Installation Manual

for the

CSC400 Combustion Safety Controller (Rev 1D)

WARNING

This manual must be read in its entirety before installation of this controller. Installation must be performed by a qualified technician and must adhere to the standards set by the local regulatory authorities.

ACL is not responsible for the misuse or incorrect application of this product.

V 2.17

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Additional Documents

The following additional documents for the CSC400 Combustion Safety Controller are available.

Document Filename	Document Description
CSC400_Modbus_Installation_Manual.pdf	Modbus documentation containing more in-depth register descriptions and additional technical details.

Introduction

The ACL CSC400 is a leading-edge Combustion Safety Controller that provides burner ignition and full first-out annunciation of all the shutdown inputs such as Level, High Temperature, High/Low Gas, Remote Shutdown, Pressure, Proof of Closure, Flame Failure, Power Failure, Auxiliary 1 & 2 and more. The CSC400 monitors three separate thermocouple inputs that can be utilized for temperature control in process applications such as tanks, line heaters, re-boilers or any other application where accurate temperature monitoring and/or control is required. The CSC400 also provides two independent 4-20mA Inputs (level, pressure, temperature) which can be configured as latched Low or High shutdowns. The system is designed to operate with or without a continuous pilot.

The CSC400 controller can be configured for a wide variety of systems:

Application	Configuration / Mode
Burners, Combustion Safety Control, Incinerators	**CSC400 Flame Ionization (FI) System** The CSC400 Flame Ionization (FI) System uses a continuous pilot and a high voltage sparker to light the pilot. It uses a single ignitor/flame rod to provide both flame acknowledgment and ignition. An alarm will signal if the CSC400 detects that either the pilot is out, or if the flame failed to light. Once the Start button is pressed on the front of the unit, the CSC400 will automatically start sparking in regular intervals based on the onboard timer settings until it detects that the pilot is lit.

Six membrane push buttons on the face of the controller are provided: Stop/Reset, Start, Menu, Select, Up, and Down. All options can be adjusted with the membrane push buttons on the face of the controller (including the three independent thermocouple temperature set points). The 4-line, 20-character LED display can be configured in a variety of ways to show the measured temperature values, temperature setpoints, 4-20mA input values, igniter/burner and solenoid status (on/off). Various user preferences can be configured through the menu system and DIP switches including a variety of display options, temperature ranges, shutdown latch control, 4-20 input/output configuration, temperature unit display, and dead band range selection.

The CSC400 Controllers are able to communicate remotely with Modbus Master Devices. A Modbus Master Device may be a Programmable Logic Controller, a PC, or another device. The CSC400 Controller is a Modbus Slave Device that implements the Modbus RTU protocol on an RS-485, half-duplex, physical connection. The default Modbus communication parameters are 9600 baud, 8 data bits, no parity bits, one stop bit (“8N1”), Modbus Slave ID (Modbus address) 2.

CSC400 Features

CSC400 Controller Features List	
•	No complex programming required. Simple menu interface provided to enable/disable burners and adjust temperature setpoints
•	Dual burner system with common shutdowns and three solenoid outputs each (6 total)
•	12/24VDC operation. Solar capable as well.
•	CSA approved for Class I, Div 2 locations
•	Operational ambient temperature of -40° to +60° Celsius
•	CSA approved C22.2 No 199-M89. Combustion safety controls and solid-state Ignitors for Gas & Oil burning equipment
•	CSA B149.3 - 10 compliant, meets NFPA standards
•	Type 4x enclosure, corrosive resistant and weatherproof
•	Modbus RTU (over RS485) communications capability with full status and Shutdown logging readout
•	100% fail safe design
•	Local and Remote On/Off controls
•	Brownout Protection. CSC400 will continue in previous state if a brownout/blackout condition is detected.
•	First out annunciation of shutdowns
•	Safety lockout for high temperature setting
•	Onboard solenoid driver option for power reduction to solenoids and peak-hold solenoids. Each solenoid can be set to an independent low-power setting.
•	Onboard solenoid output short circuit detection and notification (via LED display and Alarm Status)
•	Three adjustable type-K thermocouple inputs for monitoring three separate temperature points (2 process temp. & 1 high temp.)
•	Pilotless burner control selectable.
•	Provides control logic for **FI** ignition systems (burners, incinerators)
•	Five Shutdown inputs (dry contact switches required): High/Low Gas (ie: pressure shutdown), Level Shutdown, and Auxiliary 1 & 2 Shutdowns. Additional shutdowns may be added in series.
•	Two isolated, fail-safe, solid-state, auxiliary, configurable relay outputs (NC, COM, NO : NC-COM in Alarm state, NO-COM when burner(s) are on)
•	Two 4-20mA powered outputs. Can be configured to output any of the three thermocouples as either a linear temperature output or a proportional valve output around the selected setpoint temperature. Proportional valve range is adjustable up to +/- 100°C (200°C total) around the setpoint for smoother temperature transitions. Can also be configured to output either of the 4-20 Input readings (eg. to an external PLC).
•	Two 4-20mA (or 1V-5V) inputs with local power-sourcing availability (1A combined current limit for 4-20mA Inputs and Outputs). Can be configured to alarm and shutdown, or alarm only upon reaching user-defined High and/or Low levels. Custom range and units may be selected.
•	Thermocouple range: -60°C to 1200°C (-75°F to 2192° F) (Type-K Thermocouple)
•	Adjustable thermocouple dead band from 1 - 5°C or 2 - 10°F
•	Easy to read four-line, 20 character LED display indicating thermocouple temperature values, 4-20mA inputs, shutdowns, and On or Off status for both burners
•	°C or °F readout

Operation Summary

Supply 12/24VDC to Main Input Power connections on the CSC400 Controller, referring to "Figure 1 – CSC400 Controller Main Board, Top View" on page 7. The 4-line LED display will turn on and show the desired process temperatures, 4-20mA input levels/pressures, ignitor and solenoid status, and any shutdowns active. The CSC400's menu system is accessed and controlled via four membrane push buttons on the front panel: Menu, Select, Up, and Down. Once temperature setpoints are set to the proper values for the desired process (heater, boiler, etc.), and additional options are configured, the Start button can be pressed to start the CSC400 system.

When the Start button is pushed and the controller is calling for heat (measured temperatures are below the setpoint temperatures), the controller will attempt ignition and the pilot solenoid output will provide voltage to the pilot solenoid valve, providing pilot gas for ignition. Shutdowns, POC, and Remote Start/Stop terminals must be in a permissive state for this to occur. Pilot solenoid output will cease if there is a failure to light within five seconds. "FF" will appear and blink on the display indicating "Flame Fail". The CSC400 controller will attempt to light the pilot two more additional tries before locking out, even when using a single try ignition module. If the Flame Fail status persists after three tries, this condition can be reset either by the local Stop/Start buttons, the Remote Start/Stop switch terminals, or via Modbus Remote Stop/Start command. Main solenoid valve outputs will be turned on 10 seconds minimum after it is confirmed that the pilot has been lit (adjustable up to 120s). The Intermittent/Continuous Pilot Menu setting selects the behavior of the controller once all solenoids are opened.

In Pilotless/Intermittent pilot mode (I), once the measured temperature on thermocouple 1 reaches the TC1 setpoint temperature (but TC2 temp is still below the TC2 setpoint), all solenoid valves will be turned off.

In Continuous pilot mode (C), once the measured temperature on thermocouple 1 reaches the TC1 setpoint temperature (but TC2 temperature is still below the TC2 setpoint), only the T/Main solenoid valve is turned off. The Pilot and Main solenoid outputs will remain on as long as all shutdowns and POC remain permissive.

When Flame Ionization mode is selected, thermocouple 2 is used as a "high-temp" shutdown safety control for both Intermittent and Continuous modes. All solenoid outputs and the ignition module will be turned off if the measured temperature on thermocouple 2 is above the TC2 setpoint. An option to use thermocouple 3 as an auxiliary high-temp shutdown is available as well.

The CSC400 has a hardware revision of 1D and firmware version 00.02.09 (minimum). The menus in this version of the manual show firmware version 00.02.35.

THIS EQUIPMENT IS SUITABLE FOR USE IN CLASS1 DIVISION 2, GROUPS A,B,C & D OR NON-HAZARDOUS LOCATIONS ONLY

WARNING - EXPLOSION HAZARD - SUBSTITUTION OF COMPONENTS MAY IMPAIR THE SUITABILITY FOR CLASS 1 DIVISION 2

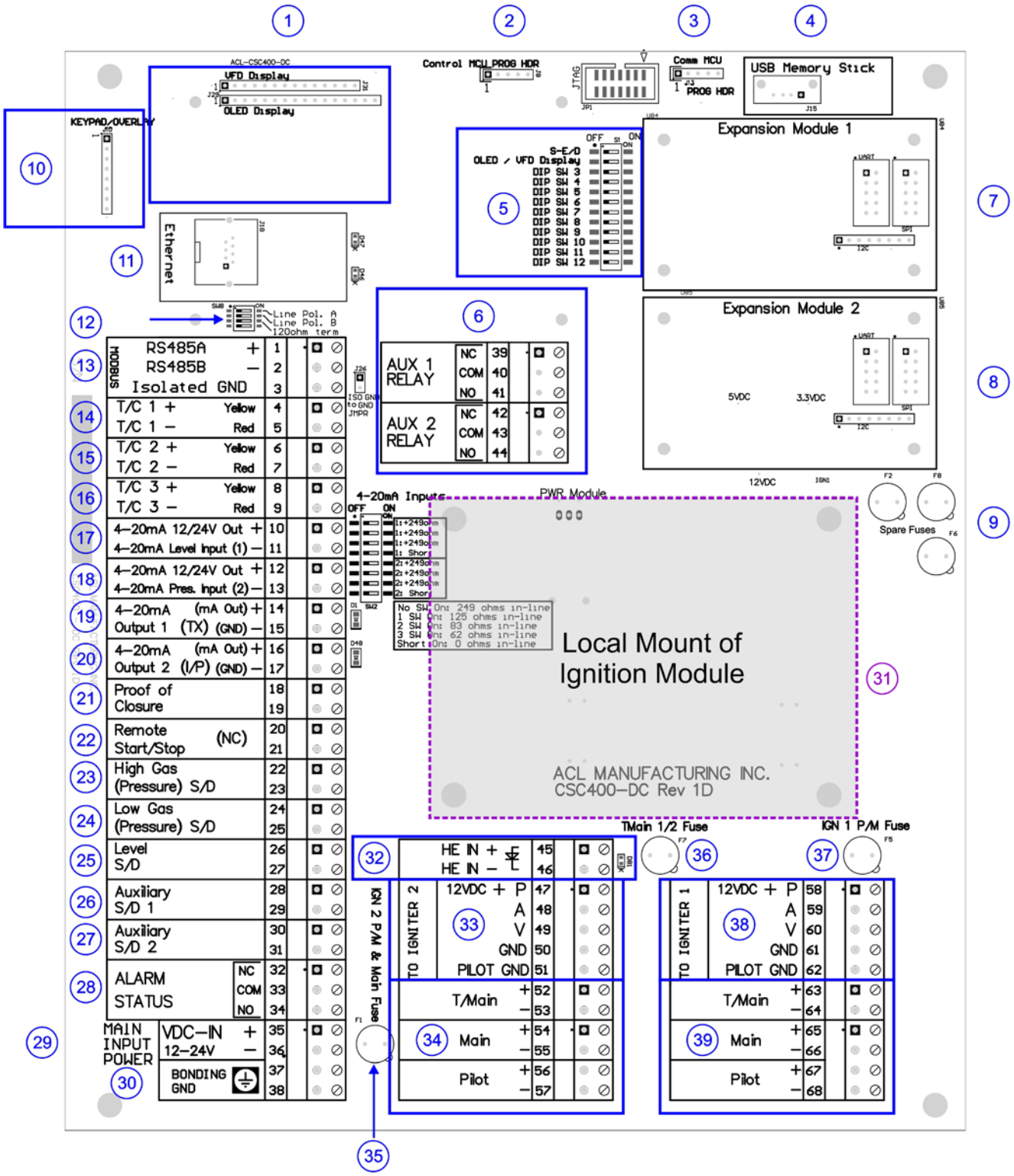
WARNING: EXPOSURE TO SOME CHEMICALS MAY DEGRADE THE SEALING PROPERTIES OF MATERIALS USED IN THE FOLLOWING DEVICES:

Twelve-position DIP switch S1
Four-position, half-pitch DIP switch SW8
Eight-position DIP switch SW2

Quickstart Installation Procedure - CSC400 Combustion Safety Controller

The Quickstart Installation Instructions assumes the user has some familiarity with Combustion Safety Controller Installation.

Figure 1 – CSC400 Controller Main Board, Top View



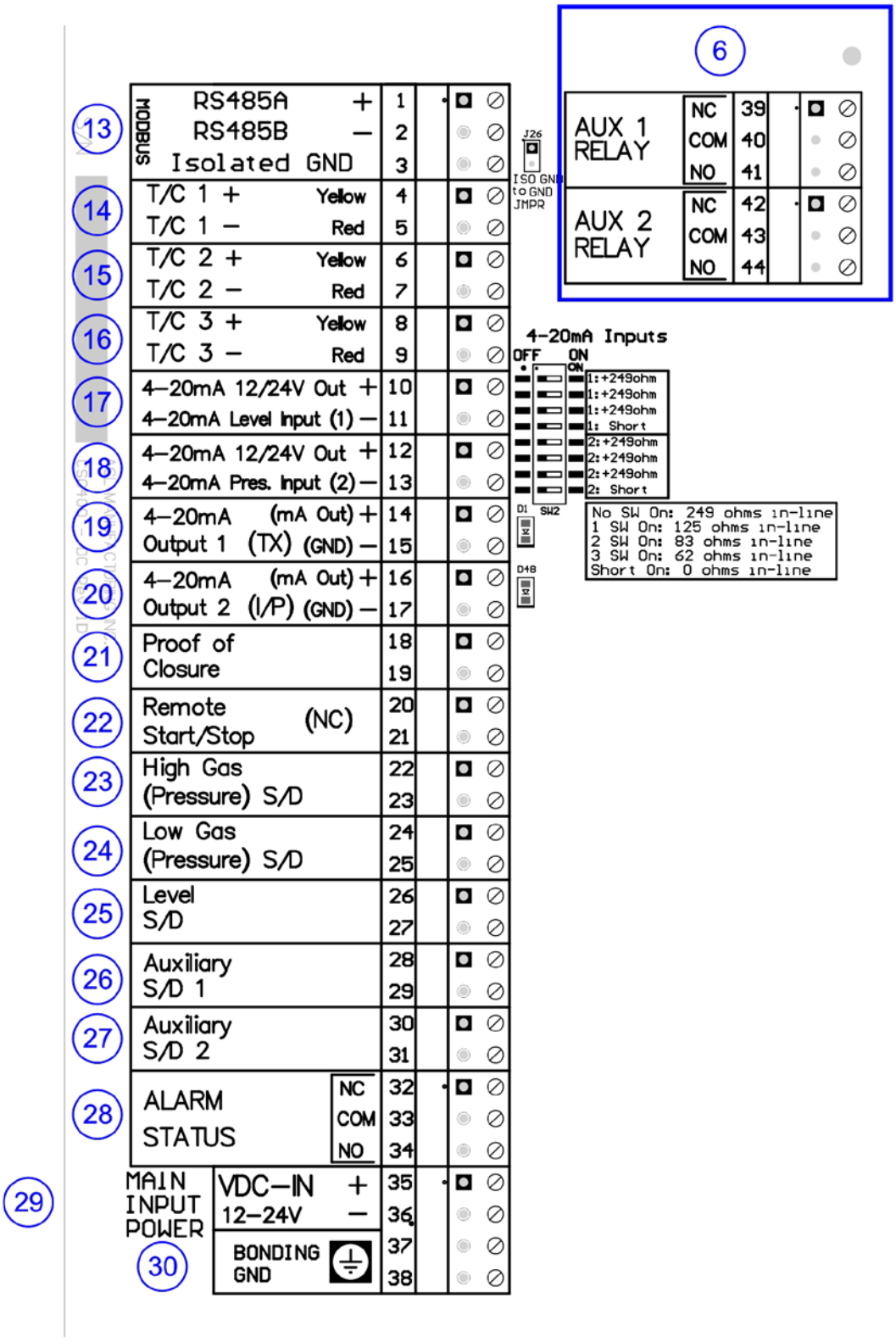
#	Name	Category	Mode	Description
1	Display Headers	Display	All	OLED Display: 16-pin header connector that the CSC400 display flex cable connects to. VFD Display: 14-pin header There are also two vertical headers (5-pin/6-pin) for alternate cabling for the displays.
2	Control Processor Programming Header	Programming	N/A	Programming header (factory use only) for reprogramming the onboard Control microcontroller.
3	Communications Processor Programming Header	Programming	N/A	Programming header (factory use only) for reprogramming the onboard Communications microcontroller (Ethernet & USB functionality only. RS485 Modbus communications is performed by the Control microcontroller).
5	DIP Switches	Inputs/Control	All	DIP switches for user options configuration (see "DIP Switch Option Settings" section on page 52).
6	"AUX1 Relay" & "AUX2 Relay" Output (dry contacts, solid state, 120mA max for each)	Control	All	"AUX1 Relay" & "AUX2 Relay" outputs are present to allow users to control external valves, switches, or other controls based on the TC1/2/3 measurements. Each relay contact can be controlled by any of the three thermocouples. - AUX1/2 Relays: "NC" and "COM" are connected together if TC measurement is lower than the selected setpoint. The thermocouple used for the "AUX1 Relay" and "AUX2 Relay" (and the mode) can be changed using the menu system on the front panel of the CSC400. See the section titled: "AUX1 Relay & AUX2 Relay Inputs" on page 16.
7, 8	Expansion Module Locations	Expansion	All	Locations for future expansion modules.
9	Spare Fuses	Power	All	Spare 6.3A fuses for field servicing.
10	Keypad / Overlay Header	Inputs/Control	All	5-pin Header connector that the flex cable from the Keypad overlay on the front panel connects to. The CSC400 will shut off all ignitor outputs and solenoid valves if the overlay is unplugged.
12	Modbus DIP Switch	Modbus/RS485	All	DIP switches for selecting termination options for the Modbus/RS485 communications cable
13	Modbus Terminals	Modbus/RS485	All	Terminals for connecting a Modbus/RS485 communications cable. CSC400 is a Modbus RTU slave in a 8N1, 9600 baud default configuration.
14	Thermocouple 1	Inputs/Control	PI, FI	Thermocouple 1 input terminal connections. Ensure proper polarity for correct operation. Use ungrounded thermocouples.
15	Thermocouple 2	Inputs/Control	All	Thermocouple 2 input terminal connections. Ensure proper polarity for correct operation. Use ungrounded thermocouples.
16	Thermocouple 3 (optional)	Inputs/Control	All	Thermocouple 3 input terminal connections. Ensure proper polarity for correct operation. Use ungrounded thermocouples.
17	4-20mA (or 1V-5V) Level Input	Inputs/Control	All	Terminals for connecting a 4-20mA (or 1V-5V) transmitter indicating a Level input for controlling CSC400 shutdown or for process measurement. Complete configuration of this input is provided using the menu system (See 4-20mA Input Level / Pressure (1 / 2) Menu Options on page 37).
18	4-20mA (or 1V-5V) Pressure Input	Inputs/Control	All	Terminals for connecting a 4-20mA (or 1V-5V) transmitter indicating a Pressure input for controlling CSC400 shutdown or for process measurement. Complete configuration of this input is provided using the menu system (See 4-20mA Input Level / Pressure (1 / 2) Menu Options on page 37).
19	4-20mA Output 1	Output Status	All	The 4-20mA output generates a current output relative to the

				measured temperature on either TC1, TC2, or TC3 (selectable via the menu system). This output can be configured as either a direct temperature conversion, a proportional valve output, or it can output either 4-20mA Input reading (emulating a "splitter" mode).
20	4-20mA Output 2	Output Status	All	The 4-20mA output generates a current output relative to the measured temperature on either TC1, TC2, or TC3 (selectable via the menu system). This output can be configured as either a direct temperature conversion, a proportional valve output, or it can output either 4-20mA Input reading (emulating a "splitter" mode).
21	Proof of Closure	Inputs/Control	All	Proof of Closure input terminal connections
22	Remote Start/Stop	Inputs/Control	All	Remote Start/Stop input terminal connections
23	High Gas Shutdown	Inputs/Control	All	High Gas Shutdown input terminal connections
24	Low Gas Shutdown	Inputs/Control	All	Low Gas Shutdown input terminal connections
25	Level Shutdown	Inputs/Control	All	Level Shutdown input terminal connections
26	Auxiliary Shutdown 1	Inputs/Control	All	Auxiliary Shutdown 1 input terminal connections
27	Auxiliary Shutdown 2	Inputs/Control	All	Auxiliary Shutdown 2 input terminal connections
28	Alarm Status	Alarm (Dry Contacts)	All	Alarm Status output terminal connections
29	Main Power Input Terminals	Power	All	Main 12-24VDC input terminal connections
30	Ground Terminals	Power	All	Extra earth ground terminal connections to assist in providing stable ground connections for solenoids, ignition modules, or other hardware
31	Ignition Module Mounting Location	Hardware	FI (optional)	The Ignition Module Mounting Location indicates the area where the ACL Ignition Module may be installed.
33	"To Igniter 2" Ignition Module Terminals	Control	All	ACL Ignition Module 2 input terminal connections: "P"ower, "A"larm, "V"alve, Ground. (Jumper "P" to "V" for PI mode to use the solenoid outputs for these modes). "IGN2" can be enabled or disabled using the menu system.
34	Solenoid Relay Terminals for IGN2	Output Solenoids: IGN2		Terminals used for controlling power delivery to the solenoid valves for Ignitor 2.
35	IGN2 P/M & Main Fuse	Power	All	Main 6.3A Input Fuse for Control Electronics & "IGN2" Pilot and Main Solenoids.
36	TMain 1/2 Fuse	Power	All	Input 6.3A Fuse for TMain Solenoids for "IGN1" and "IGN2".
37	IGN1 P/M & Main Fuse	Power	All	Input 6.3A Fuse for "IGN1" Pilot and Main Solenoids.
38	"To Igniter 1" Ignition Module Terminals	Control	All	ACL Ignition Module 1 input terminal connections: "P"ower, "A"larm, "V"alve, Ground. (Jumper "P" to "V" for PI mode to use the solenoid outputs for these modes). "IGN1" can be enabled or disabled using the menu system.
39	Solenoid Relay Terminals for IGN1	Output Solenoids: IGN1		Terminals used for controlling power delivery to the solenoid valves for Ignitor 1.

