M.S.KENNEDY CORP.

HIGH SPEED POWER AMPLIFIER 111

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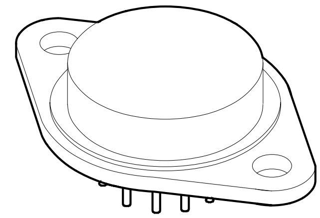
MIL-PRF-38534 CERTIFIED

FEATURES:

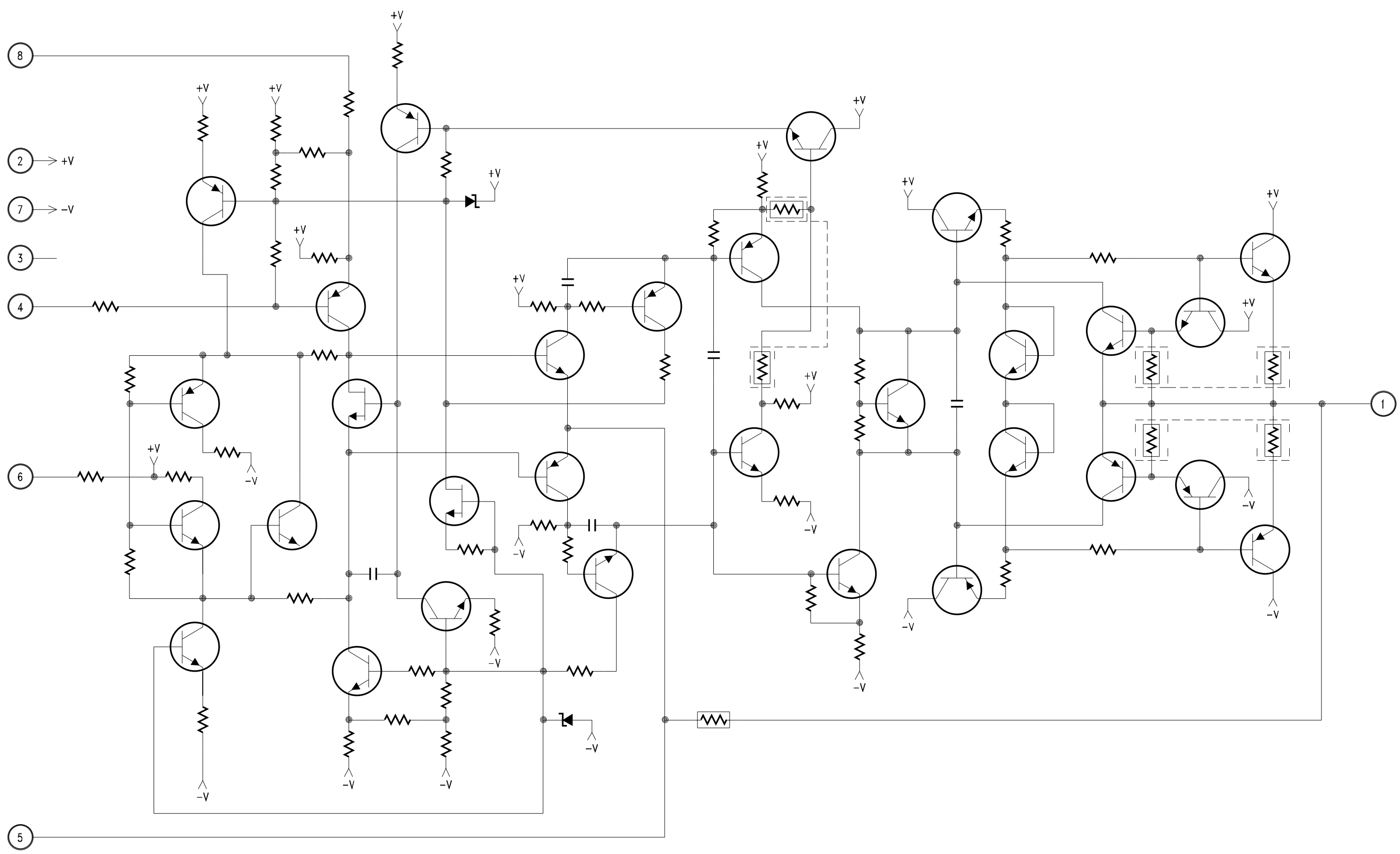
- Replaces Apex WA-01
- Internal 1.5KΩ Feedback Resistor
- High Output Current: 400mA
- Very Fast Slew Rate: 3000V/μS
- Fast Settling Time
- Low Offset Voltage: ±5mV
- Offset Null Capability



