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623-624-series
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Electronic Assembly for 6232BP10710

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Specifications

Block Type:	Six thermocouple–compatible inputs, three isolated groups of two.	

Catalog Numbers:
  115 VAC/125 VDC Thermocouple Block
    Terminal Assembly Only
    Electronics Assembly Only
 	
  24/48 VDC Thermocouple Block
    Terminal Assembly Only
    Electronics Assembly Only
	IC660BBA103
	IC660TBA103
	IC660EBA103
	
	IC660BBA023
	IC660TBA023
	IC660EBA023	

Size (Height x width x depth): **Weight:** **LEDs (I/O Block):** **Heat Dissipation:**	8.83" (22.44cm) x 3.50" (8.89cm) x 3.94" (10.00cm) 4 lbs. (1.8 kg) Unit OK, I/O Enabled 9W maximum	
Block to Block Isolation: **Group to Group Isolation:**	1500 V for one minute 300 V	

115 VAC/125 VDC block power:
 	
  Power supply voltage
  Power supply dropout time:
	115 VAC
	
	93–132 VAC @ 9W
	47–63 Hz
	1 cycle
		125 VDC
		
		105–145 VDC @ 9W
		10% max. ripple
		10 mS

24/48 VDC block power:
 	
  Power supply voltage
  Power supply dropout time
	
	18–56 VDC @ 9W, 10% max. ripple
	10 mS minimum	

Input Characteristics:
  Voltage measurement:
    Range
    Resolution
    Accuracy (at 25C)
  Bandwidth of input amplifier filter
  Temperature coefficient
	-25.0mV to $+150$mV
	Less than $4\,\mu$V
	Less than 10μV error typ, 20μV max.
	8 Hz
	2μV/C typical	

Internal Cold Junction Measurement:
  Range
  Offset at 25C
  Linearity
  Resolution
  Temperature coefficient
	0 to 60C
	2 C typ. User adjustable to zero at any temperature.
	0.15C
	Less than 0.01C
	0.05 per C	

External Cold Junction Measurement:
  Range
  Scale factors
  Resolution
  Accuracy
	-25.0C to $+150.0$ C
	1.0C per millivolt, 1.0K per microampere
	Less than 0.01 C
	0.1C	

Input update time (all channels):	2.0 sec (typ), 3.0 sec (max)	
Open wire detection response:	less than 5.0 seconds	
Diagnostics:	Open Wire, Overrange, Underrange, High Alarm, Low Alarm, Internal Fault	

Environmental:
 	
  Operating Temperature
  Storage Temperature
  Humidity
  Vibration:
	
	0C to +60C (+32F to +140F)
	-40C to $+100$ C (-40F to $+212$F)
	5% to 95% (non–condensing)
	5–10 Hz 0.2" (5.08mm) displacement, 10–200 Hz at 1G	

Block Operation

A Thermocouple Input Block has three isolated pairs of inputs. Transformers isolate power and optical couplers provide signal isolation.

For each pair of inputs:

1. After filtering, each signal input is sequentially switched into a common amplifier whose output is applied to a voltage–to–frequency converter. The output signal frequency of the VFC is applied to a frequency counter via an optical coupler. The output frequency is counted for a 400 millisecond gate time, which is a common multiple of all the common line frequency periods. This provides considerable rejection of line frequency pickups.

2. The multiplexer intersperses other inputs between the two main thermocouple input times. The other inputs come from the cold junction sensors and from internal references. The cold junction inputs are measured and stored for later compensation of the normal thermocouple input measurement errors.

3. To detect and correct for any gain or offset drift in the amplifier or VFC, the block takes new readings of factory–calibrated internal reference levels during operation. These new measurements are compared to reference values stored by the block.

4. The processor converts the cold junction temperature value to a voltage as specified by the NBS monograph for the thermocouple type in use. This voltage is then added to the thermocouple measurement before converting to thermal units. Since there may be some small differences between the cold junction temperature measurement and the actual cold junction temperature, an offset adjustment can be entered using a Hand–held Monitor. These offsets are due to variances in the terminal strip assembly and the correction factors are therefore stored in the Terminal Assembly EEPROM.

Block Measurement Accuracy

The overall accuracy of the block in a given application depends on both:

1. Accurate measurement of the thermocouple millivolt signal.

2. Accurate compensation of the cold junction connections.

The block can measure the input millivolt signal to an accuracy of " 10μV (typical) or " 20μV (maximum). Depending on the thermocouple type used and the temperatures being measured, measurement accuracy in C or F can be determined.

