Model 930 Programmable Current Source

Features

- Program Output by Potentiometer Setting or Voltage Input
- Wide Supply Range from +12V to +32V
- Fast Response from 10 µs to Step Change
- Well Regulated 10 megohms Output Impedance

Description

The Model 930 is a programmable current source that provides an output current that stays constant with changes in load impedance. The output voltage will vary as necessary to maintain the desired value of constant current through the load. Output current of the Model 930 can be set by means of an external potentiometer or by a DC voltage. It has an internal regulator and reference circuit to make the output current independent of power supply variations. Supply voltage can be unregulated and can range from +12V to +32V. The compliance voltage (maximum output voltage for highest load impedance) is dependent on the supply voltage level and is rated at the supply voltage less 5 Volts.

Operation

The Model 930 output current can be programmed by a 1000 ohm potentiometer or by a voltage input. To set the current with a potentiometer, connect the potentiometer end terminals across pins 1 and 7 and the wiper arm to pin 3. Connect pins 9, 10 and 11 to each other. This will provide a linear adjustment of output current from 0.5 mA to 50 mA. This is extended to a range of 5 mA to 500 mA on the 296HP Power Booster Mounting Kit.

For voltage programming, the potentiometer must be removed (pins 1, 3, 7 left open) and a jumper must be connected across pins 3 and 4. As with potentiometer programming, pins 9, 10 and 11 must be connected together. When connected for voltage programming, an input voltage of zero to +10V provides a linear output current of +0.5mA to +50mA.

Need more output current? It's easy, simply parallel the outputs of several programmable current sources. For example, the outputs of two Model 930/MK 296HP units can be connected to the same load to provide a combined output of up to one ampere.

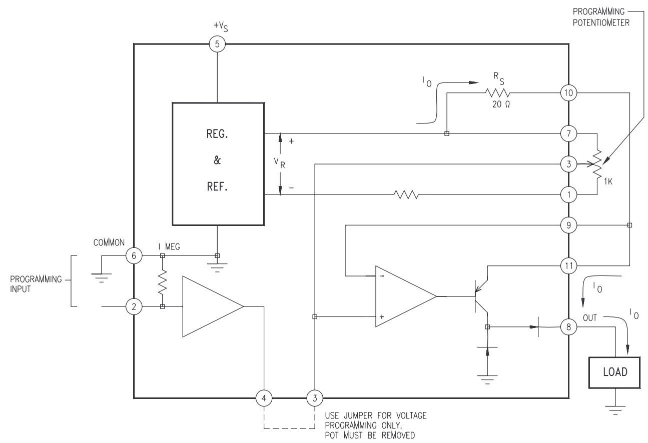


FIGURE 1.
Model 930 Connected for Potentiometer Programming of I_0.

Output or Compliance Voltage

The key parameter in applying constant current sources is the range of load impedance. This determines the range of output voltage needed to maintain a constant current through the varying load impedance. For example, if the load were to vary from 1 ohm to 200 ohms and the desired constant current were 50 mA, then the output voltage range needed would be 50 mV to 10V. The power supply must be 5 Volts greater than the compliance voltage or 15 Volts, in this case.

