ISO-9001 CERTIFIED BY DSCC

MSK
M.S.KENNEDY CORP.

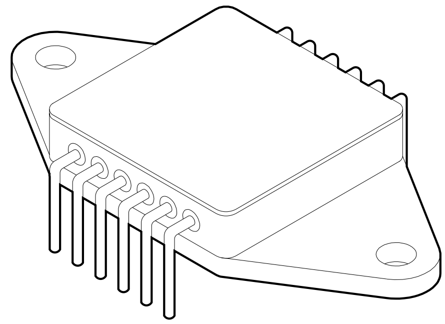
POWER OPERATIONAL AMPLIFIER 115

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

MIL-PRF-38534 QUALIFIED

FEATURES:

- High Output Current - 15A peak
- Ultra Low Thermal Resistance - 0.43°C/W
- Excellent Linearity - Class A/B Output
- Wide Supply Range - ±10V to ±50V
- High Power Dissipation - 175W at T_C=125°C
- Output Short Circuit Protected
- User Programmable Current Limit
- Isolated Case Allows Direct Heat Sinking
- Low Quiescent Current - ±22mA. Typ

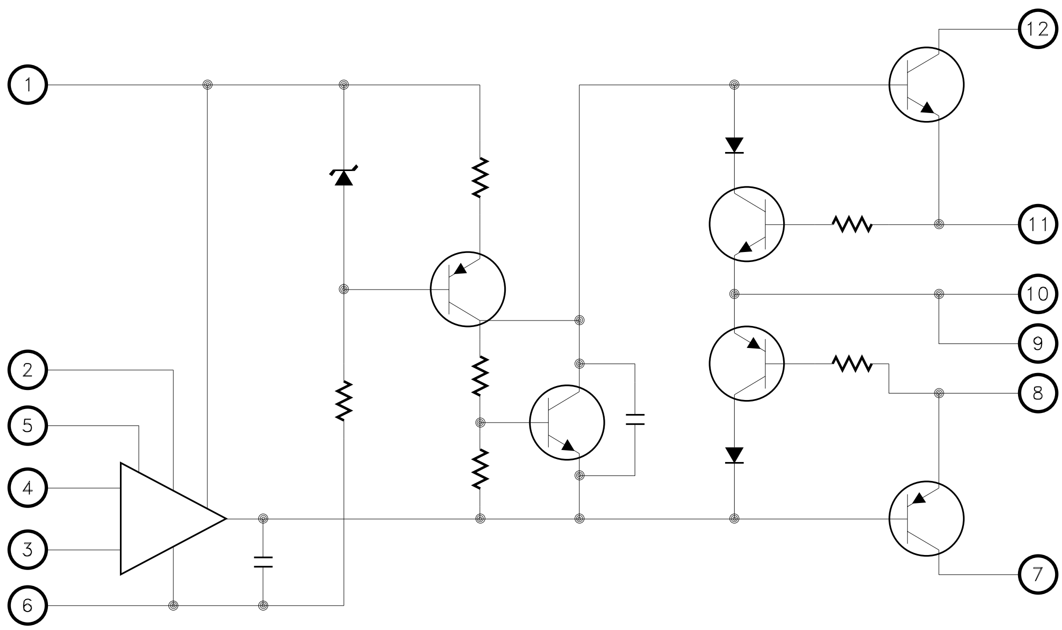


MSK 115

DESCRIPTION:

The MSK 115 is a High Power Operational Amplifier. Due to the extremely low thermal resistance from the transistor junctions to the case, the MSK 115 can dissipate extreme amounts of power at a case temperature of 125°C. The amplifier is packaged in a hermetic plug in power package with bolt down tabs.

