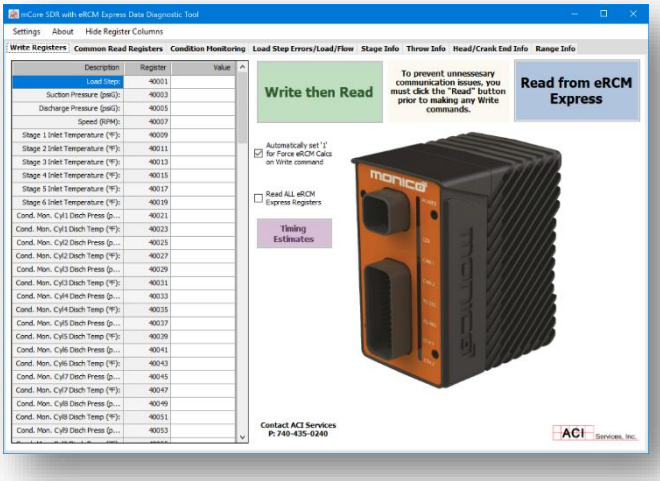
*e*RCM Express™

ACI's eRCM Express is an add-on device that calculates extensive compressor performance (load, flow, unit safety, etc.), provides useful information needed to control the compressor (Next Step Up, Next Step Down, allowable pressure and speed ranges, etc.), and provides for certain condition monitoring tasks (such as estimating cylinder leakages from valves and rings, based on actual discharge pressures and temperatures).

To complete the millions of calculations required to generate a full set of compressor data, for all cylinder ends, for all throws, for all stages, and for all load steps, the unit requires some time. Most unit models can be completed within 150 ms, while others may take upwards of 350 ms to complete.

- Data synchronization is critical. Most data input items, such as pressures, temperatures, and speed will vary very little from call to call, and as a result the calculated performances will generally vary slightly. Thus, being out of synch for a half second to a second is rarely an issue. However, a change in load step can result in significant changes to the calculated performance data.
- If communications are driven by timers rather than by synching data via the ***IsKernelBusy*** register, then make sure that the PLC (or gateway) waits long enough after writing data to the unit before reading data back to use.
    - When the above is not practical make sure that the PLC waits at least a few write/read cycles before acting on results – especially with load steps changes.

ACI's eRCM Express Diagnostic Software is a great free program to have installed on a PC. It provides valuable feedback which can significantly minimize efforts when checking communications and data validity.



Download software from the ACI website: *www.ACIServicesInc.com.*

Topic Sections

eRCM Express™

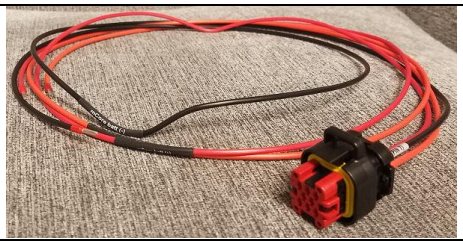
Package

Contents

Each eRCM Express unit arrives in a Monico box with foam protection, with a power cable, with a communications cable, this manual and a checklist sheet.

	
Monico Product Box (Closed)	Monico Product Box (Opened)

	
One (1) eRCM Express mCore SDR Unit	One (1) eRCM Express Manual, and One (1) Checklist Sheet

	
One (1) prewired Key Connector A. POWER CABLE About 6-foot long.	One (1) prewired Key Connector B, with RJ45 Port Connector also wired. COMMUNICATIONS CABLE

eRCM Express™

Contact and

Support

Please Contact:

ACI Services, Inc.

125 Steubenville Avenue
Cambridge, Ohio 43725

P: 740-435-0240, x538

Website: www.ACIServicesInc.com

For issues, questions, concerns, etc. related to:

- Compressor Models
- eRCM Express Product Features
- Software Diagnostics
- Integration of product features into Control Logic

Monico Inc.

18530 Klein Church Road
Spring, Texas 77379

P: 281-350-8751, Option 1

Website: www.MonicoInc.com

For issues, questions, concerns, etc. related to:

- Hardware Configuration
- Hardware Installation
- Electrical, Wiring, and Cabling
- Grounding
- Certifications and Rating

eRCM Express™

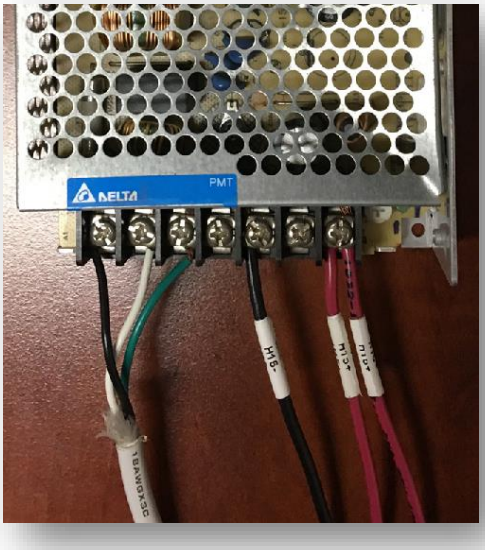
Unit

Installation

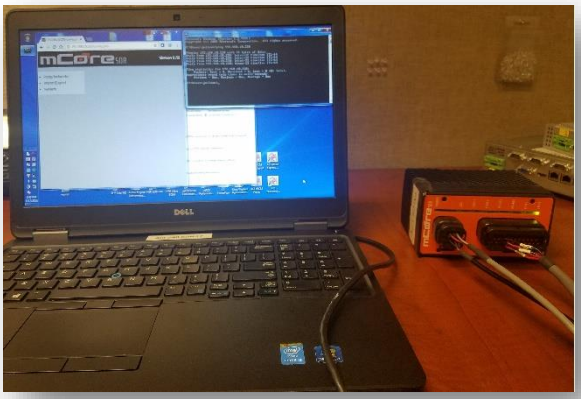
For **local workstation testing**, most users will connect the eRCM Express to a local power supply, then connect their PC to the unit to initiate communications, change IP address, and/or upload the most up-to-date compressor modeling files.

The eRCM Express unit needs connected to power and communications.

- Package includes a standard power cable with its **Key Connector A** already wired. Snap in the **Key Connector A** into its appropriate port, and then connect the three (3) wires to power supply:
  - **Red** (H16+): Positive Terminal
  - **Black** (H16-): Negative Terminal
  - **Orange** (H15+): Positive Terminal
    - ***If orange wire is not connected to positive, the unit will not boot.***



- Snap in the **Key Connector B** (Communications) into its appropriate port, and then connect a PC to the eRCM Express via the Ethernet connector.
  - Ping unit with static IP number or local device name, or
  - Use eRCM Express Diagnostic Software, or
  - Access with other software.
- Connect to mCore.

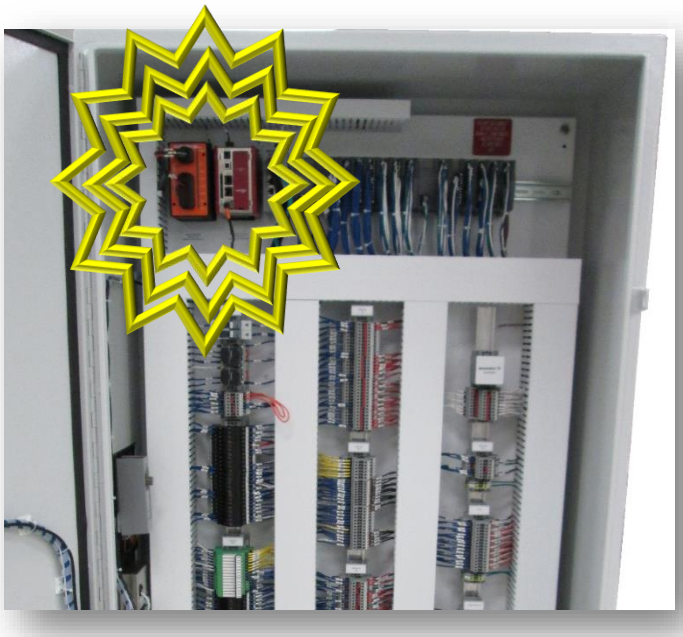


For **field installation**, most users will mount the eRCM Express into a Unit Control Panel (UCP), typically via a DIN-rail mount. Thereafter, the eRCM Express unit needs connected to power and communications.