2401 Stanwell Drive
Concord, CA 94520-4841
(510) 687-4411 • Fax (510) 687-3333

Model 930 Programmable Current Source

Specifications

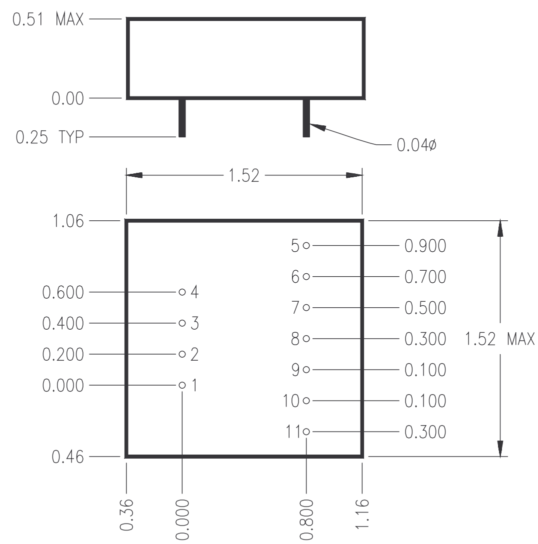
Model	930	930/MK296HP
Output		
Output Current	+0.5 to +50 mA	5 mA to 500 mA
Compliance Voltage	0 to Supply less 5 Volts	0 to Supply less 6 Volts
	(Output may not be negative with respect to common pin 6)	
Stability		
Output Current Regulation Vs. Supply Volts, DC	5 µA/Volt, max.	50 µA/Volt, max.
120 cps rejection	10 µA/Volt, typ. 50 µA/Volt, max.	20 µA/Volt, typ. 100 µA/Volt, max.
Output Impedance		
at DC	10 megohm, typ.	1 megohm, typ.
at 1 MHz	500 ohms, typ.	10 ohms, typ.
Temperature Coefficient	±5 µA/°C max.	±50 µA/°C max.
Programming Inputs		
Potentiometer	External 1K	
Voltage Input Input Range	0 to +10 Volts	
Scale Factor	5 mA/Volt	50 mA/Volt
Accuracy	±1.5% of Full Scale	±3% of Full Scale
Zero Current	0.2 mA, typ. 0.5 mA, max.	0.5 mA, typ. 5 mA, max.
Input Impedance	1 megohm, ±5%	
Frequency Response	100 ohm Load; 10 kHz, typ.	10 ohm Load; 10 kHz, typ.
Response Time		
Response to step change in load, 10 to 100 ohms in 100 ns	10 µs, max.	
Power Supply Requirements		
Potentiometer Program to Full Scale	+12 to +32 Volts	
Voltage Program	+14 to +32 Volts Derate from 50 mA to 40 mA at Vs = 14 Volts to 12 Volts	+14 to +32 Volts Derate Output to 400 mA at + 12 Volts
Current Required: No Load, 12 to 32 Volts	4 mA to 10 mA	
Total Current at Full Load	60 mA, max.	510 mA, max.
Power Dissipation Limits		
Dissipation at 25°C, Ambient	See Curve	6 Watts, max.*
Dissipation at 70°C, Ambient	See Curve	3.1 Watts, max.*

* Power Dissipation= I_0 (VS-3.5 - I_0 x RL) where: VS=Supply Voltage, I_0 = Output Current, RL = Load Resistance in ohms.

Derate 0.063 Watt/0° to 3.1 Watts at 70°C Ambient.

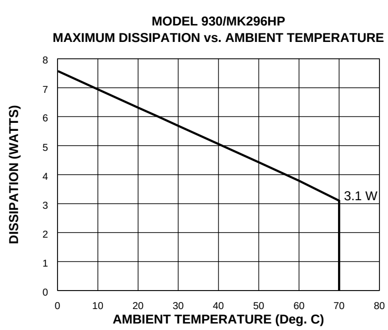
CAUTION: Heat Sink will be 100°C at 6 Watts and 25°C Ambient still air.

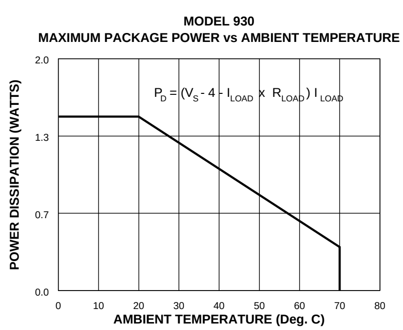
Mechanical Specifications

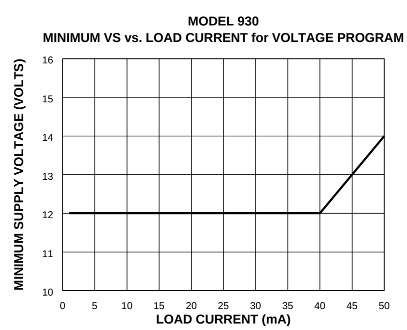


Pin Assignments

Pin Assignments	
1	Program Pot CW End
2	Voltage Program Input
3	Pot Swinger
4	Voltage Program Connect to Pin 3
5	Power Supply Postive
6	Power and Output Return
7	Program Pot CCW End
8	Output Current - to Load
9	Feedback
10	Internal 20 ohm - RS
11	Output Transistor Emmiter







