MIL-PRF-38534 CERTIFIED

RAD HARD MEDIUM POWER OP-AMP

0041RH

M.S KENNEDY CORP.
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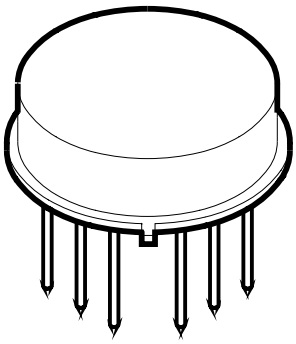
FEATURES:

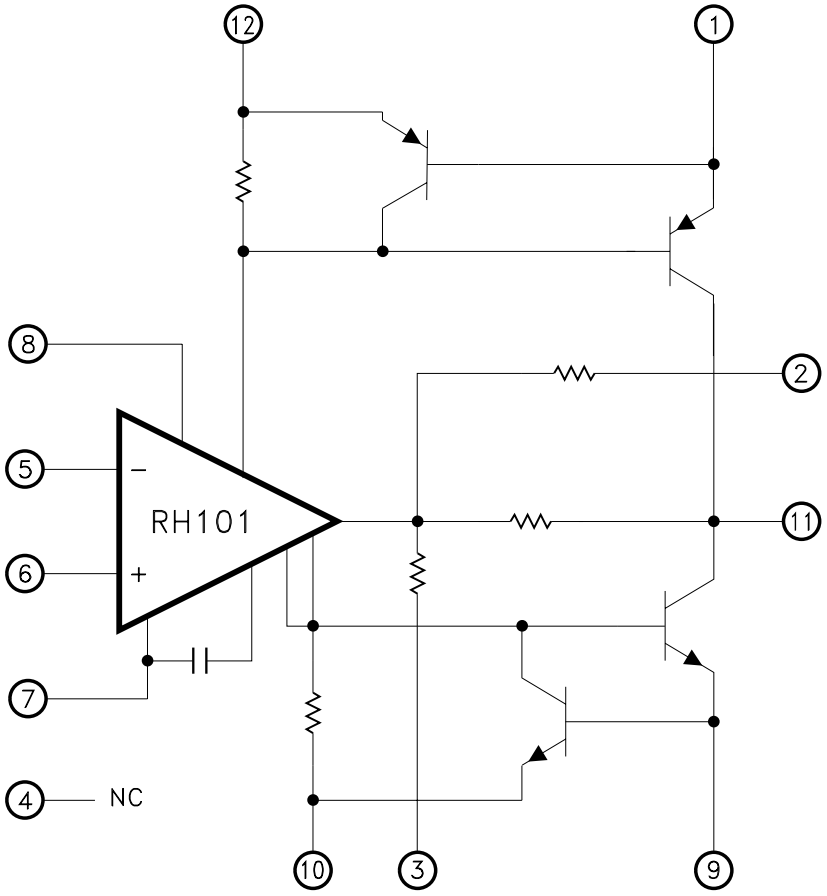
- Manufactured using LINEAR TECHNOLOGY Space Qualified RH101 Die
- Total Dose Tested to 300 Krads(Si) (Method 1019.7 Condition A)
- Output Current - 0.5 Amps Peak
- Low Power Consumption-Class C Design
- Programmable Current Limit
- Continuous Output Short Circuit Duration
- Rad Hard LH0041Replacement
- Contact MSK for MIL-PRF-38534 Qualification Status



DESCRIPTION:

The MSK 0041RH is a general purpose Class C power operational amplifier. This amplifier offers high output currents, making it an excellent choice for motor drive circuits. It is the industry wide RAD HARD replacement for the LH0041. 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. This device is also compensated with a single external capacitor. The MSK 0041RH is available in a hermetically sealed 12 pin TO-8 package.

EQUIVALENT SCHEMATIC



TYPICAL APPLICATIONS

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

PIN-OUT INFORMATION

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

Rev. B 6/08

ABSOLUTE MAXIMUM RATINGS ⑧

±VCC	Supply Voltage . . . . . ±22V	TST	Storage Temperature Range . . . . . -65° to +150°C
IOUT	Peak Output Current 0.5A	TLD	Lead Temperature Range . . . . . 300°C
VIN	Differential Input Voltage . . . . . ±30V		(10 Seconds)
VIN	Common Mode Input Voltage . . . . . ±15V	TJ	Junction Temperature . . . . . 150°C
RTH	Thermal Resistance-Junction to Case . . . . . 60° C/W	TC	Case Operating Temperature Range
			MSK0041K/H/E RH . . . . . -55°C to +125°C
			MSK0041RH . . . . . -40°C to +85°C