Input and Control Connections

Refer to the below diagram when reading the Input and Control Connections section.

Figure 2 - CSC400 Input and Control Connections

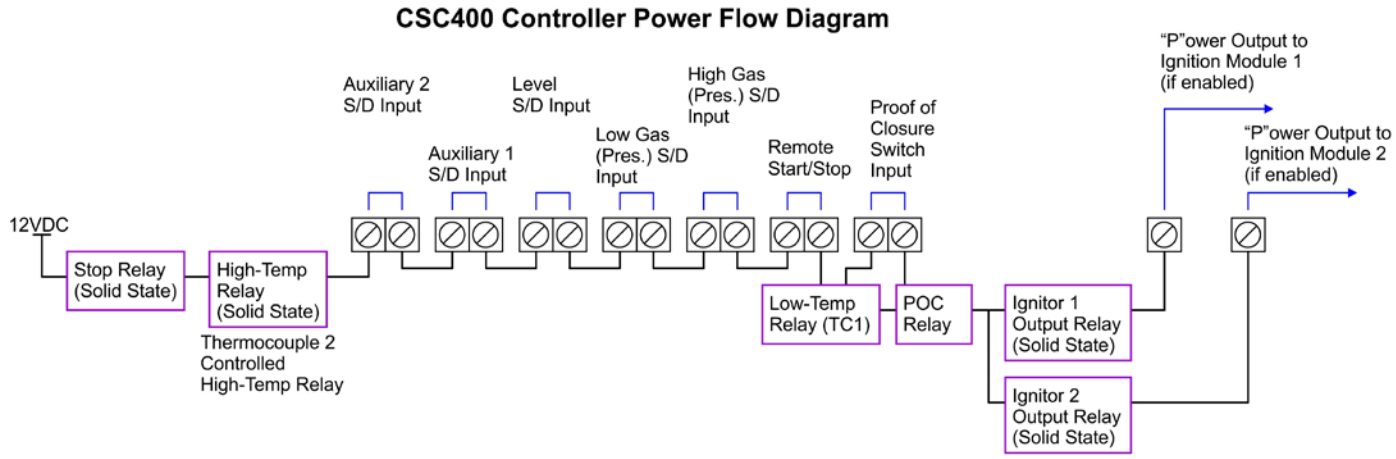


The following inputs directly control 12VDC power output to the ignition modules and must be connected to dry contacts:

Input and Control Connections Requiring Dry Contacts	Voltage on Control Inputs	Output and Control Connections That Are Dry Contacts
Proof Of Closure	12VDC	
Remote Start/Stop	12VDC	
High Gas (Pres) Shutdown	12VDC	
Low Gas (Pres) Shutdown	12VDC	
Level Shutdown	12VDC	
Auxiliary Shutdown 1	12VDC	
Auxiliary Shutdown 2	12VDC	
	N/A	AUX1 Relay
	N/A	AUX2 Relay
Alarm Status	N/A	Alarm Status

Interruption or disconnection of the Remote Start/Stop or Shutdown inputs will turn off or prevent power delivered to the ACL ignition module and turn off power to all solenoids with the exception of the Proof of Closure input. The Proof of Closure input will only interrupt power going to the ignition module if power has not been turned on already to the ignition module. If the system is already running, the Proof of Closure input is allowed to open during operation.

Figure 3 - Ignition Module(s) Power Flow Diagram



29 Main Power Input

The ACL CSC400 Combustion Safety Controller operates on an input voltage range between 10 and 30 Volts DC. Typical input voltages are 12VDC and 24VDC. Whatever input voltage is delivered to the CSC400 on the Main Power Input terminals is the same voltage delivered to the solenoid outputs. Solenoids attached to the three solenoid outputs on the CSC400 (Pilot, Main, T/Main) need to have matching control voltages (Eg. all 12VDC or all 24VDC).

Although the CSC400 will operate with input voltages as low as 10VDC, some larger solenoid valves may not operate on such a low voltage. For this reason, try to maintain the input voltage as close to (or slightly higher than) the required voltage for the desired solenoids.

The Main Power Input terminals are:

Terminal Number	Description	Typical Input Values	Allowable Input Range
35	VDCIN + (positive)	12VDC or 24VDC	10 VDC (min) - 30 VDC (max)
36	VDCIN - (negative)	0V (GND)	0V (GND)

The VDCIN - (negative) terminal is connected to ground internally on the CSC400 printed circuit board.

The Main power inputs (VDCIN + and VDCIN -) are protected against reverse polarity. The CSC400 will not operate if the Main Power Input wires are reversed and it will not cause damage to the CSC400 electronics.

30 Bonding Ground Inputs

Extra system bonding ground terminal connections are provided.

Terminal Number	Description	Typical Input Values	Allowable Input Range
37	Ground	0V (GND)	0V (GND)
38	Ground	0V (GND)	0V (GND)

14 15 16 Thermocouple 1, 2, and 3 Inputs ("T/C1", "T/C2", "T/C 3")

The CSC400 controller accepts three type-K (ungrounded) thermocouples. They are clearly marked on the board for each thermocouple and polarity (See wiring diagram "Figure 8 - CSC400 Wiring Diagram" on page 23).

Terminal Number	Description	Temperature Range
4	T/C 1 Yellow +	-60°C to 1200°C (-76°F to 2192°F)
5	T/C 1 Red -	
6	T/C 2 Yellow +	-60°C to 1200°C (-76°F to 2192°F)
7	T/C 2 Red -	
8	T/C 3 Yellow +	-60°C to 1200°C (-76°F to 2192°F)
9	T/C 3 Red -	

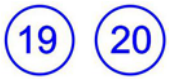
The temperature range for each thermocouple is -60°C to 1200°C (-76°F to 2192°F).

Thermocouple	Mode	Optional?	Thermocouple Purpose
1	PI	No	Flame sense temperature measurement
2	PI	Yes	May be used for process temperature measurements
3	PI	Yes	May be used for process temperature measurements
1	FI	No	Process temperature measurements and TMain solenoid control
2	FI	Yes, but is recommended for use as High Temp shutdown	High-temperature shutdown for IGN1/2
3	FI	Yes	May be used for process temperature measurements

17 18 4-20mA Level / Pressure Inputs

The 4-20mA input terminals provide a powered 4mA to 20mA (or 1V to 5V) converter that reads a current (or voltage) input from an external transmitter. The 4-20mA inputs can be configured to simply provide a scaled measurement of the external transmitter, or they can be configured to shutdown the burners if either 4-20mA input reads a value above the High Trip-point, or below the Low Trip-point. An "Alarm only" or "Shutdown on Alarm" option is provided for each input ("SD on Alarm Yes/No") in case the user wishes to alarm but not shut down the burners on a Low and/or High reading. **See the "4-20mA Input Connection Notes for Rev 1D CSC400 Boards" section for additional details in wiring these connections.**

4-20 Input	Terminal Number	Description	Output Source for 4-20mA Inputs	Allowable Input Range
Level	10	12/24VDC Output "+"	12 or 24VDC	
Level	11	4-20mA Level Input (1) "-"		4 - 20mA, 1V - 5V
Pressure	12	12/24VDC Output "+"	12 or 24VDC	
Pressure	13	4-20mA Pressure Input (2) "-"		4 - 20mA, 1V - 5V



4-20mA Outputs 1 and 2

The 4-20mA output terminals provide an internally-powered 4mA to 20mA converter that generates a current output proportional to the measured temperature on either TC1, TC2, or TC3 (selectable via the menu system). An option in the menu system allows users to select the output mode: either a direct current output directly proportional to temperature, a proportional valve output that slowly controls an external 4-20mA valve around the selected setpoint temperature (plus or minus 5 degrees window), or it can output either of the 4-20mA Input readings (emulating a "splitter" mode). The "splitter" mode allows for this output to re-broadcast one of the 4-20mA Input readings to an external PLC. **See the "4-20mA Output Connection Notes for Rev 1D CSC400 boards" section for additional details in wiring these connections.**

Notes:

- An output of 3.5mA means there's an error. This could mean that the selected thermocouple for the 4-20mA Output is disabled.

4-20 Output	Terminal Number	Description
1	14	4-20mA Output 1 (mA Out) +
1	15	4-20mA Output 1 (TX) (GND) -
2	16	4-20mA Output 2 (mA Out) +
2	17	4-20mA Output 2 (I/P) (GND) -

Proof of Closure Input

The Proof of Closure Input terminals are used when a proof of closure safety shutdown valve is used in a system. If the POC switch is open, it prevents power from being delivered to the ignition module. This safety feature eliminates the risk of igniting a burner if the POC valve is partially open and the proof of closure switch indicates open. This is also a failsafe input as it will not allow ignition to initiate if a wire is broken or disconnected.

These terminals must be wired to dry contacts of a remote Proof of Closure switch when used. A wire jumper must remain across the Proof of Closure terminals when not in use.

The CSC400 LED display will flash "POC" when the Proof of Closure input is open.

Terminal Number	Description	Allowable Input Range
18	Proof of Closure	None: use dry contacts
19	Proof of Closure	None: use dry contacts

Remote Start/Stop Input

The Remote Start/Stop input allows the user to hard wire a remote switch or relay for controlling the CSC400. These terminals must be wired to dry contacts of a remote switch or relay when used. The Remote Start/Stop switch turns on and off the power delivered to the ignition modules as long as all other shutdowns and Proof of Closure inputs are closed and temperature values for both thermocouples are within the allowable range (FI mode). A wire jumper must remain across the Remote Start/Stop terminals when not in use.

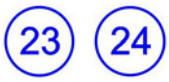
The CSC400 must have been started already for the Remote Start/Stop Input to function. The CSC400 is started by pressing the Start button locally, or by receiving a Modbus Remote Start command.

The CSC400 LED display will show "RemStop" when the Remote Start/Stop input is open.

Terminal Number	Description	Allowable Input Range
20	Remote Start/Stop	None: use dry contacts
21	Remote Start/Stop	None: use dry contacts

Shutdown Inputs: High Gas, Low Gas, Level, Auxiliary 1 / 2

Opening of any switch attached to the Shutdown inputs will shut off the ignition module and de-energize all six valve outputs (Pilot, Main, TMain for IGN1 and IGN2). If the S/D Latch menu option for any shutdown is in "Unlatched S/D" mode, the CSC400 will attempt to restart ignition (on enabled ignitors) when any switch attached to the Shutdown inputs clears. If the S/D Latch menu option is in "Latched S/D" mode for a selected shutdown, this set of shutdown terminals will prevent the system from automatically restarting after it detects any interruption in continuity on these input terminals. If a latched shutdown trips, then resets itself, the CSC400 will detect this, prevent the system from automatically restarting, and alert the user on the LED display (and via Modbus) as to which shutdown caused the latch out.



High Gas, Low Gas (Pressure) Shutdown Input

The High Gas and Low Gas (Pressure) Shutdown inputs allow the user to hard wire a remote switch or relay for controlling the CSC400. These terminals must be wired to dry contacts of remote gas pressure switchs or relays when used. The High/Low Gas switch turns on and off the power delivered to the ignition module as long as all other shutdowns and Proof of Closure inputs are closed and temperature values for both thermocouples are within the allowable range (FI mode). A wire jumper must remain across the High Gas Shutdown terminals when not in use. A wire jumper must remain across the Low Gas Shutdown terminals when not in use.

The CSC400 LED display will show "High Gas" when the High Gas Shutdown input is open.
The CSC400 LED display will show "Low Gas" when the Low Gas Shutdown input is open.

Terminal Number	Description	Allowable Input Range
22	High Gas Shutdown	None: use dry contacts
23	High Gas Shutdown	None: use dry contacts
24	Low Gas Shutdown	None: use dry contacts
25	Low Gas Shutdown	None: use dry contacts

Level Shutdown Input

The Level Shutdown switch input allows the user to hard wire a remote level switch or relay for controlling the CSC400. These terminals must be wired to dry contacts of a remote level switch (or pressure or auxiliary switch) or relay when used. If more than one shutdown switch is used, they must be wired in series. The Level Shutdown switch controls the power delivered to the ignition module as long as all other shutdowns and Proof of Closure inputs are closed and temperature values for both thermocouples are within the allowable range. A wire jumper must remain across the Level Shutdown terminals when not in use.

The CSC400 LED display will show "Level" when the Level Shutdown input is open.

Terminal Number	Description	Allowable Input Range
26	Level Shutdown	None: use dry contacts
27	Level Shutdown	None: use dry contacts

26 27 Auxiliary Shutdown 1/2 Inputs

The Auxiliary Shutdown inputs allow the user to hard wire a remote switch or relay for controlling the CSC400. These terminals must be wired to dry contacts of a remote switch (pressure or auxiliary) or relay when used. If more than one shutdown switch is used, they must be wired in series. The Shutdown switch turns on and off the power delivered to the ignition module as long as all other shutdowns and Proof of Closure inputs are closed and temperature values for both thermocouples are within the allowable range. A wire jumper must remain across the Shutdown terminals when not in use.

The CSC400 LED display will show "Aux 1" when the Auxiliary Shutdown 1 input is open.
The CSC400 LED display will show "Aux 2" when the Auxiliary Shutdown 2 input is open.

Terminal Number	Description	Allowable Input Range
28	Auxiliary Shutdown 1	None: use dry contacts
29	Auxiliary Shutdown 1	None: use dry contacts
30	Auxiliary Shutdown 2	None: use dry contacts
31	Auxiliary Shutdown 2	None: use dry contacts

28 Alarm Status Output

The Alarm Status output provides remote indication of an Alarm condition on the CSC400. When power to the CSC400 is off, the Alarm Status contacts are open between "NO" and "COM" and closed between "NC" and "COM", indicating an Alarm condition. The contacts are also in an Alarm condition when the CSC400 is in a shutdown state. Eg: a Shutdown switch or the Remote Start/Stop switch is open. This provides a complete fail-safe indicator to a remote control center of the status of the CSC400 controller.

Terminal Number	Description	Max Contact Rating
32	Alarm Status "NC"	Load current: $120mA_{rms}$ / mA_{DC} Voltage: 30VDC, $30V_P$(AC)
33	Alarm Status "COM"	Load current: $120mA_{rms}$ / mA_{DC} Voltage: 30VDC, $30V_P$(AC)
34	Alarm Status "NO"	Load current: $120mA_{rms}$ / mA_{DC} Voltage: 30VDC, $30V_P$(AC)

#	Mode	Possible Alarm Conditions
1	All	Power is off
2	All	Overlay unplugged
3	All	Remote Start/Stop switch is open
4	All	High Temperature shutdown (Thermocouple 2)
5	All	High-Temp Latch condition
6	All	Shutdown switch is open (High Gas, Low Gas, Level, Aux 1, Aux 2)
7	All	Proof of Closure valve is open
8	All	Shutdown Latch condition (High Temp, High Gas, Low Gas, Level, Aux 1, Aux 2)
9	All	Power Fail Latch condition
10	All	Short detected on solenoid valve output terminals
11	All	Modbus Stop command received

#	Mode	Mode Specific Alarm Conditions
12	PI	TC1 below TC1 setpoint (Pilot flame not present)
13	PI	Thermocouple 1 (TC1) fault/open
14	PI	Thermocouple 2 (TC2) fault/open (if enabled)
15	PI	Thermocouple 3 (TC3) fault/open (if enabled)
20	FI	Flame Fail (Alarm signal from ACL Ignition Module)
21	FI	Thermocouple 1 (TC1) fault/open (if enabled)
22	FI	Thermocouple 2 (TC2) fault/open
23	FI	Thermocouple 3 (TC3) fault/open (if enabled)

AUX1 Relay & AUX2 Relay Inputs

The AUX1 & AUX2 Relays (solid state) are present to allow users to control external valves, switches, or other controls based on thermocouple measurements. Both of the AUX1/AUX2 Relays are configurable to be controlled by any of the three thermocouples: TC1, TC2, or TC3 or to switch upon Flame Fail on either ignitor. In all modes, AUX1/AUX2 Relays are turned off ("NC" is connected to "COM") when the CSC400 system is off. If a thermocouple is enabled via the menu system, it needs to be attached to a Type-K thermocouple to operate properly. The LED Display will indicate an alarm and the system will be turned off if there is an open fault detected with the thermocouple (if enabled).

In all modes (PI, FI, I), TC1 controls the dry contact AUX1 Relay switching by default. "NC" is connected (shorted) to "COM" if the TC1 measurement is lower than the TC1 setpoint temperature. "NO" is connected (shorted) to "COM" if the TC1 measurement is higher than the TC1 setpoint temperature.

In all modes (PI, FI, I), TC3 controls the dry contact AUX2 Relay switching by default. "NC" is connected (shorted) to "COM" if the TC3 temperature measurement is lower than the TC3 setpoint temperature. "NO" is connected (shorted) to "COM" if the TC3 measurement is higher than the TC3 setpoint temperature.

Name	Terminal Number	Terminal Name	Mode	AUX1/2 Relay Operational Description
AUX1 Relay	39	NC - Normally Closed	All	"NC" is connected (shorted) to "COM" if TC1 measurement is lower than the TC1 setpoint temperature
AUX1 Relay	40	COM - Common	All	Common connection in both AUX1 Relay switched states
AUX1 Relay	41	NO - Normally Open	All	"NO" is connected (shorted) to "COM" if TC1 measurement is higher than the TC1 setpoint temperature
AUX2 Relay	42	NC - Normally Closed	All	"NC" is connected (shorted) to "COM" if TC3 measurement is lower than the TC3 setpoint temperature
AUX2 Relay	43	COM - Common	All	Common connection in both AUX2 Relay switched states
AUX2 Relay	44	NO - Normally Open	All	"NO" is connected (shorted) to "COM" if TC3 measurement is higher than the TC3 setpoint temperature

Note: Both of the AUX1/2 Relays are configurable to be controlled by any of the three thermocouples: TC1, TC2, or TC3 and may also have a custom setpoint temperature set as its switching point. Either relay may also be configured to switch upon Flame Fail on either Ignitor or upon Modbus command. Both AUX relays will turn off (connecting NC to COM) upon a shutdown.

Modbus / RS485 Communication Connections

The three Modbus/RS485 terminals are used for connecting the CSC400 Controller to a Modbus communications channel. The CSC400 Controller is a Modbus Slave Device that implements the Modbus RTU protocol on an RS-485, half-duplex, physical

connection. The default Modbus communication parameters are 9600 baud, 8 data bits, no parity bits, one stop bit (“8N1”), Modbus Slave ID (Modbus address) 2.

The RS485 signal naming convention used in this document and by many RS485 transceiver vendors is reversed from what the EIA/TIA-485 specification states:

CSC400 Modbus/RS485 Documentation	EIA/TIA-485 Naming Convention	Modbus Specification Name	Description
A (“RS485 A +” or "D0 A+")	B	D1	Non-Inverting, Transceiver Terminal 1, V1 voltage (V1 > V0 for binary 1 (OFF) state
B (“RS485 B –” or "D1 B-")	A	D0	Inverting, Transceiver Terminal 0, V0 voltage (V0 > V1 for binary 0 (ON) state
Isolated GND (or common GND)	C	Common	Signal and Optional Power Supply common ground

Due to the potential for large amounts of noise on the Modbus communication cable, the “Isolated Ground” terminal is connected to earth ground on the CSC400 board to improve noise immunity.

Refer to the "Modbus/RS-485 Cable Connections – Field Installations" section on page 38 or the document "CSC400_Modbus_Installation_Manual.pdf" for more details on additional Modbus registers, programming, testing, and troubleshooting.

Ignition Module 1 and 2 Inputs & Outputs

The four terminals marked as "To Igniter 1" on the main circuit board need to be wired directly to the ACL Ignition Module if Ignitor 1 is enabled in the menu system. The four terminals marked as "To Igniter 2" on the main circuit board need to be wired directly to the ACL Ignition Module if Ignitor 2 is enabled in the menu system. This provides two-way communication between the CSC400 and the ignition module(s), creating a complete combustion safety control and burner ignition system. (See wiring diagram).

