MIL-PRF-38534 CERTIFIED

MSK
M.S KENNEDY CORP.

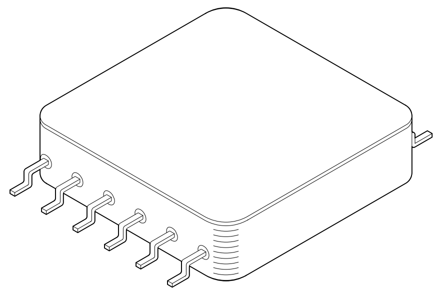
MEDIUM POWER OP-AMP

0041 SERIES

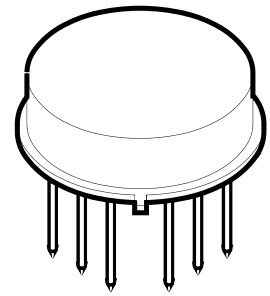
4707 Dey Road Liverpool, N.Y. 13088 (315) 701-6751

FEATURES:

- Available as SMD #5962-8508701
- Output Current - 0.5 Amps Peak
- Low Power Consumption-Class C Design
- Programmable Current Limit
- High Slew Rate
- Continuous Output Short Circuit Duration
- Replacement for LH0041
- Available in a surface mount package



MSK0041FP

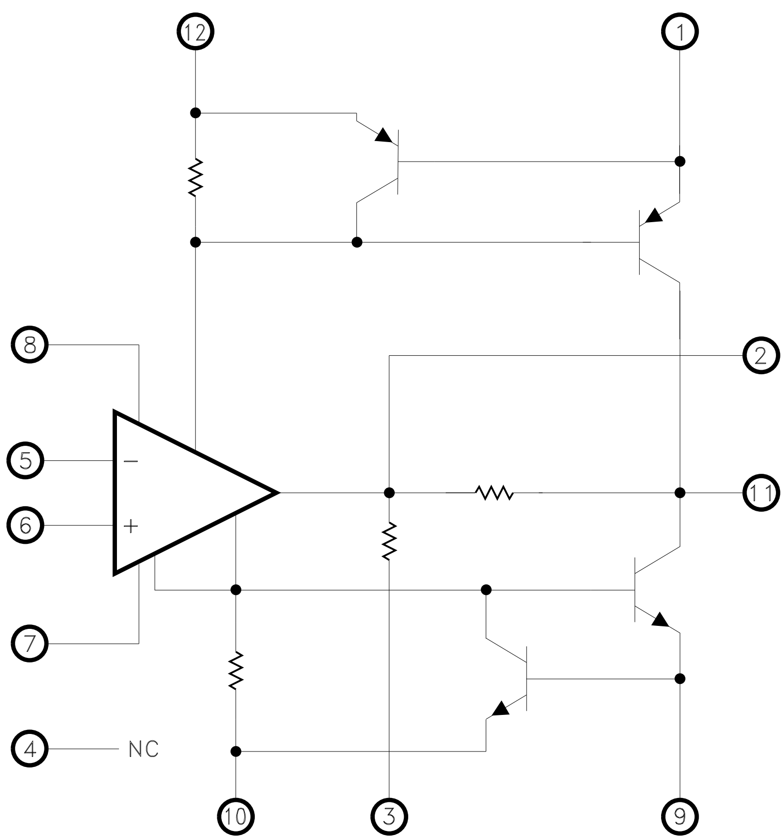


MSK0041

DESCRIPTION:

The MSK 0041 and 0041FP are general purpose Class C power operational amplifiers. These amplifiers offer high output currents, making them an excellent low cost choice for motor drive circuits. The amplifier and load can be protected from fault conditions through the use of internal current limit circuitry that can be user programmed with two external resistors. These devices are also compensated with a single external capacitor. The MSK 0041 is available in a hermetically sealed 12 pin TO-8 package. The MSK 0041FP is packaged in a 12 pin hermetic metal flatpack.

