



Solartron  
Metrology

# CAH CARD



user leaflet

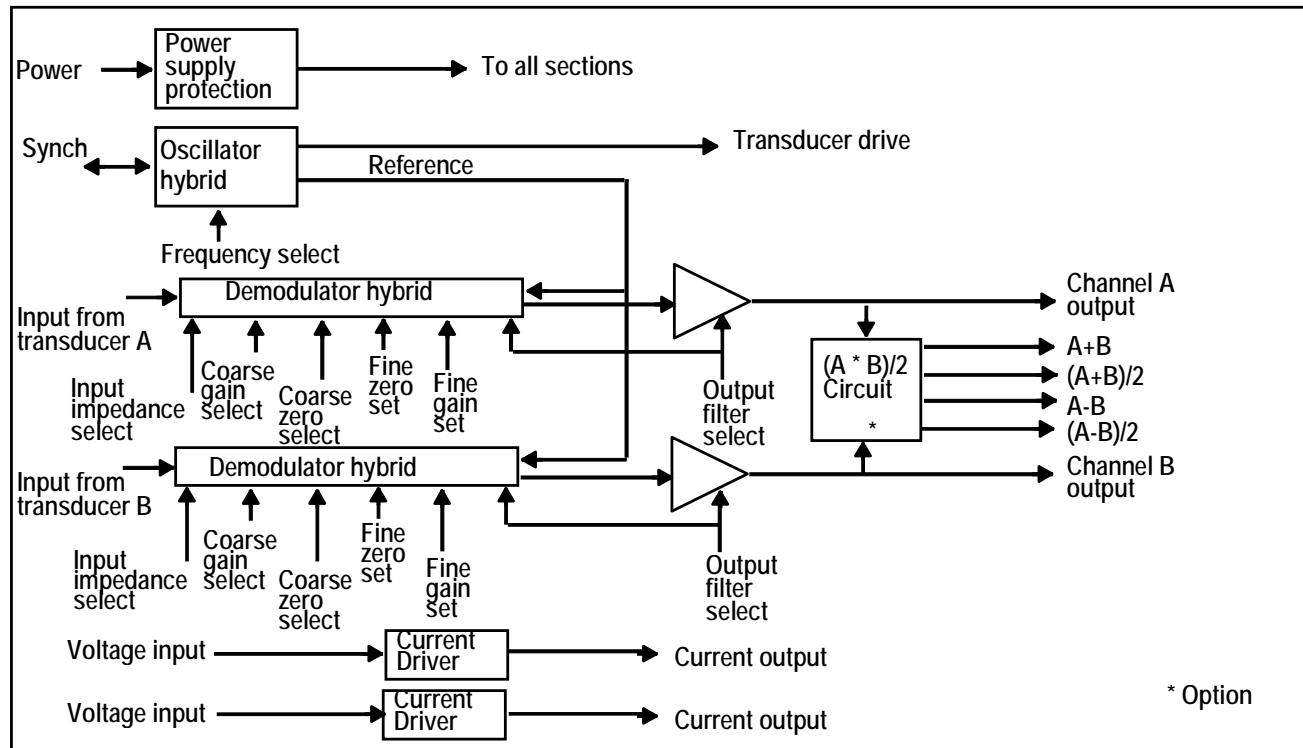
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## INTRODUCTION

The function of the card is to energise a transducer (LVDT, Half-Bridge or Full-Bridge) with a stable a.c. waveform and to convert the output of the transducer to a d.c. voltage proportional to displacement, strain, load etc.

The card should be powered from a stable twin rail d.c. supply of  $\pm 15$  V.

**Figure 1 - Schematic**



## Circuit Operation

Power supply protection is provided to protect against reversed power rails, the circuit is also tolerant of the disconnection of one supply. A pair of zener diodes offer basic protection against voltage spikes on the supply rails.

The oscillator hybrid drives the transducer and the signal from the transducer is fed into the demodulator hybrid.

The d.c. output from the demodulator is fed into another filter to reduce output ripple even further and hence to the output.

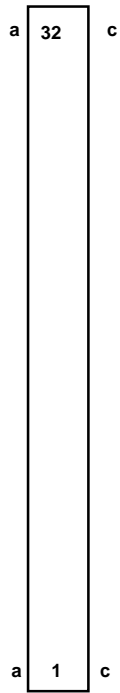
The  $(A \pm B)/2$  facility offers four outputs based on the two transducer outputs (A and B). These are A+B, A-B,  $(A+B)/2$ ,  $(A-B)/2$  and they can be used for measuring diameters etc. where two transducers are involved. The current drivers are wired up separately and so can be used with any of the d.c. outputs.

