



M.S.KENNEDY CORP.

HIGH SPEED, BUFFER AMPLIFIER

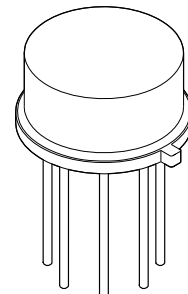
0002

4707 Dey Road Liverpool, N.Y. 13088

(315) 701-6751

FEATURES:

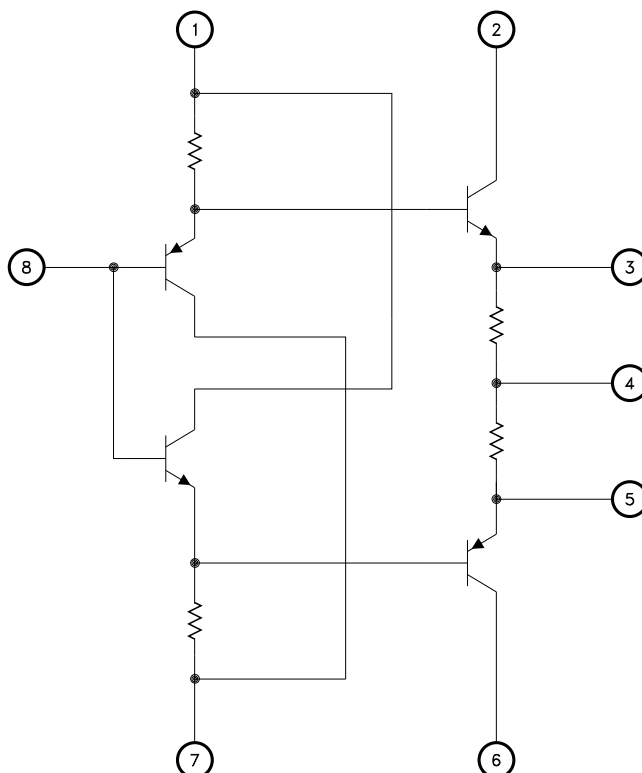
- Industry Wide LH0002 Replacement
- High Input Impedance-180KΩ Min
- Low Output Impedance-10Ω Max
- Low Harmonic Distortion
- DC to 30 MHz Bandwidth
- Slew Rate is Typically 400 V/μS
- Operating Range from ±5V to ±20V
- Available to DSCC SMD5962-7801301XC
- Equivalent Rad Hard Device MSK 0002RH



DESCRIPTION:

The MSK 0002 is a general purpose current amplifier. It is the industry wide replacement for the LH0002. The device is ideal for use with an operational amplifier in a closed loop configuration to increase current output. The MSK 0002 is designed with a symmetrical output stage that provides low output impedances to both the positive and negative portions of output pulses. The MSK 0002 is packaged in a hermetic 8 lead low profile TO-5 header and is specified over the full military temperature range.

EQUIVALENT SCHEMATIC



TYPICAL APPLICATIONS

- High Speed D/A Conversion
- 30MHz Buffer
- Line Driver
- Precision Current Source

PIN-OUT INFORMATION

1	V1 +	5	E4
2	V2 +	6	V2-
3	E3	7	V1-
4	Output	8	Input

CASE = ISOLATED

ABSOLUTE MAXIMUM RATINGS ^⑤

$\pm V_{CC}$	Supply Voltage	$\pm 22V$
V_{IN}	Input Voltage	$\pm 22V$
P_d	Power Dissipation	600mW
T_c	Case Operating Temperature (MSK 0002H)	$-55^{\circ}C$ to $+125^{\circ}C$
	(MSK 0002)	$-40^{\circ}C$ to $+85^{\circ}C$

T_{ST}	Storage Temperature Range	$-65^{\circ}C$ to $+150^{\circ}C$
T_{LD}	Lead Temperature Range (10 Seconds)	$+300^{\circ}C$
T_J	Junction Temperature	$+175^{\circ}C$
θ_{JC}	Thermal Resistance @ $T_C = 125^{\circ}C$ Output Devices	$55^{\circ}C/W$