EQUIVALENT SCHEMATIC



(PIN NUMBERS ARE FOR TO-8)

TYPICAL APPLICATIONS

- Servo Amplifer
- Motor Driver
- Audio Amplifier
- Programmable Power Supply

PIN-OUT INFORMATION

MSK0041	MSK0041 FP
1 ISC+	1 GND
2 Compensation	2 Balance
3 GND	3 -Input
4 NC	4 +Input
5 -Input	5 Balance
6 +Input	6 NC
7 Balance	7 -VCC
8 Balance	8 ISC-
9 ISC-	9 Output
10 -VCC	10 ISC+
11 Output	11 +VCC
12 +VCC	12 Compensation

ABSOLUTE MAXIMUM RATINGS ⑧

±V_{CC}	Supply Voltage	±18V
I_{OUT}	Peak Output Current	0.5A
V_{IN}	Differential Input Voltage	±30V
V_{IN}	Common Mode Input Voltage	±15V
R_{TH}	Thermal Resistance-Junction to Case @ 25°C	
	MSK 0041	90° C/W
	MSK 0041FP	90° C/W
T_{ST}	Storage Temperature Range	-65° to +150°C
T_{LD}	Lead Temperature Range (10 Seconds)	300°C
T_J	Junction Temperature	150°C
T_C	Case Operating Temperature Range	
	Military Versions (H/B)	-55°C to +125°C
	Industrial Versions	-40°C to +85°C

ELECTRICAL SPECIFICATIONS

Parameter	Test Conditions	Group A Subgroup	Military ⑤ Min.	Military Typ.	Military Max.	Industrial ④ Min.	Industrial Typ.	Industrial Max.	Units
STATIC									
Supply Voltage Range ②		-	±5	±15	±18	±5	±15	±18	V
Quiescent Current	V_{IN} = 0V	1, 2, 3	-	±1.0	±3.5	-	±1.0	±4.0	mA
Power Consumption ②	V_{IN} = 0V	1,2,3	-	75	105	-	90	120	mW
INPUT									
Input Offset Voltage	V_{IN} = 0V	1	-	±0.5	±3.0	-	±0.5	±6.0	mV
		2, 3	-	±2.0	±5.0	-	-	-	μV/°C
Input Bias Current	V_{CM} = 0V Either Input	1	-	±100	±300	-	±150	±500	nA
		2, 3	-	±0.4	±1.0	-	-	-	μA
Input Offset Current	V_{CM} = 0V	1	-	±2.0	±100	-	±2.0	±200	nA
		2,3	-	-	±300	-	-	-	nA
Input Capacitance ③	F=DC	-	-	3	-	-	3	-	pF
Input Resistance ②	F=DC	-	0.3	1.0	-	0.3	1.0	-	MΩ
Common Mode Rejection Ratio	F = 10Hz V_{CM} = ±10V	4	70	90	-	70	90	-	dB
		5,6	70	90	-	-	-	-	dB
Power Supply Rejection Ratio	V_{CC} = ±5V to ±15V	1	80	95	-	80	95	-	dB
		2,3	80	-	-	-	-	-	dB
Input Noise Voltage ③	F = 10Hz to 10KHz	-	-	5	-	-	5	-	μV_{RMS}
OUTPUT									
Output Voltage Swing	R_L = 100Ω F = 100Hz	4	±13	±14	-	±13	±14	-	V
		5,6	±13	±14	-	-	-	-	V
Output Short Circuit Current	R_{SC} = 3.3Ω V_{OUT} = MAX	4	182	220	300	180	220	300	mA
Settling Time	0.1% 2V step	-	-	4	-	-	4	-	μS
TRANSFER CHARACTERISTICS									
Slew Rate ③	V_{OUT} = ±10V R_L = 100Ω	4	1.5	3.0	-	1.0	3.0	-	V/μS
Open Loop Voltage Gain	F = 10Hz R_L = 1KΩ	4	100	105	-	100	105	-	dB
		5,6	88	96	-	-	-	-	dB
Transition Times	V_{OUT}=1V Rise and Fall	4	-	0.3	1.0	-	0.3	1.5	μS
Overshoot	Small Signal	4	-	5	20	-	5	30	%

NOTES:

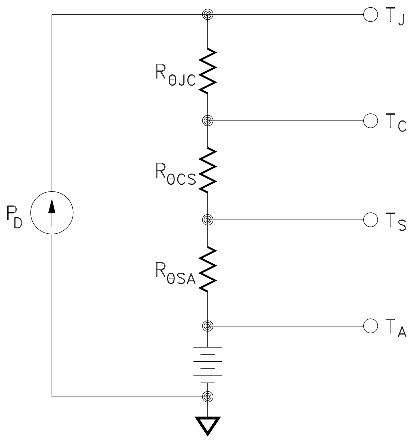
① Unless otherwise specified, ±V_{CC} = ±15V, C_C = 3000pF.
② Guaranteed by design but not tested.
③ Typical parameters are representative of actual device performance but are for reference only.
④ Industrial grade devices shall be tested to subgroups 1 and 4 unless otherwise specified.
⑤ Military grade devices (B/H suffix) shall be 100% tested to subgroups 1, 2, 3 and 4.
Subgroup 1, 4 T_A = T_C = +25°C
Subgroup 2, 5 T_A = T_C = +125°C
Subgroup 3, 6 T_A = T_C = -55°C
⑥ Reference DSCC SMD 5962-8508701 for electrical specifications for devices purchased as such.
⑦ Subgroup 5 and 6 testing available upon request.
⑧ Continuous operation at or above absolute maximum ratings may adversely effect the device performance and/or life cycle.

APPLICATION NOTES

HEAT SINKING

To select the correct heat sink for your application, 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: (TO-8 PACKAGE)

In our example the amplifier application requires the output to drive a 10 volt peak sine wave across a 100 ohm load for 0.1 amp of output current. For a worst case analysis we will treat the 0.1 amp peak output current as a D.C. output current. The power supplies are ±15 VDC.

1.) Find Power Dissipation
$P_D = [(\text{quiescent current}) \times (+V_{CC} - (V_{CC}))] + [(V_S - V_O) \times I_{OUT}]$
$= (3.5\text{ mA}) \times (30\text{V}) + (5\text{V}) \times (0.1\text{A})$
$= 0.1\text{W} + 0.5\text{W}$
$= 0.6\text{W}$
2.) For conservative design, set $T_J = +150°C$.
3.) For this example, worst case $T_A = +25°C$.
4.) $R_{\theta JC} = 85°C/W$
5.) Rearrange governing equation to solve for $R_{\theta SA}$:
$R_{\theta SA} = (T_J - T_A) / P_D - (R_{\theta JC}) - (R_{\theta CS})$
$= (150°C - 25°C) / 0.6W - (85°C/W) - (0.15°C/W)$
$= 123°C/W$

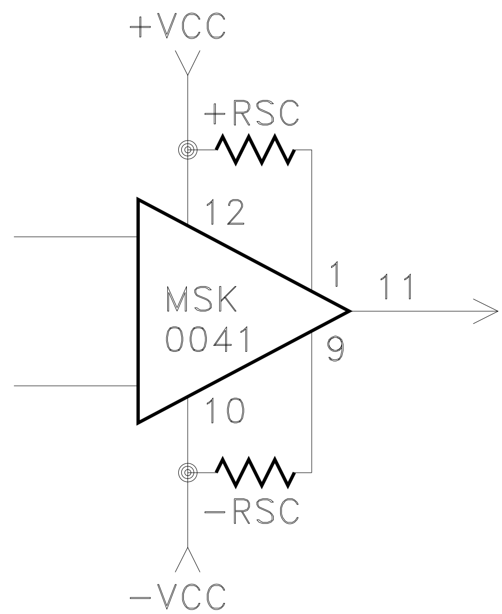
The heat sink in this example must have a thermal resistance of no more than 123°C/W to maintain a junction temperature of less than +150°C. This calculation assumes a case to sink thermal resistance of 0.15°C/W.

CURRENT LIMIT

The MSK 0041 has an on-board current limit scheme designed to limit the output drivers anytime output current exceeds a predetermined limit. The following formula may be used to determine the value of the current limit resistance necessary to establish the desired current limit.

$$R_{SC} = \frac{0.7}{I_{SC}}$$

Current Limit Connection



See "Application Circuits" in this data sheet for additional information on current limit connections.

