

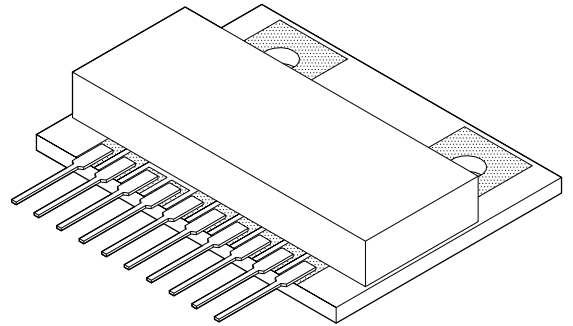


**ULTRA HIGH VOLTAGE  
HIGH SPEED  
DIFFERENTIAL OP-AMP**

**130**

**FEATURES:**

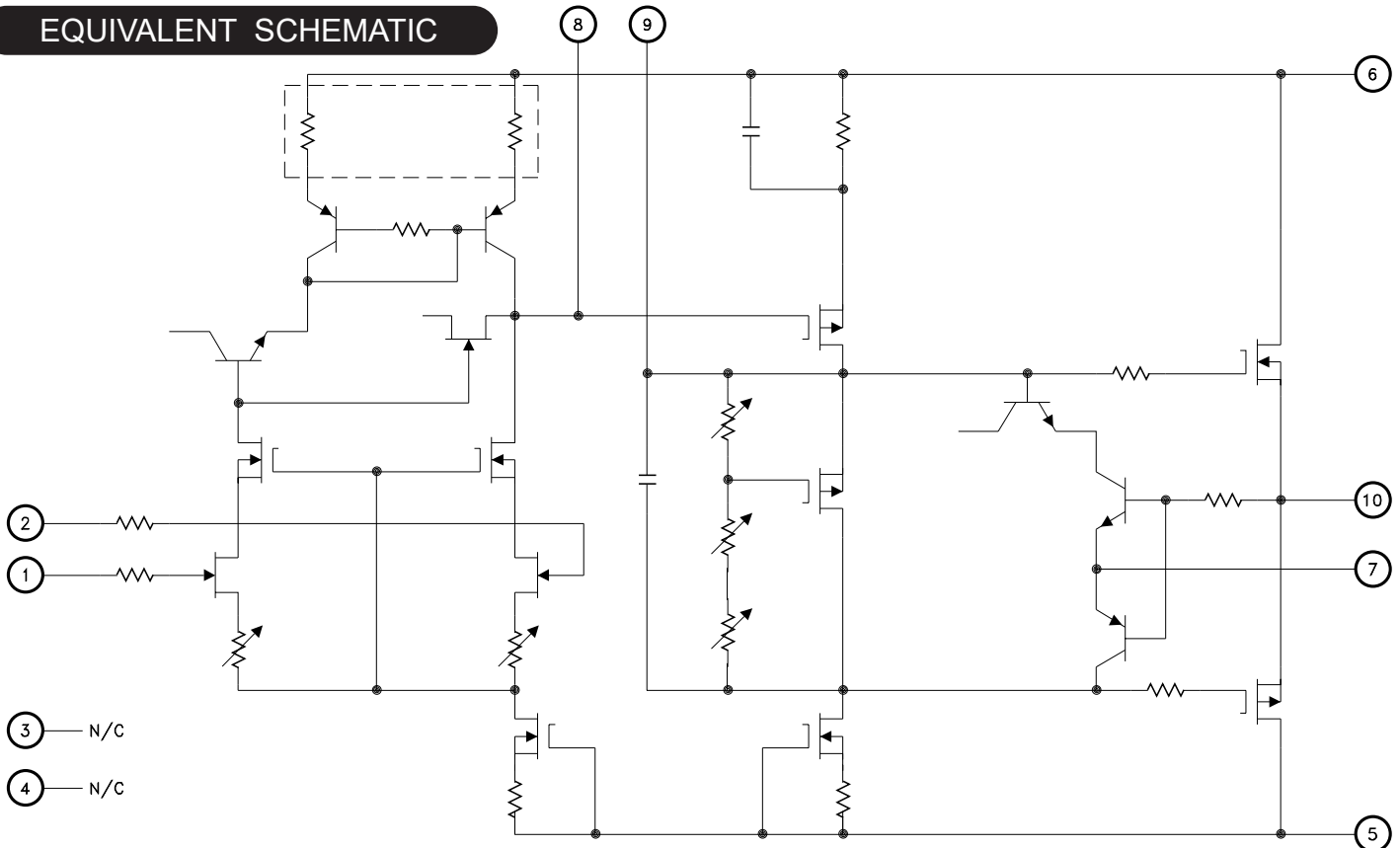
- Wide Supply Voltage Range 15V to 400V
- Fast Slew Rate - 300 V/ $\mu$ S Typ.
- FET Input - Accurate DC Specifications
- Electrically Isolated Case
- Low Cost Innovative Packaging
- Very Low Quiescent Current - 6mA Typ.
- Output Current to  $\pm$ 200mA
- Adjustable Current Limit



