



M.S.KENNEDY CORP.

# HIGH SPEED, BUFFER AMPLIFIER

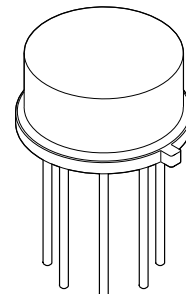
# 0002

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(315) 701-6751

**FEATURES:**

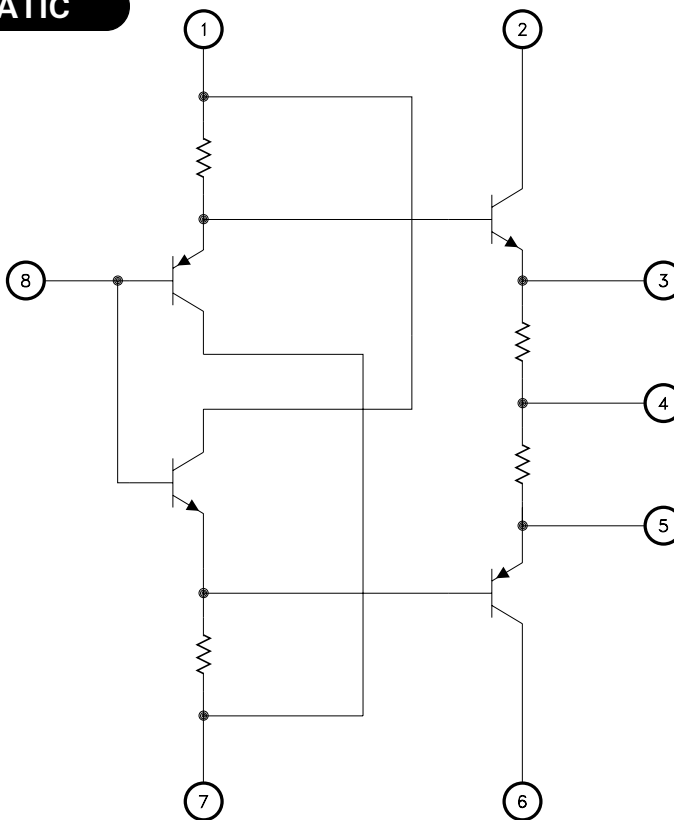
- Industry Wide LH0002 Replacement
- High Input Impedance-180KΩ Min
- Low Output Impedance-10Ω Max
- Low Harmonic Distortion
- DC to 30 MHz Bandwidth
- Slew Rate is Typically 400 V/μS
- Operating Range from ±5V to ±20V
- Available to DSCC SMD5962-7801301XC



**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

## ABSOLUTE MAXIMUM RATINGS <sup>⑤</sup>

$\pm V_{CC}$	Supply Voltage . . . . .	$\pm 22V$
$V_{IN}$	Input Voltage . . . . .	$\pm 22V$
$P_d$	Power Dissipation . . . . .	600mW
$T_c$	Case Operating Temperature (MSK 0002H/E) . . . . .	$-55^{\circ}C$ 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 . . . . .	$+175^{\circ}C$
$\theta_{JC}$	Thermal Resistance @ $T_C = 125^{\circ}C$ Output Devices . . . . .	$55^{\circ}C/W$

