Micro CPU200/250 User Manual

HE959CPU200 HE959CPU250

compatible with OCS I/O

HG-1376

MAN1507_02_EN_CPU200_250_UM

LIMITED WARRANTY AND LIMITATION OF LIABILITY

Horner APG, LLC, ("HE-APG") warrants to the original purchaser that the CPU200 and CPU250 modules manufactured by HE-APG is free from defects in material and workmanship under normal use and service. The obligation of HE-APG under this warranty shall be limited to the repair or exchange of any part or parts which may prove defective under normal use and service within two (2) years from the date of manufacture or eighteen (18) months from the date of installation by the original purchaser whichever occurs first, such defect to be disclosed to the satisfaction of HE-APG after examination by HE-APG of the allegedly defective part or parts.

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To obtain warranty service, return the product to your distributor with a description of the problem, proof of purchase, postpaid, insured, and in a suitable package.

ABOUT PROGRAMMING EXAMPLE

Any example programs and program segments in this manual or provided from Horner's website, Cscape, or on YouTube, are included solely for illustrative purposes. Due to the many variables and requirements associated with any installation, Horner APG cannot assume responsibility or liability for actual use based on the examples and diagrams. It is the sole responsibility of the system designer utilizing the CPU200 and CPU250 modules to design the end system, integrate the CPU200 and CPU250 modules, and make safety provisions for the end equipment customary to industrial applications as defined in any codes or standards which apply.

NOTE: The programming examples shown in this manual are for illustrative purposes only. Proper machine operation is the sole responsibility of the system integrator.

PREFACE

This manual explains how to use the CPU200 OCS and CPU250 OCS.

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Safety and Compliance

Chapter 1: Safety and Compliance

1.1: Warnings

When found on the product, the following symbols specify:

WARNING: Consult user documentation.

WARNING: Electrical Shock Hazard.

WARNING: EXPLOSION HAZARD – Substitution of components may impair suitability for Class I, Division 2.

WARNING: EXPLOSION HAZARD – Do not disconnect equipment unless power has been switched off or the area is known to be non-hazardous.

1. To avoid the risk of electric shock or burns, always connect the safety (or earth) ground before making any other connections.
2. To reduce the risk of fire, electrical shock, or physical injury it is strongly recommended to fuse the voltage measurement inputs. Be sure to locate fuses as close to the source as possible.
3. Replace fuse with the same type and rating to provide protection against risk of fire and shock hazards.
4. In the event of repeated failure, do not replace the fuse again as a repeated failure indicates a defective condition that will not clear by replacing the fuse.
5. Only qualified electrical personnel familiar with the construction and operation of this equipment and the hazards involved should install, adjust, operate, or service this equipment. Read and understand this manual and other applicable manuals in their entirety before proceeding. Failure to observe this precaution could result in severe bodily injury or loss of life.

WARNING: BATTERY MAY EXPLODE IF MISTREATED. DO NOT RECHARGE, DISASSEMBLE, OR DISPOSE OF IN FIRE.

WARNING: BATTERIES MUST ONLY BE CHANGED IN AN AREA KNOWN TO BE NON-HAZARDOUS.

WARNING: The USB parts are for operational maintenance only. Do not leave permanently connected unless area is known to be non-hazardous.

WARNING: If the equipment is used in a manner not specified by Horner APG, the protection provided by the equipment may be impaired.

NOTE: All applicable codes and standards must be followed in the installation of this product.

NOTE: For I/O wiring (discrete), use the following wire type or equivalent: Belden 9918, 18 AWG, or larger.

NOTE: See Electrical Installation for more details.

1.2: FCC Compliance

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference.
2. This device must accept any interference received, including interference that may cause undesired operation.

1.3: Safety Precautions

All applicable codes and standards need to be followed in the installation of this product.

Adhere to the following safety precautions whenever any type of connection is made to the module:

1. Connect the safety (earth) ground on the power connector first before making any other connections.
2. When connecting to the electric circuits or pulse-initiating equipment, open their related breakers.
3. Do NOT make connection to live power lines.
4. Make connections to the module first; then connect to the circuit to be monitored.
5. Route power wires in a safe manner in accordance with good practice and local codes.
6. Wear correct personal protective equipment including safety glasses and insulated gloves when making connections to power circuits.
7. Ensure hands, shoes, and floor are dry before making any connection to a power line.
8. Make sure the unit is turned OFF before making connection to terminals.
9. Make sure all circuits are de-energized before making connections.
10. Before each use, inspect all cables for breaks or cracks in the insulation. Replace immediately if defective.
11. Use copper conductors in Field Wiring only, 60/75°C.
12. Use caution when connecting controllers to PCs via serial or USB. PCs, especially laptops may use “floating power supplies” that are ungrounded. This could cause a damaging voltage potential between the laptop and controller. Ensure the controller and laptop are grounded for maximum protection. Consider using a USB isolator due to voltage potential differences as a preventative measure.

Intro to the CPU200/250

Chapter 2: Intro to the CPU200/250

2.1: Where To Find More Information On The CPU200/250

Datasheet - The datasheet is the first documents to refer to for key information related to specific models. (A basic datasheet is provided in the box with the unit.) . Find **MAN1138** via the Documentation Search page on the Horner website.

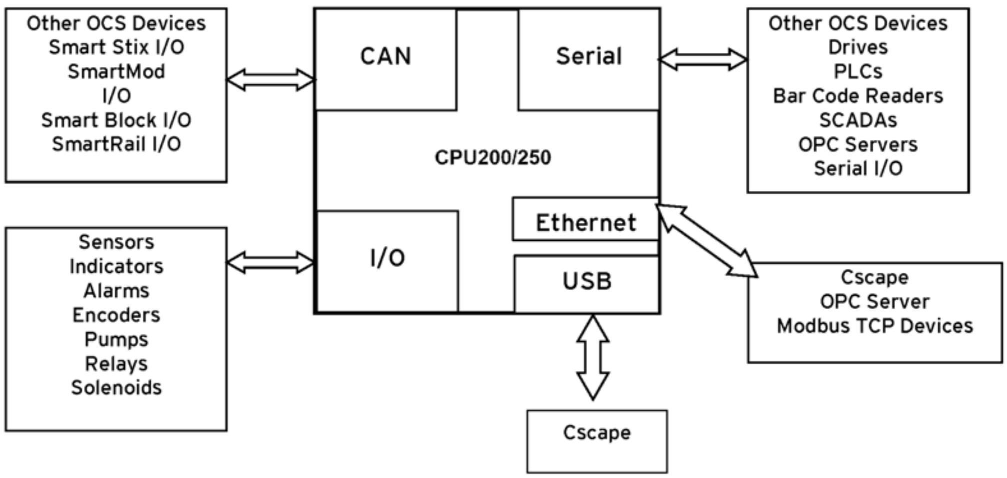
2.2: Visual Overview

NOTE: CPU200 has no built-in I/O and CPU250 has built-in I/O. Mentions of I/O in this user manual apply only to CPU250.

1. Power Input
2. Digital & Flexible In (CPU250 Only)
3. Digital Out & Analog Out (CPU250 Only)
4. MJ1/2 Serial Port
5. Ethernet Port
6. microSD Port
7. Status LEDs
8. Mode Switch
9. CAN Port
10. USB Type C Port

2.3: Connectivity to the CPU200/250

NOTE: For the CPU200 use OCS I/O or Remote I/O.



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Connectivity				
CAN	**I/O**	**USB**	**Serial**	**Ethernet**
Other OCS Devices	Sensors	Cscape	Other OCS Devices	Cscape
SmartStix I/O	Indicators		Drives	OPC Server
SmartBlock I/O	Alarms		PLCs	Modbus TCP Devices
SmartRail I/O	Encoders		Bar Code Readers	Ethernet I/P PLC
OCS-I/O	Pumps		SCADA	FTP
	Relays		OPC Servers	ASCII/TCP
	Solenoids		Serial I/O	Other OCS devices
			SmartMod I/O	

2.4: Features of CPU200/250

Unique features of the CPU200/250 include the following:

- Small, sleek profile saves space and resources.
- Physical Specifications
  - Metric (mm): 114mm x 125mm x 50mm
  - US (inch): 4.50" x 4.92" x 1.97"
  - Weight: 9.77oz (277.1g)
- Advanced control capabilities including floating point, multiple auto-tuning PID loops and string handling capabilities
- Intuitive interface
- Removable media for storage of programs and data logging.
- CsCAN networking port for communication
- Cscape programming software that allows all aspects of the CPU200/250 to be programmed and configured from one integrated application
- Fail-Safe System which allows an application to continue running in the event of “Soft” failures such as (Battery power loss or Battery Backed register RAM/Application flash corruption)
- Clone Unit allows the user to “clone” the OCS. This feature “clones” application program and unit settings stored in Battery backed RAM of an OCS. It can then be used to clone a different OCS (but must be the exact same model).
- Suited for most applications across a diverse range of industries.

Mechanical Installation

Chapter 3: Mechanical Installation

3.1: Mounting Overview

The mechanical installation greatly affects the operation, safety, and appearance of the system. Information is provided to mechanically install the unit such as mounting procedures and other recommendations for correct mechanical installation of the unit.

3.2: Requirements

- Each module is compact and mounts on the DIN rail. Each I/O module installed adds width in increments of 19mm. The distance between wiring duct and surrounding modules must be at least 50mm apart.
- The DIN rail clip adds to the overall measurements. The CAN, power, LAN, and serial connectors also add to the measurements.
- Modules can be added after the base has been installed on the DIN rail and cannot be hot swapped with power applied.

NOTE: I/O scanning will stop until the correct modules for the system are detected in all slots.

DIN Rail Alignment Requirements

1. Confirm that the DIN rail is in a horizontal position before installing the unit. Horizontal orientation is required to avoid module slippage on the DIN rail.
2. Align the unit on the DIN rail then push the DIN rail clip to until it clicks into place. Check to ensure that the unit is secure on the DIN rail.

3.3: Mounting Orientation

NOTE: Do NOT mount the unit on its side as this may cause the unit from slipping off the DIN rail.

- Mount the CPU200/250 with the locking DIN tab facing down.
- As modules mount on a DIN rail, be certain that the DIN rail is in a horizontal position before installing the unit. A horizontal orientation in required to prevent the unit from slipping off the DIN rail.

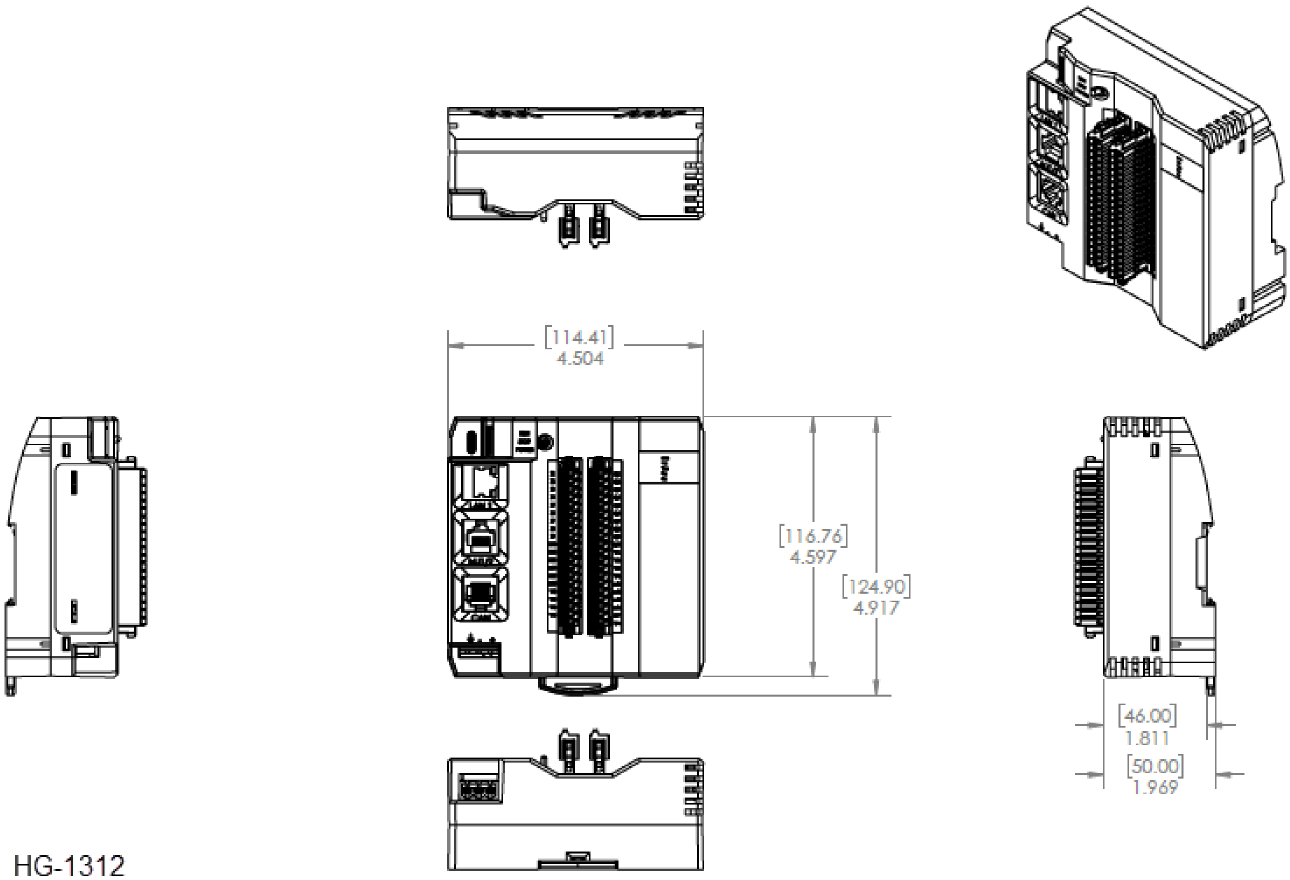
3.4: Module Removal

Modules may be removed while powered; however, I/O scanning on the remaining modules will stop and I/O will go into default state until a new module is inserted and all modules in the configuration are present.

1. Insert a flat-blade screwdriver into the DIN rail latch at the bottom of the module and Pry downwards to release the latch.
2. Rock the module up and off the DIN Rail.

3.5: Dimensions

The CPU200/250 must be mounted inside a NEMA 4X enclosure.



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3.6: Factors Affecting Panel Layout Design and Clearances

WARNING: It is important to follow the requirements of the panel manufacture and to follow all applicable electrical codes and standards.

The designer of a panel layout must assess the requirements of a particular system and to consider the following design factors.

3.6.1: Clearance/Adequate Space

Install devices to allow sufficient clearance to open and close the panel door.

Minimum Clearance Requirements for Panel Box and Door	
Minimum Distance between base of device and sides of cabinet	2" (50.80mm)
Minimum Distance between base of device and wiring ducts	1.5" (38.10mm)
If more than one device installed in panel box (or on door): Minimum Distance between bases of each device	4" (101.60mm) between bases of each device
When door is closed: Minimum distance between device and closed door (Be sure to allow enough depth for the OCS.)	2" (50.80mm)

3.6.2: Grounding

Panel Box: The panel box must be properly connected to earth ground to provide a good common ground reference.

Panel Door: Tie a low impedance ground strap between the panel box and the panel door to ensure that they have the same ground reference.

WARNING: Be sure meet the ground requirements of the panel manufactuer and also meet applicable electrical codes and standards.

3.6.3: Temperature/Ventilation

Ensure that the DIN Rail layout design allows for adequate ventilation and maintains the specified ambient temperature range. Consider the impact on the design if operating at the extreme ends of the ambient temperature range. For example, if it is determined that a cooling device is required, allow adequate space and clearances for the device in the panel box or on the panel door if DIN rail is mounted inside.

3.6.4: Noise

Consider the impact on the panel layout design and clearance requirements if noise suppression devices are needed. Be sure to maintain an adequate distance between the unit and noisy devices such as relays, motor starters, etc.

For details on output protection, especially when using contactors and solenoids, see MAN0962.

3.6.5: Shock and Vibration

The unit has been designed to operate in typical industrial environments that may inflict some shock and vibration on the unit. For applications that may inflict excessive shock and vibration, use the correct dampening techniques or relocate the unit to a location that minimizes shock and/or vibration.

3.6.6: Panel Layout Design and Clearance Checklist

The following list provides highlights of panel layout design factors:

- Meets the electrical code and applicable standards for proper grounding, etc.?
- Meets the panel manufacturer's requirements for grounding, etc.?
- Is the panel box properly connected to earth ground? Is the panel door properly grounded? Has the appropriate procedure been followed to properly ground the devices in the panel box and on the panel door?
- Are minimum clearance requirements met? Can the panel door be easily opened and closed? Is there adequate space between device bases as well as the sides of the panel and wiring ducts?
- Is the panel box deep enough to accommodate the controller?
- Is there adequate ventilation? Is the ambient temperature range maintained? Are cooling or heating devices required?
- Are noise suppression devices or isolation transformers required? Is there adequate distance between the base of the controller and noisy devices such as relays or motor starters? Ensure that power and signal wires are not routed in the same conduit.
- Are there other requirements that impact the particular system, which need to be considered?

Electrical Installation

Chapter 4: Electrical Installation

NOTE: The datasheet is the first document to refer to for model-specific information. Refer to the Documentation Search on the Horner website.

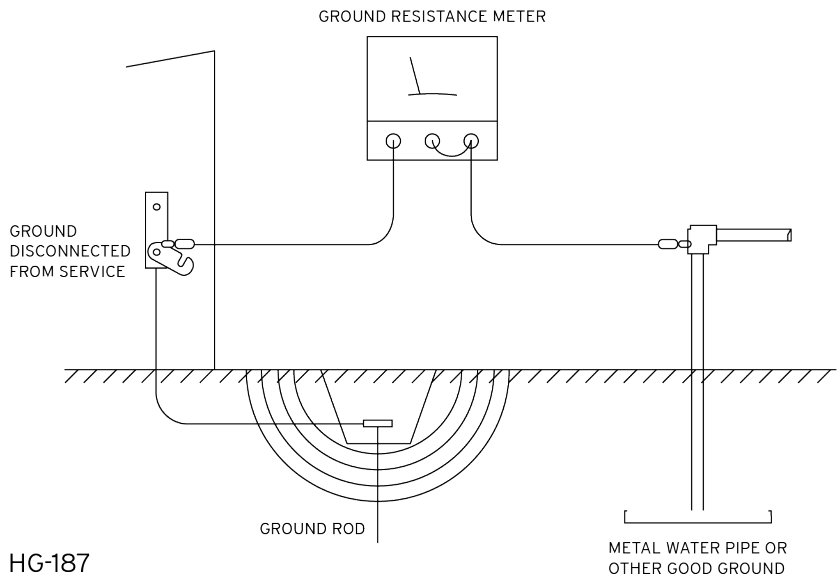
4.1: Ground Specifications

Ideally, a ground resistance measurement from equipment to earth ground is 0Ω. In reality it typically is higher. The US National Electrical Code (NEC) states the resistance to ground shall not exceed 25Ω. Horner Automation recommends less than 15Ω resistance from the equipment to ground. Resistance greater than 25Ω can cause undesirable or harmful interference to the device.

Grounding Definition - The term ***ground*** is defined as a conductive connection between a circuit or piece of equipment and the earth. Grounds are fundamentally used to protect an application from harmful interference causing either physical damage such as by lightning or voltage transients or from circuit disruption often caused by radio frequency interference (RFI).

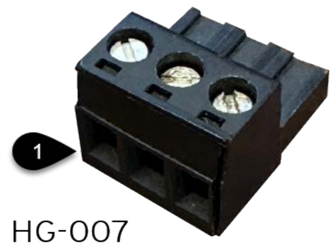
4.2: How to Test for Good Ground

In order to test ground resistance, a Ground Resistance Tester must be used. A typical Ground Resistance Meter Kit contains a meter, two or three wire leads, and two ground rods. Instructions are supplied for either a two-point or a three-point ground test. The figure shows a two-point ground connection test.



4.3: Primary Power Port

The Primary Power Range is 10-30VDC.