ELECTRICAL SPECIFICATIONS

Parameter	Test Conditions ①⑨	Group A Subgroup	MSK0041K/H/E RH ⑥ Min.	Typ.	Max.	MSK0041RH ⑤ Min.	Typ.	Max.	Units
STATIC									
Supply Voltage ③		-	±5	±15	±18	±5	±15	±18	V
Quiescent Current	VIN = 0V	1,2,3	-	±1.0	±3.5	-	±1.0	±4.0	mA
Power Consumption ③	VIN = 0V	1,2,3	-	75	105	-	90	120	mW
INPUT									
Input Offset Voltage ②	VIN = 0V	1	-	±0.5	±3.0	-	±0.5	±6.0	mV
		2,3	-	±2.0	±5.0	-	-	-	µV/°C
Input Bias Current ②	VCM = 0V Either Input	1	-	±100	±300	-	±150	±500	nA
		2,3	-	±0.4	±1.0	-	-	-	µA
	Post Radiaton	1	-	±300	±500	-	±300	±600	nA
Input Offset Current ②	VCM = 0V	1	-	±2.0	±100	-	±2.0	±200	nA
		2,3	-	-	±300	-	-	-	nA
Input Capacitance ④	F = DC	-	-	3	-	-	3	-	pF
Input Resistance ③	F = DC	-	0.3	1.0	-	0.3	1.0	-	MΩ
Common Mode Rejection Ratio	F = 10Hz VCM = ±10V	4	70	90	-	70	90	-	dB
		5,6	70	90	-	-	-	-	dB
Power Supply Rejection Ratio	VCC = ±5V to ±15V	1	80	95	-	80	95	-	dB
		2,3	80	-	-	-	-	-	dB
Input Noise Voltage ④	F = 10Hz to 10KHz	-	-	5	-	-	5	-	µVRMS
OUTPUT									
Output Voltage Swing	RL = 100Ω F = 100Hz	4	±13	±14	-	±13	±14	-	V
		5,6	±13	±14	-	-	-	-	V
Output Short Circuit Current	RSC = 3.3Ω VOUT = MAX	4	182	220	300	180	220	300	mA
TRANSFER CHARACTERISTICS									
Slew Rate	VOUT = ±10V RL = 100Ω	4	1.2	3.0	-	1.0	3.0	-	V/µS
	Post Radiaton	4	1.1	-	-	0.9	-	-	V/µS
Open Loop Voltage Gain	F = 10Hz RL = 1KΩ	4	100	105	-	100	105	-	dB
		5,6	88	96	-	-	-	-	dB
Transition Times	VOUT = 1V Rise and Fall	4	-	0.3	1.0	-	0.3	1.5	µS
	Post Radiaton	4	-	-	1.2	-	-	1.6	µS
Overshoot	Small Signal	4	-	5	20	-	5	30	%

NOTES:

① Unless otherwise specified, ±VCC = ±15V, CC = 3000pF.
② Specification applies for ±5V≤±VCC≤±18V.
③ Guaranteed by design but not tested.
④ Typical parameters are representative of actual device performance but are for reference only.
⑤ Industrial grade and "E" suffix devices shall be tested to subgroups 1 and 4 unless otherwise specified.
⑥ Military grade devices (H suffix) shall be 100% tested to subgroups 1, 2, 3 and 4.

Subgroup 1, 4 TA = TC = +25°C
Subgroup 2, 5 TA = TC = +125°C
Subgroup 3, 6 TA = TC = -55°C

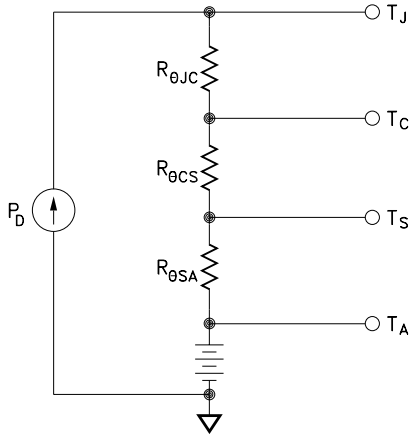
⑦ Subgroup 5 and 6 testing available upon request.
⑧ Continuous operation at or above absolute maximum ratings may adversely effect the device performance and/or life cycle.
⑨ Pre and post irradiation limits at +25°C, are identical up to 100Krad TID unless otherwise specified.