## ELECTRICAL SPECIFICATIONS

Parameter	Test Conditions <sup>①</sup>	Group A Subgroup	MSK 0002H/E <sup>④</sup>			MSK 0002			Units
			Min.	Typ.	Max.	Min.	Typ.	Max.	
Quiescent Current	$V_{IN} = 0V$ $R_S = 10K\Omega$ $R_L = 1.0K\Omega$	1	-	$\pm 6.3$	$\pm 10$	-	$\pm 6.3$	$\pm 12$	mA
Input Offset Current	$R_S = 10K\Omega$ $R_L = 1.0K\Omega$	1	-	$\pm 2$	$\pm 10$	-	$\pm 2$	$\pm 12$	$\mu A$
		2,3	-	$\pm 5$	$\pm 10$	-	-	-	$\mu A$
Input Offset Voltage	$R_S = 300\Omega$ $R_L = 1.0K\Omega$	1	-	$\pm 6$	$\pm 30$	-	$\pm 6$	$\pm 35$	mV
		2,3	-	$\pm 10$	$\pm 30$	-	-	-	mV
Input Impedance <sup>③</sup>	$V_{IN} = 1.0V_{RMS}$ $R_S = 200K\Omega$ $R_L = 1K\Omega$ $f = 1.0KHz$	4	180	-	-	180	-	-	$K\Omega$
Output Impedance <sup>③</sup>	$V_{IN} = 1.0V_{RMS}$ $R_S = 10K\Omega$ $R_L = 50\Omega$ $f = 1.0KHz$	4	-	-	10	-	-	10	$\Omega$
Output Voltage Swing	$V_{IN} = \pm 12V_p$ $R_L = 1.0K\Omega$ $f = 1.0KHz$	4	$\pm 10$	$\pm 11$	-	$\pm 10$	$\pm 11$	-	V <sub>p</sub>
	$V_{IN} = \pm 10V_p$ $R_L = 100\Omega$ $+V_{CC} = \pm 15V$ $f = 1.0KHz$	4	$\pm 9.5$	-	-	$\pm 9.5$	-	-	V <sub>p</sub>
Voltage Gain <sup>②</sup>	$V_{IN} = 3.0V_{PP}$ $f = 1.0KHz$ $R_S = 10K\Omega$ $R_L = 1.0K\Omega$	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:

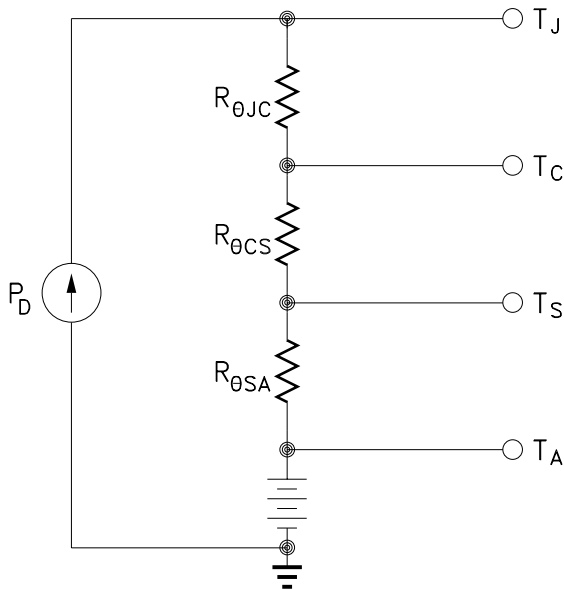
- ① Unless otherwise specified  $\pm V_{CC} = \pm 12VDC$
- ② Subgroups 5 & 6 shall be tested as part of device initial characterization and after design and process changes. Parameter shall be guaranteed to the limits specified for subgroups 5 & 6 for all lots not specifically tested.
- ③ Devices shall 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:

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

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

$$R_L = 100\Omega$$

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

1.) Find Driver Power Dissipation

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

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

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

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

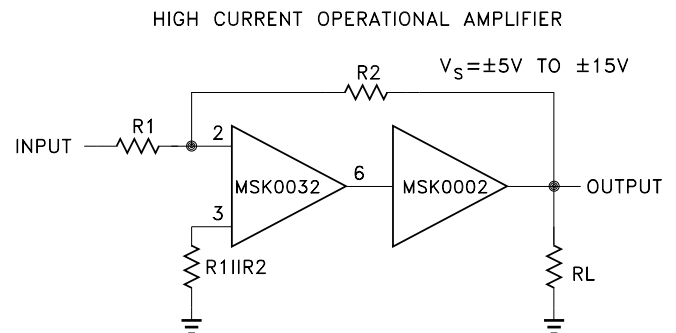
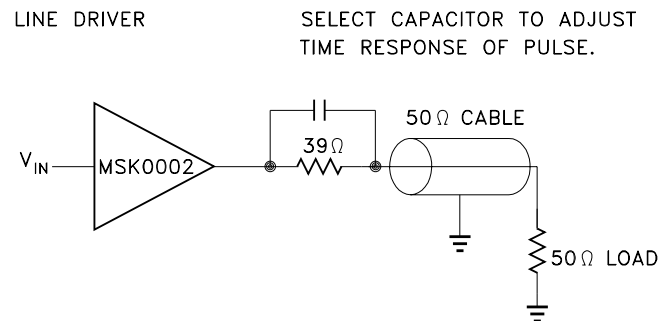
5.)  $R_{\theta CS} = 0.15^\circ C/W$  for most thermal greases