Primary Power Port Pins		
PIN	**Signal**	**Description**
1	Ground	Frame Ground
2	DC-	Input Power Supply Ground
3	DC+	Input Power Supply Voltage

4.3.1: DC Input/Frame

- Solid/Stranded Wire: 12-24 AWG (0.511 - 2.5 mm²)
- Strip length: 0.28" (7mm)
- Torque, Terminal Hold-Down Screws: 4.5 – 7 in•lbs (0.50 – 0.78 N•m)
- DC- is internally connected to I/O V-, but is isolated from the V- connection of both CAN1 and CAN2 ports. A Class 2 power supply must be used.

4.3.2: Power Up

1. **OPTIONAL**: Attach ferrite core with a minimum of two turns of the DC+ and DC- signals from the DC supply that is powering the controllers.

2. Connect to earth ground.
3. Apply recommended power.

NOTE: Refer to datasheet for power specifications

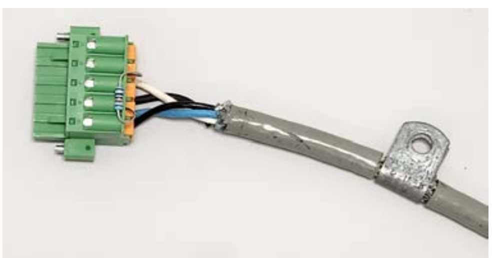
4.4: Installation Notice

When products are installed in environments of extreme Electromagnetic Interference (EMI), it is advised to take extra measures to ensure correct operation. In addition to the installation procedures, Horner APG recommends the following steps to ensure additional immunity in potential extreme EMI situations:

1. Always use a high-quality power supply. EMC ratings that include both EN61000-6-2 and EN55022 Class B can provide a reasonable amount of immunity with minimal emissions.

   NOTE: Power supplies that permit or create occasional transients can disrupt a system and can be nearly impossible to troubleshoot.

2. Power lines should be twisted and as short as possible.
3. Always attach ground wire with the heaviest gauge and shortest wire as possible.
4. Route cabling perpendicular to peripheral equipment wiring. Never install cabling parallel to any power or high voltage lines.
5. CAN cabling used should be Belden DeviceBus 3084A or 3082A. If CAN power is required externally, apply power as close to the CAN port as possible. Avoid powering CAN through the network cable. Always connect the common (0V, black) wire between devices and leave the +24 volt (Red) wire open when independently powering each node.
6. The CAN cabling should have a 360° clamp installed on the braid shield at both ends of the cable and attached to ground. In certain noise environments, attaching the shield at one end only provides the necessary immunity.



7. All analog input and output cabling should be Belden 8441 or equivalent, and in some noise environments may require a clamp as shown in the previous step.
8. Run all cable in metal conduit, separate from power and high voltage lines
9. Attach a ferrite with a minimum of two turns to interconnect lines to the device. This includes power, analog and communication lines. Horner offers a Ferrite Core (part number HE-FBD001) on the Horner APG website

Load / Run / Stop Switch Modes

Chapter 5: Load/Run/Stop Switch Modes

5.1: Load/Run/Stop Switch

The Load/Run/Stop switch in CPU250 is a multi-purpose switch which has three modes as shown in the following figure. This switch supports various functionalities, and some functionalities supported by a specific LED pattern that tells the user if the intended operation has started, completed, or failed.

A switch provides control of the following CPU250 modes: RUN, STOP, and LOAD.

Mode	Description
RUN	The unit is actively executing any programmed functions and operations.
STOP	Halts/stops the execution of all operations that may be underway.
LOAD	For loading a program from a microSD card and when updating firmware.

- The operational mode of the CPU250 may be changed with Cscape. If Cscape is used to force the device into Run mode while the switch is in Stop, the RUN LED will blink rapidly.
- If the mode is changed in Cscape to a mode that differs from the switch setting, a warning message will be presented to confirm.
- %SR58 can be used inhibit the ability of the switch to set the device to Run mode. Setting %SR58 to '1' means the run mode can only be changed from Cscape.

5.1.1: Status LEDs

Firmware Download In Progress/Complete Indicators

- OK and RUN flashing alternately indicates a firmware download is in progress.
- When the flashing stops, the firmware download is complete and the unit reboots (approximately 30 seconds).

NOTE: When flashing together, the firmware download has failed, and the number of flashes indicates the error. There will be a two second gap and the pattern will be repeated. The number of flashes and the associated error are as follows:

- 2 Flashes - The MAC ID is empty.
- 3 Flashes - The internal MAC file is corrupt.
- 4 Flashes - The MAC ID TXT file is invalid.
- 5 Flashes - The MAC ID file is not found or the microSD card is empty or missing system files.

LED BEHAVIOR UNDER DIFFERING CONDITIONS					
Status	**Power**	**OK**	**RUN**	**MS**	**NS**
OFF	No power applied	Self-test fail	Stop mode	Self-Test of Remote I/O Fail	Network ID Fault or Duplicate ID Fault
ON	9-30VDC applied	Self-test pass	Run mode	Self-Test of Remote I/O OK & Configured	Network Normal
FLASHING (1Hz)	N/a	I/O forcing enabled	Do I/O mode (Amber)	Power-up State / Waiting for Configuration	Communications Timeout with OCS
Power ON without OCSIO modules connected	Solid Green	Any	Any	OFF	Blinking Green (modules not detected)
Power ON with OCSIO modules connected	Solid Green	Any	Any	Blinking Green (configuration mismatch)	Solid Green On (Modules detected)
OCSIO configuration downloaded	Solid Green	Any	Any	Solid Green (configuration matched)	Solid Green On (Modules detected)
Diagnostics OK	Solid Green	Solid Green	OFF	Any	Any
Diagnostics not OK (fault indication)	Solid Green	OFF	OFF	Any	Any
Device in STOP mode	Solid Green	Any	OFF	Any	Any
Device in RUN mode	Solid Green	Any	Solid Green	Any	Any
Device forced to RUN mode using Cscape while	Solid Green	Any	Blinking Green	Any	Any

LED BEHAVIOR UNDER DIFFERING CONDITIONS					
switch in STOP position					
Device in DO I/O Mode	Solid Green	Solid Green	Blinking Yellow	Any	Any
BOOT update	Solid Green	OFF	OFF	OFF	OFF
Firmware Update	Solid Green	Blinking Green	Blinking Green	Any	Any
Program Clear	Solid Green	Any	OFF	Blinking red for 30 seconds	Any
Program Load Start	Solid Green	Any	OFF	Blinking Green	Blinking Green
Program Load Fail	Solid Green	OFF	OFF	Blinking red for 3 seconds	Blinking red for 3 seconds
CPLD Loaded successfully	Solid Green	Blinks green for 5 times after 30 seconds	OFF	OFF	OFF
Calibration Mode ON	Solid Green	Blinking green at 2Hz	Any	Any	Any
I/O Forcing	Solid Green	Blinking green at 1Hz	Any	Any	Any

OCS-I/O

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Chapter 6: OCS-I/O Installation

6.1: OCS-I/O Overview

OCS-I/O is a modular, flexible CsCAN I/O platform that can be applied as a local expansion I/O. The OCS-I/O can be seamlessly integrated with CPU200/250 to build-in even more custom functionality.

6.2: OCS-I/O Installation

The OCS-I/O is compact and mounts on DIN-rail. Each I/O module installed adds width in increments of 19mm.

NOTE: The distance between wiring duct and surrounding modules, above and below each module, should be at least 50mm apart.

Modules can be added after the CPU200/250 base has been installed on the DIN-rail and cannot be hot swapped with power applied.

NOTE: I/O scanning will stop until the correct modules for the system are detected in all slots.

1. Connect the bus connectors together to form a backplane that can accept up to 8 modules including the CPU200/250 or another base.
2. Snap the bus connectors into the DIN rail. The DIN rail should be 35 mm × 7.5 mm and made to EN 60715 standards.
3. Place the CPU200/250 to the leftmost connector.
4. Insert OCS-I/O modules by latching at the top of the DIN rail first and rocking down until the latch at the bottom of the DIN rail engages.

6.3: Removing an OCS-I/O

1. To remove a module, insert a flat blade screwdriver through the orange loop and into the metal DIN rail latch at the bottom of the module.
2. Pry down to release the latch, then rock the module up and off the DIN Rail. Modules may be removed while powered; however, the I/O scanning on the remaining modules will stop and I/O will go to the default state until a new module is installed.

Register Mapping

Chapter 7: Register Mapping

For I/O Register Maps for individual controllers, refer to the Horner website Document Search page.

There are two types of System Registers that may be used during programming. %S registers indicate the status of several system operations. %SR registers indicate the state of many system operations and can be used to control them in several cases. Some of the system registers have predefined I/O names, though they may still be changed if desired.

7.1: Register Definitions

When programming the OCS, data is stored in memory that is segmented into different types. This memory in the controller is referred to as registers. Different groups of registers are defined as either bits or words (16 bits). Multiple registers can usually be used to handle larger storage requirements. For example, 16 single-bit registers can be used to store a word, or two 16-bit registers can be used to store a 32-bit value.

Types of Registers	
%AI = Analog Input	16-bit input registers used to gather analog input data such as voltages, temperatures, and speed settings coming from an attached device.
%AQ = Analog Output	16-bit output registers used to send analog information such a voltages, levels or speed settings to an attached device.
%D = Display Bit	These are digital flags used to control the displaying of screens on a unit which has the ability to display a screen. If the bit is SET, the screen is displayed.
%I = Digital Input	Single-bit input registers. Typically, an external switch is connected to the registers.
%K = Key Bit	Single-bit flags used to give the programmer direct access to any front panel keys appearing on a unit.
%M = Retentive Bit	Retentive single-bit registers.
%Q = Digital Output	Single-bit output registers. Typically, these bits are connected to an actuator, indicator light or other physical outputs.
%R = General Purpose Register	Retentive 16-bit registers.
%S = System Bit	Single-bit bit coils predefined for system use.
%SR = System Register	16-bit registers predefined for system use.
%T = Temporary Bit	Non-retentive single-bit registers.

7.2: %S Registers

%S registers indicate system status as follows:

%S Registers			
S#	**Name**	**Predefined I/O Name**	**Notes**
%S1	First Scan	FST_SCN	On for 1 scan only each time the program is first run
%S2	Network OK	NET_OK	If on, the Network is OK
%S3	10ms pulse	T_10MS	Cycling pulse that is high for 5ms and low for 5ms
%S4	100ms pulse	T_100MS	Cycling pulse that is high for 50ms and low for 50ms
%S5	1 second pulse	T_1SEC	Cycling pulse that is high for 500ms and low for 500ms
%S6	I/O OK	IO_OK	If on, the I/O system is OK
%S7	Always On	ALW_ON	This bit is always on
%S8	Always OFF	ALW_OFF	This bit is always off
%S9	Pause Scan	PAUSING_SCN	On for at least 1 scan prior to Pause 'n Load
%S10	Resume Scan	RESUMED_SCN	On for 1 scan only after Pause 'n Load is done
%S11	Forcing Present	FORCE	If on, I/O is presently being forced
%S12	Forcing Enabled	FORCE_EN	If on, I/O forcing is been enabled
%S13	Net I/O OK	NET_IO_OK	If on, Network I/O is OK

7.3: %SR Registers

%SR registers are special word-length registers that display and/or control system operations in the controller. Not all controllers support all defined system registers.

Please refer to the Cscape help file for a complete list of registers.

NOTE: %SR58 is reserved for User LEDs. See Cscape System Register Tables for additional information.

7.4: I/O Register Map

NOTE: These registers can be used as general purpose registers

Fixed Address	Digital/Analog I/O Function	Registers
%I	Digital inputs	%I1-8
	Flexible Digital or Analog Inputs	%I9-16
	Reserved	%I17-24
	Digital output 1-4 fault (undervoltage or overcurrent or over temperature)	%I25
	Reserved	%I26-34
%Q	Digital Outputs	%Q1-10
	Reserved	%Q11-24
	Clear Digital Output 1-4 fault	%25
%AI	Flexible Digital Inputs or Analog Inputs	%AI1-8
	Reserved	%AI9-16
%AQ	Analog Outputs	%AQ1-8
	Reserved	%AQ9-24

7.5: Resource Limits

Resource	Value
%I	2048
%Q	2048
%AI	512
%AQ	512
%T	16384
%M	16384
%R	50000
%D	1023
%K	4
%S	13
%SR	192
Ladder Code	2MB

7.6: PWM Functions Registers Map

Register	PWM
%AQ13-14	PWM1 Duty Cycle
%AQ15-16	PWM1 Frequency
%AQ17-18	PWM2 Duty Cycle
%AQ19-20	PWM2 Frequency

7.7: Stepper Function Register Map

Register	Stepper
%AQ9	Stepper-1 Start Frequency
%AQ10	Stepper-1 Run Frequency
%AQ11-12	Stepper-1 Acceleration Count
%AQ13-14	Stepper-1 Run Count
%AQ15-16	Stepper-1 Deceleration Count
%AQ17	Stepper-2 Start Frequency
%AQ18	Stepper-2 Run Frequency
%AQ19-20	Stepper-2 Acceleration Count
%AQ21-22	Stepper-2 Run Count
%AQ23-24	Stepper-2 Deceleration Count
I30	Stepper1 - Run Status
I31	Stepper1 - Ready/Done Status
I33	Stepper2 - Run Status
I34	Stepper2 - Ready/Done Status

7.8: HSC Register Map

Register	Totalizer / Frequency / Pulse	Quad
%AI9-10	HSC1 (function) Accumulator	Quad 1 Accumulator
%AI11-12	HSC2 (function) Accumulator	
%AI13-14	HSC3 (function) Accumulator	Quad 2 Accumulator
%AI15-16	HSC4 (function) Accumulator	
%AQ9-10	HSC1 Preset	
%AQ11-12	HSC2 Preset	
%Q17	Clear HSC1	Clear Quad 1
%Q18	Clear HSC2	Set Quad 1
%Q19	Clear HSC3	Clear Quad 2
%Q20	Clear HSC4	Set Quad 2

7.9: OCS-I/O Status Register

Register	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
1	IOE							RSVD	CME							NO_CFG
2	IOCS							RSVD	WDG TRIP							RSVD
3	IO MOD1 FW VER															
4	IO MOD2 FW VER															
5	IO MOD3 FW VER															
6	IO MOD4 FW VER															
7	IO MOD5 FW VER															
8	IO MOD6 FW VER															
9	IO MOD7 FW VER															
10	RSVD															

OCS-I/O Status Register

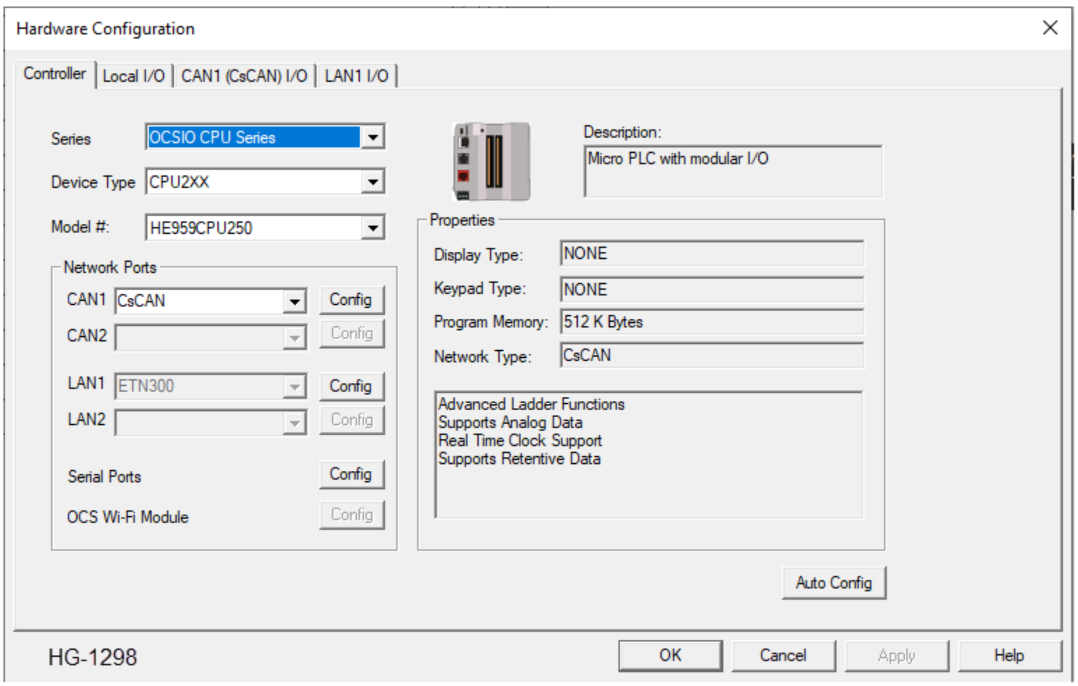
CME	Each bit (bit8 – bit2) represents communication error of each I/O modules (Module 7 to Module 1)
IOCS	Each bit (bit16 – bit10) represents I/O modules calibration status (Module 7 to Module 1)
IOE	Each bit (bit16 – bit 10) represents I/O modules error (Module 7 to Module 1)
NO_CFG	IO Module's configuration status
Register 3-9	Represents FW version of I/O modules connected
RSVD	Reserved for future use
WDG TRIP	Each bit (bit8 – bit 2) represents I/O modules watchdog trips (Module 7 to Module 1)

–

General I/O Configuration

Chapter 8: General I/O Configuration

- Chapter Applies to CPU250 Only-



8.1: Built-in Digital and Analog I/O Overview

The device is a compact unit that contains high density and very versatile I/O. Using the I/O properly requires wiring to the proper terminals and configuring Cscape properly. This section will offer some tips and suggestions to configure the I/O properly. For the register mapping of the I/O, refer to "System Register Tables" on page 1.

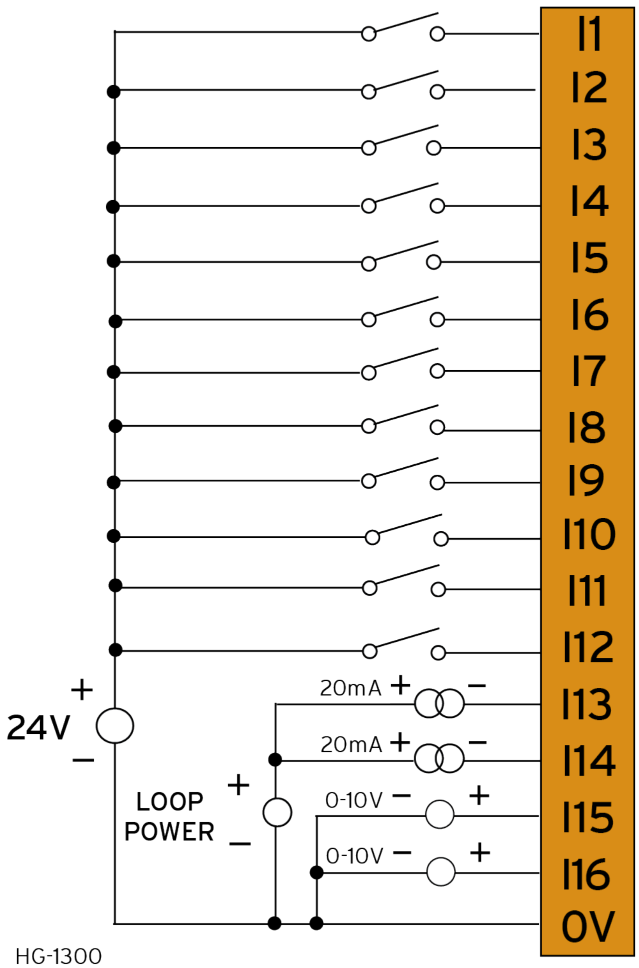
8.1.1: Model and I/O Overview

Micro CPU	Solid State Digital Outputs	Digital Inputs	Analog Inputs	Analog Outputs
HE-CPU200				
HE-CPU250	✓	✓	✓	✓

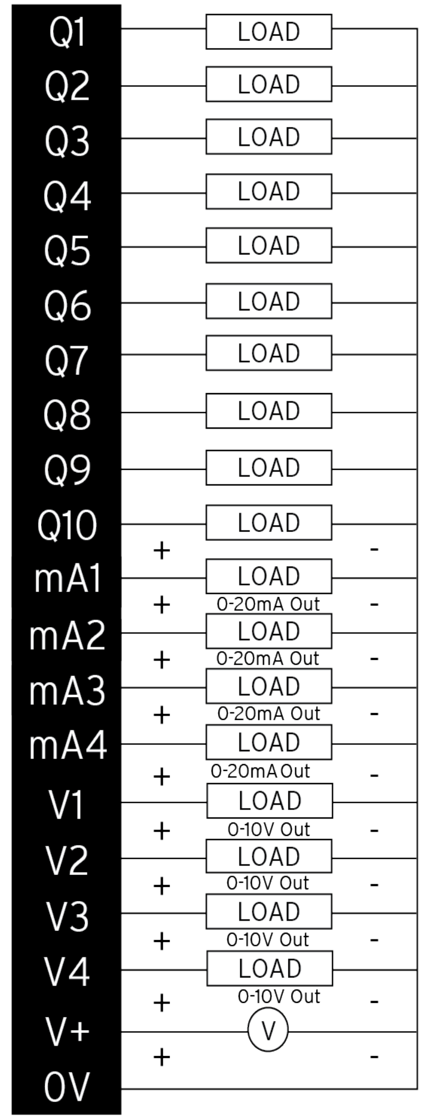
For more details, see the controller datasheet via Document Search.

