ISO 9001 CERTIFIED BY DSCC

MSK
M.S.KENNEDY CORP.

HIGH SPEED/VOLTAGE OP AMP 1461

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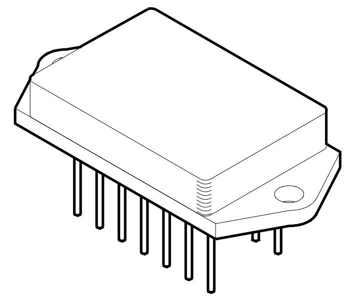
MIL-PRF-38534 CERTIFIED



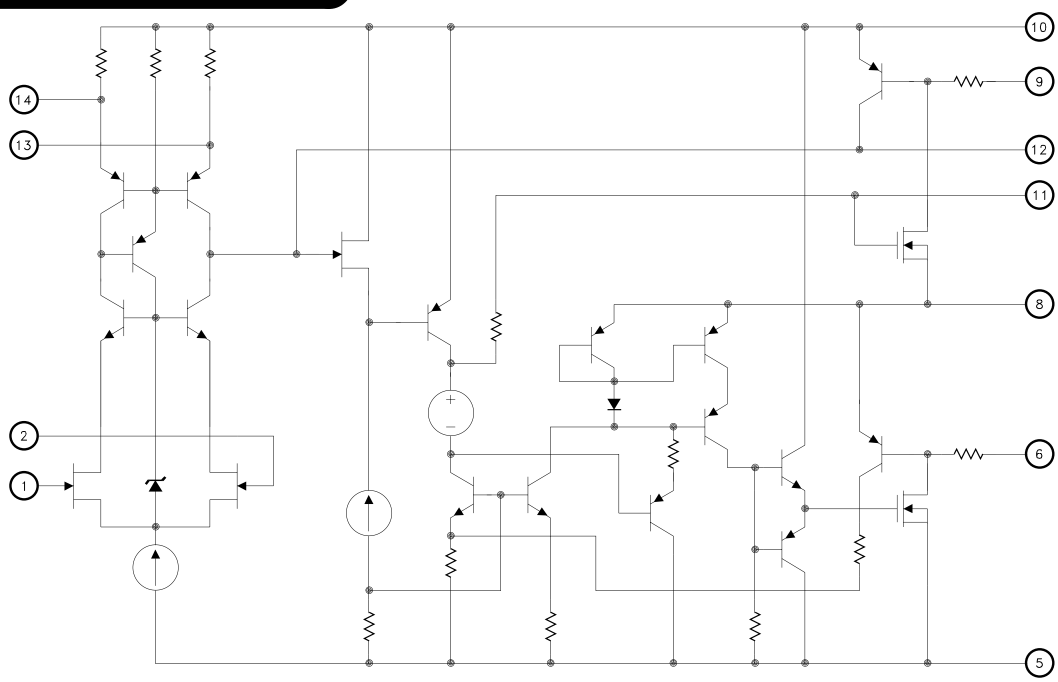
FEATURES:

- Extremely Fast - 500v/μS
- Wide Supply Range $\pm$15V to $\pm$45V
- VMOS Output, No S.O.A. Restrictions
- Large Gain-Bandwidth Product
- FET Input
- Electrically Isolated Case
- 800mA Typical Output Current

DESCRIPTION:

The MSK 1461 is a state of the art high speed FET input operational amplifier. The distinguishing characteristic of the MSK 1461 is its unique VMOS output stage which completely eliminates the safe operating area restrictions associated with secondary breakdown of bipolar transistor output stage op-amps. Freedom from secondary breakdown allows the 1461 to handle large output currents at any voltage level limited only by transistor junction temperature. 115 dB of open loop gain gives the 1461 high closed loop gain accuracy and the typical $\pm$1.0mV of input offset voltage will fit well in any error budget. A 500 V/μS slew rate and 1200 MHz gain bandwidth product make the 1461 an outstanding high-speed op-amp. A single external capacitor is used for compensation and output current limiting is user programmable through the selection of two external resistors.