**DESCRIPTION:**

The MSK130 is a high speed, high voltage differential amplifier designed for output currents up to  $\pm$ 200mA. Since the MSK130 utilizes external compensation, it exhibits wide bandwidth and greater stability over a wide gain range. High frequency, high voltage instrumentation circuits and electrostatic transducers are just a sample of the applications that the MSK130 is well suited for. The device is packaged in a 10 pin insulated ceramic SIP with holes for direct heat sink attachment.

**EQUIVALENT SCHEMATIC**



**TYPICAL APPLICATIONS**

- Ultra-High Voltage Supplies
- FET Input Instrumentation Amplifiers
- Electrostatic Deflection
- Electrostatic Transducers
- Piezo Transducer Excitation

**PIN-OUT INFORMATION**

1 Input	10 Output
2 +Input	9 Comp2
3 No Connection	8 Comp1
4 No Connection	7 Isense
5 -Vcc	6 +Vcc

## ABSOLUTE MAXIMUM RATINGS

V <sub>CC</sub>	Supply Voltage (Total).....	400V	T <sub>ST</sub>	Storage Temperature Range.....	-65°C to +150°C
I <sub>OUT</sub>	Output Current.....	±300mA	T <sub>LD</sub>	Lead Temperature Range (10 Seconds).....	220°C
V <sub>IND</sub>	Differential Input Voltage.....	±25V	T <sub>J</sub>	Junction Temperature.....	+150°C
V <sub>INCM</sub>	Common Mode Input Voltage.....	±V <sub>CC</sub>	T <sub>C</sub>	Case Operating Temperature Range MSK130.....	-55°C to +125°C
R <sub>TH</sub>	Thermal Resistance..... Junction to Case @ 125°C (Output Devices)	27.5°C/W			

## ELECTRICAL SPECIFICATIONS

Parameter	Test Conditions 1	MSK130			Units
		Min.	Typ.	Max.	
STATIC					
Supply Voltage Range	Total +V <sub>CC</sub> to -V <sub>CC</sub>	20	-	400	V
Quiescent Current	V <sub>IN</sub> = 0V	-	±6	±8	mA
INPUT					
Input Offset Voltage	V <sub>IN</sub> = 0V	-	±0.5	±2.0	mV
Input Offset Voltage Drift	V <sub>IN</sub> = 0V	-	±10	±50	µV/°C
Input Bias Current	V <sub>CM</sub> = 0V Either Input	-	±10	±200	pA
Input Offset Current	V <sub>CM</sub> = 0V	-	10	50	pA
Input Impedance	F = DC	-	10 <sup>11</sup>	-	Ω
Input Capacitance	Either Input	-	4.0	-	pF
Power Supply Rejection Ratio	ΔV <sub>CC</sub> = ±15V	-	±10	±20	µV/V
Common Mode Rejection Ratio	F = DC V <sub>CM</sub> = ±50V	80	90	-	dB
Common mode Range	Linear Operation	±V <sub>CC</sub> -15	±V <sub>CC</sub> -13	-	V
Input Noise Voltage	F = 100KHz	-	1.5	-	µVrms
OUTPUT					
Output Voltage Swing	I <sub>OUT</sub> = ±50mA	±91.5	±95	-	V
Output Current	Within SOA	±200	±250	-	mA
Output Resistance	f ≤ 10KHz, No Load	-	50	-	Ω
TRANSFER CHARACTERISTICS					
Slew Rate Limit	A <sub>V</sub> = 100V/V C <sub>C</sub> = 0pF	-	300	-	V/µS
Open Loop Voltage Gain	F = 15Hz C <sub>C</sub> = 0pF	95	110	-	dB
Settling Time to 0.1%	R <sub>L</sub> = 1KΩ 2V step C <sub>C</sub> = 10pF	-	1	-	µS