Digital Wiring Diagrams

Digital Input Wiring	Digital Output Wiring



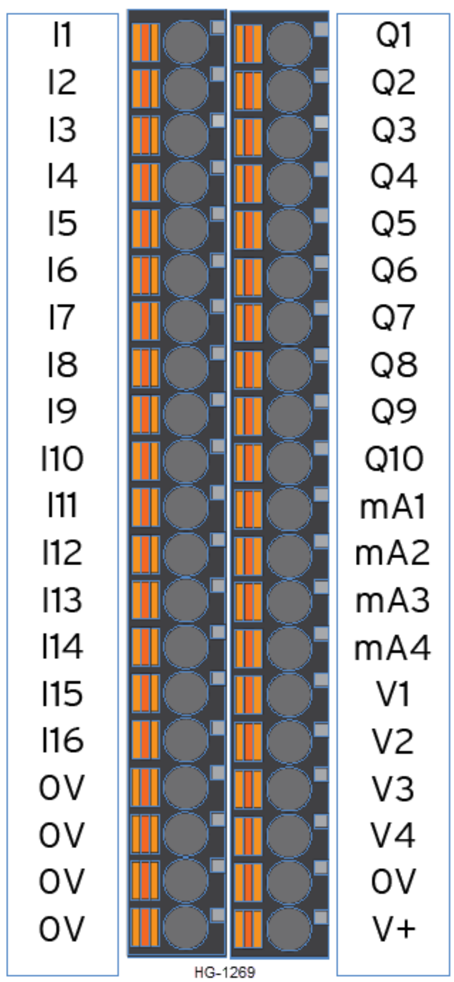
HG-1300



HG-1299

Digital and Analog I/O Function Map

Port Map



Digital Inputs	Commons	Voltage Outputs
I1	0V	V1
I2	0V	V2
I3	0V	V3
I4	0V	V4
I5		
I6	**Outputs**	**Current Outputs**
I7	Q1	mA1
I8	Q2	mA2
	Q3	mA3
Flexible Inputs	Q4	mA4
I9	Q5	
I10	Q6	**External Voltage In**
I11	Q7	V+
I12	Q8	
I13	Q9	
I14	Q10	
I15		
I16		

Digital / PWM Output Configuration

Solid-State Digital Outputs

Solid-state digital outputs are generally used to activate lamps, low voltage solenoids, relays, and other low voltage and low current devices.

NOTE: The digital outputs are "sourcing" outputs. This means the output applies a positive voltage to the output pin when turned ON. When turned off, the output applies approximately zero volts with respect to the I/O ground.

- The digital outputs have electronic short circuit protection and current limiting. While these electronic protections work in most applications, some applications may require external fusing on these outputs.
- The digital outputs are typically controlled via %Q bits in the register mapping. Some of the outputs are designed for high-speed applications and can be used for PWM or frequency output applications.

When the controller is stopped, the operation of each output is configurable. The outputs can hold the state they were in before the controller stopped or they can go to a predetermined state. By default, digital outputs turn off. For more information on Stop State, refer to Cscape Configuration.

8.2: Flexible Analog Inputs

- The flexible analog inputs can be configured to measure current (mA) and voltage.
- Flexible Analog input can be configured from Cscape or through dynamic configuration registers to read 0-10V, 0-20mA or 4-20mA.

The analog inputs have a digital filter that can be used to filter electrical noise that may be unavoidable in some installations. The downside to digital filtering is the inputs will respond more slowly to sudden changes in the actual input.

NOTE: To configure digital filtering, refer to the datasheet and the Cscape Configuration chapter.

Analog Input Overcurrent Detection

When flexible inputs are configured as 0-20 or 4-20mA mode, overcurrent in the channel can be detected and it is indicated in system register %SR196. Each bit in this register corresponds to the analog input channels

- SR196 Bit 1 – High- AI Channel 1 (mA) Overcurrent Detection.
- SR196 Bit8 – High – AI Channel 8 (mA) Overcurrent Detection.

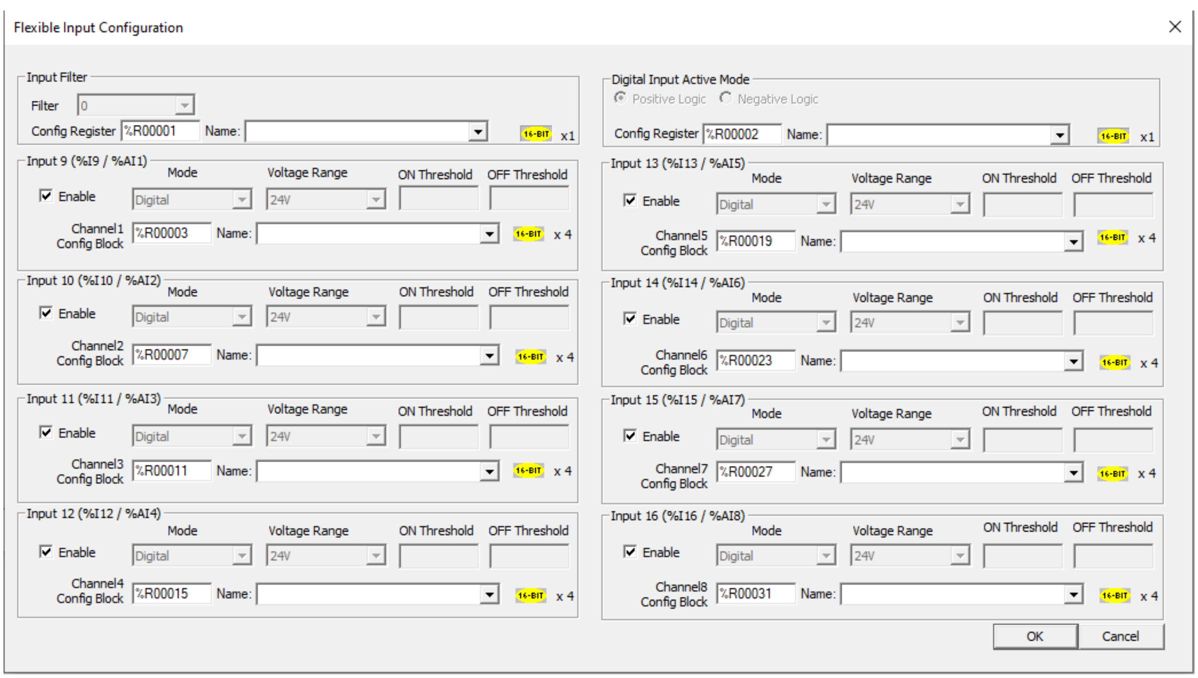
NOTE: Once Overcurrent is detected in any channel, it will hold the last value and an Idle to Run mode transition is required to make the channel normal.

NOTE: Overcurrent detection is not applicable for Volt mode.

Config Register

If a Config Register is configured, it takes immediate precedence over other configuration for the I/O, resulting in requiring valid values in the registers. These values can be changed during runtime, so show additional caution to not mistakenly overwrite these values with program logic.

8.3: Flexible Digital/Analog Input Dynamic Configuration Registers



<table>
<tr><th>Register (Rx)</th><th>Config</th><th colspan="4">Values</th></tr>
<tr><td>1</td><td>Mode</td><td>0 (Digital)</td><td colspan="3">1 (Analog)</td></tr>
<tr><td>2</td><td>Type</td><td>0 (24V) 1 (12V) 2 (5V) 3 (Custom)</td><td colspan="3">0 (0-10V)
1 (0-20mA)
2 (4-20mA)</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">Data Range (Analog) or Custom Range (Digital)</td><td rowspan="2">ON Threshold (5-20V)</td><td>10V</td><td>20mA</td><td>4-20mA</td></tr>
<tr><td>0 (0-4000)
1 (-2000-2000)
2 (0-1000)
3 (Reserved)
4 (Reserved)
5 (0-32000)</td><td>0 (0-4000)
1 (-2000 ~ 2000)
2 (0-1000)
3 (0-2000)
4 (Reserved)
5 (0-32000)</td><td>0 (0-4000)
1 (-2000 ~ 2000)
2 (0-1000)
3 (Reserved)
4 (400-2000)
5 (0-32000)</td></tr>
<tr><td>4</td><td>Custom Range</td><td>OFF Threshold 5-20 (V)</td><td colspan="3">Not Applicable</td></tr>
</table>

Analog Input Filter

Register (Rx)	Filter Values
1	0 to 7

Digital Input Active Mode

Register (Rx)	Active Mode
1	0 Positive logic 1 Negative logic

NOTE: If Negative Logic is selected, a Custom range is not applicable.

<table>
<tr><th>Register (Rx)</th><th>Config</th><th></th><th></th><th></th><th>Values</th></tr>
<tr><td>1</td><td>Mode</td><td>0 Digital</td><td colspan="3">1 Analog</td></tr>
<tr><td>2</td><td>Type</td><td colspan="4">0 (24V)
1 (12V)
2 (5V)
3 (Custom)</td></tr>
</table>

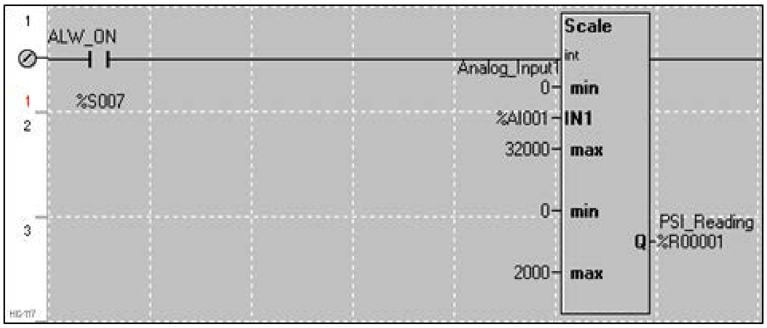
Register (Rx)	Config				Values
			10V	20mA	4-20mA
3	Data Range	N/a	0 (0-4000) 1 (-2000-2000) 2 (0-1000) 3 (Reserved) 4 (Reserved) 5 (0-32000)	0 (0-4000) 1 (-2000 ~ 2000) 2 (0-1000) 3 (0-2000) 4 (Reserved) 5 (0-32000)	0 (0-4000) 1 (-2000 ~ 2000) 2 (0-1000) 3 (Reserved) 4 (400-2000) 5 (0-32000)
4	On Threshold	5-20 (V)	N/a		
5	Off Threshold	5-20 (V)	N/a		

Scaling Analog Inputs & Examples

To access the Advanced Math Scaling function, select **Home > View > Project Toolbox**. This will open a side bar, and then select **Advanced Math > Scale**.

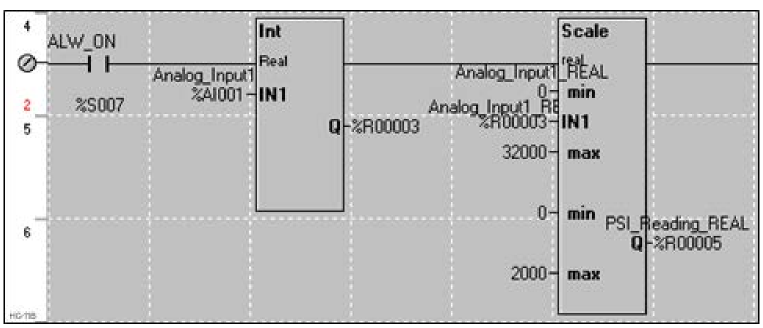
Example 1

The Cscape Scale function, found in the Advanced Math functions, allows for very easy conversion of the raw input value into a meaningful reading. For example, a pressure transducer may be specified as a 4-20mA signal to signify a 0-2000 psi pressure reading. With the analog channel set to the 4..20mA range, the raw analog input value, which is in INT format ranges from 0 to 4mA to 32000 for 20mA. Use the Scale function to obtain an Integer pressure reading using the 0-32000 raw input range and the sensor's 0-2000psi output range.



Example 2:

If readings with fractions are required, the raw Integer input value must first be translated in REAL, or Floating Point Format, see note below. The Cscape INT-to-REAL Conversion function may be used to convert the raw input value from INT to REAL format in an intermediate memory location. The SCALE function, specified as REAL type, may be used to scale the converted raw value into a reading that supports digits beyond the decimal place, i.e. 475.25psi.



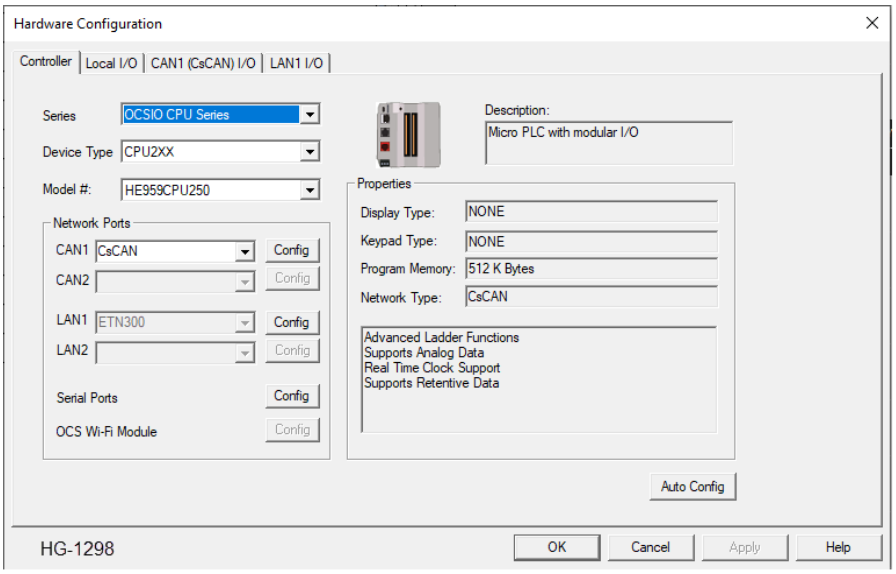
Analog Output Configuration

NOTE: Refer to the datasheet and the I/O chapter for more information.

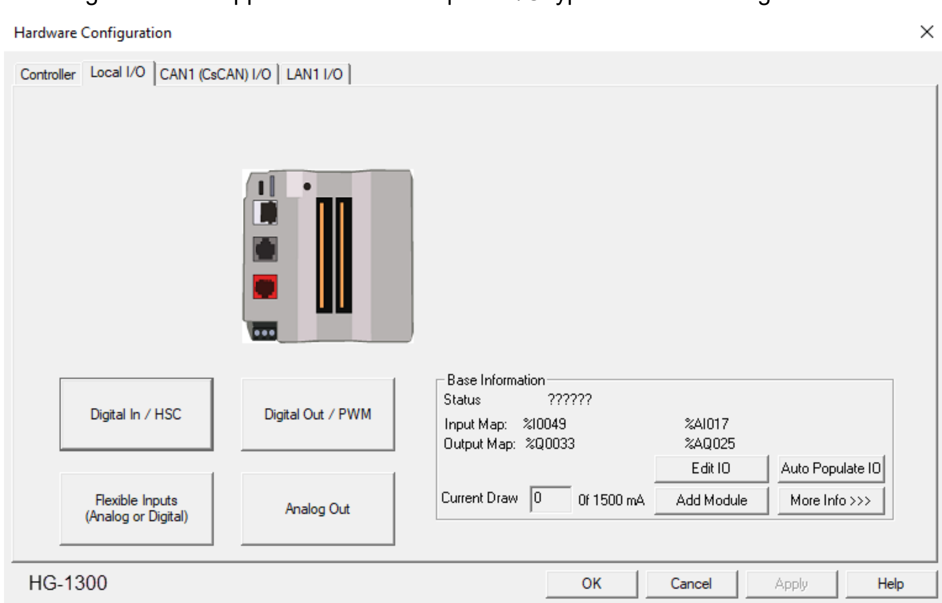
The analog outputs on devices provide high resolution current outputs and voltages.

When the controller is stopped, the operation of each output is configurable. The outputs can hold the state they were in before the controller stopped or they can go to a predetermined value. By default, analog outputs are set to a value of zero (0). For more information on Stop State, refer to "Cscape Configuration" on page 1.

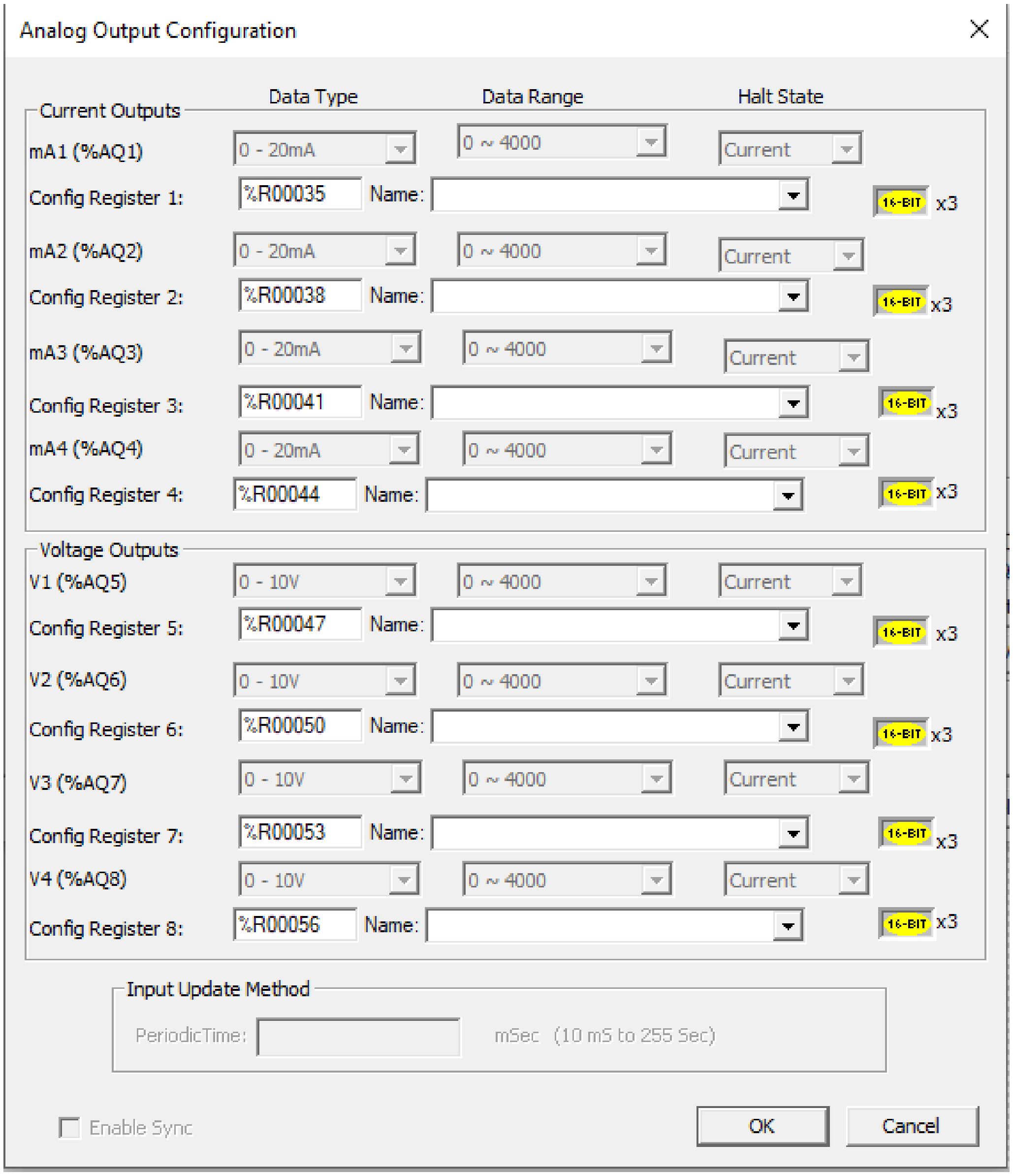
Select Hardware Configuration from the Home menu and ensure that the correct Device Type and Model# are selected. Then select the **Local I/O** tab.



