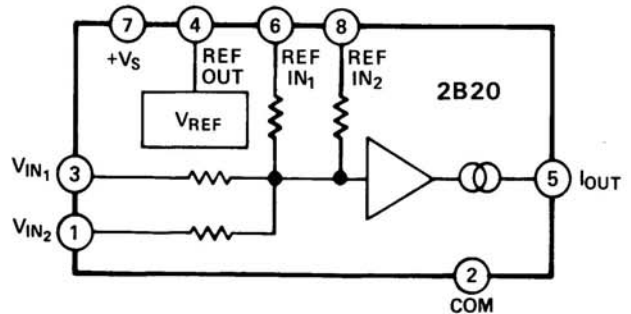


### FEATURES

- Complete, No External Components Needed
  - Small Size: 1.1" x 1.1" x 0.4" Module
  - Input: 0 to +10V; Output: 4 to 20mA
  - Low Drift: 0.005%/°C max; Nonlinearity: 0.005% max (2B20B)
  - Wide Temperature Range: -25°C to +85°C
  - Single Supply: +10V to +32V
  - Meets ISA Std 50.1 for Type 3, Class L and U, Nonisolated Current Loop Transmitters
  - Economical
- ### APPLICATIONS
- Industrial Instrumentation and Control Systems
  - D/A Converter – Current Loop Interface
  - Analog Transmitters and Controllers
  - Remote Data Acquisition Systems

### FUNCTIONAL BLOCK DIAGRAM



### GENERAL DESCRIPTION

Model 2B20 is a complete, modular voltage-to-current converter providing the user with a convenient way to produce a current output signal which is proportional to the voltage input. The nominal input voltage range is 0 to +10V. The output current range is 4 to 20mA into a grounded load.

Featuring low drift (0.005%/°C max, 2B20B) over the -25°C to +85°C temperature range and single supply operation (+10V to +32V), model 2B20 is available in two accuracy grades. The 2B20B offers precision performance with nonlinearity error of 0.005% (max) and guaranteed low offset error of ±0.1% max and span error of ±0.2% max, without external trims. The 2B20A is an economical solution for applications with lesser accuracy requirements, featuring nonlinearity error of 0.025% (max), offset error of ±0.4% (max), span error of ±0.6% (max), and span stability of 0.01%/°C max.

The 2B20 is contained in a small (1.1" x 1.1" x 0.4"), rugged, epoxy encapsulated package. For maximum versatility, two signal input ( $V_{IN1}$  and  $V_{IN2}$ ) and two reference input ( $REF_{IN1}$  and  $REF_{IN2}$ ) terminals are provided. Utilizing terminals  $V_{IN1}$  and  $REF_{IN1}$  eliminates the need for any external components, since offset and span are internally calibrated. If higher accuracy (up to ±0.01%) is required, inputs  $V_{IN2}$  and  $REF_{IN2}$  with series trim potentiometers may be utilized.

### APPLICATIONS

Model 2B20 has been designed for applications in process control and monitoring systems to transmit information between subsystems or separated system elements. The 2B20 can serve as a transmission link between such elements of process con-

trol system as transmitters, indicators, controllers, recorders, computers, actuators and signal conditioners.

In a typical application, model 2B20 may act as an interface between the D/A converter output of a microcomputer based system and a process control device such as a variable position valve. Another typical application of the 2B20 may be as a current output stage of a proportional controller to interface devices such as current-to-position converters and current-to-pneumatic transducers.

### DESIGN FEATURES AND USER BENEFITS

**Process Signal Compatibility:** To provide output signal compatibility, the 2B20 meets the requirements of the Instrument Society of America Standard S50.1, "Compatibility of Analog Signals for Electronic Industrial Process Instruments" for Type 3, Class L and U, nonisolated current loop transmitters.

**External Reference Use:** For increased flexibility, when ratio-metric operation is desired, the 2B20 offers a capability of connecting an external reference (i.e., from multiplying D/A converter) to the  $REF_{IN2}$  terminal.

**Wide Power Supply Range:** A wide power supply range (+10V to +32V dc) allows for operation with either a +12V battery, a +15V powered data acquisition system, or a +24V powered process control instrumentation.

