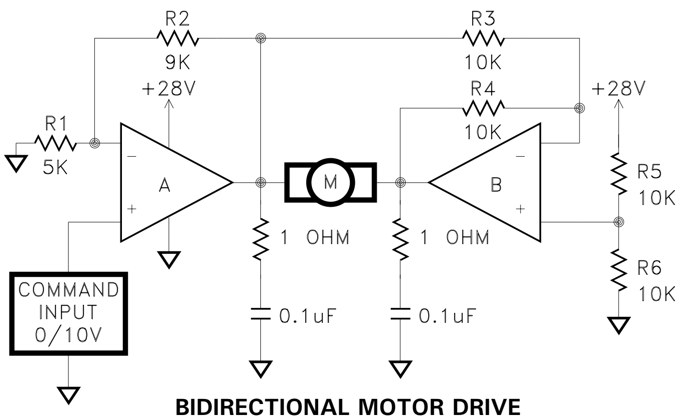
If the inductive load is driven near steady state conditions allowing the output to drop more than 6V below the supply rail while the amplifier is current limiting, the inductor should be capacitively coupled or the supply voltage must be lowered to meet the SOA criteria. It is a good practice to also 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 should be added externally 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.



PARALLEL CONNECTION
yields single 4A amplifier



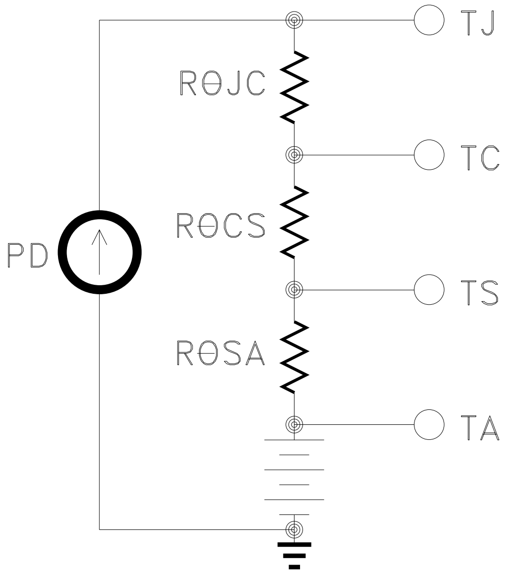
BIDIRECTIONAL MOTOR DRIVE

APPLICATION NOTES CONTINUED

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

DEVICE SOLDERING

The MSK 173 is a highly thermally conductive device and the thermal path from the package to the internal junctions is very short. Standard surface mount techniques should be used when soldering the device into a circuit board. A hole can be cut in the printed circuit board to allow the heat sink of the package to be thermally bonded to an external heat sink for high power applications.

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 ±12VDC. The device is the SOIC version.

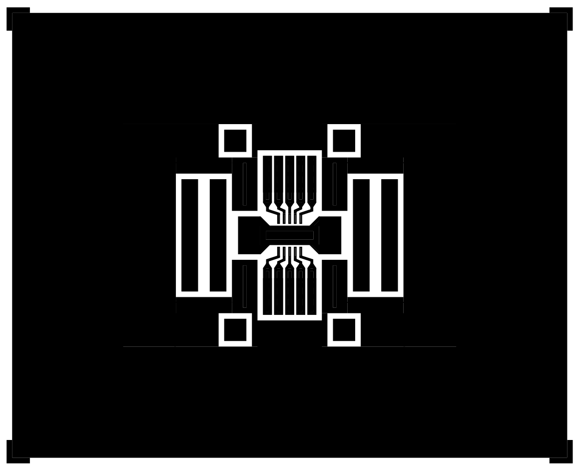
1.) Find Driver Power Dissipation
P_D = [(quiescent current) x (+V_{CC} - (-V_{CC}))] + [(V_{CC}-V_O) x I_{OUT}]
= (75mA) x (24V) + (2V) x (0.5A) + (2V) x (0.5A)
= 1.8W + 2W
= 3.8W
2.) For conservative design, set T_J = +150°C.
3.) For this example, worst case T_A = +25°C
4.) $R_{\theta JC}$ = 3.0°C/W
5.) 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) / 3.8W) - (3°C/W)
≅ 29.9°C/W

The heat sink in this example must have a thermal resistance of no more than 30°C/W to maintain a junction temperature of no more than +150°C.