ELECTRICAL SPECIFICATIONS

Parameter	Test Conditions ^①	Group A Subgroup	MSK 0002H ^④			MSK 0002			Units
			Min.	Typ.	Max.	Min.	Typ.	Max.	
Quiescent Current	$V_{IN} = 0V$ $R_S = 10K\Omega$ $R_L = 1.0K\Omega$	1	-	± 6.3	± 10	-	± 6.3	± 12	mA
Input Offset Current	$R_S = 10K\Omega$ $R_L = 1.0K\Omega$	1	-	± 2	± 10	-	± 2	± 12	μA
		2,3	-	± 5	± 10	-	-	-	μA
Input Offset Voltage	$R_S = 300\Omega$ $R_L = 1.0K\Omega$	1	-	± 6	± 30	-	± 6	± 35	mV
		2,3	-	± 10	± 30	-	-	-	mV
Input Impedance ^③	$V_{IN} = 1.0V_{RMS}$ $R_S = 200K\Omega$ $R_L = 1K\Omega$ $f = 1.0KHz$	4	180	-	-	180	-	-	$K\Omega$
Output Impedance ^③	$V_{IN} = 1.0V_{RMS}$ $R_S = 10K\Omega$ $R_L = 50\Omega$ $f = 1.0KHz$	4	-	-	10	-	-	10	Ω
Output Voltage Swing	$V_{IN} = \pm 12V_p$ $R_L = 1.0K\Omega$ $f = 1.0KHz$	4	± 10	± 11	-	± 10	± 11	-	Vp
	$V_{IN} = \pm 10V_p$ $R_L = 100\Omega$ $+V_{CC} = \pm 15V$ $f = 1.0KHz$	4	± 9.5	-	-	± 9.5	-	-	Vp
Voltage Gain ^②	$V_{IN} = 3.0V_{PP}$ $f = 1.0KHz$ $R_S = 10K\Omega$ $R_L = 1.0K\Omega$	4	0.95	0.97	-	0.95	0.97	-	V/V
		5,6	0.95	-	-	-	-	-	V/V
Rise Time	$V_{OUT} = 2.5V_{PP}$ $f = 10KHz$ $R_S = 100\Omega$ $R_L = 50\Omega$	4	-	8	12	-	8	15	nS

NOTES:

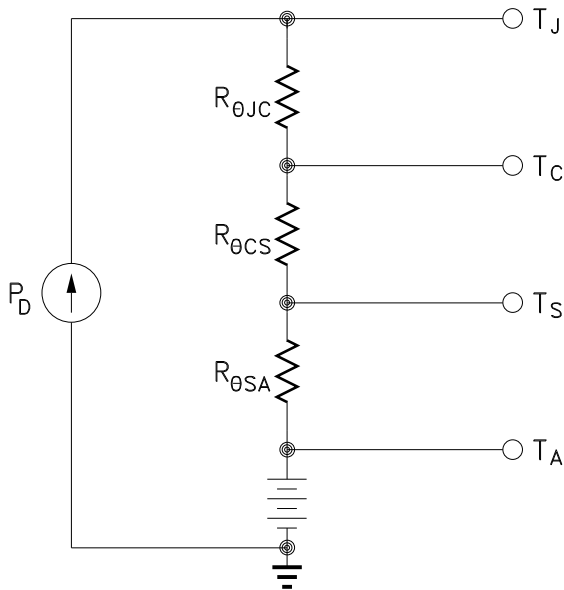
- ① Unless otherwise specified $\pm V_{CC} = \pm 12VDC$
- ② Subgroups 5 & 6 shall be tested as part of device initial characterization and after design and process changes. Parameter shall be guaranteed to the limits specified for subgroups 5 & 6 for all lots not specifically tested.
- ③ Devices shall be capable of meeting the parameter, but need not be tested.
- ④ Subgroup 1,4 $T_A = T_C = +25^{\circ}C$
Subgroup 2,5 $T_A = T_C = +125^{\circ}C$
Subgroup 3,6 $T_A = T_C = -55^{\circ}C$
- ⑤ Continuous operation at or above absolute maximum ratings may adversely effect the device performance and/or life cycle.