DESCRIPTION:

The MSK 111 is a high speed operational amplifier which utilizes low impedance push-pull circuitry to achieve high speed amplification. Laser trimmed offset voltage provides a high DC accuracy typically less than ±2mV. The MSK 111 also offers an external offset null capability for applications in which zero offset is critical. The speed and output current offered by the MSK 111 makes it an excellent choice for video processing circuits and high speed test circuits. The MSK 111 is packaged in a hermetically sealed 8 pin TO-3 package.

EQUIVALENT SCHEMATIC



TYPICAL APPLICATIONS

- Sample and Hold Circuits
- Video Processing
- Line Drivers
- Function Generators

PIN-OUT INFORMATION

1	Output	8	Balance
2	+Vcc	7	-Vcc
3	NC	6	+Input
4	Balance	5	-Input

ABSOLUTE MAXIMUM RATINGS ⑦

- V_{CC} Total Supply Voltage 32V
- I_{OUT} Output Current 0.4A
- V_{IN} Differential Input Voltage . . . . ±6V
- V_{IN} Common Mode Input Voltage . . . . ±VCC
- T_{ST} Storage Temperature Range . . . -65°C to +150°C
- T_{LD} Lead Temperature Range . . . . 300°C (10 Seconds)
- T_C Case Operating Temperature
  - MSK111. . . . . -40°C to +85°C
  - MSK111H/E . . . . -55°C to +125°C
- T_J Junction Temperature . . . . 175°C

ELECTRICAL SPECIFICATIONS

Parameter	Test Conditions ①	Group A Subgroup	MSK 111H/E Min.	MSK 111H/E Typ.	MSK 111H/E Max.	MSK 111 Min.	MSK 111 Typ.	MSK 111 Max.	Units
STATIC									
Supply Voltge Range ②		-	±12	±15	±16	±12	±15	±16	V
Quiescent Current	V_{IN}=0V	1	-	±28	±30	-	±28	±35	mA
		2,3	-	-	±50	-	-	-	mA
INPUT									
Input Offset Voltage	V_{IN}=0V	1	-	±0.5	±5	-	±0.5	±10	mV
		2,3	-	-	±30	-	-	-	mV
Input Bias Current ②		1	-	5	20	-	5	30	μA
Common Mode Rejection ②	V_{CM}= ±5V	4	48	54	-	48	54	-	dB
Power Supply Rejection ②	V_{CC}=24V to 30V	1	60	75	-	60	75	-	dB
OUTPUT									
Output Voltage Swing	f=1KHz R_L=1KΩ	4	±10	±11	-	±10	±11	-	V
Output Current	f=1KHz R_L=50Ω	4	400	-	-	400	-	-	mA
Power Bandwidth ②	V_O=20V_{PP}	-	-	40	-	-	40	-	MHz
Settling Time ②	10V Step	-	-	20	-	-	20	-	nS
Slew Rate	V_{OUT}= ±10V R_L=1KΩ	4	2500	3000	-	2500	3000	-	V/μS
Propagation Delay ②	T_C=25°C	-	-	2.9	-	-	2.9	-	nS
Thermal Resistance ②	Junction to Case @ 125°C	-	-	31	-	-	35	-	°C/W
Internal Feedback Resistor	Rf	-	1.497	1.5	1.503	1.495	1.5	1.505	KΩ

NOTES:

① Unless otherwise specified, ±V_{CC}= ±15V A_V=10V/V and R_L=∞ and T_C=25°C.
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 ("H" suffix) shall be 100% tested to subgroups 1,2,3 and 4.
⑤ Subgroup 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
⑦ Continuous operation at or above absolute maximum ratings may adversely effect the device performance and/or life cycle.