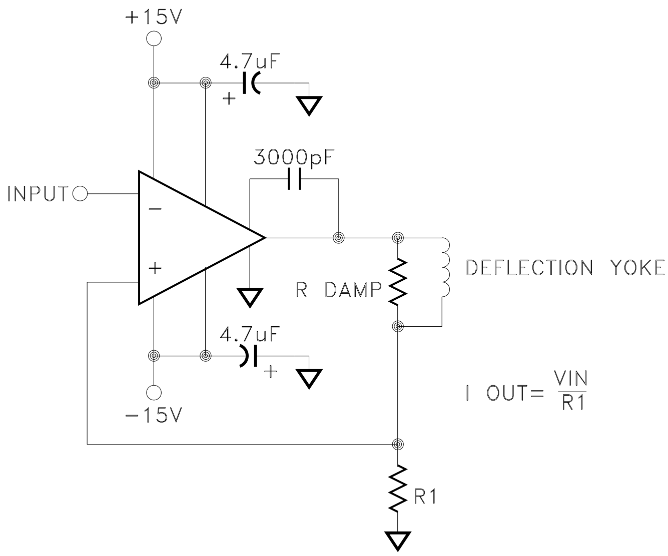
POWER SUPPLY BYPASSING

Both the negative and the positive power supplies must be effectively decoupled with a high and low frequency bypass circuit to avoid power supply induced oscillation. An effective decoupling scheme consists of a 0.1 microfarad ceramic capacitor in parallel with a 4.7 microfarad tantalum capacitor from each power supply pin to ground.This capacitor will eliminate any peak output voltage clipping which may occur due to poor power supply load regulation. All power supply decoupling capacitors should be placed as close to the package power supply pins as possible.

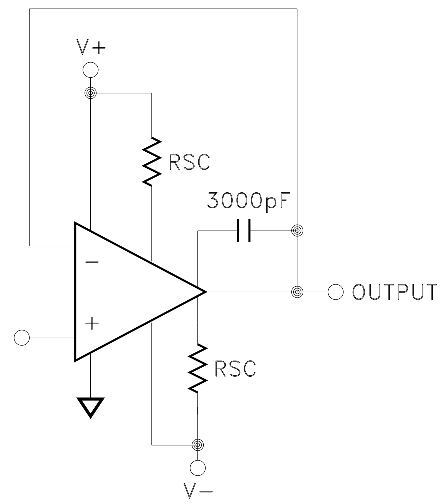
SAFE OPERATING AREA

The safe operating area curve is a graphical representation of the power handling capability of the amplifier under various conditions. The wire bond current carrying capability, transistor junction temperature and secondary breakdown limitations are all incorporated into the safe operating area curves. All applications should be checked against the curves to ensure high M.T.B.F.