The I/O configuration dialog screen will appear. Select the required I/O type for further configurations.



Select Analog Out to open the following dialogue:

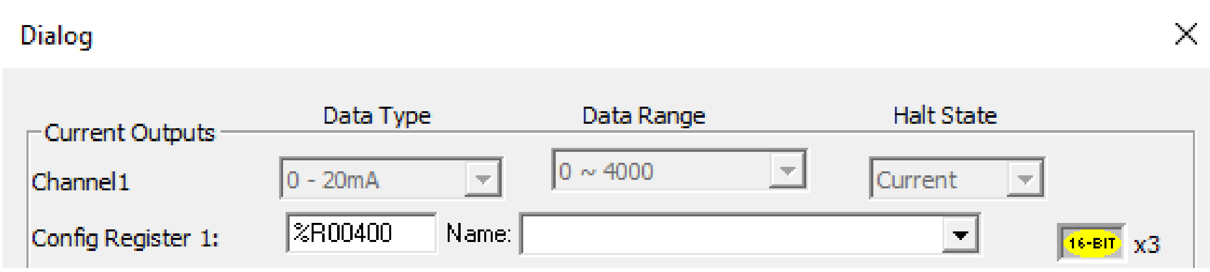


The **Halt State** group box contains items that allow the user to specify how the analog output channels behave when the controller is stopped. The outputs can either hold their value or default to a value when the controller is stopped.

The **Data type and Data range** group box allows users to select the type of analog output and their corresponding range.

NOTE: If a Config Register is configured, it takes immediate precedence over other configuration for the I/O, thus requiring valid values in the registers. These values can be changed during runtime so care needs to be taken to not mistakenly overwrite these values in program logic.

Analog Output uses three consecutive 16-Bit registers for configuration and each register has the following description:
Example: If %R400 is configured for Analog Output channel.



Register (Rx)	Config	Values		
1	Type	0 (0-10V) 1 (0-20mA) 2 (4-20mA) 3 (Disabled)		
2	Data Range	10V	20mA	4-20mA
		0 (0-4000) 1 (-2000-2000) 2 (0-1000) 3 (Reserved) 4 (Reserved) 5 (0-32000)	0 (0-4000) 1 (- 2000 ~ 2000)2 (0-1000) 3 (0-2000) 4 (Reserved) 5 (0-32000)	0 (0-4000) 1 (-2000 ~ 2000) 2 (0-1000) 3 (Reserved) 4 (400-2000) 5 (0-32000)
3	Halt State	0 (Current) 1 (Minimum) 2 (Maximum) 3 (Average)		

High Speed I/O (HSC & PWM)

Chapter 9: High Speed I/O

- Chapter Applies to CPU250 Only-

9.1: Overview

In addition to the compliment of simple analog and digital I/O, the OCS controller supports High Speed Counting (HSC) I/O functions and may support Pulse Width Modulation (PWM) Output functions. The HSC functions include frequency, totalizing, pulse width, and quadrature measurement.

The PWM functions include traditional PWM including variable rate and duty, with variable acceleration and deceleration rates, and a Stepper (limited functionality) with variable acceleration and deceleration rates . To determine function availability, refer to the model's Specification/Installation sheet (Digital DC Input/Output sections).

High Speed I/O Terms Glossary	
Accumulator	Register used to accumulate or store up a sum or count of many items or events.
Clear	A special function to zero out the value in a specific register. (Not used with Frequency or Period Measurement.)
Disable	A special function to prevent the counter from running.
Encoder	A sensor or transducer for converting rotary motion or position to a series of electronic pulses
FPGA	An integrated, configurable circuit that allows the controller to be programmed to have either two high-speed counters or four high-speed counters.
Frequency Input	The number of times an electromagnetic signal repeats an identical cycle in a unit of time, usually one second.
Latch (strobe)	A special function that uses a digital logic circuit to store one or more bits. A latch has a data input, a clock input and an output. When the clock input is active, data on the input is "latched" or stored and transferred to the output register either immediately or when the clock input goes inactive. The output retains its value until the clock goes active again.
Marker	Input into the OCS that indicates a particular position. Typically, an encoder has a marker output that represents a specific point in the rotation.
Polarity	A Polarity pull-down box is associated with each function and indicates the manner in which the trigger happens (e.g., High level, Low Level, Falling Edge, Rising Edge).
Preset	An address that contains the comparison count for use with direct high-speed output control.
Quadrature	A high-speed device that expresses the phase relationship between two periodic quantities of the same period when the phase difference between them is one fourth of a period. A coupler in which the two output signals are 90° out of phase.
Totalizer	A counter that sums the total number of cycles applied to its input.

9.2: High Speed Counter (HSC) Functions

Four dedicated inputs are available that can be configured for one of four modes of operation. Those modes are Frequency, Count (totalize), Pulse width or period (pulse) and Quadrature measurement. For some modes, more than one HSC input may be consumed. The measurement value is provided to ladder in a %AI register.

NOTE: While the high-speed input circuitry has a resolution of 1µs, measured edge transitions must not occur faster than 100µs for accurate measurements. Keep in mind that pulse width measurements utilize both the rising and falling edges of the waveform, thus the pulse width must exist longer than 100µs.

NOTE: The **edge** polarity selection in the mode parameter for the totalize and pulse width functions (Digital/HSC Input Configuration) assume Positive Logic regardless of the associated I/O board's jumper setting for the **Digital DC inputs polarity**. If Negative logic is configured when using these functions, the opposite edge polarity must be selected in the mode parameter.

9.2.1: Frequency

In frequency mode, the frequency of the input signal is written to the accumulator in terms of Hertz (cycles/second). When using frequency mode, four update selections are provided which specify the width of the sample window.

NOTE: Selecting a shorter sample window provides a quicker measurement (faster response) but lowers the frequency accuracy (resolution) and increases the minimum frequency measurement limit.

9.2.2: Totalize

In totalize mode, the accumulator is simply incremented each time the input transitions in a specific direction. Totalize mode is configurable to specify the edge (rising or falling) on which the accumulator is incremented.

Three different options are available to reset the current count:

- **Configured reset value** - When configuring the Totalize function, a value may be specified under the Counts per Rev column. When the totalizer accumulator reaches this value minus one (N-1), the accumulator will reset to zero on the next count. Specifying zero for this value allows the totalizer to count through the full 32-bit range before resetting.
- **Ladder control** - Setting registers %Q17-20 reset HSC1-4 (respectively) with no additional configuration. When these registers are asserted, the associated totalizer accumulator is reset and held at zero (level sensitive).
- **Direct digital input control (HSC1 and HSC2 only)** - HSC3 (%I11) and HSC4 (%I12) may be configured as hardware digital reset signals for HSC1 and HSC2 (respectively). To enable these inputs as reset signals, specify the type as Totalize Reset (NOTE: The corresponding Totalize HSC must be previously configured before this option is available). The direct digital reset controls are edge sensitive with the edge polarity configurable.

Maximum direct digital reset latency is 100µs.

The totalize function also supports an option which compares the current accumulator value with a supplied Preset Value (PV), which is provided through a %AQ, and drives a physical digital output based on the that comparison.

- This option (available for HSC1 and HSC2 only) drives Q1 or Q2 output point (respectively) once the associated totalizer accumulator reaches (or exceeds) the PV value. To enable this function, the corresponding PWM function output (Q1 or Q2) must be configured for HSCx Output.

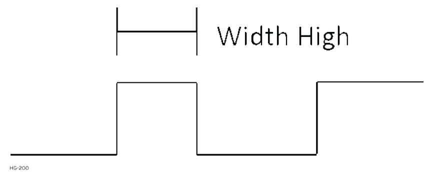
NOTE: Q1 and Q2 are PWM function outputs that may be configured independently as one of the following: standard digital output, PWM, HSCx or stepper output.

Preset values may be modified during run-time. A preset value of zero disables (resets) the totalizer compares function output causing the output to remain low.

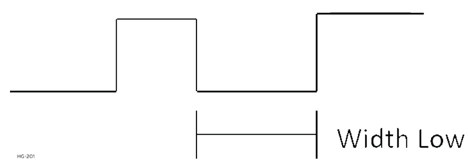
9.2.3: Pulse

In pulse mode, the high-speed input can measure the width or period of a pulse stream in one of four modes and provides a continuous indication of the last sampled value.

Width High 1µs Counts – In this sub-mode the accumulator value will contain the number of 1µs counts the pulse is high.



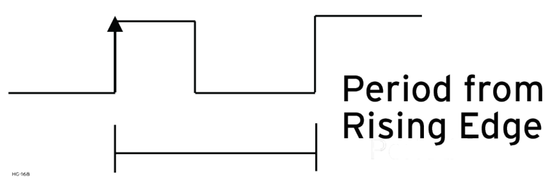
Width Low 1µs Counts - In this sub-mode the accumulator value will contain the number of 1µs counts the pulse is low.



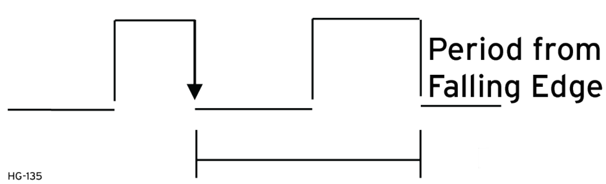
9.2.4: Period Measurement

In period measurement mode, the high-speed input can measure the period of a pulse stream in one of two modes and provides a continuous indication of the last sampled value. In this mode the Disable and Latch special functions are allowed.

Period Rising Edges 1µs Counts – In this sub-mode the period of the input signal is reported in one (1) µs units. The period measurement will start on the rising edge of the input.



Period Falling Edges 1µs Counts – In this sub-mode the period of the input signal is reported in one (1) µs units. The period measurement will start on the falling edge of the input.

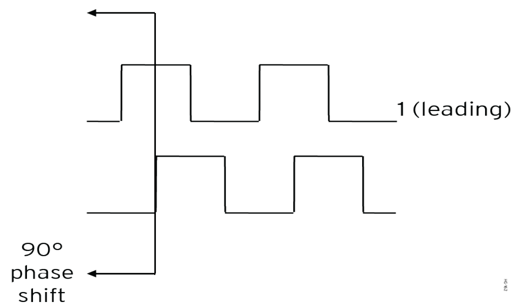


9.2.5: Quadrature

Two HSC inputs are consumed for each of the two possible Quadrature counters. For example, selecting quadrature mode for HSC 1 will use HSC inputs 1 and 2, which correspond to A and B quadrature signals. Therefore, HSC 1 and 3 may be configured for quadrature input. Alternately, HSC 3 may be configured to reset HSC1 (quadrature) count on a marker input

Quadrature mode works much like the totalizer except the accumulator will automatically increment or decrement based on the rotation phase of the two inputs. See the following example for more details. Quadrature inputs are typically used for reporting the value of an encoder.

Two modes are available for quadrature that select whether the accumulator counts up or down when the phase of input 1 leads input 2. Check your encoder's documentation to determine the output form it uses or try both modes to determine if the encoder counts up when expected.



Using the above waveforms and a HSC input configuration of "Quadrature" - "1 leads 2, count up," the accumulator will count up when 1 is rising and 2 is low, 1 is high and 2 is rising, 1 is falling and 2 is high, and when 1 is low and 2 is falling. This results in 4 counts per revolution. So in order to determine the number of cycles, the accumulator would have to be divided by 4.

Three different options are available to reset (or set) the current count:

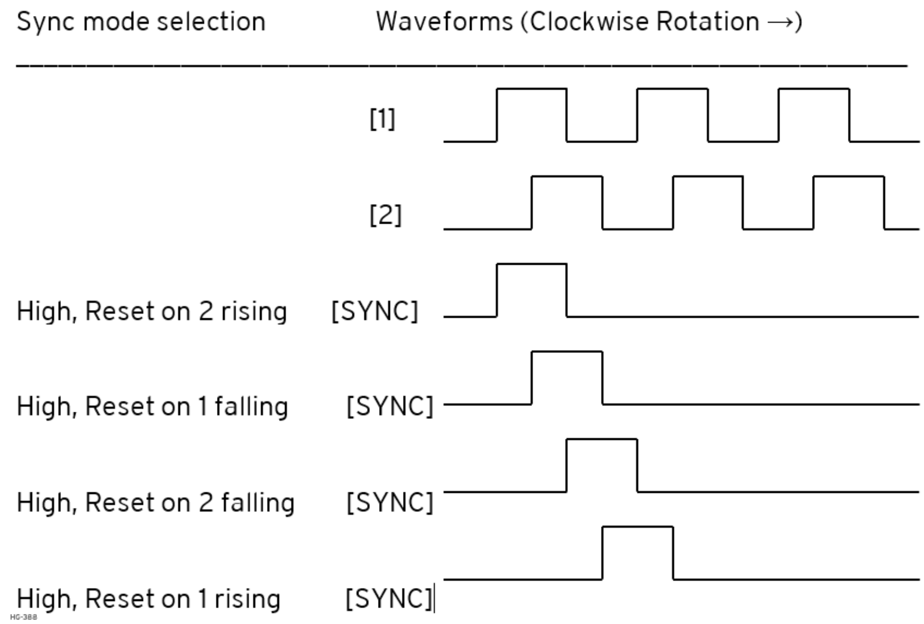
- **Configured Counts per Rev Value** - When configuring the quadrature function, a value may be specified under the Counts per Rev column. When rotation produces an increasing count, the quadrature accumulator resets to zero on reaching the Counts per Rev count. Alternately, when rotation produces a decreasing count, the quadrature accumulator is set to Counts per Rev – 1 on the count following zero. Specifying zero for this value allows the totalizer to count through the full 32-bit range before resetting. For example, if your encoder outputs 1024 counts per revolution, the value of 1024 can be entered into the configuration for Counts per rev. This will result in a counter that produces counts in the range of 0 to 1023.
- **Ladder Control** - Setting registers %Q17 or Q19 resets quadrature (HSC) 1 or quadrature (HSC) 3 (respectively) with no additional configuration. Setting registers %Q18 or Q20 sets quadrature (HSC) 1 or quadrature (HSC) 3 (respectively) to Counts per Rev – 1.
- **Direct Digital Input Control (HSC3) [Marker]** - When HSC input 1 and 2 are used for quadrature inputs, an additional choice of marker input becomes available for HSC input 3. The marker input is typically part of an encoder or motion system that signals when a cycle of motion is complete. When the marker input is triggered, the accumulator is reset to zero or to Counts per rev - 1 based on rotation direction. Marker reset operation is enabled when HSC3 is configured for Marker type. Once selected, one of several modes is available for marker operation. These modes can be sub-divided into two groups of marker operation.

Asynchronous modes ignore the quadrature inputs and reset the quadrature accumulator to zero on the configured edge (rising, falling or both). These are the most common settings used. When configuring, asynchronous mode selections are prefixed with the word Async.

Synchronous modes synchronize the reset (or set) to the selected quadrature input and the selected marker polarity. Figure 11.1 below indicates which mode to select based on the markers timing diagram. Consult the documentation provided with your encoder to determine the marker pulse timing.

NOTE: The Marker input is sampled within 50µs of the associated quadrature edge. It is left to the user to determine if this meets the time constraints of the measured drive.

NOTE: If the Marker input pulse consecutively spans more than one of the specified edges, quadrature-decoding operation is unpredictable.



*While not displayed in this figure, modes for low level (inverse logic) are also supported for each state.

The accumulator is reset to zero on the specified edge if rotation is clockwise (as shown in figure above). However, if rotation is reversed, the accumulator is alternately set to Counts per rev – 1 on that same physical edge. When direction is reversed, that same physical edge is seen (by the internal decoder) as having the opposite edge polarity as shown below.

9.2.6: Sync Pulse Mode Table

Definition: **CPR** most commonly stands for Counts per Revolution, and refers to the number of quadrature decoded states that exist between the two outputs A and B. With both outputs A and B switching between high and low, there exists 2 bits of information represented as 4 distinct states.

Mode	Direction	A (HSC1)	B (HSC2)	Marker (HSC3)	Reset Value
Async, Reset on rising edge				Rising	0
Async, Reset on falling edge				Falling	0
Async, Reset on both edge				Both	0
High, Reset on 1 rising	Clockwise	Rising		High	0
“	Counter	Falling		High	CPR - 1
Low, Reset on 1 rising	Clockwise	Rising		Low	0
“	Counter	Falling		Low	CPR - 1
High, Reset on 1 falling	Clockwise	Rising		High	CPR - 1
“	Counter	Falling		High	0
Low, Reset on 1 falling	Clockwise	Rising		Low	CPR - 1
“	Counter	Falling		Low	0
High, Reset on 2 rising	Clockwise		Rising	High	0
“	Counter		Falling	High	CPR - 1
Low, Reset on 2 rising	Clockwise		Rising	Low	0
“	Counter		Falling	Low	CPR - 1
High, Reset on 2 falling	Clockwise		Rising	High	CPR - 1
“	Counter		Falling	High	0
Low, Reset on 2 falling	Clockwise		Rising	Low	CPR - 1
“	Counter		Falling	Low	0

9.3: High Speed Counter

When either Q1 or Q2 is configured for HSC operation, HSC1 or HSC2 totalize functions are extended to allow respective direct output control based on a comparison of the current count and a preset value (PV). Refer to the Totalize section in the HSC section above for more information.

9.3.1: HSC Functions Register Map

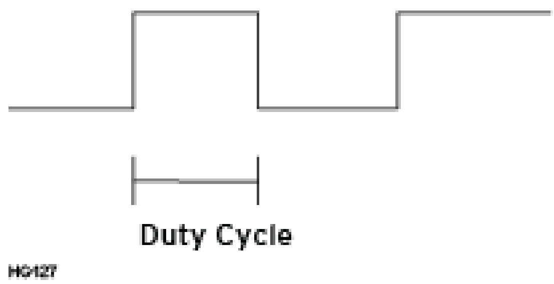
Register	Frequency	Totalize	Pulse	Quad
%AI9-10	HSC1 (function) Accumulator			Quad 1 Accumulator
%AI11-12	HSC2 (function) Accumulator			
%AI13-14	HSC3 (function) Accumulator			Quad 2 Accumulator
%AI15-16	HSC4 (function) Accumulator			
%AQ9-10		HSC1 Preset		
%A11-12		HSC2 Preset		
%Q17		Clear HSC1		Clear Quad 1
%Q18		Clear HSC2		Set Quad 1
%Q19		Clear HSC3		Clear Quad 2
%Q20		Clear HSC4		Set Quad 2

9.4: Pulse Width Modulation (PWM) Functions

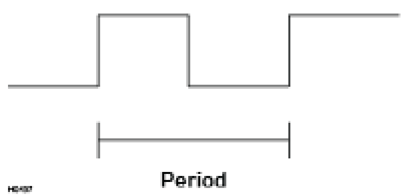
On units that support the PWM, two dedicated outputs are available that can be configured for one of four modes of operation. Those modes are Normal, PWM, HSC (count = PV) and Stepper.

Normal - When either Q1 or Q2 is configured for Normal operation, the digital output registers %Q1 and %Q2 drives that respective output.

Duty Cycle - The Duty Cycle is a 32-bit value from 0 to 32,000 indicating the relative duty cycle of the output. For example, a value of 8000 would indicate a 25% duty cycle, a value of 16,000 would indicate a 50% duty cycle. Zero (0) turns the output off, 32,000 turns the output on.



Frequency - The Frequency is a 32-bit value indicating the output frequency in Hertz. One over the frequency is the period.