# 2B20—SPECIFICATIONS (typical @ +25°C and $V_S = \pm 15V$ unless otherwise noted)

Model	2B20A	2B20B
<b>INPUT SPECIFICATIONS</b>		
Voltage Signal Range	0 to +10V	*
Input Impedance	10k $\Omega$	*
<b>OUTPUT SPECIFICATIONS</b>		
Current Output Range <sup>1</sup>	4 to 20mA	*
Load Resistance Range <sup>2</sup>		
$V_S = +12V$	0 to 350 $\Omega$ max	*
$V_S = +15V$	0 to 500 $\Omega$ max	*
$V_S = +24V$	0 to 950 $\Omega$ max	*
NONLINEARITY (% of Span)	$\pm 0.025\%$ max	$\pm 0.005\%$ max
<b>ACCURACY<sup>3</sup></b>		
Warm-Up Time to Rated Specs	1 minute	*
Total Output Error @ +25°C <sup>3,4</sup>		
Offset ( $V_{IN} = 0$ volts)	$\pm 0.4\%$ max	$\pm 0.1\%$ max
Span ( $V_{IN} = +10$ volts)	$\pm 0.6\%$ max	$\pm 0.2\%$ max
vs. Temperature (-25°C to +85°C)		
Offset ( $V_{IN} = 0$ volts)	$\pm 0.01\%/^{\circ}C$ max	$\pm 0.005\%/^{\circ}C$ max
Span ( $V_{IN} = +10$ volts)	$\pm 0.01\%/^{\circ}C$ max	$\pm 0.005\%/^{\circ}C$ max
<b>DYNAMIC RESPONSE</b>		
Settling Time – to 0.1% of F.S.		
for 10V Step	25 $\mu s$	*
Slew Rate	2.5mA/ $\mu s$	*
<b>REFERENCE INPUT<sup>5</sup></b>		
Voltage	+2.5V dc	*
Input Impedance	10k $\Omega$	*
<b>POWER SUPPLY</b>		
Voltage, Rated Performance	+15V dc	*
Voltage, Operating	+10V to +32V dc max	*
Supply Change Effect (% of Span) <sup>6</sup>		
on Offset	$\pm 0.005\%/V$	*
on Span	$\pm 0.005\%/V$	*
Supply Current	6mA + $I_{LOAD}$	*
<b>TEMPERATURE RANGE</b>		
Rated Performance	-25°C to +85°C	*
Storage	-55°C to +125°C	*
CASE SIZE	1.125" X 1.125" X 0.4"	*

## NOTES

\*Specifications same as 2B20A.

<sup>1</sup> Current output sourced into a grounded load over a supply voltage range of +10V to +32V.

<sup>2</sup> See Figure 1 for the maximum load resistance value over the power supply range.

<sup>3</sup> Accuracy is guaranteed with no external trim adjustments when REF<sub>IN</sub> is connected to REF<sub>OUT</sub>.

<sup>4</sup> All accuracy is specified as % of output span where output span is 16mA ( $\pm 0.1\% = \pm 0.016mA$  output error).

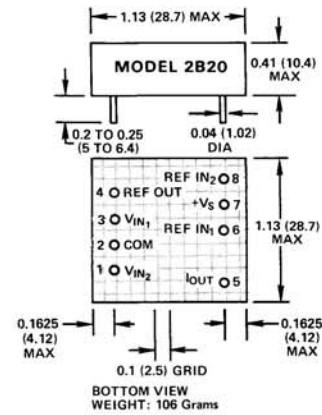
<sup>5</sup> Reference input is normally connected to the reference output (+2.5V dc).

<sup>6</sup> Optional trim pots may be used for calibration at each supply voltage.

Specifications subject to change without notice.

## OUTLINE DIMENSIONS

Dimensions shown in inches and (mm).



MATING SOCKET: AC1016

## LOAD RESISTANCE RANGE

The load resistance is the sum of the resistances of all connected receivers and the connection lines. The 2B20 operating load resistance is power supply dependent and will decrease by 50 ohms for each 1 volt reduction in the power supply. Similarly, it will increase by 50 ohms per volt increase in the power supply, but must not exceed the safe voltage capability of the unit.