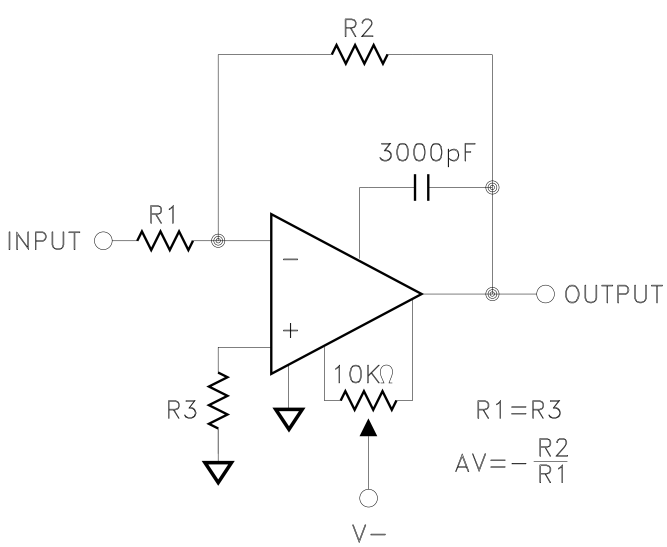
APPLICATION CIRCUITS



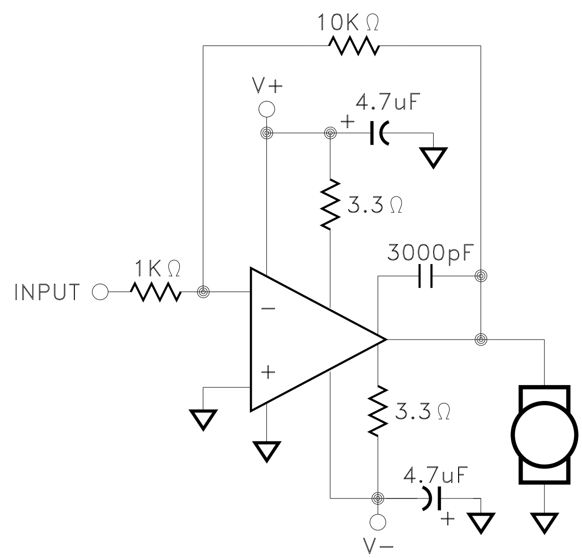
CRT DEFLECTION YOKE DRIVER



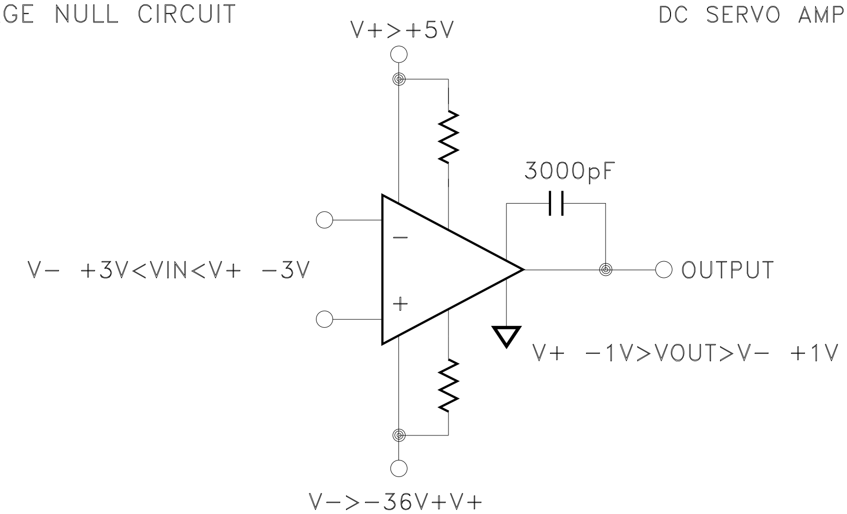
UNITY GAIN CIRCUIT WITH
SHORT CIRCUIT LIMITING