Please reference the mCore SDR Operations Manual (Addendum V) for full hardware installation directions, including wiring, power, electrical, shielding, restrictions, and cabling.

- Package includes a standard power cable.
- Connect wires to appropriate 24 VDC power.
- When appropriate, connect ground to mCore's Grounding lug (back of device).
    - **Red** (H16+): Positive Terminal
    - **Black** (H16-): Negative Terminal
    - **Orange** (H15+): Positive Terminal
        - ***If orange wire is not connected to positive, the unit will not boot.***

- Package includes a standard Ethernet connector.
- Snap in the **Key Connector B** (Communications) into its appropriate port, and then connect the PLC (or gateway device such as ProSoft Card or Red Lion) to the eRCM Express via the Ethernet connector.
- Connect to device.



eRCM Express™

mCore User Interface

Initial Setup

Logging into a New mCore Unit

The mCore has a web-based UI (User Interface) for configuring the unit that can be accessed using a web browser. Unless the new mCore has been provisioned with a unique configuration, Ethernet 1 and 2 will be set to DHCP. On the bottom of the mCore will be a sticker with useful information and a QR code.

The label will contain the following:

- Serial Number
- MAC-1 Address
- MAC-2 Address
- Username
- Password

1. Plug the mCore's Ethernet 1 or 2 directly into a computer or network switch using an Ethernet cable.
2. Locate the Serial Number written on the label sticker on the bottom of the mCore.
3. Open a browser and enter connected mCore unit's serial number.
    - Example: If the serial number is mc-1234-5678, enter:
        i. http://mc-1234-5678.local
        ii. Or, https://mc-1234-5678.local
    - If unit was previously changed to support a static IP address, enter that IP address by itself (or use the serial number method as shown above).

The following screen appears in browser once the connection is made:

The username is: admin
The default password is: *(see sticker on the bottom the mCore unit)*

For more details about mCore hardware, including how to Factory Reset the unit, please consult the mCore Manual.

Page intentionally left blank for end-user's notes about actual eRCM Express installation.

eRCM Express™

Hardware and

Communications

Please reference the mCore SDR Operations Manual (Addendum V) for full hardware and full communications specifications and support.

While other protocols may be supported, the base protocol for eRCM Express is Modbus communications. When Modbus is used:

- eRCM Express is a Modbus slave,
- Use Function 16 to write to Modbus Registers, and
- Use Function 03 to read from Modbus Registers.

⚠ For **Modbus over IP**, only read a Maximum of **100** (16-bit) Registers at a time. Reading more registers than the maximum will usually cause the Modbus protocol to stop responding.

MODBUS Application Protocol Specification V1.1a Modbus-IDA
June 4, 2004 http://www.Modbus-IDA.org Page 15 of 51

6.3 03 (0x03) Read Holding Registers
This function code is used to read the contents of a contiguous block of holding registers in a remote device. The Request PDU specifies the starting register address and the number of registers. In the PDU Registers are addressed starting at zero. Therefore registers numbered 1-16 are addressed as 0-15.

The register data in the response message are packed as two bytes per register, with the binary contents right justified within each byte. For each register, the first byte contains the high order bits and the second contains the low order bits.

Request

Function code	1 Byte	**0x03**
Starting Address	2 Bytes	0x0000 to 0xFFFF
Quantity of Registers	2 Bytes	1 to 125 (0x7D)

Response

Function code	1 Byte	**0x03**
Byte count	1 Byte	2 x **N***
Register value	**N*** x 2 Bytes	

***N** = Quantity of Registers

Error

Error code	1 Byte	**0x83**
Exception code	1 Byte	01 or 02 or 03 or 04

Here is an example of a request to read registers 108 – 110:

Request		**Response**	
Field Name	*(Hex)*	*Field Name*	*(Hex)*
Function	**03**	Function	**03**
Starting Address Hi	**00**	Byte Count	**06**
Starting Address Lo	**6B**	Register value Hi (108)	**02**
No. of Registers Hi	**00**	Register value Lo (108)	**2B**
No. of Registers Lo	**03**	Register value Hi (109)	**00**
		Register value Lo (109)	**00**
		Register value Hi (110)	**00**
		Register value Lo (110)	**64**

The contents of register 108 are shown as the two byte values of 02 2B hex, or 555 decimal. The contents of registers 109–110 are 00 00 and 00 64 hex, or 0 and 100 decimal, respectively.

⚠ **Write and read data at most two (2) times per second.**

eRCM Express™

Sending/Reading

Data Rates

The mCore unit uses a shared data pool. This allows multiple devices the ability to read and write data to this shared set of data. However, this also means that there can be a slight delay between writing data to the shared pool, the unit acting on that data and generating all of the compressor's performance, and then writing the results back to the shared data pool.

This delay can be from 150 ms to 350 ms. It is important that new writes are not being implemented during this time, and that reading of compressor performance data is not acceptable until after all data has been fully updated. Otherwise, results read back may be a mixture of previous point performance and current point performance.

- This generally is not critical as results would vary very little between previous and current points. However, when load steps are changed, the results between previous and current can be dramatic.

Thus, to guarantee calculated results are synched to inputs, follow these rules.

1. Write operating inputs to eRCM Express with the correct compressor model loaded.
2. Wait long enough for all results to be calculated (**at least 150 ms**).
    a. 150 ms is minimum wait time, with around 250 ms being common, and 350 ms should be about the max wait – it really depends on the complexity of the compressor model, number of load steps, etc.
        i. See Addendum IV for determining reasonable calculation times for models being reviewed.
3. Read back desired results.

A common approach is as follows:

1. Start a 1000 ms timer in PLC
2. When timer event triggers:
    a. If still in previous timer event's call then exit.
    b. Otherwise:
        i. Write data to eRCM Express (or via gateway),
        ii. Start a 250 ms timer, and then
        iii. When this 250 ms timer triggers, stop this timer and read data from the eRCM Express.

The above approach will write data, do calculations, and read data back one (1) time per second. This is good and ideal for units with speeds from 200 to 440 rpm.

For "Twice per Second", use a 500 ms timer. Good for units with speeds from 600 to 1800 rpm.

eRCM Express™

Diagnostics

Software

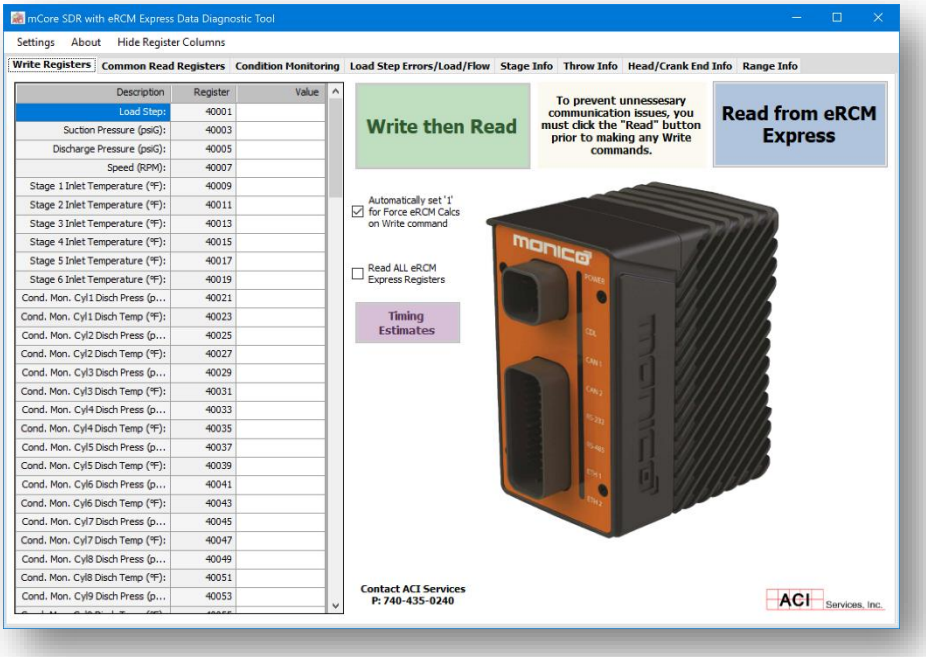
The latest version of the eRCM Express Diagnostic Software can be downloaded from the ACI Services, Inc. website.