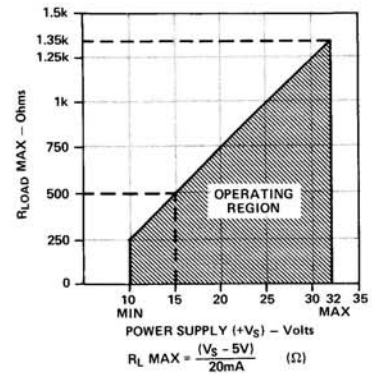


Figure 1. Maximum Load Resistance vs. Power Supply

## PRINCIPLE OF OPERATION

The design of the 2B20 is comprised of high performance op amps, precision resistors and a high stability voltage reference to develop biasing and output drive capability. The 2B20 is designed to operate from a single positive power supply over a wide range of +10V to +32V dc and accepts a single ended, 0 to +10V voltage input. The internal reference has nominal output voltage of +2.5V (REF<sub>OUT</sub>) and is used to develop 4mA output current for a zero volts input when REF<sub>IN</sub> is connected to REF<sub>OUT</sub>.

The output stage of the 2B20 utilizes a sensing resistor in the feedback loop, so the output current is linearly related to the voltage input and independent of the load resistance. There is no minimum resistance for the loads driven by the 2B20; it can drive even a short circuit with no damage to the unit. The maximum resistance of the load as seen by the unit (resistance of the load plus the resistance of the connecting wire) is limited. The maximum external loop resistance, R<sub>L</sub>, is given by:

$$R_L (\Omega) \max = \left( \frac{+V_S - 5V}{20\text{mA}} \right)$$

Figure 1 shows the operating region of the 2B20. The load must be returned to power supply common. The voltage appearing between I<sub>OUT</sub> (pin 5) and COM (pin 2) should not exceed V<sub>max</sub> = +V<sub>S</sub> - 5V. Exceeding this value (up to +32V dc) will not damage the unit, but it will result in a loss of linearity.

The basic connections of the 2B20 are shown in Figure 2.

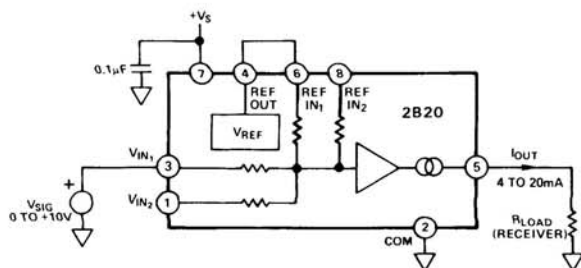


Figure 2. Basic Connections Diagram

## OPTIONAL CALIBRATION AND TRIM PROCEDURE

Model 2B20's factory trimmed offset error is ±0.1% max and span error is ±0.2% max (2B20B). In most applications, further trimming will not be required. If it is necessary to obtain calibrated accuracy of up to ±0.01%, or, if a high signal source resistance (with respect to 10kΩ) introduces calibration error, inputs VIN<sub>2</sub> and REF<sub>IN2</sub> and optional trim pots should be used with VIN<sub>1</sub> and REF<sub>IN1</sub> open. To perform external trims, connect 500Ω potentiometers in series with VIN<sub>2</sub> (span trim) and REF<sub>IN2</sub> (offset trim) as shown in Figure 3. Adjust span pot, monitoring voltage drop across R<sub>LOAD</sub>, to obtain an output voltage of 5.000V (I<sub>OUT</sub>=20mA) for a +10V input. Next, with 0 volts input, adjust offset pot to obtain 1.000V output (I<sub>OUT</sub>=4mA). Check both offset and span and retrim if necessary after each adjustment.

