coiltek
coil technology inc.®

OPERATING MANUAL

CS-5100 Series Controls

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Introduction

The CS-5100 is a series of ultrasonic sensors integrated with a microprocessor based control card. All of the series of controls use the same control electronics. The sensing head varies from product to product. The base CS-5100 is a single transducer ultrasonic sensing system. The CS-5140 has a four transducer sensing module where each sensor is polled sequentially. It is used in situations where the target stock moves around and the array provides a larger sensing area. The CS-5103 is a three transducer system. Two extra transducers are used exclusively to increase the sound pressure of the acoustic burst, thereby increasing the likelihood of an echo return from very narrow materials. The CS-5100L is a laser sensor version of the standard CS-5100.

All of these variations of the control have been specifically designed to monitor material hung in a slack loop. Slack loop control is used for the feed and/or rewind of products manufactured in a continuous, linear manner. The diagram below is more instructive of the control's purpose. Typically, the CS-5100's sensor(s) is placed over a draped loop of slack material. The position of the loop valley is sensed and is used to govern the speed of a follower device (in the diagram, it's a powered winder). These controls may be programmed to control either upstream or downstream process followers. Typical of upstream devices would be decoilers, straightener/flatteners, dereelers. Typical downstream devices would be winders, cut-to length machinery.

The ultrasonic transduction is fairly straightforward. A burst of acoustic energy is broadcast toward the target (the loop valley). Milliseconds later, the transducer is switched to receive mode to await the echo return. The time between transmit and receive is measured. The speed of sound in air is reasonably constant so the position of the target is accurately calculated by the system's processor.

The system works best when the target viewed is perpendicular to the beam axis. Some angular variation is tolerated (about +/- 5 angular degrees), but when the angle is too severe, the echo return misses the receiver entirely. In this case, the system will register a far loop even if the target is physically in the control range. Most loops have either a parabolic or catenary curvature which aids in bouncing the echo back to the receiver, much like a radar dish does.

When the system is set-up, a *control range* is defined. Near and far set points define it. Within the control range, a signal (both 0-10VDC and 4-20mA are available) varies from either low to high or high to low.

POWERED FOLLOWER   SLACK LOOP CONTROLLER   LEAD PROCESS
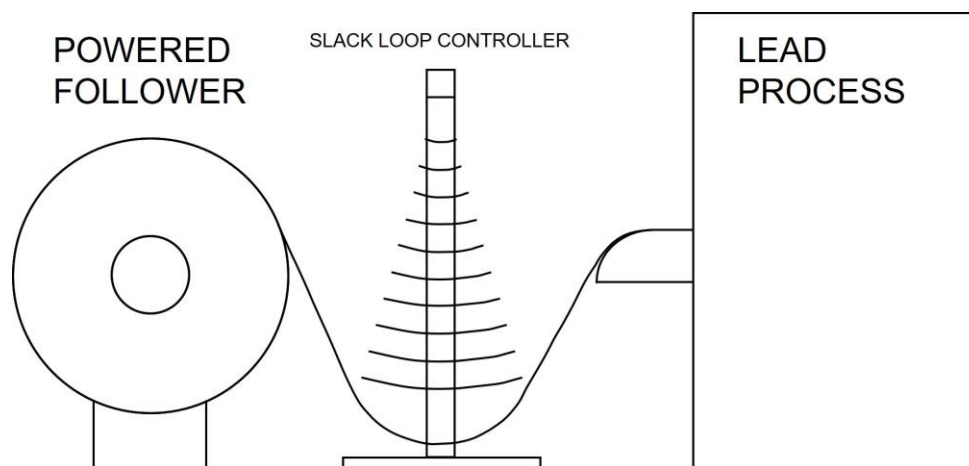
Standard Configurations and Options

The CS-5100 has been made since 1994. The latest version of the control (main) circuit board operates on 24VDC. This is a common industrial standard voltage source. Since our older cards operated on either 115 or 230 VAC, our standard configuration of the main board includes a small, 0.8W power supply, as shown below. The supply accepts any AC power source between 90 and 240VAC. The supply requires only L1 and L2. Connect incoming ground to the subpanel or enclosure.

The CS-5100, CS-5140 or CS-5103 may be ordered without the supply (-LPS) when a 24VDC source of sufficient amperage is available.

Any of the CS-5100 series controls may be ordered with an M12 connector termination.

The layout of the CS-5100's main processor board with power supply is shown at right.
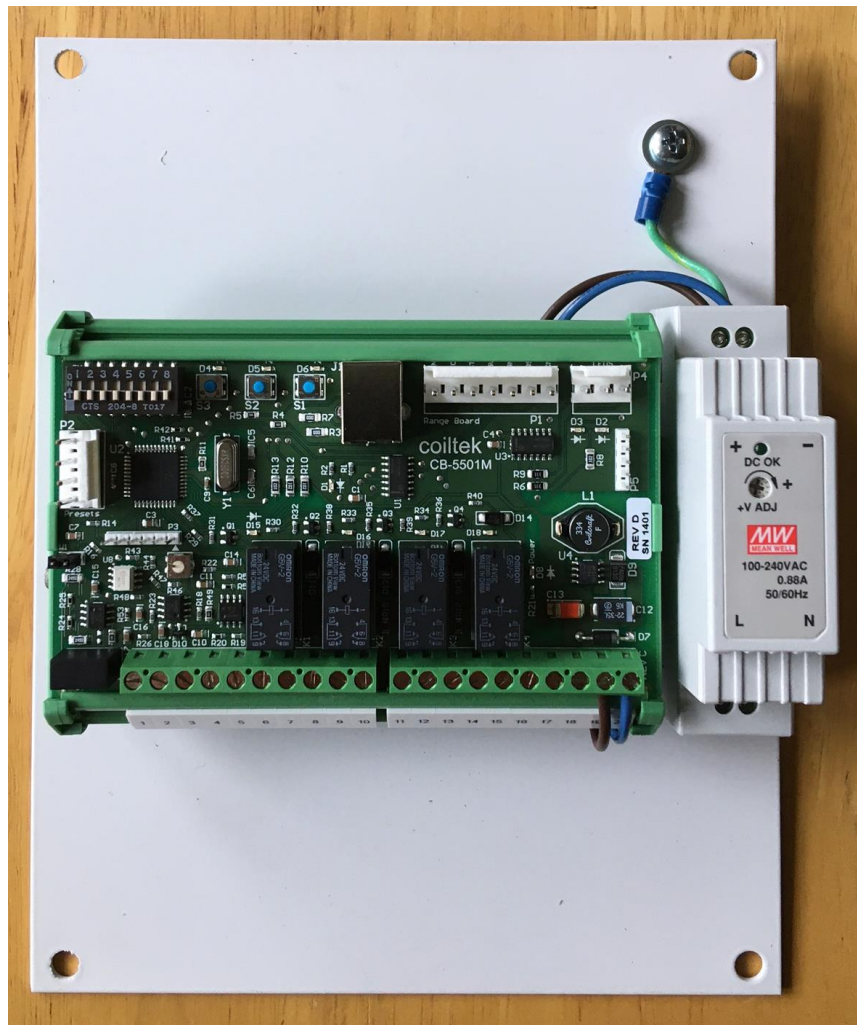
Notes on Slack Loop Control