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

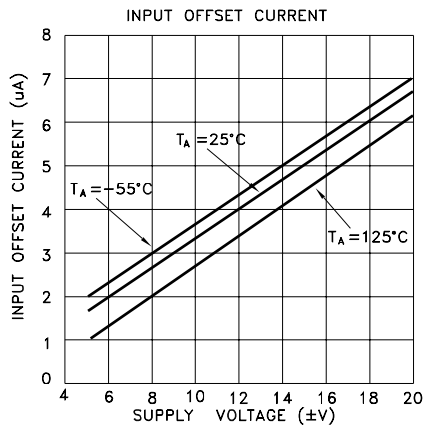
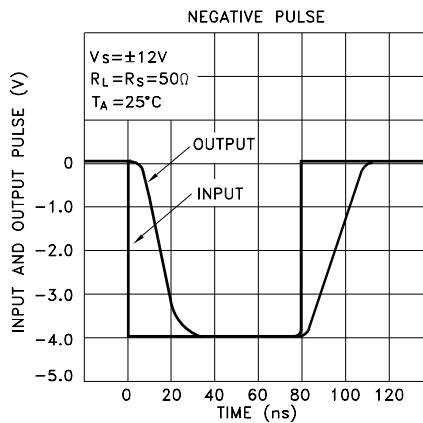
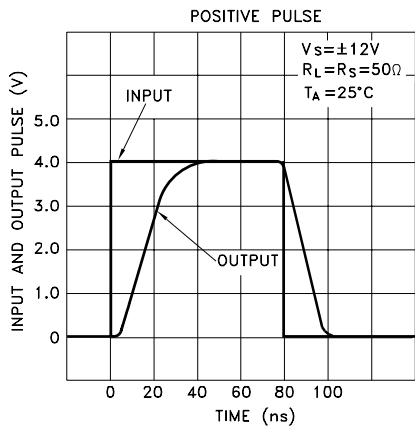
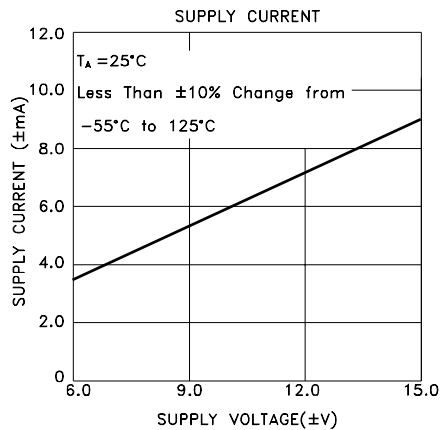
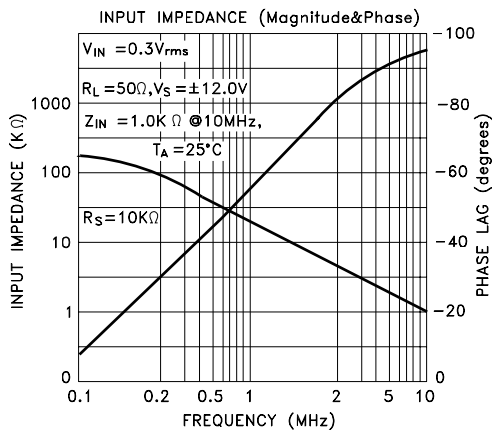
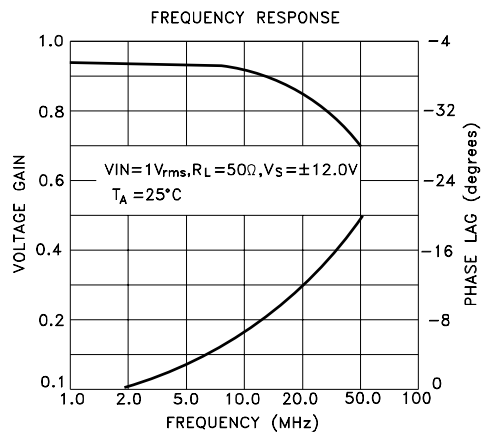
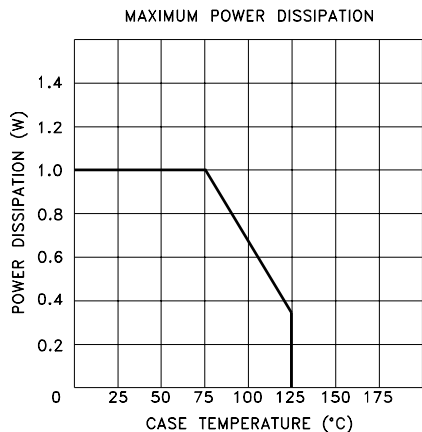
$$\begin{aligned} R_{\theta SA} &= ((T_J - T_A) / P_D) - (R_{\theta JC}) - (R_{\theta CS}) \\ &= ((125^\circ C - 80^\circ C) / 0.36W) - 55^\circ C/W - 0.15^\circ C/W \\ &= 125 - 55.15 \\ &= 69.9^\circ C/W \end{aligned}$$