As shown in the Ignition Module Power Flow Diagram above, the "P"ower outputs to the ignition modules can be interrupted by eleven methods (shutdowns, on/off switches, temperature relays, solid-state control relays).

Due to the fact that the two ignitors are independently controlled, a disabled ignitor does not need to have a jumper installed between the "P" and "V" terminals to ensure that the enabled ignitor still works.

All of the below signals need to be attached between the CSC400 and Ignition Module 1 for the burner system to work properly when Ignitor 1 is enabled. The Pilot GND signal is used to connect the ground wire attached to the Pilot assembly ground lug to the ground of the CSC400.

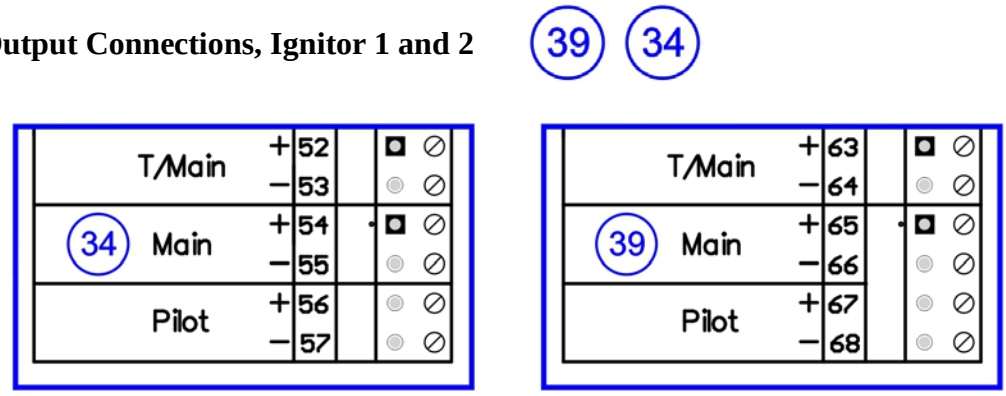
"IGN 1" Terminal Number	Designation	Description	Ignition Module Wiring Harness Color	Direction
58	P	Power (12VDC)	Red	Power output to Ignition Module
59	A	Alarm	Blue	Input signal from Ignition Module (12VDC level)
60	V	Valve	Brown	Input signal from Ignition Module (12VDC level)
61	GND	Ground	Yellow	Ground

62	Pilot GND	Ground to Pilot Ground lug connection	N/A	Ground

All of the below signals need to be attached between the CSC400 and Ignition Module 2 for the burner system to work properly when Ignitor 2 is enabled. The Pilot GND signal is used to connect the ground wire attached to the Pilot assembly groung lug to the ground of the CSC400.

"IGN 2" Terminal Number	Designation	Description	Ignition Module Wiring Harness Color	Direction
47	P	Power (12VDC)	Red	Power output to Ignition Module
48	A	Alarm	Blue	Input signal from Ignition Module (12VDC level)
49	V	Valve	Brown	Input signal from Ignition Module (12VDC level)
50	GND	Ground	Yellow	Ground
51	Pilot GND	Ground to Pilot Ground lug connection	N/A	Ground

Solenoid Output Connections, Ignitor 1 and 2



The solenoid output connections are designed for driving external solenoid valves. Each output is rated for a maximum of 3A of steady-state current output. The main input voltage (either 12VDC or 24VDC) is fused and then directed through solid-state relays which controls this voltage output to each solenoid terminal. The solid-state relays are able to detect direct shorts and elevated current levels on solenoid outputs and shut down the affected solenoid outputs.

Note: All solenoid outputs can be configured to use separate Low Power Solenoid settings. Therefore, the setting for each solenoid output must be verified to work with the attached solenoid. Larger solenoids with higher power requirements will need to be set to a higher setting (40% or 50%) to remain open when desired. Smaller solenoids (Pilot valves) should be able to work on a setting down to 10% - 20%. A lower solenoid driver setting means more power savings.

The solenoid output connections are matched with their corresponding Ignition module, as shown in the following table:

"IGN 1" Solenoid Terminal Number	Ignitor Block	Designation	Solenoid Output Description
63	IGN 1	T/Main +	Temperature Main +
64	IGN 1	T/Main -	Temperature Main - (GND)
65	IGN 1	Main +	Main +
66	IGN 1	Main -	Main - (GND)
67	IGN 1	Pilot +	Pilot +

68	IGN 1	Pilot -	Pilot - (GND)
"IGN 2" Solenoid Terminal Number	Ignitor Block	Designation	Description
52	IGN 2	T/Main +	Temperature Main +
53	IGN 2	T/Main -	Temperature Main - (GND)
54	IGN 2	Main +	Main +
55	IGN 2	Main -	Main - (GND)
56	IGN 2	Pilot +	Pilot +
57	IGN 2	Pilot -	Pilot - (GND)

Pilot Solenoid

The Pilot Solenoid terminals provide power to the Pilot Solenoid valve. The Pilot valve allows gas to flow through the pilot valve train for initial ignition and flame sensing. During normal operation, the CSC400 turns on the pilot solenoid first while attempting to light the pilot flame via the ignition module. The pilot's flame needs to be stable before the Main and T/Main solenoid outputs are turned on.

This output has a low power solenoid feature provided by an onboard solenoid driver circuit. This circuit can reduce power consumption of the solenoids by as much as 80%. This circuit also helps eliminate any noise that may be produced by some solenoids, and helps extend the life of the solenoids.

For more information on the Low Power Solenoid Driver, see the Low Power Solenoid Drivers section on page 19.

Main Solenoid

The Main Solenoid terminals provide power to the Main Solenoid valve. Power to these terminals is present a minimum of 10 seconds (adjustable to 120s max) after the pilot's flame is detected and the shutdowns are satisfied.

The Main Solenoid output also has the same low power solenoid feature provided by an onboard solenoid driver circuit. For more information on the Low Power Solenoid Driver, see the Low Power Solenoid Drivers section on page 19.

T/Main Solenoid (Process Temperature Control Valve)

The Temperature Main ("T/Main" or "TMain") Solenoid terminals provide power to the T/Main solenoid valve for process temperature control. Power to these terminals is present a minimum of 10 seconds (adjustable to 120s max) after the pilot's flame is detected and the shutdowns are satisfied. The T/Main solenoid valve is also controlled by the measured temperature on Thermocouple 1 (TC1). This allows for individual temperature control of one of the main solenoids (T/Main), eliminating unnecessary stroking of the main safety shutdown valves to control main gas to the burner.

The T/Main Solenoid output also has the same low power solenoid feature provided by an onboard solenoid driver circuit. For more information on the Low Power Solenoid Driver, see the Low Power Solenoid Drivers section on page 19.

Low Power Solenoid Drivers

The Low Power Solenoid Drivers are individual control circuits added to each solenoid output that saves power drawn by the solenoid by altering the cycle time power is delivered to the solenoid once it is driven fully on. Larger solenoids require more power to keep them open, therefore needing a larger cycle time (eg: 40%). The cycle time percentage is shown in the Solenoid Drivers menu section: 100% means the solenoid is driven without any power savings, 10% cycle time means that the maximum power savings for the selected solenoid is utilized. The setting for each solenoid output must be verified to work with the attached solenoid.

CSC400 Front Panel Buttons and LED Display

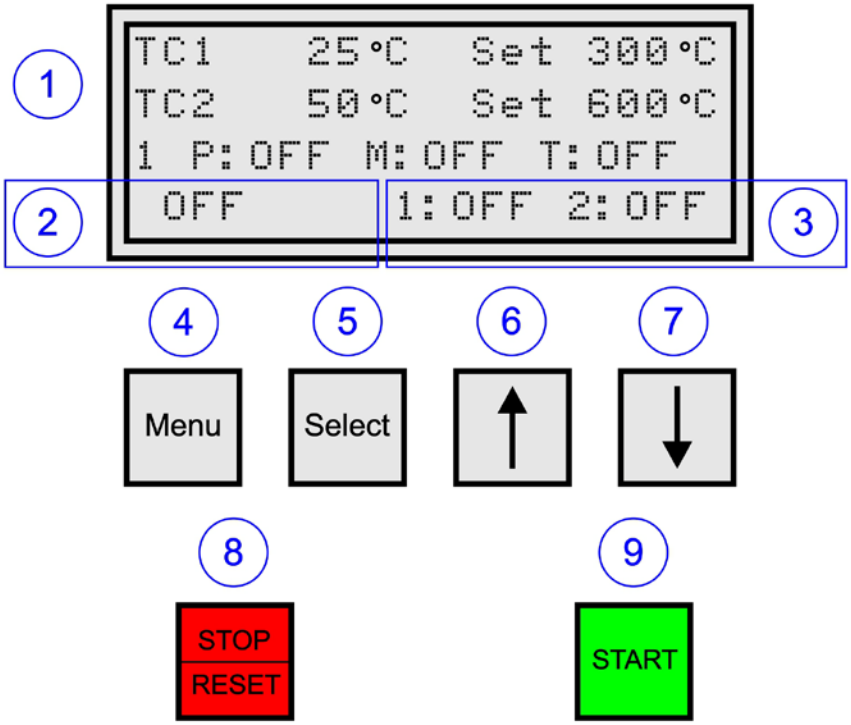
The CSC400 Controller provides a simple status and control interface to the user on the overlay mounted on the outside of the CSC400's box. A 4-line, 20-character LED display provide temperature status, 4-20mA input levels, and shutdown status and feedback while six membrane push buttons provide control for setting temperature setpoints, selecting menu options, and configuring the CSC400.

After configuring options and setting the setpoints, pressing the Menu key will go back to the Main Screen of the display, showing the actual thermocouple temperature readings. The measured temperatures and the setpoint displayed are configurable in the menu settings but the default settings show a typical profile: TC1 and TC2 displayed with setpoints and IGN1 enabled with IGN1's solenoid output status.

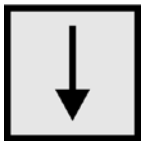
The display will show "Disab" when thermocouples are not enabled through the menu system.

The display will show "OPEN" if the thermocouples are not connected or if they have failed in an open condition.

Figure 4 - CSC400 Controller Front Panel Overlay



#	Overlay Button / Display	Mode	Description
1	OLED Display: 4-Lines, 20 characters per line	All	The LED display shows the temperature for thermocouples 1, 2, and 3, any selected 4-20mA input levels, and provides a variety of shutdown and solenoid status messages to the user. The information displayed per line is user configurable. For example, any of three thermocouples can be displayed, solenoid status of either Ignitor, and 4-20mA input values.

2	Shutdown Status Area	All	The Shutdown Status Area shows the current state of the CSC400: "OFF", "ON" (blank), or whether a Shutdown (first-out) is active (flashing).
3	Ignitor 1 & 2 Status Area	All	Ignitor 1 & 2 Status Area shows the state of each Ignitor (if enabled): "ON", "OFF", or "FF" (flame fail). If an Ignitor is disabled, it will not be displayed.
4		All	The Menu button is used in two ways: 1) To show the Top Menu when the Main Screen is displayed 2) To "back up" by one menu each time it is pressed to a parent menu, eventually getting back to the Main Screen
5		All	The Select button is used in the menu system to either select an option to modify, or to select a sub-menu to branch to. A "selected" option will show a blinking cursor: ">" alternating with "  "
6		All	The Up button is used for incrementing values (ie: temperature setpoints) and moving up the list in the currently displayed menu. Hold the button down to increase values by larger increments. Release button when desired value is reached.
7		All	The Down button is used for decrementing values (ie: temperature setpoints) and moving down the list in the currently displayed menu. Hold the button down to decrease values by larger increments. Release button when desired value is reached.
8		All	Pressing the Stop Button will cause the system to stop: power to ignitor outputs and shutdowns will be shutoff. Valve solenoid power outputs will be turned off. Pressing the Stop button will also clear any shutdown and shutdown latch indicators present on the LED display. Other methods of shutting off the system include: - Remote Start/Stop in the Stop position (open contacts). Note: 12VDC power will remain on the shutdown terminals if only the Remote Start/Stop is opened - Modbus Remote Stop command - Shutdown terminals (system will restart automatically if SD terminals close again and the SD Latch menu option is disabled for the selected shutdown)
9		All	Pressing the Start button will cause the system to start Pressing the Start button will also clear any shutdown indicators present on the LED display. Other methods of turning on the system include: - Remote Start/Stop toggled Off, then On again (open contacts, then close contacts again) - Modbus Remote Start command

The main Stop/Reset switch acts as a reset to clear any latched shut downs that have tripped and been detected by the CSC400. A shutdown configured as a latched shutdown prevents the system from automatically restarting after it detects any interruption in continuity on the input terminals for the selected shutdown. If a latched shutdown trips, then resets itself, the CSC400 will detect this, prevent the system from automatically restarting, and alert the user on the LED display (and via Modbus) as to which shutdown caused the latch out.

Adjusting Temperature Setpoints and Deadbands

From the Main Screen (shown below in Figure 5), press the Menu button. The Top Menu will be displayed, seen in Figure 6.

Figure 5 - Main Temperature Display Screen (Example)

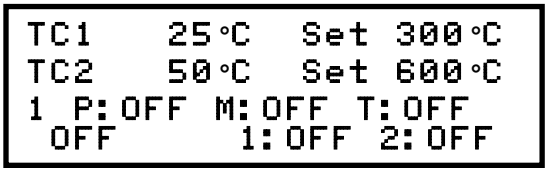
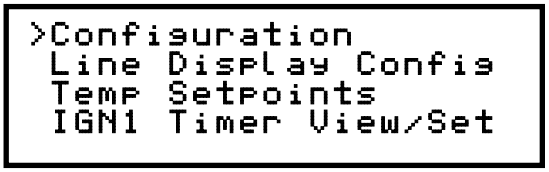
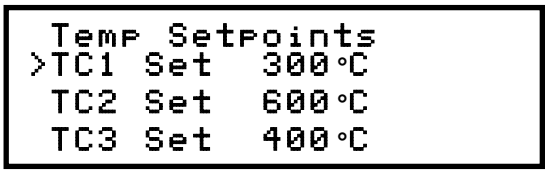


Figure 6 - CSC400 Top Menu



Move the cursor (">") to the "Temp Setpoints" line using the Down button and then press the Select button. The Temperature Setpoints menu will be displayed, showing the setpoints for all three thermocouples (even if they're disabled) as well as their deadband settings.

Figure 7 - Temperature Setpoints Menu



Use the Up and Down buttons to select the desired thermocouple setpoint (or deadband) you wish to change and then press the Select button. The cursor will blink ">" alternating with "  " to indicate the current thermocouple's setpoint is now in Edit mode. Use the Up and Down buttons to modify the temperature setpoint of the selected thermocouple to the new desired value, and then press the Select button again to exit Edit mode.

Press the Menu button twice to return to the Main Screen.

Wiring Diagrams - FI (Flame Ionization) Mode

The following diagram shows the wiring connections for the CSC400 Combustion Safety Controller in FI mode.

Figure 8 - CSC400 Wiring Diagram - FI (Flame Ionization) Mode, Remote IGN Module

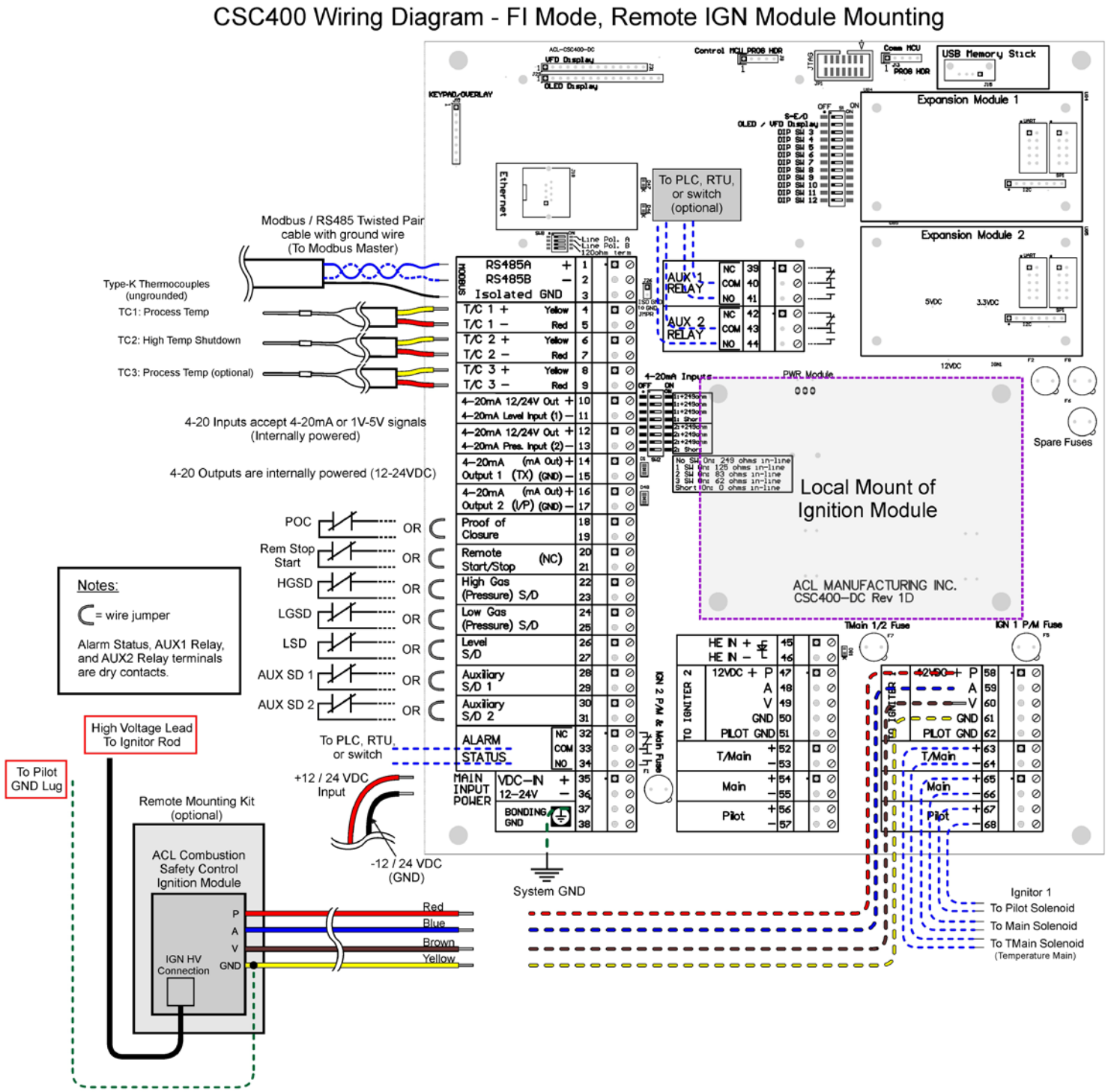
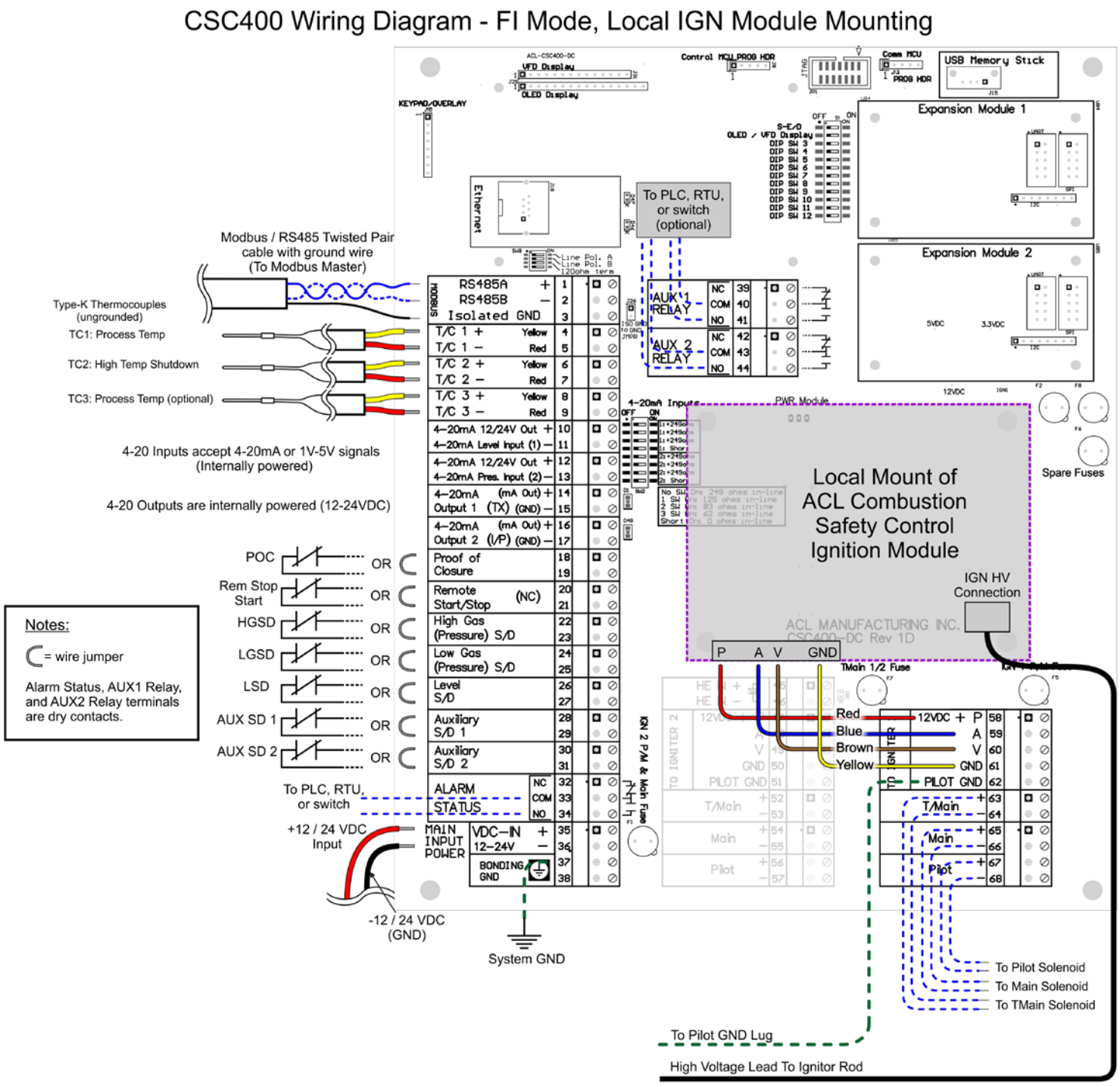