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:

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 = [(quiescent current) X (+ V_{CC} - (V_{CC}))] + [(V_S - V_O) X I_{OUT}]
= (3.5 mA) X (30V) + (5V) X (0.1A)
= 0.1W + 0.5W
= 0.6W
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 - (60°C/W) - (0.15°C/W)
= 148°C/W

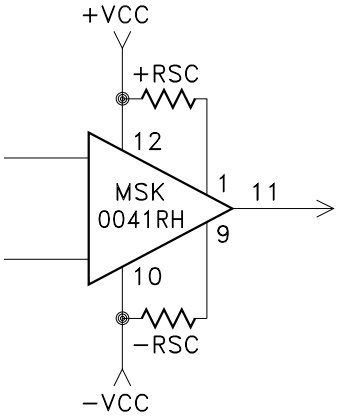
The heat sink in this example must have a thermal resistance of no more than 148°C/W to maintain a junction temperature of less than +150°C. This calculation assumes a case to sink thermal resistance of 0.15°C/W.

CURRENT LIMIT

The MSK 0041RH 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

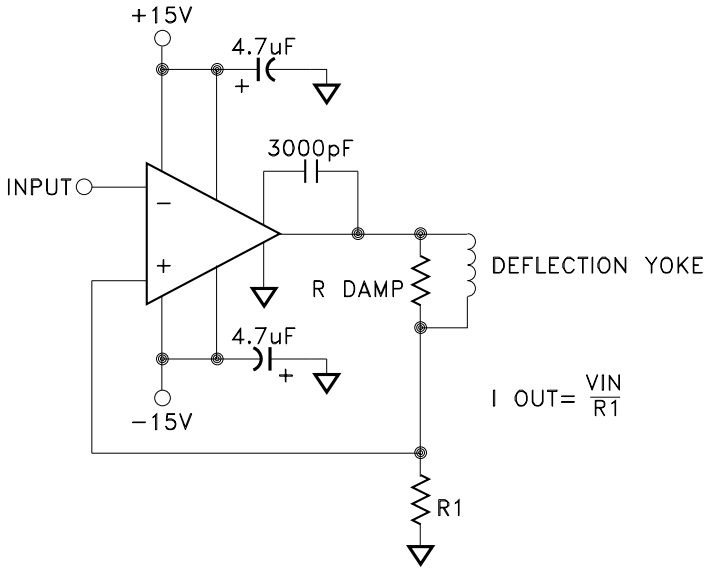
The safe operating area curve is a graphical representation of the power handling capability of the amplifier under various conditions. The wire bond current carrying capability, transistor junction temperature and secondary breakdown limitations are all incorporated into the safe operating area curves.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

TOTAL DOSE RADIATION TEST PERFORMANCE

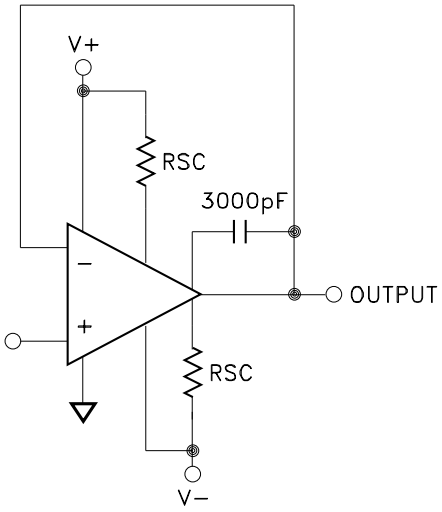
Radiation performance curves for TID testing have been generated for all radiation testing performed by MS Kennedy. These curves show performance trends throughout the TID test process and can be located in the MSK 0041RH radiation test report. The complete radiation test report will be available in the RAD HARD PRODUCTS section on the MSK website.