With the eRCM Express unit set up (powered on, and with an active Ethernet communications line), run the eRCM Diagnostic Software on a Windows®-based PC connected to the eRCM Express unit.

Select the mCore SDR with eRCM Express item.

Depending on protocol used, and whether the mCore is acting as the Master or Slave device, the software interaction will vary.

Click the **Read from eRCM Express** button to initiate connections and read back unit information. Now, enter values via data cells on the displayed *Write Registers* tab, then click the **Write to eRCM Express** button. If the unit is connected and communicating correctly, all appropriate registers on the remaining tabs will be populated with calculated and returned values.



NOTE: Determine roughly how long (ms) it takes to calculate full compressor performance for any model in the eRCM Express by using the **Timing Estimates** feature in the Diagnostic Software.

eRCM Express™

Uploading

Modeling File(s)

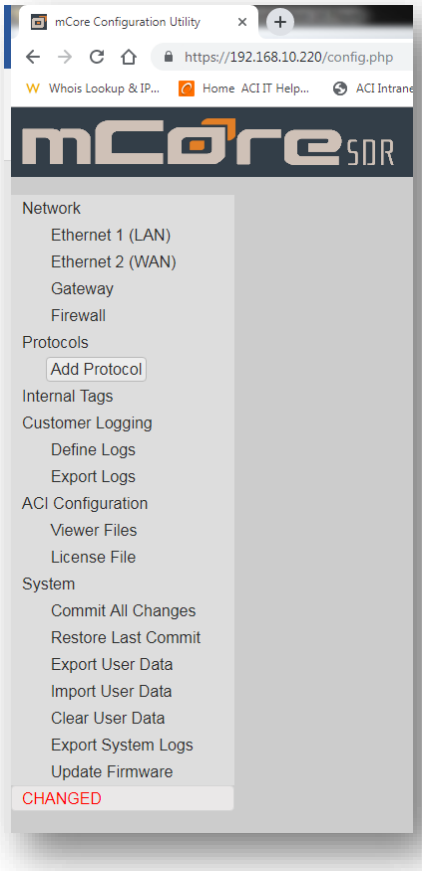
Steps to Install new eRCM Viewer™ File(s)

- Make sure the desired eRCM Viewer files (*.rvf) available for this eRCM Express.
  a. Models should reflect correct compressor hardware, gas composition, unit staging, unloading devices, operating ranges, and unloading steps.

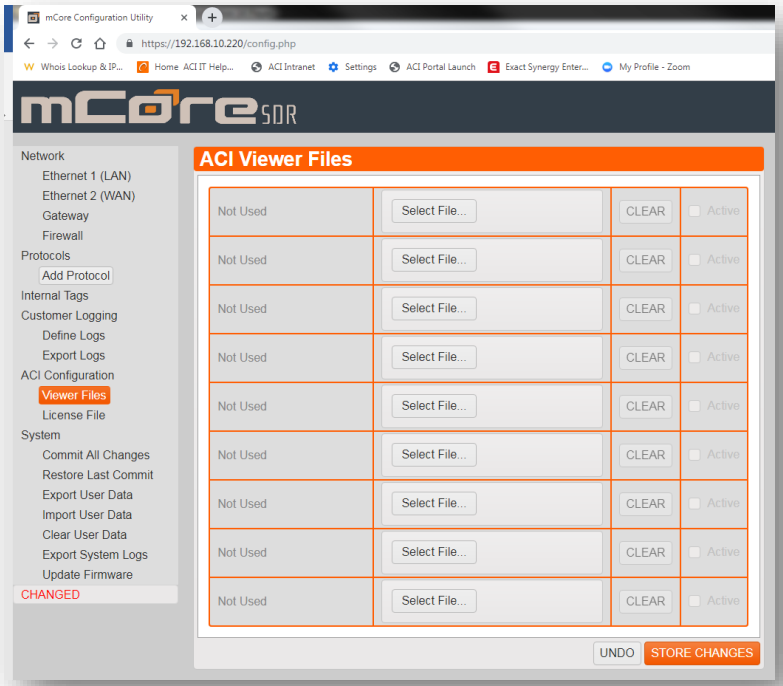
- Connect a PC to the mCore unit and then the main mCore screen will be presented.

The default account is **Admin**.
The default password is: ***(indicated on mCore stickers)***.

Once logged in, then the main panel will be shown:



- From this page, via the **ACI Configuration** menu, select **Viewer Files** to display the adjacent screen.



- To clear the unit of any previous eRCM Viewer models, click the **CLEAR** button adjacent to each model.

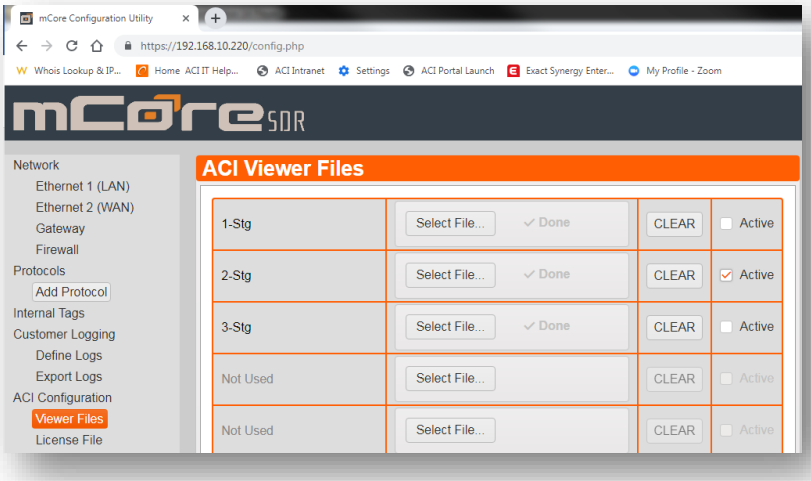
⚠

   a. **Clearing old models is recommend for users. Then upload all new models that need to be on the eRCM Express.**

- To specify new files to load onto the eRCM Express, select one of the **Select File…** buttons and select desired file. Repeat until all desired files are uploaded to eRCM Express.

⚠

   a. **One file must be set to ☑ Active before exiting web app.**



b. **NOTE**: Click on a file's filename link to download a copy of that file from the eRCM Express to PC.
    i. This is important if questions arise about "the actual unit modeling file" in the eRCM Express. Using this feature, a copy of the actual file used can readily be obtained.

- The one file set to **Active** will be the modeling file loaded during startup of the eRCM Express.
    a. *If no file is Set Active, then the eRCM Express may not function correctly.*

WARNING: All eRCM Viewer files (*.rvf) uploaded to the eRCM Express must:
- Begin with a digit "1" through "9", inclusive.
- Only use the characters 'A' - 'Z', '0' - '9', '_', and '-'.
- Use no more than 24 characters in name.
- Do not use spaces in filenames.

WARNING: Uploading more than one modeling file that starts with the exact same digit will create problems.

Troubleshooting

Certain settings, or security settings, on web browser being used to interface with your mCore unit may cause undesired results, such as selected file not being uploaded to unit. Using a different browser usually eliminates these issues.

mCore actions and interactions have been checked and work with (using browser's general settings) the following common browsers: Chrome, Edge, Firefox, and IE.

eRCM Express™

Uploading a

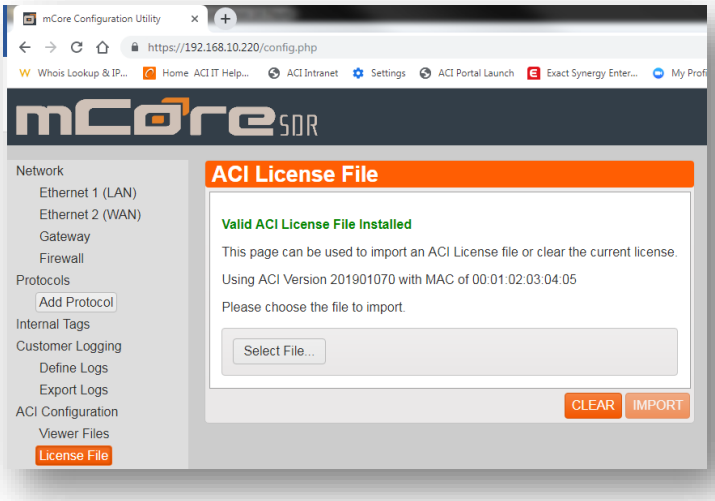
License File

Steps to Upload a New eRCM Express License File

Most end-users will **never** need to do this.