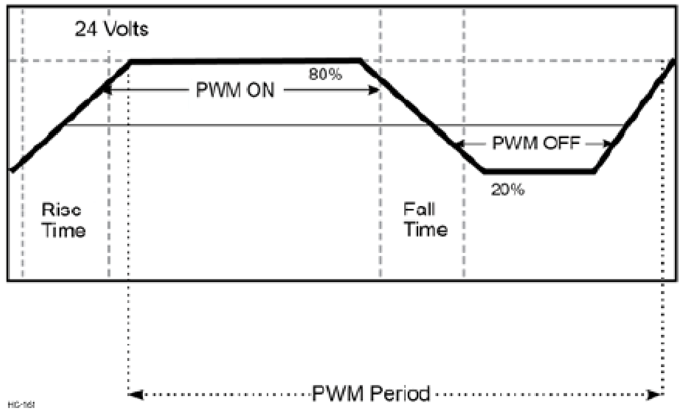


At controller power-up or during a download, the PWM output is maintained at zero until both the Frequency and the Duty cycle are loaded with non-zero values.

When the controller is placed in stop mode, the state of the PWM outputs is dependent on the PWM State on Controller Stop configuration. This configuration allows for either hold-last-state or specific frequency and duty cycle counts.

Specifying zero for either the period or duty causes the PWM output to remain low during stop mode.

9.4.1: PWM Output Waveform



PWM Output Waveform Table	
Rise Time	150ns Max
Fall Time	150ns Max
PWM Period	Frequency = 1/Period

9.4.2: PWM Functions Register Map

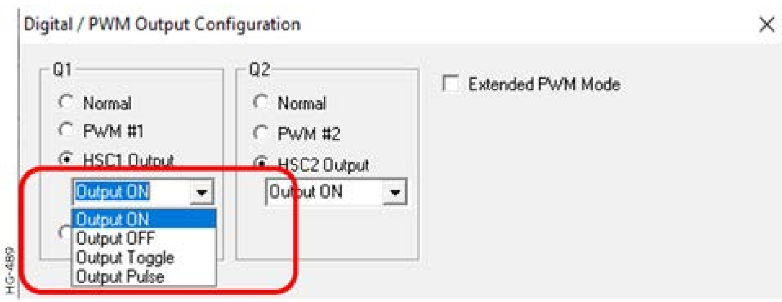
Register	PWM
%AQ13 - 14	PWM1 Duty Cycle (32-bit)
%AQ15 - 16	PWM1 Frequency (32-bit)
%AQ17 - 18	PWM2 Duty Cycle (32-bit)
%AQ19 - 20	PWM2 Frequency (32-bit)

9.4.3: PWM Examples

Example 1	Duty Cycle	Frequency
To get a 50% Duty Cycle @ 10kHz waveform on PWM1:	Set %AQ13-14 = 16,000	Set %AQ15-16 = 10,000
Example 2	**Duty Cycle**	**Frequency**
To get a 25% Duty Cycle @ 5kHz waveform on PWM2:	Set %AQ17-18 = 8,000	Set %AQ19-20 = 5,000
Example 3	**Duty Cycle**	**Frequency**
To turn PWM 1 output ON all the time:	Set %AQ13-14 = 32,000	Set %AQ15-16 = Any Value
Example 4	**Duty Cycle**	**Frequency**
To turn PWM 1 output OFF all the time:	Set %AQ13-14= 0	Set %AQ15-16 = Any Value

9.5: HSC Pulse Output

This feature allows configuring the high-speed output to turn ON, OFF, toggle, or as a pulse output. Select **Digital Out/PWM** to open the dropdown menu of HSC output options.



- **OUTPUT ON**: Starts with LOW. When HSC1 accumulator value is greater than or equal to AQ9-10 UDINT value, then the Output Q1 becomes high, otherwise it will be low.
- **OUTPUT OFF**: Starts with High. When the HSC1 accumulator value is greater than or equal to AQ9-10 UDINT value, then the Output Q1 becomes low, otherwise it will be high.
- **OUTPUT TOGGLE:** When the HSC1 accumulator value is equal to **AQ9-10** UDINT value, then the Output Q1 toggles.
- **OUTPUT PULSE:** The Output Pulse option permits sending a configurable output pulse on a timer match. The starting analog output permits two additional 32-bit words that define the output pulse in microseconds.

Functionality: When the counter accumulator matches the match value stored in %AQ registers, the HSC output will be enabled. The firmware will then wait based on the configurable microsecond pulse width. After the elapsed time, the output will be turned off.

If another match happens while the countdown to turn off the output, then the pulse countdown will restart but the output will not change state until the countdown happens.

When HSC1 accumulator value is equal to AQ9-10 UDINT value, then the Output Q1 becomes high for AQ27-28 UDINT value microseconds.

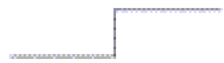
NOTE:

a. Resolution for the pulse width will be limited to 50 microseconds on the OCS series hardware.
b. Match value is stored in register AQ11-12 UDINT for HSC2.
c. AQ29-30 UDINT is Pulse width value for HSC2

9.6: Stepper Functionality

CPU200/250 supports two stepper functions, one on each high-speed output.

Step Function - A signal that has a zero (0) value before a certain instant of time and a constant nonzero value immediate after that instant.



HG-1313

The Stepper requires five parameters (%AQ) to be set for operation. These parameters may be set at run-time but are 'latched' when the stepper is commanded to start:

Start Frequency (cycles per second)	This value (%AQ9) sets the frequency for the first cycle during the acceleration phase and the frequency of the last cycle during the deceleration phase. When an acceleration or deceleration count is specified, the Start Frequency must be greater than zero (0) and must not exceed the run frequency or an error is generated.
Run Frequency (cycles per second)	This value (%AQ10) sets the frequency for the last cycle during the acceleration phase, the consistent frequency during the run phase, and the frequency of the first cycle during the deceleration mode.
Acceleration Count	This value (%AQ11-12) sets the number of cycles to occur within the acceleration phase. The frequency of the cycles within this mode will vary linearly between the specified Start and Run frequency. The Accel count must not equal 1 or an error is generated. Setting this value to zero (0) disables this phase.
Run Count	This value (%AQ13-14) sets the number of cycles to occur within the run phase. The frequency of the cycles within this mode is constant at the specified Run frequency. The Run count may be any value. Setting this value to zero disables this phase.
Deceleration Count	This value (%AQ15-16) sets the number of cycles to occur within the deceleration phase. The frequency of the cycles within this phase will vary linearly between the specified Run and Stop frequency. The Decel count must not equal 1 or an error is generated. Setting this value to zero disables this phase.

The stepper provides two Boolean registers to provide stepper status:

Ready/Done	A high indication on this register indicates the stepper sequence can be started (i.e. not currently busy) and also when the move is completed.
Error	A high indication on this register indicates that one of the analog parameters specified above is invalid or the stepper action was aborted before the operation was complete. This register is cleared on the next start command if the error was corrected.

The stepper requires one discrete register to control the stepper action. Setting this register starts the stepper cycle. This register must remain set to complete the entire cycle. Clearing this register before the cycle is complete aborts the step sequence and sets the error bit. NOTE: Setting the PLC mode to stop while the stepper is in operation causes the stepper output to immediately drop to zero and the current stepper count to be lost. NOTE: The stepper output level may cause damage or be incompatible with some motor drive inputs. Consult drive documentation to determine if output level and type is compatible.

STP Examples: Example 1

	Start Frequency	Run Frequency	Accel Count	Run Count	Decel Count
10,000,000 steps control sequence	Set %AQ9 = 2500 (Hz)	Set %AQ10= 5000 (Hz)	Set %AQ11-12= 1,000,000 (Steps)	Set %AQ13-14= 8,000,000 (Steps)	Set %AQ15-16= 1,0000,000 (Steps)
When the start bit is energized, the example starts at 2.5kHz and ramps up to 5kHz during the first 1,000,000 steps. Then, it runs at 5kHz for the next 8,000,000 steps. Finally, during the last 1,000,000 steps it slows to a stop.					

STP Examples: Example 2

	Start Frequency	Run Frequency	Accel Count	Run Count	Decel Count
5,000,000 steps control sequence	Set %AQ9 = 500 (Hz)	Set %AQ10= 1000 (Hz)	Set %AQ11-12= 2,000,000 (Steps)	Set %AQ13-14= 2,000,000 (Steps)	Set %AQ15-16= 1,0000,000 (Steps)
When the start bit is energized, the example starts at 0.5 kHz and ramps up to 1 kHz during the first 2,000,000 steps. Then, it runs at 1 kHz for the next 2,000,000 steps. Finally, during the last 1,000,000 steps it slows to a stop					

STP Examples: Example 3

	Start Frequency	Run Frequency	Accel Count	Run Count	Decel Count
6,000,000 steps control sequence	Set %AQ9 = 50 (Hz)	Set %AQ10= 250 (Hz)	Set %AQ11-12= 1,500-0 (Steps)	Set %AQ13-14= 5,500000 (Steps)	Set %AQ15-16= 3,50000 (Steps)
When the start bit is energized, the example starts at 50Hz and ramps up to 250Hz during the first 150,000 steps. Then, it runs at 250Hz for the next 5,500,000 steps. During the last 350,000 steps it slows to a stop.					

NOTE: Prior to the start of a move, the Ready/Done bit for that channel must be ON (%I30 or %I33 for channel 1 and 2 respectfully). The Ready/Done bit will turn OFF during the move, and then back ON once the move is completed.

NOTE: The pulse generation hardware on the OCS can generate any frequency that can be evenly divided into 10MHz (10,000,000Hz) under the maximum recommended frequencies for each model. This results in a very smooth operation at lower frequencies, with a progressively choppier operation at higher frequencies, as the units reach their maximum recommended frequency.

NOTE: The highest usable frequency is 500kHz for the PWM output.

Serial Communications

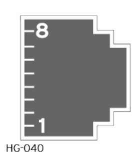
Chapter 10: Serial Communications

All OCS Controller models provide two serial ports, which are implemented with a single 8-position modular jack that is labeled **MJ1/2**. The MJ1 serial port is RS-232 while the MJ2 port is RS-485. MJ1 defaults to OCS programming by connecting it to the COM port of a PC running Cscape. In addition, both MJ1 and MJ2 can be used for application-specific communication, using a variety of standard data exchange protocols.

10.1: Port Descriptions

- The MJ1 serial port contains a RS-232 interface with RTS/CTS handshaking.
- The MJ2 serial port contains half-duplex RS-485 interface with no handshaking. The MJ2 RS-485 interface provides switchable termination and bias resistors internally.

10.2: Wiring—MJ1/MJ2 Serial Ports

<table>
<tr><td rowspan="10"></td><td rowspan="10">2 Serial Ports on 1 Modular jack (8p8c)

MJ1: RS-232 w/Full Handshaking
MJ2: RS-485 Half-Duplex - RS-485 termination and biasing via System Register</td><th colspan="3">MJ1 & MJ2 PINS</th></tr>
<tr><th>PIN</th><th>SIGNAL</th><th>DIRECTION</th></tr>
<tr><td>**8**</td><td>TXD (MJ1)</td><td>OUT</td></tr>
<tr><td>**7**</td><td>RXD (MJ1)</td><td>IN</td></tr>
<tr><td>**6**</td><td>0V</td><td>COMMON</td></tr>
<tr><td>**5**</td><td>+5V @ 60mA</td><td>OUT</td></tr>
<tr><td>**4**</td><td>RTS (MJ1)</td><td>OUT</td></tr>
<tr><td>**3**</td><td>CTS (MJ1)</td><td>IN</td></tr>
<tr><td>**2**</td><td>RX-/TX-/- (MJ2)</td><td>IN/OUT</td></tr>
<tr><td>**1**</td><td>RX+/TX+/+ (MJ2)</td><td>IN/OUT</td></tr>
</table>

10.3: RS-485 Termination and Biasing

Termination - Proper RS-485 termination minimizes reflections and improves reliability.

The MJ2 serial port allows an internal termination resistor to be placed across pins 1 and 2 by software control. Only the two devices physically located at the endpoints of the RS-485 network should be terminated.

This termination is only in place when the OCS Controller is powered on. This would typically only be an issue if the OCS Controller is being used as a slave on the RS-485 network. In that case, the electronic termination should not be used, but a physical external termination resistor should be used instead.

Biasing - RS-485 biasing passively asserts a line-idle state when no device is actively transmitting, which is useful for multi-drop RS-485 networking. The MJ2 serial port allows internal bias resistor to be activated by software control, pulling pin 1 up to 3.3V and pulling pin 2 down to ground.

NOTE: If biasing is used, it should be enabled in only one of the devices attached to the RS-485 network.

Biasing Details:

- %SR152.3 enables RS-485 Port Termination
- %SR164.1 enables RS-485 Port Biasing

10.4: Cscape Programming via Serial Port

MJ1 is the serial port available for programming. The connection is RS-232 and is compatible with the Horner programming cable kits HE-XCK or HE-XCPK. Unlike some other OCS models, the MJ2 port cannot be configured as a programming port. The USB port is also available for programming.

The “Set Serial Ports” option in the OCS System Menu contains an entry for Default Programming Port (Dflt Pgm Port). However, the entry is fixed at MJ1-232. No OCS configuration is required to use either the MJ1 serial port or USB port for programming.

NOTE: Only one Cscape software connection is allowed at a time.

10.5: Ladder-Controlled Serial Communication

Using Serial Communication function blocks, both MJ1 and MJ2 support Generic, Modbus Master and Modbus Slave Protocols. In addition, external modems can be connected and accessed using Init, Dial and Answer Modem function blocks.

10.6: Configuration by USB

NOTE: The unit must be connected via the USB port to the PC or laptop.

It is possible to load the program and monitor data via the USB. To load by USB, configure the communications port in Cscape as follows:

Navigate to: **Home Tab> Controller** and select the **Connection Wizard**.

It is possible to download or upload and use the data monitoring functions once connected.

NOTE: It is advisable to use an isolated USB cable between the PC or laptop and the OCS Controller when third party devices are connected to the OCS Controller to avoid damage to the PC or laptop and/or the OCS Controller.

CAN Communications

Chapter 11: CAN Communications

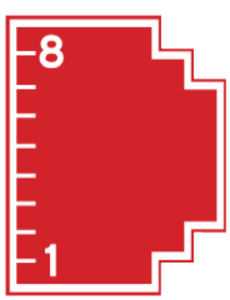
NOTE: For additional CAN information, refer to the CAN Networks manual (**MAN0799**) via Documentation Search for more details .

11.1: Overview

The CPU200/250 provides a CAN networking port, which is implemented with an 8-pin RJ-45 modular jack. The connector is labeled CAN and is **red**.

HG-1343

CAN Port Wiring



HG-042

Modular jack (8p8c)

CAN Pin Assignments	
PIN	**SIGNAL**
8	No Connection
7	Ground
6	[CAN] Shield
5	No Connection
4	No Connection
3	Ground
2	CAN Data Low
1	CAN Data High

Cscape Programming by CAN

The CAN port supports CsCAN Programming Protocol. If a PC has a CAN interface installed (by PCI card or USB), and the PC CAN port is connected to the CPU200/250 CAN port, then Cscape can access the CPU250 for programming and monitoring.

In addition, the CPU200/250 supports single-point-programming of all CPU200/250 and other Horner controllers that are connected to a CAN network. If the PC COM port is connected to the CPU200/250 programming port, then the CPU200/250 can act as a pass-through gateway allowing Cscape to access all CPU200/250 and Horner controllers that are attached to the CAN network.

Ladder-Controlled CAN Communication

Using Put and Get Network Words function blocks, the CAN port can exchange digital and analog global data with other CPU200/250, or Horner controllers attached to the CAN network.

In addition, Put and Get Network Heartbeat function blocks allow nodes on the CAN network to regularly announce their presence and to detect the presence (or absence) of other nodes on the network.

Using CAN for I/O Expansion (Network I/O)

Connecting remote I/O to the CPU200/250 CAN port allows the CPU200/250 I/O to be economically expanded and distributed. A variety of remote I/O modules is available for this purpose.

CAN and Termination and Bias

If there is a controller-to-controller communication on a network, and a CPU200/250 will be at either end, then it is recommended that onboard electronic termination NOT be used. Physical external resistors should be used instead. In this case, utilizing RJ-45 to open-style connector will make termination easier.

NOTE: %SR152 enables CAN port termination.

NOTE: When powered down, the biasing and termination is no longer in effect.

Ethernet Communication

Chapter 12: Ethernet Communications

NOTE: Refer to the Ethernet Supplement (**SUP0740**)on the Document Search page for more details.

12.1: Ethernet Module Protocols

The following table describes the Ethernet Module Protocols and features supported by the Ethernet port on an OCS controller.

Protocol/Feature	Protocol/Feature Description
ASCII over TCP/IP	ASCII Data over Ethernet
EGD	Ethernet Global Data
Ethernet /IP	ODVA CIP over Ethernet
FTP (File Server)	File Transfer Protocol
ICMP (Ping)	Internet Control Message Protocol
Modbus Slave	Modbus over Ethernet
NTP Protocol	Network Time Protocol

12.2: Ethernet System Requirements

Full Ethernet functionality requires:

- PC running Cscape Programming Software Version 9.8 or later (for configuration).
- OCS controller with onboard Ethernet port.

12.3: Ethernet Module Specifications

Speeds	10 BASE-T Ethernet (10Mbps), 100BASE-Tx Fast Ethernet (100Mbps)
Modes	Half or Full Duplex
Auto-Negotiation	Both 10/100Mbps and Half/Full Duplex
Connector Type	Shielded RJ-45
Cable Type (Recommended)	CAT5 (or better) UTP
Port	Auto MDI/MDI-X (Auto Crossover)

12.4: Ethernet Module Configuration

NOTE: The following configuration is required for all applications regardless of the protocols used. Additional configuration procedures must be performed for each protocol used.

To configure the Ethernet Module, use Cscape Programming Software to perform the following steps:

- **Step 1**: On the main Cscape screen, select the **Home Tab > Controller** menu and its **Hardware Configuration** sub-menu to open the Hardware Configuration dialog.
- **Step 2**: If configuring a different OCS Model than the one shown in the **Hardware Configuration** dialog, click on the topmost Config button, select the desired OCS Model, and then click **OK**.
- **Step 3**: Click **Config** to the right of the LAN1 for LAN 1 or LAN2 for LAN 2, revealing the Ethernet Module Configuration dialog.

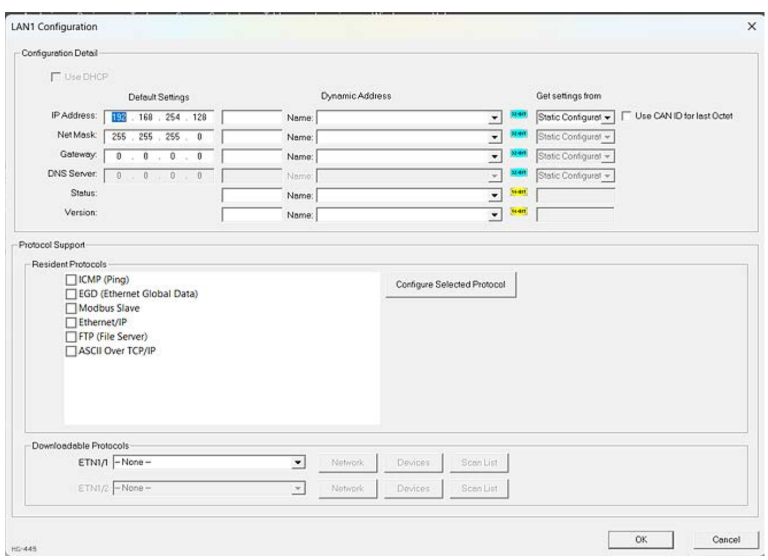
Configure the following:

- **IP Address**: Enter the static IP Address for the Ethernet Module being configured.

  NOTE: IP Addresses are entered as four numbers, each ranging from 0 to 255. These four numbers are called octets, and they are always separated by decimal points. See also: "Ethernet Configuration – IP Parameters" on page 62

- **Net Mask**: Enter the Net Mask (sometimes called Subnet Mask) being used by all nodes on the local network. Typical local networks use Class C IP Addresses, in which case the low octet (rightmost number) is used to uniquely identify each node on the local network. In this case, the default Net Mask value of 255.255.255.0 should be used.

- **Gateway**: Enter the IP Address of a Gateway Server on the local network that allows for communication outside of the local network. To prevent the Ethernet Module from communicating outside the local network, set the Default Gateway IP Address to 0.0.0.0 (the default setting).



- **Status Register**: Enter an OCS Register reference (such as %R100) to indicate which 16-bit OCS register will have the Ethernet Status word written to it. The table shows how this register value is formatted and explains the meaning of each bit in the Status Word.

