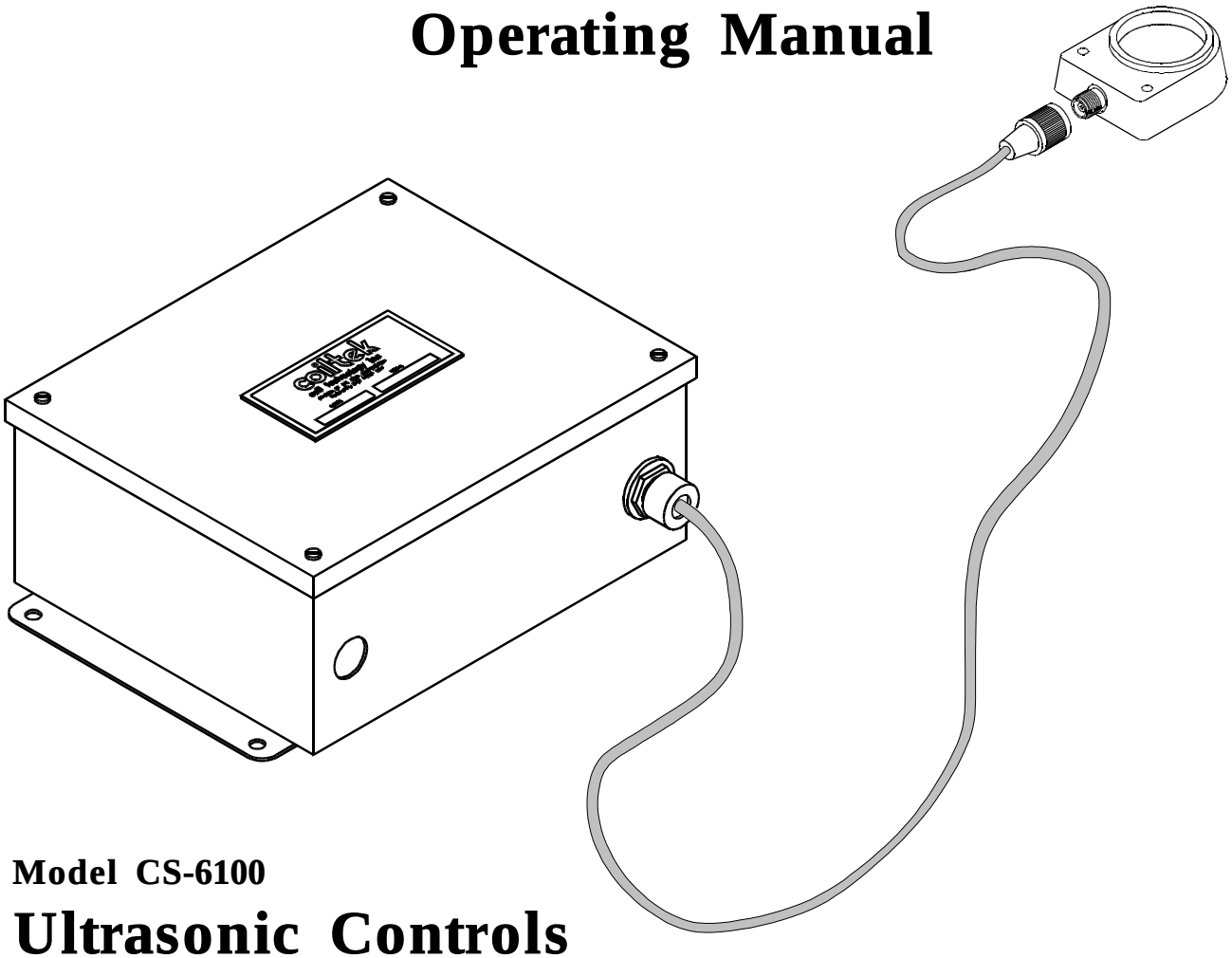
coiltek®

Operating Manual



Model CS-6100

Ultrasonic Controls

COIL TECHNOLOGY, INCORPORATED Wadsworth, Ohio 44281

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6101MN-09-97

COILTEK

Operating Manual
CS-6100 Ultrasonic Control

TABLE OF CONTENTS

INTRODUCTION

This manual contains information about the normal installation, operation and maintenance of the **COILTEK CS-6100 Ultrasonic Control** as used with SCR (DC) motor controls, eddy-current drive controls, and variable-frequency AC motor controls.

The manual tells how the loop control works, gives basic setup procedures, and shows wiring connections for typical motor controls. Because different drives and control systems have unique terminal arrangements and input requirements, the specific manual for the motor control to be connected to the CS-6100 is *essential* support to our "generic" diagrams. Maintenance personnel should have access to the motor control manual as well as the manual for the CS-6100.

Our service department stands ready to help with any problems.

COILTEK Service Department

Phone: (330) 334-1524 Fax: (330) 335-4406

May 1996

DESIGN

Your ***COILTEK CS-6100*** Loop Control will give years of reliable service in normal industrial environments provided the circuit board is housed in an appropriate enclosure. Coiltek offers an optional oil-tight enclosure (NEMA-12) for applications where there is no existing housing. The **ultrasonic sensor** has its own aluminum housing and is protected by an integral stainless steel grid. It is quite rugged, but some care is necessary.

Do not:

Allow fluids to contact it.

Paint over it.

Puncture it.

Expose it to temperatures over 180 degrees Fahrenheit.

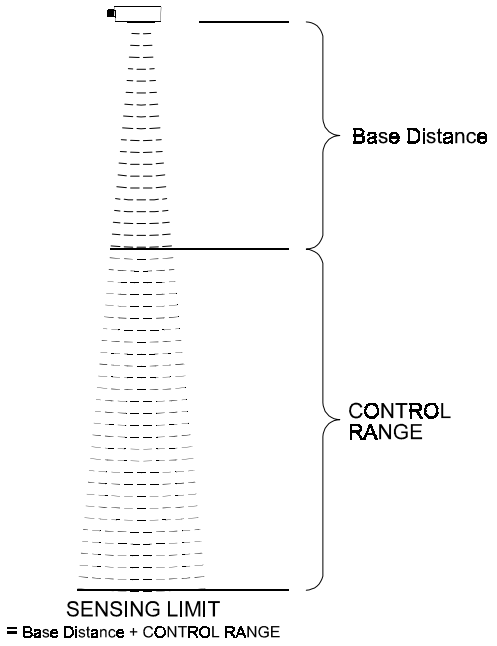
Setup switches for normal loop-control operations are on the main circuit board. Auto ranging allows easy setup. However, setup changes should be made by authorized personnel only.

For special setup and gauging applications, Coil Technology markets the CS-60 Software Package which lets any IBM-compatible computer communicate with the CS-6100. ***Menu driven software*** lets you select all of the many control parameters and functions built into the control. The computer can remain interactive with the system on line so you can monitor the effects of parameter changes. Once configured, disconnect the computer. The control retains all program parameters.

The control is ***microprocessor*** based, so the output will not drift. No adjustments are necessary after initial setup. Control parameters are safely locked in an EEPROM *(**E**lectrically **E**rasable **P**rogrammable **R**ead **O**nly **M**emory*).

HOW THE CONTROL WORKS

The CS-6100 constantly measures distance between the sensor and a target by echo location - the same principle that bats use to find mosquitoes in the dark. The sensor emits a burst of high-frequency sound (50 to 60 kHz.) about 20 times per second[1]. This burst is actually a controlled sequence of four distinct frequencies. The 6100's ultrasonic element acts as both a transmitter *and* a receiver.



The control measures the time it takes for the burst to return to the sensor. After emitting a burst, It listens for the echo. Because sound travels at a known speed, the microprocessor can calculate the distance with the equation: Distance = Rate X Time.