1) All units are shipped with either a valid eRCM Condition Monitoring license file, or a valid eRCM Express license file.
    a. **However**, if a device is upgraded from a Condition Monitoring unit to a full eRCM Express unit, then a new license file will need to be uploaded to access all eRCM Express features.
    b. To accomplish this, after purchase of an upgrade license, a license file will be sent (e.g. emailed). This license file is unique for each hardware unit and cannot be used on other mCore units. Thus, make sure it is installed on the appropriate unit.

2) Connect PC to the mCore unit. From the main mCore screen, select **License File** from the **ACI Configuration** menu.



WARNING: ***If the license file is cleared, and a new one is not uploaded, then the eRCM Express unit will not function as desired.***

3) From this prompt, select the **Import** button and carefully follow all prompts.

In general, end-users should not remove license files unless requested by Tech Support.

eRCM Express™

Updating Unit

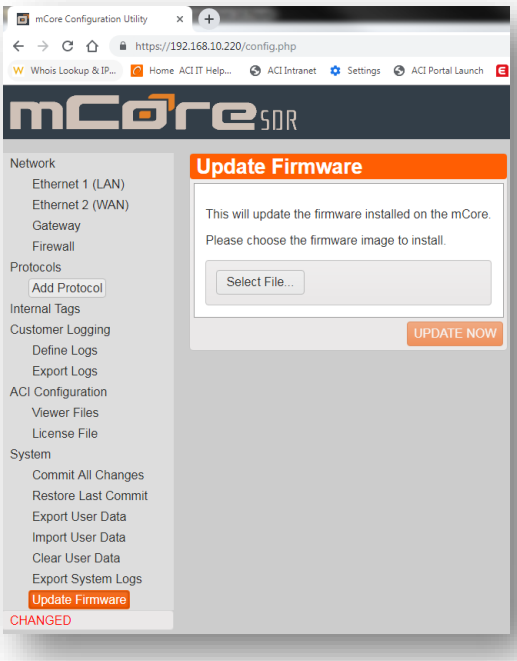
Firmware

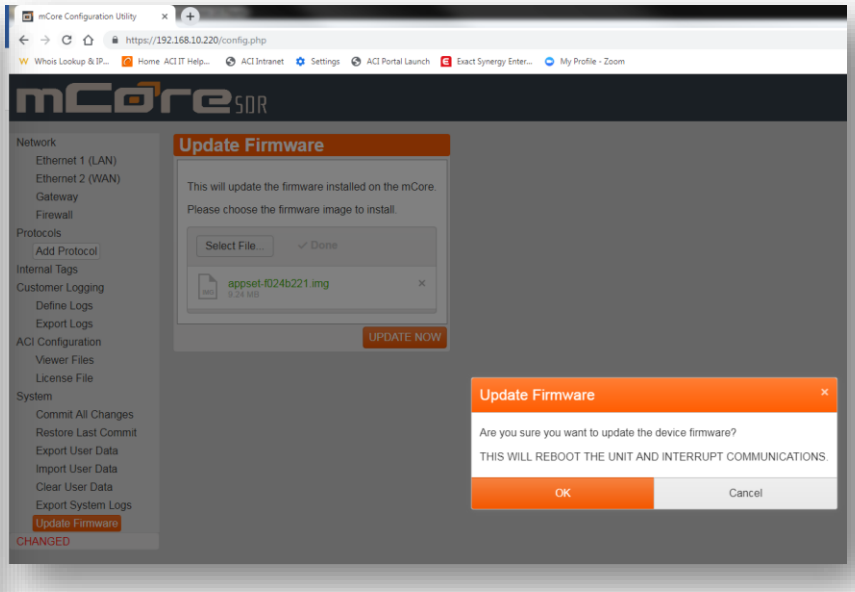
Steps to Install New eRCM Express Software

When available, Monico will provide appropriate Firmware update/upgrade files.

1) Connect PC to the mCore unit. The main mCore screen will be presented. Log in.

2) With the correct Firmware update/upgrade file(s) downloaded to a PC, select **Update Firmware** under the **System** menu, **Select File…** button, browse to file, and then select **UPDATE NOW** button and then follow any additional prompts.





It is recommended that all eRCM Viewer model(s) are re-installed for this unit after any firmware updates/upgrades are finished.

It is recommended that end-users review firmware changes before installing them. Certain product changes may require coding changing in the PLC and/or gateway.

Certain firmware updates may require multiple uploads and/or multiple reboots.

eRCM Express™

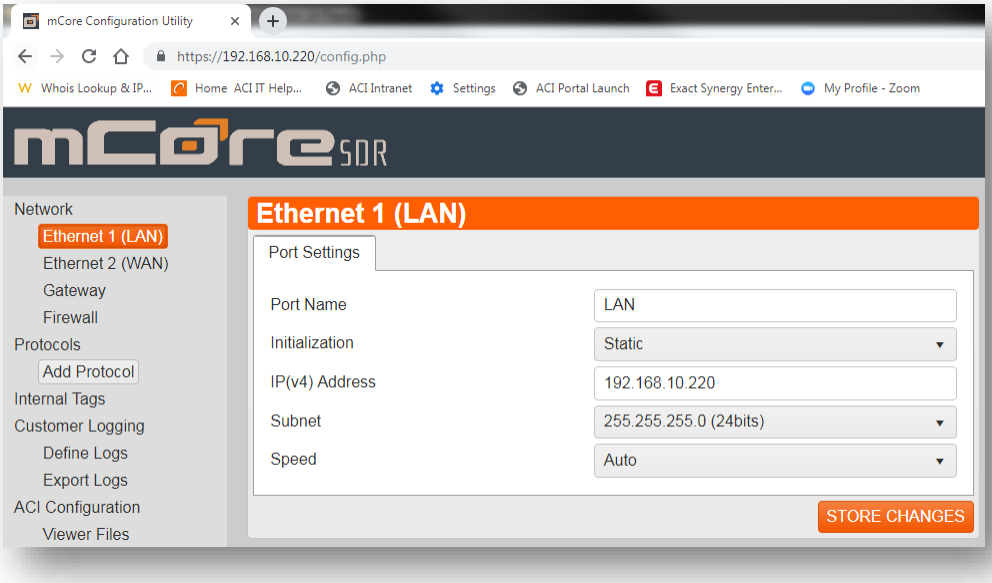
Changing LAN

Settings

Steps to Change IP Settings for eRCM Express

1) Connect PC to the mCore unit. The main mCore screen will be presented. Log in.

2) Now from the **Network** menu, select **Ethernet 1 (LAN)**.



3) Enter new IP information, and then select **STORE CHANGES**.

4) If IP numbers are lost, consult the mCore Manual on how to Factory Reset the unit.

eRCM Express™

General Process

1. When the PLC starts, if there is more than one potential eRCM Viewer model within the eRCM Express, then the PLC needs to make sure that it loads in the correct eRCM Viewer model.
    i. If there is only one (1) eRCM Viewer model, then this step can be skipped.
    ii. Otherwise, the best option is to identify which file to load (1 through 9) via the **SetViewerFile** (REG#40101) item – see Using Select Features (Item #1) in this manual.

2. Next, if access to the Discharge Header Pressure (the discharge pressure the compressor will compress to **after** the bypass valve is closed) is available, then identification of the best safe load step to configure the unit before closing the bypass valve (to prevent rod load and/or pin non-reversal issues during Start Up) can be made. This is done by using the ***CheckSafeStartup*** (REG#40107) and the ***SafeLoadStepStartup*** (REG#40329) registers – see Using Select Features (Item #6) in this manual.