EQUIVALENT SCHEMATIC



TYPICAL APPLICATIONS

- Magnetic Deflection Circuit Driver
- Programmable Power Supplies
- Motor, Valve and Actuator Control
- Audio Amplifier

PIN-OUT INFORMATION

1	+VCC	12	+VC
2	Balance	11	+Current Limit
3	Inverting Input	10	Output
4	Non-Inverting Input	9	Output
5	Balance	8	-Current Limit
6	-VCC	7	-VC

ABSOLUTE MAXIMUM RATINGS

$\pm V_{CC}$ Supply Voltage . . . . ±50V
I_{OUT} Output Current 15A
V_{IN} Differential Input Voltage . . . . ±37V
T_C Case Operating Temperature Range
(MSK 115B/E) . . . . -55°C to +125°C
(MSK 115) . . . . -40°C to +85°C

T_{ST} Storage Temperature Range . . -65°C to +150°C
T_{LD} Lead Temperature Range . . . . 300°C
(10 Seconds)
P_D Power Dissipation . . . . See SOA Curve
T_J Junction Temperature . . . . 175°C

ELECTRICAL SPECIFICATIONS

±Vcc = 40VDC Unless Otherwise Specified

Parameter	Test Conditions	Group A Subgroup	MSK 115B/E Min.	MSK 115B/E Typ.	MSK 115B/E Max.	MSK 115 Min.	MSK 115 Typ.	MSK 115 Max.	Units
STATIC									
Supply Voltage Range ②		-	±10	-	±50	±10	-	±50	V
Quiescent Current	V_{IN} = 0V	1	-	±22	±35	-	±22	±40	mA
	A_V = -10V/V	2,3	-	±28	±45	-	-	-	mA
Thermal Resistance ②	Junction to Case	-	-	0.43	0.55	-	0.43	0.6	°C/W
INPUT									
Input Offset Voltage	V_{IN} = 0V A_V = 10V/V	1	-	±2	±6	-	±2	±10	mV
	Bal.Pins = NC	2,3	-	±3	±12	-	-	-	mV
Input Offset Adjust	R_{POT} = 10KΩ To $-V_{CC}$ A_V = -10V/V	1	Adjust to zero			Adjust to zero			mV
		2,3	Adjust to zero			-	-	-	mV
Input Bias Current	V_{CM} = 0V	1	-	±10	±30	-	±10	±50	nA
	Either Input	2,3	-	±15	±60	-	-	-	nA
Input Offset Current	V_{CM} = 0V	1	-	±5	±30	-	±5	±50	nA
		2,3	-	±10	±50	-	-	-	nA
Input Impedance ②	F = DC	-	50	250	-	35	250	-	MΩ
Common Mode Range ②		-	-	±35	-	-	±35	-	V
Common Mode Rejection Ratio ②	F = 100Hz V_{CM} = ±5V	-	80	100	-	74	100	-	dB
OUTPUT									
Output Voltage Swing	R_L = 500Ω A_V = -10V/V	4	±35	±37	-	±33	±37	-	V
	R_L = 10Ω R_{SC} ≤ 0.02Ω	4	±35	±37	-	±33	±37	-	V
Output Current, Peak	A_V = -10V/V T_J < 175°C	4	15	-	-	10	-	-	A
Settling Time ① ②	0.1% 10V step	-	-	2	-	-	5	-	μS
TRANSFER CHARACTERISTICS									
Slew Rate	V_{OUT} = ±10V R_L = 500Ω A_V = -10V/V	4	2.5	5	-	1	2.5	-	V/μS
Open Loop Voltage Gain ②	R_L = 500Ω F = 10Hz	4	95	105	-	85	105	-	dB
Gain Bandwidth Product ②	R_L = 10Ω F = 1 MHz	-	-	4	-	-	3	-	MHz

NOTES:

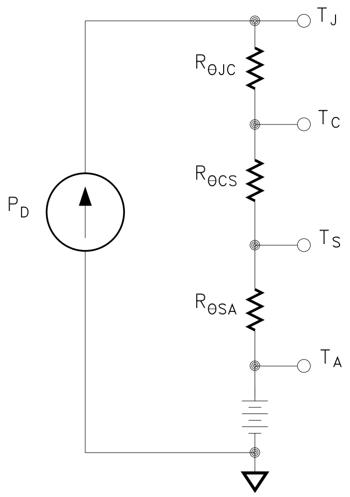
① AV = -1, measured in false summing junction circuit.
② Guaranteed by design but not tested. Typical parameters are representative of actual device performance but are for reference only.
③ Industrial grade and "E" suffix devices shall be tested to subgroups 1 and 4 unless otherwise specified.
④ Military grade devices ("B" suffix) shall be 100% tested to subgroups 1,2,3 and 4.
⑤ Subgroups 5 and 6 testing available upon request.
⑥ 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

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

$R_{\theta CS}$ = 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 20 volt peak sine wave across a 20 ohm load for 1 amp of output current. For a worst case analysis we will treat the 1 amp peak output current as a D.C. output current. The power supplies are ±40 VDC.