Figure 9 - CSC400 Wiring Diagram - FI (Flame Ionization) Mode, Local IGN Module

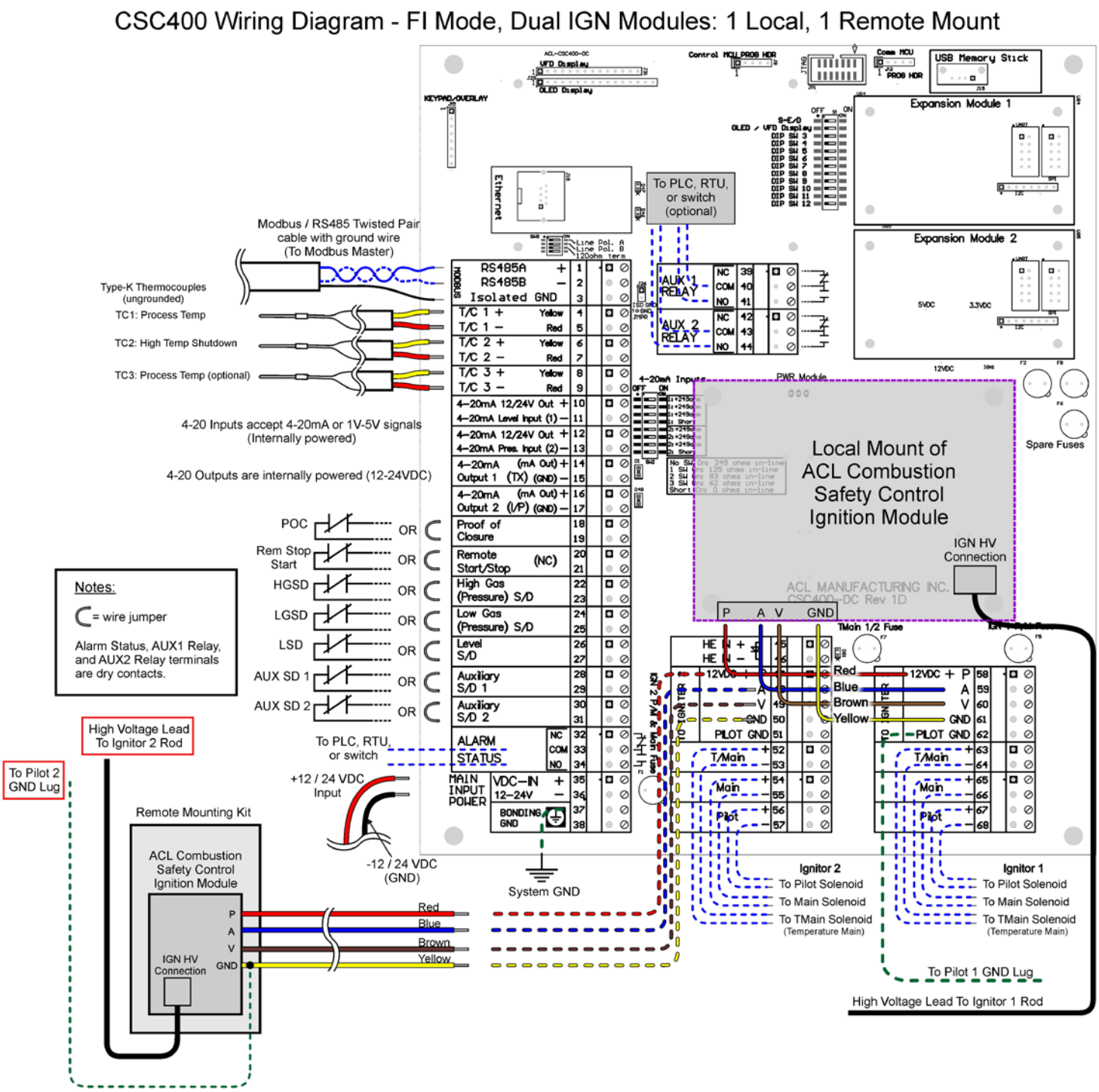


Minimum Required Wiring Connections
Thermocouple 1
Ignition Module: P, A, V, GND
Main Input Power (+12/24VDC, -12/24VDC)
Pilot Solenoid Output
Main Solenoid Output (if a minimum of two valves are required)

Optional or Additional Functionality Connections
Thermocouple 2 (Set TC2 menu option to Disabled if not used)
Remote Start/Stop (jumper if not used)
High / Low Gas Shutdowns (jumper if not used)
Level Shutdown (jumper if not used)
Auxiliary 1 / 2 Shutdowns (jumper if not used)
Alarm Status (dry contacts)
Proof of Closure (jumper if not used)
Main Solenoid Output (keep open/unconnected if not used)
T/Main Solenoid Output (keep open/unconnected if not used)

Note: Ignition Module connections are matched with their corresponding Pilot/Main/TMain solenoid blocks. Ensure that the solenoid outputs used (IGN1 / IGN2) match with the Ignition Module (IGN1 / IGN2).

Figure 10 - CSC400 Wiring Diagram - Dual IGN Modules: 1 Local, 1 Remote Mounting



CSC400 Controller Menu System

The CSC400 has an in-depth but intuitive and simple to use menu system. The entire menu system is accessed via the overlay buttons and the 4-line display. Individuals menus are explained in their respective sections following the CSC400 Menu System Chart.

Type Column:

Menu - a submenu that allows lines and options to be selected, and possibly further submenus
Option - Selectable line that can be modified using the Up and Down buttons once it's selected
Information - Simply shows information only, no menu selections are available

CSC400 Menu Structure Summary Chart

#	Menu	Menu Selections	Type	Description
1	Main Screen	None available except "Menu" button	Top Screen	Main Display showing desired temperature and/or 4-20mA input values, Ignitor status, and shutdown status
2	Top Menu		Menu	
2.1		Configuration	Menu	Configure CSC400 options
2.2		Line Display Config	Menu	Change lines displayed on Top Screen
2.3		Temp Setpoints & DB	Menu	Change Temperature Setpoints
2.4		Show Last IGN SD	Information	Show most recent shutdowns for IGN1/2
2.5		View TMain1 ON Time	Menu	View/Reset TMain1 Solenoid ON Time
2.6		View TMain2 ON Time	Menu	View/Reset TMain2 Solenoid ON Time
2.7		Solenoid Drivers	Menu	Change Solenoid Driver Cycle Times
2.8		Time Set	Menu	Set the time in the CSC400
2.9		Date Set	Menu	Set the date in the CSC400
2.10		Modbus Settings	Menu	Change Modbus Comm. Settings
2.11		Diagnostics	Information	Shows firmware version, diagnostics info
2.12		Reset SDLog	Menu	Reset (clear) Shutdown Log
2.13		Reset Settings	Menu	Reset Settings to default
2.14		Recalibrate TC	Menu	Recalibrate Thermocouple inputs
2.1	Configuration		Menu	Burner Configuration settings
2.1.1		IGN1 Enabled	Option	Ignitor 1 Enabled/Disabled
2.1.2		IGN2 Disabled	Option	Ignitor 2 Enabled/Disabled
2.1.3		°C/°F °C	Option	Select °C/°F
2.1.4		TC2 Enabled	Option	TC2 Enable/Disable
2.1.5		TC3 Enabled	Option	TC3 Enable/Disable
2.1.6		TC3 AUX HT SD No	Option	Use TC3 as an auxiliary High-temp SD (Y/N)
2.1.7		Low Temp SD No	Option	Enable Low Temp shutdown/alarm on Thermocouples? (No, TC1, TC2, TC3, TC1&2, TC1&3, TC2&3, TC1&2&3), Alarm or Shutdown
2.1.8		I/C Pilot Contin	Option	Intermittent / Continuous Pilot Select
2.1.9		P to M Delay 10s	Option	Pilot On to Mains On Delay (10s - 120s)
2.1.10		Num IGN Trials 3	Option	Select Number of trials for ignition before Flame Fail lock-out
2.1.11		All IGN SD @ FF Yes	Option	Shutdown both Ignitor outputs upon Flame Fail on one Ignitor? Yes/No
2.1.12		ALM Only if Both FF	Option	Alarm Only if Both Ignitors are in Flame Fail: "ALM Only if Both FF" or Alarm if Any Ignitor goes into Flame Fail: "ALM if Any IGN FF" Both Ignitors must be enabled for this option to have an effect on the Alarm/Status contacts

2.1.13		Dual TC1&2 SD No	Option	Dual TC1&2 10°C Difference Shutdown Y/N Yes: Shutdown if TC1 & 2 are different by greater than 10°C (18°F) No: No link between TC1 & TC2
2.1.14		4-20 Out Settings	Menu	4-20mA Output Settings Menu
2.1.15		4-20 In 1 Settings	Menu	4-20mA Input 1 Settings Menu (Level)
2.1.16		4-20 In 2 Settings	Menu	4-20mA Input 2 Settings Menu (Press.)
2.1.17		Purge Cycle Off	Option	Purge Cycle On/Off Selection
2.1.18		Purge Cycle 10s	Option	Purge Cycle Time (0s - 300s) (before first ignition trial)
2.1.19		IGN Int-Purge 0s	Option	Extra Inter-Purge Time (0s - 240s) between Ignitor relight trials.
2.1.20		AUX1 Relay Settings	Menu	AUX1 Relay Settings Menu
2.1.21		AUX2 Relay Settings	Menu	AUX2 Relay Settings Menu
2.1.22		PWR Save Disabled	Option	Power Save Enable/Disable
2.1.23		PWR Fail Latched	Option	Power Fail Shutdown Latched/Unlatched
2.1.24		High Temp Latched	Option	High Temp Shutdown Latched/Unlatched
2.1.25		Hi Tmp TC3 Latched	Option	TC3 High Temp SD Latched/Unlatched
2.1.26		High Gas Latched	Option	High Gas Shutdown Latched/Unlatched
2.1.27		Low Gas Latched	Option	Low Gas Shutdown Latched/Unlatched
2.1.28		Level Latched	Option	Level Shutdown Latched/Unlatched
2.1.29		Aux 1 Latched	Option	Auxiliary 1 Shutdown Latched/Unlatched
2.1.30		Aux 2 Latched	Option	Auxiliary 2 Shutdown Latched/Unlatched
2.2	Line Display Config		Menu	Line Display Configuration - Select items to display on the three top lines on the display
		Line 1: TC1 temp w setpoint	Option	Select information to display for Line 1
		Line 2: TC2 temp w setpoint	Option	Select information to display for Line 2
		Line 3: FI mode: IGN1	Option	Select information to display for Line 3
2.3	Temp Setpoints		Menu	
		TC1 IGN1 Set 200°C	Option	Change TC1 Ignitor 1 Setpoint temperature
		TC1 IGN2 Set 300°C		Change TC1 Ignitor 2 Setpoint temperature
		TC2 Set 600°C	Option	Change TC2 Setpoint temperature
		TC3 Set 400°C	Option	Change TC3 Setpoint temperature
		Low Temp Set 200°C	Option	Change Low Temp SD/ALM Setpoint temperature
		Deadband TC1 IGN1 1	Option	Set Deadband for TC1 IGN1: 1-5°C or 2-10°F
		Deadband TC1 IGN2 1	Option	Set Deadband for TC1 IGN2: 1-5°C or 2-10°F
		Deadband TC2 1	Option	Set Deadband for TC2: 1-5°C or 2-10°F
		Deadband TC3 1	Option	Set Deadband for TC3: 1-5°C or 2-10°F
2.4	Show Last IGN SD		Information	Show the last shutdown(s) for IGN 1 / 2 and the time and date that they occurred
2.5	TMain 1 On Time View		Menu	Display time that the TMain 1 solenoid has been on since the last TMain timer reset
		Years Hours	Information	
		Months Minutes	Information	
		Days	Information	
		Reset TMain 1 Timers	Option	Reset TMain 1 solenoid timers
2.6	TMain 2 On Time View		Menu	Display time that the TMain 2 solenoid has been on since the last TMain timer reset
		Years Hours	Information	
		Months Minutes	Information	
		Days	Information	

		Reset TMain 2 Timers	Option	Reset TMain 2 solenoid timers
2.7	Solenoid Drivers		Menu	Low Power Solenoid Driver settings
		Pilot 1 100	Option	Cycle time for Pilot 1 solenoid output
		Main 1 100	Option	Cycle time for Main 1 solenoid output
		TMain 1 100	Option	Cycle time for TMain 1 solenoid output
		Pilot 2 100	Option	Cycle time for Pilot 2 solenoid output
		Main 2 100	Option	Cycle time for Main 2 solenoid output
		TMain 2 100	Option	Cycle time for TMain 2 solenoid output
2.8	Time Set		Menu	
		Hours	Option	Hour for the current time
		Minutes	Option	Minutes for the current time
		12/24 Hour Time	Option	Select between 12 or 24 hour time display
2.9	Date Set		Menu	
		Day	Option	Current day
		Month	Option	Current month
		Year	Option	Current year
2.10	Modbus Settings		Menu	
		Slave ID	Option	Modbus Slave ID of the CSC400
		Baud Rate	Option	Serial Baud rate for Modbus RTU
		Format	Option	Serial Format for the CSC400 (eg. "8N1": 8 bits, No parity bits, 1 stop bit)
2.11	Diagnostics		Information	Shows firmware version and diagnostics information
2.12	Reset SD Log		Menu	
		Reset SDLog to Default		Reset (clear) all stored Shutdown Log entries: (Yes, No/Cancel)
2.13	Reset Settings		Menu	
		Reset Settings to Default		Reset all CSC400 settings to the defaults: (Yes, No/Cancel)
2.14	Recalibrate TC		Menu	
		Recalibrate Thermocouple inputs		Recalibrate Thermocouple inputs (Yes, No/Cancel)
	Configuration Submenus:			
2.1.14	4-20 Out Settings		Menu	4-20mA Output Settings Menu
		4-20 Out 1 Temp TC1	Option	4-20mA Output 1 Mode Select
		Low (4) -60°C	Option	4-20mA Output 1 Low value for 4mA
		High(20) 1200°C	Option	4-20mA Output 1 High value for 20mA
		FS Ramp Time 10s	Option	Full-scale (4 to 20mA or 20 to 4mA) Ramp Time
		PVLV Ctrl IGN1	Option	Proportional Valve Ignitor Control for 4-20 Output 1
		PVLV Min Disabled	Option	Proportional Valve Minimum Mode Enable/Disable
		Min mA Set NA	Option	Minimum mA Value for Proportional Valve Minimum Mode

		PVLV + Range	Option	Proportional Valve Range above selected Setpoint
		PVLV - Range	Option	Proportional Valve Range below selected Setpoint
		4-20 Out 2 Temp TC2	Option	4-20mA Output 2 Mode Select
		Low (4) -60°C	Option	4-20mA Output 2 Low value for 4mA
		High(20) 1200°C	Option	4-20mA Output 2 High value for 20mA
		FS Ramp Time 10s	Option	Full-scale (4 to 20mA or 20 to 4mA) Ramp Time
		PVLV Ctrl IGN2	Option	Proportional Valve Ignitor Control for 4-20 Output 2
		PVLV Min Disabled	Option	Proportional Valve Minimum Mode Enable/Disable
		Min mA Set NA	Option	Minimum mA Value for Proportional Valve Minimum Mode
		PVLV + Range	Option	Proportional Valve Range above selected Setpoint
		PVLV - Range	Option	Proportional Valve Range below selected Setpoint
2.1.15 2.1.16	4-20 In 1 / 2 Settings		Menu	4-20mA Level (1) and Pressure (2) Inputs Menu
		Format: 4-20mA	Option	Format of the 4-20mA input: 4-20mA / 1V-5V
		SetPt Ctrl: None	Option	Secondary 4-20 Input setpoint control for selected TMain: None, IGN1, IGN2, or IGN1&2.
		Lo Alarm Enabled	Option	Alarm if 4-20mA Input is Below Trip-point: Enable/Disable
		Hi Alarm Enabled	Option	Alarm if 4-20mA Input is Above Trip-point: Enable/Disable
		SD on Lo Alarm Yes	Option	Shutdown upon Low Alarm? Yes/No
		SD on Hi Alarm No	Option	Shutdown upon High Alarm? Yes/No
		SD Latched	Option	Shutdown Latched/Unlatched Select
		Units mA	Option	Units for 4-20mA input
		Low (4) 4.00mA	Option	Range Low value (at 4mA)
		High (20) 20.00mA	Option	Range High value (at 20mA)
		Lo TrpPt: 12.00mA	Option	Low Trip-point value (Alarm and/or SD Below this value)
		Hi TrpPt: 18.00mA	Option	High Trip-point value (Alarm and/or SD Above this value)
		Setpoint 4.00mA	Option	Setpoint for Secondary TMain control (TC1 & 2 still have priority)
		Deadband 0.00mA	Option	Deadband value for 4-20mA Inputs: 0 - 50 (eg: 0.00mA to 0.50mA, or 0.0 - 5.0%, etc.)
		1V-5V 1/2 Calib	Option	1V-5V Inputs 1 & 2 Calibration (internal)
2.1.20 2.1.21	AUX1/2 Relay Settings		Menu	AUX1/AUX2 Relay Settings Menus
		Contrl: TC1 Custom	Option	Control source variable for selected AUX relay: TC1 IGN1 / TC1 IGN2 / TC2 / TC3 setpoints, TC1/2/3 custom temperature setpoint, extra Alarm signal for IGN1 FF or IGN2 FF, Modbus Control, or TMain1 / TMain2 state Mirror
		Cust Temp: 425°C	Option	Custom temperature setpoint
		Deadband 1	Option	Deadband value for custom temperature setpoint for selected AUX relay

Top Menu Options

The CSC400 Top Menu allows users to select a variety of submenus with additional options and configurations available. It provides the most often used options at the top of the menu list.

#	Top Menu Selections	Type	Description
1	Configuration	Menu	Configure CSC400 options
2	Line Display Config	Menu	Change lines displayed on Top Screen
3	Temp Setpoints	Menu	Change Temperature Setpoints and Deadband values
4	Show Last IGN SD	Screen	Show the most recent shutdowns for IGN1 & 2
5	View TMain1 ON Time	Menu	View/Reset TMain1 Solenoid ON Time
6	View TMain2 ON Time	Menu	View/Reset TMain2 Solenoid ON Time
7	Solenoid Drivers	Menu	Change Solenoid Driver Cycle Times
8	Time Set	Menu	Set the time in the CSC400
9	Date Set	Menu	Set the date in the CSC400
10	Modbus Settings	Menu	Change Modbus Comm. Settings
11	Diagnostics	Screen	Shows firmware version, diagnostics information
12	Reset SD Log	Menu	Reset (clear) Shutdown Log
13	Reset Settings	Menu	Reset Settings to default
14	Recalibrate TC	Menu	Recalibrate Thermocouple inputs

Configuration Menu Options

The CSC400 provides the options most often changed in the first menu named the "Configuration" menu. This menu allows users to set the operation mode, which ignitors and thermocouples are enabled, intermittent or continuous mode, deadband values, 4-20mA output and input modes, and shutdown latch settings.