### NOTES:

- ① ±V<sub>CC</sub>=±100V, T<sub>C</sub>=25°C, R<sub>C</sub>=100Ω, C<sub>C</sub>=68pF unless otherwise specified.
- ② Devices shall be capable of meeting the parameter, but need not be tested.
- ③ Typical parameters are representative of actual device performance but are for reference only.
- ④ Maximum supply voltage should be derated 0.625V/°C below 25°C case temperature. Above 65°C derate linearly to 120V total at 125°C, see SOA.
- ⑤ Internal solder reflow temperature is 180°C, do not exceed.

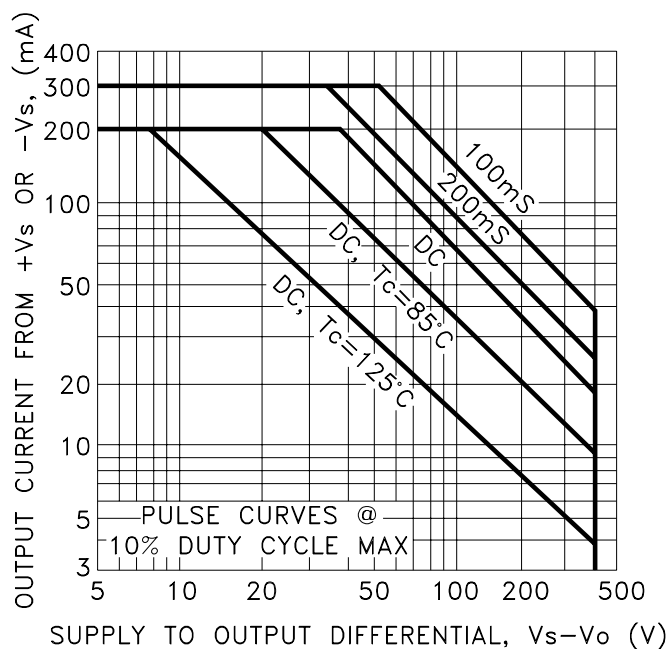
## APPLICATION NOTES

### SAFE OPERATING AREA

The output stage of the MSK130 is fabricated using state of the art complimentary MOSFETs and is free from secondary breakdown limitations. There are two distinct limitations for the output stage:

1. The internal wire bonds and the geometry of the MOSFET have a maximum peak current capability of  $\pm 300\text{mA}$ .
2. The junction temperature of each MOSFET should be kept below the maximum rating of  $150^\circ\text{C}$ .

The SOA Curves below illustrate various conditions of power dissipation.