The output from a thermocouple varies in a non–linear manner as the temperature being measured changes. Furthermore, each thermocouple type has a unique characteristic.

The following table may be used as a guide to estimate accuracy in units of degrees. It lists optimal accuracy for each thermocouple type, without allowing for conditions that might be encountered in the application, or for the accuracy of the specific thermocouple being used. For a more accurate estimate, consult the NBS monograph published for the thermocouple type used in the application, referencing the temperature range to be measured.

Thermocouple Type	Average Sensitivity: μV/C	Optimal Accuracy in C
J	52.6	0.19
K	38.8	0.26
T	40.5	0.25
E	67.9	0.15
B	7.6	1.32
R	12.0	0.84
S	10.6	0.95
N	38.5	0.26

Cold junction compensation can be performed internally by the block itself, or remotely. The block has a cold junction sensor which is set at the factory to compensate the cold junction to within " 2C typically. If a more accurate setting is required, this compensation can be adjusted using a Hand–held Monitor, after the block is installed (see page 15-14).

Diagnostics

Circuit diagnostics for Thermocouple Input Blocks are listed below. These diagnostics are automatically performed by the block for any active circuit. Active circuits can be configured not to send diagnostic messages to the CPU if a fault occurs. However, such circuits still respond to faults and report them to the Hand–held Monitor. If a circuit is configured as "inactive", it will not *detect faults* or report diagnostics.

If the CPU requests diagnostic information from the block using a Read Diagnostic datagram, the block returns current diagnostics for all active circuits, including any with CPU fault reporting disabled. It will not return diagnostics from inactive circuits.

Internal Fault

An internal fault occurs if one or more of the internal references is faulty. While this fault is present, the block reports a value of zero for each channel using the faulty reference(s). The block's Electronics Assembly should be replaced.

Open Wire

The block reports an Open Wire diagnostic if there is a missing or faulty connection to the thermocouple input, XJV input, or XJI input for the channel.

Overrange/Underrange

This diagnostic is reported only if engineering units of Celsius or Fahrenheit are selected. It indicates either that:

1. The input temperature exceeds the expected range for the thermocouple type in use. The expected range for each thermocouple type, derived from the corresponding NBS monograph, is:

Thermocouple Type	Range		
J	–210.0C	to	+1200.0C
K	–270.0C	to	+1370.0C
T	–270.0C	to	+400.0C
E	–270.0C	to	+1000.0C
B	+20.0C	to	+1820.0C
R	–50.0C	to	+1770.0C
S	–50.0C	to	+1770.0C
N	0.0C	to	+1300.0C
L	–3276.7C	to	+3276.7C

2. (If **Overrange**): the cold junction sensor reading is above +150C. It may be caused by an open wire if an XJV sensor is in use. (If **Underrange**): the cold junction sensor reading is below –50C. It may be caused by an open wire if an XJI sensor is in use.

Low Alarm/High Alarm

Individual low and high alarm thresholds can be configured for each input. If an input reaches one of its alarm thresholds, the block reports a Low Alarm or High Alarm diagnostic. The diagnostic is triggered upon reaching the limit and will not be repeated until circuit faults are cleared.

Field Wiring

Terminals 5 through 32 are used for input power, Bus Switching Module control, and field wiring devices. These terminals accept AWG #22 to AWG #14 wires. For the smaller gauge thermocouple wires, connector–type crimp pins of the same alloy are recommended to make installation easier.

For block power, connect an appropriate power source to terminals 5 and 6. For the 115 VAC/125 VDC block version, connection can be of either polarity. For the 24/48 VDC version, the polarity should be observed as marked, although protection is provided against accidental reversed input polarity.

When a Bus Switching Module is installed, connect the BSM control wires, which are not polarized, to terminals 7 and 8.

Wiring for Thermocouples

Thermocouple wires should be connected to the six channels observing the proper polarity. For American color coding, connect the red wire to the (–) terminal.

Typical connections for both types of remote cold junction sensing are shown in the following illustration.