1.) Find Power Dissipation

$P_D = [(\text{quiescent current}) \times (V_S-(V_S))] + [(+V_S-V_O) \times I_{OUT}]$
$= (25mA) \times (80V) + (20V) \times (1A)$
$= 2W + 20W$
$= 22W$

2.) For conservative design, set $T_J = +125°C$

3.) For this example, worst case $T_A = +50°C$

4.) $R_{\theta JC} = 0.55°C/W$ from MSK 115B Data Sheet

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

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

$R_{\theta SA} = ((T_J-T_A)/P_D) - (R_{\theta JC}) - (R_{\theta CS})$
$= ((125°C - 50°C)/22W) - (0.55°C/W) - (0.15°C/W)$
$= 2.71°C/W$

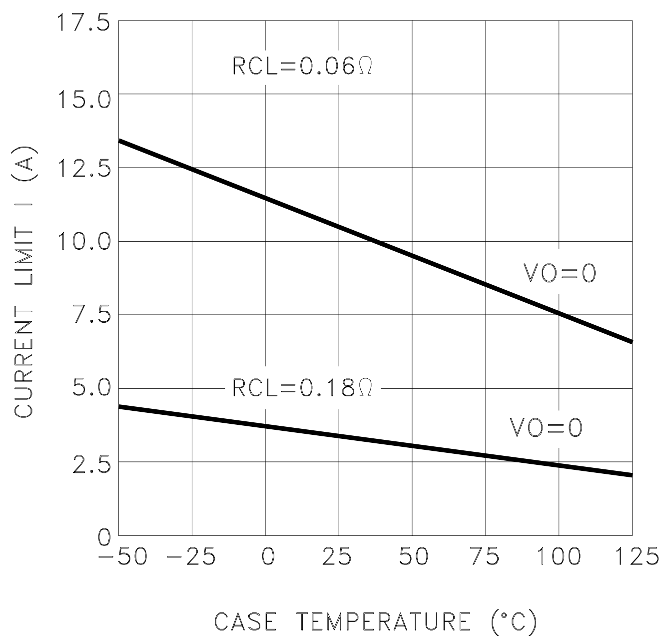
The heat sink in this example must have a thermal resistance of no more than 2.71°C/W to maintain a junction temperature of no more than +125°C.

CURRENT LIMIT

The MSK 115 has an on-board current limit scheme designed to shut off the output drivers anytime output current exceeds a predetermined limit. The following formula may be used to determine the value of current limit resistance necessary to establish the desired current limit.

R_{CL} = (OHMs) = (0.65 volts/current limit in amps) - 0.01OHM

The 0.01 ohm term takes into account any wire bond and lead resistance. Since the 0.65 volt term is obtained from the base emitter voltage drop of a bipolar transistor: the equation only holds true for operation at +25°C case temperature. The curve below illustrates the effect of case temperature on current limit.

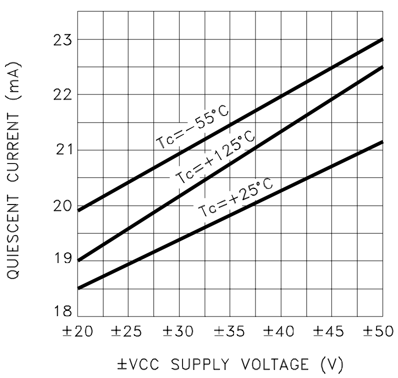


POWER SUPPLY BYPASSING

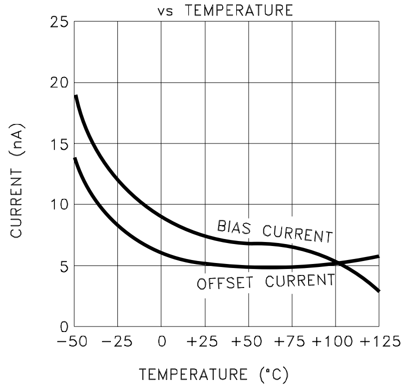
Both the negative and the positive power supplies must be effectively decoupled with a high and low frequency bypass circuit to avoid power supply induced oscillation. An effective decoupling scheme consists of a 0.1 microfarad ceramic capacitor in parallel with a 4.7 microfarad tantalum capacitor from each power supply pin to ground. It is also a good practice with very high power op-amps, such as the MSK 115, to place a 30-50 microfarad non-electrolytic capacitor with a low effective series resistance in parallel with the other two power supply decoupling capacitors. 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 (pins 7 and 12).