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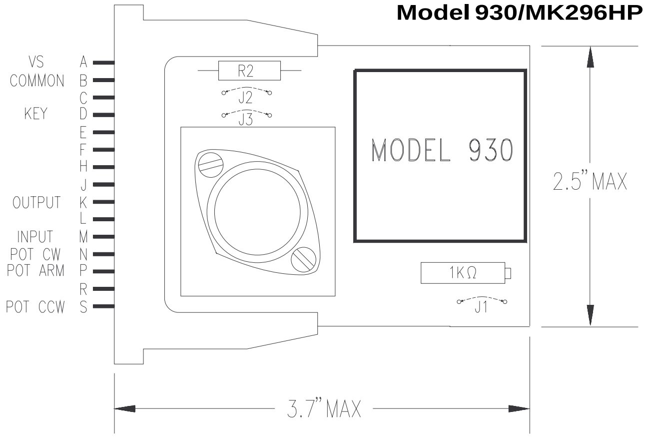
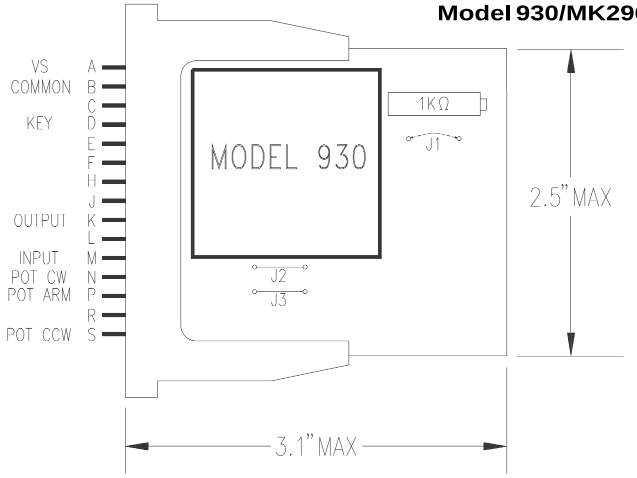
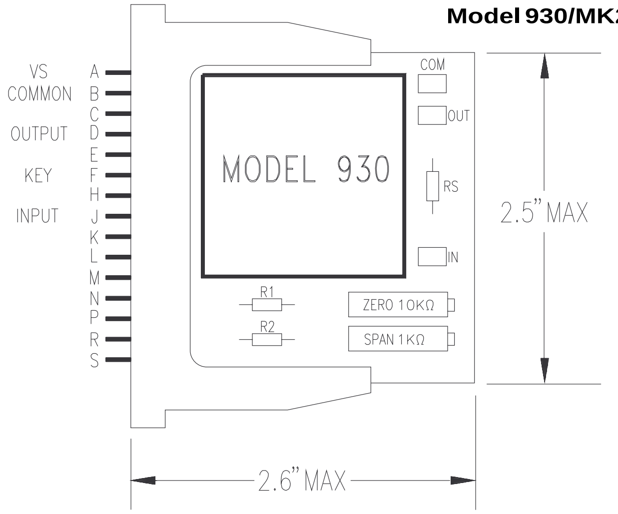
Model 930/MK296HP