In order to exploit the transducer to the full, a number of facilities are provided. Span is adjustable in 9 coarse ranges and with a fine span control to allow the use of transducers with sensitivities in the range 0.5mV/V to 750mV/V for a full scale output of 5V d.c. Coarse and fine zero controls are provided to enable the transducer to be zeroed anywhere in its stroke. Two operating frequencies are provided, 5kHz and 10kHz and the output filter cut off frequency can be set to 500Hz to 1kHz to allow for the best response time/output ripple trade off. The standard card is provided with an input transformer and a pair of resistors to be used when half-bridge transducers are in use. These two resistors are precision low drift types to reduce drift. (A transformer may be used in critical Half-Bridge applications.)

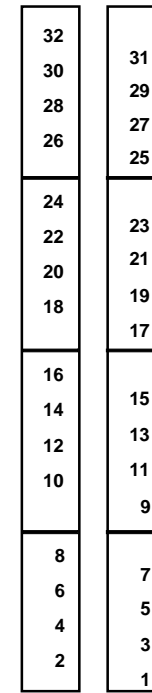
**Figure 2 - Connections**

FUNCTION	DIN 41612 PINS	SCREW TERMINAL
<b>Power Supply</b> +15V dc 0V -15V	32a & c 30a & c 28a & c	32 30 28
<b>Transducer Drive</b> Oscillator Output (LVDT Red) Oscillator 0V Return (LVDT Blue) Oscillator/2 for use with Half-Bridges Synch (to Synchronise cards) Transducer Screens	22a & c 20a & c 18a & c 21a 24a & c	22 20 18 21 24
<b>Channel A Demodulator</b> Input (LVDT White) Input return (LVDT Green) dc output	16a & c 14a & c 26a & c	16 14 26
<b>Channel B Demodulator</b> Input (LVDT White) Input return (LVDT Green) dc output	19a 17a 23a	19 17 23
<b>Current Drivers</b> Driver A input Driver A output Driver B input Driver B output	25a 27a 29a 31a	25 27 29 31
<b>(A ± B)/2 Section</b> A+B Output (A+B)/2 Output A-B Output (A-B)/2 Output Selected Output X Selected Output Y	7a 9a 11a 13a 15a 15c	7 9 11 13 15

**Figure 3 – Card Layout**



**End view on pins  
DIN 41612 Connector**



**Top view (Component Side)  
Screw Terminals**

## Potentiometers

If it is required to mount the span or zero potentiometers remotely, the pins are available on the edge connector to do so. Wire lengths should be kept short to avoid pick up of electrical noise, and lengths greater than 0.5m may cause some degradation of performance.

The potentiometer leads should be wired to the pins specified in external connections, ensuring the clockwise and anticlockwise leads are not reversed.

**Figure 4 -**

FUNCTION			DIN 41612 PINS	SCREW TERMINAL
<b>Potentiometers</b>				
Span and zero potentiometers are connected to the edge connector, so that they can be replaced by ones off board.				
Channel A & B	Zero	Clockwise	8a & c	8
Channel A & B	Zero	Counterclockwise	10a & c	10
Channel A	Zero	Wiper	12a & c	12
Channel B	Zero	Wiper	5a	5
Channel A & B	Span	Clockwise	2a & c	2
Channel A	Span	Counterclockwise	4a & c	4
Channel A	Span	Wiper	6a & c	6
Channel B	Span	Counterclockwise	1a	1
Channel B	Span	Wiper	3a	3

## Synch

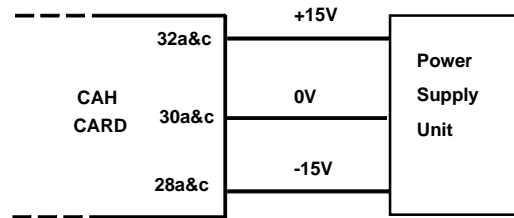
Pin 21a is a synchronising pin to be used in systems using more than one card. Link pin 21a on all cards together with short wires to synchronise the oscillators.

If this is not done it is possible to create beat notes between oscillators causing fluctuations in the dc outputs.

## Wiring Up

This section details how to connect the card to power supplies, transducer and readouts.