#	Configuration Menu Selections	Type	Description	Possible Options/Values
2.1.1	IGN1 Enabled	Option	Ignitor 1 Enabled/Disabled	Enabled/Disabled
2.1.2	IGN2 Disabled	Option	Ignitor 2 Enabled/Disabled	Enabled/Disabled
2.1.3	°C/°F °C	Option	Select °C/°F	°C/°F
2.1.4	TC2 Enabled	Option	TC2 Enable/Disable	Enabled/Disabled
2.1.5	TC3 Enabled	Option	TC3 Enable/Disable	Enabled/Disabled
2.1.6	TC3 AUX HT SD No	Option	Use TC3 as an auxiliary High-temp SD	Yes/No
2.1.7	Low Temp SD No	Option	Enable Low Temp Shutdown/Alarm on Thermocouples? - Either SD or Alarm can be selected for any combination of thermocouples. - There is only one Low Temp setpoint for all three thermocouples.	No, (SD TC1, TC2, TC3, TC1&2, TC1&3, TC2&3, TC1&2&3), (ALM TC1, TC2, TC3, TC1&2, TC1&3, TC2&3, TC1&2&3)
2.1.8	I/C Pilot Intermit	Option	Intermittent / Continuous Pilot Select	Intermittent / Continuous Pilot
2.1.9	P to M Delay 10s	Option	Pilot On to Mains On Delay	10s - 120s
2.1.10	Num IGN Trials 3	Option	Select Number of trials for ignition before Flame Fail lock-out	1 - 3 trials
2.1.11	All IGN SD @ FF Yes	Option	Shutdown both Ignitor outputs upon Flame Fail on one Ignitor? Yes/No	Yes/No
2.1.12	ALM Only if Both FF	Option	Alarm Only if Both Ignitors are in Flame Fail: "ALM Only if Both FF" or Alarm if Any Ignitor goes into Flame Fail: "ALM if Any IGN FF" Both Ignitors must be enabled for this to have an effect on the Alarm/Status contacts	"ALM Only if Both FF" or "ALM if Any IGN FF"
2.1.13	Dual TC1&2 SD No	Option	Dual TC1&2 10C Difference Shutdown Y/N	Yes / No
2.1.14	4-20 Out Settings	Menu	4-20mA Output Settings Menu	(Branch to submenu)
2.1.15	4-20 In 1 Settings	Menu	4-20mA Input 1 Settings Menu	(Branch to submenu)
2.1.16	4-20 In 2 Settings	Menu	4-20mA Input 2 Settings Menu	(Branch to submenu)
2.1.17	Purge Cycle Off	Option	Purge Cycle On/Off Selection	On/Off
2.1.18	Purge Cycle 10s	Option	Purge Cycle Time	0s - 300s
2.1.19	IGN Int-Purge 0s	Option	Extra Inter-Purge Time between Ignitor	0s - 240s

			relight trials.	
2.1.20	AUX1 Relay Settings	Menu	AUX1 Relay Settings Menu	(Branch to submenu)
2.1.21	AUX2 Relay Settings	Menu	AUX2 Relay Settings Menu	(Branch to submenu)
2.1.22	PWR Save Disabled	Option	Power Save Enable/Disable (Enable = turn display off after 10 minutes of no button activity)	Enabled/Disabled
2.1.23	PWR Fail Unlatch	Option	Power Fail Shutdown Latched/Unlatched	Latched/Unlatched (see pg 45)
2.1.24	High Temp Unlatch	Option	High Temp Shutdown Latched/Unlatched	Latched/Unlatched
2.1.25	Hi Tmp TC3 Latched	Option	TC3 High Temp SD Latched/Unlatched	
2.1.26	High Gas Unlatch	Option	High Gas Shutdown Latched/Unlatched	Latched/Unlatched
2.1.27	Low Gas Unlatch	Option	Low Gas Shutdown Latched/Unlatched	Latched/Unlatched
2.1.28	Level Unlatch	Option	Level Shutdown Latched/Unlatched	Latched/Unlatched
2.1.29	Aux 1 Unlatch	Option	Auxiliary 1 Shutdown Latched / Unlatched	Latched/Unlatched
2.1.30	Aux 2 Unlatch	Option	Auxiliary 2 Shutdown Latched / Unlatched	Latched/Unlatched

Line Display Configuration Menu Options

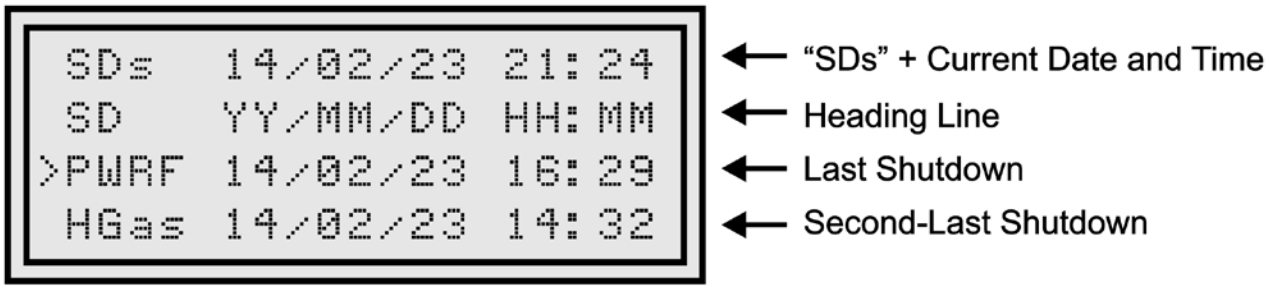
The CSC400 allows the user to select what they wish to view on the top temperature / shutdown status screen. Lines 1 to 3 may be configured to show a variety of status and temperatures. Some selections show information on more than two lines. Line 4 always shows shutdown status and Ignitor status (On, Off, Flame Fail "FF").

#	Line	Possible Selections	Type	Description
1	Line 1, 2, 3	TC1 temp w IGN1 setpoint	Option	Display TC1 Temperature and IGN1 Setpoint
		TC1 temp w IGN2 setpoint	Option	Display TC1 Temperature and IGN2 Setpoint
		TC2 temp w setpoint	Option	Display TC2 Temperature and Setpoint
		TC3 temp w setpoint	Option	Display TC3 Temperature and Setpoint
		TC1 TC2	Option	Display TC1 and TC2 Temperatures
		TC1 TC3	Option	Display TC1 and TC2 Temperatures
		TC2 TC3	Option	Display TC1 and TC2 Temperatures
		TC1 TC2 TC3	Option	Display TC1, TC2, and TC3 Temperatures
		4-20mA Input 1	Option	Display 4-20mA Input 1 measured value (including desired units)
		4-20mA Input 2	Option	Display 4-20mA Input 2 measured value (including desired units)
		FI mode: (2 lines) IGN1 Pilot, Main, TMain status (On/Off)	Option	Display IGN1 Pilot, Main, and TMain solenoid output status (On/Off) on 2 lines
		FI mode: (2 lines) IGN2 Pilot, Main, TMain status (On/Off)	Option	Display IGN2 Pilot, Main, and TMain solenoid output status (On/Off) on 2 lines
		FI mode: IGN1 P:ON/P:OFF, M:ON/M:OFF, T:ON/T:OFF	Option	Condensed display of IGN1 Pilot, Main, and TMain solenoid output status (On/Off) on one line
		FI mode: IGN2 P:ON/P:OFF, M:ON/M:OFF, T:ON/T:OFF	Option	Condensed display of IGN2 Pilot, Main, and TMain solenoid output status (On/Off) on one line
		Blank Line	Option	

Show Last IGN SD Menu Options

The "Show Last IGN SD" menu option displays a separate screen showing the shutdowns for the system and the date and time that they occurred. The shutdowns are displayed on the four-line display in the format shown below:

Figure 11 - CSC400 - Show Last SD Menu Screen



When the "Show Last IGN SD" screen is first displayed, the cursor is shown on line 3 which indicates the last shutdown that occurred for the system. The up and down pushbuttons may be used to scroll through the previous shutdowns stored in the Shutdown log. As an alternative to scrolling through the menu, the shutdowns may be read out via Modbus by a PC or a PLC. The CSC400 can currently store over 65000 shutdown events in the shutdown log.

Note that the SD Log only stores shutdowns that are enabled for storing in the SD Log. By default, all shutdowns are stored in the SD Log except the Start/Stop buttons, the Remote Start/Stop terminal, and Modbus Remote Stop/Start commands. (see the CSC400 Modbus manual for additional details).

Shutdown Log Codes:

#	SD Log Code	Shutdown Description
1	HTmp	High Temperature (TC2)
2	HGas	High Gas SD terminal
3	RStp	Remote Stop terminal
4	Modb	Modbus Remote Stop/Start command received
5	PWRF	Power Fail
6	Stop	Stop Button
7	1FF	Flame Fail on Ignition module 1
8	Aux1	Auxiliary 1 SD terminal
9	Aux2	Auxiliary 2 SD terminal
10	Lvl	Level SD terminal
11	LGas	Low Gas SD terminal
12	2FF	Flame Fail on Ignition module 2
13	420L	4-20 Level Input shutdown (High or Low)
14	420P	4-20 Pressure Input shutdown (High or Low)
15	LTmp	Low Temp shutdown (any thermocouple)

View TMain 1 / 2 Menu Options

The "View TMain1 ON Time" and " View TMain2 ON Time" menu options display a separate screen and menu showing the TMain solenoid ON Time for burner usage calculations and environmental legislation requirements.

Line #	Menu	Information	Type	Description
1	IGN 1 / 2 TMain On Time View			Menu Title

2		Years Hours	Info	Number of Years and Hours that the TMain solenoid has been on since the last TMain timer reset
3		Months Min	Info	Number of Months and Minutes that the TMain solenoid has been on since the last TMain timer reset
4		Days	Info	Number of Days that the TMain solenoid has been on since the last TMain timer reset
5		Reset TMain 1 Timer	Option	Reset TMain 1 / 2 solenoid timer

Solenoid Drivers Menu Options

The CSC400 incorporates low power solenoid driver technology to save power on each solenoid output while maintaining the ON state. Refer to the Low Power Solenoid Drivers section on page 19 for more information.

#	Solenoid Drivers Menu Selections	Type	Description	Possible Options/Values (Cycle time)
1	Pilot 1	Option	Cycle time for Pilot 1 solenoid output	10% - 100%
2	Main 1	Option	Cycle time for Main 1 solenoid output	10% - 100%
3	TMain 1	Option	Cycle time for TMain 1 solenoid output	10% - 100%
4	Pilot 2	Option	Cycle time for Pilot 2 solenoid output	10% - 100%
5	Main 2	Option	Cycle time for Main 2 solenoid output	10% - 100%
6	TMain 2	Option	Cycle time for TMain 2 solenoid output	10% - 100%

Time and Date Set Menu Options

The CSC400 allows the user to modify the current time and date. A time and date stamp is added to the shutdown log for each shutdown event.

#	Menu	Menu Selections	Type	Description
1	Time Set	Hours	Option	Hour for the current time
		Minutes	Option	Minutes for the current time
		12/24 Hour Time	Option	Select between 12 or 24 hour time display
2	Date Set	Day	Option	Current day
		Month	Option	Current month
		Year	Option	Current year

Modbus Settings Menu Options

The Modbus RTU settings for the CSC400 are changed in this menu. Refer to the "
Modbus/RS-485 Cable Connections – Field Installations - Field Installations" section on page 38. Also refer to the CSC400 Modbus Manual for additional details.

#	Menu Selections	Type	Description	Possible Options/Values
1	Slave ID	Option	Modbus Slave ID of the CSC400	1 - 247
2	Baud Rate	Option	Serial Baud rate for Modbus RTU	300, 1200, 2400, 9600, 19200, 38400
3	Format	Option	Serial Format for the CSC400 (eg. 8N1)	8N1, 8E1, 8O1, 8N2

4-20mA Output (1 / 2) Menu Options

The 4-20mA Outputs on the CSC400 allow the user to configure a variety of options to support a wide variety of applications and equipment. Normal 4-20mA or 1-5V ranges can be selected, or custom ranges and units can be entered by the user for displaying on the four-line display. The 4-20mA outputs can also be configured to change how fast they respond to temperature by altering the "FS Ramp Time" (Full-scale Ramp Time).

#	Menu Selections	Type	Description	Additional Notes & Possible Options/Values
1	**4-20 Out 1 Temp TC1**	Option	4-20mA Output 1 Mode Select	"Temp" = Normal temperature output: TC1, TC2, or TC3 "PVLV" = Proportional Valve output: TC1, TC2, or TC3 "Level In" = 4-20mA Input 1 (Repeater/Splitter mode) "Press In" = 4-20mA Input 2 (Repeater/Splitter mode)
2	Low (4) -60°C	Option	4-20mA Output 1 Low value for 4mA	A measured temperature below this Low value outputs 4mA. -60°C to 1200°C (-76°F to 2192°F)
3	High(20) 1200°C	Option	4-20mA Output 1 High value for 20mA	A measured temperature above this High value outputs 20mA. -60°C to 1200°C (-76°F to 2192°F)
4	FS Ramp Time 10s	Option	Full-scale (4 to 20mA or 20 to 4mA) Ramp Time	Time taken to change from fully closed (4mA) to fully open (20mA) and vice versa. 5s - 120s
5	PVLV Ctrl IGN1	Option	Proportional Valve Ignitor Control for 4-20 Output 1	Selects which ignitor to control in Proportional Valve mode: 1, 2, or 1&2
6	PVLV Min Disabled	Option	Proportional Valve Minimum Mode Enable/Disable	"Minimum Fire" position for Proportional Valve Mode. If enabled while set to PVLV TC1, TC2, or TC3 modes, this 4-20 output will never output less than the Minimum mA Value set in the "Min mA Set" line below. Possible Values: Enabled/Disabled
7	Min mA Set NA	Option	Minimum mA Value for Proportional Valve Minimum Mode	If PVLV Minimum Mode is enabled and this output is set to PVLV TC1, TC2, or TC3 modes, this 4-20 output will never output less than the Minimum mA Value set here. Possible Values: 4 - 20mA
8	PVLV + Range	Option	Proportional Valve Range above selected Setpoint	Example: PVLV TC1, TC1 setpoint = 500°C. If this value is set to 20 degrees, the PVLV output will be at 4mA (I/P valve closed) above TC1 Setpoint+20 (520°C). The PVLV 4-20mA Output spans the entire band of the +/- range. Possible Values: 0 - 100 degrees
9	PVLV - Range	Option	Proportional Valve Range below selected Setpoint	Example: PVLV TC1, TC1 setpoint = 500°C. If this value is set to 30 degrees, the PVLV output will be at 20mA (I/P valve closed) below TC1 Setpoint-30 (470°C). The PVLV 4-20mA Output spans the entire band of the +/- range. In this example: 470°C = 20mA, 520 = 4mA with a linear calculation of the 4-20mA

				Output in between these temperatures. Possible Values: 0 - 100 degrees
8	**4-20 Out 2 Temp TC2**	Option	4-20mA Output 2 Mode Select	"Temp" = Normal temperature output: TC1, TC2, or TC3 "PVLV" = Proportional Valve output: TC1, TC2, or TC3 "Level In" = 4-20mA Input 1 (Repeater/Splitter mode) "Press In" = 4-20mA Input 2 (Repeater/Splitter mode)
9	Low (4) -60°C	Option	4-20mA Output 2 Low value for 4mA	A measured temperature below this Low value outputs 4mA. -60°C to 1200°C (-76°F to 2192°F)
10	High(20) 1200°C	Option	4-20mA Output 2 High value for 20mA	A measured temperature above this High value outputs 20mA. -60°C to 1200°C (-76°F to 2192°F)
11	FS Ramp Time 10s	Option	Full-scale (4 to 20mA or 20 to 4mA) Ramp Time	Time taken to change from fully closed (4mA) to fully open (20mA) and vice versa. 5s - 120s
12	PVLV Ctrl IGN2	Option	Proportional Valve Ignitor Control for 4-20 Output 2	Selects which ignitor to control in Proportional Valve mode: 1, 2, or 1&2
13	PVLV Min Disabled	Option	Proportional Valve Minimum Mode Enable/Disable	"Minimum Fire" position for Proportional Valve Mode. If enabled while set to PVLV TC1, TC2, or TC3 modes, this 4-20 output will never output less than the Minimum mA Value set in the "Min mA Set" line below. Possible Values: Enabled/Disabled
14	Min mA Set NA	Option	Minimum mA Value for Proportional Valve Minimum Mode	If PVLV Minimum Mode is enabled and this output is set to PVLV TC1, TC2, or TC3 modes, this 4-20 output will never output less than the Minimum mA Value set here. Possible Values: 4 - 20mA
15	PVLV + Range	Option	Proportional Valve Range above selected Setpoint	Example: PVLV TC1, TC1 setpoint = 100°C. If this value is set to 5 degrees, the PVLV output will be at 4mA (I/P valve closed) above TC1 Setpoint+5 (105°C). The PVLV 4-20mA Output spans the entire band of the +/- range. Possible Values: 0 - 100 degrees
16	PVLV - Range	Option	Proportional Valve Range below selected Setpoint	Example: PVLV TC1, TC1 setpoint = 100°C. If this value is set to 20 degrees, the PVLV output will be at 20mA (I/P valve closed) below TC1 Setpoint-20 (80°C). The PVLV 4-20mA Output spans the entire band of the +/- range. In this example: 80C = 20mA, 105 = 4mA with a linear calculation of the 4-20mA Output in between these temperatures. Possible Values: 0 - 100 degrees

4-20mA Input Level / Pressure (1 / 2) Menu Options

The 4-20mA Inputs on the CSC400 allow the user to configure a variety of options to support a wide variety of applications and equipment. Normal 4-20mA or 1-5V ranges can be selected, or custom ranges and units can be entered by the user for displaying on the four-line display. The 4-20mA inputs can also be configured to alarm and/or shutdown the ignitors once the desired trip-point has been reached (above a High Trip-point and/or below a Low Trip-point). The High Trippoint must be above the Low Trippoint value. Similarly, the Low Trippoint value must be below the High Trippoint value.

#	Menu Selections	Type	Description	Possible Options/Values
1	Format: 4-20mA	Option	Format of the 4-20mA input: 4-20mA or 1V-5V	4-20mA input, 1-5V input
2	SetPt Ctrl: None	Option	Secondary 4-20 Input setpoint control for selected TMain.	None, IGN1, IGN2, or IGN1&2. (Only one 4-20mA Input may control a TMain solenoid, not both)
3	Lo Alarm Enabled	Option	Alarm if 4-20mA Input is Below Trip-point: Enable/Disable	Enable/Disable
4	Hi Alarm Enabled	Option	Alarm if 4-20mA Input is Above Trip-point: Enable/Disable	Enable/Disable
5	SD on Lo Alarm Yes	Option	Shutdown upon Low Alarm? Yes/No	Yes, No
6	SD on Hi Alarm No	Option	Shutdown upon High Alarm? Yes/No	Yes, No
7	SD Latched	Option	Shutdown Latch select	Latched/Unlatched
8	Units mA	Option	Units for 4-20mA input	4-20mA, 1-5V, gallons, m3, psi, kPa, %
9	Low (4) 4 mA	Option	Range Low value (4mA level)	4.00 - 20.00, 0 - 32000, -60 - 1200 (depending on selected units)
10	High (20) 20mA	Option	Range High value (20mA level)	4.00 - 20.00, 0 - 32000, -60 - 1200 (depending on selected units)
11	Lo TrpPt: 12.00mA	Option	Low Trip-point value (Alarm and/or SD Below this value)	4.00 - 20.00, 0 - 32000, -60 - 1200 (depending on selected units)
12	Hi TrpPt: 18.00mA	Option	High Trip-point value (Alarm and/or SD Above this value)	4.00 - 20.00, 0 - 32000, -60 - 1200 (depending on selected units)
13	Setpoint 4.00mA	Option	Setpoint for Secondary TMain control (TC1 & 2 still have priority)	4.00 - 20.00, 0 - 32000, -60 - 1200 (depending on selected units)
14	Deadband 0.00mA	Option	Deadband value for 4-20mA Inputs:	0 - 50 (eg: 0.00mA to 0.50mA, or 0.0 - 5.0%, or 0.0 to 5.0 degrees, etc.)
15	1V-5V 1/2 Calib	Option	1V-5V 1 & 2 Calibration (internal)	Start an internal 1V-5V calibration

AUX1 & AUX2 Relay Settings Menu Options

The AUX1 and AUX2 Relays can be configured in the menu system to switch based on a variety of options. Either relay can be selected to switch upon reaching the setpoint temperature of any of the three thermocouple inputs, a custom thermocouple setpoint temperature can be used, the relay can be selected to switch upon one of the Ignitors going into Flame Fail (Alarm), or the relay may be selected to only turn on upon Modbus control.

As an example, for incinerator systems, an option to turn on external fans once the TC1 temperature reaches 960°C may be desired, but the setpoint temperature for TC1 is set to 980°C. In this case, the user would use one set of AUX Relay terminals to control the 12VDC fan relay coil: set the "Ctrl:" option to "TC1 Custom", and then set the "Cust Temp:" field to 960°C.

#	Menu Selections	Type	Description	Possible Options/Values
1	Control: ("Ctrl:")	Option	Control source variable for the AUX 1/2 Relay	TC1 SetPoint, TC2 Setpoint, TC3 Setpoint, TC1 Custom Setpoint, TC2 Custom Setpoint, TC3 Custom Setpoint, IGN1 FF Alarm (On when IGN1 is in FF), IGN2 FF Alarm (On when IGN2 is in FF), Modbus Control (turns off upon any SD),

				TMain1 Mirror, TMain2 Mirror
2	Cust Temp:	Option	Custom Temperature setpoint for the selected AUX relay.	-60°C to 1200°C (-76°F to 2192°F)
3	Deadband	Option	Deadband value for custom temperature setpoint for selected AUX relay	1-5°C or 2-10°F

Note: Both AUX relays will turn off (connecting NC to COM) upon a shutdown or if the system is Off.