3. If not set by the PLC, the eRCM Express will use the default values assigned to each of the following when the eRCM Viewer model was created. If different values are preferred, set them now.
    i. **MinLoadFlowPercChange** (%): Usually 1%-2%. REG#40117.
    ii. **MaxLoadPercChange** (%): Usually in the 15-20% range. Set lower if engine cannot handle large step changes in load, set higher if engine can handle larger step changes in load and those changes are needed in areas of the operating map. REG#40119.
    iii. **LSSelectionMode**: There is a variety of these, and the unit needs to be reviewed to decide when one (or ones) are best suited for the unit. *Units with automated VVCPs are generally set to specific modes that **cannot** be changed via the PLC.* REG#40105.
        i. See Addendum I for more details regarding LS Selection Modes.

4. If desired for an HMI screen, read the **Ranges** for key items and store them in the PLC. These do not change until a new eRCM Model is loaded, so this set of registers does not need to be continually read. REG#s 43605 through 43647.

5. Read the following set of items, and store in PLC. These do not change until a new eRCM Model is loaded, so this set of registers does not need to be continually read.
    i. REG#40331, AuxLoad (HP)
    ii. REG#40333, BHPMax (HP)
    iii. REG#40337, Elevation (ft)
    iv. REG#40339, AtmPress (psiA)

v. REG#40341, NumCyls (#)
vi. REG#40343, NumLSs (#)
vii. REG#40345, NumStgs (#)
viii. REG#40347, NumThrws (#)
ix. REG#40349, OEM_ID (#)
x. REG#40353, MaxDischF (degF)
xi. REG#40355, RelHumid (%)

6. After the compressor and driver have warmed up, and ready to close the Bypass Valve, then set the compressor's load step to:
   i. The load step identified in Item #2, **or**
   ii. The load step Operations has identified to use when starting a unit.

7. Close the Bypass Valve

8. When the Bypass Valve is fully closed, then the unit is Online.
   i. At this point, the eRCM Express now can provide useful compressor performance and safety data that can be used to properly control the online compressor.
      i. **NOTE**: *Performance data returned via the eRCM Express before bypass is closed is not considered valid data and thus it should not be used for alarms, shut downs, etc.*

9. WHEN UNIT IS ONLINE: **(Main Loop)**
   i. Set the Current Load Step in eRCM Express via **CurrLS** (REG#40001).
   ii. From unit sensors, read inlet pressure (Stage #1 Suction Pressure **PsG**) and inlet temperature (Stage #1 Suction Temperature, **Ts1F**), the last stage's discharge pressure (Discharge Pressure, **PdG**), and the suction temperature to each stage after the 1st stage **Ts2F..Ts6F**, and the current operating speed **CurrSpeed**.
   iii. Pass this information to eRCM Express via:
      i. **PsG** (REG#40003),
      ii. **PdG** (REG#40005),
      iii. **CurrSpeed** (REG#40007),
      iv. **Ts1F** (REG#40009), and as needed
         1. **Ts2F..Ts6F** (REG#40011.. REG#40019).
   iv. Set the Maximum Torque Limit (%) **TorqSP** (REG#40109).
      i. Most all users just need to set this to 100%.
   v. Force an eRCM Express calculation by putting the value of 1 into **ForceERCMExpressCalculations** (REG#40273 or REG#40075).

vi. Do not try to retrieve any performance data back from the eRCM Express until the value in **IsKernelBusy** (REG#40275) goes to zero (0). This item changes to one (1) when eRCM Express starts the compressor calculations and changes back to a zero (0) when those calculations are complete. This happens very fast (less than 250 ms for most calls).

i. **NOTE:** *If polling the IsKernelBusy is not easily achievable via the PLC or gateway, then next best option is to just wait about* ***250 ms*** *after writing the Write data items. It will generally be finished by then.*

vii. When **IsKernelBusy** is zero (0), then read the following items:

==========

i. eRCMExpressWatchdogPulse (REG#40277)
ii. NextLoadStepUp (REG#40279)
iii. NextLoadStepDown (REG#40281)
iv. NextLSUpPercentChange (REG#40283)
v. NextLSDownPercentChange (REG#40285)
vi. MinSpeedCurrentLS (REG#40287)
vii. MaxSpeedCurrentLS (REG#40289)
viii. MinSuctPressureCurrentLS (REG#40291)
ix. MaxSuctPressureCurrentLS (REG#40293)
x. FindOptimalLoadStep (REG#40295)
xi. CurrentTorque (REG#40297)
xii. IsentropicEfficiency (REG#40299)
xiii. Fuel Rate (REG#40301)

ITEMS TO REVIEW, AND ACTIONS TO TAKE IF NEEDED:

1. **Shut Downs:**
    a. Communication Issues:
        i. If Modbus errors exist for more than a couple seconds, or if more than five (5) consecutive errors occur, then Shut Down.
        ii. If WatchdogPulse does not change after setting items when forcing a new calculation and waiting long enough for calculations to finish, then Shut Down.
    b. Stay Online Mode:
        i. If a(i) or a(ii) above happens, then the PLC can try to keep the unit online and running (after issuing appropriate alarms). To do this, it needs to record the Ps, Pd, and Ts's at time of lost communications.

Then, it needs to hold Load Step and Speed at current settings. The unit can stay online (and still be safe without its eRCM Express connection) provided:

1. MaxPsChange = (Ps.Max - Ps.Min) / 100
2. MaxPdChange = (Pd.Max - Pd.Min) / 100
3. IF ABS(CurrentPs – Ps) <= MaxPsChange psi, AND
   ABS(CurrentPd – Pd) <= MaxPdChange psi, AND
   ABS(CurrentRPM – RPM) <= 8 rpm, AND
   ABS(CurrentTs1 – Ts1) <= 10 °F, AND
   ABS(CurrentTs2 – Ts2) <= 10 °F, AND
   ABS(CurrentTs3 – Ts3) <= 10 °F, AND
   ABS(CurrentTs4 – Ts4) <= 10 °F, AND
   ABS(CurrentTs5 – Ts5) <= 10 °F, AND
   ABS(CurrentTs6 – Ts6) <= 10 °F

ii. If the above holds true, then the unit's operating conditions have not changed so much that the unit has drifted in territory where safety is unknown.

c. No safe Load Steps present:
   i. If NextLoadStepUp = -1 AND NextLoadStepDown = -1 AND FindOptimalLoadStep = -1 then Shut Down. No exceptions.

2. <u>Adjustments to PLC Setpoints:</u>

a. Set the PLC's Min Allowed Speed to MinSpeedCurrentLS
b. Set the PLC's Max Allowed Speed to MaxSpeedCurrentLS
c. Set the PLC's Min Allowed Suction Pressure to MinSuctPressureCurrentLS
d. Set the PLC's Max Allowed Suction Pressure to MaxSuctPressureCurrentLS

3. <u>Controls:</u>

a. If there is an active call for More Load (or more Flow), then the PLC controls changing loading (sample device preferences given here, but actual device preferences determined by control logic in the PLC):

i. If Recycle Valve not closed, start to Close Recycle, then
ii. If available, Unpinch Suction Throttle (up to MaxSuctPressureCurrentLS), then
    1. *Ok for flow, use caution with power.*
iii. If not at Max Allowed Speed, Increase Speed, then
iv. If NextLoadStepUp ≠ -1, change load step to NextLoadStepUp.

b. If there is an active call for Less Load (or less Flow), PLC to change loading:
i. If not at Min Allowed Speed, Decrease Speed, then
ii. If NextLoadStepDown ≠ -1, change load step to NextLoadStepDown.
iii. If available, Pinch Suction Throttle (down to MinSuctPressureCurrentLS), then
    1. *Ok for flow, use caution with power.*
iv. Start to Close Recycle Valve.