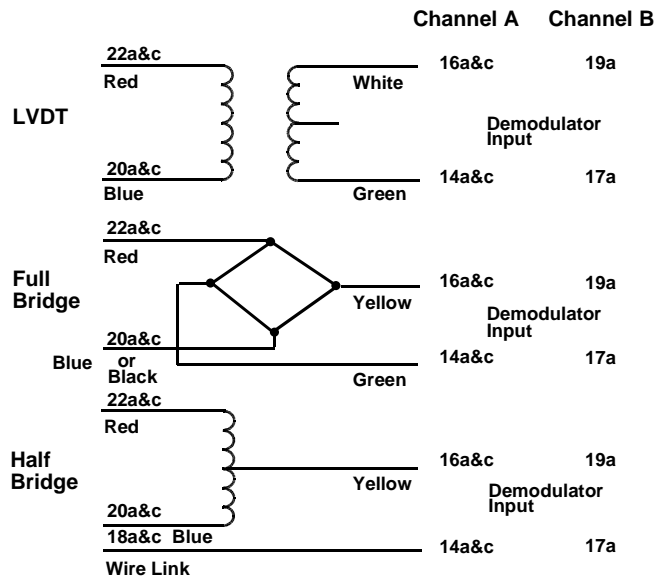
**Figure 5 - Power Supply**



**Transducers**

The CAH card can be used with three different types of transducers: LVDT, Full-Bridge or Half-Bridge (either inductive or resistive). Note that on the dual channel card the two transducers are driven in parallel, but their outputs go to separate demodulators.

**Figure 6 - Transducer Wiring**



Note that colours of wires may vary with different manufacturers. The colours quoted are standard for Solartron Metrology. In all cases the transducer lead screen may be connected to Pins 24 a&c.

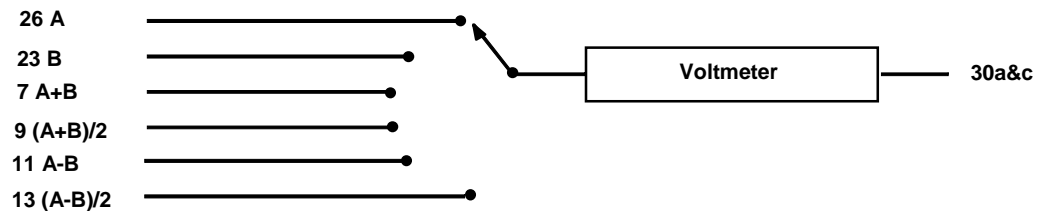
## Output Voltages

The dc output voltage from the card can be read by putting a voltmeter (either digital or analogue) between the output and 0V (Pin 30).

Similarly, when the  $(A\pm B)/2$  facility is used, the four outputs (A+B, A-B,  $(A+B)/2$ ,  $(A-B)/2$ ) can be read by connecting the voltmeter between the appropriate output pin and 0V. All outputs can be read at once.

To enable the use of one meter, a six way selector switch can be used:

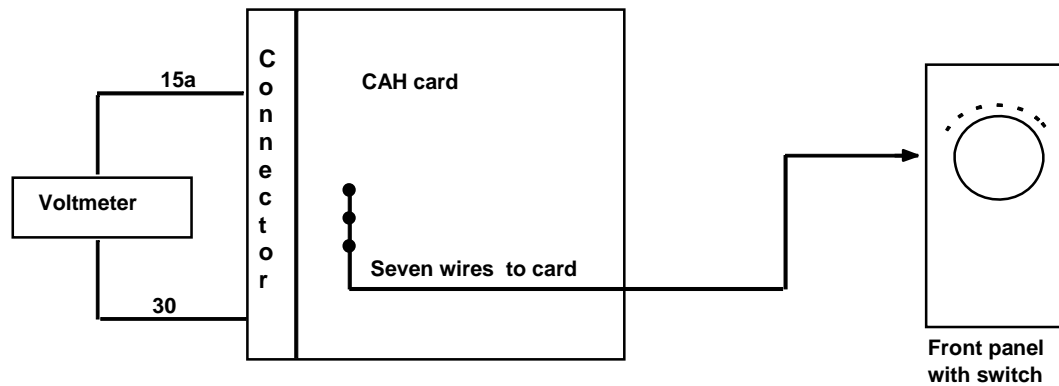
**Figure 7 -  $(A\pm B)/2$  Wiring using Single Voltmeter**



In some cases it may be desired to mount this switch on a front panel attached to the card, with the selected output from the switch wiper being fed to a remote meter via the edge connector. For this purpose there are two output pins (15a&c) assigned to be 'selected outputs', and the wiper of the switch should be wired to one of these. To enable this to be done the appropriate pins (26, 23, 7, 11 & 13) on the edge connector are wired to pads near the edge connector so wires to the switch can be attached.