APPLICATION NOTES

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

$R_{\theta CS}$ = Heat Sink to Ambient Thermal Resistance

T_C = Case Temperature

T_A = Ambient Temperature

T_S = Sink Temperature

Example:

This example demonstrates a worst case analysis for the buffer output stage. This occurs when the output voltage is 1/2 the power supply voltage. Under this condition, maximum power transfer occurs and the output is under maximum stress.

Conditions:

$$V_{CC} = \pm 12\text{VDC}$$

$$V_o = \pm 6\text{Vp Sine Wave, Freq.} = 1\text{KHz}$$

$$R_L = 100\Omega$$

For a worst case analysis we will treat the $\pm 6\text{Vp}$ sine wave as an 6 VDC output voltage.

1.) Find Driver Power Dissipation

$$\begin{aligned} PD &= (V_{CC} - V_o) (V_o / R_L) \\ &= (12\text{V} - 6\text{V}) (6\text{V} / 100\Omega) \\ &= 360\text{mW} \end{aligned}$$

2.) For conservative design, set $T_J = +125^\circ\text{C}$ Max.

3.) For this example, worst case $T_A = +80^\circ\text{C}$

4.) $R_{\theta JC} = 55^\circ\text{C/W}$ from MSK 0002H Data Sheet

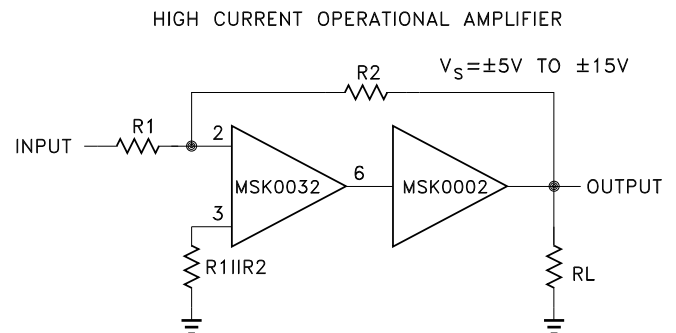
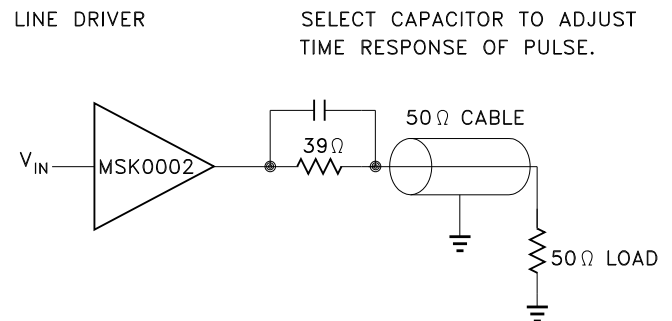
5.) $R_{\theta CS} = 0.15^\circ\text{C/W}$ for most thermal greases