POWER SUPPLY BYPASSING

Both the negative and the positive 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 0.01 microfarad ceramic capacitor in parallel with a 4.7 microfarad tantalum capacitor from each power supply pin to ground. All power supply decoupling capacitors should be placed as close to the package power supply pins as possible.

Output, power supply, and bypass leads should be kept as short as possible. Long connections can add significant inductance, raising impedance and limiting output current slew rate. This is especially true in the video frequency range.

The case of the MSK 111 is electrically isolated and should be connected to a common ground plane. In addition to the case, the input signal and input resistors should be connected to this common ground plane using a single point grounding scheme. This will help to prevent undesired current feedback that can cause instability in the circuit.

GAIN

The MSK 111, unlike most operational amplifiers, has an internal feedback resistor. The value of this resistor is 1.5KΩ. Fewer external components are required to configure the MSK 111 in either inverting or non-inverting modes. Using an internal feedback resistor shortens the feedback path, lowering summing node capacitance to ground and stabilizing high frequency characteristics.

OUTPUT OFFSET NULL

Typically,the MSK 111 has an input offset voltage of less than ±2mV. The input offset voltage is laser trimmed to less than ±5mV, but in applications where offset is critical, the balance pins may be used to null the offset to zero. A 20KΩ potentiometer may be placed between pins 4 and 8 with the wiper arm connected to $+V_{CC}$. If the balance function is not used pins 4 and 8 should not be connected (floating). However, if settling time is extremely important, pin 8 should be tied to the AC ground with a 100-150pF capacitor.

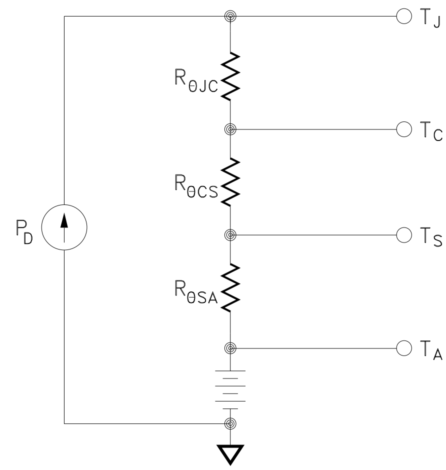
SAFE OPERATING AREA-POWER DISSIPATION

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 S.O.A. curves to ensure high M.T.B.F.

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

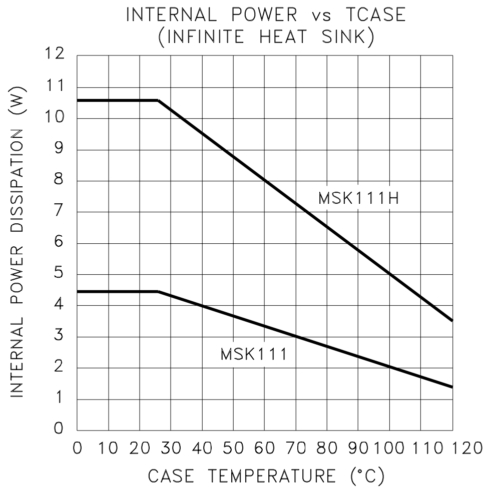
Example:

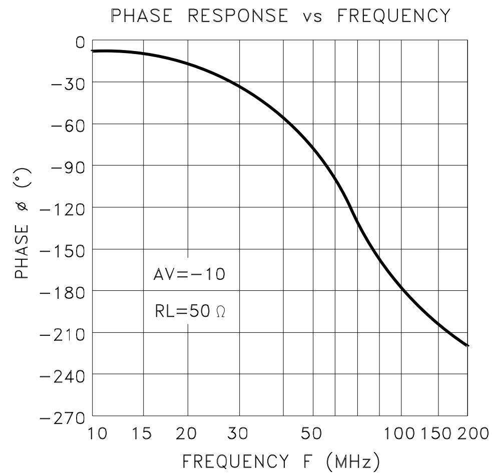
In our example the amplifier application requires the output to drive a 10 volt peak sine wave across a 50 ohm load for 0.2 amp of output current. For a worst case analysis we will treat the 0.2 amp peak output current as a D.C. output current. The power supplies are ±15 VDC.