Ethernet Status Word Register Format

High Byte								Low Byte							
Bit 16	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1
0	0	Dup	Spd	0	Rx	Tx	Link	TCP Connections							

Status Bit	Status Indication	Status Values	
		Minimum	**Maximum**
0	Reserved	Always 0	
Dup	Link Duplex (Auto-Negotiated)	0 = Half Duplex	1 = Full Duplex
Spd	Link Speed (Auto-Negotiated)	0 = 10 Mbps	1 = 100 Mbps
Rx	Receive State	0 = Inactive	1 = Active
Tx	Transmit State	0 = Inactive	1 = Active
Link	Link State	0 = Down	1 = Up
TCP Connections	Total Number of Active TCP Connections (CsCAN, SRTP, Modbus, EtherNet/IP, FTP, HTTP)	0	40

- **Version Register**: Enter an OCS Register reference (such as %R101) to indicate which 16-bit OCS register will have the Ethernet Firmware Version written to it. The value stored in the Version Register is (Ethernet Firmware Version * 100). For example, for Ethernet Firmware Version 4.30, the Version register will contain 430.
- **Get Setting From**: “Get settings from” allows the programmer to either configure the IP Address, Net Mask, or Gateway for two functions: Configuration or Register.
- **Configuration**: The configuration for the IP Address, Net Mask, Gateway, or DNS Server will be assigned using the value in the Default Settings in this window.
- **Register**: The configuration for the IP Address, Net Mask, Gateway, or DNS Server will be assigned using the values in the registers assigned.

12.5: Ethernet Configuration – IP Parameters

For primary operation, the IP address, Net Mask, and Gateway should be set in the LAN config of the **Cscape Hardware Configuration**. There are options to get IP parameters from the LAN Config or to get parameters from registers.The following points on IP parameter configuration should be considered.

IP Parameters in Non-Volatile RAM: The IP parameters of the Cscape LAN Config are written to non-volatile RAM on power down.

"Cscape LAN Config"/"Get Settings from" Configuration: When 'Get settings from' is set to Configuration, the IP parameters specified under 'Static Configuration' is used after downloading to the controller.

- The IP parameters always follow the values in the registers unless the OCS unit is placed in idle mode. Then the IP parameters can be edited in System Menu/Set Networks. When the OCS is placed back into run mode, it reverts to the registers for IP parameters.

DHCP: When the 'Use DHCP' box is checked, the IP Address, Net Mask, Gateway, and DNS Server are automatically set, obtaining their parameters from the connected server. The parameters obtained by the server are accessible by the addressing assigned under the dynamic configuration.

12.6: Ethernet Module Protocol Configuration

The Protocol Support area contains a list of all the resident protocols supported by the platform being configured. To activate a protocol, check its checkbox.

For protocols that require additional configuration, click on a listed protocol to select it and then click the Configure Selected Protocol button. This will open a new dialog with configuration options for the selected protocol.

NOTE: Refer to the Ethernet Supplement (**SUP0740**)on the Document Search page for more details.

Downloadable Protocols

Chapter 13: Protocol Configuration

13.1: Overview

Through loadable protocol device drivers, certain models of the OCS family can provide the ability to exchange data with remote devices such as variable-frequency drives, PLCs, and remote I/O devices. This feature greatly expands OCS control capability with negligible effect on OCS ladder scan time.

Remote devices that communicate serially must do so under certain rules of data transfer known as a protocol. Many device manufactures have created their own protocol for communications with their device. For a OCS to communicate with a specific device, it must be loaded with the corresponding serial communications protocol device driver that supports that protocol.

A limited number of protocol device drivers are packaged with the Cscape distribution; however, as more are developed, they will be made available as add-on packages. A device driver is typically distributed as a Windows module, which contains the configuration menus, help files and the target executable driver code. When updating device drivers, an install routine loads the device driver to the Cscape directory structure and makes that driver available to Cscape applications.

Once installed, the protocol device driver can be included as part of a Cscape application by selecting it from a list of installed protocol device drivers and attaching it to the desired serial port (**Home > Protocols**). Only one protocol device driver can be associated with a serial port, though some OCS models support multiple protocols on a single EtherNet port.

Once the protocol is selected for a specific port, that port must be configured to match the bit transfer size and rate of the target device(s). This is configured under the **Network Config** menu, which contains port specific information such as the basic serial port parameters (i.e. baud rate, stop bits parity, retries, etc.). In addition to the serial port parameters, this menu also contains the transaction scan update control configuration and any network level protocol specific configuration.

Once the network is configured, each device on the serial communications network must be configured. For some communications (i.e. RS-232), the network can be limited to one device. The devices are configured under the **Device Config** menu, which contains an arbitrary device name, the device ID and optionally a OCS status register that contains any device fault information.

Once each device(s) is configured, a Scan List of entries must be created which defines the transfer of data between a local (OCS) register(s) and a remote device register(s). These entries are created under the Data Mapping menu, which contains a OCS register, a target device ID, a target device register address, the number of registers to transfer, and update type.

Each entry can be configured for one of two types of initiating a transaction: **Polled and Triggered**. Polled type entries initiate a transaction with the remote device on every transaction scan. Triggered type entries only initiate a transaction when a corresponding local (OCS) binary trigger register is set. Once a triggered type transaction completes, the protocol device driver resets the local (OCS) binary register to indicate completion.

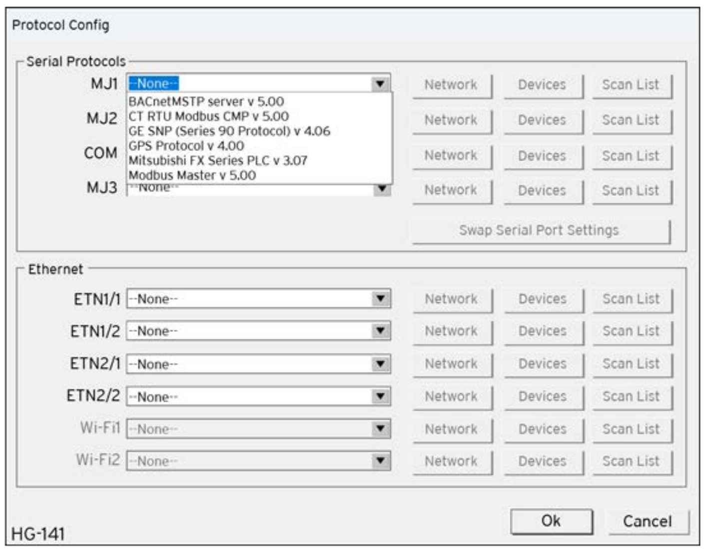
These basic types are also subdivided into read or write operations. For polled operations, a Read operation only reads from a remote device. Likewise a Read/Write operation continuously reads from the remote device unless the target OCS register value changes from one ladder scan to another. In this case, the new OCS value is written to the target device. For triggered operations, only a read or write action is available.

When downloaded to the OCS , the Scan List is scanned sequentially to generate data transactions with the remote device. This transaction scanning can be on a continual basis (**automatic**) or controlled from ladder logic (manual) once a complex connection is created via a program. The specific transaction-scanning mode is selected from the **Network Config** menu.

Refer to the Cscape Help file for more information on Downloadable Protocols Configuration.

13.2: Protocol Device Driver Selection

From the Cscape **Home > Protocols** menu, select the port drop-down box to select a protocol device driver. All protocol device drivers currently loaded in Cscape are displayed in the drop down selection along with their version numbers. A selected protocol can be removed by selecting **None** from the drop-down selection. Some OCS models can be limited in the number of ports or number of protocol device drivers that can be selected. Once a protocol is selected, the Network, Devices and Data (Scan List) must be configured through corresponding dialogues accessible through the respective buttons (Network, Devices and Scan List).



NOTE: If the MJ1 port is to be used in the Protocol Config, it will no longer be available for Cscape programming unless the controller is put into IDLE mode.

Three fields must be configured after a protocol is selected:

1. Network
2. Devices
3. Scan List

13.3: Network Configuration

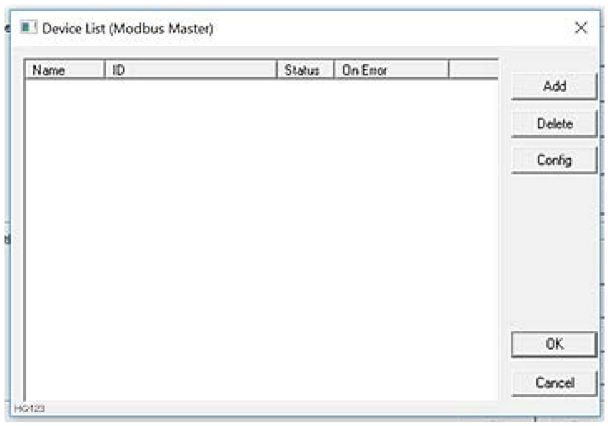
Network Configuration provides the required parameters to configure the network. Each protocol is different and may not require the entire Network Config field. Refer to the table below for the options in the Network Config field.

Network Protocols		
Baud Rate, Data Bits, Stop Bits, Parity	These field define the bit level transfer over the serial port.	
Handshake	**None** – No handshake lines are used **Multidrop Full** – Rx remains active while Tx is occurring. **Multidrop Half** – Rx is shut off while Tx is occurring. **Radio Modem** – Wait for CTS acknowledgment before transmitting (legacy radio modem support).	
Protocol	If a driver supports multiple protocols, it is selected here, (i.e., Modbus-TCP/UDP supports RTU or ANSI).	
Mode	Specifies if port operates in RS-232 or RS-485 mode.	
Retries	Specifies number of times a transaction is retried on a failed response.	
Timeout	Specifies the amount of time for a device to wait for a valid response.	
Update Scan	Automatic	**Update Interval** – Specifies the update interval at which all the mapped entries are executed.
		Reacquire Time – Specifies the amount of time to wait before attempting communications with an offline device.
	Manual	**Trigger** – Specifies the binary register that a single transaction scan of the

Network Protocols		
		Scan List.
		ID Select – If an analog is specified in the field, the ID Select filter is enabled.
Status Register	Specifies the starting OCS register of eight (8) consecutive registers (4-32bit counters), which provide an indication of the network health.	
Scanner Address	Specifies the OCS's device (network) ID if a master ID is required by the protocol.	
Protocol Help	Provides protocol specific help.	

13.4: Device List and Device Configuration

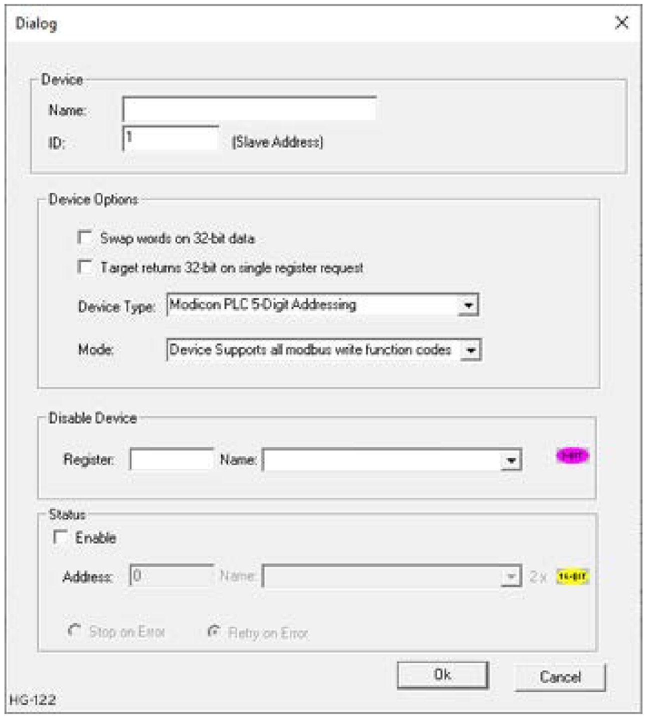
13.4.1: Device List



This configuration list is reached from the Device button on the Protocol Config screen and provides a list of the configured devices on the Network. Devices must be created and exist in this list before corresponding Scan List entries can be created for this device. Typically, the number of entries is limited to **64 devices**.

- **Add** - Opens the Device Config dialog to add a new device to the list.
- **Delete** - Remove selected device from list (all corresponding Scan List entries are also removed).
- **Config** - Invoke the Device Config dialog for the currently selected device. This can also be accomplished by double-clicking a device entry.
- **Mapping** - Invoke the Scan List limiting the entries displayed for the selected device.

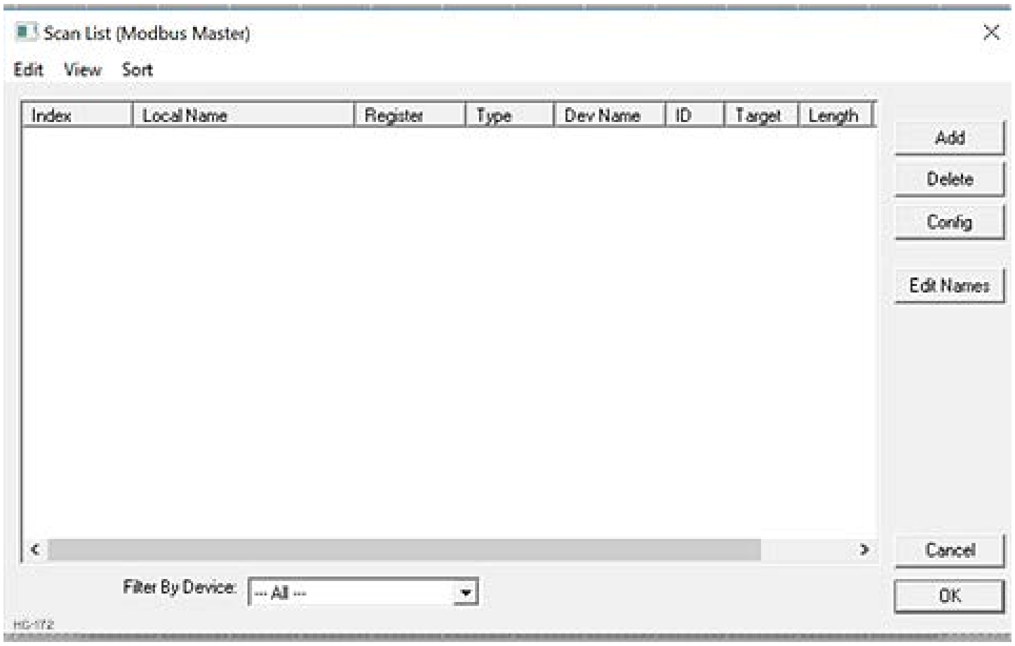
13.4.2: Device Configuration



This configuration is reached from the device list when adding or modifying an existing device. While each protocol is somewhat different and can contain protocol specific field, all protocols typically support at least:

- **Device Name** - Specifies a tag name for this device. This tag name is used in the Data Mapping configuration to identify this device. This allows device addresses to be modified without the need to update all associated Data Mapping entries.
- **Device ID** - Specifies the target device communications ID or station address.
- **Swap Words on 32-bit Data** - If a Scan List entry is configured to transfer 32-bits and this option is checked, the high and low 16-bit values are swapped when transferred between the target and OCS.
- **Disable Device** - From Cscape 9.90 SP3 and firmware 15.40 onwards, disable device feature has been added in protocol device configuration. This option is used to disable a particular slave configured in the network. Single bit register has to be configured to use this function. Setting the bit high disables the slave and OCS will not send any serial (TCP for EtherNet/IP protocols) packets only to this slave until the bit is high. Setting the bit low enables the communication with the slave again.
- **Status Enable** - This checkbox enables device status to be displayed and controlled from two consecutive 16-bit registers.
- **Status Address** - Enter the starting 16-bit OCS register of two consecutive registers used for device status. The first register contains the protocol device driver specific error code while the second register contains the index of the offending Scan List entry.
- **Status Modes**:
  a. **Stop on Error** - Specifies that communications be only reattempted after offline status when the corresponding device status register is cleared.
  b. **Retry on Error** - Specifies that communications be reattempted either during the reacquire interval or when the corresponding device status register is cleared.

13.5: Scan List



This configuration list is reached from the Scan List button on the Protocol Config screen or the **Mapping** button on the Device List screen and provides a Scan List of the Data Mapping entries. To transfer data between the OCS and remote target, a Scan List must be created that defines each transaction. Each mapping entry (transaction) contains the source and destination registers, the number of consecutive registers transferred, the direction of the transfer and what triggers the transfer. Typically, **the number of entries is limited to 512**.

NOTE: The order of the Scan List is the order in which the transactions occur. Sort functions are provided to change the order of the list. Each entry also has an identifying index. If the device status register is enabled and a transaction failure occurs, the status register indicates the index number of the transaction that failed.

13.5.1: Menu

- **Edit > Copy All** - Copies Scan List to clipboard in a tab delimited format suitable for pasting into an application like Microsoft Excel.
- **Edit > Paste** - Loads Scan List from clipboard. Pasted items are added to the scan list even if they are duplicates.
- **View > Toggle All Name View** - Expands Scan List such that each point and corresponding local name is displayed.
- **Sort** Scan List by different criteria. The firmware will scan the devices based on the order they are displayed or sorted. There are four ways to sort the scan list:
    a. **By Local Address** – Sorts the list by local register address in increasing order.
    b. **By Target Address** – Sorts the list by target register address in increasing order.
    c. **By Device Name** – Sorts by device name, then target address.
    d. **Interleave Devices** – This sort evenly distributes request among the different devices. Instead of requesting 100 blocks from device A, then 100 blocks from device B, one requests is sent to device A, then one request is sent to device B until all the data has been requested. This is useful for devices that may have a timeout timer because the time between each scan for a particular device is minimized. This sorting options usually doesn't affect performance.

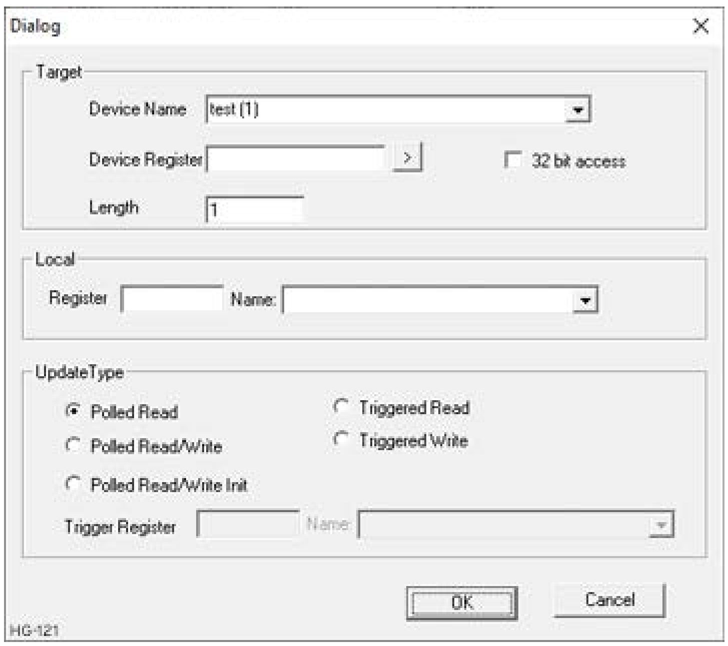
13.5.2: Buttons

- **Add** - Opens the Data Mapping dialog to add a new entry to the Scan List.
- **Delete** - Removes selected entry from Scan List
- **Config** - Opens the Data Mapping dialog for the currently selected entry. This can also be accomplished by double-clicking an entry.
- **Edit Names** - Invokes the Edit Names dialog for the currently selected entry. The Edit Names dialog provides the ability to create OCS program names for each point in the transaction.

13.5.3: Display Control

Filter by Device - Limits displayed entries to only those assigned to the indicated device. To show all entries select **–All**--.