EQUIVALENT SCHEMATIC



TYPICAL APPLICATIONS

- Video Yoke Drivers
- Video Distribution Amplifiers
- High Accuracy Audio Amplification
- High Speed ATE Pin Drivers

PIN-OUT INFORMATION

1	Inverting Input	8	Output
2	Non-Inverting Input	9	Positive Current Limit
3	No Connection	10	Positive Power Supply
4	No Connection	11	Compensation
5	Negative Power Supply	12	Compensation
6	Negative Current Limit	13	Offset Adjust
7	No Connection	14	Offset Adjust

ABSOLUTE MAXIMUM RATINGS

$\pm V_{CC}$ Supply Voltage . . . . ±45V
I_{OUT} Output Current 800mA
V_{IN} Differential Input Voltage . . . . ±25V
R_{TH} Thermal Resistance . . . . 12°C/W
Junction to Case
(Output Devices Only)

T_{ST} Storage Temperature Range -65°C to +150°C
T_{LD} Lead Temperature Range . . . . 300°C
(10 Seconds)
T_C Case Operating Temperature
(MSK 1461B) . . . . -55°C to +125°C
(MSK 1461) . . . . -40°C to 85°C
T_J Junction Temperature . . . . +175°C

ELECTRICAL SPECIFICATIONS

Parameter	Test Conditions	Group A Subgroup	MSK 1461B Min.	MSK 1461B Typ.	MSK 1461B Max.	MSK 1461 Min.	MSK 1461 Typ.	MSK 1461 Max.	Units
STATIC									
Supply Voltage Range ③		-	±15	-	±45	±15	-	±45	V
Quiescent Current	V_{IN}=0V	1	-	±19	±25	-	±19	±28	mA
		2,3	-	±21	±35	-	-	-	mA
Thermal Resistance ③	Junction to Case	-	-	11	12	-	11	15	°C/W
INPUT									
Input Offset Voltage	V_{IN}=0V A_V=-10V/V	1	-	±1.0	±5.0	-	±1.0	±8.0	mV
Input Offset Voltage Drift	Bal. Pins=N/C	2,3	-	±6.0	±50	-	±10	-	μV/°C
Input Offset Adjust ③	R_{POT}=10KΩ to $+V_{CC}$	-	-	±8.0	-	-	±8.0	-	V
Input Bias Current	V_{CM}=0V	1	-	±10	±300	-	±10	±300	pA
	Either Input	2,3	-	±10	±100	-	-	-	nA
Input Offset Current ③	V_{CM}=0V	-	-	±5.0	-	-	±5.0	-	pA
		-	-	±5.0	-	-	-	-	nA
Input Impedance ③	F=DC	-	-	$3x10^{12}$	-	-	$3x10^{12}$	-	Ω
Common Mode Range ③		-	±22	±24	-	±22	±24	-	V
Common Mode Rejection Ratio ③	F=10KHz V_{CM}=±22V	4	90	100	-	90	100	-	dB
OUTPUT									
Output Voltage Swing	R_L=50Ω A_V=-5V/V	4	±27	±31	-	±27	±31	-	V
	R_L=1KΩ	4	±30	±33	-	±30	±33	-	V
Output Current, Peak	R_L=33Ω A_V=-5V/V T_J<175°C	4	±600	±800	-	±600	±800	-	mA
Settling Time ② ③	0.1% 10V step	4	-	400	800	-	400	800	nS
TRANSFER CHARACTERISTICS									
Slew Rate	V_{OUT}=±10V R_L=1KΩ A_V=-5V/V	4	200	500	-	200	500	-	V/μS
Open Loop Voltage Gain ③	R_L=1KΩ F=100Hz	4	90	106	-	90	106	-	dB
Gain Bandwidth Product ③	F=100KHz	4	800	1200	-	800	1200	-	MHz

NOTES:

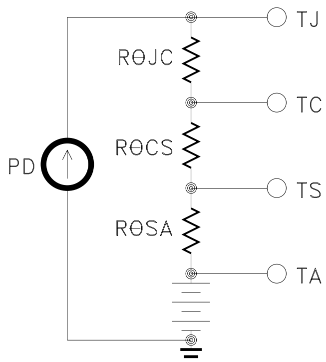
① R_{SC}=0Ω and $\pm V_{CC}$=36VDC unless otherwise specified.
② AV=-1, measured in false summing junction circuit.
③ Devices shall be capable of meeting the parameter, but need not be tested. Typical parameters are for reference only.
④ Industrial grade devices shall be tested to subgroups 1 and 4 unless otherwise specified.
⑤ Military grade devices ("B" suffix) shall be 100% tested to subgroups 1,2,3 and 4.
⑥ Subgroups 5 and 6 testing available upon request.
⑦ Subgroup 1,4 T_C=+25°C
Subgroup 2,5 T_J=+125°C
Subgroup 3,6 T_A=-55°C

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 20 volt peak sine wave across a 400Ω load for 50mA of peak output current. For a worst case analysis we will treat the 50mA peak output current as a D.C. output current. The power supplies shall be set to ±40VDC.