Loop Geometry

While it may seem counter-intuitive, slack loop control works best when the two points from which the stock is draped are as close together as possible. It is the amount of slack or free material in the loop that provides the time for the follower device to accelerate or decelerate.
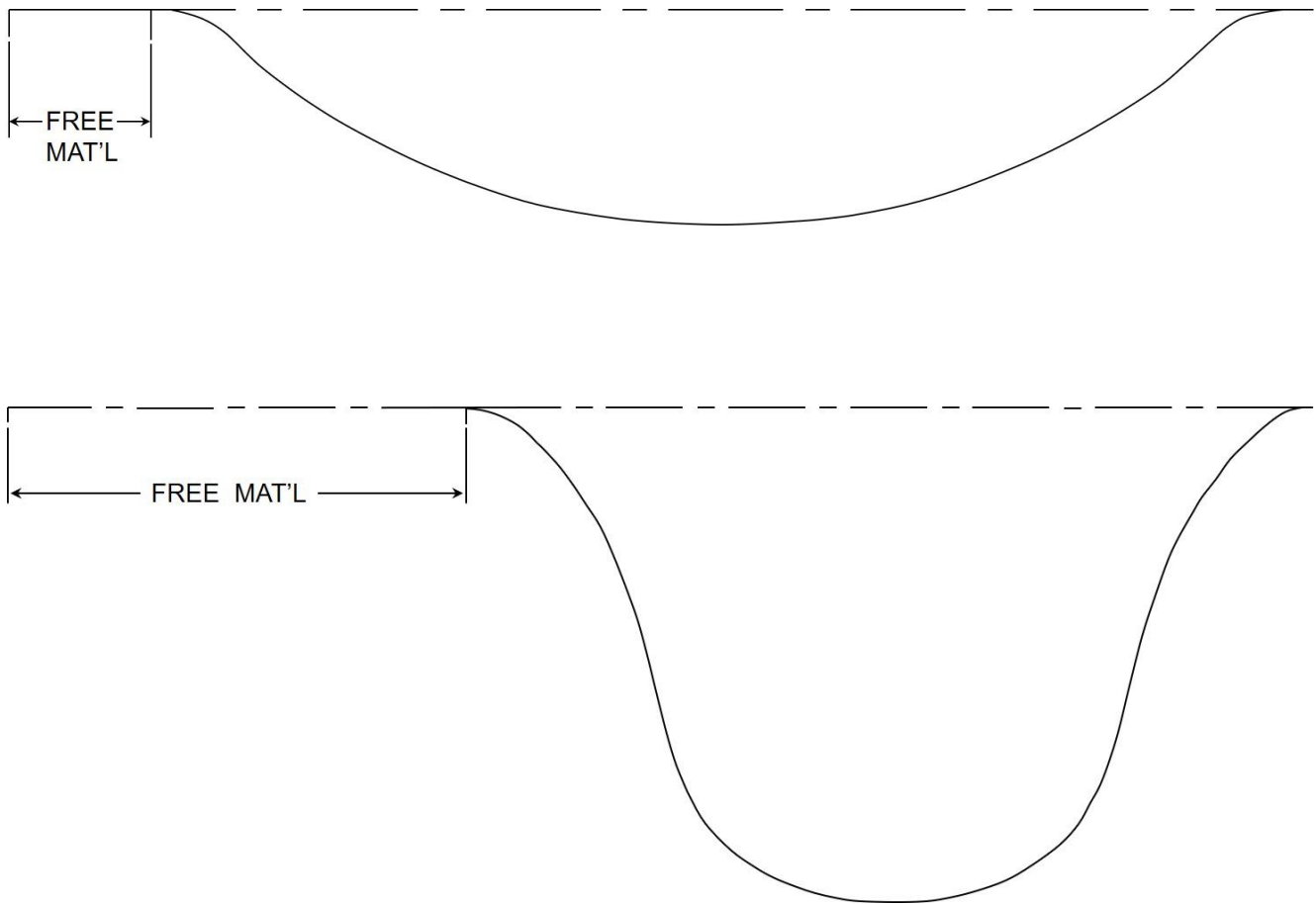
FREE
MAT'L

FREE MAT'L

In the diagrams above, it's clear that the deeper 'U' shaped loop develops the most free material between long and tight loop, avoiding the generally undesired tight loop shown at the top.
There is a caveat: some materials will be damaged if pressed into too tight of a bend. The cross-section of tubing or hose may be distorted or crimped. Thick metal strip may be pushed past elastic limits.
Good loop geometry is a balance between mutually exclusive parameters.