13.5.4: Data Mapping Configuration (Scan List Entry)



Target

- **Device Name** - Selects the target device (by tag name) to use for this transaction. Only those device entries previously created from the Device Config menu are available.
- **Device Register** - Specifies the target device's register to use for this transaction. This designation is target-specific. The configuration menu displays an error if a specified address is unacceptable. **Generally, the data type of the local (OCS) register must match the data type of the device register**.
- **The Right Arrow button** - Displays protocol device driver specific help for the target addressing. Note that some devices can require register addresses that exist on 8-bit, 16-bit or 32-bit boundaries.
- **Local Register** - Specifies the local (OCS) register that is the source or destination for the transaction.
- **Local Name [Optional]** - Optionally allows selection of a OCS register by name <or> creation of a name for a register already selected by direct reference. Created names can be used thereafter to specify the local (OCS) register in ladder or graphics address fields.
- **32-Bit Access** - Allows two local (OCS) 16-bit registers to be treated as a single 32-bit value. For example, if the value in either 16-bit register is modified, both registers are written to the device. Device-specific, 32-bit word swapping options also apply to this designation. Since the transaction is treated as a 32-bit access, the length is generally limited to 16. Note that some protocols can disable this feature.

- **Length**
  a. Specifies the number of consecutive device registers that are transferred in this transaction. Note that some protocols can limit the length that can be transferred. However, typically the **length is limited to 32**. The configuration menu displays an error if a specified length is unacceptable.
  b. **If allowed, specifying a length greater than one (multiple consecutive register transfers per transaction) is more efficient than creating a single transaction for each register**. This grouping of registers per transaction can significantly reduce the transaction scan time; however, **update types that include writing on a polled basis require additional consideration.**
  c. On **Read/Write** and **Read/Write/Init** update types, the write transaction only occurs when the local (OCS) register value changes. If the length is greater than 1 for Read/Write and Read/Write/Init types, only the local register(s) that change in value are written. More specifically, only one write transaction occurs per scan per mapping entry for the register or consecutive sub-group of local registers that changed in value. Depending on the protocol, the number of points written with that write transaction are limited either to one or the number of consecutive points that changed value.
  d. **Therefore, if several local registers (specified in a single mapping entry) change in value prior to a transaction scan, it takes SEVERAL transaction scans to complete all the write operations. Furthermore, all write operations are completed before a read operation is scheduled.**
  e. **For Manual Update (transaction) scans (i.e. dialup modem), it is recommended that all Read/Write Scan List entry lengths be limited to 1.**

Update Type

This field specifies the direction and what triggers the transfer of data between the OCS and target device for a mapping entry.

- **Polled Read** - On every transaction scan, a read-only target device register(s) transaction occurs.
- **Polled Read/Write**
  a. On every transaction scan, a read target device register transaction occurs unless a local register value has changed. The write transaction only updates those local registers that have changed in value. If several non-consecutive local registers (contained in a single mapping entry) change value between transaction scans, it takes several consecutive transaction scans to write each changed register.
  b. When the OCS is placed in RUN mode, **the initial action for this mapping type is a read target register transaction**. This transaction initializes the local (OCS) register(s) to match that of the remote device register(s). Thereafter, any change to the corresponding OCS register(s) triggers a write operation to the remote device.

- **Polled Read/Write/Init**
  a. On every transaction scan, a read target device register transaction occurs unless a local register value has changed. The write transaction only updates those local registers that have changed in value. If several non-consecutive local registers (contained in a single mapping entry) change value between transaction scans, it takes several consecutive scans to write each changed register.
  b. On every transaction scan, a read target device register transaction occurs unless a local register value has changed. The write transaction only updates those local registers that have changed in value. If several non-consecutive local registers (contained in a single mapping entry) change value between transaction scans, it takes several consecutive scans to write each changed register.
  c. When the OCS is placed in RUN mode, **the initial action for this mapping type is a write target register transaction**. This transaction initializes the target device register(s) to match that of the local (OCS) register (s). Thereafter, any change to the corresponding OCS register(s) triggers a write operation to the remote device.
  d. The initial write transaction does not occur until after the first logic scan of the OCS . This allows registers to be initialized locally before Writing to the target device register(s).
- **Triggered Read** - A read transaction is triggered by a high level on a separately designated OCS (binary) trigger register. Once the read transaction is complete (or the device is offline), the OCS trigger register is cleared by the OCS . This update type can be used for occasional data accesses such as retrieving trend data. Note that this operation increases the associated transaction scan time and can cause the **Update Interval Exceeded Counter** to increment on a tightly adjusted update interval.

- **Triggered Write** - A write transaction is triggered by a high level on a separately designated OCS (binary) trigger register. Once the write transaction is complete (or the device is offline) the OCS trigger register is cleared by OCS . This function can be used for occasional data accesses such as sending recipe data. Note that this operation increases the associated transaction scan time and can cause the **Update Interval Time Exceeded Counter** to increment on a tightly adjusted update interval.

Removable Media

Chapter 14: Removable Media

All Horner controllers models provide a Removable Media slot, which supports standard microSD flash memory cards. microSD cards can be used to save and load applications,and to log data for later retrieval.

14.1: microSD Cards

MicroSD cards (Memory Cards) with up to 32GB of flash memory, are compatible with the Horner controller Memory Card slot.

A microSD card can be safely inserted into the Memory Card slot whether the Horner controller power is On or Off.

Installing the microSD Card

To Install a microSD card: align the gold edge connector toward the switch and carefully push it all the way into the slot. To remove, gently pull up on the card.

14.1.1: microSD File System

The microSD Memory Card slot uses the PC-compatible FAT32 File System. This means that a PC, with a microSD-compatible card reader, can read files that have been written by the Horner controller and can write files that can be read by the Horner controller.

However, the Horner controller does not support long filenames, but instead implements the 8.3 filename format. This means that all file and directory names must consist of up to eight (8) characters, followed by an optional dot, and an optional extension with up to three (3) characters.

Directories and sub-directories can be nested up to 16 levels deep as long as each path name string does not exceed 147 characters.

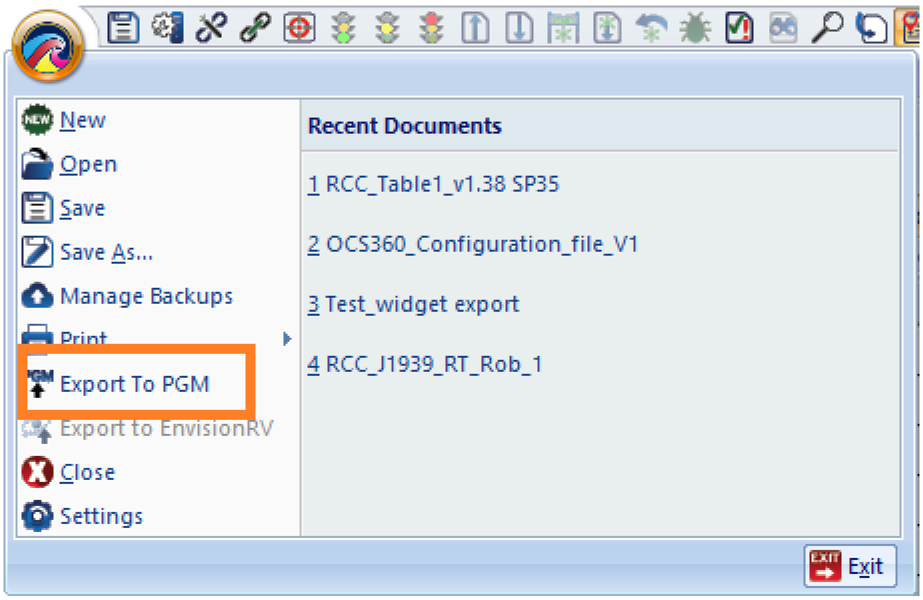
14.2: Log Data

Using Read and Write Removable Media function blocks, an application ladder program can read and write Horner controller register data in the form of comma-delimited files, with a .csv extension. These files are compatible with standard database and spreadsheet PC programs. In addition, an application ladder program can use Rename and Delete Removable Media function blocks to rename and delete files.

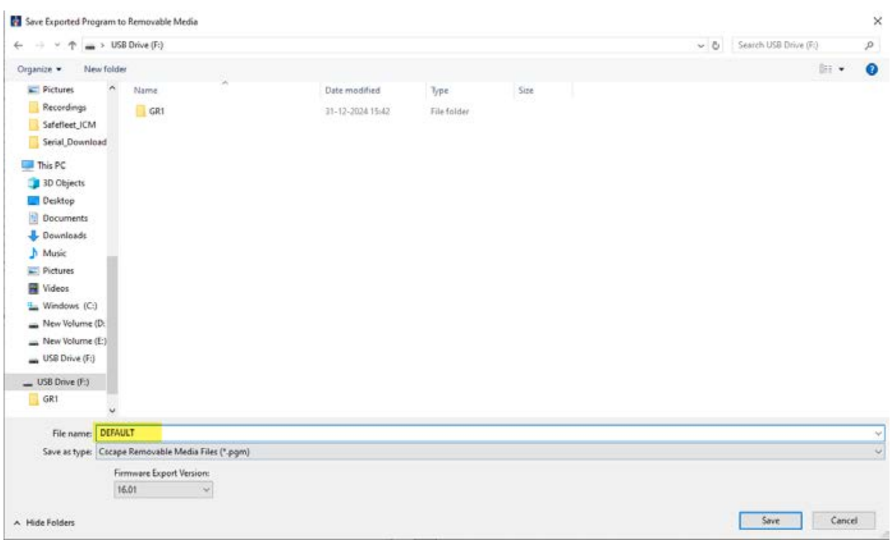
14.3: Loading Program from microSD Card Using Switch

Use the following steps to load a program from microSD card:

1. Copy the .PGM file from Cscape using the **Export To PGM** option.



2. Select the correct Firmware Export Version.
3. Rename the file to **DEFAULT.PGM**.



4. Copy DEFAULT.PGM to root of a MicroSD Card.

14.4: Clear Application Using the Switch

To clear an application, do the following:

1. Hold the switch in LOAD position for 10 seconds, then release it. The MS LED will blink RED indicating that the device is ready to clear the application.
2. While the MS LED is still blinking RED, turn the switch to LOAD position again and hold it for 10 more seconds. At the end of the 10 seconds the MS LED will stop blinking
3. Turn the switch to the STOP position, when the switch is released to the STOP position, the device will start clearing the application and restart itself.

If the MS LED is blinking RED and the switch is not turned to the LOAD position for second time, it will blink for 30 seconds, turn off, and the application will not be cleared.

14.5: Function Blocks in Cscape

NOTE: For detailed information regarding RM function blocks and parameters, refer to the Help File in Cscape Software. Refer to 'USB flash Media support for RM Functions' for USB flash drive access details.

The following RM functional blocks are available in Cscape Software. These function blocks will reference:

a. microSD when filename is prefixed with 'A:' or nothing
b. USB A flash drive when filename is prefixed with 'B:'

Read RM csv	Allows reading of a comma-separated value file from the microSD interface into the controller register space.
Write RM csv	Allows writing of a comma-separated value file to the microSD interface from the controller register space.
Rename RM csv	Allows renaming a file on the RM card. The data in the file is not changed.
Delete RM csv	Allows deleting a file on the RM card
Copy RM csv	Allows copying a file on the RM card. The data in the file is not changed.

14.5.1: Program Features

a. **Datalog Configuration** - This feature allows the controller to periodically log register values to Removable Media. The register data is stored in .csv (comma separated value) format, which is compatible with 3rd party PC applications, such as Microsoft Excel.
b. **Report Editor** - This feature allows the OCS to be configured to generate text printouts which incorporate data from the registers embedded in the text. The reports can be printed using a serial interface printer through any of the serial ports of the OCS or can be saved on the removable media of the device.
c. **Recipes Editor** - Recipes allow the user to send or update multiple registers simultaneously.

14.6: Filenames

The RM function blocks support the flash with a Windows standard FAT-16 file system. All names must be limited to the "8.3" format where the filename contains eight characters a period then a three-character extension.

The entire filename including any path must be less than or equal to 147 characters.

When creating filenames and directories, it is sometimes desirable to include parts of the current date or time. There are six special symbols that can be entered into a filename that are replaced by the OCS with current time and date information.

Filename Special Symbols		
Symbol	**Description**	**Example**
$Y	Substitutes the current 2-digit year	2015 = 15
$M	Substitutes the current month with a 2-digit code	March = 03
$D	Substitutes the current day	22nd = 22
$h	Substitutes the current hour in 24-hour format	5 pm = 17
$m	Substitutes the current minute	45 = 45
$s	Substitutes the current second	34 = 34

NOTE: All the symbols start with the dollar sign ($) character. Date symbols are in upper case, time symbols are in lower case.

The following are examples of the substituted time/date filenames:

Current date and time: March 1, 2015 5:45:34 PM

Filename: Data$M$D.csv = Data0301.csv

Filename: Year$Y\Month$M\aa$D_$h.csv = Year15\Month03\aa01_17.csv

Filename: Month_$M\Day_$D\$h_$m_$s.csv = Month_03\Day_01\17_45_34.csv

14.7: System Registers and Removable Media

%SR174 – Removable Media Protect. Write a one (1) to %SR174 to prohibit read/write access to the removable media card. Write a zero (0) to allow access.

%SR175 Status – This shows the current status of the RM interface.

%SR176 Free Space – This 32-bit register shows the free space on the RM card in bytes.

%SR178 Card Capacity – This 32-bit register shows the total card capacity in kilobytes.

Possible status values are shown in the table:

RM Status Values	
0	RM interface OK
1	Card present but unknown format
2	No card in slot
3	Card present, but not supported
4	Card swapped before operation was complete
5	Unknown error

Clone Unit

Chapter 15: Clone Unit

"Clone Unit" feature allows the user to “clone” the OCS of the exact same model. This feature “clones” application program and unit settings stored in the following:

- Prime Series: retentive memory
- Non-Prime controllers: battery-backed RAMregister/variable memory of an OCS into the RM

This feature can be used for:

- Replacing an OCS by another unit of the same model.
- Duplicating or “clone” units without a PC.

15.1: Make Clone

Make/Create clone can be triggered by setting %SR164.9 bit to “1” from the Ladder program or graphics. When the operation is completed, this bit is made zero by the firmware. When the Make Clone operation is triggered by this SR bit, it does not ask the user for confirmation for making clone.

In case of failure, %SR164.11 bit is set to “1” by the firmware and never reset.

NOTE: Backup of registers in flash memory is not performed by Clone Feature. Refer to "Fail-Safe System" on page 81.

15.2: Load Clone

Load Clone can also be triggered by setting %SR164.10 bit to “1” from the Ladder program. When the operation is completed, this bit is made zero by the firmware. When the Load Clone operation is triggered by this SR bit, it does not ask the user for confirmation for loading clone.

In case of failure, %SR164.12 bit is set to “1” by the firmware and never reset.

Fail-Safe System

Chapter 16: Fail-Safe System

16.1: Fail-Safe Features

16.2: Fail-Safe System Overview

The Fail-Safe System has the following capabilities:

- Manually backup the current retentive register settings into flash memory.
- Manually restore register settings from the values previously backed up in flash memory to retentive registers.
- Detect corrupted register settings at power-up and then automatically restore them from flash.
- Detect corrupted or empty application in flash memory at power-up and then automatically load the AUTOLOAD.PGM application file from Removable Media (Compact flash or microSD).
- If an automatic Register Restore or Application Load occurs, the OCS can automatically be placed in RUN mode.

16.3: Settings

To use the Fail-Safe feature, the following steps are required:

1. From Cscape, create AUTOLOAD.PGM for the application program using **Export to Removable Media**.
2. Place the Removable Media with AUTOLOAD.PGM in the device.
3. Set the **Enable AutoLoad** option by setting HIGH %SF164.6.
4. Enable the AUTORUN option by making High %SR164.5. if the controller needs to be placed in RUN mode automatically after automatic restore of data or AutoLoad operation.
5. Backup the current primary memory register contents in the onboard flash memory.

16.3.1: Backup OCS Data

When initiated, the user can manually copy register contents onto the an alternate section of onboard flash memory of the OCS. This will have result in backing up all the registers and controller settings (Network ID, etc.) that would otherwise be lost due to a memory failure. %SR164.4 is set to 1 when backup operation is performed.

16.3.2: Restore OCS Data

Automatic Restore Operation

When initiated, the user can copy the backed-up data from the onboard flash to the battery-backed RAM.

A restore operation is automatically initiated if 1) a backup has been previously created and 2) on power-up the battery-backed RAM registers fail their check.

The following process will be followed for restoring data:

- The controller will be placed in IDLE mode.
- Data will be copied from onboard flash memory to OCS battery-backed RAM •
- The controller will reset.
- The controller will be put in RUN mode if the AutoRun setting is 'Yes', or else it will remain in IDLE mode.

%SR164.3 is set to 1 when an automatic restore operation is performed. This bit is reset to the value of "0" when a new backup is created.

Manual Restore Operation

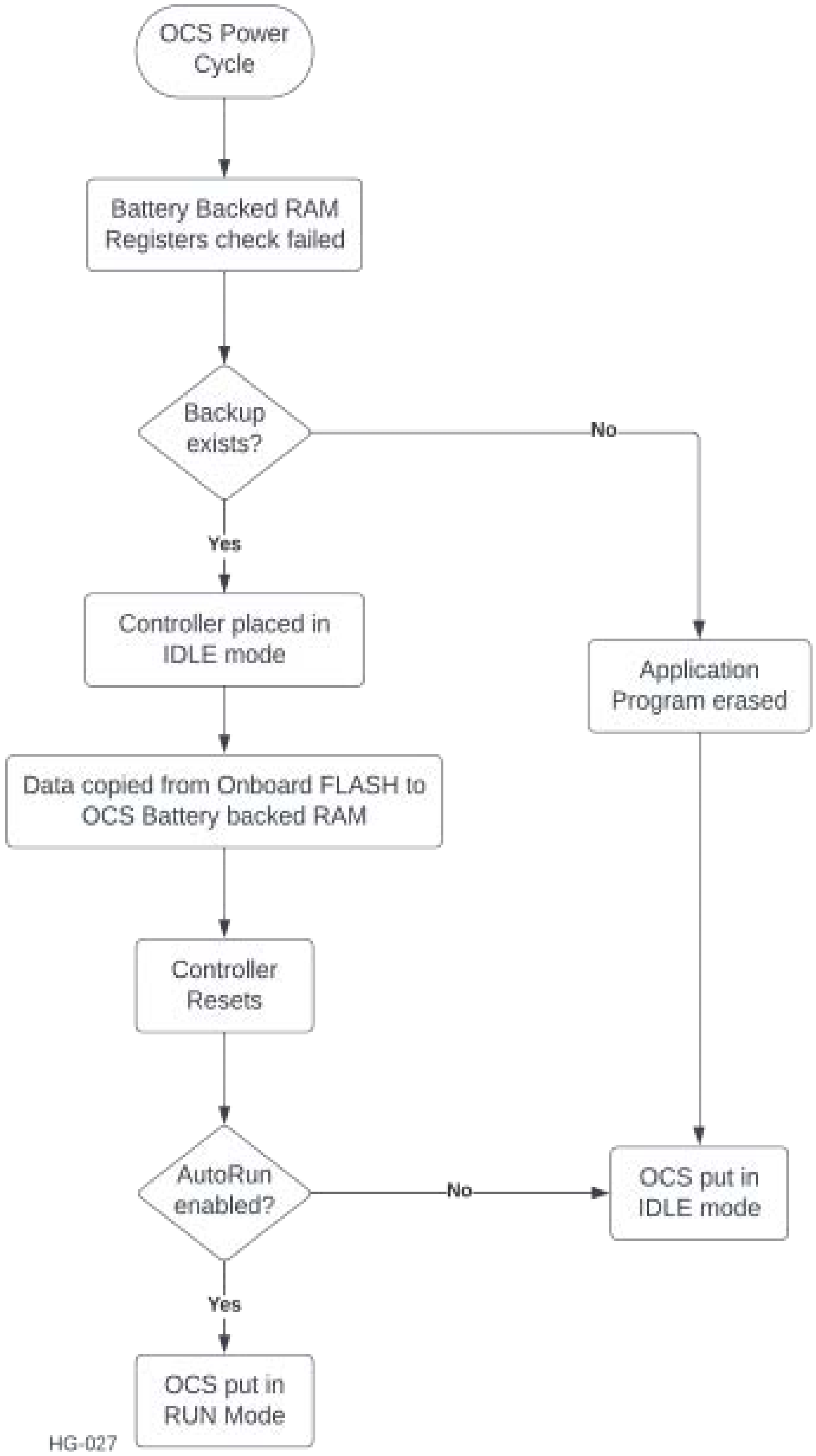
- Restoring of data can be manually performed by setting %SR164.14 to 1, this in turn sets %SR164.15 to 1.
- The user needs to set %SR164.15 to 0 complete the restore operation or set %SR164.14 to 0 to abort

%SR164.3 is set to 1 only when an automatic restore operation is performed, not on a manual one. This bit is reset to the value of "0" when a new backup is created.

