CLASS C HIGH POWER OPERATIONAL AMPLIFIER 138/139

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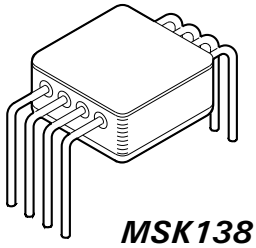
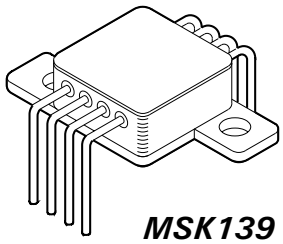
FEATURES:

- Low Cost
- High Voltage Operation: 150V
- Ultra Low Quiescent Current: ±4.0 mA Typ.
- High Output Current: 5A Min.
- No Second Breakdown
- Monolithic MOS Technology
- External Compensation for Optimum Gain-Bandwidth

MIL-PRF-38534 QUALIFIED



MSK138

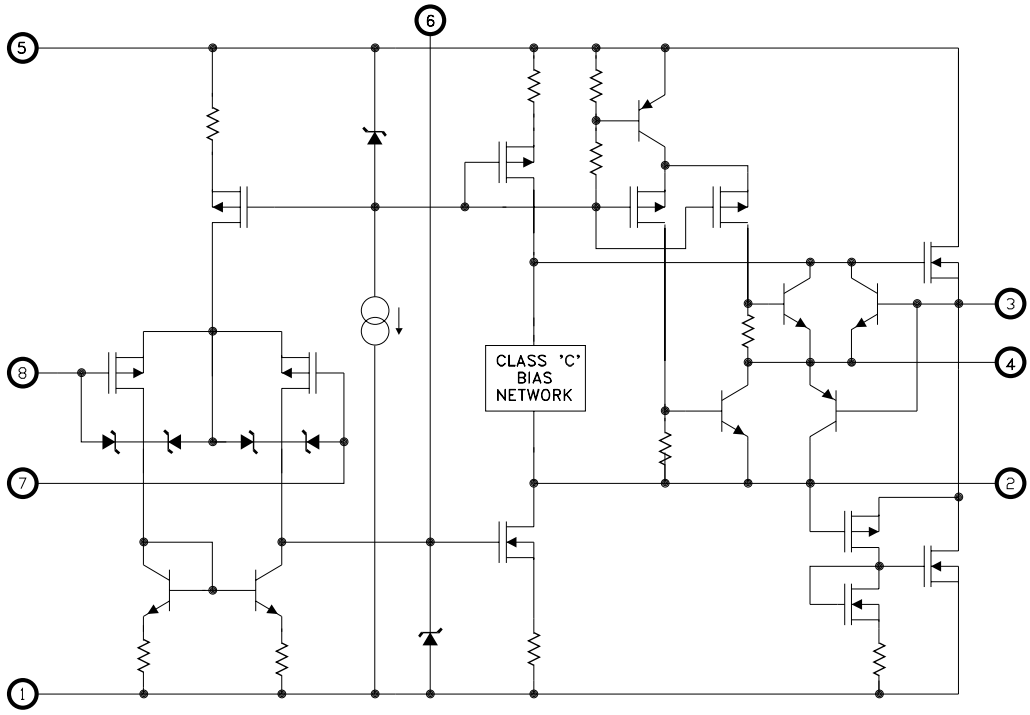


MSK139

DESCRIPTION:

The MSK 138 is a high power class "C" MOSFET operational amplifier ideally suited for high power amplification and magnetic deflection applications. With a total supply voltage rating of 150 volts and 5A of available output current, the MSK 138 is also an excellent low cost choice for motor drive circuits. The MOSFET output frees the MSK 138 from secondary breakdown limitations and power dissipation is kept to a minimum with a quiescent current rating of only ±4.0mA. The MSK 138 is packaged in a hermetically sealed 8 pin power dip which has two external compensation pins. For applications requiring heat sinking, the MSK 139 is available with bolt down tabs and is otherwise identical to the MSK 138 (see mechanical specifications).