The control measures the distance to the nearest reflective surface. To make it useful, we must limit its range of "vision". That is, it should see only the thing that we want to control; a target within known limits. The control shouldn't look beyond that limit and get confused by floor, wall, or ceiling. The Figure at the left shows the *CONTROL RANGE* concept and explains the terms used in this manual. A pair of lights (red and green) on the circuit board let you know whether there is a target within the control range. Green shows a target in range. Red means that the echo return time is too long or too short and there's no target within the control range. The output from the CS-6100 is a DC voltage which is directly proportional to the distance of the nearest target within the CONTROL RANGE,

Used as a loop control, the CS-6100 will automatically match the speed of one process machine to another by holding aloop of slack material at a fixed distance from the sensor. Its output signal is electrically isolated and can connect directly to a motor control as the speed reference input.

In addition to loop control, the CS-6100 can perform other control functions such as:

- Proportional or differential trim around an external 0 to 5V speed reference.
- Tension Control by diameter measurement.
- Level Control of liquids, solids, and stacked materials.

[1] The user can set sampling rate with the CS60 programming software.

SPECIFICATIONS

Range

The CS-6100 monitors the distance of any target that is greater than 6 inches but less than 360 inches away from the transducer. In Linear operating mode, the output voltage varies linearly from minimum to maximum as the target moves though the CONTROL RANGE. The Figure on page 5 shows the ***Range*** concept and explains the terms used in this manual

Angle of Vision

The sensor views a conical area with a beam angle of 17.3 degrees (8.6 degrees from center line. The diameter (**d**) relates to the distance (**y**) from the sensor. The approximate diameter is: $d \cong 0.3 \cdot y$.

Sampling

The sampling rate for the CS-6100 is preset to a default value of 20 samples per second (50 msec sampling interval). Sampling rate is the inverse of the sampling interval, or the amount of time that it takes for the sound-burst to reach the nearest target and bounce back, plus some dwell time.

The default value can be altered using Coiltek CS-60 software, which can set sampling intervals from 10-msec to 63- msec.

Averaging

To integrate (or smooth) the output control voltage, the CS-6100 computes a running average of consecutive data samples. The default setting is 8.[2] That is, the control monitors a running average of 8 consecutive samples (equal to 0.4 seconds averaging time). Averaging time equals number of samples times the sampling interval.

The CS-6100 recognizes an “out-of-range” condition after counting a certain number of consecutive out-of-range samples. The default value is 10, approximately 0. 5 seconds.[3]

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(2)(3) These numbers can be changed to any value between 3 and 255 using computer software.

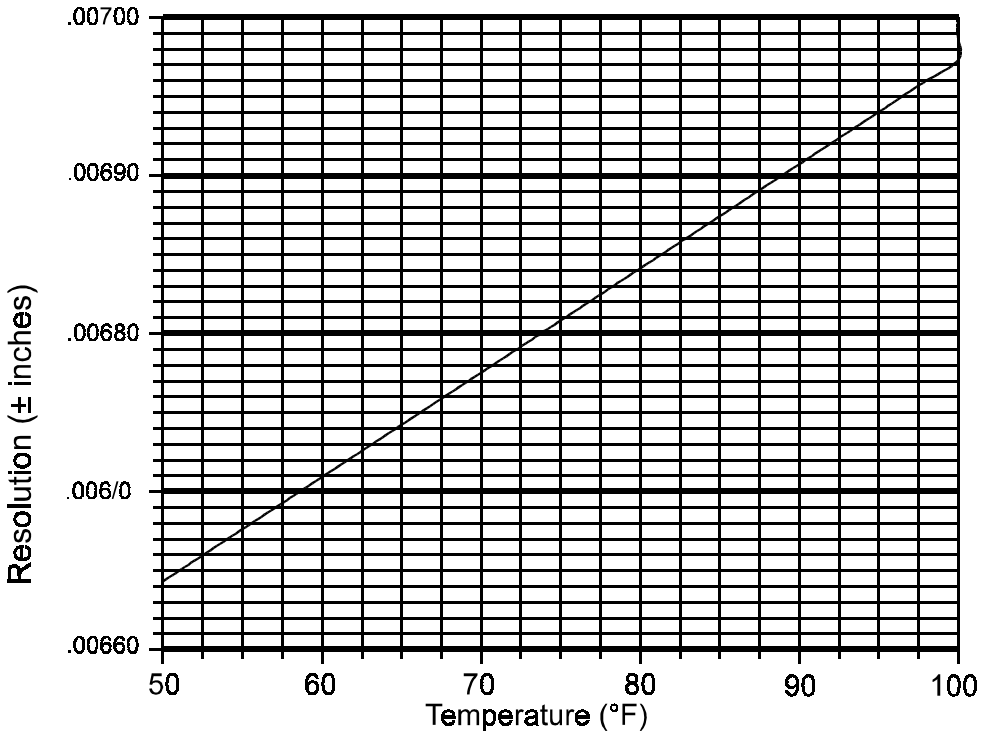
Control Range

Using the manual setup procedure, the control range can be varied in 5 inch increments from 5 to 75 inches[4]. The default range is 30 inches.

Resolution

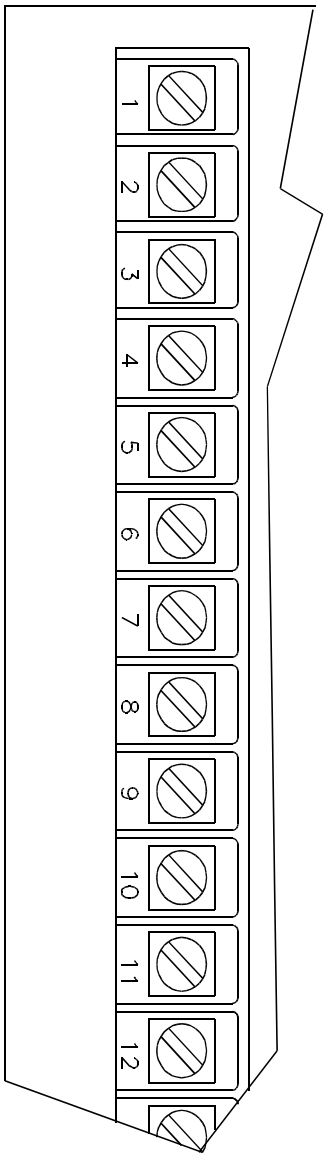
Basic resolution of the instrument is ±0.0068 inches (±0.171 mm). The graph in Figure 2 plots the change in resolution (inches/msec) as a function of temperature. Note that the values shown in the plot refer to resolution, not accuracy.

Absolute measured distance between the sensing head and target can be inaccurate. However, *changes* in target position will be correct within the resolution shown in the plot. Most loop control functions depend on changes in loop position, not absolute distance. Please see Appendix A for a discussion of accuracy.

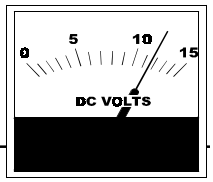


(4) Computer software permits the user to set ranges from 1 to 354inches (in 1inch increments) . The control range can be anywhere within the 6 to 360 inch limits, but the entire range must fit within those limits.

OUTPUTS



J6 - TERMINAL STRIP CONNECTIONS



SIGNAL OUTPUTS

JOG

Terminal 1 is a constant DC voltage output. A trim potentiometer on the CS-6100 board sets the level. This output and the SIGNAL output below are positive with respect to COMMON (Terminal 3).

SIGNAL

Terminal 2 is the main control output, a DC electrically isolated signal positive with respect to COMMON (Terminal 3). Output voltage varies with the position of the target within the CONTROL RANGE.

Terminal 2 can connect directly to the input circuit of any variable-speed drive or control system. A trim potentiometer (marked OUTPUT) adjusts the maximum output for 0-1 to 0-12 volt DC operation.

The output is an integrated pulse width modulated signal. The default modulation frequency is 1321 Hz. Signal resolution is 0.13% of the range setting.

COMMON

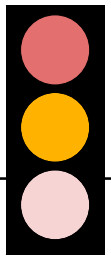
Terminal 3 is COMMON to Terminals 1,2 and 4. Power for JOG, SIGNAL and RESET are isolated from the rest of the circuitry.