16.4: Clear Backup Data

When initiated, the backup data will be erased from the onboard flash and no backup will exist. %SR164.4 and %SR164.3 are reset to 0 when backed-up data is erased.

The OCS follows the following sequence in execution of Automatic Restore:



16.5: AutoLoad

This option allows the user to specify whether the OCS automatically loads the application AUTOLOAD.PGM located in Removable Media.

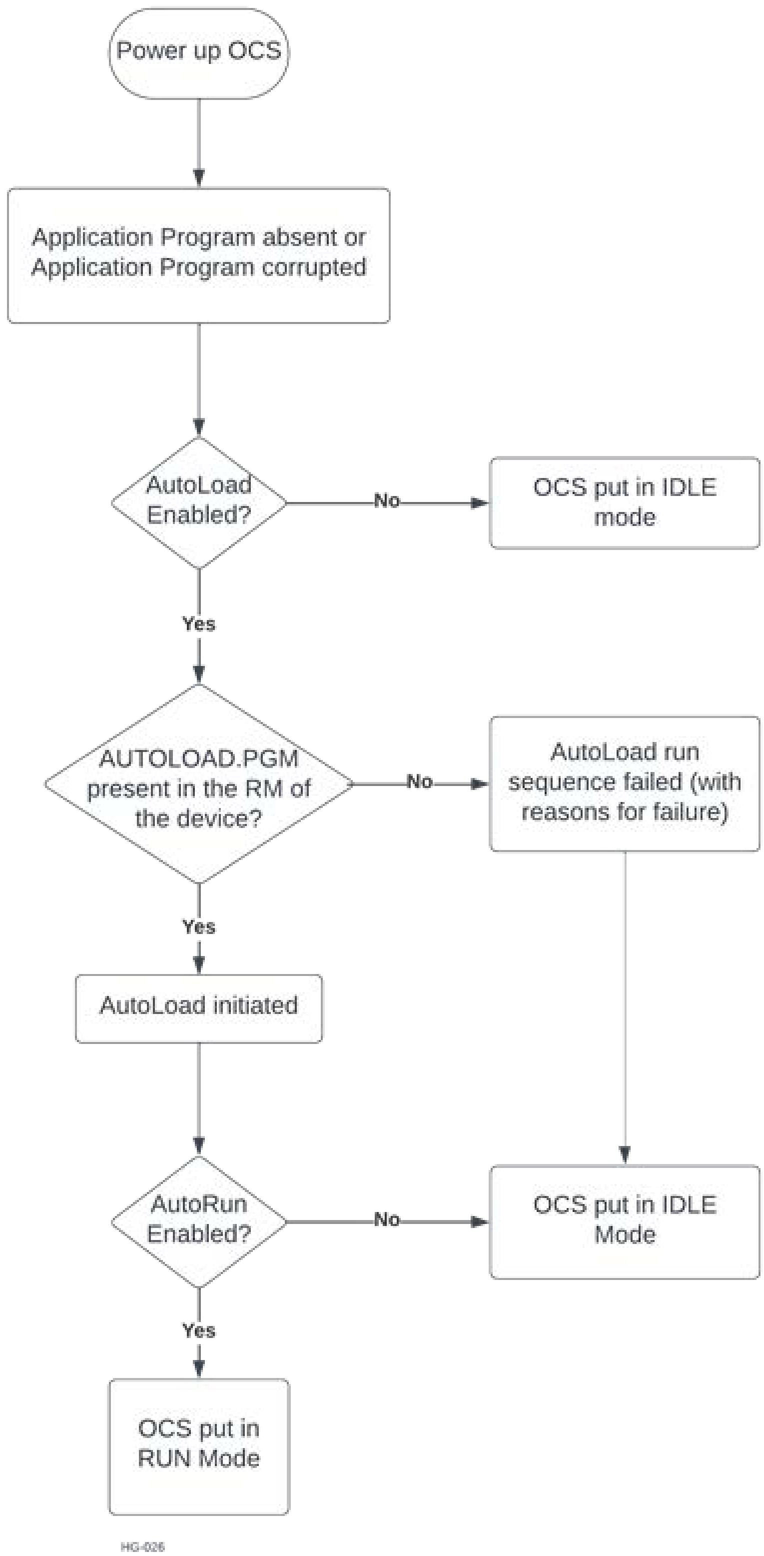
When the AutoLoad setting is enabled (%SR164.6=1), it can be automatically initiated at power-up.

The automatic initiation will happen only in the following two cases:

- When there is no application program in the OCS and a valid AUTOLOAD.PGM is available in the removable media of the device.
- When the program residing in onboard memory is corrupted and a valid AUTOLOAD.PGM is available in the removable media of the device.

When the AutoLoad setting is not enabled (%SR164.6=0), OCS will be in IDLE mode and the application is not loaded. %SR164.6 can be set to enable AutoLoad feature.

The OCS follows the following sequence in execution of AutoLoad:



16.6: AutoRun

This option, when enabled (%SR164.5=1), allows the user to automatically place the OCS into RUN mode after the AutoLoad operation or automatic Restore Data operation. When the AutoRun setting is disabled (NO), the OCS remains in the IDLE mode after a Restore Data or AutoLoad operation. %SR164.5 can be set for putting the system into RUN mode automatically, once an AutoLoad has been performed or an Automatic Restore has occurred.

Modbus-TCP/UDP Communications

Chapter 17: Modbus Communications

For complete Modbus instructions, see the Help file in Cscape.

Modbus (serial) is a popular, de-facto standard protocol that allows industrial devices from multiple manufacturers to easily share data in real-time. For Modbus serial communications, the OCS controller can act as either a Master or a Slave.

Modbus protocol (serial) allows for one master and multiple slaves. The master always initiates the conversation by sending a request to a particular slave. Only the addressed slave will send a response when the request is completed. Should the slave be unable to complete the request, it returns the appropriate error response. Should the slave be unable to respond, the master's timeout timer expires to provide an indication of No Response.

17.1: Modbus Slave Overview

The Modbus slave function block, when used with the appropriate Modem and/or Open Function Blocks, allows the primary serial port on the controller to act as a Modbus slave. The Modbus function supports both ASCII and RTU modes of operation across a range of baud rates and protocol frames. Also supported is port activity status, an inactivity timer, support for call-on exception, and support for store and forward (repeater) operation for radio modems.

The Modbus Addressing section describes the supported Modbus Commands as well as the Modbus Map for OCS controller references (%R, %M, etc.).

17.2: Modbus Master Overview

For complete Modbus Master instructions, please refer to the Help file in Cscape.

When acting as a Modbus master, there are two primary mechanisms used by the OCS controller to allow the user to specify the data to be read/written from/to the slaves.

Modbus Master Function Block—This is for serial only. This is an advanced feature that should only be used in rare occasions.

Protocol Config—The Protocol Config is configured in the Hardware Configuration dialog box in Cscape (serial). Refer to the Modbus Addressing section. This is the preferred method in most applications.

After the protocol has been selected from the dropdown menu, the Network, Devices, and Scan List become available. The Protocol Config is configured on three different levels:

- **Network**—Parameters, such as the polling rate of the data scan, are specified along with timeout values, retry, and re-acquisition settings. Serial configuration, baud rate, parity, etc. are also set here.
- **Devices**—For every slave to be polled, configuration details are added in the Devices dialog box. This includes Slave ID (serial). Under Device Type, the Modbus addressing style matching that specified in the slave's user documentation may be selected. For instance, some slaves specify Modbus addresses (i.e. 40,001), and others specify offsets (i.e. 0000).
    - **Hex or Decimal**—Some specify addresses in hex, and others in decimal. By allowing the user to select the Modbus addressing style for each slave on the network, minimal address conversion is required. Also, if the slave is another Horner product (i.e. another OCS), the "Native Addressing" option can be selected (i.e. %R1, %M17, etc.), and this skips the conversion to Modbus style altogether.
- **Scan List**—This is where the specific Modbus addresses to be read/written from/to each slave are specified. Up to 32 words of data can be read at the same time.

17.3: Modbus Addressing Table

To access the registers, a Modbus Master must be configured with the appropriate register type and offset. This is usually accomplished with one of two methods:

Method 1: The first method uses Traditional Modbus References, in which the high digit represents the register type, and the lower digits represent the register offset (starting with Register 1 for each type). Since only four register types can be represented in this manner, OCS controller Modbus Function Blocks pack several register types into each Modbus register type. Starting addresses of each register type are shown in the Traditional Modbus Reference column of the Mobus Table.

Method 2: The second method requires the Modbus Master to be configured with a specific Modbus Command and Modbus Offset. The supported Modbus commands and the associated offsets are also illustrated in Modbus Table.

<table>
<tr><th colspan="6">OCS Controller Modbus Master Mapping</th></tr>
<tr><th>Reference</th><th>Maximum Range</th><th>Trad. Modbus Reference (5 Digits)</th><th>Expanded Modbus Ref. (6 Digits)</th><th>Modbus Command (s)</th><th>Modbus Offset</th></tr>
<tr><td>%I1</td><td>1024</td><td>10001</td><td>010001</td><td rowspan="4">Read Input Status (2)</td><td>0</td></tr>
<tr><td>%IG1</td><td>256</td><td>13001</td><td>013001</td><td>3000</td></tr>
<tr><td>%S1</td><td>256</td><td>14001</td><td>014001</td><td>4000</td></tr>
<tr><td>%K1</td><td>10</td><td>15001</td><td>015001</td><td>5000</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>%Q1</td><td>1024</td><td>00001</td><td>000001</td><td rowspan="4">Read Coil Status (1)
Force Coil (5)
Force Multiple Coils (15)</td><td>0</td></tr>
<tr><td>%M1</td><td>1024</td><td>03001</td><td>003001</td><td>3000</td></tr>
<tr><td>%T1</td><td>1024</td><td>06001</td><td>006001</td><td>6000</td></tr>
<tr><td>%QG1</td><td>256</td><td>09001</td><td>009001</td><td>9000</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>%AI1</td><td>256</td><td>30001</td><td>030001</td><td rowspan="3">Read Input Register (4)</td><td>0</td></tr>
<tr><td>%AIG1</td><td>32</td><td>33001</td><td>033001</td><td>3000</td></tr>
<tr><td>%SR1</td><td>200</td><td>34001</td><td>034001</td><td>4000</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>%AQ1</td><td>256</td><td>40001</td><td>040001</td><td rowspan="5">Read Holding Register (3)
Load Register (6)
Load Multiple Registers (16)</td><td>0</td></tr>
<tr><td>%R1</td><td>2488</td><td>40513</td><td>040513</td><td>512</td></tr>
<tr><td>%R1</td><td>2048</td><td>43001</td><td>043001</td><td>3000</td></tr>
<tr><td>%AQG1</td><td>32</td><td>46001</td><td>046001</td><td>6000</td></tr>
<tr><td>%R1</td><td>5000</td><td>--</td><td>410001</td><td>10000</td></tr>
</table>

Firmware Update

Chapter 18: Firmware Updates

NOTE: For information on how to update firmware for the CPU200/250, see MAN1521 on the Document Search page.

The OCS products contain field updatable firmware to allow new features to be added to the product. Firmware updates should only be performed when a new feature or correction is required.

WARNING: Firmware updates should only be performed when the equipment being controlled by the OCS is in a safe, non-operational state. Communication or hardware failures during the firmware update process can cause the controller to behave erratically resulting in injury or equipment damage. Make sure the functions of the equipment work properly after a firmware update before returning the device to an operational mode.

Backup Battery

Chapter 19: Battery

The OCS controller contains a run-time battery monitor that checks the voltage of the internal lithium battery. This battery is used to run the real-time clock and maintains retentive registers when power is disconnected.

The battery will generally last seven (7) to ten (10) years. Environmental conditions, including extreme temperatures and humidity, can affect battery life. If the battery older than seven (7) to ten (10) years old, it is recommended that it be replaced as preventative maintenance.

WARNING: DO NOT USE IF BATTERY IS LEAKING OR HAS BEEN DAMAGED.

WARNING: LITHIUM BATTERIES MAY EXPLODE OR CATCH FIRE IF MISTREATED.

WARNING: DO NOT RECHARGE, DISASSEMBLE, HEAT ABOVE 100° C (212° F) INCINERATE, OR PUNCTURE.

WARNING: EXPLOSION HAZARD – BATTERIES MUST BE ONLY BE CHANGED IN A AREA KNOWN TO BE NON-HAZARDOUS.

WARNING: Disposal of lithium batteries must be done in accordance with federal, state, and local regulations. Be sure to consult with the appropriate regulatory agencies before disposing batteries. In addition, do not recharge, disassemble, heat or incinerate lithium batteries.

WARNING: Do not make substitutions for the battery. Be sure to only use the authorized part number to replace the battery.

The OCS controller uses a 3V lithium coin battery which can be ordered from Horner APG, part number **HE-BAT009**.

19.1: Low or Missing Battery

If the battery voltage is low or if the battery is lost, **the program will be completely erased at power down**. There will be an error message on bootup stating that the battery is low or missing. The following will also occur.

- %SR55.13 bit will be High if battery is low or lost
- Device date and time will set to default values 01-01-1996 ,12am. This will need to be set again once the battery is replaced.

19.1.1: Lost Program

If the user has created a backup, then the program, along with the register data, will be saved in the internal memory and can be auto-restored.

To create a backup, see "Fail-Safe System" on page 1.

19.2: Steps to Replace the Battery

1. Make sure the user program and any data stored in retentive memory is backed up.
2. Disconnect all power from the OCS unit including I/O power.
3. Remove all connectors, and then use a flat head screwdriver to press and release the four (4) clips. Remove the back cover.
4. Remove the old battery. It may require a small flat blade screwdriver to lift it from the holder.

5. Dispose of the battery properly; refer to the above warning on disposal regulations.
6. Slide the new battery into the holder. Make sure the battery is inserted with the proper polarity. The top tab of the battery holder should contact the positive (+) terminal of the battery.
7. Place the back cover over the unit and gently press each corner evenly in order to snap the clips back into place.
8. Apply power to the unit. Check that the battery error is no longer reported. If the unit still reports the error, remove the battery immediately and contact "Troubleshooting" on page 96.

Troubleshooting & Tech Support

Chapter 20: Troubleshooting

20.1: Connecting to the OCS

Cscape connects to the local controller automatically when the serial connection is made. The status bar below shows an example of a successful connection. This status bar is located in the bottom right-hand corner of the Cscape window.

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In general, the **Target** number should match the **Local** number. The exception to this is when the controller is being used as a "pass through" unit where other controllers on a CsCAN network could be accessed through the local controller. See Cscape Help File for more details.

Determine connection status by examining feedback next to Local & Target in the status bar of Cscape.

Cscape Target & Local Numbers	
Local: ###	If a number shows next to **Local** then communication is established to the local controller.
Local: No Port	Cscape is unable to access the COM port of the PC. This could mean that Cscape is configured for a COM port that is not present or that another program has control of the COM port. Only one Cscape window can access a port at a time. Subsequent instances of Cscape opened will indicate No Port.
Local: No Com	Cscape has accessed a PC COM port but is not communicating with the controller. This typically occurs when the controller is not physically connected.
Local: ???	Unknown communication error. Close Cscape, power cycle the controller and reopen Cscape with a blank project. Check Local.
Target: #(I,R,D)	If I (idle), R (run), or D (do I/O) shows next to **Target number**, then communication is established to the target controller.
Target: #(?)	Communication is not established to the target controller. Check node ID of controller and set Target to match. Make sure **local** connection is established.

20.1.1: Serial Port – MJ1 Programming

1. Controller must be powered up.
2. Ensure that the correct COM port is selected in Cscape. **Tools > Applications Settings > Communications**.
3. Ensure that a cable with proper pinout is being used between PC and controller port MJ1.
4. Check that a Loaded Protocol or ladder is not actively using MJ1. Taking the controller out of Run Mode will make MJ1 available to Cscape.
5. Successful communications with USB-to-serial adapters vary. If in doubt, Horner APG offers a USB to serial adapter: part number HE-CPK.

20.1.2: USB Port Programming

1. Power-up the controller.
2. Ensure that the correct COM port is selected in Cscape.**Tools > Applications Settings > Communications > Configure**
3. Confirm that the USB cable is connected between the PC and the controller.
4. Examine the Windows Device Manager to confirm that the USB driver is correctly installed and to verify the port number.
5. The USB port driver installs.

20.1.3: ETN Port Programming

1. Controller must be powered up.
2. Ensure that the correct IP address is given in the Ethernet field and correct Mode is selected, in Cscape: **Tools > Applications Settings > Communications > Configure**Home tab / Controller Group > Connection Wizard.
3. Ensure that an Ethernet connection has been established by pinging the controller from the Windows DOS prompt.
4. The PC and the OCS should be on the same IP subnet.

20.2: Local Controller and Local I/O

20.2.1: Local I/O Troubleshooting Checklist

1. Verify the controller is in RUN mode.
2. Check diagnostics to ensure controller passed self-tests. View Diags in Cscape, click Controller/Diagnostics.
3. Check data sheets to ensure proper wiring.
4. Ensure that hardware jumpers and software configuration for I/O match.
5. Check data sheets for voltage and current limits.
6. Take ladder out of the picture. From Cscape set controller to “Do I/O” mode. In this mode inputs can be monitored, and outputs set from a data watch window in Cscape without interference from the ladder program. Some I/O problems are only a result of a mistake in the ladder program.

WARNING: Setting outputs ON in Do I/O mode can result in injury or cause machinery to engage in an unsafe manner depending on the application and the environment.

20.3: CsCAN Network

For complete information on setting up a CsCAN network, refer to CAN Networks manual (MAN0799) by using Horner's Documentation Search page.

Network status, node ID, errors, and baud rate in the controller System Menu are all in reference to the CsCAN network. These indications can provide performance feedback on the CsCAN network and can also be used to aid in troubleshooting.

20.3.1: CsCAN Network Troubleshooting Checklist

1. Use the proper Belden wire type or equivalent for the network as specified in the CAN Networks Manual, MAN0799.
2. The Horner OCS does not provide 24VDC to the network. An external voltage source must be used for other devices such as SmartStix I/O.
3. Check voltage at both ends of the network to ensure that voltage meets specifications of attached devices.
4. Proper termination is required. Use 121Ω (or 120Ω) resistors at each end of the network. The resistors should be placed across the CAN_HI and CAN_LO terminals.
5. Measure the resistance between CAN_HI and CAN_LO. If the network is properly wired and terminated, there should be around 60Ω.
6. Check for duplicate node ID's.
7. Keep proper wires together. One twisted pair is for V+ and V- and the other twisted pair is used for CAN_HI and CAN_LO.
8. Make sure the baud rate is the same for all controllers on the network.
9. Assure shields are connected at one end of each segment—they are not continuous through the network.
10. Do not exceed the maximum length determined by the baud rate and cable type.
11. Total drop length for each drop should not exceed 6m (20'). A drop may include more than one node. The drop length adds to the overall network length.
12. Network should be wired in "straight line" fashion, not in a "star" pattern.
13. In applications requiring multiple power supplies, make sure the V- of all supplies is connected and to earth ground at one place only.
14. In some electrically noisy environments, it may be necessary to add repeaters to the network. Repeaters can be used to add additional nodes and/or distance to the network and protect the signal against noisy environments.

20.4: Basic Removable Media Troubleshooting

Description	Action
OCS does not read media card.	Attempt reformatting the media card.
OCS will not download a program file from removable media.	When downloading to the OCS from removable media the program file must have a .pgm extension. A program file with the typical .csp extension will not work. A .pgm file is created either by exporting to .pgm in Cscape or by doing a save program or make clone from an OCS controller. The filename must follow the short filename convention which is an 8.3 format; For example, program.pgm is a valid filename. Programming.pgm is not a valid filename as characters left of the point exceed the maximum of 8 characters.

20.5: Technical Support Contacts

For manual updates and assistance, contact Technical Support at the following locations:

North America:
Tel: (317) 916-4274
Fax: (317) 639-4279
Website: https://hornerautomation.com
Email: APGUSATechSupport@heapg.com

Europe:
Tel: (+) 353-21-4321-266
Fax: (+353)-21-4321826
Website: https://www.hornerautomation.eu
Email: technical.support@horner-apg.com