1.) Find Driver Power Dissipation
P_D = [(quiescent current) x (+V_S - (-V_S))] + [(+V_S-V_O) x I_{OUT}]
= [(50mA) x (80V)] + [(20V) x (0.05A)]
= 4W + 1.0W
= 5Watts
2.) For conservative design, set T_J = +125°C.
3.) For this example, worst case T_A = +50°C
4.) $R_{\theta JC}$ = 12°C/W from MSK 1461B 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) / 5W) - (12°C/W) - (.15°C/W)
≅ 2.85°C/W

The heat sink in this example must have a thermal resistance of no more than 2.85°C/W to maintain a junction temperature of no more than +125°C.

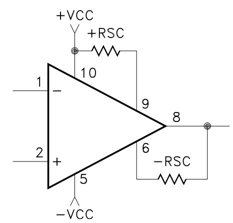
CURRENT LIMIT

The output current of the MSK 1461 is internally limited to approximately ±750mA by two 0.8Ω internal current limit resistors. Additional current limit can be achieved through the use of two external current limit resistors. One resistor (+RSC) limits the positive output current and the other (-RSC) limits the negative output current. The value of the current limit resistors can be determined as follows:

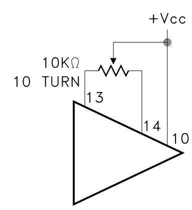
$$\pm R_{SC} = [(0.65V/\pm I_{LIM}) - 0.8\Omega]$$

Since the 0.65V term is obtained from the base to emitter voltage drop of a bipolar transistor, the equation only holds true for +25°C operation. As case temperature increases, the 0.65V term will decrease making the actual current limit set point decrease slightly.

The following schematic illustrates how to connect each current limit resistor:



INPUT OFFSET ADJUST CONNECTION



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 0.1μF ceramic capacitor in parallel with a 4.7μF tantalum capacitor from each power supply pin to ground.

SAFE OPERATING AREA

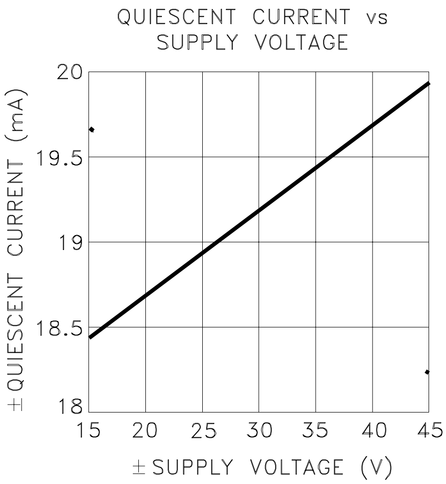
Any designer who has worked with power operational amplifiers is familiar with Safe Operating Area (S.O.A.) curves. S.O.A. curves are a graphical representation of the following three power limiting factors of any bipolar transistor output op-amp.

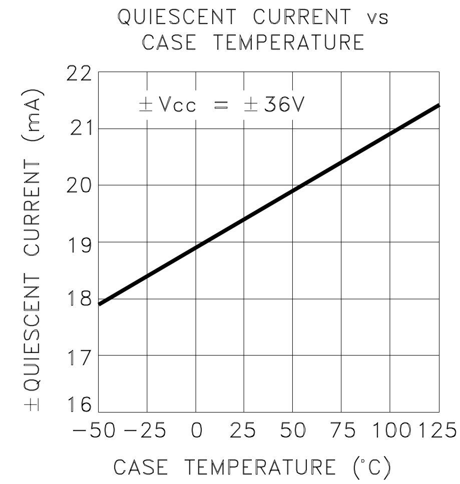
1. Wire Bond Current Carrying Capability
2. Transistor Junction Temperature
3. Secondary Breakdown Limitations

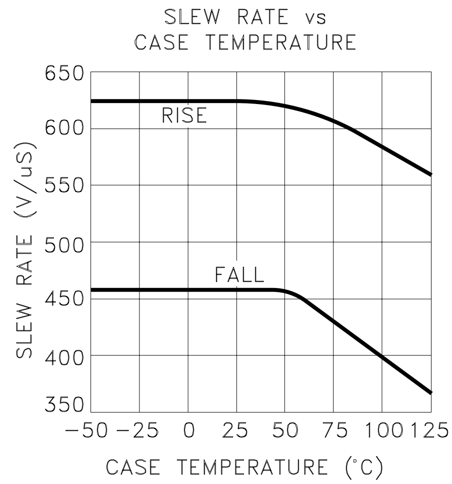
Since the MSK 1461 utilizes a MOSFET output, there are no secondary breakdown limitations and therefore no need for S.O.A. curves. The only limitation on output power is the junction temperature of the output drive transistors.