RESET

Momentary contact of Terminal 4 to COMMON resets the microprocessor. Terminal 4 is optically isolated from the logic circuitry. This contact duplicates the function of the RESET button to allow remote RESET.

NOTE: Terminals 1 through 4 are electrically isolated and relate only to . Terminal 3 as COMMON. The *Signal Common* on most DC motor controls is not at ground potential. DO NOT connect Terminals 1, 2, 3, or 4 to ground!

STATUS OUTPUTS



Three switched outputs (Terminals 5 through 10) provide ON/OFF control functions.

CONTROL Terminals 5 and 6. The CONTROL OUTPUT is a special function which must be programmed using the CS-60 software and computer interface. Its default state is OFF. The output can be programmed to turn ON at one target distance and OFF at another.

NEAR Terminals 7 and 8. The NEAR OUTPUT is OFF whenever the target is closer to the sensor than the near boundary of the control range. Otherwise it is ON.

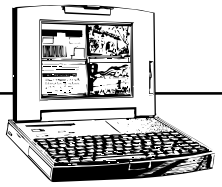
FAR Terminals 9 and 10. The FAR OUTPUT is OFF whenever the target is farther from the sensor than the far boundary of the control range. Otherwise it is ON.

The STATUS outputs are NPN open-collector Darlington switches to drive Programmed Logic Controls, relay coils, or other digital logic circuits. They are optically isolated from the entire CS-6100 circuit. Electrical specifications

Isolation Voltage	5000 V_{AC}
Vce (Max)	40 V
$I_{collector}$ (Max)	160mA

When driving a logic circuit, the collector terminal (marked *COL*) must be pulled high with a 22KΩ, 1/4w resistor. When driving an inductive load, such as a relay coil, a flyback diode must be connected across the load to prevent damage to the output circuit. Remember to limit the output current to 160mA. See typical wiring diagrams under INSTALLATION.

OTHER



RS-232 C PORT

Terminals 11 and 12 are normally OFF unless activated by:

- Setting the **MSR/SLV** switch (SW#2-8) to the **SLV** (ON) position, or
- Activating the secondary RS-232 serial output using CS-60 software.

When open for data-acquisition, the port transmits a continuous stream of distance data remote data acquisition. Values are in ASCII code, truncated at 3 decimal places, and separated by carriage returns. The user can select either decimal or hexadecimal format. The output spans 240 inches regardless of the range setting.

Two, three, or four CS-6100 controllers can be multiplexed through this port. Multiplexing is used to prevent *cross talk* when multiple sensors must operate close to one another. All multiplexed units must have SW#2-8 in the **SLV** (ON) position. Units are *daisy-chained* through Terminals 11 and 12; that is, Terminal 11 connects to Terminal 12 on the next unit - and so on.

AUXILLIARY INPUTS, OUTPUTS, AND FUNCTIONS

These input and output functions are used for special system applications. They are accessible only with special factory-furnished modification or by using the CS-60 Coiltek software and an IBM-Compatible Computer.

J3 DB-9 Connector

J3 is the RS-232 communications Link to an IBM compatible armed with Coiltek CS-60 software. The software lets the user customize all control functions. By making changes with the control "on-line", the user can see the effect of each change.

J4 4-Pin Header Connector

J4 provides remote duplication of three switches:

- The CAL/RUN switch (SW1-4) and
- The PRESET switches 1 and 2 (SW2-4 & 5).

The optically coupled links permits the user to perform calibration and change programs from a remote location.

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J5 20-pin Dual In Line Connector

This 20-pin Header provides multiple inputs and outputs for special systems applications. These include:

- An additional RS-232 serial port for data acquisition and multiplexing. (Duplicates Terms 11 and 12 on J6).
- A second PWM output that can either echo or mirror the control signal output.
- Four multiplexed A/D converter inputs.
- 5-volt dc supply and ground.
- Clock output.

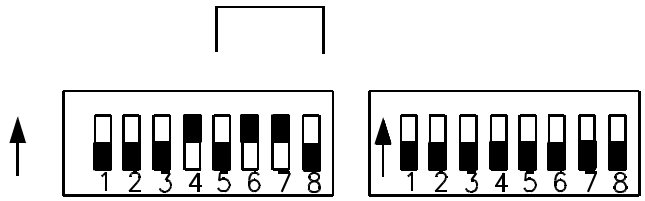
THERMAL CALIBRATION- For Gauging Applications

The CS-6100 Control offers an optional accessory for automatic temperature calibration/compensation which plugs into J5 (above).

Calibration is of no value for loop control applications, but is essential for gauging applications that must retain accuracy under changing environmental conditions. The small temperature sensor which is mounted near the sensing area. With auto calibration turned ON *(using the CS-60 Software)*, the control periodically corrects for changes in the speed of sound caused by climatic conditions.

CONTROL FUNCTIONS

The CS-6100 control compresses many control functions into two blocks of eight DIP switches. Switches are labeled as follows:



SWITCH BLOCK 1

OUT/UP (payOUT/takeUP) SW1-1

This switch sets the operating mode for payout (OUT) or take-up (UP) control. In the UP position, the control output decreases as the target moves closer to the transducer. In OUT position, the output increases as the target moves closer to the transducer.

LIN/ADAP. (Linear/Adaptive) SW1-2

In Linear position, the control output swings linearly from zero to maximum as the target moves between the limits of the control range.

The Adaptive position is for loop-control in winding applications. The switch activates a control algorithm to hold a loop of moving strip material at a fixed position regardless of the velocity of movement. This position will be the center of the control range (±10% of that range).

HOLD (Hold last value) SW1-3

In normal operation, with the HOLD switch OFF, the control output drops to zero if there is no target closer to the transducer than the SENSING LIMIT. With the HOLD switch ON, the control output holds the last value indefinitely, rather than dropping out.

CAL/RUN (CALibrate/RUN) SW1-4

The CAL/RUN switch lets the user position the control range anywhere within the 6 - 360 inch limits. In CALibrate position, the control automatically seeks the target closest to the transducer and sets its position as the far limit of the control range. When returned to the RUN position, the switch locks this far limit value into memory. The setting stays in memory until purposely reset. Memory does not depend on power.

CONTROL RANGE (40, 20, 10, 5) SW1-5,-6,-7, and -8

These 4 switches, in combination, serve several functions.

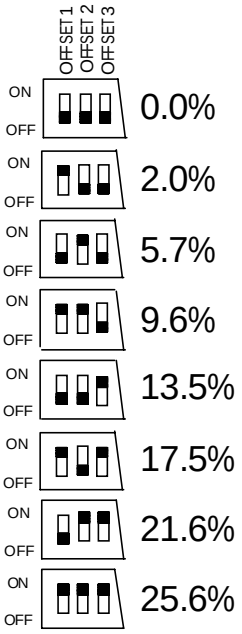
- They select one of 15 preset control ranges from 5 to 75 inches.
- They open the RS-232 port for computer interface.
- They reload initial defaults into the system.

When not connected to an external computer through J3 (the RS-232 port,) at least one range switch must be ON. Switch selections are added together. Any four of the control range switches can be ON at the same time to form the 15 combinations of control ranges, from a 5-inch range to a 75-inch range. Note, however, that the PRESET function switches (SW2-4,-5, and -6) take precedence over the range switches. The Range switches are only effective in Program #0, which corresponds to all preset switches being turned off. (more on that later.)

With all four RANGE switches **and** SW2-7 OFF, the primary RS-232 port , accessible via J3, is open for serial communication with any IBM-PC loaded with the Coiltek CS-60 Software. Unless connected to a computer, the RS-232 port should remain closed. This is accomplished by turning on at least one of the control range switches on switch block one.