EQUIVALENT SCHEMATIC



TYPICAL APPLICATIONS

- PA Audio
- Magnetic Deflection
- Motor Drive
- Noise Cancellation
- DC Power Regulators

PIN-OUT INFORMATION

1	-Vcc	8	Inverting Input
2	Comp 1	7	Non-Inverting Input
3	Output Drive	6	Comp 2
4	Current Sense	5	+Vcc

ABSOLUTE MAXIMUM RATINGS

V_{CC} ②	Total Supply Voltage 150V	T_{ST}	Storage Temperature . . . . . -65°C to +150°C
$\pm I_{OUT}$	Output Current (within S.O.A.) . . . . . ±5A	T_{LD}	Lead Temperature . . . . . 300°C
V_{IND}	Input Voltage (Differential) . . . . . ±16V	T_C	Case Operating Temperature
V_{IN}	Input Voltage (Common Mode) . . . . . ±Vcc		(MSK138B/139B) . . . . . -55°C to +125°C
T_J	Junction Temperature . . . . . 150°C		(MSK138/139) . . . . . -40°C to +85°C
		R_{TH}	Thermal Resistance (DC)
			Junction to Case . . . . . 1.0°C/W

ELECTRICAL SPECIFICATIONS

Parameter	Test Conditions ①	Group A Subgroup	MSK138B/139B Min.	MSK138B/139B Typ.	MSK138B/139B Max.	MSK138/139 Min.	MSK138/139 Typ.	MSK138/139 Max.	Units
STATIC									
Supply Voltage Range ② ④		-	±15	±50	±75	±15	±50	±75	V
Quiescent Current	V_{IN} = 0V	1	-	±4	±6	-	±4	±8	mA
INPUT									
Offset Voltage	V_{IN} = 0V	1	-	±5	±10	-	±5	±15	mV
Offset Voltage Drift ④	V_{IN} = 0V	2,3	-	±10	±50	-	±10	-	µV/°C
Offset Voltage vs ±Vcc ④	V_{IN} = 0V	1	-	±8	±15	-	±8	±15	µV/V
Input Bias Current ④	V_{CM} = 0V	1,3	-	±20	±100	-	±20	±100	pA
		2	-	-	±50	-	-	-	nA
Input Impedance ④	(DC)	-	-	10^{11}	-	-	10^{11}	-	Ω
Input Capacitance ④		-	-	5	-	-	5	-	pF
Common Mode Rejection ④	V_{CM} = ±30VDC	-	90	106	-	90	106	-	dB
Noise	10KHz BW	-	-	10	-	-	10	-	μV_{RMS}
OUTPUT									
Output Voltage Swing	I_{OUT} = ±5A Peak	4	±40	±42	-	±40	±42	-	V
Output Current	V_{OUT} = MAX	4	±5	±5.5	-	±5	±5.5	-	A
Power Bandwidth ④ ⑨	V_{OUT} = 80V_{PP}	-	-	66	-	-	66	-	KHz
Settling Time to 0.1% ③ ④	10V Step	-	-	2	-	-	2	-	µS
Capacitive Load ④	A_V = +1V/V C_C = 68pF	-	10	-	-	10	-	-	nF
TRANSFER CHARACTERISTICS									
Slew Rate ④ ⑨	C_C = Open	-	-	27	-	-	27	-	V/µS
Open Loop Voltage Gain ④	F = 15Hz	4	94	106	-	94	106	-	dB

NOTES:

① Unless otherwise noted C_C = 10pF, R_C = 1.0KΩ, ±V_{CC} = ±50VDC.
② Derate maximum supply voltage 0.5V/°C below T_C = +25°C. No derating is needed above T_C = 25°C.
③ A_V = -10V/V measured in false summing junction circuit.
④ Devices shall be capable of meeting the parameter, but need not be tested. Typical parameters are for reference only.
⑤ Industrial grade devices shall be tested to subgroups 1 and 4 unless otherwise requested.
⑥ Military grade devices ('B' suffix) shall be 100% tested to subgroups 1,2,3 and 4.
⑦ Subgroup 5 and 6 testing available upon request.
⑧ Subgroup 1,4 T_C = +25°C
Subgroup 2,5 T_C = +125°C
Subgroup 3,6 T_A = -55°C
⑨ Parameter is specified with the output above the deadband near zero volts