http://www.mskennedy.com/store.asp?pid=9951&catid=19680

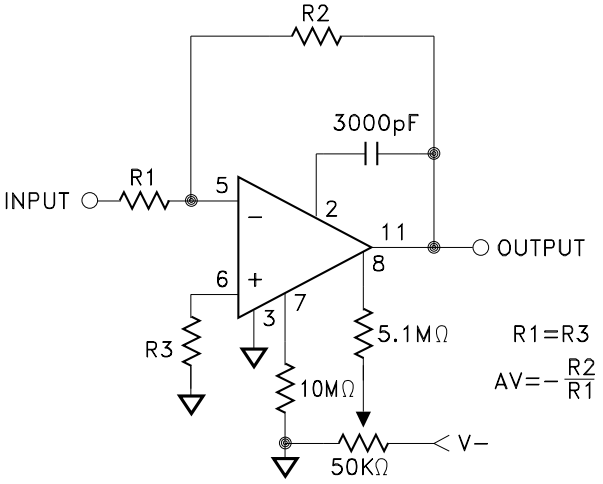
APPLICATION CIRCUITS



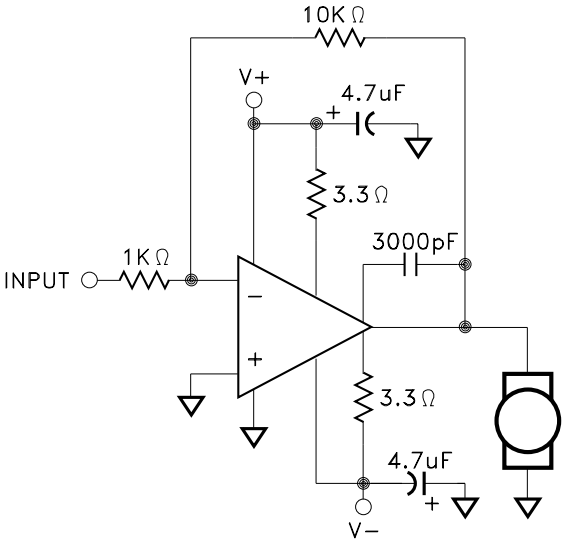
CRT DEFLECTION YOKE DRIVER



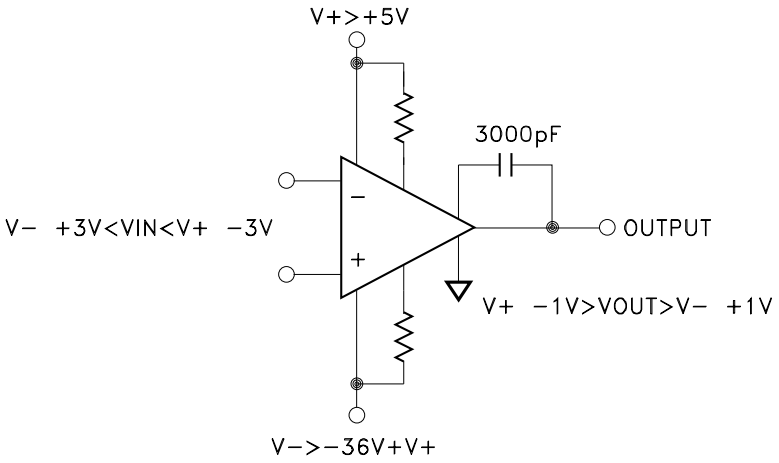
UNITY GAIN CIRCUIT WITH
SHORT CIRCUIT LIMITING