OFFSET VOLTAGE NULL CIRCUIT



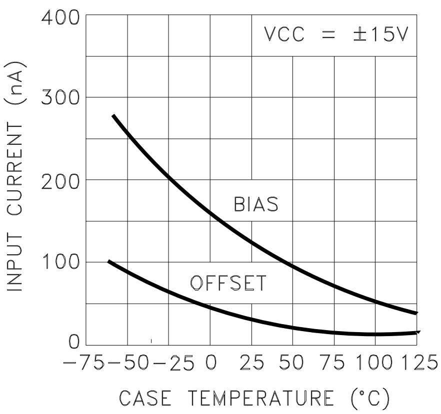
DC SERVO AMPLIFIER



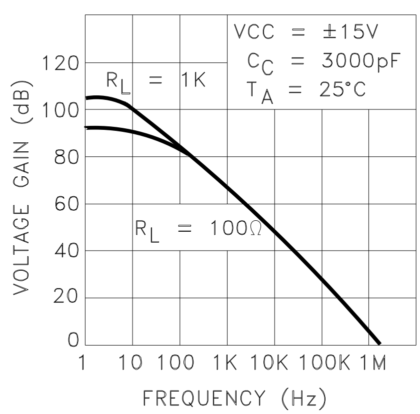
NON SYMMETRICAL SUPPLIES

TYPICAL PERFORMANCE CURVES

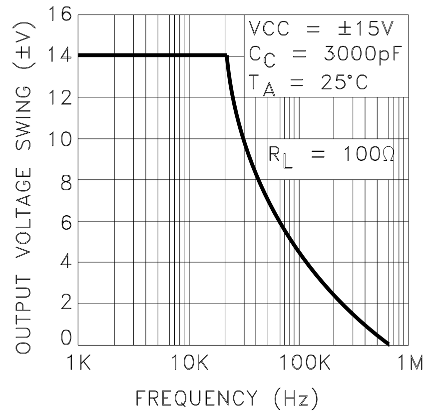
INPUT CURRENT vs TEMPERATURE



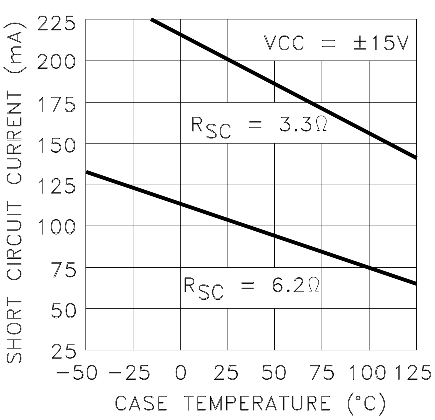
OPEN LOOP FREQUENCY RESPONSE



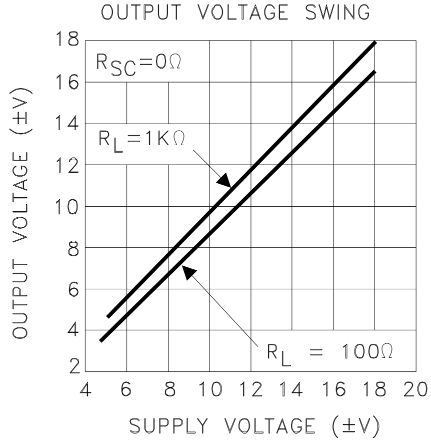
LARGE SIGNAL FREQUENCY RESPONSE



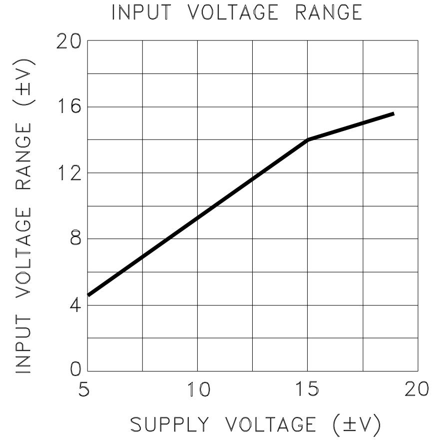