Notes on Slack Loop Control

Uneven Drape Points
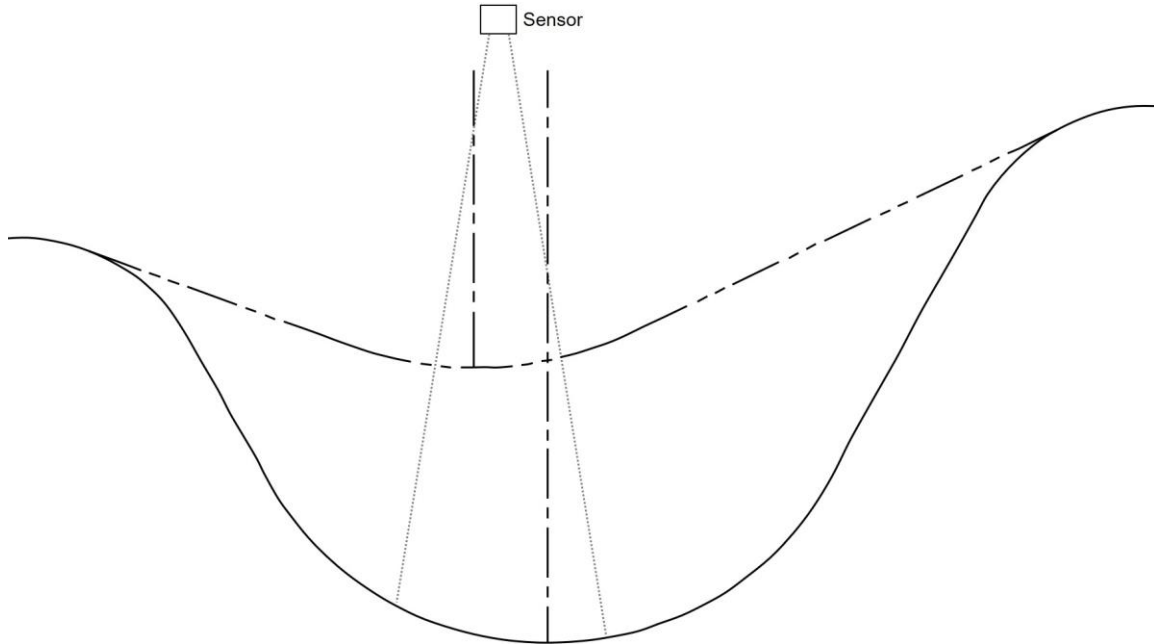
When the slack loop is draped from uneven positions as shown above, the loop valley will shift. It will always shift toward the lower drape point as the valley rises, regardless of stock flow direction. Note the valley center lines with a full loop and tighter loop and position the sensor between the two. The goal is to get solid position signal through the working span desired.

A similar situation occurs when using the loop control between a process and an un-winder or winder. The depletion or growth changes the tangential wrap point – also the drape point – as the line runs. Hence, the valley of the loop will move over time.

Speed of Response

Most slack loop control applications govern variable-speed powered follower machinery. When this is the case, a well-proportioned loop will yield better performance if the control range is larger. A reasonable amount of vertical travel between far loop set point and near loop set point will nearly always improve follower performance as the slack material buys time for the powered follower to respond.

Since the loop control measures position but is used to coordinate velocity, it is by definition *integral* control. The characteristics of integral control are zero long term error with modest speed of response. Hence, the CS-5100 on its own works well for slow to moderate speed processes. For higher speed applications, it must be used in conjunction with more sophisticated control systems that will improve speed of response.

Manual Set-Up

The CS-5100 is very easy to set up if the W1 jumper is in place. Here's how:

W1 Jumper

to

S3 Switch

S2 Switch

S1 Switch
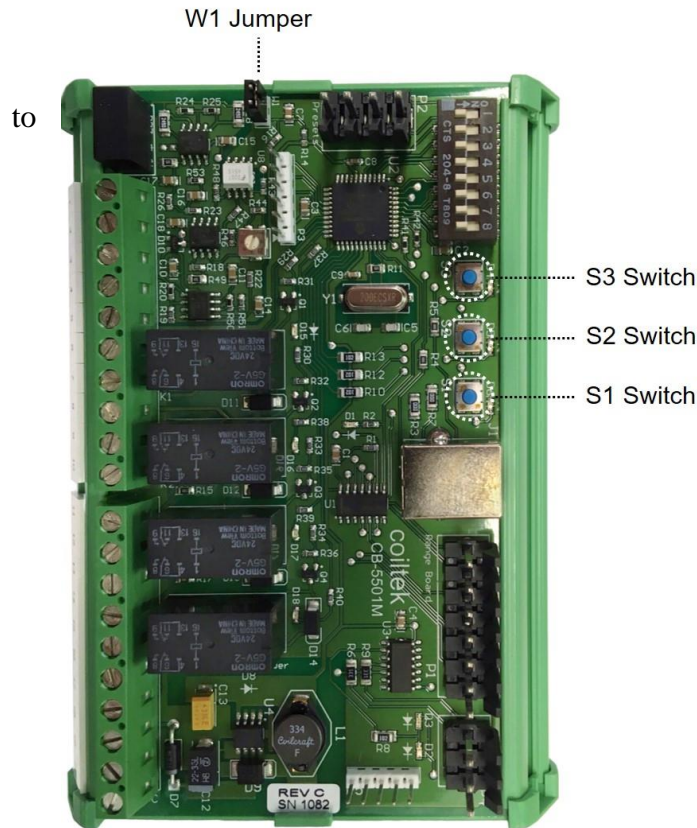
1. Press button S1. Lights above buttons S2 and S3 will begin blink.
2. Put a target beneath the sensor (unless the product is very narrow, say <3/4" wide, use the material you're running). Place it in the position farthest from the sensor. It will be the outer limit of your control range. Press S3. The light above S3 will stay on and stop blinking.
3. Place the same target at the desired near point of the control range. Press S2. If the set-up is accepted, the lights above S2 and S3 will go out and the system will return to run mode. Calibration is complete.