APPLICATION NOTES

CURRENT LIMIT *(SEE TYPICAL CONNECTION DIAGRAM)*

A value of current limit resistance can be calculated as follows:

$$R_{CL} = (0.83 - (0.05 * I_{CL})) / I_{CL}$$

Where:

R_{CL} is the current limit resistor value

I_{CL} is the current limit

$0.05 * I_{CL}$ is the voltage dropped in the current limit path across internal impedances other than the actual current limit resistor

0.83 volts is the voltage drop that must be developed across the current limit connections to activate the current limit circuit

The maximum practical value of current limit resistance is 16 ohms. The current limit resistor will decrease available output voltage swing in the following manner:

$$V_R = I_O * R_{CL}$$

V_R is the reduction in output voltage swing due to the current limit resistor. It is recommended the user limit output current to a value as close to the required output current as possible, without clipping output voltage swing. Current limit will vary with case temperature. Refer to the typical performance curves to predict current limit drift. If current limit is not required replace the resistor with a short.

STABILITY

The MSK 138/139 has sufficient phase margin when compensated for unity gain to be stable with capacitive loads of at least 10nF. However, it is recommended that the parallel sum of the input and feedback resistor be 1000 ohms or less for closed loop gains of ten or less to minimize phase shift caused by the R-C network formed by the input resistor, feedback resistor and input capacitance. The user can tailor the performance of the MSK 138/139 to their application using the external compensation pins. The graphs of small signal gain and phase as well as the graphs of slew rate and power response demonstrate the effect of various forms of compensation. The compensation capacitor must be rated at 150 volts working voltage if maximum power supply voltages are used. The compensation resistor and capacitor lead lengths must be kept as short as possible to minimize spurious oscillations. A high quality NPO capacitor is recommended for the compensation capacitor. An effective method of checking amplifier stability is to apply the worst case capacitive load to the output of the amplifier and drive a small signal square wave across it. If overshoot is less than 25%, the system will typically be stable.

INPUT PROTECTION

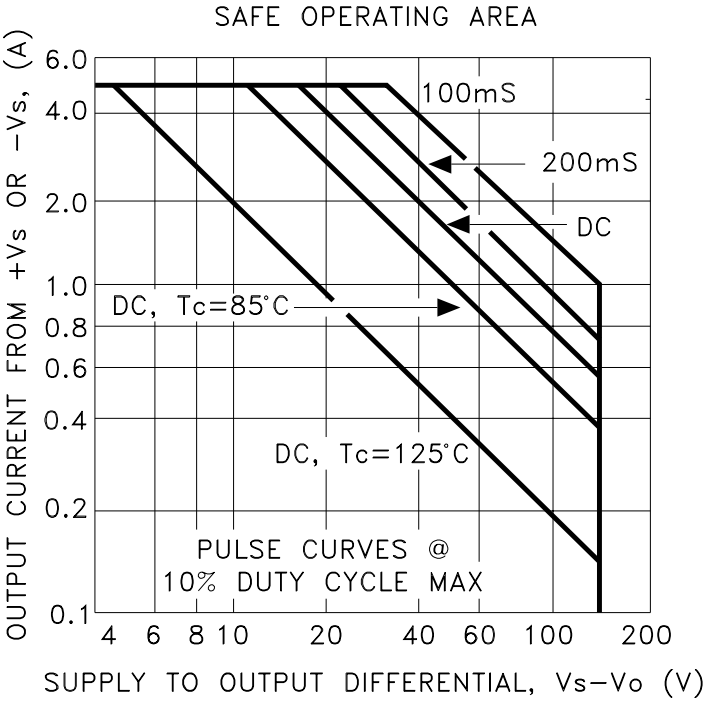
Input protection circuitry within the MSK 138/139 will clip differential input voltages greater than 16 volts. The inputs are also protected against common mode voltages up to the supply rails as well as static discharge. There are 300 ohm current limiting resistors in series with each input. These resistors may become damaged in the event the input overload is capable of driving currents above 1mA. If severe overload conditions are expected, external input current limiting resistors are recommended.