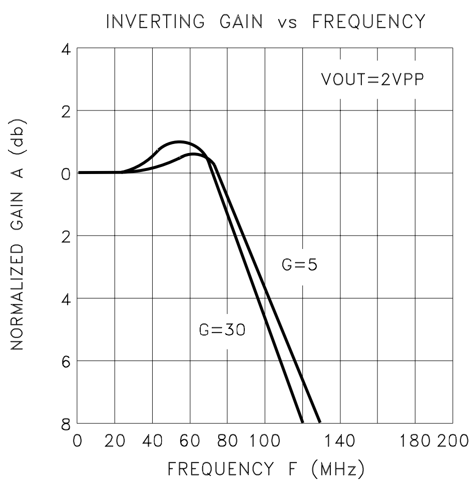
1.) Find Power Dissipation
$P_D = [(\text{quiescent current}) \times (+V_{CC} - (V_{CC}))] + [(V_S - V_O) \times I_{OUT}]$
$= (28\text{ mA}) \times (30V) + (5V) \times (0.2A)$
$= 0.84W + 1W$
$= 1.84W$
2.) For conservative design, set $T_J = +150°C$.
3.) For this example, worst case $T_A = +25°C$.
4.) $R_{\theta JC} = 31°C/W$
5.) Rearrange governing equation to solve for $R_{\theta SA}$:
$R_{\theta SA} = (T_J - T_A) / P_D - (R_{\theta JC}) - (R_{\theta CS})$
$= (150°C - 25°C) / 1.84W - (31°C/W) - (0.15°C/W)$
$= 36°C/W$

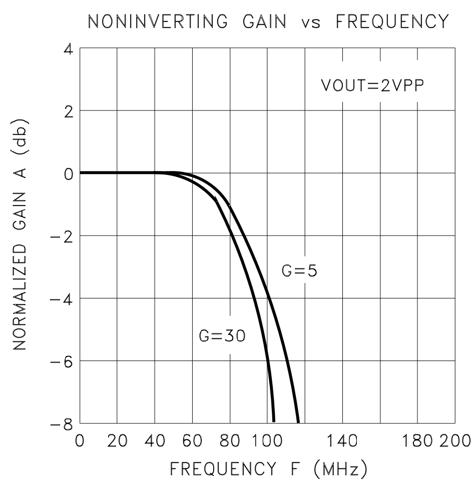
The heat sink in this example must have a thermal resistance of no more than 36°C/W to maintain a junction temperature of less than +150°C. This calculation assumes a case to sink thermal resistance of 0.15°C/W.