Alternately:

1. Press button S1. Lights above buttons S2 and S3 will begin to blink.
2. Put a target beneath the sensor. Place it in the desired near position. It will be the upper limit of your control range. Press S2. The light above S2 will stay on and stop blinking.
3. Place the same target at the desired far point of the control range. Press S3. If the set-up is accepted, the lights above S2 and S3 will go out and the system will return to run mode. Calibration is complete.

As shipped, after performing the procedure above, signal output will be 0VDC (4mA) at the far point and 10VDC (20mA) at the near point of the control range. This output may be used to control upstream or process feeding devices. In order to control downstream processes, the signal must be inverted. To do this, turn on DIP switch #7. If you remove jumper W1, your settings cannot be over-written.

Relays, Extended Upper Limit

When the set-up is complete, the near and far relays toggle at the respective near and far set points. The relays operate in a fail-safe manner. Specifically, the NEAR relay is ON unless the near limit is encroached. The FAR relay is ON unless the target drops below the far limit.

In feed applications, it is sometimes useful to move the near relay's activation point above the top of the control range. The near relay is used to stop the leader process when the feed device isn't keeping up. If the full 10VDC or 20mA signal is required to synchronize the feeder with the process, nuisance trips transpire. Setting up this feature is described on the following page.

Auxiliary Relays

The CS-5100 has two auxiliary relays that may be programmed to fire anywhere in the set control range. To set them up,
- Turn ON DIP switch #8.
- Press S1.
- Lights above S2 and S3 blink.
- To set leftmost aux. relay, set target and press S3.
- To set the other aux. relay, press S2.
- Turn OFF DIP switch 8.

This set-up does not affect the basic loop control settings, however, relay operation is NOT fail safe. These relays remain OFF until the target has reached or is nearer to the sensor than the set point.

Program Lock Out

As previously mentioned, the W1 jumper must be in place to manually program the system. When it is removed, programming the system manually is not possible. This may be useful in plants where only authorized personal are allowed access to machinery set-up.

W1 Jumper – must be in place beforehand to manually set up this board and extend the upper limit.
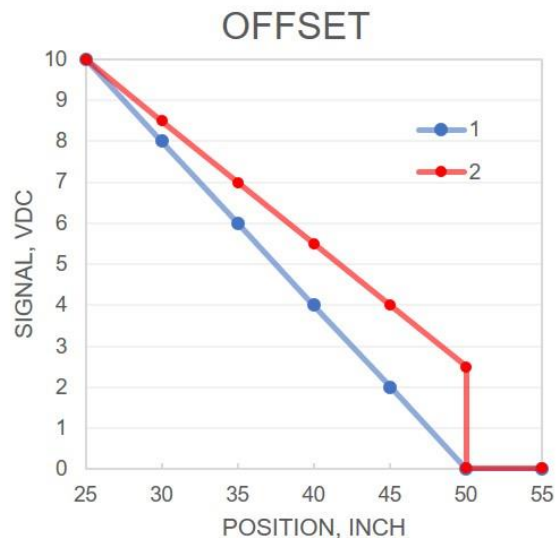
S3 Switch

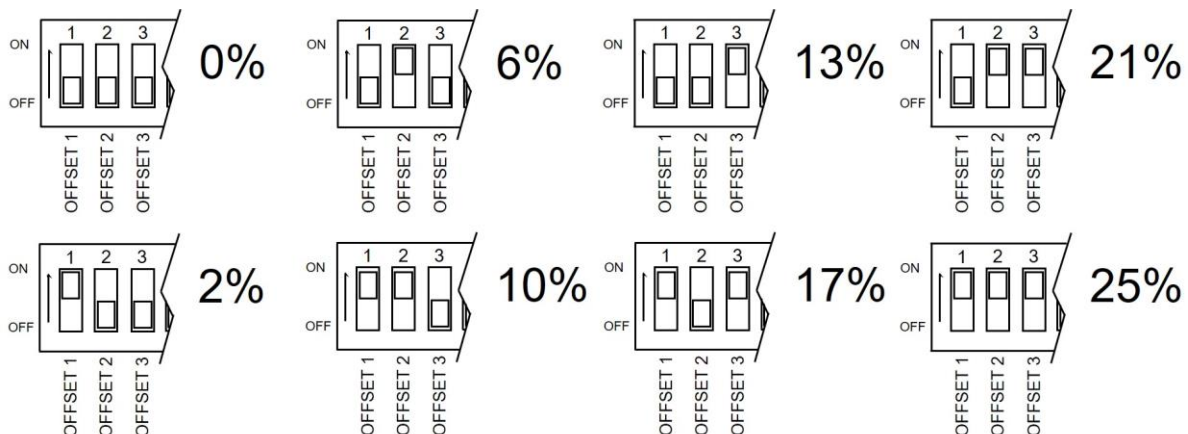**S2 Switch**
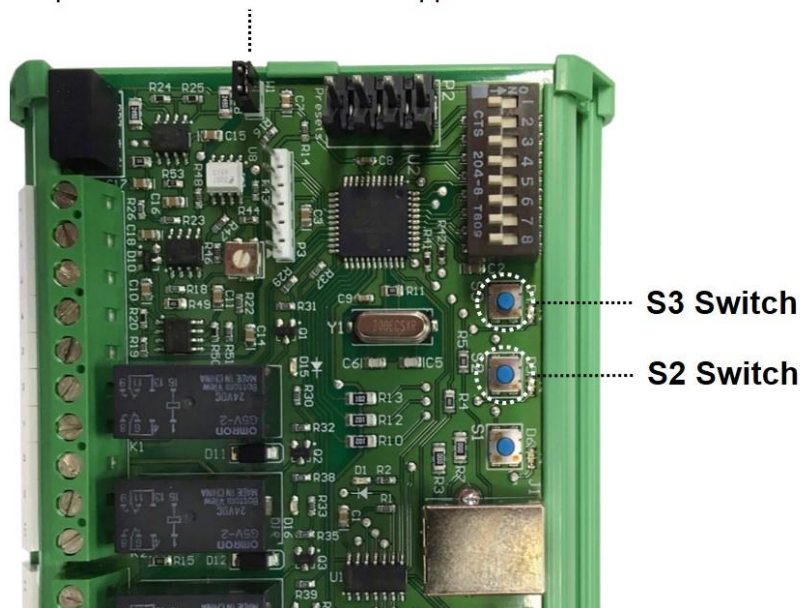
Extending Upper Limit