Modbus Communications

Modbus/RS-485 Cable Connections – Field Installations

Special Notes
Ensure that only industrial-rated equipment is used for field installations, with appropriate measures for handling noisy environments.

If using a PC with USB-to-RS485 connectivity for field installations, use an industrial-rated USB hub (preferably one with a metal case) for connecting the PC to the USB-to-RS485 cable.

Refer to Appendix C for additional Modbus cabling technical details.

Refer to the document "CSC400_Modbus_Installation_Manual.pdf" for additional details on additional Modbus registers, testing, and troubleshooting.

Cabling

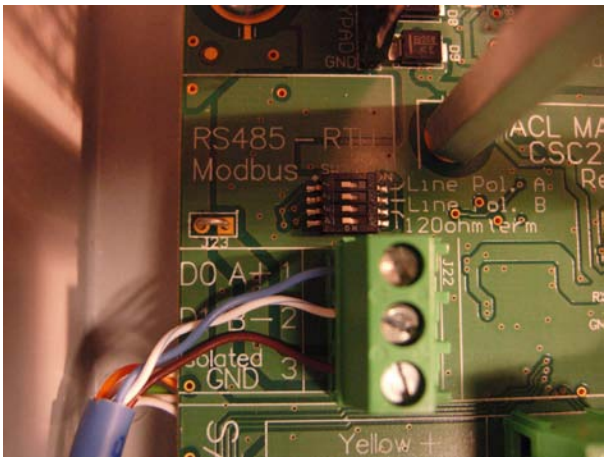
Connect a cable from a PLC (Programmable Logic Controller) or a PC to the 3-pin terminal strip of the CSC400 labeled "Modbus", observing proper connections:

- The RS-485 standard suggests using twisted pair type cables (CAT5E or a shielded twisted pair with ground) for connecting devices together. This is definitely a requirement for longer cable runs (25m to 1000m) and for use in noisy environments like industrial or commercial installations.

- The RS485 signal naming convention used in this document and by many RS485 transceiver vendors is reversed from what the EIA/TIA-485 specification states:

CSC400 Modbus/RS485 Documentation	EIA/TIA-485 Naming Convention	Modbus Specification Name	Description
A (“RS485 A +” or "D0 A+")	B	D1	Non-Inverting, Transceiver Terminal 1, V1 voltage (V1 > V0 for binary 1 (OFF) state
B (“RS485 B –” or "D1 B-")	A	D0	Inverting, Transceiver Terminal 0, V0 voltage (V0 > V1 for binary 0 (ON) state
Isolated GND (or common GND)	C	Common	Signal and Optional Power Supply common ground

Figure 12 - Example CAT5E Cable Connection



- Ensure that the "Isolated Ground" terminals are all attached together on all RS485 devices on the bus. This ground should be connected to earth ground at one point along the bus, preferably at the Master.

- If using a CAT5E (or similar) cable with unused wires, do not leave them "floating". Connect these wires at one point on the cable to the ground (or "Isolated GND") terminal at the CSC400, or at the master's ground terminal.

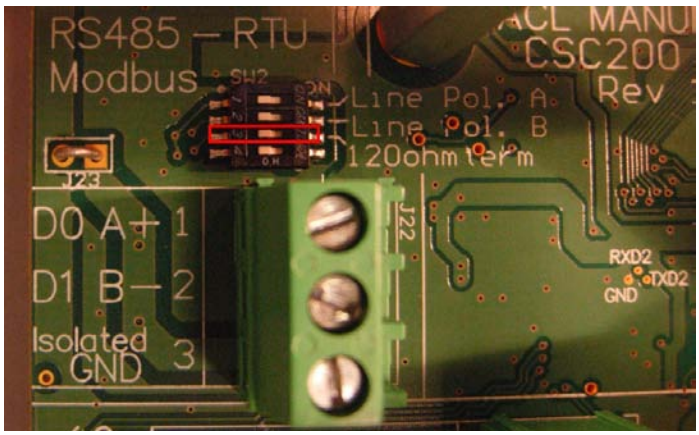
- A USB-to-RS485 cable may also have unused wires if the provided Terminator resistor wires are not used (the FTDI Chip cable as an example). These should be connected to ground as well, to reduce noise propagation.

Termination

An RS-485 bus should only be terminated at each end of the cable (at each device at the end of the cable). No other devices in-between the two devices at each end should have termination resistors installed or enabled. If there are 20 devices on an RS-485 bus in a daisy-chain, the 120 ohm termination resistors should only be enabled at the first device and at the 20th device.

The CSC400 Controller has a 4-pin DIP switch with the third switch from the top labeled "120ohm term". This can be used to connect a built-in 120 ohm resistor. Simply push the third DIP switch to the right and the 120ohm termination resistor will be connected.

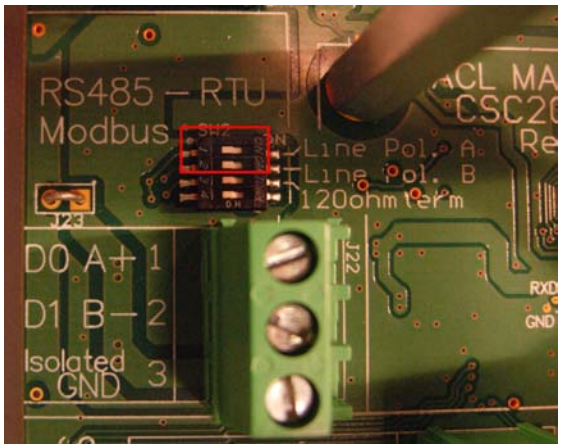
Figure 13 - 120 ohm Termination Resistor DIP Switch



Line Polarization

If Line Polarization is not available on the Master device and is required for the RS-485 bus in this installation, two "Line Polarization" DIP switches on the CSC400 Controller are available. To enable the Line Polarization terminations, move them to the right (towards the "Line Pol…" text) as shown in the picture below. If the DIP switches are moved towards the left, the Line Polarization terminations are removed from the RS-485 bus on this CSC400 device.

Figure 14 – Line Polarization DIP Switches



"Line Polarization" enables a pullup resistor on the "Data A +" signal and a pulldown resistor on the "Data B –" signal. It ensures that the bus is put into a known state with the "Data A +" signal High and the "Data B -" signal Low.

Line Polarization should only be enabled on one device on the RS485 bus, if necessary. Usually this is done at the end of the bus where the master device resides.

Isolated (or Common) Ground

The "Isolated Ground" terminal on each CSC400 Controller is isolated from the onboard CSC400 ground. This isolated ground connection should be used to connect all common ground connections on all RS-485 devices on the bus. This common ground should be connected to earth or protective ground at one end of the RS-485 cable only (preferably), usually at the master device.

Due to the potential for large amounts of noise to be conducted onto the RS485 cable, an option is provided to connect the RS485 isolated ground to the CSC400 earth ground to shunt noise away locally instead of at the Modbus master. A solid ground connection should be made between a CSC400 earth ground terminal to an earth ground external to the CSC400 using a minimum 16AWG wire.

Commonly Used CSC400 Modbus Registers

Notes:

- SCADAPack Register Addresses are listed for reference when programming SCADAPack PLC units.
- See the CSC400 Modbus Installation Manual for additional registers and specific details about reading and writing registers.

Function Code 0x01 - Read Coils

Function used to read the state of each relay. Read Coil function code 0x01 can read all relay coils in two bytes.

Example PLC Register Address	Coil #	Modbus Coil Address	Description	Type	Notes
1	1	0	"AUX1 Relay" control relay	Auxiliary Control relay	Dry contacts, max 0.12A @ 30VDC 1 = relay ON
2	2	1	"AUX2 Relay" control relay	Auxiliary Control relay	Dry contacts, max 0.12A @ 30VDC 1 = relay ON
3	3	2	IGN1 Pilot solenoid relay	Solenoid relay	1 = relay ON
4	4	3	IGN1 Main solenoid relay	Solenoid relay	1 = relay ON
5	5	4	Alarm relay	Control relay	**0 = relay OFF = Alarm**

					condition. 1 = relay ON, no Alarm
6	6	5	Not used	N/A	Reserved
7	7	6	Proof of closure, IGN1 output relay	Control relay	1 = relay ON
8	8	7	IGN1 Temperature Main solenoid relay	Solenoid relay	1 = relay ON
9	9	8	IGN2 Pilot solenoid relay	Solenoid relay	1 = relay ON
10	10	9	IGN2 Main solenoid relay	Solenoid relay	1 = relay ON
11	11	10	IGN2 Temperature Main solenoid relay	Solenoid relay	1 = relay ON
12	12	11	Proof of closure, IGN2 output relay	Control relay	1 = relay ON

Function Code 0x02 - Read Discrete Inputs

This Function is used to read the state of each input. 1 = ON, 0 = OFF (unless otherwise stated)

Example PLC Register Address	Input #	Modbus Discrete Input Address	Inputs Byte	Input Bit	Description	Notes
10001	1	0	0	0 (LSB)	Igniter 1 Alarm input	1 = Alarm signal high (Alarm indicated)
10002	2	1	0	1	Igniter 1 Valve input	1 = Valve signal high
10003	3	2	0	2	IGN1 Main solenoid	1 = Main solenoid is on
10004	4	3	0	3	IGN1 Pilot solenoid	1 = Pilot solenoid is on
10005	5	4	0	4	IGN1 T/Main solenoid	1 = T/Main solenoid is on
10006	6	5	0	5	Reserved	
10007	7	6	0	6	POC, IGN1 relay output measurement	1 = POC IGN1 relay output is High (12VDC present)
10008	8	7	0	7 (MSB)	POC minus terminal	1 = POC "minus" terminal is High (12VDC present)
10009	9	8	1	0 (LSB)	High Gas Shutdown input	1 = High Gas Shutdown input is High (12VDC present, shutdown sensor not tripped)
10010	10	9	1	1	Remote Start/Stop input	1 = Remote Start/Stop switch is On/Closed (12VDC present)
10011	11	10	1	2	HT input: AUX 2 terminal "minus" input (output of TC2 "R2" relay)	1 = High Temp R2 relay output is High (12VDC is present, not in High Temp shutdown), 0 = high temp shutdown
10012	12	11	1	3	Output of TC1 "R1" relay (input to POC relay)	1 = "Low" Temp R1 relay output is High (12VDC is present), 0 = TC1 temp is in shutdown (if in Intermittent Pilot mode)
10013	13	12	1	4	PWR fail condition (only on briefly upon powerup)	

10014	14	13	1	5	PWR fail latch condition	1 = Latch is on presently
10015	15	14	1	6	HT/HT latch condition	1 = Latch is on presently
10016	16	15	1	7 (MSB)	High Gas SD/SD latch condition	1 = High Gas SD Latch is on presently
10017	17	16	2	0 (LSB)	Thermocouple 1 open/fault	1 = TC fault, 0 = no fault
10018	18	17	2	1	Thermocouple 2 open/fault	1 = TC fault, 0 = no fault
10019	19	18	2	2	Modbus Remote Stop condition	1 = Modbus Remote Stop is active (CSC400 is stopped via Modbus)
10020	20	19	2	3	Level Shutdown input	1 = Level Shutdown input is High (12VDC present, shutdown sensor not tripped)
10021	21	20	2	4	IGN1 Pilot Solenoid Fault (Short)	1 = Solenoid fault (short), 0 = no fault
10022	22	21	2	5	IGN1 Main Solenoid Fault (Short)	1 = Solenoid fault (short), 0 = no fault
10023	23	22	2	6	IGN1 TMain Solenoid Fault (Short)	1 = Solenoid fault (short), 0 = no fault
10024	24	23	2	7 (MSB)	Reserved	
10025	25	24	3	0 (LSB)	"Stop" relay output measurement	1 = "Stop" relay is on
10026	26	25	3	1	Thermocouple 3 open/fault	1 = TC fault, 0 = no fault
10027	27	26	3	2	AUX2 SD/SD latch condition	1 = AUX2 SD Latch is on presently
10028	28	27	3	3	AUX1 SD/SD latch condition	1 = AUX1 SD Latch is on presently
10029	29	28	3	4	Level SD/SD latch condition	1 = Level SD Latch is on presently
10030	30	29	3	5	Low Gas SD/SD latch condition	1 = Low Gas SD Latch is on presently
10031	31	30	3	6	4-20mA Level Input (1) Shutdown / SD Latch	1 = 4-20mA Level Input SD has tripped and is active
10032	32	31	3	7 (MSB)	AUX2 Shutdown input	1 = AUX2 Shutdown input is High (12VDC present, shutdown sensor not tripped)
10033	33	32	4	0 (LSB)	AUX1 Shutdown input	1 = AUX1 Shutdown input is High (12VDC present, shutdown sensor not tripped)
10034	34	33	4	1	Low Gas Shutdown input	1 = Low Gas Shutdown input is High (12VDC present, shutdown sensor not tripped)
10035	35	34	4	2	Unplug Detect signal	1 = Overlay is removed (Alarm condition), 0 = overlay is present
10036	36	35	4	3	Stop Button input	1 = Stop button is high, not pressed, 0 = button is

						pressed
10037	37	36	4	4	Start Button input	1 = Start button is high, not pressed, 0 = button is pressed
10038	38	37	4	5	CSC400 System State	1 = System On, 0 = System Off
10039	39	38	4	6	Reserved	Reserved
10040	40	39	4	7 (MSB)	4-20mA Pressure Input (2) Shutdown / SD Latch	1 = 4-20mA Pressure Input SD has tripped and is active
10041	41	40	5	0 (LSB)	Igniter 2 Alarm input	1 = Alarm signal high (Alarm indicated)
10042	42	41	5	1	Igniter 2 Valve input	1 = Valve signal high
10043	43	42	5	2	IGN2 Pilot Solenoid Fault (Short)	1 = Solenoid fault (short), 0 = no fault
10044	44	43	5	3	IGN2 Main Solenoid Fault (Short)	1 = Solenoid fault (short), 0 = no fault
10045	45	44	5	4	IGN2 TMain Solenoid Fault (Short)	1 = Solenoid fault (short), 0 = no fault
10046	46	45	5	5	POC, IGN2 relay output measurement	1 = POC relay output is High (12VDC present), IGN2
10047	47	46	5	6	Low Temp Alarm flag	1 = a Low Temp Alarm has occurred
10048	48	47	5	7 (MSB)	Low Temp Shutdown flag	1 = a Low Temp Shutdown has occurred

Function Code 0x03 - Read Holding Registers

Holding registers are 16-bit values (2 bytes)
Register bytes are read back as MSB then LSB

Example PLC Register Address	Register #	Modbus Holding Register Address	Description	Notes
40001	1	0	TC1 temp setpoint (deg C)	
40002	2	1	TC2 temp setpoint (deg C)	
40003	3	2	TC1 temp setpoint (deg F)	
40004	4	3	TC2 temp setpoint (deg F)	
40050	50	49	TC3 temp setpoint (deg C)	
40051	51	50	TC3 temp setpoint (deg F)	

Function Code 0x04 - Read Input Registers

Input registers are 16-bit values (2 bytes)
Register bytes are read back as MSB then LSB

Example PLC Register Address	Register #	Modbus Inputs Register Address	Description	Notes
30001	1	0	TC1 current temp (deg C)	
30002	2	1	TC2 current temp (deg C)	
30003	3	2	TC1 current temp (deg F)	
30004	4	3	TC2 current temp (deg F)	
30005	5	4	TC3 current temp (deg C)	
30006	6	5	TC3 current temp (deg F)	

Function Code 0x05 – Write Single "Coil" (or setting)

The individual coils can't actually be written to, they're influenced by the temperature.
Remote Stop and Remote Start are allowed though.
Remote Stop will turn off all relays in the CSC400. CSC400 can only be started again by a Remote Start command, or by turning ON/OFF switch to OFF, then back to ON.

Example PLC Register Address	Coil #	Modbus Write Coil Address	Description	Notes
1	1	0	AUX1 Control Relay	Write access only allowed when the Modbus control option is selected in the AUX1 Relay Settings (Holding Register 140)
2	2	1	AUX2 Control Relay	Write access only allowed when the Modbus control option is selected in the AUX1 Relay Settings (Holding Register 144)
3-16	3-16	2 - 15	(Reserved for reading coil status. See Function Code 0x01)	
17	17	16	Increment TC1 setpoint	ON = increment TC1 setpoint, OFF = no effect
18	18	17	Decrement TC1 setpoint	ON = increment TC1 setpoint, OFF = no effect
19	19	18	Increment TC2 setpoint	ON = increment TC1 setpoint, OFF = no effect
20	20	19	Decrement TC2 setpoint	ON = increment TC1 setpoint, OFF = no effect
21	21	20	Increment TC3 setpoint	ON = Stop, OFF = no effect
22	22	21	Decrement TC3 setpoint	ON = Start, OFF = no effect
23	23	22	Remote Stop	ON = increment TC3 setpoint, OFF = no effect
24	24	23	Remote Start	ON = decrement TC3 setpoint, OFF = no effect

Notes:

- Write Single "Coil" (or setting) function code 0x05 can increment/decrement the setpoint temperatures of either thermocouple, and can also trigger a Remote Stop or Remote Start command.
- "0xFF00" (or 65280 in decimal) turns a "coil" ON, "0x0000" turns a coil "OFF"
- For our "coils" or settings, 0x0000 or OFF, has no effect on the Setpoints or Remote Stop/Start settings.
- Remote Stop disables all power going to ignition modules and closes (turns of power to) all six valve solenoids
- Remote Stop can be cleared by a physical toggling of the Remote Start/Stop power rung or by pressing the Stop button, then the Start button
- Remote Stop can also be cleared by receiving a Modbus message turning Remote Start ON

- Remote Start enables the CSC400 to be turned on
- Remote Start can be interrupted if Remote Start/Stop is open, if a Shutdown is open, or if POC is still open
- Remote Start can also be cleared by receiving a Modbus message turning Remote Stop ON

Function Code 0x06 - Write Holding Registers

Holding registers are 16-bit values (2 bytes)
Register bytes are written as MSB then LSB

Example PLC Register Address	Register #	Modbus Holding Register Address	Description	Notes
40001	1	0	TC1 temp setpoint (deg C)	Writing a value to TC1 in degrees C, also writes to the TC1 degrees F register (after conversion)
40002	2	1	TC2 temp setpoint (deg C)	Writing a value to TC2 in degrees C, also writes to the TC2 degrees F register (after conversion)
40003	3	2	TC1 temp setpoint (deg F)	Writing a value to TC1 in degrees F, also writes to the TC1 degrees C register (after conversion)
40004	4	3	TC2 temp setpoint (deg F)	Writing a value to TC2 in degrees F, also writes to the TC2 degrees C register (after conversion)
40050	50	49	TC3 temp setpoint (deg C)	
40051	51	50	TC3 temp setpoint (deg F)	

Additional CSC400 Feature Details

Latched versus Unlatched Shutdowns

Opening of any switch attached to the Shutdown inputs will shut off the ignition module and de-energize all six valve outputs (Pilot, Main, TMain for IGN1 and IGN2). If the S/D Latch menu option for any shutdown is in "Unlatched S/D" mode, the CSC400 will attempt to restart ignition (on enabled ignitors) when any switch attached to the Shutdown inputs clears. If the S/D Latch menu option is in "Latched S/D" mode for a selected shutdown, this set of shutdown terminals will prevent the system from automatically restarting after it detects any interruption in continuity on these input terminals. If a latched shutdown trips, then resets itself, the CSC400 will detect this, prevent the system from automatically restarting, and alert the user on the LED display (and via Modbus) as to which shutdown caused the latch out.

Intermittent (Pilotless) or Continuous Pilot Feature

The CSC400 incorporates a feature that allows the user to select between Pilotless/Intermittent Pilot (I) or Continuous pilot (C) modes for burner control using the menu system. This option is set through the Configuration Menu Options (see page 31).

Intermittent / Pilotless Pilot (I)

The ACL CSC400 controller provides the Intermittent/Pilotless Pilot feature for applications where a continuous pilot may not be desirable. The pilot output (on enabled Ignitors) is only energized when the controller is calling for heat (the measured temperature on thermocouple 1 is below the TC1 setpoint temperature). In this case, the pilot turns on, then after 10 seconds the Main and T/Main outputs become energized. This allows for a low fire start through the main burners or a pilot/main start where an individual pilot and main are used. This is only initiated if the Start button has been pressed (or Modbus Start command received) and all shutdowns and POC are closed.

Continuous Pilot (C)

When Continuous Pilot (C) is selected via the Configuration Menu option, the pilot output (on enabled Ignitors) becomes energized when the CSC400 has been started and all shutdowns and POC are clear and permissive, regardless of whether the controller is calling for heat.

Once the Pilot turns on, 10 seconds later the Main and T/Main solenoid outputs become energized, if calling for heat. When the TC1 setpoint is reached, the T/Main output turns off and the Pilot and Main solenoid outputs stay energized.