==========

xiv. Read in ErrorArray (REGs#40445 to 40443+NumLSs*2)
1. If NextLoadStepUp = -1 AND NextLoadStepDown = -1 AND ErrorArray(CurrLS) <> 0 then Shut Down.

xv. Read in LoadArray (REGs#40645 to 40643+NumLSs*2)

xvi. Read in FlowArray (REGs#40845 to 40843+NumLSs*2)
1. Display data from above three arrays on one HMI screen (as a table) to show operators which load steps are valid, and the potential flow rates those load steps can deliver and their associated required loads.
2. Many end-users highlight the current Load Step row, as well as identifying which rows are for Next Load Step Up and Next Load Step Down (when those items are valid, i.e. not -1).

xvii. Read in StageArray (REGs#41045 to 41043+NumStgs*60)
1. Display data on HMI

xviii. If/when key Throw Data is desired to be displayed on HMI screen, then:
1. Read in ThrowArray (REGs#41405 to 41403+NumThrws*60)
    a. Display data on HMI

xix. If/when key HE Cylinder Data is desired to be displayed on HMI screen, then:
    1. Read in HECylinderInfo (REGs#42005 to 42003 + NumCylinders*80)
        a. Display data on HMI

xx. If/when key CE Cylinder Data is desired to be displayed on HMI screen, then:
    1. Read in CECylinderInfo (REGs#42805 to 42803 + NumCylinders*80)
        a. Display data on HMI

viii. Go back to Item #9 (WHEN UNIT IS ONLINE section).

eRCM Express™

Pseudo Code

Examples

Read/Write Pseudo Code Examples

Sending Data to eRCM Express™:

```
  Modbus.Data(1)   = 1      // Current Hardware Load Step
  Modbus.Data(2)   = 206.5 // Current Suction Pressure (psiG) into First Stage
  Modbus.Data(3)   = 318.9 // Current Discharge Header Pressure (psiG) out of Last Stage
  Modbus.Data(4)   = 1158   // Unit's Speed (RPM)
  Modbus.Data(5)   = 74.5   // First Stage Suction Gas Temperature (degF)
  Modbus.Data(6)   = 128.2 // Second  Stage Suction Gas Temperature (degF), when required

  Modbus.NumberOfValues = 6    // 6 is the number of input values (1 Value = two 16-bit regs)
  Modbus.Address = 40001       // 40001 is the starting address for the input values
  Modbus.WriteData()           // Write new input values to the Modbus registers.
```

Force eRCM Express™ to Recalculate New Compressor Performance:

```
  Modbus.Data(1)   = 1          // "1" is flag to recalculate
  Modbus.NumberOfValues = 1    // 1 is the number of input values (1 Value = two 16-bit regs)
  // Reg#40075 is ideal if only using the shorter Quick Writes list (smaller Modbus block)
  Modbus.Address = 40075       // 40075 is the address for ForceERCMExpressCalculations
OR  Modbus.Address = 40273     // 40273 is the address for ForceERCMExpressCalculations
  Modbus.WriteData()           // Write value to the Modbus register.
```

Waiting for eRCM Express™ to Complete Calculations – Using IsKernelBusy Method:

```
  DIM eRCMExpressCount as Integer
  Modbus.NumberOfDataValues = 1
  Modbus.Address = 40275  // The address of the "IsKernelBusy" register.
                          // Will return false (0) when eRCM Express has completed
                          // all of its performance and safety calculations.
                          // This usually takes less than 250 ms.
  eRCMExpressCount = 0
  DO
    Sleep 20                 // Sleep 20 ms
    Modbus.ReadData()        // Read data in the "IsKernelBusy" register.
    If Modbus.Data(1) = 0 Then Exit DO     // If 0, then calculations are now complete.
    eRCMExpressCount = eRCMExpressCount + 1
  LOOP UNTIL eRCMExpressCount > 15         // Prevent Infinite Loop

  IF eRCMExpressCount > 15 THEN
    MSG "CRITICAL ISSUE: eRCM Express Unit does not appear to be returning data."
    // NOTE: If a Gateway device is between eRCM Express and PLC, then you may need
    // to wait longer for updates to happen.
  ELSE
    …Now proceed with reading in eRCM Express data…
  END IF
```

Waiting for eRCM Express™ to Complete Calculations – 250 ms Method:

```
  Sleep 250   // Sleep at least 150 ms. eRCM Express will be done by then for MOST models.
              // If model has lots of load steps (20+) or multiple stages (2+) then
              // more time may be required to finish all of the calculations.
              // 250-350 is usually the MOST you need to wait.
  …Now proceed with reading in eRCM Express data…
```

Reading Data from eRCM Express™:

```
  DIM NextLoadStepUp as Double
  …
  DIM LoadStepBHPs(23) As Double

  Modbus.NumberOfDataValues = 1
  Modbus.Address = 40275  // The address of the "IsKernelBusy" register.
                          // Will return false (0) when eRCM Express has completed
                          // all of its performance and safety calculations.
                          // This usually takes less than 150 ms.
  Modbus.ReadData()               // Read data in the "IsKernelBusy" register.
  If Modbus.Data(1) = 0 Then      // If 0, then calculations are now complete.
        // Do the following to read specific items:
        Modbus.NumberOfDataValues = 13 (1 Value = two 16-bit registers)
        Modbus.Address = 40277      // Start of a block of data
        Modbus.ReadData()
        eRCMExpressWatchdogPulse  = Modbus.Data(1)
        NextLoadStepUp            = Modbus.Data(2)
        NextLoadStepDown          = Modbus.Data(3)
        NextLSUpPercentChange     = Modbus.Data(4)
        NextLSDownPercentChange   = Modbus.Data(5)
        MinSpeedCurrentLS         = Modbus.Data(6)
        MaxSpeedCurrentLS         = Modbus.Data(7)
        MinSuctPressureCurrentLS  = Modbus.Data(8)
        MaxSuctPressureCurrentLS  = Modbus.Data(9)
        FindOptimalLoadStep       = Modbus.Data(10)
        CurrentTorque             = Modbus.Data(11)
        IsentropicEfficiency      = Modbus.Data(12)
        FuelRate                  = Modbus.Data(13)

        // Do the following to read an array of values at once:
        // Example: Get the load for load steps 1 through 23
        Modbus.NumberOfDataValues = 23
        Modbus.Address = 40645 // Modbus address for start of LoadArray values (Load Step 1)
        Modbus.ReadData()
        LoadStepBHPs(1) = Modbus.Data(1)    // Load for Load Step 1  (Address 40645)
        LoadStepBHPs(2) = Modbus.Data(2)    // Load for Load Step 2  (Address 40647)
        LoadStepBHPs(3) = Modbus.Data(3)    // Load for Load Step 3  (Address 40649)
        LoadStepBHPs(4) = Modbus.Data(4)    // Load for Load Step 4  (Address 40651)
…
        LoadStepBHPs(23) = Modbus.Data(23)  // Load for Load Step 23 (Address 40689)
…
  END IF
```

eRCM Express™

Using Select

Features

1. **How do I make sure that the correct eRCM Viewer model is loaded into eRCM Express?**
    a. If there is only one (1) eRCM Viewer model used, then it is loaded by default and no check is usually needed.
    b. If there are multiple unit models loaded into eRCM Express (or you want to verify default file for security), then run some code during start up to check:
        i. A default model will load in when eRCM Express starts. This may, or may not, be the desired model.
        ii. If there are multiple eRCM Viewer models on the eRCM Express, then the PLC needs to identify which one it wants to load (and then verify it afterwards). This is done via employing the **File Identification Method**, which is describe in more detail under the "Change Current Modeling File via PLC" section`.
    c. Best to wait at least 500 ms after loading a new file before checking it.
    d. Also, see section on **Sample Pseudo Start Up Code**
    e. Alternatively, check **UserModelID** (Reg#40375) to make sure it is the value assigned to the model of interest by your team.

2. **How can I verify that eRCM Express is working, via code?**
    a. Check the value in the **eRCMExpressWatchdogPulse** register. If this value changes after your next call to **ChangeOpCondition** then eRCM Express is working as intended. The returned value will always be an integer from 0 to 6 million and should never be the same as the previous number.

3. **How do I know if the eRCM Express is working and returning correct values in the unit's registers?**
    a. Install ACI's eRCM Express Diagnostics & Communications Software (available free from the ACI website). Install that software onto your Windows PC, set up an Ethernet connection from your PC to the eRCM Express unit and run the software. Reference that software's Help for more information about how to effectively use it.
    b. This software can readily help troubleshoot communications issues by eliminating the PLC and gateway devices from the chain.

4. **What do I change to make eRCM Express select load steps using larger (or smaller) increments?**
    a. Set the percent of desired change (for either load or flow) in the register **MinLoadFlowPercChange**. Subsequent changes to conditions will lead to determination of **NextLoadStepUp** and **NextLoadStepDown** based on the new percent change value.