Model 930/MK296



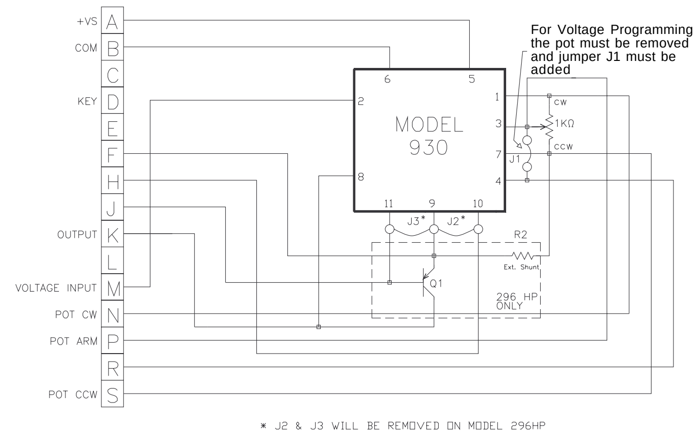
Model 930/MK298



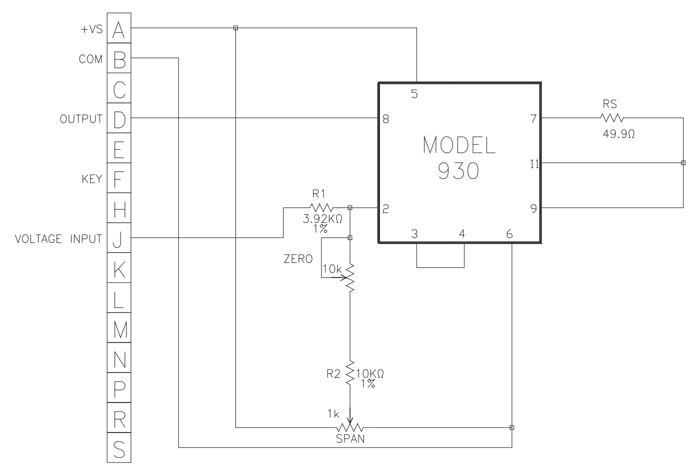
Mounting Kits

The Model MK 296 and MK 296HP Mounting Kits are for resistive or voltage programming of the Model 930. The MK 296HP is a high current version with a power transistor to increase the range to 0.5A. The Model MK 298 allows adjustment of the "live zero" for 4 to 20 mA systems. All three mounting kits consist of the PC board, PC connector with built-in guides, and the necessary potentiometers. When ordered with the Model 930 the unit will be delivered mounted. They can be plugged into the 22-100MK Power Source Kit (page F2) or used with any of the CALEX supplies or DC/DC Converters.

Mounting Kit Model 930/MK296HP



Mounting Kit Model 930/MK298



For the MK 298 the output current can be programmed for input voltages other than 0 to 10 Volts by changing the value of RS.

The formula for RS is: $RS = \dfrac{V_{in}\text{ (max)}}{10\ I_0\text{ (max)}}$

Where: V_{in} (max) = max programming (input) voltage

I_0 = max output current

Note: $+V_S$ must be a regulated (0.1% or better) source, and be 14 Volts to 24 Volts.

To Calibrate: repeat as necessary

1. With the max V_{in} adjust the span pot. for max I_{out}
2. With min V_{in} adjust the zero pot. for min I_{out}

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Transducer Bridge Drive

A bridge circuit located a significant distance from the exciting and measuring system can be effected by unknown and or changing drive line resistance. This can be eliminated by driving the bridge with a constant current. The following equation is used to determine the transducer resistance. The voltage across the bridge is determined by the transducer resistance.

The transducer resistance, RG, when in the upper arm, is determined by the following equation:

$$RG = r\,(I \times r - 3\,Vo)\,/\,(I \times r + Vo)$$

where r is the resistance of the 3 fixed arms of the bridge. I is the constant current drive, and Vo is the bridge output voltage. If RG is in the lower arm of the bridge, the minus and plus signs in the equation are reversed.

Resistance Temperature Measurement (RTD)

RTD's are used to make accurate and stable temperature measurements as one arm of a Wheatstone Bridge. Although the RTD is more linear than the thermocouple, it still requires curve fitting for best accuracy. A bridge circuit produces a non-linear output for a linear change and thus requires an additional curve fit. A single RTD driven by a constant current source eliminates the errors associated with the bridge method, including variable line resistance, although 4 wires are required.