6.) Rearrange governing equation to solve for $R_{\theta SA}$

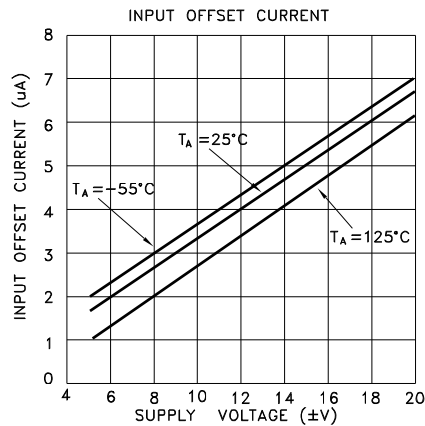
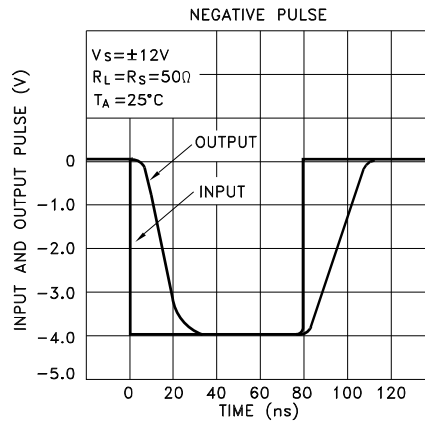
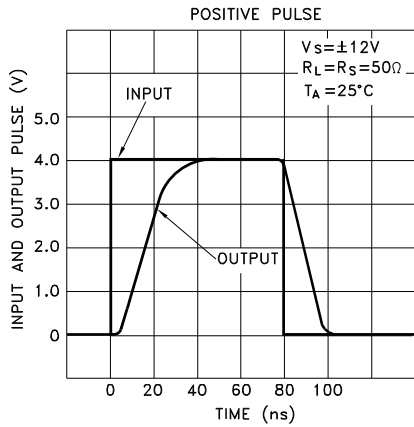
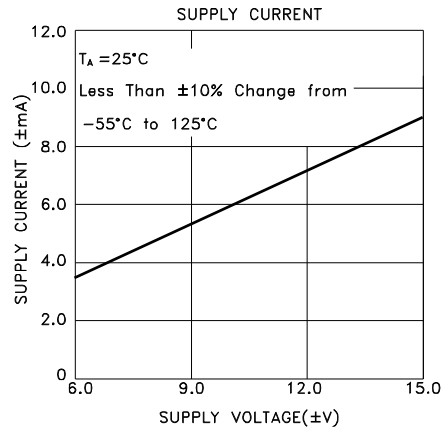
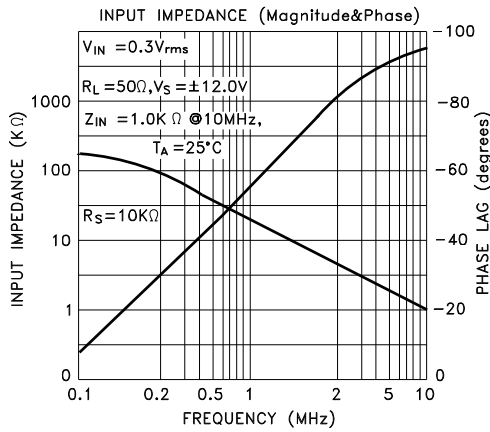
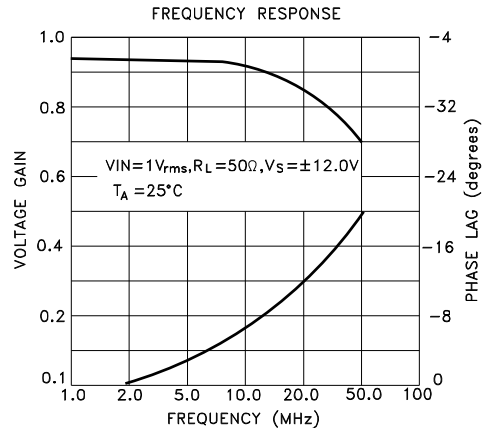
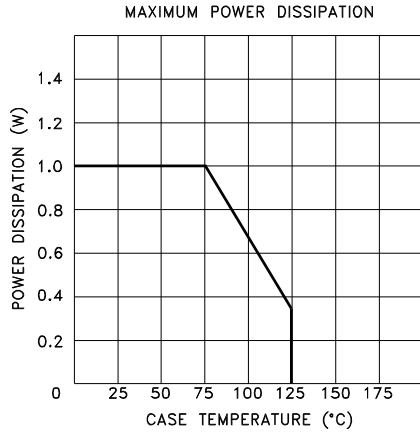
$$\begin{aligned} R_{\theta SA} &= ((T_J - T_A) / P_D) - (R_{\theta JC}) - (R_{\theta CS}) \\ &= ((125^\circ\text{C} - 80^\circ\text{C}) / 0.36\text{W}) - 55^\circ\text{C/W} - 0.15^\circ\text{C/W} \\ &= 125 - 55.15 \\ &= 69.9^\circ\text{C/W} \end{aligned}$$

This heat sink in this example must have a thermal resistance of no more than 69.9°C/W to maintain a junction temperature of no more than $+125^\circ\text{C}$.