5. **How do I force eRCM Express to select load steps based on different criteria?**
    a. Please review the section **Addendum I – Load Step Selection Modes**.
    b. Models using automated VVCPs may not allow changes to their methods of load step selection.
    c. The eRCM Viewer models should be set by default to the most useful load step selection based on the unit, the load steps, and the operation map.
    d. LSSelectionMode (Reg#40105) is used to set load step selection mode.

6. **How do I determine which load step to set the unit to before closing the bypass valve during Start Up?**
    a. To determine which load step to set the hardware configuration to, before closing the bypass valve, set the current operating conditions (**PsG**, **PdG**, **CurrSpeed**, **Ts1F**, …), and then set **CheckSafeStartup** to 1 and then force a calculation by setting **ForceERCMExpressCalculations** to 1. When calculations are complete the **SafeLoadStepStartup** register contains the load step to use.
        i. **NOTE**: For this option to be useful, during this mode you must send the discharge line pressure (***after the bypass valve***), and not a cylinder discharge pressure (before the bypass valve), when you set the current operating conditions.
        ii. **WARNING**: You must set this register (**CheckSafeStartup**) back to zero (0) after retrieving the safe load step to use during Start Up. If left non-zero, subsequent eRCM Express data may not be appropriate.

7. **What does *MaxLoadPercChange* do?**
    a. The register value in **MaxLoadPercChange** is used to prevent eRCM Express from selecting a load step that could result in undesirable consequences to the engine. A significant and sudden change in load (increase or decrease) can lead to engine problems (over-speeding or under-speeding or surging). For many engines, the maximum load change limit is about a 15% change in load, whilst some may go as high as 25-30%. For electric motors, the limit may be higher since electric flows react faster than fuel flows.

8. **What's the logic behind selecting Next Load Step Up (and Down)?**
    a. In general, based on the unit load (or flow) of the Current Load Step, eRCM Express identifies which load steps are at least ***MinLoadFlowPercChange*** percentage points higher (or lower for Next Load Step Down) but no more than ***MaxLoadPercChange*** percentage points away. Then, the closest safe load steps to that limit are selected. If more than one load step is reasonable,

then the load step with the best Load per Unit Flow ratio is selected (as it is the most efficient).

b. However, more information can be found at **Addendum I – Load Step Selection Modes**.

9. I'm not matching the correct bits set in the registers defined by ErrorArray().

a. The bits in ErrorArray() can only be properly identified when their two (2) 16-bit Modbus Integer registers are correctly interpreted as a 32-bit Long.

i. The most common issues are:

1. The two (2) 16-bit Modbus registers are juxtaposed. If so, swap the two 16-bit register locations when creating the 32-bit Long.

2. Data is read as a Floating Point instead of an Integer.

10. How do I use the Live Pressures feature? *(Future Option)*

a. *Check back with ACI for future firmware updates that support this option.*

11. How do I use one of the Special 2-Stage Modes – the mode with Dynamically Adjustable Interstage Pressure, or the mode with Dynamically Adjustable Side Stream Out amounts. (*Only 2-stage models supported*.)

a. If your eRCM model is set for adjustable interstage pressure, then:

i. Set the unit's controlled interstage pressure (psiG) via the **Stage 1 Pd** (Reg#40063). If entered amount is outside of allowed values, then it will be clipped to upper/lower limits. Set to zero (0) to exit this mode and return to modeling unit as a true 2-stage compressor.

ii. Set this value before forcing an eRCM Express update.

b. If your eRCM model is set for adjustable side stream out amounts, then:

i. Set the Side Stream Out amount (MMscfd) via the **SS12** (Reg#40141). Since this is a Side Stream Out, it should be a negative number. Set to 0 for no side stream out. If entered amount is outside of allowed values, then it will be ignored (i.e. side stream out of 0 MMscfd).

ii. Set this value before forcing an eRCM Express update.

eRCM Express™

Change Current

Modeling File

via PLC

File Identification Method:

At times, multiple eRCM Viewer files will be loaded and ready in the eRCM Express unit. Examples may include:

- One model for 1-stage injection, one model for 2-stage injection, and a third model for 1-stage withdrawal.
- One model for process gas, and another model for purge gas.
- One model for unit with no valve spacers, one for all suction valve spacers in, one for all valve spacers in, and one model for suction valves pulled.

eRCM Viewer files must be specifically identified with a leading digit of "1" through "9" in their filenames.

- **Warning**: Filenames with the same leading digit will lead to confusion. Thus, do not use filenames like "**1**-0_Unit-12.rvf" and "**1**-1_Unit-12b.rvf" as both have the same leading digit "**1**".
    - ***NOTE: Do not put spaces and special characters in filenames.***
    - ***NOTE: Length of filenames must be less than or equal to 24 characters.***

- Sample filenames that Can and Cannot be used:

Filenames that Can be Used	Filenames that Cannot be Used
1Unit7-Ariel_2-Stg.rvf	Unit7-Ariel 2-Stg.rvf *(has spaces, does not start with digit)*
8Superior_MH6_1-Stage.rvf	Superior MH6 Single Stage Unit.rvf *(has spaces, too many characters in filename)*
2.rvf	Rev2.rvf *(does not start with digit)*
6_GE-DS_Service1-CNG.rvf	6GEDS_Service1@CNG.rvf *(has invalid character)*

- To select the file to use, simply set the register ***SetViewerFile*** (Register Address 40101) to the special ID number of that file, from "1" to "9".
    - Best to wait at least 500 ms after loading a new file before checking it.

- Sample Pseudo Code for this Method

```
' Load in file "4CooperBessermer_2-Stg.rvf" into eRCM Express
Modbus.NumberOfDataValues = 1
Modbus.Address = 40101
Modbus.Data(1) = 4     // Load in eRCM Model that starts with the digit "4"
Modbus.WriteData()

Sleep 500 ms
' Correct model should now be loaded in eRCM Express.

' Check it (NumStages, NumThrows, NumLSs, etc. to make sure it is correct)
```

  - See section on **Sample Pseudo Start Up Code**

eRCM Express™

Miscellaneous

Notes

Relax eRCM Limits to Station Limits:

When implementing a compressor model in a Unit Control Panel environment, end-user should set certain limits within the model so that those limits do not trigger an invalid condition before the PLC would trigger an invalid condition.

- Example 1: If the PLC alarms at a discharge temperature of 300 °F and shut downs at a discharge temperature of 325 °F, then the maximum allowed discharge temperature in the eRCM Viewer model should be 325 °F, and not 300 °F.
- Example 2: If the unit is allowed to go down to 40% torque, then make sure that the Min Allowed Torque setting in the eRCM Express is 40% or lower.

The goal is to not have the eRCM Express trigger unnecessary shut downs by indicating all load steps as unsafe, when in fact they may still be within the PLC's limits.

Using Compressor to Pack a Discharge Line:

If the unit needs to pack a discharge pipe that has fallen below its normal minimum discharge pressure, then ensure that the following limits are set in the eRCM Viewer model being used in the eRCM Express unit:

- Minimum Compression Ratio = 1.00
- Minimum Discharge Pressure = Minimum Suction Pressure

Running Unit at Low Torque:

If the unit needs to occasionally run in low torque conditions, then make sure that in the eRCM Viewer model being used:

- Minimum Torque = A number from 1% to 60%.
  Typical Default for Motors is 25%, and Typical Default for Engines is 60%.

Running Unit when Discharge Pressure is Less Than Suction Pressure:

If the unit needs to occasionally run when the discharge header pressure is less than the suction header pressure, then:

1) Make sure that this is okayed by the OEM. Operations in blow-through can potentially significantly degrade the life of compressor valves.
2) eRCM Express is not useful for determining unit safety under these conditions (blow-through). So, if that mode is ok with the OEM, then to keep eRCM Express from indicating operating issues, simply set the Discharge Pressure equal to the Suction Pressure+5 psi. Thus, if Ps=390 psiG, and Pd=340 psiG, when sending data to eRCM Express, simply send 390 for Ps, and 395 for Pd.

eRCM Express™

Modbus Registers

Commonly Used Lists

*e*RCM™ Express Quick Write List

eRCM Express acts as a Modbus slave using Ethernet/IP protocol Q414.
- Use Function 16 to write Operating Point Inputs to Modbus Registers 40001- 40273.
- Use Function 03 to read back CPASA Outputs from Modbus Registers 40275- 43653.
- The default Modbus port used by the mCore unit is **Port 552**.