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

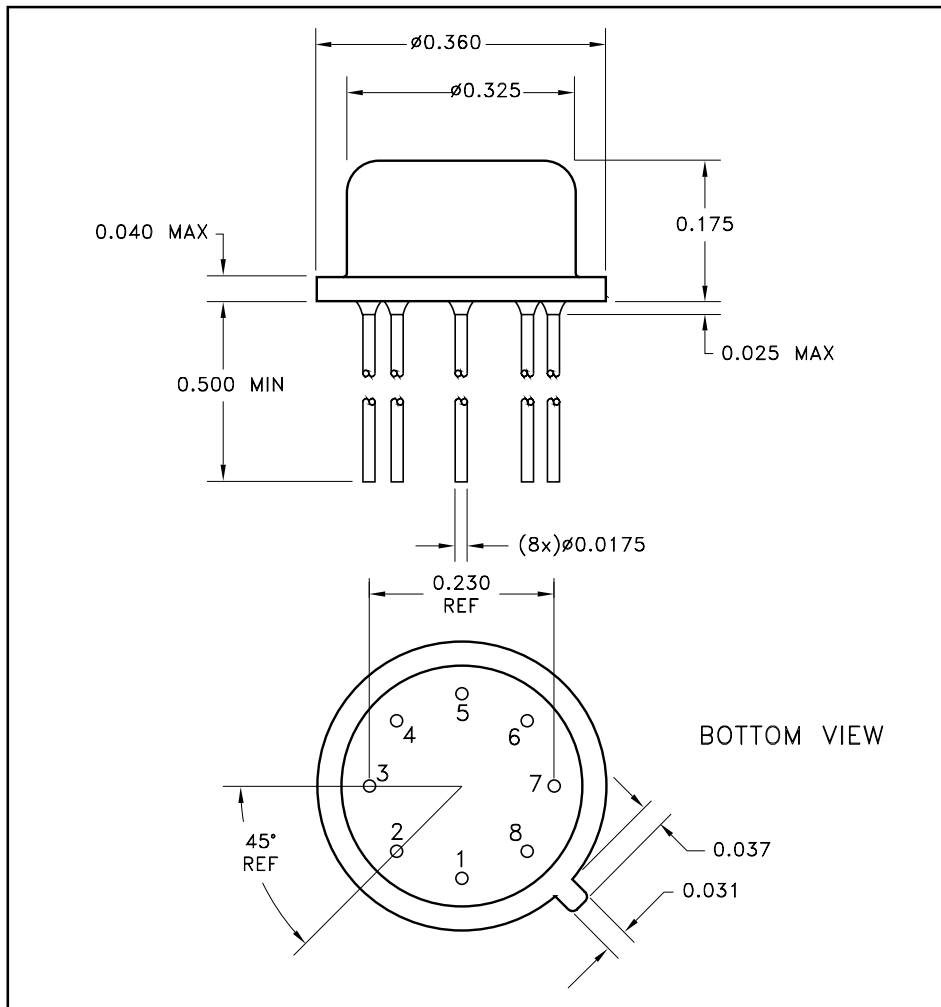
#### Typical Applications:



# TYPICAL PERFORMANCE CURVES



## MECHANICAL SPECIFICATIONS



ALL DIMENSIONS ARE  $\pm 0.010$  INCHES UNLESS OTHERWISE LABELED

## ORDERING INFORMATION

Part Number	Screening Level
MSK0002	Industrial
MSK0002E	Extended Reliability
MSK0002H	Mil-PRF-38534 Class H
7801-301XC	DSCC-SMD

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