The Model 930 is an excellent constant current source for this application. The 930 scale factor is set by an external RS value of 10,000 ohms, providing a full scale output of 100 microamp. This resistor should be a 0.1%, 25 ppm, metal film resistor. The other resistor values shown in Figure 4 provide a small adjustment range around a 100 microamp output current. This low level of current minimizes RTD self heating error and produces a voltage change of 38.5 microvolts per degree across a standard 100 ohm RTD with an alpha of 0.00385.

The components shown in Figure 4 will provide a current source with a stability of 0.02% per degree ambient, from 0 to +70°C.

If a copper RTD is being used, the current source is easily changed to 500 microamps by replacing the 10 kRS with a 2000 ohm, 0.1%, 25 ppm stable resistor.

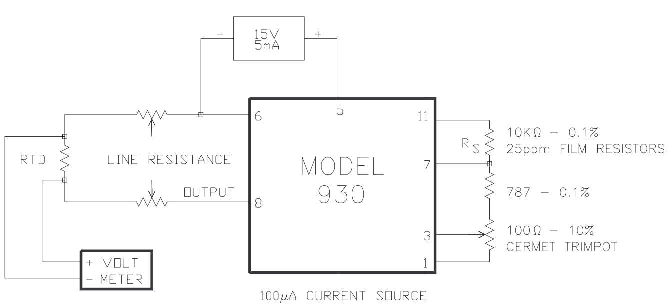


FIGURE 4.

Slip-ring Application

Slip-rings are often required to interface across a rotating boundary. As an example, consider a temperature or strain measurement that uses a 100 ohm transducer. Used in a bridge circuit, every 1 ohm of varying line resistance could contribute up to 1% error for each line that crosses the slip-ring interface.

By using the sensor as a single resistance element and constant current excitation as in Figure 5, the errors due to the slip-ring changing resistance can be eliminated. If the 100 ohm transducer required 10 mA of drive current, the Model 930 could be operated from a 15 Volt supply allowing the slip-ring and line resistance to vary from zero ohms to 900 ohms without effecting the drive to the transducer. This also eliminates the curve fitting step required by non-linear bridge circuit outputs.

The measurement path would, in most cases, contribute a negligible error. A typical volt meter has 10 megohms input resistance, so a 1000 ohm series resistance change due to the slip-rings would contribute only 0.01% of reading error.

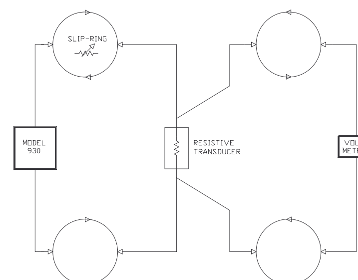
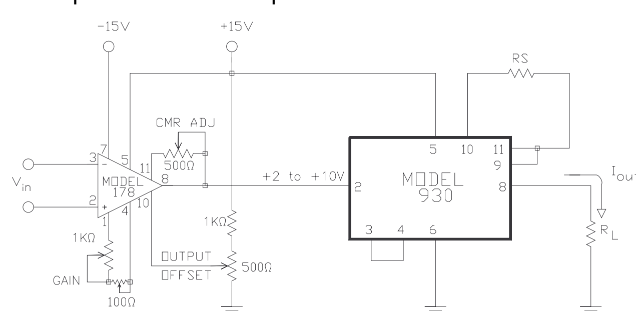


FIGURE 5.

Voltage-to-Current Converter

A Model 930 can be teamed up with a Model 178 instrumentation amplifier to convert low-level transducer bridge voltages to output currents compatible with process control equipment. The Model 930 is connected for a voltage input. The output current range can be selected by varying the impedance between pins 10 and 11.



R_S (Ω)	180	30	0
I_{out} (mA)	1–5	4–20	10–50

FIGURE 6.

Other Applications

Other applications include charging batteries at a constant current rate, Hall effect sensors, microplating using the electrolytic process, and testing gyro torquers.

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