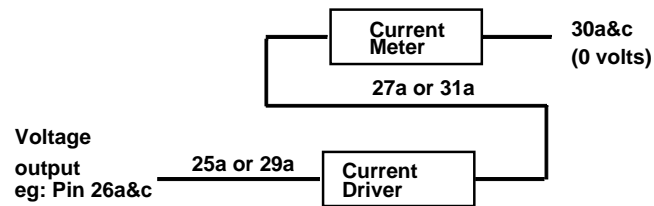
**Figure 8 -**



**Current Outputs**

These are provided by two current drivers, wired separately to the rest of the card electronics. They can be looked upon as voltage to current converters and can be operated with any of the six output voltages mentioned above.

**Figure 9 - Current Outputs**



The current drivers provide 2mA of output per volt input, so that  $\pm 5V$  on the voltage output causes  $\pm 10mA$  output.

**Setting Up**

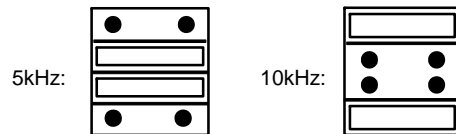
Facilities exist on the card for adjusting oscillator frequency, output filter frequency, demodulator input impedance, span and zero. This is carried out by moving links to short out elected pairs of vertical pins. These links simply lift off and push onto the pins. In the case of span and zero there are also potentiometers for fine adjustment.

### **Oscillator Frequency**

Two oscillator frequencies are selectable using the four way set of pin pairs. If the links are placed over the two centre pairs, the oscillator will run at 5 kHz, and, if over the other pairs, at 10 kHz.

Frequency should be selected to be near the zero phase shift frequency of the transducer for minimum temperature drift. Most transducers are calibrated at 5 kHz and so this frequency can be relied upon for good results. However, if a faster speed of response is required, then the 10 kHz oscillator frequency can be used with most transducers (not ac long strokes).

**Figure 10 - Oscillator Frequency Links**



### **Output Filter Frequency**

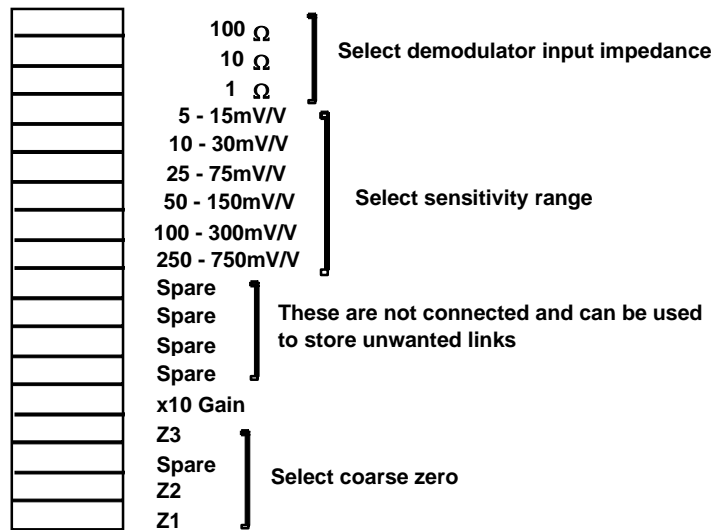
Each demodulator has a low pass filter on the output to remove the ac signal used to energise the transducer. The cut off frequency of this filter can be set to either 500Hz or 1kHz using pin pairs LK1 - LK4. Under normal use the 500 Hz setting would be used with the 5kHz oscillator frequency and 1kHz with 10 kHz oscillator. The benefit of using the higher frequency is that the output will follow the movement of the transducer armature more quickly, but use of the lower frequency results in less ripple on the dc output. The best compromise is with the settings above, but if, for example, a fast response with a long stroke is required, it will be necessary to use a 5 kHz oscillator and a 1 kHz filter. The disadvantage is an increase in ripple. LK1 and LK3 are used for channel A. Put the link on LK1 for 1 kHz filter frequency or LK3 for 500 Hz.

LK2 and LK4 are used for channel B. Put the link on LK2 for 1 kHz filter frequency, or on LK4 for 500 Hz.