NOTE:
Heavy lines (▬▬) represent copper wires.
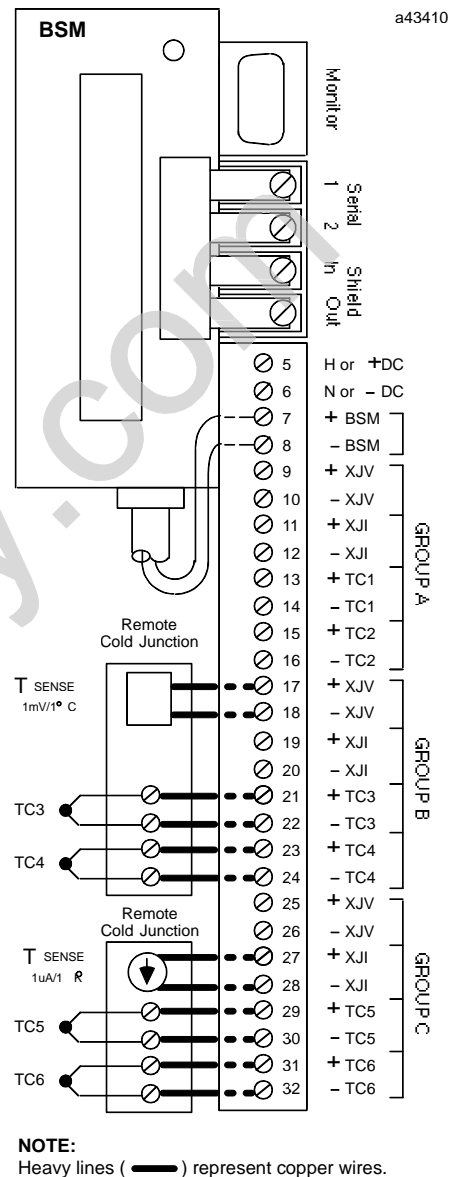
Block Configuration

The configurable features of a Thermocouple Block are listed below. For most, the factory setting is suitable for many applications and will not need to be changed.

Feature	Circuit or Block	Factory Setting	Selections
Device Number*	Block	null	0 to 31 (a number must be selected)
Reference Address*	Block	none	Depends on host CPU type
Baud Rate*	Block	153.6 std	153.6 std, 153.6 ext, 76.8, 38.4 Kbd
Report Faults	Circuit	yes	yes, no
Channel inactive	Circuit	active	active, inactive
Units	Block	C	C, F, millivolts, counts
Thermocouple type	Circuit	Type J	Type J, K, T, E, B, R, S, N or (L)inear
Compensation method	Circuit	Internal	Internal, external voltage, external current, or user–supplied compensation value
Compensation value (for user–supplied method)	Circuit	0.00mV	range is " 326.67mV
Offset value	Circuit	0.00	" 100.0C or " 100.0F
Low Alarm	Circuit	–250C	range is –32767 to +32767
High Alarm	Circuit	+1400C	range is –32767 to +32767
BSM Present	Block	no	yes, no
BSM Controller	Block	no	yes, no

Features marked with an asterisk in the table are configured from the Program Block ID screen of the Hand–held Monitor, as explained in chapter 3.

The rest of the features can be configured either using a Hand–held Monitor, or by sending a Write Configuration datagram to the block from the host.

Before configuration begins, the block's features should be decided on and recorded on a copy of the Configuration Worksheet printed on the next page.

Thermocouple Input Blocks Configuration Worksheet

Block _____ Location _____

Block Features:

Configuration Protected (Y/N) _____ Block Number (0–31) _____

Reference Address _____ through _____

Baud Rate (153.6 Kb Std/153.6 Kb Ext/76.8 Kb/38.4 Kb) _____

Units (tenths of degrees Celsius/tenths of degrees Fahrenheit/millivolts/counts) _____

Circuit Features:

	1	2	3	4	5	6
References: From	____	____	____	____	____	____
To	____	____	____	____	____	____
Report Faults? (Y/N)	____	____	____	____	____	____
Channel Active? (Y/N)	____	____	____	____	____	____
Thermocouple Type (J, K, T, E, B, R, S, N, L)	____	____	____	____	____	____
Compensation Method (I, XJV, XJI. U)	____	____	____	____	____	____
Compensation Value (" 327.67mV)	____	____	____	____	____	____
Input Offset Value (" 100.0º)	____	____	____	____	____	____
Alarm Thresholds: Low (eng units)	____	____	____	____	____	____
High (eng units)	____	____	____	____	____	____

Report Faults to CPU

Fault reports to the host can be disabled or enabled for any circuit on a block. If fault reporting is enabled for a circuit, the block will send a message to the host if any fault occurs on that circuit. If Fault reporting is disabled, the block will not send fault reports to the CPU for that circuit.

Regardless of whether fault *reporting* is enabled, the block will detect faults on the circuit, and take appropriate actions. The Unit OK LED will blink when a fault occurs, and a fault report is sent to a Hand–held Monitor. The fault condition must be corrected for proper operation of the block.

If the CPU requests diagnostic information from the block using Read Diagnostics datagrams, the block returns current diagnostics for all circuits, including any with CPU fault reporting disabled.