CASE CONNECTION

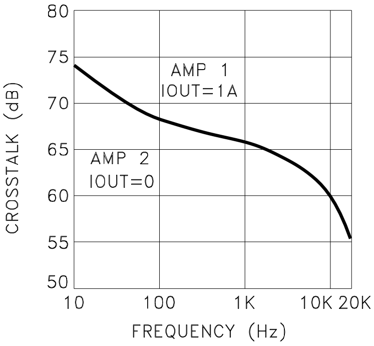
The heat sink and lid of the MSK 173 are electrically connected to the negative power supply rail. The user is urged to keep this in mind when designing the printed circuit card the MSK 173 will be placed in. There should be no printed circuit traces making contact with the case of the device except for -Vcc. The -Vcc plane or ground for single supply systems, can be used to pull heat away from the device and must be connected electrically to the heat sink.

UNIVERSAL EVALUATION PC BOARD LAYOUT

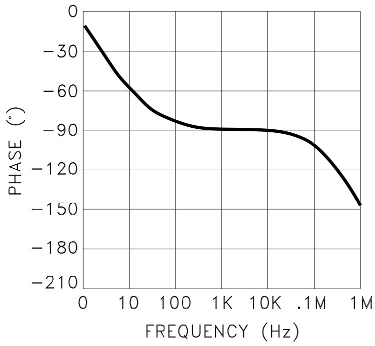


TYPICAL PERFORMANCE CURVES

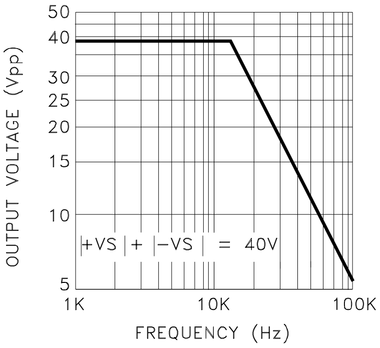
CROSSTALK vs FREQUENCY



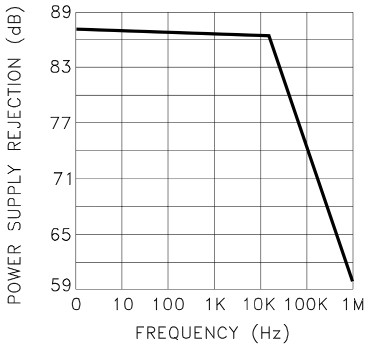
PHASE RESPONSE vs FREQENCY



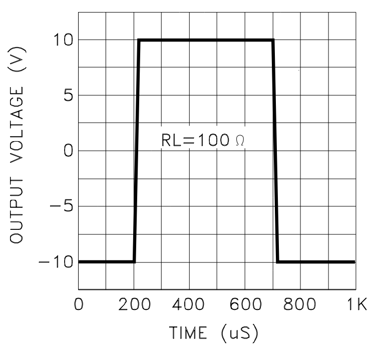
POWER RESPONSE vs FREQUENCY



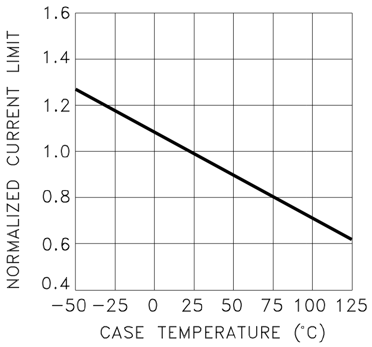