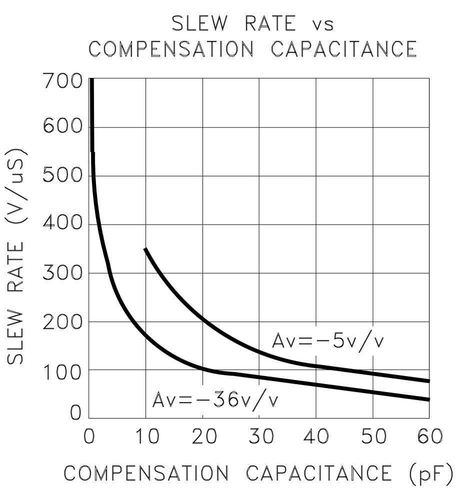
Whenever possible, junction temperature should be kept below 150°C to ensure high reliability. See "Heat Sinking" for more information involving junction temperature calculations.

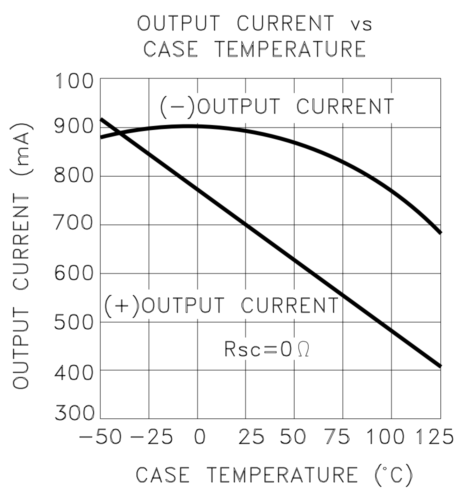
TYPICAL PERFORMANCE CURVES

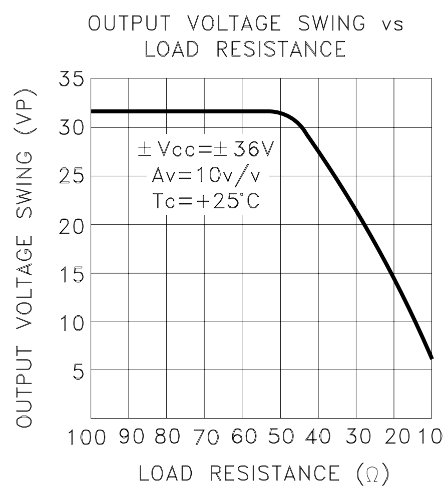


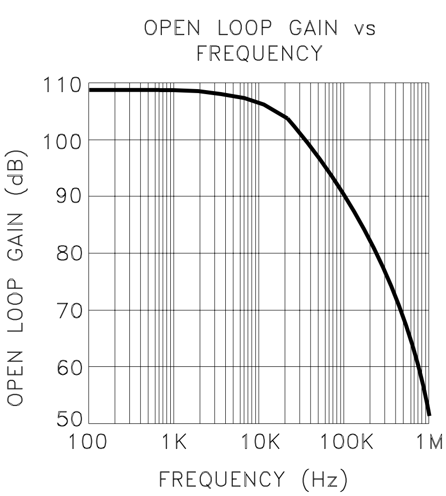