Another important feature on all new boards shipped after 7/15/14 is the ability to set an extended upper limit for the relay. This feature allows the user to set the emergency stop function higher than the original high point of the loop, thus increasing the amount of top-loop max feed time and minimizing nuisance stoppage. To use this feature, press the S2 and S3 buttons simultaneously. This causes the unit to enter a near relay setup mode, indicated by LEDs above S2 and S3 turning on. Place an object at the new near point you would like to set, and press S2 and S3 together a second time. The LEDs above the buttons should go out. To cancel the near relay set-up, press the S1 button, returning the unit to normal parameters. Ensure that the lockout jumper (W1) is in place before you attempt to use this feature.

Offset

Offset bias is available and useful in some situations. The graph at right explains what happens when offset is employed. The standard control signal is shown in blue in the foreground. Behind it, the red shows the output of the CS-5100 when 25% offset is implemented. Here, the output of the control jumps to 2.5 VDC when the loop crosses the long loop limit into the control range. The discontinuity in the output may be useful when the follower machinery must start rapidly. Since the working slope is reduced, this feature is frequently chosen in stamping operations with long feed progressions. Feed 'wow' is reduced.

To set up offset, set DIP switches 1-3 in position to implement the desired amount of offset. See the key below. Using CSWin, offset as large as 50% may be set.

Remote Access to Presets

The CS-5100 is capable of storing multiple loop control set ups. These are set up and addressed by selecting PRESET switches on the DIP switch block. There are 3 preset selector switches allowing the setup of 8 distinct loop control settings. Moreover, the presets may be accessed remotely by dry contacts by connecting to the board's P2 header. Typically, the DIP switches are used for manual programming of the system. Then, they are all turned off and the remote switches or contacts access the presets via the header at P4. Since the DIP switches and the contacts of P2 address the same processor inputs, combining DIP switch and remote switching may have unintended consequences.
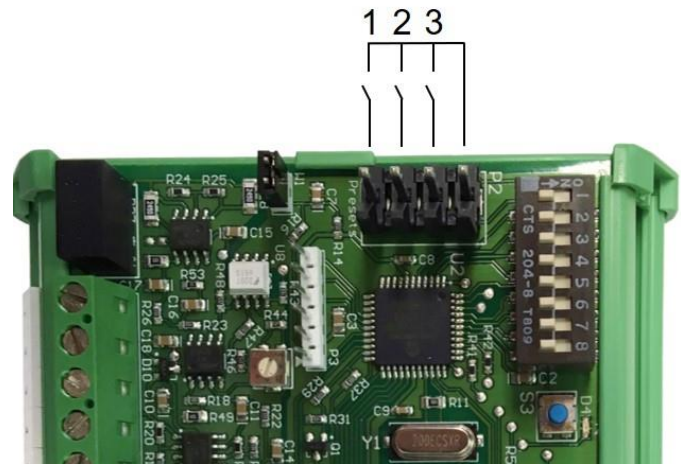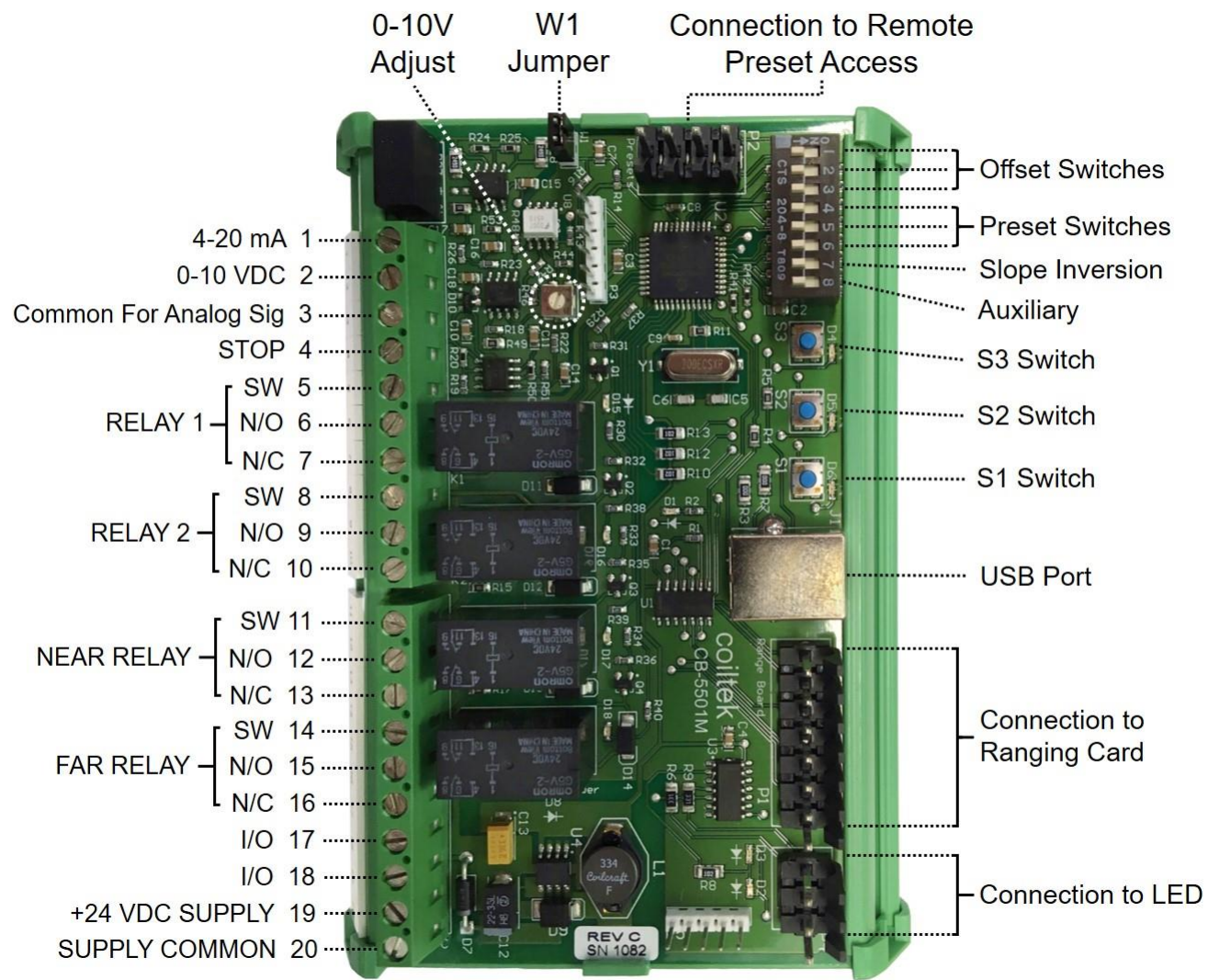
Preset Number	State SW 1	State SW 2	State SW 3
0	0	0	0
1	1	0	0
2	0	1	0
3	1	1	0
4	0	0	1
5	1	0	1
6	0	1	1
7	1	1	1