OFFSET VOLTAGE NULL CIRCUIT



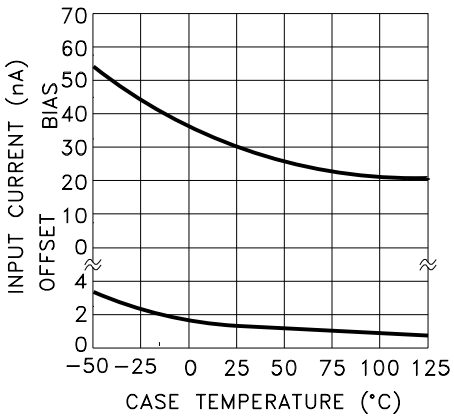
DC SERVO AMPLIFIER



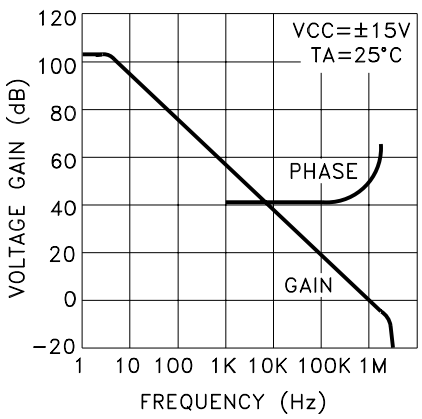
NON SYMMETRICAL SUPPLIES

TYPICAL PERFORMANCE CURVES

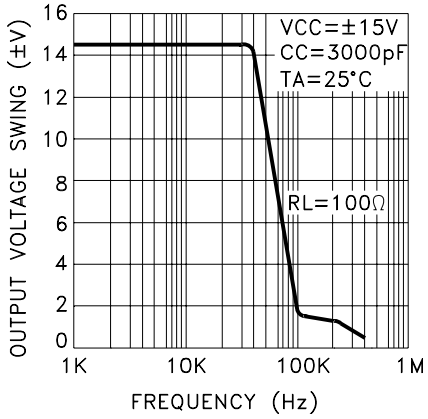
INPUT CURRENT vs TEMPERATURE



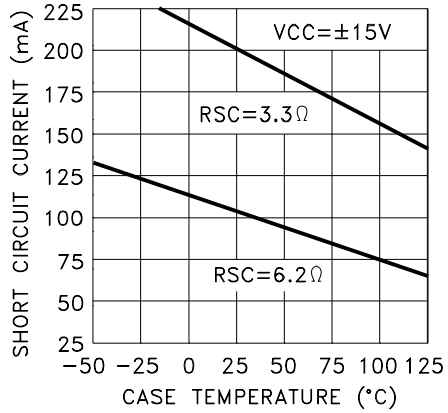
OPEN LOOP FREQUENCY RESPONSE



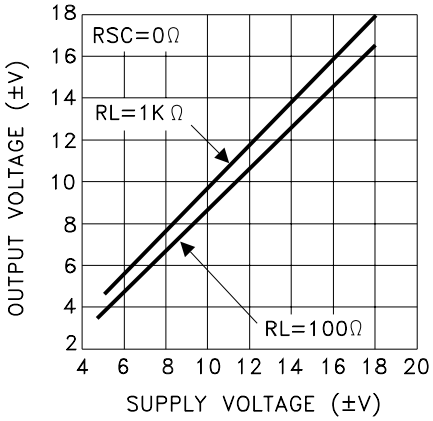
LARGE SIGNAL FREQUENCY RESPONSE



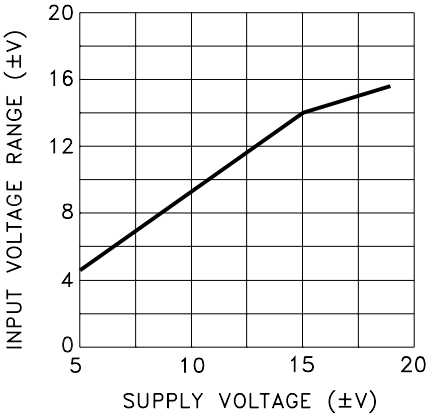
SHORT CIRCUIT CURRENT vs. TEMPERATURE



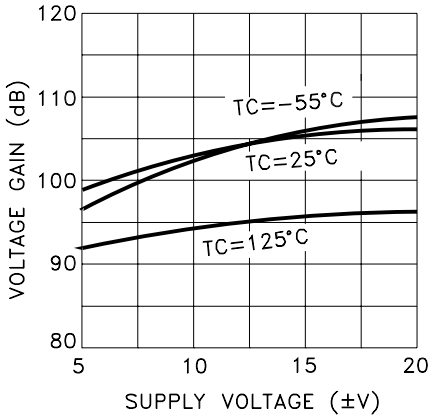
OUTPUT VOLTAGE SWING