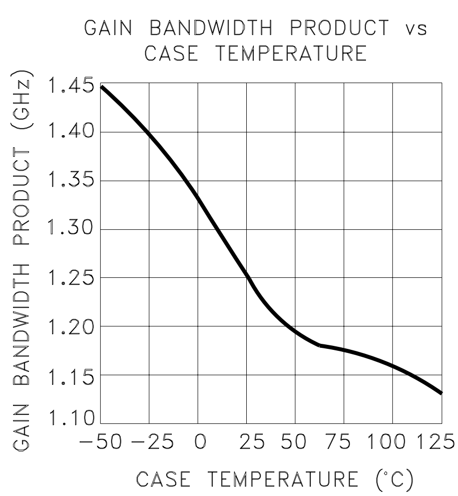


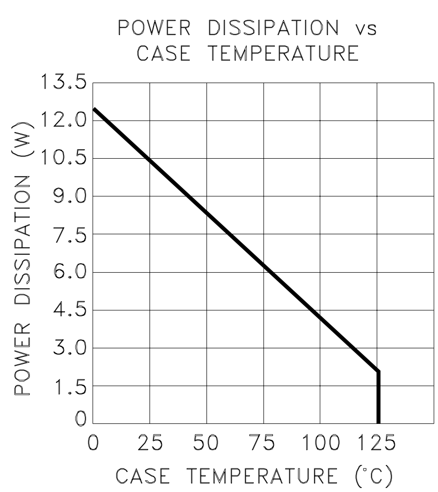




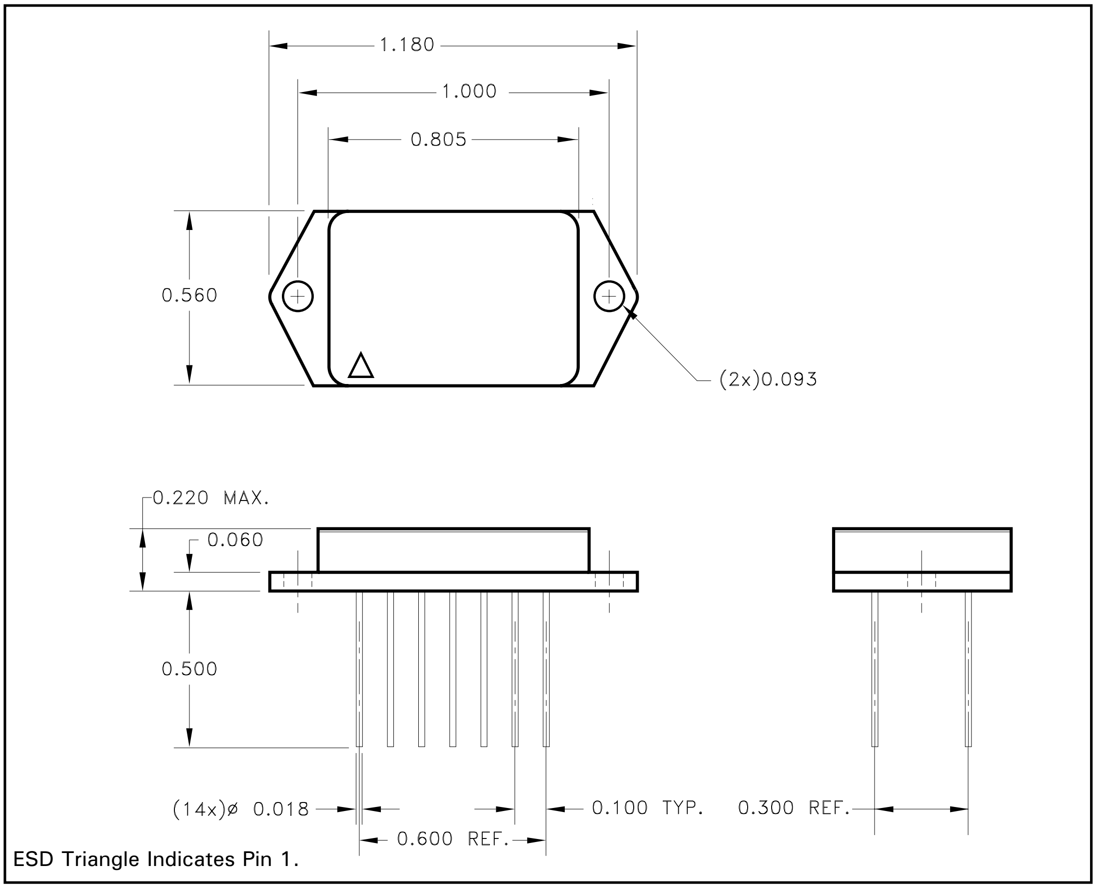








MECHANICAL SPECIFICATIONS



NOTE: ALL DIMENSIONS ARE ±0.010 UNLESS OTHERWISE LABELED.

ORDERING INFORMATION

Part Number	Screening Level
MSK1461	Industrial
MSK1461B	Military-Mil-PRF-38534

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