The truth table for preset access follows. Remote preset access must be via dry contact.

DO NOT USE PLC 24VDC SOURCING OR SINKING PLC OUTPUTS.

Terminals and Inputs

- 0-10V Adjust
- W1 Jumper
- Connection to Remote Preset Access
- 4-20 mA 1
- 0-10 VDC 2
- Common For Analog Sig 3
- STOP 4
- RELAY 1 — SW 5 / N/O 6 / N/C 7
- RELAY 2 — SW 8 / N/O 9 / N/C 10
- NEAR RELAY — SW 11 / N/O 12 / N/C 13
- FAR RELAY — SW 14 / N/O 15 / N/C 16
- I/O 17
- I/O 18
- +24 VDC SUPPLY 19
- SUPPLY COMMON 20
- Offset Switches
- Preset Switches
- Slope Inversion
- Auxiliary
- S3 Switch
- S2 Switch
- S1 Switch
- USB Port
- Connection to Ranging Card
- Connection to LED

DIP Switch Functions

The settings of the DIP switches dictate how the control behaves. The system is capable of storing and instantly retrieving a number of behaviors as presets. The functions of the individual switches are labeled in the graphic below.
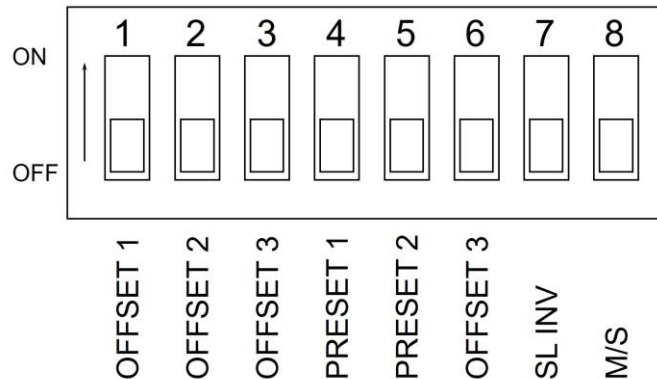
The first three settings, for OFFSET bias, are covered in another section. The PRESET switches allow selection of 8 different stored control behaviors. In short, the PRESETs are simply storage for different desired loop control behavior. PRESET storage is discussed at length in another section of this manual.
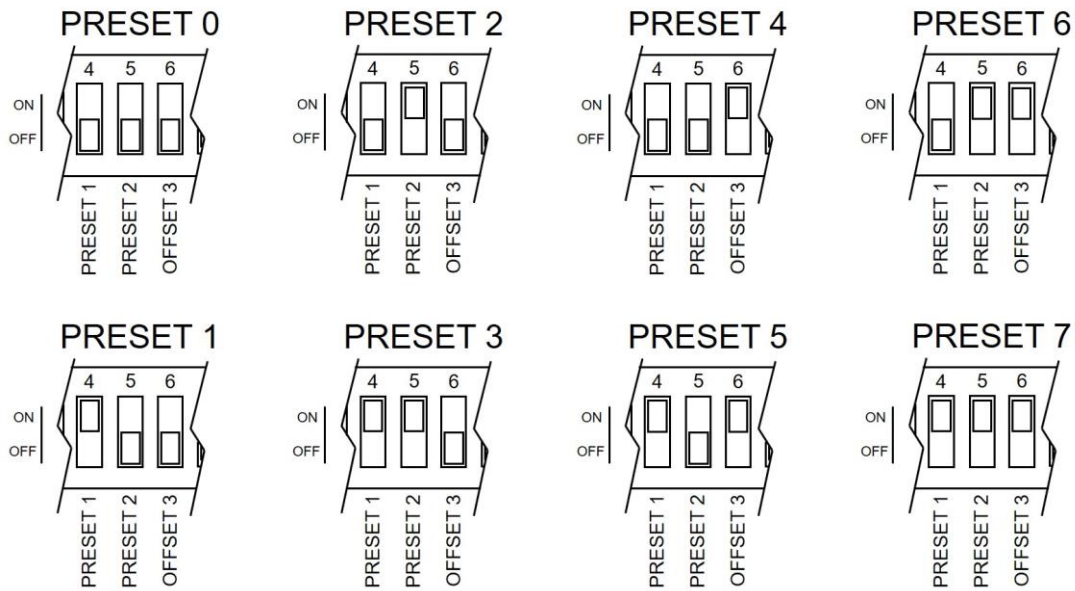
Slope Inversion