Hand-held Monitor Configuration Steps

```
REPORT FAULT 97
I I I I I
Y Y Y Y Y
 > tgl entr nxt
```

1. Line 3 shows the current Report Faults configuration of each circuit (circuits are shown on line 2 for reference).

2. To move the cursor and select a circuit for configuration, press F1 (>).

3. To change a selection, press F2 (tgl). To save the new selection, press F3 (entr).

4. Press F4 (next) when you are ready to advance to the next configuration display.

Channel Active

Used to disable fault detection for a channel that is not wired, or from which no diagnostics should be reported. If enabled, the block will continue to report input data, but will perform no fault detection on the input channels. The Unit OK LED will not indicate faults for inactive channels.

Hand-held Monitor Configuration Steps

```
CH    ACTIVE 97
I I I I I
Y Y Y Y Y
 > tgl entr nxt
```

1. Line 3 shows the current Channel Active configuration of each circuit (circuits are shown on line 2 for reference).

2. To move the cursor and select a circuit for configuration, press F1 (>).

3. To change a selection, press F2 (tgl). To save the new selection, press F3 (entr).

4. Press F4 (next) to advance to the next configuration display.

Units

The block can be configured to report data as engineering units or as unconverted counts.

If units of Celsius, Fahrenheit, or millivolts are selected, the block will automatically calibrate and convert input data into engineering units of:

- tenths of a degree Celsius
- tenths of a degree Fahrenheit
- hundredths of millivolts

Temperature values are reported to the CPU as tenths of units. For example, 300.2 degrees Celsius is reported to the CPU as 3002. This provides greater resolution than simply reporting integer values.

The Hand–held Monitor accurately displays the temperature value to one decimal place. The same 300.2 degrees Celsius appears on the HHM as:

300.2C

Millivolt values are reported to the CPU as hundredths of millivolts. For example, 300.25mV is reported to the CPU as:
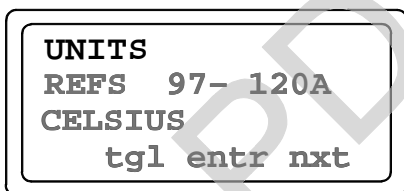
30025

The Hand-held Monitor accurately displays the millivolt value to two decimal places. The same 300.25mV appears on the Hand-held Monitor as:

300.25

If counts are selected, values are reported as they are received from the hardware, with no auto calibration performed.

Hand-held Monitor Configuration Steps

```
UNITS
REFS  97- 120A
CELSIUS
    tgl entr nxt
```

1. Line 3 shows the currently–selected units.

2. To change the units, press F2 (tgl). To save the new selection, press F3 (entr).

3. Press F4 (next) to advance to the next configuration display.

Thermocouple Type

Each channel can receive inputs from a type **J, K, T, E, B, R, S,** or **N** thermocouple. If one of these thermocouple types is configured, the block will convert input values to engineering units using an internal linearization table for that thermocouple type.

If Linear is selected, the block will convert input values to appropriate engineering units, using a fixed scaling factor of 10C/mV.

Hand-held Monitor Configuration Steps

```
T/C TYPE     97
I I I I I
J K T E B R
 > tgl entr nxt
```

1. Line 3 shows the type of thermocouple currently selected for each input. To change the thermocouple type for input indicated by the cursor, press F2 (tgl). To save the new selection, press F3 (entr).

2. To select another circuit, press F1 (>).

3. Press F4 (next) to advance to the next configuration display.

Compensation Method

The source of cold junction compensation for each input is configured separately. The block uses this compensation when converting input readings to temperature values.

I   Internal sensor selects input from the sensor in the block's Terminal Assembly.
X_V External voltage compensation selects input from an XJV sensor.
X_I External current compensation selects input from an XJI sensor.
U   Selects the User–supplied Compensation Value (see next page).

Hand-held Monitor Configuration Steps

```
COMP METHOD  97
I I I I I I
I X_V U X_I I I
 > tgl entr nxt
```

1. Line 3 shows the type of compensation currently selected for each thermocouple input. To change the compensation method for input indicated by the cursor, press F2 (tgl).

2. To save the new selection, press F3 (entr). To select another circuit, press F1 (>).

3. Press F4 (next) to advance to the next configuration display.

User–supplied Compensation Value

This value is entered only if user–supplied compensation was selected for a channel, and the units are C or F. The range for the compensation value is " 327.67mV.

The compensation value is a mV value, not an engineering units value. During operation, the block will automatically add this value to the measured input voltage BEFORE calibrating and converting voltage to tenths of degrees.