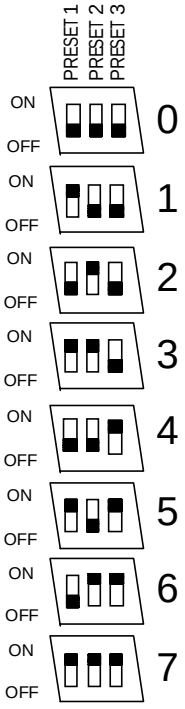
SWITCH BLOCK 2

OFFSET BIAS SW2-1,-2 and -3



Some drive systems falter at low speed; the result of low torque, high inertia, or poor current regulation. Under load, the motor does not react until the control signal reaches a certain value. (This is often a PAYOUT problem) The OFFSET switches (1,2, and 3) in combination, will introduce offset bias equivalent to a minimum speed setting. When the CS-6100 signals the drive to start, the control signal jumps from 0 to a known, *offset* value. This value is a fixed percentage of the maximum signal output voltage set by the Output Adjust pot, R16.

NOTE: The processor will not recognize OFFSET switch changes until the 6100 has been reset. To do so: press the RESET button PB1.



PRESET PROGRAMS SW2-4, -5 and -6

PRESET switches SW2-4,5 & 6, in combination, allow the CS6100 control to store up to eight separate and distinct operating programs. Programs can be stored either directly using the CAL/RUN switch or by using the computer interface. The CS-60 Software package can read and store settings for each program. These switches select which program is operational. When any program other than #0 is selected, the stored program supersedes all other switch settings except:

- the **CAL/RUN** switch
- the **TEST** switch

However, if PRESET Programs are in effect (see SW2 settings) at least one range switch should be ON.

TEST SW2-7

This switch is used for memory reset (see RANGE SWITCHES). (It is also used for factory testing and servicing.)

MSR/SLV SW2-8

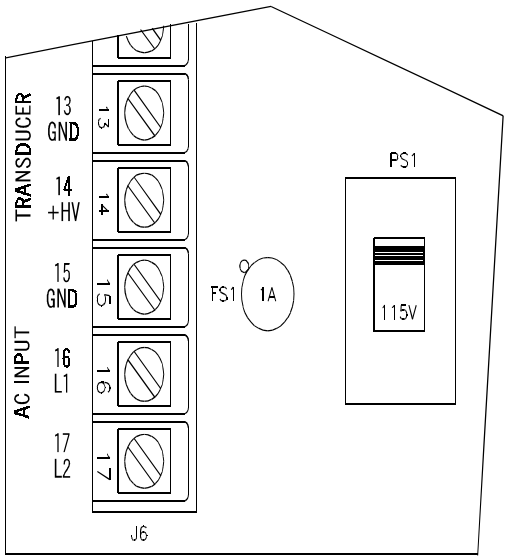
Normally, this switch is set to MSR (master). The switch is in SLV (slave) position only when two or more controls are multiplexed through the auxiliary RS-232 port. SW2-8, in MSR position, closes the RS-232 port to stray electrical impulses.

INSTALLATION

CONNECTING THE TRANSDUCER

The cable from the transducer connect to Terminals 13 and 14.

- Terminal 13 is the ground termination for the shield of the transducer cable.
- Terminal 14 is the termination for the center wire of the transducer cable. Do not touch terminal 14 while the CS-6100 is powered. Voltage here is about 400 volts DC. While the output current is very low and presents no hazard, the shock is uncomfortable.



CONNECTING POWER

Terminals 15, 16, and 17 are the AC power input connections.

- Terminal 15 is the earth ground (**green**) connection. A good ground is essential for proper operation. Use # 14 GA wire

115-120 VAC 50-60Hz. 1Φ operation.

With the power selector switch (PS1) set for 115V operation, connect the hot **black** line **(L1)** to terminal 16 and the neutral **white** line **(L2)** to terminal 17. Use # 16 GA wire

240-VAC, 50-60Hz., 1 or 2Φ operation.

With the power selector switch (PS1) set for 240V connect one power line to terminal16 and the other to terminal 17. Use # 16 GA wire

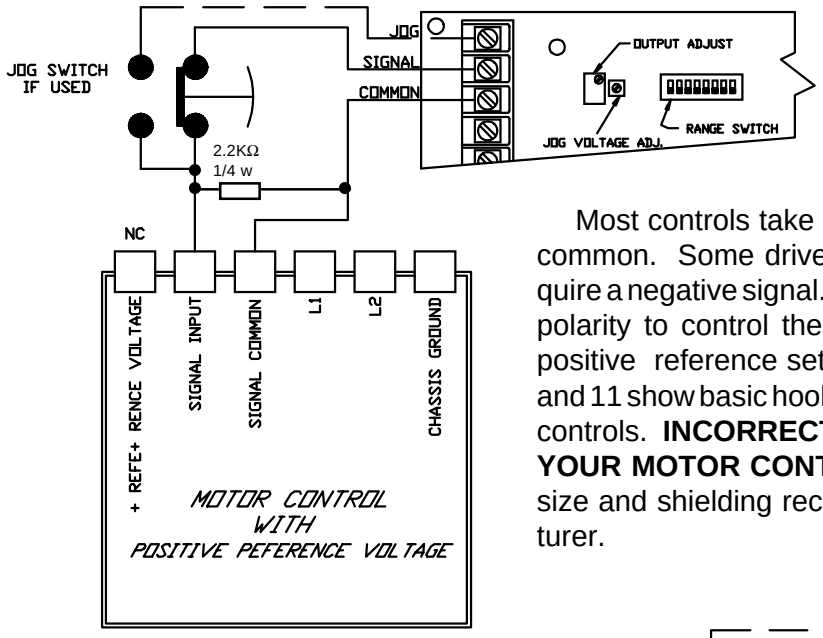
The CS-6100 should remain powered at all times during system operation. If power is removed from your motor control during standby, use a separate power source for the CS-6100. The CS-6100 is fused for 1 Amp.

Motor Control Settings

Follow your motor control manual making sure the drive operates normally before connecting the CS-6100. The minimum speed setting of your motor control should be zero and the maximum speed set to limit the motor to its rated maximum rpm.

Control Wiring

CHECK THE POLARITY AND LEVEL OF THE REFERENCE VOLTAGE REQUIRED BY YOUR MOTOR CONTROL.



Most controls take a signal that is positive with respect to common. Some drives, particularly eddy-current drives, require a negative signal. Regenerative SCR controls take either polarity to control the direction of motor rotation. Use the positive reference setup for regenerative drives. Figure 10 and 11 show basic hookups for positive and negative reference controls. **INCORRECT SIGNAL POLARITY CAN DAMAGE YOUR MOTOR CONTROL AND CS-6100.** Follow the wire size and shielding recommendations of your drive manufacturer.

CONTROL SETUP

IMPORTANT! BEFORE YOU APPLY POWER TO THE CS-6100, MAKE SURE THAT THE MOTOR DRIVE CAN NOT RUN. Switch the drive to STANDBY, disconnect power to the motor control, or disconnect the input signal.

Unless ordered with a special preset program, CS-6100 controls are shipped with default values loaded into all seven PRESET programs. (Default values are listed in Table 1.) Any special factory loaded program will be placed in Program # 1) To use a factory-loaded program, set PRESET switch 1 ON. Make certain that the TEST switch (SW#2-7) is OFF when you apply power so that you don't clear the program. *(See CLEARING PRESET PROGRAMS on Page xx.)*