Switch 7, labeled SL/INV inverts the output slope. The default (SW7 OFF) is a 0V (4mA) signal at the FAR position of the control range. The signal increases as the target gets closer to the sensor. This behavior is associated with the control of machinery that feeds a process, such as a decoiler. With SW7 ON, the output is inverted such that 0V (4mA) is generated at the near point of the control range and increases as the target draws away from the sensor. This behavior is requisite for rewinding or other take-up equipment. The setting of the SW7 dictates how the control will react in a given PRESET when the set-up procedure is performed.

Presets

The graphic below shows the binary address scheme for programming and retrieving programmed presets manually. The switch setting in place at the time of set-up dictates where that particular set up is stored. Removal of the jumper from W1, as with any of the set-up parameters, makes the preset(s) programmed non-volatile.

If you frequently switch between several presets, you may want to consider integrating a 3CPO accessory into your unit. This 3 position selector switch allows for immediate, remote access to presets. Please also see the section on programming your presets with our CSWin software.

PRESET 0 | PRESET 2 | PRESET 4 | PRESET 6
4 5 6 | 4 5 6 | 4 5 6 | 4 5 6
ON / OFF
PRESET 1 PRESET 2 OFFSET 3

PRESET 1 | PRESET 3 | PRESET 5 | PRESET 7
4 5 6 | 4 5 6 | 4 5 6 | 4 5 6
ON / OFF
PRESET 1 PRESET 2 OFFSET 3

Diagnostics

The operation of the ranging card with the main processor card is as follows. The main board emits a START pulse. The range card replies with two consecutive pulses: the first is a START acknowledge pulse, the second is the ECHO return pulse. The time between these two pulses is used by the main board to calculate the distance measurement.

Normally, the LEDs D2 and D3 on the main board, as well as the LED on the end of the sensor arm, indicate the position of the target as follows:

- Above the control range, RED or, after 11-2018, blinking red
- In the control range, GREEN
- Below the control range, RED

If the main board receives no second or ECHO return signal, the position indicator LEDs both turn on. If no START ACKNOWLEDGE pulse returns, these LEDs blink back and forth periodically. This would also happen should the range card become disconnected.

The RED/GREEN LED on the end of the sensor head mirrors the LEDs D2 and D3 (red/green). It gives an immediate indication of the target position. Red means the loop is out of the control range. Green indicates the target is within the set control range. On systems built 9/19 or later, the NEAR out of range condition occurs, the LED will blink RED on and off.

Relays

The main board is equipped with two ancillary relays. Current firmware (11-2018) allows for the programming them to any position within the control range. Here's how. Flip the ancillary DIP switch (switch #8) ON. Place a target under the sensor at the position at which you'd like the relay to make. Press button S1. Lights over buttons S2 and S3 will blink. To set the K1 (leftmost) relay, press S3. To set K2 (2nd left) relay, move the position of the target to the place desired and press S2. Lights will go out. When finished, return DIP switch 8 to the OFF position.

STOP Input

Closing a contact between terminal 4 and terminal 20 forces the 0-10VDC signal to zero. Likewise, the 4-20 mA signal drops to 4 mA. This is useful when de-coiling equipment is left in automatic mode when the leader process is stopped. Because the CS-5100 is a non-contact sensor, it can be inadvertently actuated by external inputs. By wiring the STOP input to the loop control from the leader process, this possibility is eliminated. A red LED (D1) lights when STOP is active.

Cable Connections

The two boards in the CS-5000 V2 and CS-5100 V2 controls are connected by nine-conductor cable. The colored wires on each end of the cable are connected in the same order, the only difference being that one end of the cable will have longer green and brown wires than the other. This end of the cable will connect to the range card with the longer wires connecting to the LED mounted in the endcap of the boom. Please follow the diagrams below to wire your unit.

Range Card & Endcap
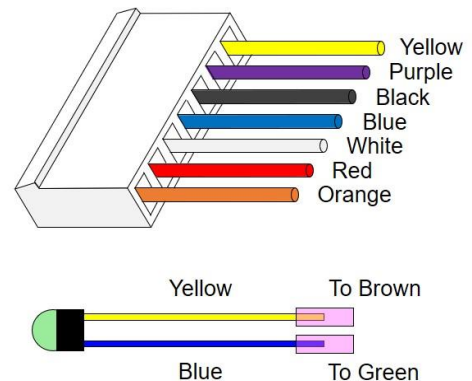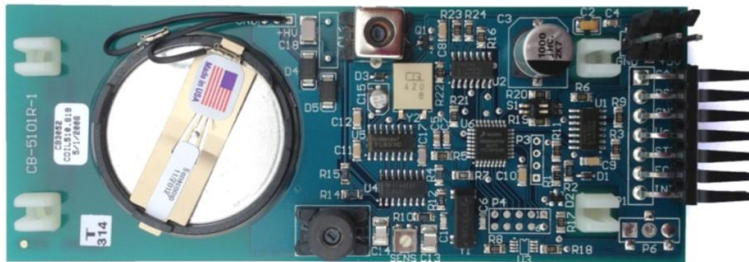
Features of the CB-5101R-2 Range Card
This latest update of the Coiltek range card is form, fit and function compatible with the CB-5101R, CB-5101R-1 versions (above). All installation procedures and precautions associated with previous versions apply, including removal of the 7 pin connector (above).