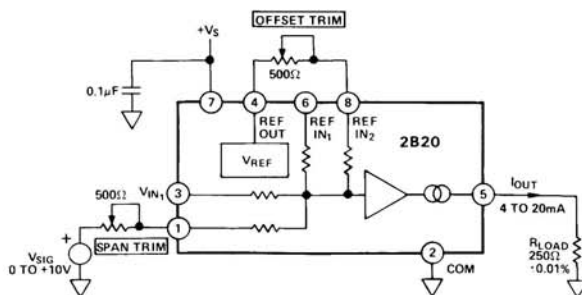


Figure 3. Model 2B20 Connections Using Optional Offset and Span Trims

## CONNECTING THE 2B20 FOR 0 TO 10mA OUTPUT

The 2B20 may be utilized in applications requiring 0 to 10mA current output for a 0 to +10V input voltage range as shown in Figure 4a. To obtain 0mA output for 0V input, adjust the offset potentiometer until there is no current flowing in the output. The 2B20 span calibration may be adjusted by a 2kΩ gain potentiometer in series with the V<sub>SIG</sub> input.

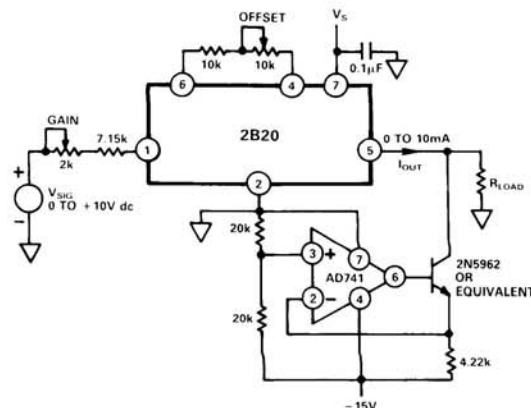


Figure 4a. 2B20 Configuration for 0 to 10mA Operation

## CONNECTING THE 2B20 FOR 0 TO 20mA OUTPUT

The 2B20 may also be configured for use in applications requiring 0 to 20mA output for a 0 to +10V input range as shown in Figure 4b. To obtain 0mA output for 0V input, adjust the offset potentiometer. The 2B20 span calibration may be adjusted by a 2kΩ gain potentiometer in series with the V<sub>SIG</sub> input.

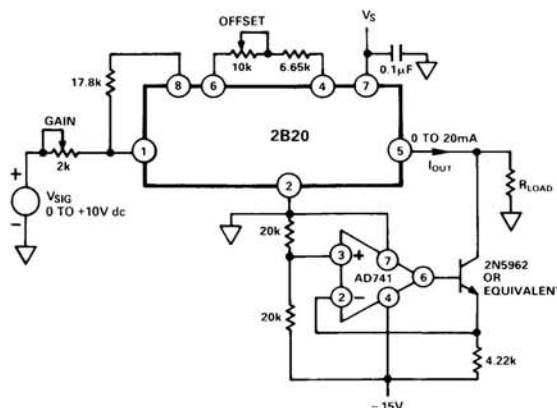


Figure 4b. 2B20 Configuration for 0 to 20mA Operation

# 2B20

## OUTPUT PROTECTION

In many industrial applications, it may be necessary to protect the 4 to 20mA output from accidental shorts to ac line voltages. The circuit shown in Figure 5 can be used for this purpose. The maximum permissible load resistance will be lowered by a fuse resistance value when protection circuitry is utilized.

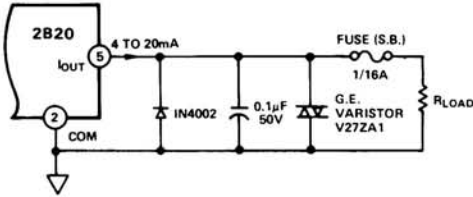


Figure 5. Output Protection Circuitry Connections

## APPLICATIONS

**Interfacing Voltage Output D/A Converters:** The 2B20 is well suited in applications requiring 4 to 20mA output from D/A converters. The voltage necessary to power the current loop can be derived from the same +15V supply that is used to power the converter. The D/A converter, such as the 12-bit AD DAC80, should be connected for operation on the unipolar 0 to +10V output range. This is shown in Figure 6. After the load resistor connection has been made, the current loop can be calibrated using the offset and span adjustment potentiometers associated with the 2B20 (or the AD DAC80). First, a digital input code of all ones is loaded into the D/A, and the offset adjustment potentiometer is adjusted for a current output of exactly 4mA. Then, a digital code of all 0s is loaded into the D/A, and the span adjustment potentiometer is adjusted for a voltage across the load that corresponds to a current of 20mA - 1LSB = 19.9961mA.