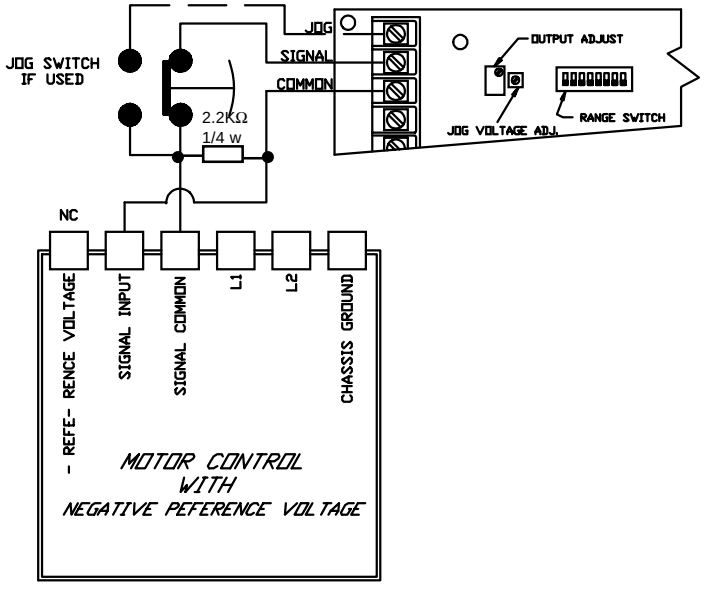


Table 1 Default Settings	
OUT/UP	Depends on Switch Position at time of RESET
LIN/ADAPT	Depends on Switch Position at time of RESET
HOLD	Depends on Switch Position at time of RESET
BASE DISTANCE	13 inches (330 mm)
CONTROL RANGE	30 inches (762 mm)
SENSING LIMIT	43 inches (1092 mm)
CONTROL RELAY	OFF
NEAR RELAY	13 inches (330 mm)
FAR RELAY	43 inches (1092 mm)
AVERAGING	8 samples
OVER RANGE*	10 samples
CALIBRATION**	0.00670 inches (0.17018 mm)/æsecond
RS-232	OFF
DWELL TIME	50 msec
OFFSET	Depends on Switch Position at time of RESET

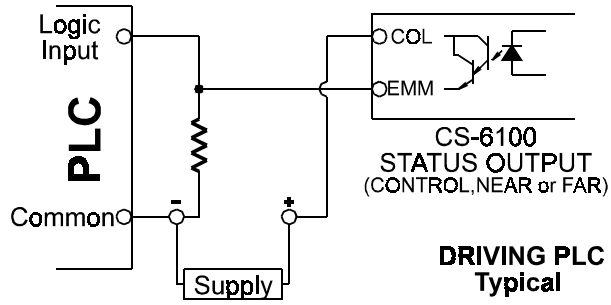
* Number of "missed samples" before dropout.
** Speed of Sound.

WIRING STATUS OUTPUTS

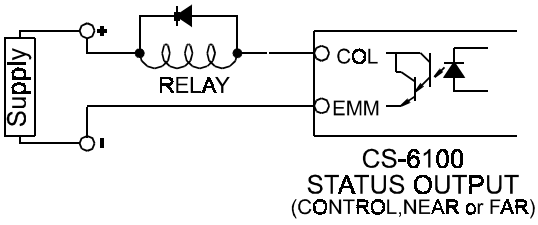
The CS-6100 recognizes NEAR, and FAR limit conditions and provides an ON/OFF status output for each condition with NPN Darlington transistor switches. The FAR output *(Terminals 9 and 10)* turns OFF when the target exceeds the SENSING LIMIT. Unless set otherwise through the computer interface, the NEAR output *(Terminals 7 and 8)* turns OFF when the target moves into the BASE DISTANCE area. When The target is within the CONTROL RANGE, both NEAR and FAR outputs are ON. The out-of-range condition gives the same result as a power loss; thus providing fail-safe detection.

The CS-6100 also has a logic CONTROL output *(Terminals 5 and 6).* CS-60 Software and computer interface are needed to activate this output. The output can be programmed to turn ON at one target distance and OFF at another.

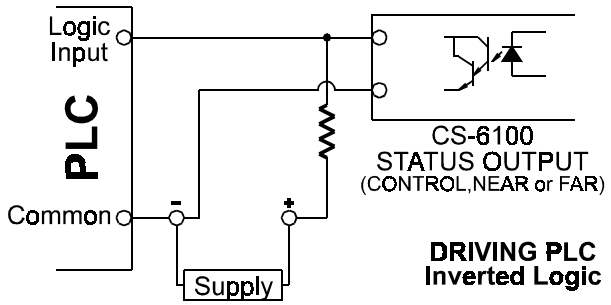
The following diagrams show typical wiring of status outputs.



DRIVING PLC
Typical



DRIVING INDUCTIVE LOAD



DRIVING PLC
Inverted Logic

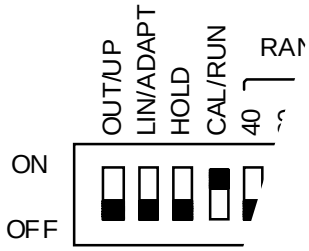
MANUAL PROGRAMMING

Begin with the power OFF!

Set Switch Block 1:

SW#1-1 Set switch for pay**OUT** (OFF) or take**UP** (ON) to match your application.

Note: If you are working with the CS-6100 for the first time, we suggest that you set SW1-1 to pay**OUT** (OFF). It is easier to test the control voltages in pay**OUT** mode. If your application requires the take**UP** mode, be sure to change the switch setting before going on-line!



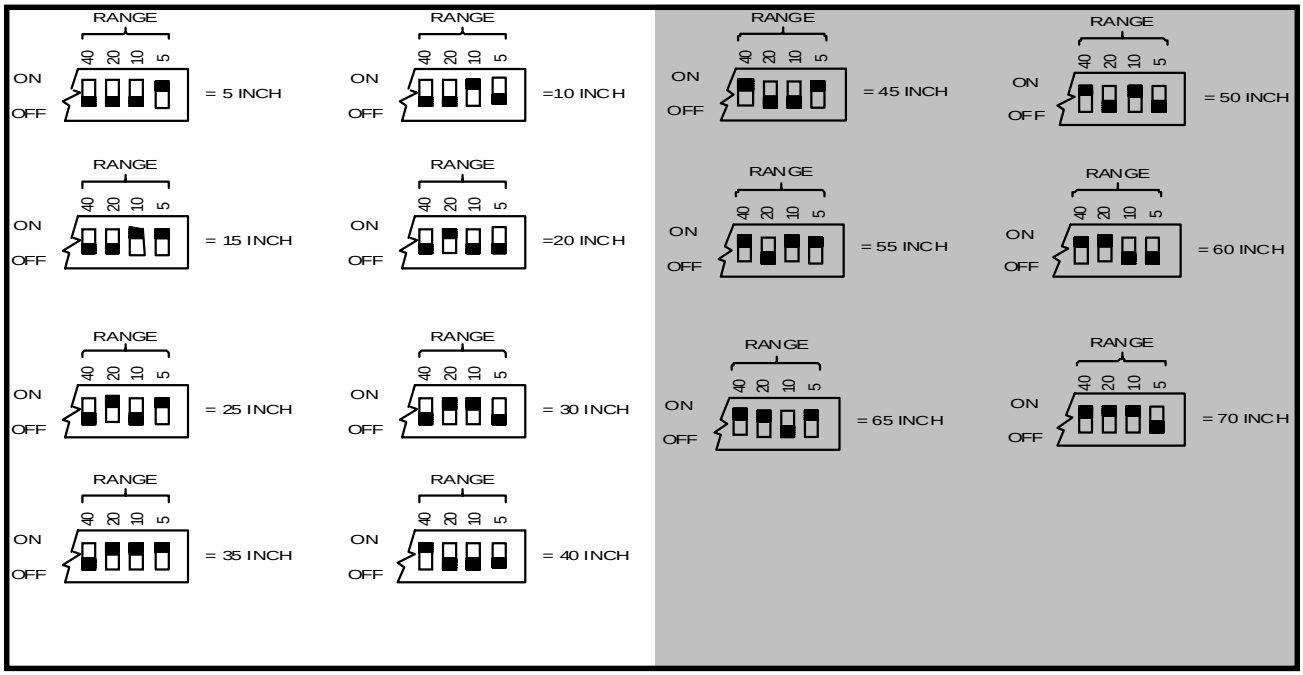
SW#1-2 Set switch for **LIN**ear output (OFF).

SW#1-3 Set **HOLD** switch OFF.

SW#1-4 Set **CAL/RUN** switch to the **RUN** position (ON).

SW#1-5, through -8:

Set the desired control range. We suggest ranges from 10 to 25 inches for normal loop control applications.



Set Switch Block 2:

SW#2-1 through 3 Set **OFFSET 1. 2** and **3** OFF for 0.0% offset.