TYPICAL PERFORMANCE CURVES

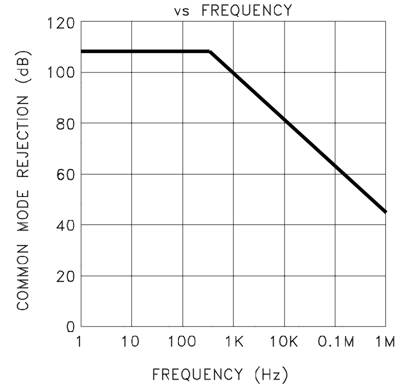
QUIESCENT CURRENT vs. SUPPLY VOLTAGE



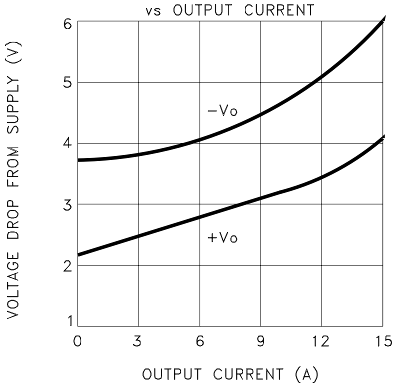
INPUT BIAS AND OFFSET CURRENT vs TEMPERATURE



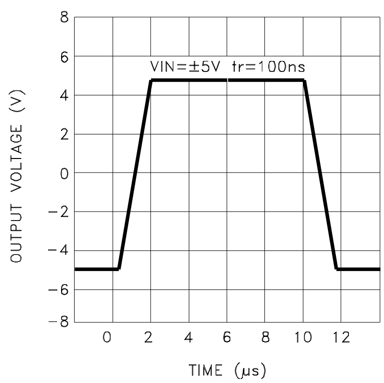
COMMON MODE REJECTION vs FREQUENCY



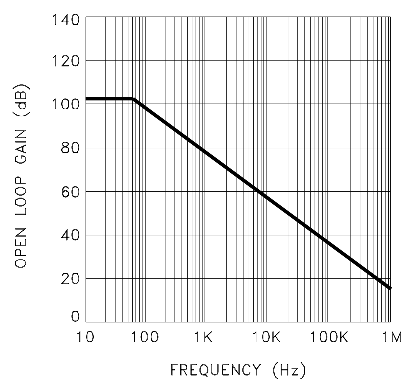
OUTPUT VOLTAGE SWING vs OUTPUT CURRENT



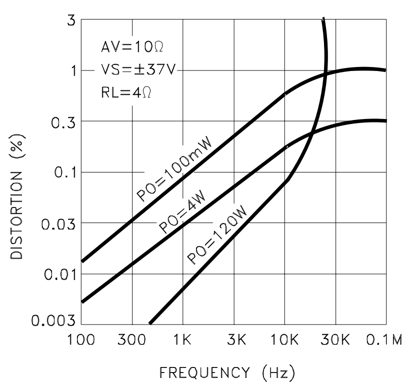
PULSE RESPONSE