### **Demodulator Input Impedance**

Different transducers are calibrated into different loads. For instance most LVDT's are calibrated with 100k $\Omega$  loads, but half bridges use 1k $\Omega$ . For this reason the input impedance of the demodulator can be set to 100 k $\Omega$ , 10 k $\Omega$  or 1 k $\Omega$ , using the three pin pairs at the top of the eighteen way selector. The channel A and B selectors are laid out as follows:

**Figure 11 - Channel A and B Selectable Links**



A link should be placed over one of the 100 kΩ, 10 kΩ or 1 kΩ, pin pairs to select the correct impedance. If unsure, use the 100 kΩ setting.

**Selecting Sensitivity Range**

Before adjusting the fine zero and span controls it is necessary to set the sensitivity range links for the appropriate transducer being used. All Solartron transducers have a sensitivity value supplied with the transducer and the appropriate links should be made as shown in Table A. There are nine coarse ranges in two overlapping ranges of six each. If unsure select 100-300 mV range to start.

**Table A**

Range	Transducer Sensitivity		Select Pin Pair	x10 Link Fitted
	Minimum	Maximum		
1	250mV/V	750mV/V	250 - 750	No
2	100	300	100 - 300	No
3	50	150	50 - 150	No
4	25	75	25 - 75	No
5	10	30	10 - 30	No
6	5	15	5 - 15	No
4	25	75	250 - 750	Yes
5	10	30	100 - 300	Yes
6	5	15	50 - 150	Yes
7	2.5	7.5	25 - 75	Yes
8	1	3	10 - 30	Yes
9	0.5	1.5	5 - 15	Yes

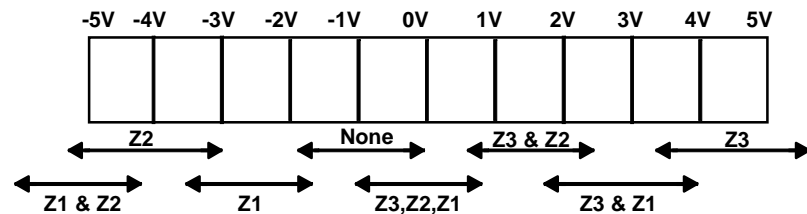
Selecting the x10 link increases the gain of the amplifier and so reduces the necessary sensitivity of the transducer. The span control is used to set the span in the range between minimum and maximum. The above sensitivity ranges are for a standard  $\pm 5$  V or  $\pm 10$  mA output (10V or 20 mA total range).

If a different output range is required (say V volts) then the necessary transducer sensitivities shown should be multiplied by v/10. For example, if an output of  $\pm 3$  V is required (total range 6 V) then range 1 becomes  $250 \times 0.6$  to  $750 \times 0.6$  which is 150 to 450 mV/V.

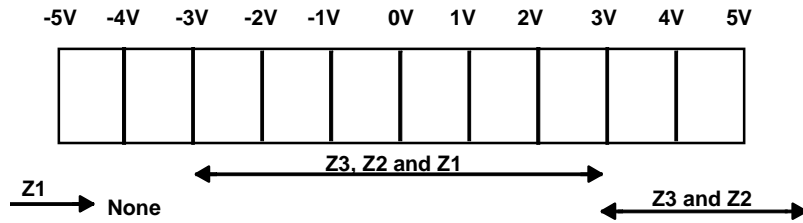
**Setting Coarse Zero Range**

Eight coarse zero ranges are provided and selected by linking up to three off pin pairs Z1 to Z3. A fine control is used to set the zero anywhere required. This means that on minimum gain, the ranges provided are:

**Figure 12 -**



As the gain is increased this opens out, so that at maximum gain it becomes three times wider:



Note that the normal mode of operation is with all three links on, to provide fine adjustment about zero.

### Span and Zero

To set up the span and zero controls, examine the output that will finally be required, ie. the voltage or current output, to avoid errors in the current drivers. If the  $(A \pm B)/2$  facility is being used, then it is possible to calibrate on (for instance) the  $A+B$  output, again for maximum accuracy.

Note that it is necessary in this case to zero the unwanted transducer, or remove the secondary and short the demodulator input so that one transducer is examined at a time.

With transducers such as load cells that have an obvious centre point (ie. no load) then it is merely necessary to set the card span and zero as described below. However, for LVDT's and Half-Bridges it is necessary to find the mechanical zero (ie. centre of linear stroke) first. To accomplish this:

- (a) Remove transducer from card input.
- (b) Short the demodulation input (Pins 14 & 16 or 17 & 19) to simulate a transducer at centre of stroke and read the d.c. output from the card demodulator. Adjust the appropriate zero adjust pot if necessary to read 0V.
- (c) Remove the short and reconnect the transducer.
- (d) Mechanically adjust the transducer to its mid-position to give zero output voltage. The transducer is now set to the middle of its stroke and the zero adjust can be used to set the d.c. output to exactly 0V.
- (e) Now move the transducer to the desired full stroke value and adjust the span potentiometer to give 5V.
- (f) Re-check the zero and span positions until both are correct.