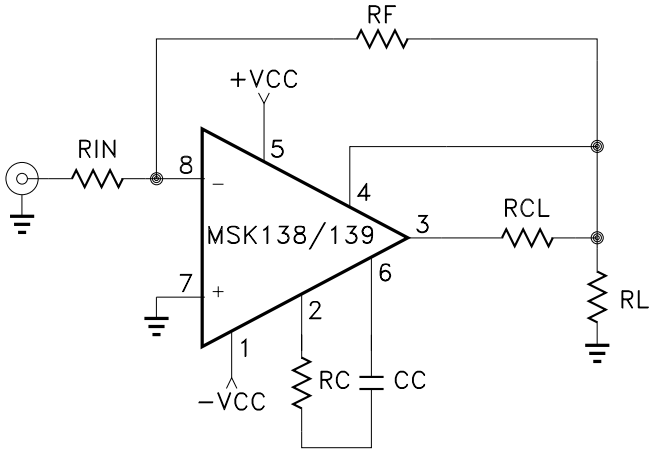
SAFE OPERATING AREA (SOA)

The MOSFET output stage of this power operational amplifier has two distinct limitations:

1. The current handling capability of the die metallization.
2. The junction temperature of the output MOSFET's.

NOTE: The output stage is protected against transient flyback. However, for protection against sustained, high energy flyback, external fast-recovery reverse biased diodes should be connected from the output to ground.





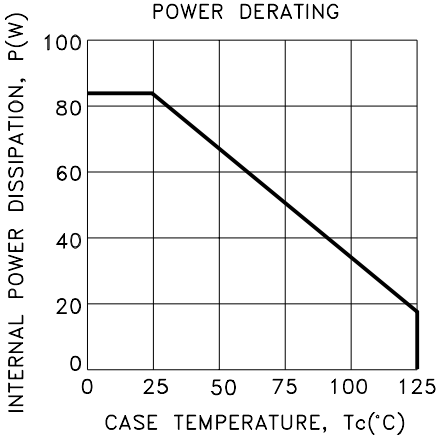
TYPICAL CONNECTION DIAGRAM

CLASS "C" PERFORMANCE

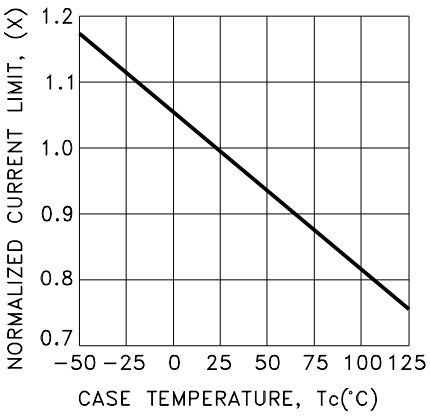
The MSK 138/139 output is biased for class "C" operation to yield ultra low quiescent current. A small amount of cross-over distortion will be present under heavy load conditions. The user must verify that this condition will not affect circuit performance. Applications requiring a high degree of linearity near the zero point with minimum distortion should use the MSK 148/149.