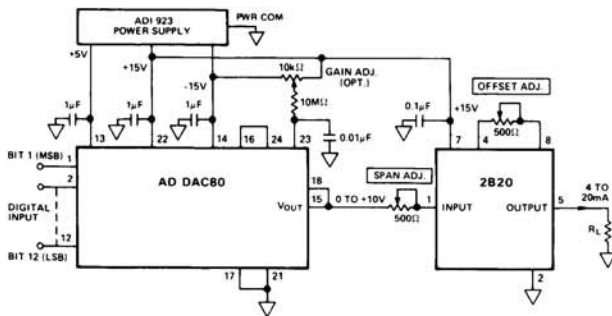


Figure 6. AD DAC80 - 4 to 20mA Current Loop Interface

**Interfacing Current Output D/A Converters:** To interface current output D/A converters, such as the AD562, a circuit configuration illustrated in Figure 7 should be used. Since the AD562 is designed to operate with an external +10V reference, the same external reference may be utilized by the 2B20 for ratiometric operation. The output of the AD562 is used to drive the summing junction of an operational amplifier to produce an output voltage. Using the internal feedback resistor of the AD562 provides a 0 to +10V output voltage range suitable to drive the 2B20.

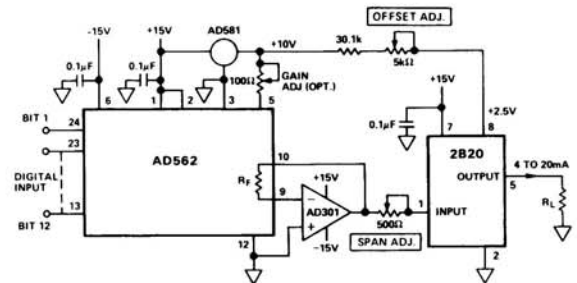


Figure 7. 12-Bit - 4 to 20mA Current Loop Interface

**Microcomputer - Current Loop Interface:** Figure 8 shows a typical application of the 2B20 in a multichannel microcomputer analog output system. When a microcomputer is to control a final control element, such as a valve positioner, servo-mechanism or motor, an analog output board with 4 to 20mA outputs is often necessary. The output boards typically have from one to eight channels, each with its own D/A converter. The 2B20, in a compact package, allows for an easy installation without any additional components and offers a 12-bit system compatible performance.

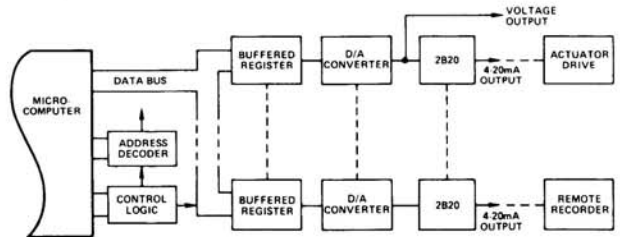


Figure 8. Microcomputer Analog Output Subsystem

**Pressure Control System:** In Figure 9, model 2B20 is used in a proportional pressure control system. The 3-15psi working pressure of a system is monitored with a pressure transducer interfaced by the model 2B31 signal conditioner. The high level voltage output of the 2B31 is converted to a 4 to 20mA to provide signal to the limit alarm and proportional control circuitry. A current-to-position converter controlling a motorized valve completes the pressure-control loop.

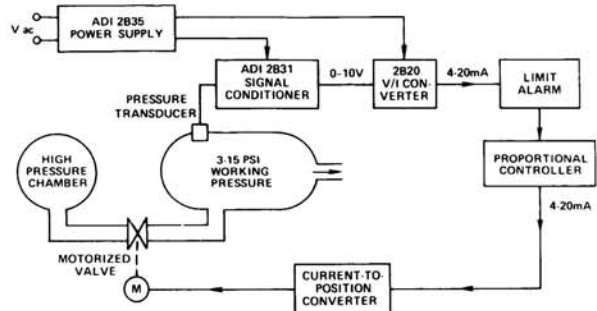


Figure 9. Proportional Pressure Control System

**Isolated 4 to 20mA Output:** For applications requiring up to ±1500V dc input to output isolation, consider using Analog Devices' model 2B22 isolated voltage-to-current converter.