The sensitivity potentiometer, which governs the amount of echo received, has been repositioned such that adjustment may be made by removing the case end cap (figure below). On previous cards, this pot was mounted flat so that adjustment required removing the card from the case or stand boom. Adjust clockwise to increase sensitivity, counterclockwise to decrease.
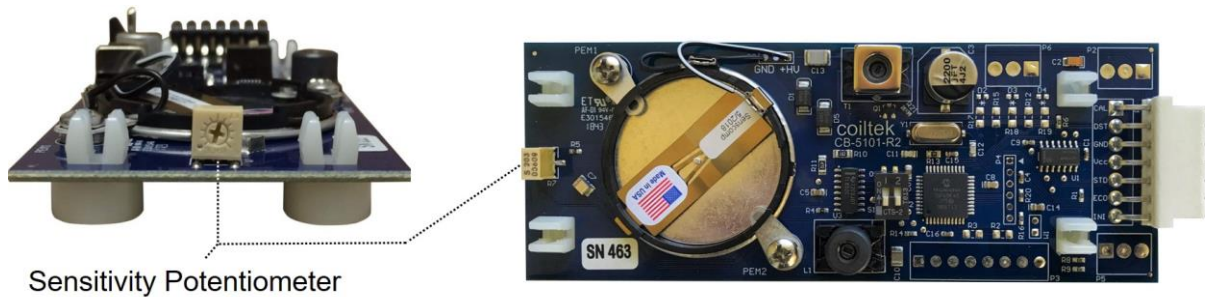
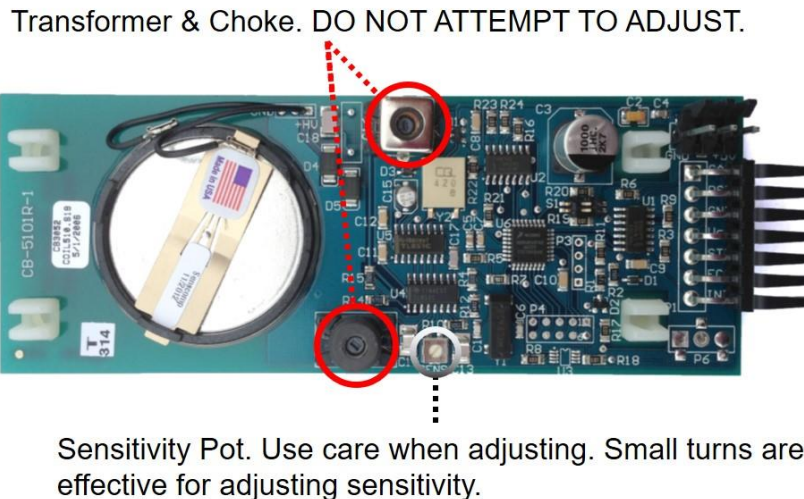Sensitivity Potentiometer

Mainboard
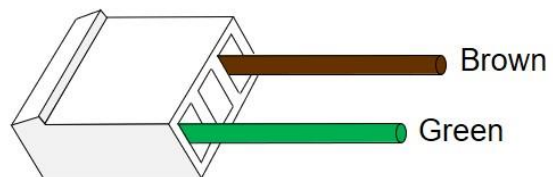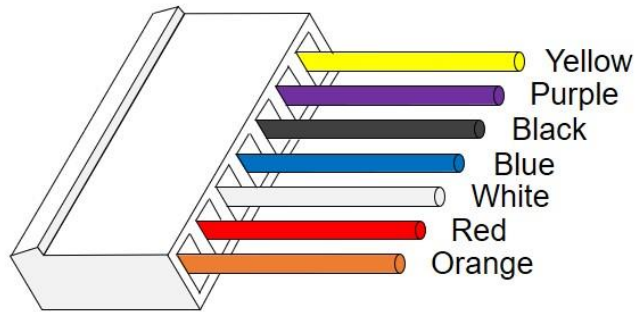
Software and Sensitivity

Setting Up Your Unit with a PC

The new CB-5501M mainboard has a USB connector for connection and programming the control via PC. The actual connection is RS-232 with USB emulation. As such, a driver is included with the downloadable software CSWin32. Upon connection with the control, Windows will recognize a new device. It will query for a driver. Choose to manually select the driver and use the mchpcdc.cat driver downloaded. A new version of our software, CSWin64, is under development. When available it will be posted in the downloads section of our website: www.coiltek.com.

Adjusting Unit Sensitivity

You can adjust the sensitivity of your unit by turning the dial of the sensitivity potentiometer on the range card clockwise to increase sensitivity and counterclockwise to lessen. A 5 degree turn is all that is necessary for most applications.

Transformer & Choke. DO NOT ATTEMPT TO ADJUST.

Sensitivity Pot. Use care when adjusting. Small turns are effective for adjusting sensitivity.

The CB-5101R-1 shown above is obsolete. However, may are still in operation. The same caveat applies to the choke and transformer on the new CB-5101R-2.

Upgrading to the CB-5501M

If you have an older loop control system with a **3CPO accessory** and are upgrading to the new CB 5501M mainboard, please note the following changes:

1) The Reset button no longer functions. The presets are immediately available using the 3 position selector switch, which makes the Reset button obsolete. Its attachment to the system will cause manual programming to become unavailable.

2) The above may result in the need for a new connection harness, as the pin-out has changed. If you should need assistance in reconfiguring your 3CPO for use with your new card, please contact us and we will walk you through the process.

3) Although not absolutely necessary, we recommend that you reference the 24 VDC supply to ground (the negative terminal of the power supply).

If you have any questions about the upgrade, please call for assistance.

Notes