SHORT CIRCUIT CURRENT vs. TEMPERATURE



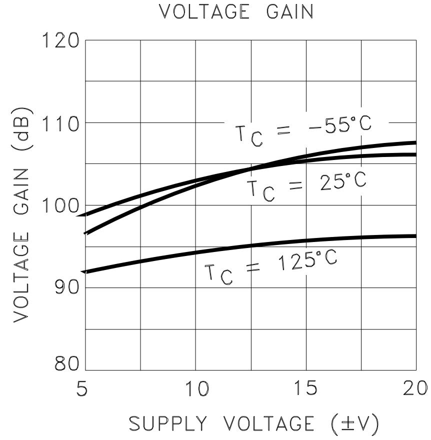
OUTPUT VOLTAGE SWING



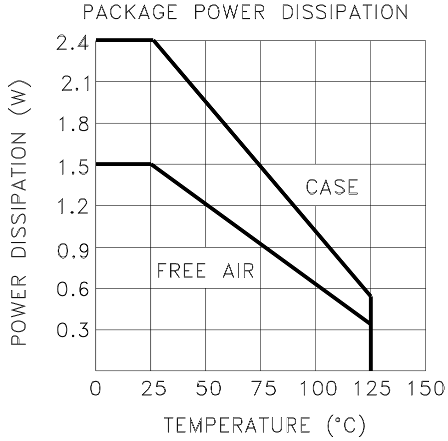
INPUT VOLTAGE RANGE



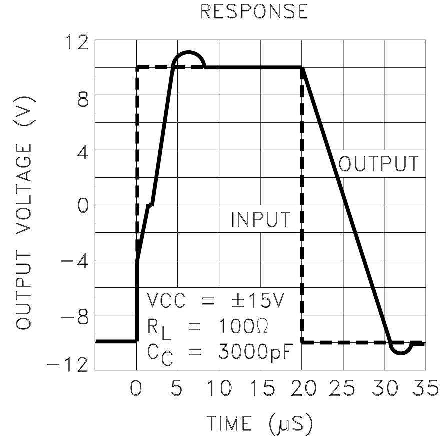
VOLTAGE GAIN



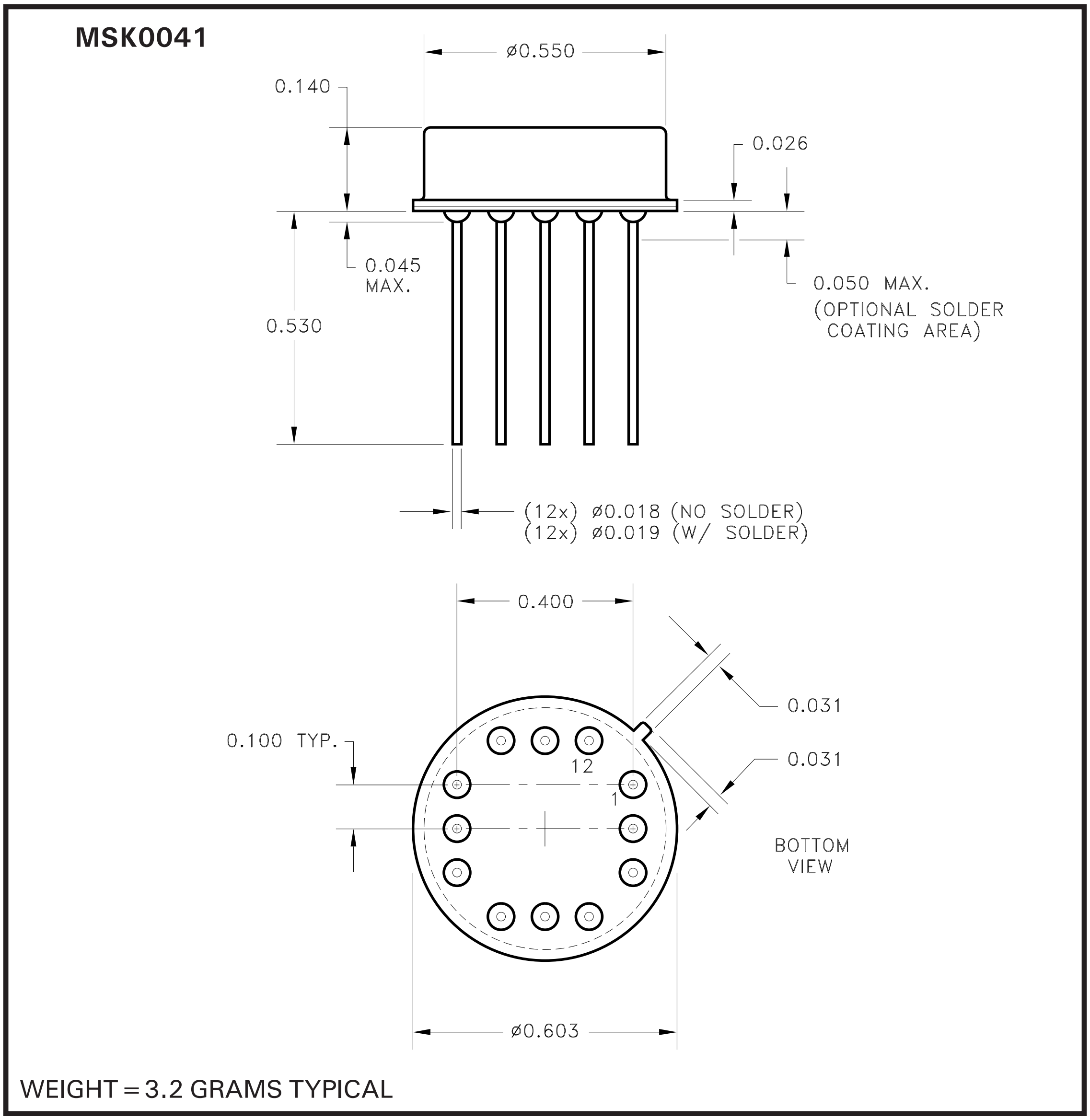
PACKAGE POWER DISSIPATION



VOLTAGE FOLLOWER PULSE RESPONSE



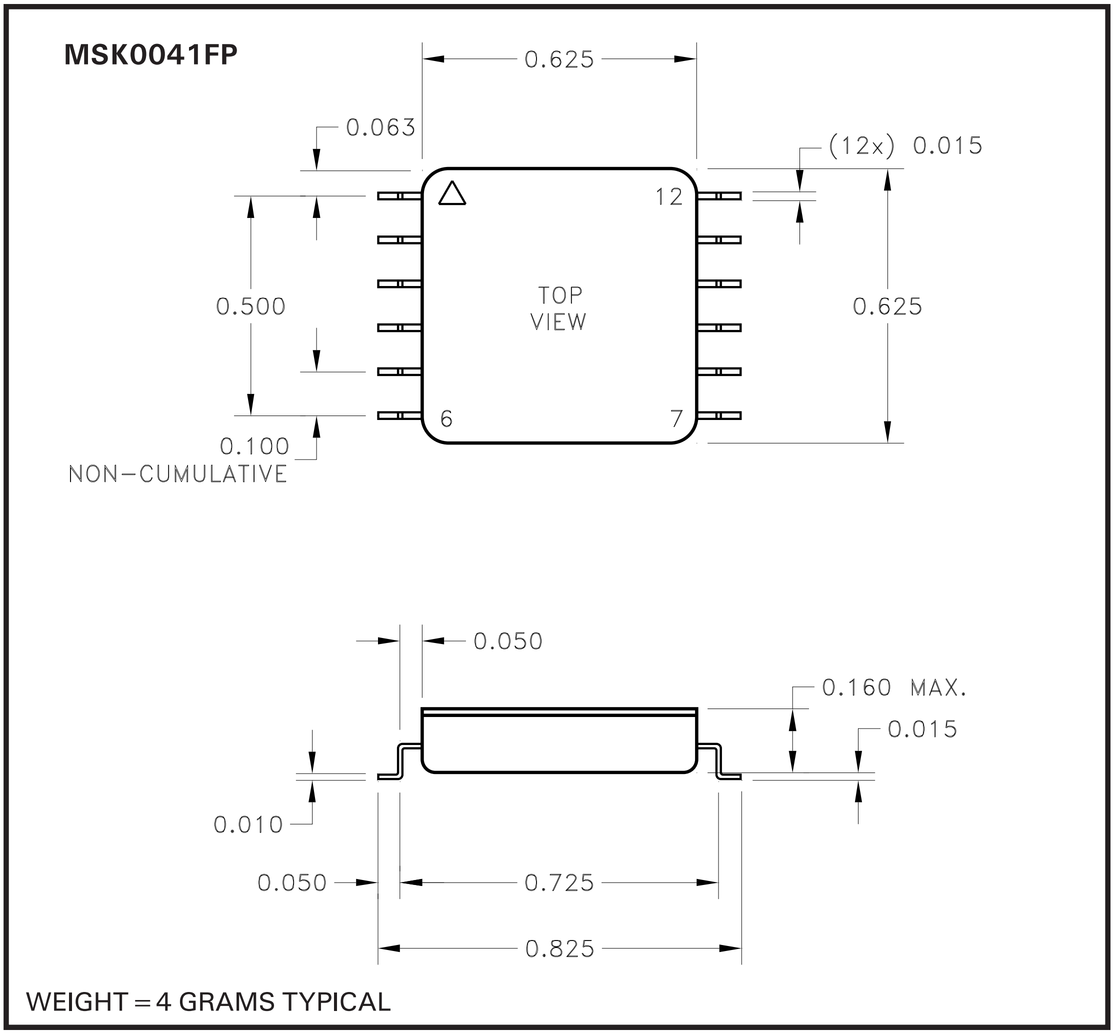
MECHANICAL SPECIFICATIONS



NOTE: ALL DIMENSIONS ARE ±0.010 INCHES UNLESS OTHERWISE LABELED

ORDERING INFORMATION

Part Number	Screening Level
MSK 0041	Industrial
MSK 0041 B	MIL-PRF-38534 CLASS H
5962-8508701X	DSCC - SMD



NOTE: ALL DIMENSIONS ARE ±0.010 INCHES UNLESS OTHERWISE LABELED.
ESD Triangle indicates pin 1.

ORDERING INFORMATION

Part Number	Screening Level
MSK 0041FP	Industrial
MSK 0041FP H	MIL-PRF-38534 CLASS H
TBD	DSCC - SMD

DEVICE IS ALSO AVAILABLE WITHOUT LEAD FORMING.

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