If an offset zero is required (such as on a 4-20 mA system) then first adjust for normal mid-range zero as detailed previously in steps (b) to (d).

Now move the transducer mechanically to the offset position required and use the zero adjust to give a 4mA reading. Then set the transducer to the desired full stroke relative to the new offset zero and use the span adjust for 20 mA (in conjunction with coarse zeroes if necessary).

Re-check 4 and 20 mA positions until fully set up, as, because the zero position is offset, it is affected by the span adjustment.

## Card Specification

Dimensions	100 mm x 160 mm (Eurocard)
Weight	Up to 120 g
Operating Temperature Range	0 to 50 °C
Power Supply	Regulated $\pm 15$ V ( $\pm 1$ V) at $\pm 100$ mA [This can be reduced to $\pm 12$ V, but it will only be possible to overrange to approx. $\pm 9$ V instead of $\pm 10$ V. Note, if output transformer fitted to oscillator reduce oscillator output to 4 V.]
Supply Protection	Protected against reverse polarity, overvoltage transients, and is insensitive to failure of a single supply
Transducers Usable	LVDT's, Full Bridges and Half Bridges, both inductive and resistive. The use of the two resistors provided as standard to complete the second half for a Half Bridge may introduce slight zero drift at the highest gains.

## Oscillator

Transducer Drive	5 V RMS sine wave, at 5kHz or 10kHz, user selectable
Drive Current	50 mA maximum (100 $\Omega$ load) [40 mA (130 $\Omega$ load) if output transformer (T3) fitted]
Oscillator Protection	Open and short circuit protected

## Each Demodulator

Transducer Secondary Load	100 K, 10 K or 1 K user selectable (Demodulator Input Impedance)
Transducer Sensitivity Range	0.5 mV/V to 750 mV/V in 9 coarse ranges (see Table A)
Range of Gain Controls	500:1 Coarse and 3:1 Fine control
Range of Zero Control	8 coarse settings and fine control enabling zero to be placed anywhere in transducer stroke.
Output Voltage (Full Scale $\pm 5$ V)	$\pm 5$ VDC, but linear to $\pm 10$ V, with positive output for inward stroke of transducer, if wired in accordance with instructions. To reverse polarity, reverse input or output leads of transducer.

Output Load	2 K $\Omega$ minimum for $\pm 5$ VDC output.
Output Impedance	<1 $\Omega$
Output Protection	Open and short circuit protected. Insensitive to capacitive loads
Output Ripple	<5 mV pk-pk (0.1%) when oscillator frequency is 10 times filter frequency
Output Filter	Third order, cut off frequency user selectable at 500 Hz or 1 kHz to minimise ripple or maximise speed
Step Response (Nominal)	3.5 mS at 500 Hz and 2 mS at 1 kHz
Non-Linearity	<0.02%
Temperature Coefficients	Span <0.05%/ $^{\circ}$ C Zero <0.05%/ $^{\circ}$ C

### A+B Outputs

Outputs Available	A+B, A-B, A+B/2, A-B/2
Output Voltage	$\pm 5$ V, Linear to $\pm 10$ V minimum load, impedance, protection as on demodulator output
Accuracy of Calculation	<0.5%
Temperature Coefficients	Span <0.005%/ $^{\circ}$ C ) In addition to demodulator Zero <0.005%/ $^{\circ}$ C ) temperature coefficients

### Current Outputs

Two current drivers are provided which can be used with any of the six outputs (A, B, A+B, A-B, A+B/2, A-B/2) above.

Output Current	$\pm 10$ mA for $\pm 5$ VDC input, but linear to $\pm 20$ mA for $\pm 10$ VDC input. By appropriate use of span and zero controls, these can be set for a 0-20 mA or 4-20 mA output
Output Load	500 $\Omega$ maximum for 20 mA output on $\pm 5$ V supply
Output Impedance	>50 K
Output Protection	Open and short circuit protected. Insensitive to capacitive loads
Temperature Coefficients	Span <0.005%/ $^{\circ}$ C ) In addition to Zero <0.005%/ $^{\circ}$ C ) voltage coefficients