POWER SUPPLY REJECTION vs FREQUENCY



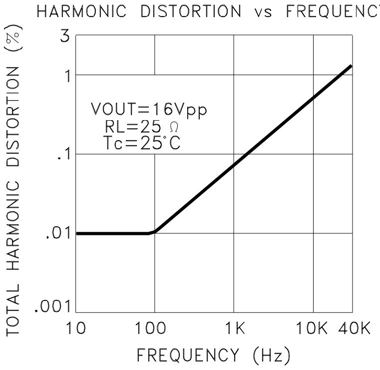
PULSE RESPONSE



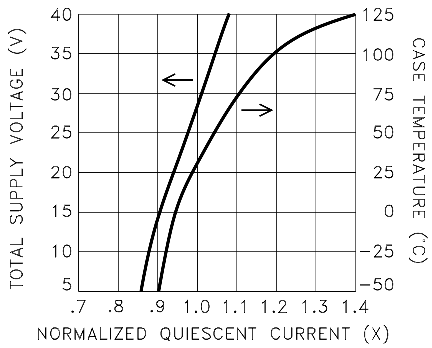
INTERNAL CURRENT LIMIT vs TEMPERATURE



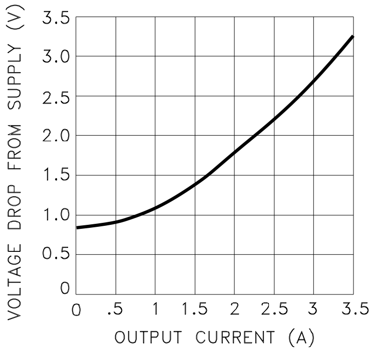
HARMONIC DISTORTION vs FREQUENCY



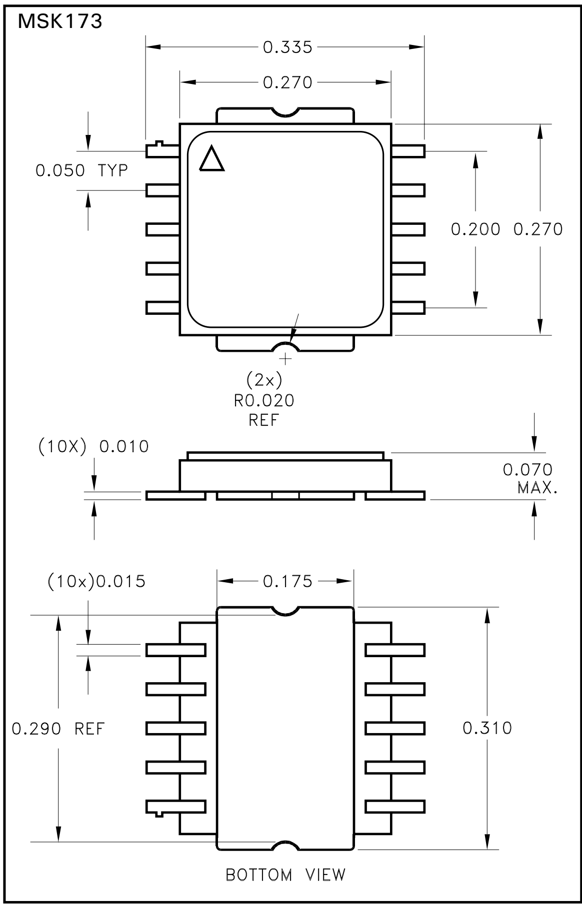
QUIESCENT CURRENT vs SUPPLY VOLTAGE
AND TEMPERATURE

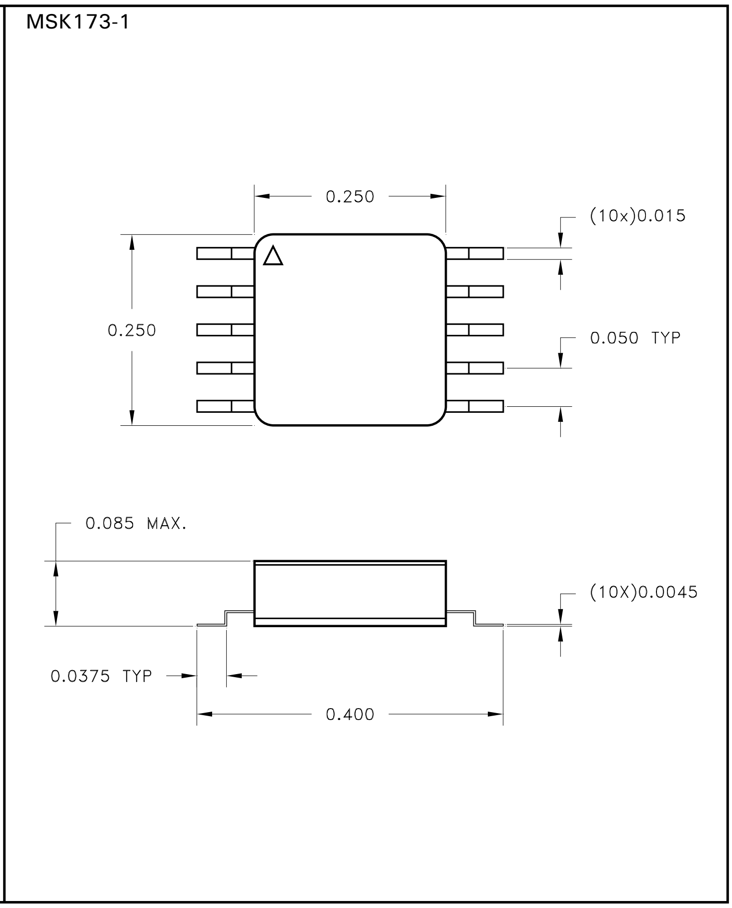


OUTPUT VOLTAGE SWING vs
OUTPUT CURRENT



MECHANICAL SPECIFICATIONS





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

ORDERING INFORMATION

Part Number	Screening Level	Package Style	θJC (°C/W)
MSK173	Industrial/Non-Hermetic	10 Pin Power SOIC	3.0
MSK173B	Military-Mil-PRF-38534	10 Pin Power SOIC	3.0
MSK173-1	Industrial/Non-Hermetic	10 Pin Flatpack	12
MSK173B-1	Military-Mil-PRF-38534	10 Pin Flatpack	12

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