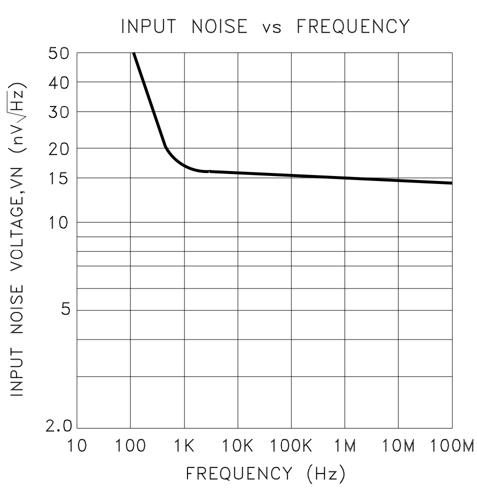
TYPICAL PERFORMANCE CURVES

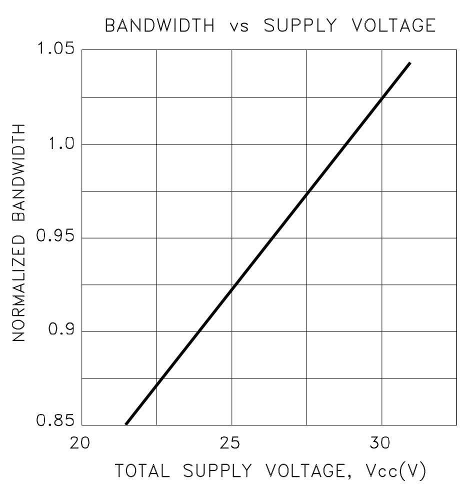




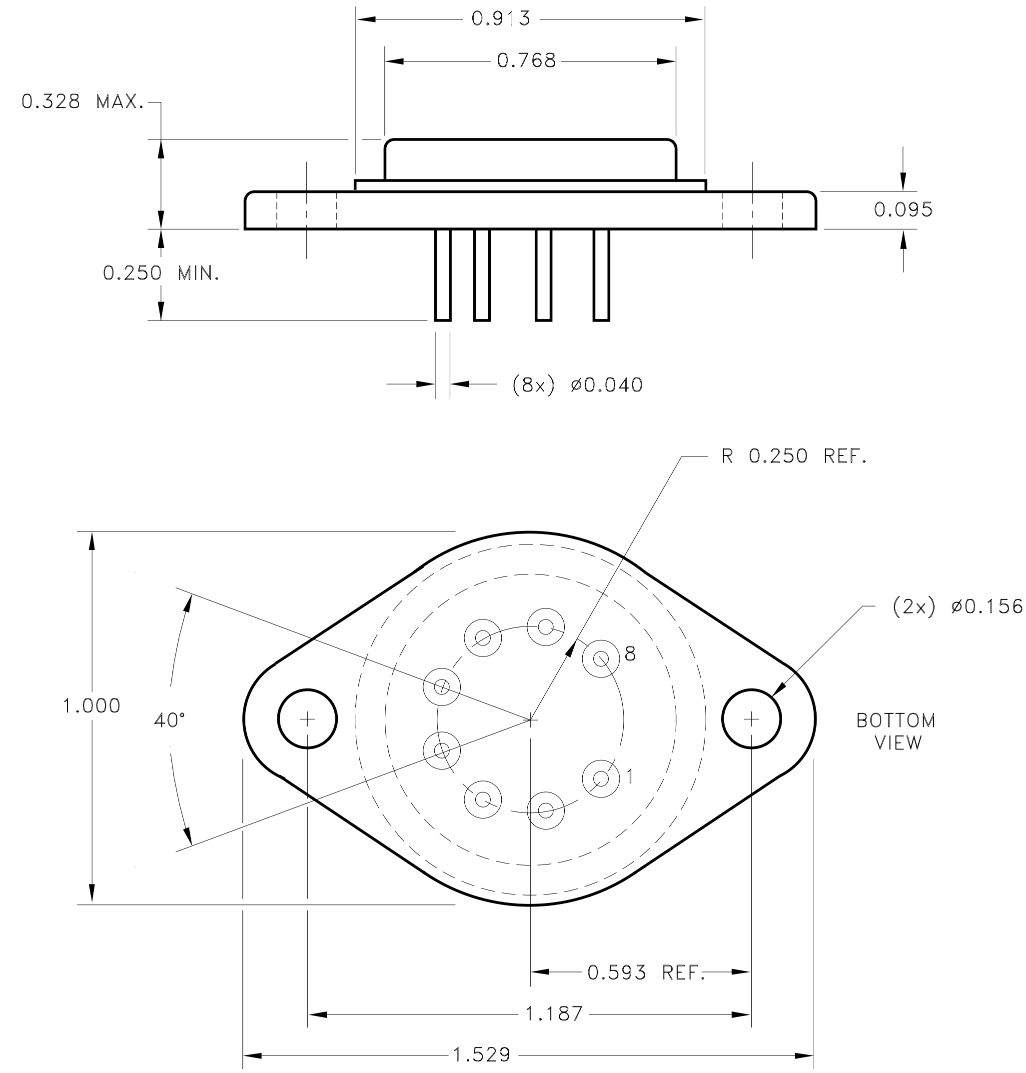








MECHANICAL SPECIFICATIONS



CONTAINS INTERNAL BeO (BERYLLIUM OXIDE)
WEIGHT = 15 GRAMS TYPICAL

NOTE: ALL DIMENSIONS ARE ±0.010 INCHES UNLESS OTHERWISE LABELED

ORDERING INFORMATION

Part Number	Screening Level
MSK111	Industrial
MSK111E	EXTENDED RELIABILITY
MSK111H	MIL-PRF-38534 CLASS H

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