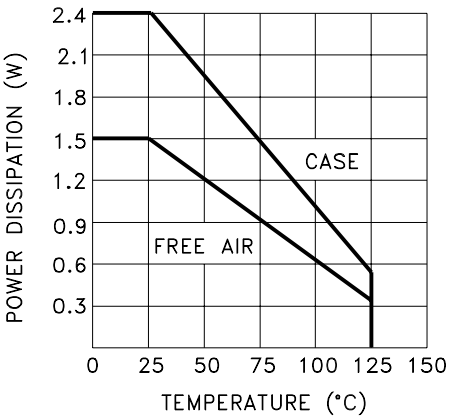
INPUT VOLTAGE RANGE



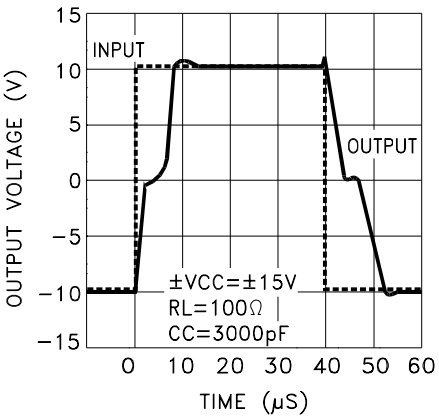
VOLTAGE GAIN



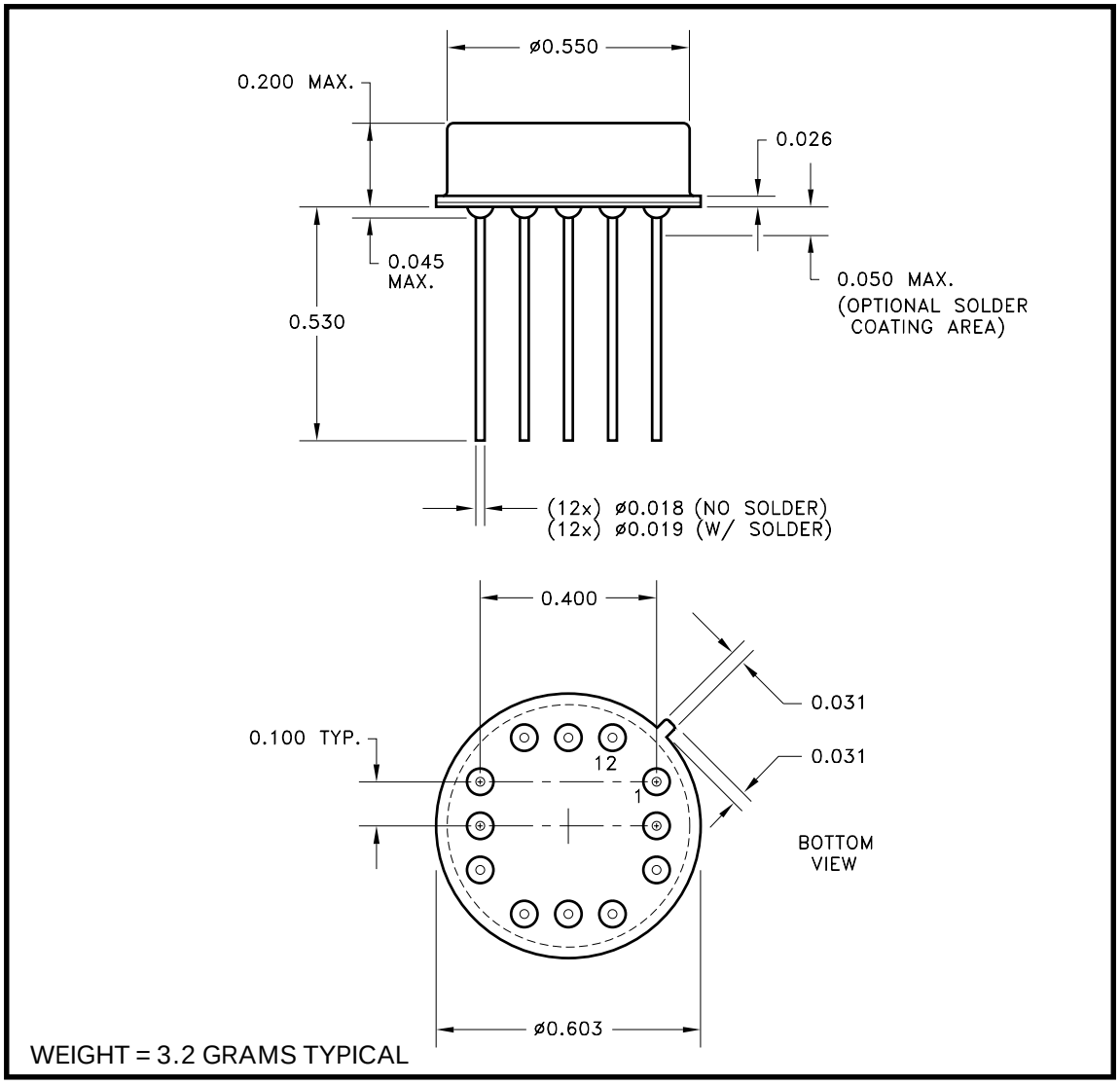
PACKAGE POWER DISSIPATION



VOLTAGE FOLLOWER PULSE RESPONSE



MECHANICAL SPECIFICATIONS



NOTE: ALL DIMENSIONS ARE ± 0.010 INCHES UNLESS OTHERWISE LABELED

ORDERING INFORMATION

Part Number	Screening Level
MSK 0041RH	Industrial
MSK 0041ERH	EXTENDED RELIABILITY
MSK 0041HRH	MIL-PRF-38534 CLASS H
MSK0041KRH	MIL-PRF-38534 CLASS K

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