Purge Cycle Feature

The CSC400 incorporates a feature that allows the user to enable a Purge Cycle when the Start button is pushed or when the Remote Start/Stop terminal is toggled. The Purge Cycle On/Off and Purge Cycle duration time options are set through the Configuration Menu Options (see page 31).

Inter-Purge Cycle Feature (Between Ignition Trials)

The "Int-Purge" Time feature allows the user to add additional time between each ignition trial. Purge Cycle does not have to be enabled to use this feature.

TC3 Auxiliary High Temperature Shutdown

An option to have TC3 used as an additional auxiliary high-temperature shutdown is provided. TC2 is normally the high-temperature shutdown thermocouple, but TC3 may be used as a backup as well by setting this option to "Yes".

Low Temperature Shutdown/Alarm

The Low Temperature Shutdown/Alarm option is provided as a method of detecting Main solenoid valve freeze-off if the fuel gas is composed of very "wet" gas (high water content). Once the selected process temperature (TC1/2/3) rises above the "Low Temp SD/ALM" setpoint, a flag is triggered so that an Alarm or shutdown trips if this temperature then falls below this setting. Note that for this Low Temp Alarm or shutdown feature to trip, the measured temperature needs to fall below the Low Temp setpoint minus the deadband used for the selected thermocouple.

For example: TC1 deadband = 2, TC3 deadband = 4, Low Temp Alarm is set to monitor both TC1 and TC3. To trip this alarm on TC1, the TC1 temp would need to fall below (Low Temp setpoint - 2). To trip this alarm on TC3, the TC3 temp would need to fall below (Low Temp setpoint - 4).

Dual TC1/TC2 Difference Shutdown

The Dual TC1/TC2 Difference Shutdown feature is used as a safety feature to sense an issue with a thermocouple. Both thermocouples need to be close to each other to ensure the burner keeps operating. If the difference between TC1 and TC2 (using a dual thermocouple) is greater than 10°C, issue a shutdown because there's an issue with either thermocouple wires melting or a short in a thermocouple at the junction point.

CSC400 Controller Shutdown Display Codes

The following table provides a summary of all the possible Shutdown Display codes that the user may see on the CSC400 Controller's 4-line LED display.

LED Display Indicator	Name	Description and/or Corrective Action if Necessary
Common Operational / Shutdown Messages (Shutdown line only)		
PWR FaiL	Power Fail / Power Fail Latch	Indicates there was a power failure on the main input power to the controller. Seen if the Power Fail Latch menu setting is set to Latched and a power failure occurs. Pressing the Stop then Start buttons, or a toggling of the Modbus Remote Stop/Start power rung is required to reset this condition.
FF	Flame Fail	Indicates that the pilot has gone out and/or failed to re-light. "FF" will flash on the bottom right part of the display beside the respective ignitor ("1:" or "2:") indicating Flame Fail status. Press the Stop then Start buttons, toggle the Remote Start/Stop switch, or send Modbus Remote Stop then Start commands to retry the ignition sequence.
OFF	Power is Off	Indicates that the system is in the Off state (Stop button was pressed, Modbus Remote Stop command received).
TC1 OPEN	TC1 is Open	TC1 thermocouple is currently open. Check TC1 thermocouple and terminal connections.
TC2 OPEN	TC2 is Open	TC2 thermocouple is currently open. Check TC2 thermocouple and terminal connections.
TC3 OPEN	TC3 is Open	TC3 thermocouple is currently open. Check TC3 thermocouple and terminal connections.
POC	Proof of Closure	Indicates that the "POC" input is open, preventing power from going to the ignition module and allowing the system to start.
RemStoP	Remote Stop	Indicates that the "Remote Start/Stop" input terminals are in the Off or Stop (open) position. Jumper with a wire jumper when not used.
Hish Gas	High Gas Shutdown	Indicates that the "High Gas Shutdown" switch inputs (or terminals) are open (in shutdown). Jumper with a wire jumper when not used.
Low Gas	Low Gas Shutdown	Indicates that the "Low Gas Shutdown" switch inputs (or terminals) are open (in shutdown). Jumper with a wire jumper when not used.
LevelL	Level Shutdown	Indicates that the "Level Shutdown" switch inputs (or terminals) are open (in shutdown). Jumper with a wire jumper when not used.
Aux 1	Auxiliary 1 Shutdown	Indicates that the " Auxiliary 1 Shutdown" switch inputs (or terminals) are open (in shutdown). Jumper with a wire jumper when not used.
Aux 2	Auxiliary 2 Shutdown	Indicates that the " Auxiliary 2 Shutdown" switch inputs (or terminals) are open (in shutdown). Jumper with a wire jumper when not used.
Hi TemP	High Temperature Shutdown	Indicates that the measured temperature on TC2 is at or above the TC2 setpoint, thereby shutting off all solenoid valve outputs (Pilot, Main, T/Main) for both Ignitor output blocks. May also indicate that the system is in High Temp Latch mode if the "HT Latch" menu option is Enabled. Pressing the Stop then Start buttons, or issuing Modbus Remote Stop then Start commands is required to reset this condition.
HT TC3	High Temperature Auxiliary Shutdown - TC3	Indicates that the measured temperature on TC3 is at or above the TC3 setpoint, thereby shutting off all solenoid valve outputs (Pilot, Main, T/Main) for both Ignitor output blocks. This will only be seen if the menu option " TC3 AUX HT SD" is set to "Yes" and if TC3 is enabled.

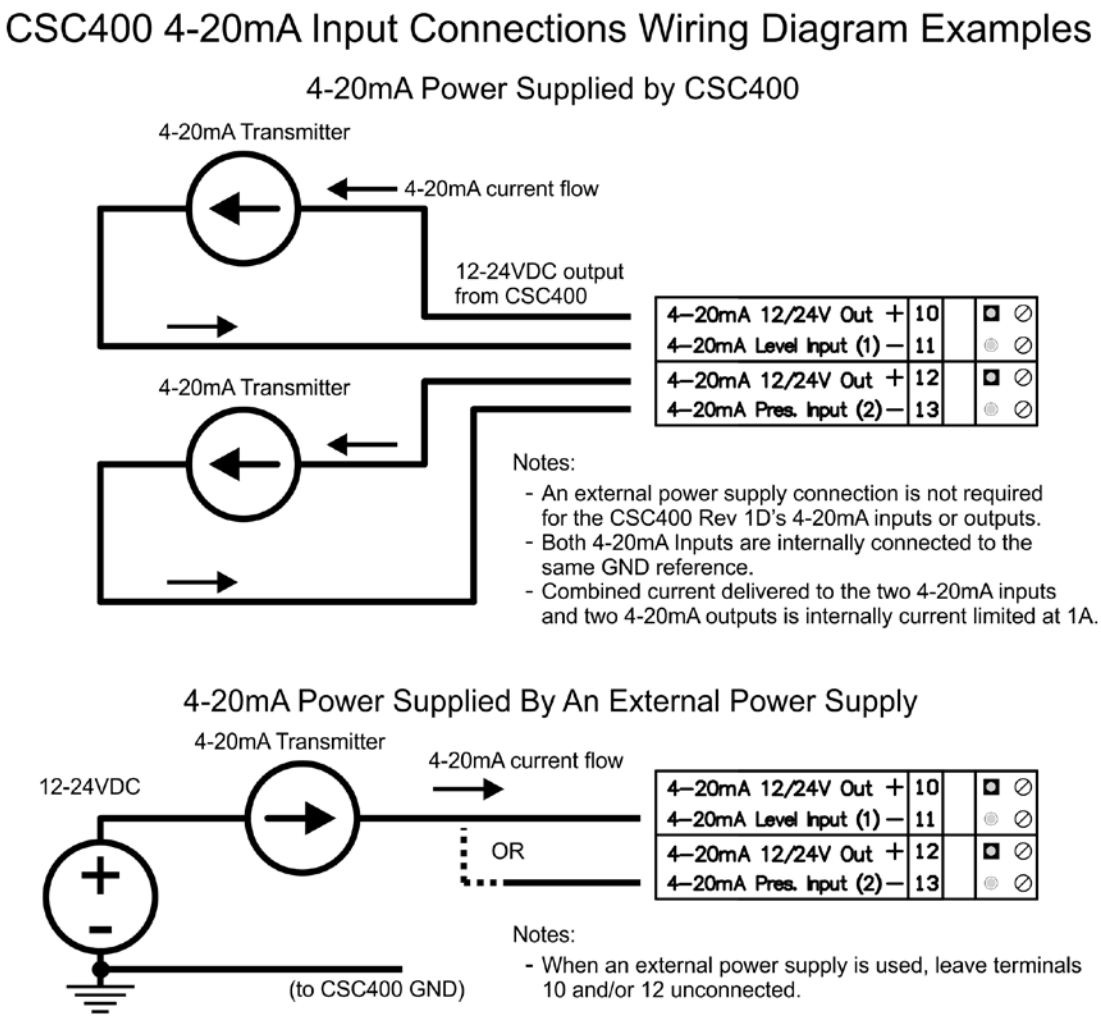
MB RStop	Modbus Remote Stop	Indicates that the CSC400 has received a Modbus Remote Stop command and is waiting for either a Modbus Remote Start command, or a toggling of the On/Off or Remote On/Off switch before the system will start again.
Pilot F	Pilot Fail	A Pilot output has been detected as not being on when the Main and/or TMain solenoid attempts to turn on.
420 1 Lo	4-20mA Input 1 Lo Shutdown	Indicates that the 4-20mA Input 1 Low Shutdown has been triggered, shutting down Ignitors and output solenoids. If "Lo Alarm" is Enabled in the 4-20mA Input 1 settings and "SD on Lo Alarm" is set to "ON", the measured 4-20mA input has fallen below the selected Low Trip-point value.
420 1 Hi	4-20mA Input 1 Hi Shutdown	Indicates that the 4-20mA Input 1 High Shutdown has been triggered, shutting down Ignitors and output solenoids. If "Hi Alarm" is Enabled in the 4-20mA Input 1 settings and "SD on Hi Alarm" is set to "ON", the measured 4-20mA input has risen above the selected High Trip-point value.
420 2 Lo	4-20mA Input 2 Lo Shutdown	Indicates that the 4-20mA Input 2 Low Shutdown has been triggered, shutting down Ignitors and output solenoids. If "Lo Alarm" is Enabled in the 4-20mA Input 2 settings and "SD on Lo Alarm" is set to "ON", the measured 4-20mA input has fallen below the selected Low Trip-point value.
420 2 Hi	4-20mA Input 2 Hi Shutdown	Indicates that the 4-20mA Input 2 High Shutdown has been triggered, shutting down Ignitors and output solenoids. If "Hi Alarm" is Enabled in the 4-20mA Input 2 settings and "SD on Hi Alarm" is set to "ON", the measured 4-20mA input has risen above the selected High Trip-point value.
420 1*Lo	4-20mA Input 1 Lo Alarm (no shutdown)	Indicates that the 4-20mA Input 1 Low Alarm has been triggered, but Ignitors and output solenoids are not shutdown. If "Lo Alarm" is Enabled in the 4-20mA Input 1 settings and "SD on Lo Alarm" is set to "OFF", the measured 4-20mA input has fallen below the selected Low Trip-point value.
420 1*Hi	4-20mA Input 1 Hi Alarm (no shutdown)	Indicates that the 4-20mA Input 1 High Alarm has been triggered, but Ignitors and output solenoids are not shutdown. If "Hi Alarm" is Enabled in the 4-20mA Input 1 settings and "SD on Hi Alarm" is set to "OFF", the measured 4-20mA input has risen above the selected High Trip-point value.
420 2*Lo	4-20mA Input 2 Lo Alarm (no shutdown)	Indicates that the 4-20mA Input 2 Low Alarm has been triggered, but Ignitors and output solenoids are not shutdown. If "Lo Alarm" is Enabled in the 4-20mA Input 2 settings and "SD on Lo Alarm" is set to "OFF", the measured 4-20mA input has fallen below the selected Low Trip-point value.
420 2*Hi	4-20mA Input 2 Hi Alarm (no shutdown)	Indicates that the 4-20mA Input 2 High Alarm has been triggered, but Ignitors and output solenoids are not shutdown. If "Hi Alarm" is Enabled in the 4-20mA Input 2 settings and "SD on Hi Alarm" is set to "OFF", the measured 4-20mA input has risen above the selected High Trip-point value.
TC1&2 SD	TC1&2 Difference Shutdown	Indicates that TC1 and TC2 are different by greater than 10°C (18°F). This will only be shown under these conditions if the "Dual TC1&2 SD" configuration option is set to "Yes". For use with a dual thermocouple.
LT1 SD	Low Temp Shutdown, TC1	Indicates that a Low Temperature Shutdown has occurred on TC1. ie: TC1 rose above the Low Temp setpoint, but has now fallen below it, causing a full shutdown.
LT2 ALM	Low Temp Alarm, TC2	Indicates that a Low Temperature Alarm has occurred on TC2. ie: TC2 rose above the Low Temp setpoint, but has now fallen below it, causing an alarm.

Error Message Indicators (any display line)		
Disab	TC1/2/3 Thermocouple Disabled	Indicates that the selected thermocouple (TC1, TC2, or TC3) is not enabled through the menu options.
OPEN	Selected Thermocouple is Open or Failed Open	Indicates that a thermocouple is not connected or that it has failed in an open condition. If a thermocouple indicating "OPEN" is enabled, all solenoid valve outputs will not open and the CSC400 system will not start until the thermocouple "OPEN" condition is fixed.
Uncal	Uncalibrated	Indicates that the CSC400 Controller's thermocouples are uncalibrated. Seen if the internal thermocouple calibration procedure failed.
Uncommon Error Message Indicators (Shutdown line only)		
PilF 1	Pilot Solenoid Output Fail, IGN1	IGN1's Pilot solenoid output has failed but it's supposed to be open. ie: no output voltage is present on the Pilot + terminal
P1 Fault	Solenoid Fault - Pilot, IGN1	There has been a fault on IGN1's Pilot Solenoid output due to a short circuit or excessive current draw on the Pilot + terminal (to ground).
M1 Fault	Solenoid Fault - Main, IGN1	There has been a fault on IGN1's Main Solenoid output due to a short circuit or excessive current draw on the Main + terminal (to ground).
TM1 Fault	Solenoid Fault - TMain, IGN1	There has been a fault on IGN1's T/Main Solenoid output due to a short circuit or excessive current draw on the T/Main + terminal (to ground).
PilF 2	Pilot Solenoid Output Fail, IGN2	IGN2's Pilot solenoid output has failed but it's supposed to be open. ie: no output voltage is present on the Pilot + terminal
P2 Fault	Solenoid Fault - Pilot, IGN2	There has been a fault on IGN2's Pilot Solenoid output due to a short circuit or excessive current draw on the Pilot + terminal (to ground).
M2 Fault	Solenoid Fault - Main, IGN2	There has been a fault on IGN2's Main Solenoid output due to a short circuit or excessive current draw on the Main + terminal (to ground).
TM2 Fault	Solenoid Fault - TMain, IGN2	There has been a fault on IGN2's T/Main Solenoid output due to a short circuit or excessive current draw on the T/Main + terminal (to ground).
TC1 F	TC1 Fault, Intermittent Pilot Mode	TC1 has shut off power to the ignition module in Intermittent Pilot mode due to a fault condition on thermocouple 1.
4201 OPN	4-20mA Input 1 Open	Indicates that the 4-20mA Input 1 is Open. A Shutdown has been triggered and all Ignitors and output solenoids are turned off. If "Lo Alarm" or "Hi Alarm" are Enabled in the 4-20mA Input 1 settings, the 4-20mA Input 1 has been detected as being open.
4202 OPN	4-20mA Input 2 Open	Indicates that the 4-20mA Input 2 is Open. A Shutdown has been triggered and all Ignitors and output solenoids are turned off. If "Lo Alarm" or "Hi Alarm" are Enabled in the 4-20mA Input 2 settings, the 4-20mA Input 2 has been detected as being open.
R9Fail	Relay 9 (Stop relay) output failure	Indicates that there is an internal error with the 12VDC voltage level. This message may show briefly during normal operation timing. If condition persists, contact ACL for details.

4-20mA Input Connection Notes for Rev 1D CSC400 Boards

The CSC400 Rev 1D board changes how the 4-20mA inputs and outputs are powered. The CSC400 Rev 1D board provides a shared 12-24VDC power switch with a combined maximum output current of 1A for all 4-20mA Inputs and Outputs. The provided input voltage (eg: 12VDC or 24VDC) will be the same voltage on the power output terminals for the 4-20mA Inputs (terminals 10 and 12) and the same voltage supplied to the two sets of 4-20mA Output circuitry.

Figure 15 - CSC400 4-20mA Input Connections Wiring Diagram Examples



4-20mA Input DIP Switches

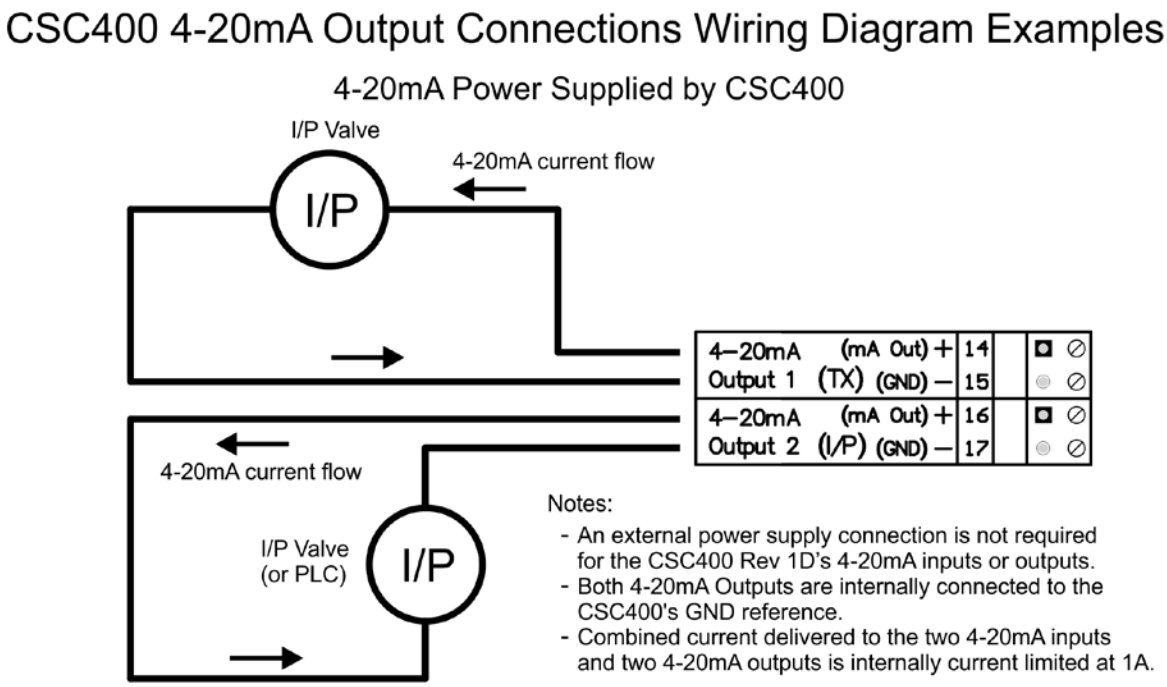
There are 4 DIP switches for each 4-20mA Input. They select the inline (series) resistor added to each 12/24V Output (terminals 10 and 12). A DIP switch is "On" when it is moved to the right side (towards the "Local Mount of the Ignition Module" area). The inline resistance options are present to assist with 4-20mA Input impedance adjustments and for possible HART communication devices. DIP Switches labeled "1:" correspond to "Level Input (1)". DIP Switches labeled "2:" correspond to "Pressure Input (2)". Operation of each 4-20mA Input is identical regardless of the "Level" or "Pressure" label.

Number of DIP Switches On	Resulting Inline Series Resistance
All DIP Switches Off	249 ohms
1 of top three DIP switches "On"	124.5 ohms
2 of top three DIP switches "On"	83 ohms
3 of top three DIP switches "On"	62 ohms
"Short" DIP switch "On"	0 ohms: All external resistors are bypassed, shorting the internal 12/24V power supply output to the terminal(s) (10 and 12) directly

4-20mA Output Connection Notes for Rev 1D CSC400 boards

The CSC400 Rev 1D board changes how the 4-20mA inputs and outputs are powered. The CSC400 Rev 1D board provides a shared 12-24VDC power switch with a combined maximum output current of 1A for all 4-20mA Inputs and Outputs. The provided input voltage (eg: 12VDC or 24VDC) will be the same voltage on the power output terminals for the 4-20mA Inputs (terminals 10 and 12) and the same voltage supplied to the two sets of 4-20mA Output circuitry. The 4-20mA Output terminals 14 and 16 should be connected directly to the external I/P valve, 4-20mA PLC input, or other 4-20mA controlled device.