Hand-held Monitor Configuration Steps

```
USER COMP VALUE
IN3   97- 120I
      0.00mV
 > chng     nxt
```

1. This screen appears once for each input configured as U on the Compensation Method screen. The first of these is indicated on line 2. If a compensation value has already been entered for the input indicated on line 2, that value appears on line 3. To enter a new compensation value for the input, press F2 (chng).

2. To save the new selection, press F3 (entr).

3. If U has been selected as the compensation method for more than one input, press F1 (>) to select the next input.   Enter additional compensation values as needed.

4. Press F4 (next) to advance to the next configuration display.

Input Offset Value

For each channel, an offset value can be specified to correct for observed measurement inaccuracy. The range for this offset value is " 100.00C or " 100.00F .

The following screen appears when the selection for Units is either Celsius or Fahrenheit. Offset adjustments should be made following the procedure explained below.

Hand-held Monitor Configuration Steps

```
I1  OFFSET VALUE
OFST:      0.00 C
MEAS:      30.2 C
  > chng      nxt
```

1. Line 1 indicates the input being configured. Line 3 shows the actual measured value from that input. To enter an offset, press F2 (chng).

2. To save the new selection, press F3 (entr).

3. Press F4 (next) to advance to the next configuration display.

Field Offset Adjustment

After the block is installed, follow the steps below when making offset adjustments to temperature input values. Repeat these steps for each channel being adjusted.

1. Operate the block at its normal ambient operating temperature for at least two hours to allow for thermal stabilization.

2. Using a Hand–held Monitor, configure the block for units of Fahrenheit to obtain more resolution.

3. Connect a thermocouple simulator set for 32.0F to the input being adjusted.

4. Subtract the average measured value from 32.0 to find the amount of offset.

5. On the Hand–held Monitor, display the Offset Value configuration screen. Enter the number found in step 4.

6. Repeat steps 3, 4, and 5 until HHM displays an average measured value of 32.0F .

7. Reconfigure the block to the desired units.

Alarm Thresholds

For each input, these configured values determine the values at which low alarm and high alarm conditions will be reported. The selectable range is –32767 to +32767 engineering units, if the configuration for Units was Celsius, Fahrenheit, or millivolts. If counts were configured as the units for the block, the range is 0 to 65535 counts.

Because alarm thresholds are engineering units values, if units are changed, alarm thresholds should be reviewed and adjusted if necessary. The block will automatically switch to the default alarm thresholds when the engineering units are changed. The previous alarm limits will be saved and restored if the units selection is changed back to its previous value. If power is removed from the block, the thresholds for the currently–selected engineering units will be saved and restored when power is restored to the block.

Alarm thresholds can also be changed by the application program in the CPU. If an input reached its high alarm, a new limit could be set. This could generate a high–high alarm or an alarm–cleared threshold. Two examples are described on page 10-18.

Hand-held Monitor Configuration Steps

```
ALARM        97
I1 LOW I1 HI
   -0.1    0.1
 > chg     nxt
```

1. The screen first displays the low and high alarm thresholds for the first input. To select the next circuit, press F1 (>) to move the cursor from L O W to H I, then press F1 (>) again.

2. To change the Alarm threshold shown at the cursor location, press F2 (chng), then enter the new value.

3. To save the new selection, press F3 (entr).

4. Press F4 (next) to advance to the next configuration display.

BSM Controller

A BSM Controller is a block to which a Bus Switching Module is directly attached, which controls the BSM's switching action. For a new block, the default is NO. Change it only if the block will be used as a BSM Controller.

To change this configuration with a Hand–held Monitor, the block must first be configured for BSM PRESENT. The BSM CONTROLLER menu will not appear if BSM PRESENT is set to NO.

Hand-held Monitor Configuration Steps

```
BSM CONTROLLER
REF  97-  120A
STATUS= NO
   tgl entr nxt
```

1. To change the configuration, press F2 (tgl).

2. To save the new selection, press F3 (entr).

3. Press F4 (next) to advance to the next configuration display.

Configuration Protection

After the block is configured, its Configuration Protection should be enabled to prevent unwanted changes (from a Hand–held Monitor and from the CPU). Configuration Protection can only be set and removed by a Hand–held Monitor. For a new block, Configuration Protection is disabled.

Hand-held Monitor Configuration Steps

```
CONFIG PROTECT
REF  97-  120A
DISABLED
   tgl entr nxt
```

1. To change the current selection, press F2 (tgl).

2. Press F3 (entr) to save the new selection.

3. Press F4 (next) to return to the first configuration display.