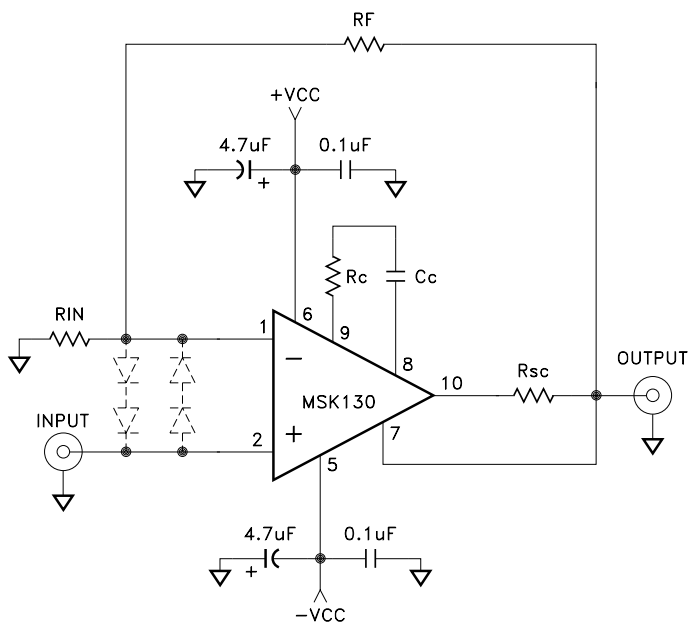
### INPUT PROTECTION

The MSK130 can safely handle up to  $\pm 25\text{V}$  of differential input voltages. In applications where this may be violated, external protection is required. Four diodes can be used as shown in the typical connection diagram. If leakage current is of concern, use JFETs connected as diodes instead. JFETs will also yield very low capacitance for high speed applications.

### CURRENT LIMIT

The MSK130 has an internal active current limit circuit that can be programmed with a single external resistor  $R_{sc}$ . The value of this resistor should be kept between  $2\Omega$  and  $150\Omega$ . The following equation is used to select the resistor for a given current limit value:

$$R_{sc} = 0.6/I_{LIMIT} \text{ (See Typical Connection Diagram)}$$



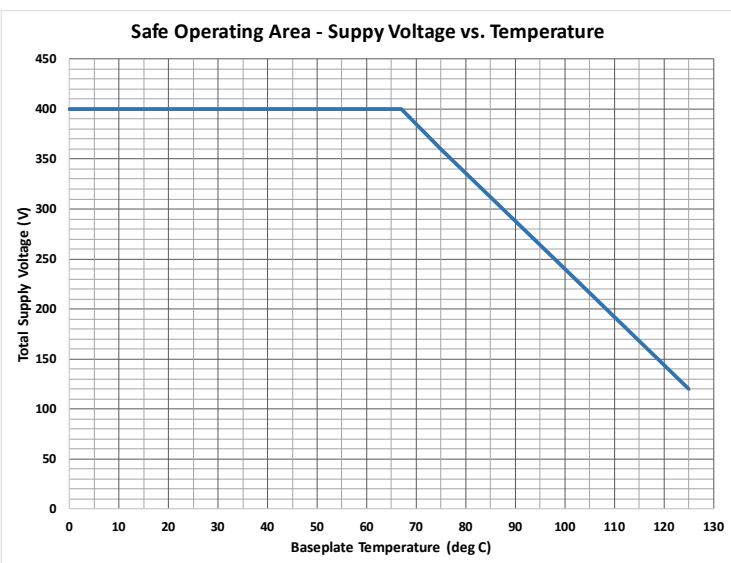
TYPICAL CONNECTION DIAGRAM

### STABILITY AND COMPENSATION

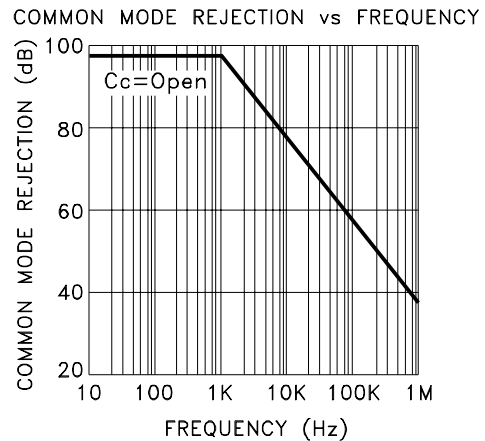
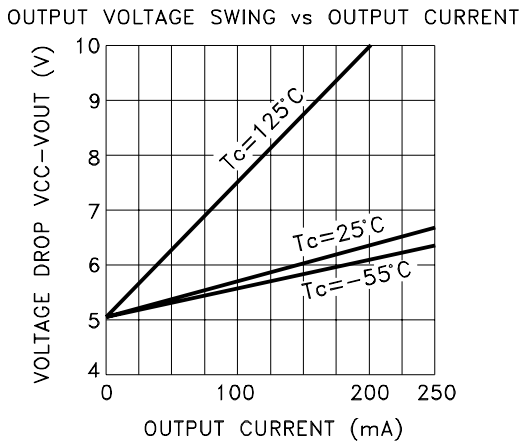
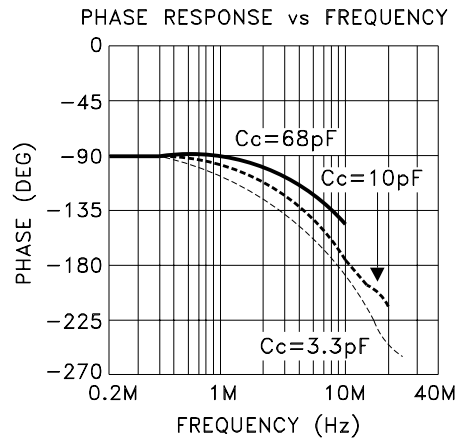
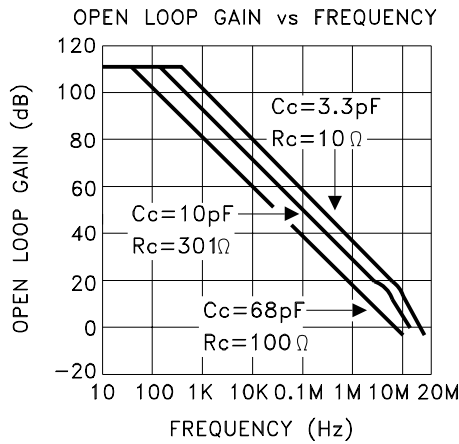
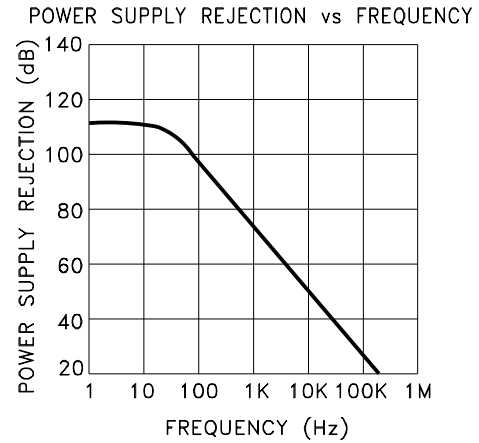
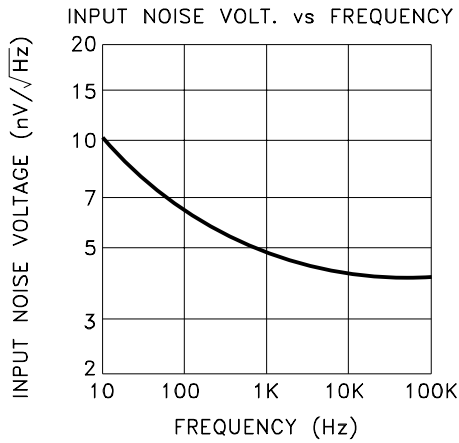
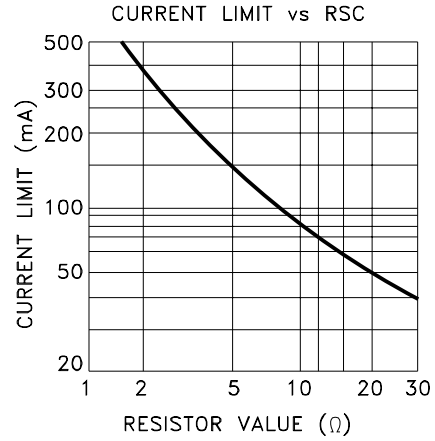
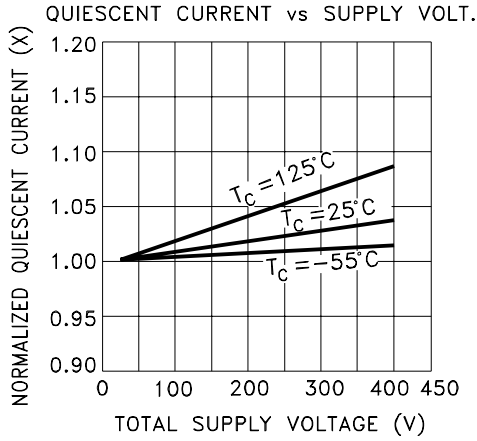
Since the MSK130 is externally compensated the bandwidth can be optimized for any gain selection. The external compensation components should be located as close to the compensation pins as possible to avoid unwanted oscillations. The capacitor  $C_c$  should be rated for the full supply voltage. Use a high quality dielectric such as NPO to maintain a desired compensation over the full operating temperature. Refer to the typical performance curves for a guide to select the desired compensation. Refer to the typical connection diagram for the location of the  $R_c$  and  $C_c$  components.