<<INSERT FIGURE 12 HERE AND IN THE FLOW Chart>>

SW#2-4 through 6 Set **PRESET 1. 2** and **3** OFF to select Program #0.

SW#2-7 Set **TEST** OFF

SW#2-8 Set **MSR/SLV** to **MSR** (OFF).

If OFFSET BIAS is required (see the section on CONTROL FUNCTIONS), OFFSET Switches 1,2, and 3 can be reset after initial calibration.

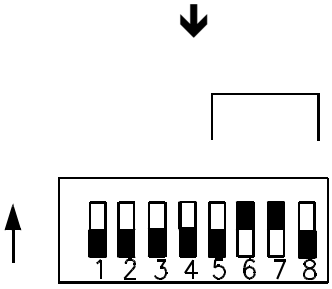
APPLY POWER

Locate the Control Range

Set a target at the point where you want the SENSING LIMIT (the full loop, or FAR relay limit point). This usually is 4 inches from the floor. (If there's no material draped in the loop, a small box makes a good target.)

Calibrate

Now set SW#1-4, the **CAL/RUN** switch, to the **CAL** position (OFF). The transducer will click more slowly. The alignment light LD2 (*lower right corner of the circuit board*) will glow red. After a short time (less than a minute) the LD2 will go out and alignment light LD3 (*just below*) will glow green. The control has now locked on to your target, and has set the SENSING LIMIT.



Store

Reset SW#1-4, the **CAL/RUN** switch, to the **RUN** position (ON). The transducer will resume its rapid clicking. Your settings are now stored in PROGRAM #0.

If the LD2 and LD3 blink red to green, there has been an error in the programming. The most likely cause of this error is that the BASE DISTANCE is shorter than the minimum allowed 13". (*See the Trouble-shooting section for more help on this problem*.)

Check Settings.

Remove the target. LD2 should again turn red. Place your hand where the target was and move it up and down. LD3 should turn green as your hand passes through the CONTROL RANGE and turn red again as your hand rises above the BASE DISTANCE. A voltmeter across terminals 2 and 3 will show a linear voltage relation to the position of your hand within the CONTROL RANGE.

Modifying Program #0

In program #0, you may change all of the following functions using Switch Block #1 and Switch Block #2 to match your application.

Pay**OUT**/Take**UP**	SW#1-1
LINear/**ADAP**tive	SW#1-2
HOLD	SW#1-3
CONTROL RANGE	SW#1-5 through 8
OFFSET	SW#2-1 though 3

After any change in switch settings, **PRESS the RESET button**, or interrupt power. The processor will not recognize the new setting until it has reset.

Storing PRESETS

You can operate the CS-6100 indefinitely with settings stored in PROGRAM #0. However, we suggest you lock "working" programs into one of the seven PRESET addresses. That way, you can experiment with Program #0, yet always have the option of returning to a previously stored program. Storing your program to a PRESET saves all of the following settings. When operating with a PRESET program, the control is immune to any change in these switch settings.

Pay**OUT/**take**UP**	SW#1-1
LINear**/ADAPT**ive	SW#1-2
HOLD	SW#1-3
CONTROL RANGE	SW#1-5 through 8
OFFSET	SW#1-1 through 3
SENSING LIMIT	Set by the calibration procedure

To store to a preset, you must repeat the calibration procedure to set the SENSING LIMIT. When LD3 (the green light) comes on, set PRESET switches (SW#2-4 through 6) to the desired Address. *(PRESET settings on page 12.)* When you return the **CAL/RUN** switch to the **RUN** (ON) position, all parameters will be locked into the PRESET address.

You may store up to seven programs. To do so, return to Program #0 by setting the three PRESET switches (SW#2-4 through 6) OFF and pressing the RESET button. Repeat the above procedure storing each setup to a different PRESET address.

With any of the three PRESET switches ON, the CS6100 operates under one of the seven stored preset programs. Preset programs take precedence over any other switch settings. More elaborate setups can be entered directly to the program addresses via computer and Coiltek Software. These procedures are covered in the Software Manual.

In changing from one preset program to another, RESET the processor. Use the RESET button, remote reset contacts, or interrupt power to the control.

RECALIBRATION

The SENSING LIMIT can be changed in any of the programs without disturbing any other parameter.

Set **PRESET** switches (SW#2-4 through 6) to the correct program *(See page 12.)*

Locate new target.

Set the **CAL/RUN** switch (SW#1-4) to **CAL** (OFF).

Wait for LD3 set to turn green**.**

Return **CAL/RUN** switch (SW#1-4) to **RUN** (ON).

CLEARING PRESET PROGRAMS

A simple Procedure clears any Program address by reloading the default settings. This action returns to a known starting point should programming errors occur. To reload defaults:

Set **PRESET** switches (SW#2-4 through 6) to the program you wish to clear. *(See Page 12.)*

Set all 4 **CONTROL RANGE** switches (SW#1-5 through 8) ON.

Set the **TEST** switch ON.

Press the **RESET** button**.**

WARNING! Double check Preset Switches (SW2-4 through 6) BEFORE you hit the RESET button. Don't erase a program you need!

ADJUSTING SENSOR OUTPUT

(Omit this step if your motor control operates on a 0-10 volt DC signal or if the control output has been previously set. If you do not know, please follow this procedure as well.)

Turn Power OFF.

Set SW1-1 to pay**OUT**.

Disconnect the motor control from your sensor.

Attach a DC voltmeter (10 or 15 volt range) to terminals 2 and 3. Positive to terminal 2 (SIGNAL), negative to terminal 3 (COMMON).

Turn Power ON.

Place your hand (or some object) 5" to 10" from the transducer. The output will be at maximum.

ROTATE the OUTPUT ADJUST potentiometer, R16 (*a 25-turn trimpot*) to match the maximum output to your motor control. CW increases the output voltage.

If SW#1-1 was originally in take**UP**, return it to its proper position. Press the RESET button.

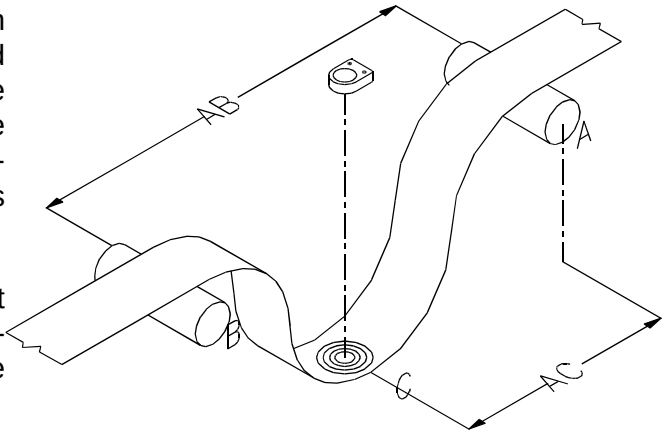
RUNNING THE LINE

Turn power OFF. Connect motor control and motor in accord with INSTALLATION instructions. Check the section on Control Wiring if you are unsure about wiring up the sensor. Turn power ON.

DON'T RUN MATERIAL yet! Move your hand under the sensor to make sure the control does what you expect. If something odd happens, recheck the control wiring and switch settings. Once the system checks out, turn power off and thread the material under the sensor as per Figure 19. Distance AB should be only slightly greater than the natural bend of the material as illustrated. For steel, the natural bend radius will be 360 times the material thickness. The optimum loop forms when distance AB is 4 times the bend radius or 1440 times the material thickness.

Distance AB should not exceed twice the natural loop length. If it does, erratic operation may result. See Troubleshooting for a discussion on solving this problem. Distance AC should locate the sensing element directly over the base of the loop. (AC is usually 1/2 AB).

Now start the system at LOW SPEED. When low speed operation checks out, increase line speed slowly. Make sure that the system tracks all speed changes and that the material stays in the field of the sensor. Watch the LED set in the lower right corner of the board. If it stays green- then all is OK.



When you are confident that everything is aligned properly, secure the position of the transducer.

ADJUSTING TRANSDUCER SENSITIVITY (R29)

We do not recommend alteration of the factory setting.