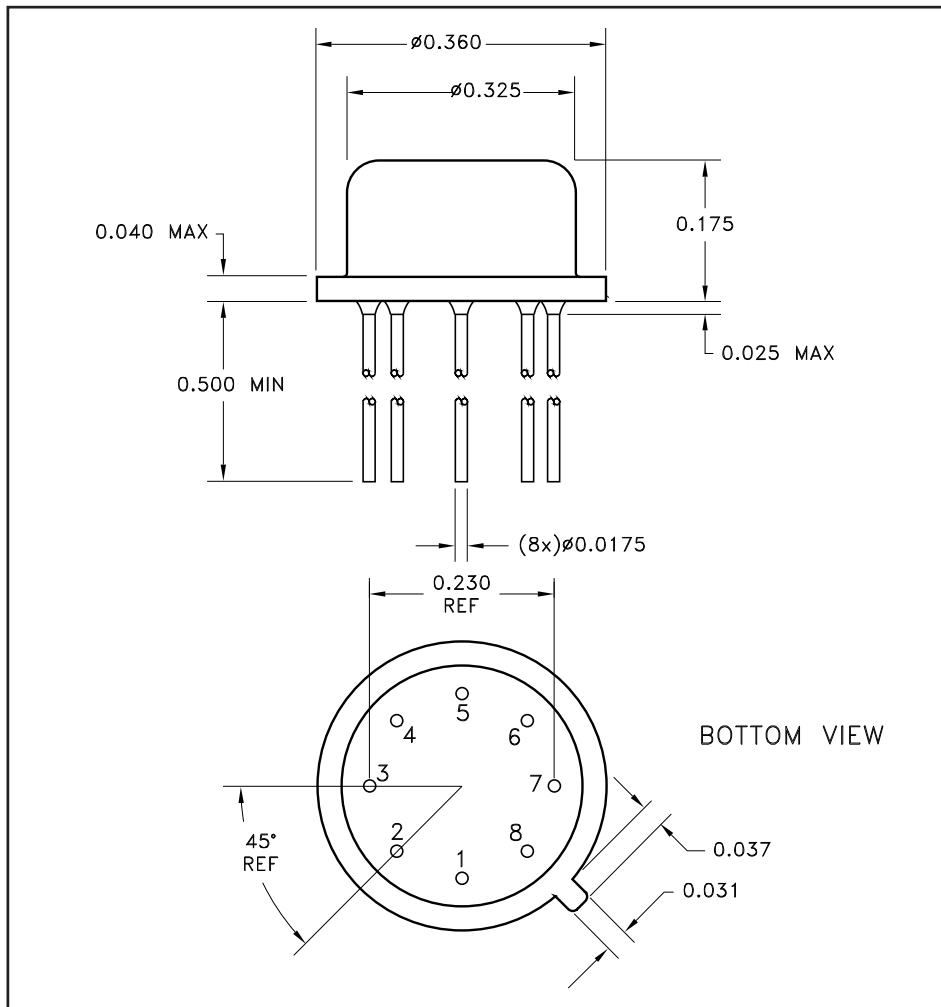
Typical Applications:



TYPICAL PERFORMANCE CURVES



MECHANICAL SPECIFICATIONS



ALL DIMENSIONS ARE ± 0.010 INCHES UNLESS OTHERWISE LABELED

ORDERING INFORMATION

Part Number	Screening Level
MSK0002	Industrial
MSK0002H	Mil-PRF-38534 Class H
7801-301XC	DSCC-SMD

M.S. Kennedy Corp.
 4707 Dey Road, Liverpool, New York 13088
 Phone (315) 701-6751
 FAX (315) 701-6752
www.mskennedy.com

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