TYPICAL PERFORMANCE CURVES

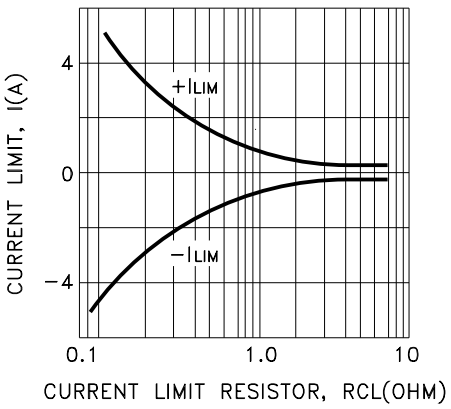
POWER DERATING



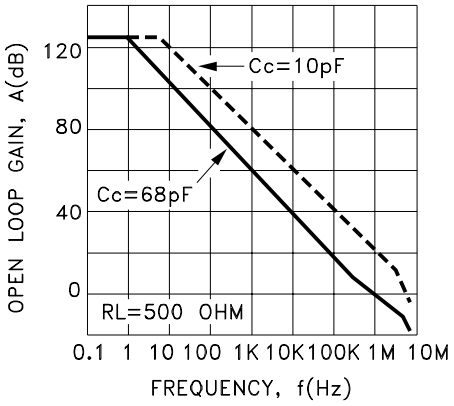
CURRENT LIMIT DRIFT



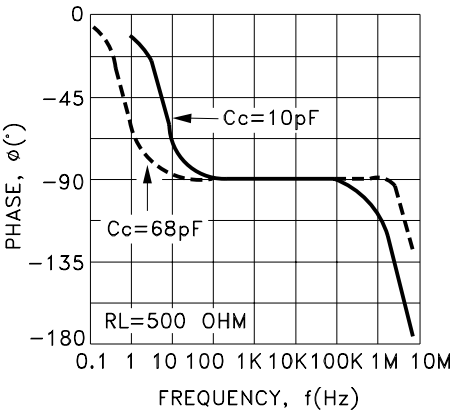
ABSOLUTE CURRENT LIMIT



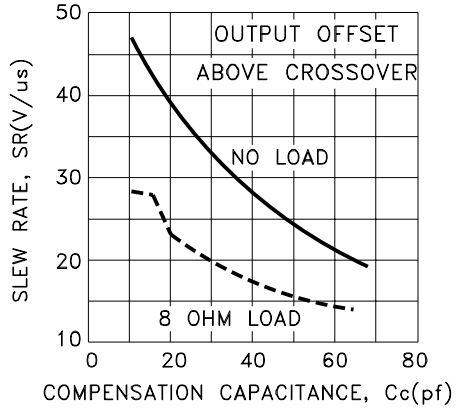
SMALL SIGNAL RESPONSE



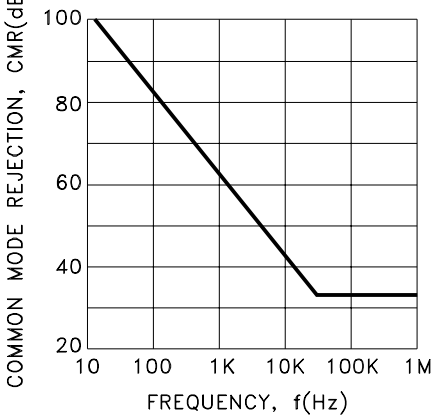
PHASE RESPONSE



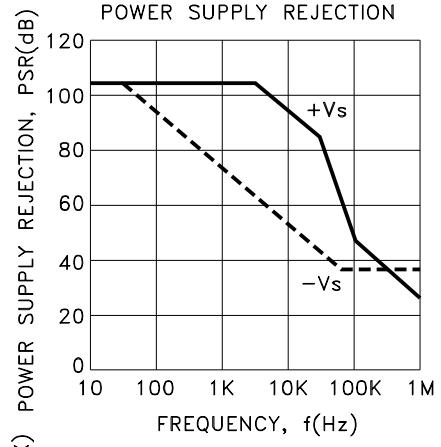
SLEW RATE



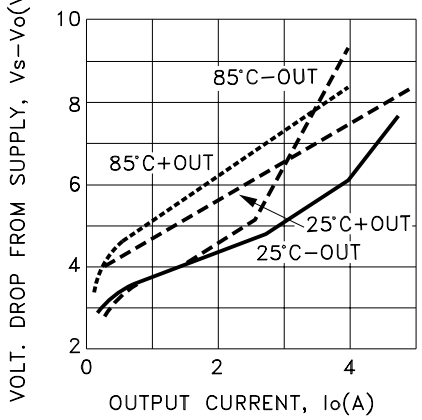
COMMON MODE REJECTION