When the CS-6100 must monitor very small targets *(0.2 inches width or less)* increased sensitivity may be needed. Under very unusual operating environments extraneous reflections may cause the control to see "ghosts". Reducing gain will eliminate these "phantoms". The user can increase or decrease sensitivity with the CS-6100's single-turn gain pot R29 *(located just below the RESET button)*. Clockwise rotation increases sensitivity; counter-clockwise rotation reduces it. The factory setting is usually between 1/2 and 3/4 turn from minimum.

NOTES ON LOOP CONTROL

The geometry of the loop is crucial to stable control. To check your application, make this simple measurement before running the line. Fill the loop so that it sags to the SENSING LIMIT; usually slightly above the floor. Secure the material at Point A and pull material from Point B until the loop rises to the top of the desired control range. The length of stock you pull represents the free material in the loop. Now calculate:

$$\frac{\text{free material (in inches)}}{\text{material line speed (in inches / second)}} = \text{Response Time (RT)}$$

RT is the maximum time (in seconds) your drive system has to respond to changes in loop position. For loop control application of the CS-6100, the value should be 1 second or more. (Maximum response of most drives is about 0.5 seconds.) If RT is less than 0.5 seconds, you have three options.

1) Gain more free material. This may be done by shortening the distance between point A and point B. Note: Standard practice for steel strip sets this distance at 1440 * metal thickness.

2) Always start your process slowly, ramping to speed within the allowable RT.

2) Use the output of the CS-6100 to trim a base speed reference signal.

3) Install a larger drive.

Response of the CS-6100 in normal operation is less than 0.1 seconds, much faster than any conventional motor drive. If your system responds sluggishly, or tends to hunt, check the acceleration settings on your drive. Drive response varies as a function of available motor torque, load, and your motor control settings. You may have to adjust the Current Limit (Torque) and IR Compensation (Gain) on your drive to optimize system response.

TROUBLESHOOTING

The CS-6100 ultrasonic control should provide years of trouble-free service. Several features are integrated into the CS-6100 to aid in fault identification. If the CS-6100 fails to perform properly, please refer to the list of symptoms, checks, probable faults, and corrective action listed in this section.

LEDs

The CS-6100 circuit board has 4 surface mounted LEDs. Two indicate the status of the power supply, and the other two indicate loop, or target alignment.

Power Status

Table 2
Power Circuit LED indications

LD 1	Lit	The 5 volt logic supply is OK.
	Dark	The 5 volt logic supply is not working.
	Blinking	The 5 volt logic supply is OK, but the processor is not running through the program.
LD 6	Lit	The 15 volt reference supply is OK.
	Dark	The 15 volt reference supply is not working.

If both LD1 and LD6 are out,

- Power is not turned ON.
- Power mains are out of tolerance.
- The fuse has blown.
- The wrong AC voltage input is selected.

Alignment

LD2 and LD3 work as a team to indicate target alignment. One of these LEDs should be on at all times. During normal operation, LD3 glows green showing that the target material is within the CONTROL RANGE. If the target is outside of the CONTROL RANGE, LD2 glows red.

Blinking alignment lights may indicate some kind of problem. Here are clues.

LD2 and LD3 blink alternately with a constant rhythm. The program is incorrect. The BASE DISTANCE (distance from sensor to the near end of the control range) is less than 13 inches. Check the Range settings. SENSING LIMIT must be greater than the selected RANGE plus 13". (In the manual programming mode the minimum BASE DISTANCE is 13 inches.).

LD2 and LD3 blink erratically. There are three possible causes

- The control does not *see* material consistently due to improper setup.
- There is electrical noise in the system.
- There is an extraneous source of ultrasonic energy.

The CS-6100 will give solid process control even if there is slight flickering of the alignment lights. If red more than green, however, jerky operation can result. 99% of all loop-control problems relate to the physical setup of the material loop, or the position of the sensor with respect to that loop.

Fixing Setup Problems

Aim the sensor so that reflected sound bounces directly back from the target. In loop control applications, the sensor should sit directly over or directly under the base of the loop.

Keep the loop length (distance AB) as short as possible. (See installation.) Feed mechanisms generate waves in the material. The material *humps*, directing the echo away from the sensor. Shorter loop length (AB) damp out these waves.

Make sure the material does not sway from side to side out of *sight* of the sensor. If swaying proves a problem,

- Shorten the loop length (AB), or
- Add vertical stock guides.

Fixing Electrical Problems

The CS-6100 power supply is immune to power line transients, but electrical noise can result from improper grounding. Both CS-6100 board AND the surrounding enclosure must be properly grounded. High power variable frequency drives and old SCR controls often create severe electrical noise. If the CS-6100 shares an enclosure with such a device, keep as much separation as possible and do not ground the two units at the same point. In the rare cases where noise persists, SCR's or switching IGBT's may have to be fitted with *QuenchArc* suppressers (RC arc suppression).

Outside Noise Sources

The CS-6100 responds to sound energy in the 50 to 60 kHz range (beyond the range of human hearing). Normal industrial noise seldom affects the system. A high pressure air jet close to the transducer can cause interference if the jet is strong enough to cause cavitation. *(Cavitation creates a broad band of ultrasonic noise.)* The best corrective actions are:

- Move the air jet away from the transducer,
- Alter the jet orifice to eliminate cavitation,
- Create a barrier between the source and the transducer.

Ultrasonic welding and cleaning equipment can also cause interference. These devices usually operate near 40 kHz, below the operating frequency

of the CS-6100. Most are poorly tuned; generating overtones that reflect from any hard surface. High power ultrasonic equipment will interfere with proper operation of the CS-6100. The fixes are:

- Move the ultrasonic equipment to another room.
- Create a barrier between the source and the transducer.
- Add absorptive material to reflective surfaces near the transducer (particularly the floor under the sensor.

Multiplexed Operation

Two or more CS-6100 transducers in close proximity will eavesdrop on each other and cause erratic operation. Where side by side operation is a requirement, the control has a built-in multiplexing function that enables two, three, or four units to *fire* in sequence. The MAS/SLV switch in Switch Block 2 (SW#2-6) for all multiplexed units must be in the SLV (ON) position. Multiple units are *daisy - chained*. That is, Terminal 11 on one unit always connects to Terminal 12 on another as shown below.

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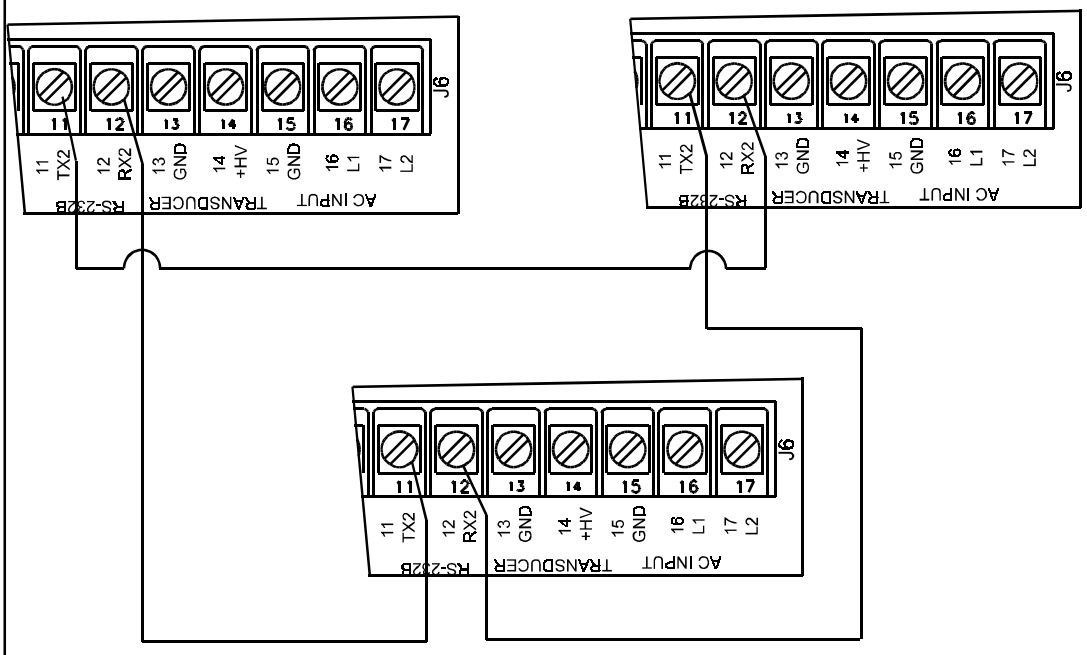


APPENDIX A

MEASUREMENT ACCURACY

Systemic Errors

The accuracy of the CS-6100 becomes important only when the instrument is used for gaging. Two factors effect measurement accuracy: air temperature, and the surface of the target. In considering measurement accuracy, we must differentiate between

absolute distance between the sensing head and target, and
relative distance between two positions of the same target.