Figure 16 - CSC400 4-20mA Output Connections Wiring Diagram Examples



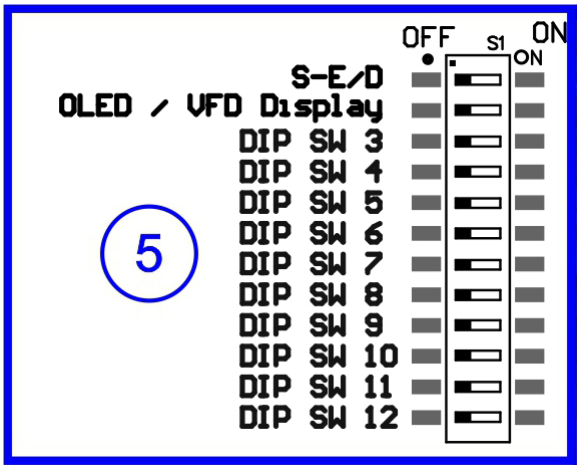
Notes:

- An output of 3.5mA means there's an error. This could mean that the selected thermocouple for the 4-20mA Output is disabled.

DIP Switch Option Settings

Main DIP Switch (S1, 12-pin)

For the main DIP switches, an "OFF" setting means the DIP switch is moved to the left. An "ON" setting means the DIP switch is moved to the right.



DIP Switch Number	Name on Circuit Board	Description	OFF	ON	Operation
1	S-E/D	Security Enable/Disable	(Default)		Security mode is Off (Disabled). The CSC400 will accept all button input modifications, including temperature setpoint changes.
					Security mode is On (Enabled). The CSC400 will not accept temperature setpoint modifications. The Menu and Select Buttons will still work but the Up and Down buttons will not.
2	OLED/VFD Display	OLED/VFD Display Mode Select	(Default)		OLED / VFD Select switch indicating that the OLED type display is attached to the CSC400. This DIP switch should only be changed by factory personnel or by trained technicians.
					OLED / VFD Select switch indicating that the VFD (vacuum fluorescent display) type display is attached to the CSC400. This DIP switch should only be changed by factory personnel or by training technicians.
3-12	(none)	Spare DIP switches			Spare DIP switches are provided for future options or expansion.

Appendix A - CSC400 Rev 1D Technical Specifications

General Notes:

- All components on the CSC400 Controller are RoHS compliant.

Modbus Notes:

- Receivers are designed to fail-safe to a logic high output state if inputs (terminals A and B) are left un-driven or shorted. If the bus is un-driven for long periods of time, the receivers are designed to not require line polarization on the bus (adding a pullup resistor to "A" and a pulldown resistor to "B"). Line polarization may be enabled (via the two DIP switches on the top of the CSC400 Controller's Modbus DIP switches (4 half-pitch DIP switches)) for use with other devices on the same RS-485 bus.
- Drivers are protected from excess current flow caused by bus contention or output short-circuits by both an internal current limit and a thermal-overload shutdown.
- RS-485 inputs (terminals A and B) are protected against ESD (Electrostatic Discharge) events up to +/- 15kV (Air-Gap and Human Body Model) and up to +/- 8kV Contact Discharge (IEC61000-4-2).

Specification	Default Value	Possible Values or Range
Modbus Protocol	Modbus RTU	Modbus RTU
Modbus Slave ID (address)	2	1 - 247
Modbus/RS-485 Serial Settings:		
Baud rate	9600	300, 1200, 2400, 4800, 9600, 19200, 38400
Number of data bits	8	8
Parity bit setting	None	None, Even, Odd
Stop bits	1	1, 2 (only with parity set to "None")
Operating Temperature		-40°C to 60°C ambient
RS-485 (Modbus) Signals:		
Input voltage on A and B signals		-7 VDC to +12 VDC
Driver Short Circuit Current Limit		+/- 250mA maximum
Differential Driver Output, No Load		5 VDC
Differential Driver Output, R_L = 54ohms		1.5 VDC minimum, 2.7 VDC typical, 5 VDC maximum
Receiver Input Resistance		96k ohms minimum ($1/8^{th}$ of a Modbus "Unit Load")
Receiver Differential Threshold (VA – VB)		-200mV minimum -125mV typical -40mV maximum
Receiver Input Hysteresis		25mV typical
Termination		None or 120ohms (2-pin jumper may be installed by user)
Line Polarization Resistors		560 ohms +/- 1%, selectable by user via two DIP switches
Line Polarization Pullup voltage		5 VDC +/- 1% (5% max)
Line Polarization Pulldown voltage		RS-485 Isolated or Common GND (0V)

Inputs and Control Outputs:		
Main Power Input, Voltage Range		10VDC (minimum) to 29VDC (maximum)
System Current Draw, no solenoid outputs on, OLED display on, system off		350mA Max, 143 mA typical (at 12VDC)
System Current Draw, no solenoid outputs on, OLED display off, system off		300mA Max, 100mA typical (at 12VDC)
System Current Draw, no solenoid outputs on, Ignition module on, Max		620mA / 310mA (12VDC / 24VDC)
System Power Draw, no solenoid outputs on, Ignition module on, Max		7.44W (no solenoids on)
4-20mA Inputs:		
Allowable Voltage Input, 4-20mA mode (Terminals 11 and 13)		12VDC minimum, 26VDC maximum (up to 24VDC typical)
Allowable Voltage Input, 1V-5V mode (Terminals 11 and 13)		0V-26VDC, 1V - 5V for input measurements, 0V sensed as "open" or disconnected
Input Impedance		249 ohms, +/- 0.1%
Solenoid Outputs:		
Voltage Output on Solenoid terminals (12VDC main input)		Main Power Input minus a small voltage drop that is dependent on current draw and temperature: Solenoid outputs are 11.85V to 11.98V (approx.)
Voltage Output on Solenoid terminals (24VDC main input)		Main Power Input minus a small voltage drop that is dependent on current draw and temperature: Solenoid outputs are 23.85V to 23.98V (approx.)
Voltage Output on Solenoid terminals (10VDC main input)		Main Power Input minus a small voltage drop that is dependent on current draw and temperature: Solenoid outputs are 9.85V to 9.98V (approx.)
Maximum Allowed Continuous Output Current per Solenoid Output		3A
Alarm / Status Contacts, AUX1 & AUX2 Solid-State Relays:		
Maximum Voltage ("NC" to COM or "NO" to COM)		30VDC, $30V_P$(AC)
Maximum Current ("NC" to COM or "NO" to COM)		$120mA_{rms}$ / mA_{DC}
Resistance ("NC" to COM or "NO" to COM)		35 ohms max
Physical Dimensions:		
Length		10.750” (273.05mm)
Width		9.000” (228.6mm)
Height, maximum (from bottom of components on bottom layer to top of components on top layer)		1.130” (28.70mm)

Appendix B - Modbus/RS-485 Cabling Technical Details

> Refer to the document "CSC400_Modbus_Installation_Manual.pdf" for additional details on additional Modbus registers, programming, testing, and troubleshooting.

Additional Modbus documentation is available at www.modbus.org:

RS-485 Signal Naming Conventions

The RS485 signal naming convention used in this document and by many RS485 transceiver vendors is reversed from what the EIA/TIA-485 specification states:

CSC400 Modbus/RS485 Documentation	EIA/TIA-485 Naming Convention	Modbus Specification Name	Description
A ("Data A +")	B	D1	Non-Inverting, Transceiver Terminal 1, V1 voltage (V1 > V0 for binary 1 (OFF) state
B ("Data B –")	A	D0	Inverting, Transceiver Terminal 0, V0 voltage (V0 > V1 for binary 0 (ON) state
Isolated GND (or common GND)	C	Common	Signal and Optional Power Supply common ground

Half-Duplex vs Full-Duplex

Half-duplex communication allows only one device to communicate over the two RS-485 wires (one differential pair) at a time. Full-duplex communication adds another pair of wires to allow bi-directional communication between a PC/PLC master and a slave unit simultaneously.

The CSC400 provides a three pin terminal for half-duplex communication between the CSC400 and a host master Modbus device.

Cable Types

Master Used	Cable Type To Use For Testing	Notes
PC	USB to RS485 cable	RS485 cable should have stripped wires for connecting to terminal blocks on the CSC400 Controller
PLC – Programmable Logic Controller (eg: SCADAPack, ROC800 series)	CAT5E	Use a matched twisted pair for RS485A+/B- Eg: Blue for RS485A+ Blue with white stripe for RS485B-

Allowable Pairings of CAT5E Cable

Signal	CAT5E Cable Wire Color Twisted Pairs	Notes
RS485A + or Data +	Blue	
RS485B - or Data -	Blue with white stripe	

RS485A + or Data +	Green	
RS485B - or Data -	Green with white stripe	
RS485A + or Data +	Orange	
RS485B - or Data -	Orange with white stripe	
RS485A + or Data +	Brown	
RS485B - or Data -	Brown with white stripe	

The common ground connection should use a wire from an unused pair in the CAT5E cable.

Examples of USB to RS485 cables

Manufacturer	Part #	Length	Website	Available at
Moxa	UPort 1130/1130I or UPort 1150/1150I		www.moxa.com	www.moxa.com
FTDI Chip	USB-RS485-WE-5000-BT	5m	www.ftdichip.com	www.digikey.com, www.mouser.com
FTDI Chip	USB-RS485-WE-1800-BT	1.8m	www.ftdichip.com	www.digikey.com, www.mouser.com
Startech	ICUSB422	6ft	www.startech.com	www.startech.com

Industrial-Rated USB Hubs

Manufacturer	Part #	Website	Available at
Startech	ST4200USBM	www.startech.com	www.startech.com
Moxa	UPort 404, UPort 407	www.moxa.com	www.moxa.com

Wiring topology

For connecting multiple Modbus devices on to the same RS-485 bus, a “daisy-chain” wiring topology should be used (one long cable with short “stub” connections to each device). Ensure that short “stub” connections are made at each device to the main RS485 cable to reduce signal reflections and interference.

A “star” or “ring” wiring topology should not be used. An example of a “star” configuration would be separate, multiple cables branching out from the Master to each individual slave device. Only one cable should be connected at the Master end.

Line Polarization

Line Polarization enables a pullup resistor on the “Data A +” signal and a pulldown resistor on the “Data B –“ signal. It ensures that the bus is put into a known state with the “Data A +” signal High and the “Data B -” signal Low. Some RS485 receivers are susceptible to external noise or interference if the RS485 bus is not driven to a known state when the bus is idle (no device is driving a signal on the bus).

Line Polarization should only be enabled on one device on the RS485 bus, if necessary. Usually this is done at the end of the bus where the master device resides. The CSC400 Controller allows the implementation of Line Polarization via two DIP switches located on the top of the board.

Some PC software (or other Masters) will work with Line Polarization off, while others may need the non-inverting signal to be driven high during idle times on the RS485 bus. For example, the PC software Modnet for Modbus RTU will work with Line Polarization off but it shows an extra "0x00" byte received at the beginning and end of a Modbus packet. However, the Modbus Reader PC software shows a Frame Error received by the CSC400 Controller if no Line Polarization is turned on.

Termination

This type of termination refers to bus termination between the pairs, not the termination resistors used for Line Polarization. This termination connects signal "Data A +" to "Data B –" through a 120 ohm resistor.

An RS-485 bus should only be terminated at each end of the cable (at each device at the end of the cable). No other devices in-between the two devices at each end should have termination resistors installed or enabled.

The CSC400 Controller has a 4-pin DIP switch with the third switch from the top labeled "120ohm term". This can be used to connect a built-in 120 ohm resistor. Simply push the third DIP switch to the right and the 120ohm termination resistor will be connected.

Number of Allowed Devices on the RS-485

The number of devices allowed on an RS-485 bus depends on a variety of factors: the total length of the wire, the wire gauge, the signaling characteristics or the "Unit Load" of each device on the bus (receiver input impedance, capacitance).

The CSC400 Controller uses newer RS485 transceivers with advanced fail-safe features. Due to these newer transceivers, the theoretical maximum number of devices allowed on the bus is 256 because the receiver's input impedance is 96kohm which is $1/8^{th}$ the input impedance of older transceivers at 12kohm ($1/8^{th}$ of a "Unit Load"). The Modbus specification limits this theoretical maximum further to 247 devices allowed on an RS-485 bus.

Any Modbus system allows a minimum of 32 devices on the RS-485 bus without use of a repeater. More devices may be allowed depending on the characteristics of all devices on the RS-485 bus.

The CSC400 Controller allows more than 32 devices to be present on the RS-485 bus due to each transceiver occupying $1/8^{th}$ of a Unit Load on the bus. Since each installation is different, with different cable lengths and the potential for other devices to be present on the bus, the user needs to test out the maximum number of devices that can be placed on each RS-485 bus.

Slew Rate

The CSC400 Controller incorporates RS-485 transceivers with slew rate limited drivers. Slew rate refers to the speed at which a signal changes state from a 0 (Low) to a 1 (High) or from a High to a Low state. Slew rate limited drivers slow down the rise and fall times of a signal which help with reducing signal reflections, reducing EMI emissions, and possibly allowing a bus to work without termination resistors.

Unfortunately, with slower rise and fall times, the maximum communication speed (or baud rate) is reduced. The drivers on the CSC400 Controller can operate at a maximum rate of 115kbps but the maximum setting allowed in the CSC400 firmware is 38.4kbps (38400 baud, or raw bits per second).

Isolated (or Common) Ground

The "Isolated Ground" terminal on each CSC400 Controller is isolated from the onboard CSC400 ground. This isolated ground connection should be used to connect all common ground connections on all RS-485 devices on the bus. This common ground should be connected to earth or protective ground at one end of the RS-485 cable only (preferably), usually at the master device.

Due to the potential for large amounts of noise to be conducted onto the RS485 cable, the Isolated GND terminal is connected to the CSC400 earth ground to shunt noise away locally instead of at the Modbus master. This is done using a wire jumper soldered onto the main CSC400 circuit board at jumper J23, to the left of the three Modbus terminals and Modbus DIP switch.

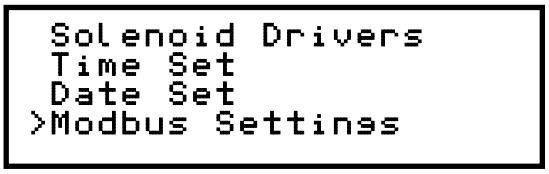
A solid ground connection should be made between a CSC400 earth ground terminal to an earth ground external to the CSC400 using a minimum 16AWG wire.

Appendix C - Programming a New Modbus Slave ID (Address)

The default Modbus Slave ID for a new CSC400 is “2”.

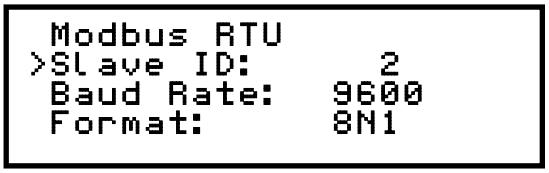
Press the Menu key to show the Top Menu. Press and hold the Down Arrow key to scroll down the Top Menu's options until the cursor reaches "Modbus Settings" (see Figure 17). Press the select button.

Figure 17 - Top Menu - Modbus Settings



The cursor (">") should be on the "Slave ID:" line of the "Modbus Settings Menu". If not, use the Up and Down arrow keys to move the cursor to this line. Press the Select button. The cursor will blink ">" alternating with "▶" to indicate the Slave ID is now in Edit mode.

Figure 18 - Modbus Settings Menu



Use the Up and Down buttons to modify the Modbus Slave ID to the new desired value and then press the Select button again to exit Edit mode.

Press the Menu button twice to return to the main temperature display screen.

Appendix D - Troubleshooting

Burner Management Troubleshooting

#	Issue	Possible Reason	Corrective Action
1	Fails to attempt ignition	Blown fuse	Check if the display is on or not: a menu screen or the Status screen should always be displayed. If Display is off, replace fuse with a 6.3A max fuse
		Supply voltage too low	Ensure that the minimum input voltage is 11.5VDC (measured with a volt meter) for use with 2-3 solenoid outputs
		Poor power connections	Check all connections on the terminal strips. Ensure that there are no short circuits, that the wires are tightly gripped inside the terminals, and that the screws on each terminal are tight.
		POC terminal not closed, display showing "POC"	Ensure that 12VDC is measured on both the POC+ and POC- terminals
2	Attempts ignition but pilot doesn't light	Fuel gas supply to Pilot may be too high or too low	Pilot fuel gas supply should be set at 5 pounds
		Gap setting on ignitor/flame rod not correct	Gap should be approximately 1/8" (3.175mm) and rod tip needs to be cut to a sharp point
		Ignition cable defective or insulation worn	Check continuity through the ignition cable. Multimeter should read close to zero ohms. If not, cable needs to be replaced.
		Poor ground connection	Ensure that good, thick ground connections are made at the CSC400 and at the Pilot/burner valve.
		Pilot solenoid failure	Check supplied power to solenoid. Check gas flow through solenoid.
		Plugged orifice on Pilot	Clean out Pilot orifice (Do Not redrill!)
3	Weak or Erratic Spark	Gap setting too wide or rod not cut to a point	Shorten gap setting to approximately 1/8" (3.175mm) and recut the ignitor rod tip.
		Ignition cable defective or insulation worn	Check continuity through the ignition cable. Multimeter should read close to zero ohms. If not, cable needs to be replaced.
		Poor ground connection	Ensure that good, thick ground connections are made at the CSC400 and at the ignitor tip.
		Contaminated ignitor rod or Pilot nozzle	Remove Pilot assembly, clean rod and nozzle, and reinstall.
4	Solenoid valve not opening	No power to solenoid valve or faulty solenoid valve	Replace defective solenoid valve
5	Solenoid valve opens but then closes again (intermittent operation)	Wrong Low Power Solenoid Driver setting for the attached solenoids	Verify that the Low Power Solenoid Driver DIP switch settings are matched to the solenoid valves connected to the CSC400.
		Voltage droop on input	Some larger solenoid valves rated for 12VDC require an output voltage very near to 12VDC. Measure the output voltage on the solenoid terminals to ensure that it's sufficient (approx. >= 11.5VDC). Higher current drawn on each solenoid output will cause slightly higher voltage drops which may interfere with solenoid operation. Input voltage may

			need to be boosted to 12.5VDC if multiple large solenoids are attached to one solenoid output.

Modbus Communications Troubleshooting

#	Issue	Possible Reason	Corrective Action
1	Modbus Master can't read temperature values from CSC400 (or any other data)	RS485 cable isn't connected properly	Ensure the wires for the RS485 cable are connected properly at the CSC400 and at the master and that the screw terminals are gripping the metal wire, not the insulation. Wires may also become damaged with frequent bending or if they've been pinched. Ensure that the RS485 signal wires haven't been broken by testing continuity.
		Modbus Slave ID (address) is different than the address used for the CSC400	Verify that the address used by the master to communicate with the CSC400 matches the address set in the CSC400. Try using the default address: "2". The master may need to poll a variety of modbus addresses (from 1 to 247) to find slaves that respond.
		Power to the CSC400 may have been interrupted	Verify the CSC400 has power locally.
		Inappropriate, non-twisted pair cable has been used for the RS485, for long distances	Ensure that an appropriate twisted-pair cable (like CAT5e cable, or other appropriate cable) is used for the RS485 bus.
2	Modbus communication interrupted, noise issues suspected	Inadequate or ineffective grounding	Ensure that an adequate connection has been made between the earth ground terminal on the CSC400 and an appropriate earth ground external to the CSC400 (eg: thick spike in the ground, underground water pipes, earth ground pin on an AC wall outlet).
			Ensure that unused, non-power sourcing wires in any RS485cable are grounded.
			Connect the "Isolated GND" terminal on the CSC400 Controller to the CSC400 earth ground terminal to provide a localized ground path for noise. (Attach GND jumper on Rev 2B cards and later)
		Power to the CSC400 may have been interrupted	Verify the CSC400 has power locally.
3	Modbus PC Master communication with CSC400 interrupted	If a USB-to-RS485 conversion cable has been used, the PC test software may have lost connection to the virtual COM port, or noise may have interfered with USB communications.	Unplug the USB-to-RS485 conversion cable from the USB port on the PC, wait 10 seconds, then plug it back in. Retry connecting to the COM port in the test software.
			Add an industrial-rated USB hub between the PC and the USB-to-RS485 cable. Ensure that the hub is powered locally, not bus-powered from the PC.
			Refer to Troubleshooting item # 2 for additional

			grounding notes
		Power to the CSC400 may have been interrupted	Verify the CSC400 has power locally.
4	Modbus communication works for writing Remote Stop, Remote Start, but no values are being read back	CSC400's ignition module may be "sparking".	The CSC400 will not respond to Modbus requests when the ignition module is powering its high-voltage sparker to ignite the Pilot.
		If a USB-to-RS485 conversion cable has been used, the PC test software may have lost connection to the virtual COM port, or noise may have interfered with USB communications.	Unplug the USB-to-RS485 conversion cable from the USB port on the PC, wait 10 seconds, then plug it back in. Retry connecting to the COM port in the test software.

Notes:

Notes:

ACL

Manufacturing Inc.

Website: www.aclmfg.com

Limited Warranty

Seller warrants that the product hereby purchased is, upon delivery, free from defects in material and workmanship and that any product which is found to be defective in such workmanship or material will be repaired or replaced by Seller for a period of one year from purchase date. Warranty of such items do not include shipping, installation or set-up.

Liability Statement

ACL Manufacturing Inc. Shall not be liable for any special, indirect, consequential or other damages of a like general nature, including, without limitation, loss of profits or production, or loss of expenses of any nature incurred by the buyer or any third party.

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