### POWER SUPPLIES

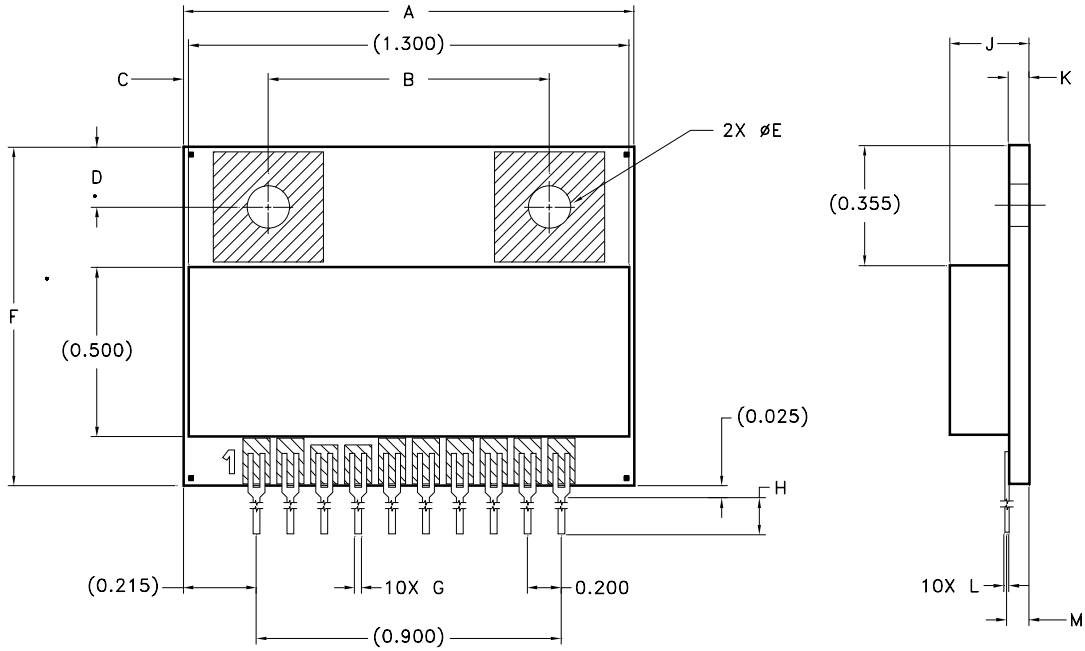
Both the negative and positive power supplies must be effectively decoupled with a high and low frequency bypass circuit to avoid power supply induced oscillation. An effective decoupling scheme consists of a  $0.1$  microfarad ceramic capacitor in parallel with a  $4.7$  microfarad tantalum capacitor for each power supply pin to ground. All power supply decoupling capacitors should be placed as close to the package power supply pins as possible (pins 5 and 6).



# TYPICAL PERFORMANCE CURVES



# MECHANICAL SPECIFICATIONS



REF	MIN	MAX
A	1.320	1.340
B	0.825	0.835
C	0.245	0.255
D	0.1725	0.1825
E	0.120	0.130
F	0.990	1.010
G	0.015	0.025
H	0.275	
J		0.260
K	0.057	0.063
L	0.008	0.012
M	0.058	0.072

ALL DIMENSIONS ARE SPECIFIED IN INCHES

TORQUE SPECIFICATION 3-5 IN./LBS. TEFLON SCREWS OR WASHERS ARE RECOMMENDED.

## ORDERING INFORMATION

Part Number	Screening Level
MSK 130	Industrial

## REVISION HISTORY

REV	STATUS	DATE	DESCRIPTION
D	Released	06/14	Add new note for solder reflow and clarify mechanical outline.
E	Released	07/17	Update Thermal Resistance
F	Released	01/18	Update Note 4 and SOA
G	Released	09/21	Remove MIL-PRF-38535

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