This CS-6100 will measure relative position of the same target with great accuracy. However, if you compare the digital output with the actual distance between sensing head and target, you may find a discrepancy. When using digital output data, one can gain accuracy by computing the difference between the position of the changing target and that of a fixed reference target.

The cause of inaccuracy is related to the acoustic reflectivity of the surface of the target. The mechanism is as follows. The CS-6100 emits a coded burst of ultrasound at four distinct frequencies: 8 cycles at 60 kHz, 8 cycles at 57 kHz, 16 cycles at 53 kHz, and 24 cycles at 50 kHz. Time duration of the total burst is 1056 µseconds. There are two reasons for the use of this coded burst.

1. The use of this coded burst helps in noise rejection. That is, the instrument can recognize its own voice against the background of possible interference noises.

2. The use of multiple frequencies insures that the instrument "sees" the target regardless of its surface condition. Surface conditions may cause an object to reflect sound waves of one frequency yet absorb or disipate sound waves at another frequency. Unless there is reflection, the CS-6100 will not "see" an object. It is transparent. Use of the multiple frequency burst greatly improves the instrument's vision. For example, if a surface is transparent to first 8 cycles of 60 kHz sound, it may reflect the succeding 8 cycles of 57 kHz. So it goes down to the final 24 cycles at 50 kHz.

You can see the potential source of inaccuracy. The distance measurement depends on timing the echo return and relating time to the speed of sound 1127 ft/sec, or 13524 in/sec at 68º F. The instrument starts the timer when the sound burst starts, but can't determine which frequency the target will reflect. The

following table shows the possible error in measuring distance (echo time).

Frequency	60,000	57,000	53,000	50,000	Hertz
Number Of Cycles	8	8	16	24	
Time Duration (t)	1.33×10^{-04}	1.40×10^{-04}	3.02×10^{-04}	4.80×10^{-04}	sec
Cum. Duration	——	2.74×10^{-04}	4.42×10^{-04}	7.82×10^{-04}	sec
Equiv. Distance	0.902	0.949	2.041	3.246	inch
Potential Error	———	0.902	1.851	3.892	inch

Although minor in comparison to the above source of error, there is another possible source of error. How deeply the signal penetrates the surface of a target before it bounces back is uncertain. The "observed" target position depends on the relation between signal wavelength and surface texture. In general, this uncertainty will be within the bounds set by the 1/4 wavelength of the signal as follows.

60 KHz	±0.056
57 KHz	±0.059
53 KHz	±0.064
50 KHz	±0.068

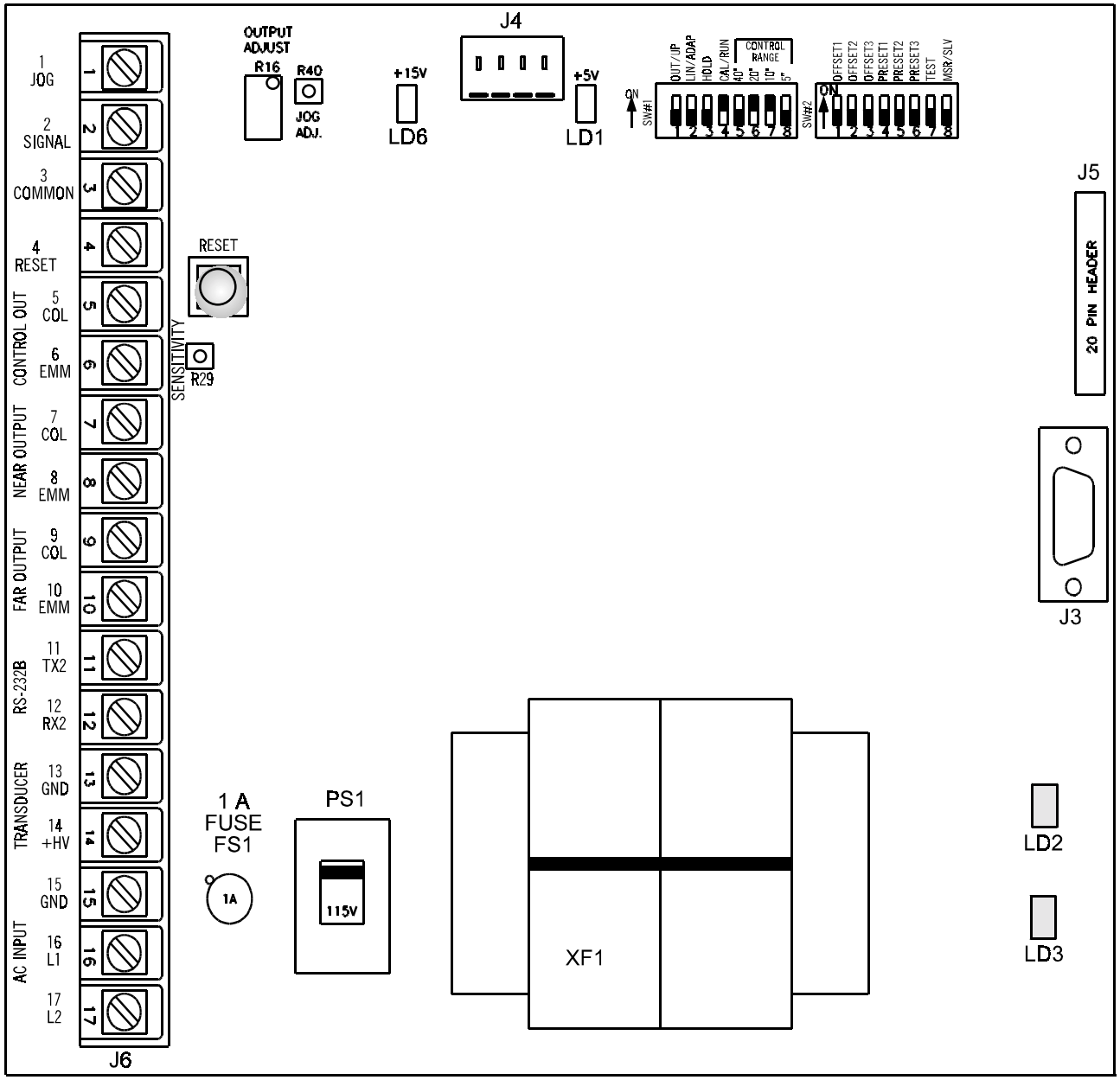
Please note, however, that all these forms of systemic error relate only to that distance between the sensing head and the target. Provided the target surface remains constant, the instrument, with temperature compensation, can measure target movement within the resolution charted on Page 6 of the manual. Without the temperature compensation *(activated through the computer interface and Coiltek software)*, measurements are also subject to environmental error as outlined in the following section.

Environmental Error

The primary environmental error is ambient air temperature. With the default settings, the CS-6100 is calibrated for sound velocity at 68º F. (c=344 M·sec^{-1}). This velocity changes with air temperature according to the relation

$$c = c_0 \cdot \sqrt{\frac{T}{T_0}}$$

where: *T=absolute temperature in degrees Kelvin, and*
c_0=known velocity at temperature T_0



Location of components on CS-6100 Circuit Board.

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