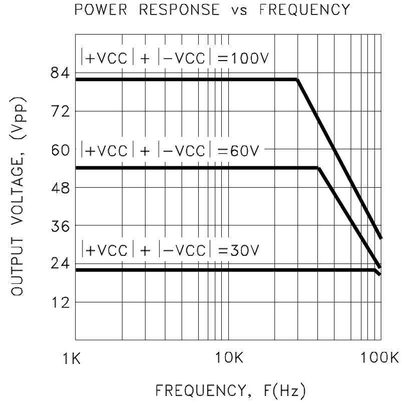
OPEN LOOP GAIN vs. FREQUENCY



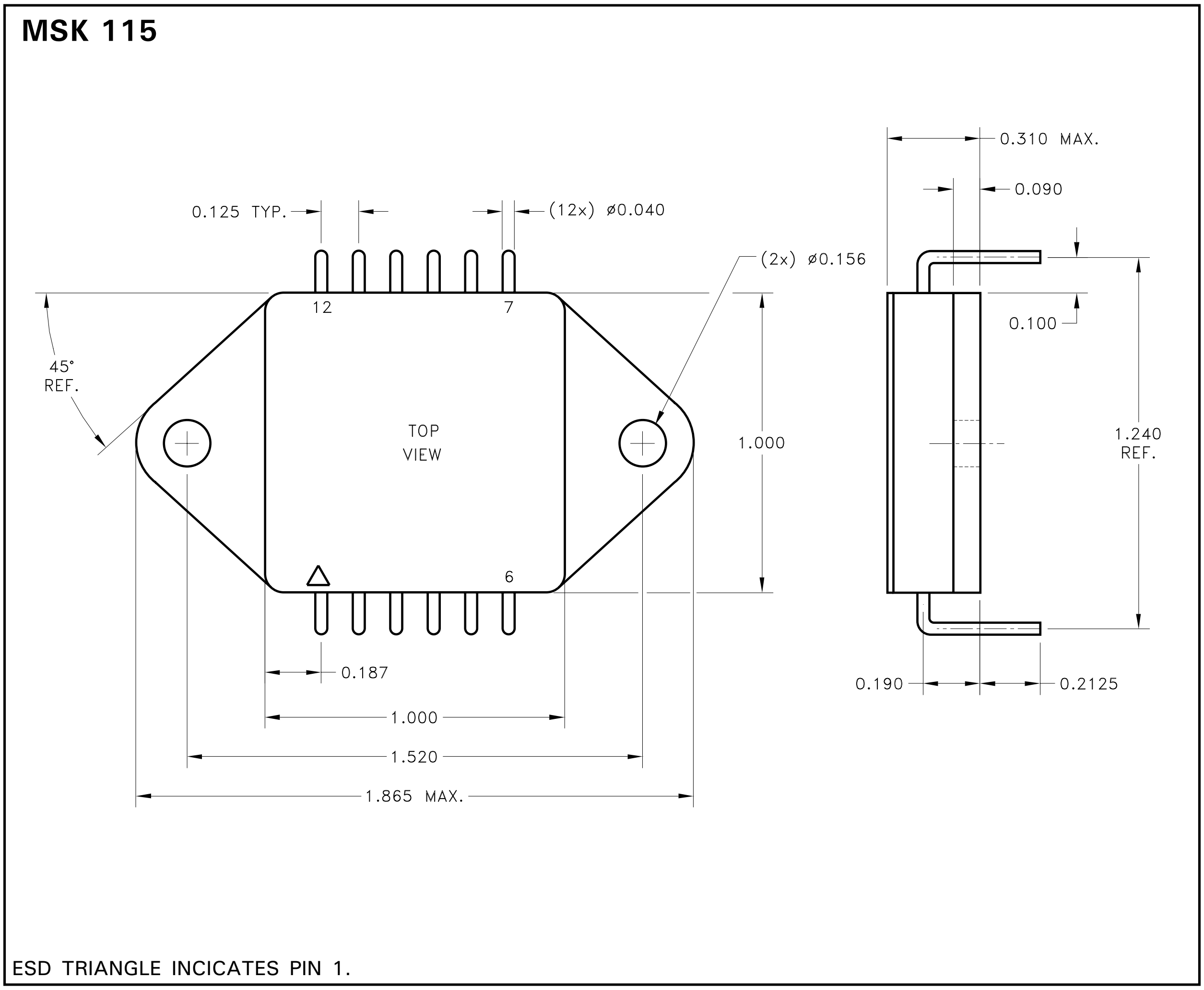
HARMONIC DISTORTION



POWER RESPONSE vs FREQUENCY



MECHANICAL SPECIFICATIONS



NOTE: ALL DIMENSIONS ARE ±0.010 INCHES UNLESS OTHERWISE LABELED.

ORDERING INFORMATION

Part Number	Screening Level
MSK115	Industrial
MSK 115E	Extended Reliability
MSK115B	Mil-PRF-38534 Class H

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