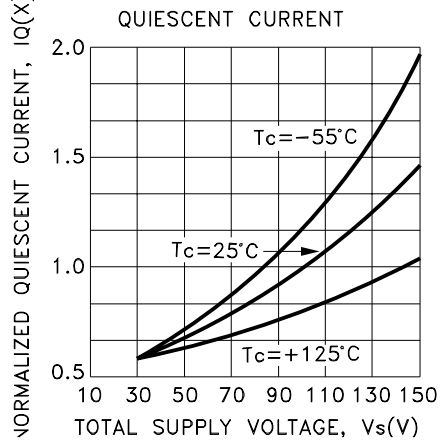
POWER SUPPLY REJECTION



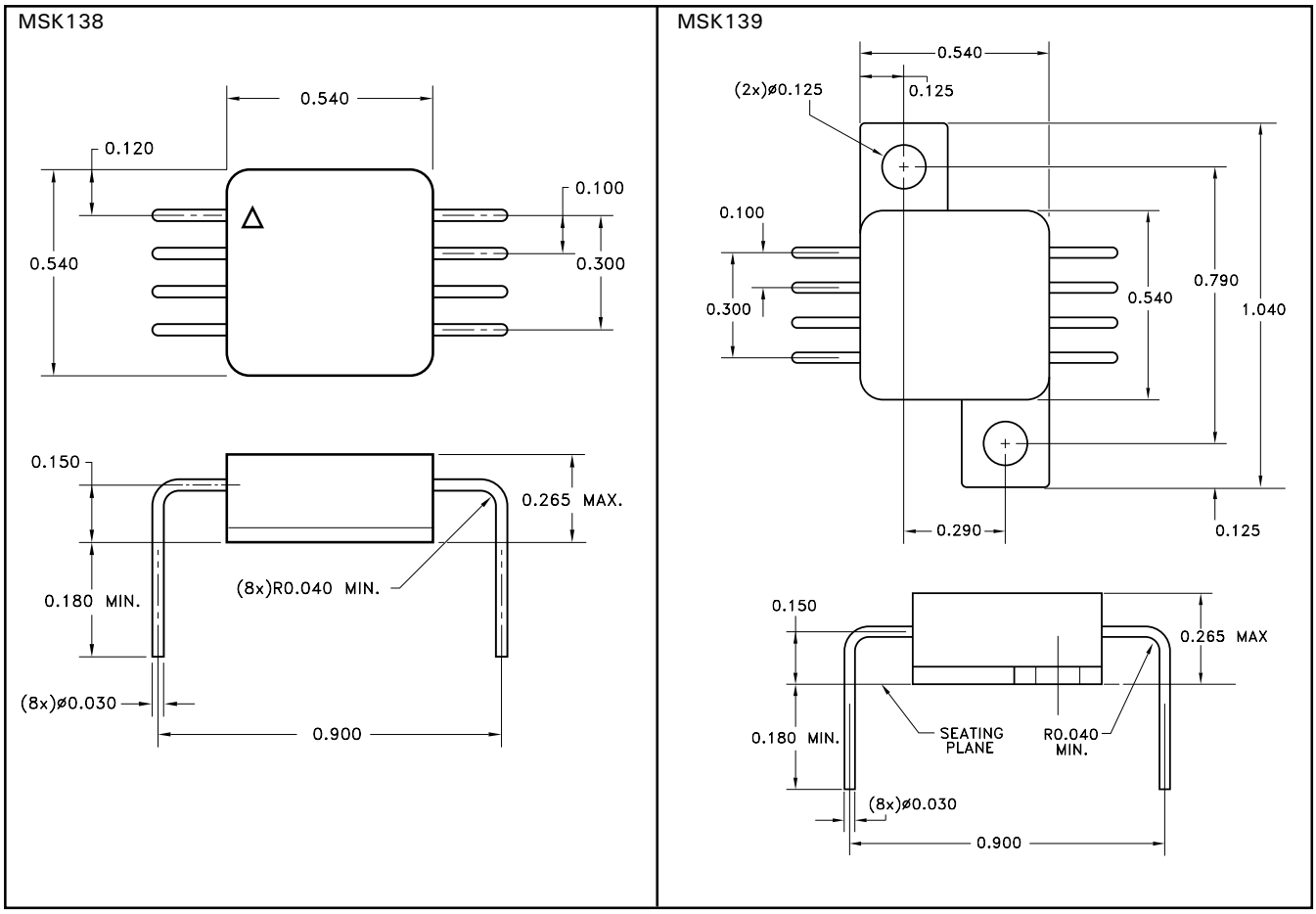
OUTPUT VOLTAGE SWING



QUIESCENT CURRENT



MECHANICAL SPECIFICATIONS



ESD TRIANGLE INDICATES PIN 1.
ALL DIMENSIONS ARE ±0.010 INCHES UNLESS OTHERWISE LABELED.

ORDERING INFORMATION

Part Number	Screening Level
MSK138	Industrial
MSK138B	Military-Mil-PRF-38534
MSK139	Industrial
MSK139B	Military-Mil-PRF-38534

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