- ***NOTE**: All registers (read & write) are 32-bit Floating Point type, **except** for those between 40445 and 40643 inclusive which form the ErrorArray() and all of these represent 32-bit Integer type. Modbus usually reads items as 16-bit registers, so make sure the two 16-bit registers are transferred correctly to create the final 32-bit Floating Point number (or Integer number).*

- ***NOTE**: To prevent shut downs during operations due to speed (rpm) spikes (from the engine or motor), if a value sent as speed (CurrSpeed) is less than minimum allowed then the minimum allowed speed is used instead, and no errors are generated. Also, if value sent as speed (CurrSpeed) is greater than the maximum allowed then the maximum allowed speed is used instead and no again errors are generated.*

*e*RCM™ Express Quick WRITE List

Most Commonly Used Items

Function	Register	Units	Operating Point inputs	Common Tag Name
16	40001	#	**Unit's Current Load Step**	**CurrLS**
16	40003	psiG	**Suction Pressure into Stage-1**	**Ps_psiG**
16	40005	psiG	**Discharge Pressure out of Last Stage**	**Pd_psiG**
16	40007	rpm	**Operating Speed**	**CurrSpeed**
16	40009	°F	**1st Stage Suction Gas Temperature**	**Ts1_F**
16	40011	°F	**2nd Stage Suction Gas Temperature**	**Ts2_F**
16	40013	°F	**3rd Stage Suction Gas Temperature**	**Ts3_F**
16	40015	°F	**4th Stage Suction Gas Temperature**	**Ts4_F**
16	40075	#	**Set to "1" to force eRCM Express Recalculation**	**ForceERCMExpressCalculations**
16	40109	%	Set Current Max Allowed Torque, **usually set to 100**(%). If set once after the unit model loaded, this does NOT need to be sent thereafter.	**TorqSP**

Less Commonly Used Items

Function	Register	Units	Operating Point inputs	Common Tag Name
16	40101	#	**Set which eRCM Viewer Model to use (1/2/3/4/5/6/7/8/9)**	**SetViewerFile**
16	40103	HP	Set Driver's Max Power, only if dynamically changes Set back to 0 to return to model's original Max Rated Power	**SetDriverMaxHP**
16	40105	#	**Set to Load Step Selection Mode Number**	**LSSelectionMode**
16	40107	#	0 = Normal Operations; 1 = Request Safe Start Up Load Step	**CheckSafeStartUp**
16	40111	0	**Always set to 0**	**LSMode**
16	40113	°F	Set to current Ambient Temperature **only** if engine ambient rating used in model.	**TambF**
16	40115	0/1	**0 = Normal Mode;** 1 = Allow Load Steps with non-critical issues	**IgnoreNonCriticalErrors**
16	40117	%	Set Min % of Rated Power (or percent of current max flow) to consider when determining Next Step Up and Next Step Down	**MinLoadFlowPercChange**
16	40119	%	Set Max % of Available Power to consider when determining Next Step Up and Next Step Down	**MaxLoadPercChange**
16	40273	#	**Set to "1" to force eRCM Express Recalculation (same effect as setting 40075)**	**ForceERCMExpressCalculations**

*e*RCM™ Express Quick READ List

Fnct	Register	Units	Description/Use	Common Tag Name
03	40275	#	Returns a one (1) that indicates if the eRCM Express computational engine is currently busy doing calculations. A zero (0) indicates that it is safe to poll for information as calculations are complete.	KrnlBusy
03	40277	#	Returns a unique number (from 0 to 6 million) that changes every time new operating conditions are processed by eRCM Express. Helps PLC determine if the full loop of communication/calculations is being implemented.	WDPulse
03	40279	#	Relative to Current Operating Conditions and Current Load Step, this register contains the Next Safe Up (increased load). If there is no safe load step with higher load, then a -1 is returned.	NextLSUp
03	40281	#	Relative to Current Operating Conditions and Current Load Step, this register contains the Next Safe Down (decreased load). If there is no safe load step with lower load, then a -1 is returned.	NextLSDown
03	40283	%	Returns the percent of load change from Current Load Step to Next Step Up, relative to maximum allowed load at the current speed. If there is no safe load step up, then this function returns 999999 as the percent change.	NSU_Perc
03	40285	%	Returns the percent of load change from Current Load Step to Next Step Down, relative to maximum allowed load at the current speed. If there is no safe load step down, then this function returns 999999 as the percent change.	NSD_Perc
03	40287	Rpm	For the Current Load Step, returns the lowest speed (rpm) for which unit can be adjusted without causing safety issues.	MinRPM
03	40289	Rpm	For the Current Load Step, returns the highest speed (rpm) for which unit can be adjusted without causing safety issues.	MaxRPM
03	40291	psiG	For the Current Load Step, returns the lowest suction pressure (psiG) for which unit can be adjusted without causing safety issues.	MinPs1
03	40293	psiG	For the Current Load Step, returns the highest suction pressure (psiG) for which unit can be adjusted without causing safety issues.	MaxPs1
03	40295	#	Returns the ideal Load Step to which to load, to fully load the unit. This is for reference only as the unit's/PLC's goals may not always be to maximize unit's load. Additionally, this register returns a value of -1 if all load steps are invalid.	OptimalLS
03	40297	%	For the Current Load Step, returns the Current Torque (%), which is the percent of Required Power relative to Driver's Derated Power.	CurrTorq
03	40299	%	Returns unit's efficiency (measure of how efficient the compressor is at current operating point).	IsenEff
03	40301	scf/hr	Returns fuel rate based on current load and current speed, only if modeled in the eRCM Viewer model. Otherwise, returns 0.	FuelRate

***NOTE*: If NextLSUp = -1 and NextLSDown = -1 and OptimalLS = -1, then there are NO SAFE LOAD STEPS, and hence unit should Shut Down.**

***NOTE*: If NextLSUp = -1 and NextLSDown = -1 and ErrorArray(CurrLS) <> 0, then the current load step is unsafe, and there are no safe loads obtainable (too far away), and hence unit should Shut Down.**

Fnct	Register	Units	Description/Use	Common Tag Name
03	40325	%	Returns Minimum Percent of Load (or flow depending on Load Step Selection Mode) to consider when looking for Next Step Up or Down.	MinLoadFlowPercChange
03	40327	%	Returns the Maximum Percent of Load Change allowed when determining Next Step Up or Down.	MaxLoadPercChange
03	40329	#	**Use CheckSafeStartup to force a calculation of this item. If value= -1, then there is no safe load step for which to start unit.**	LStoSetforSU
03	40331	HP	Returns the Auxiliary Load plus any Frame Friction Load.	AuxLoad
03	40333	HP	Returns the driver's maximum Power.	BHPMax
03	40335	HP	Returns current Max Allowed Load (HP) based on current torque setting, rated load, current speed and T-Amb (if engine is ambient rated).	BHPMax at TorqSP
03	40337	ft	Returns the elevation used for compressor modeling.	Elevation
03	40339	psiA	Returns Atmospheric Pressure.	AtmPress
03	40341	#	Returns number of cylinders modeled in the current model.	NumCyls
03	40343	#	Returns number of load steps defined in the model.	NumLSs
03	40345	#	Returns number of compression stages used in the current model.	NumStgs
03	40347	#	Returns number of throws modeled in the current model.	NumThrws
03	40349	#	Returns ID Number indicating the OEM of the frame/unit being modeled. (See eRCM Software for list of OEM IDs.)	OEM ID
03	40351	#	Returns mechanical efficiency used to convert indicated horsepower to brake horsepower.	MechEff
03	40353	DegF	Returns the average Maximum Discharge Temperature allowed for all modeled cylinders on the unit.	MaxDischF
03	40355	%	Returns Relative Percent Humidity of Initial Inlet Gas being modeled, from 0 to 100 (%).	RelHumid

Fnct	Register	Units	Description/Use	Common Tag Name
03	40445…	#, INT	**Only read as many as needed.** Then look at bits of 32-bit Integers for specific errors encountered per load step.	ErrorArray()
03	40643	#, INT	Any item with a non-zero value indicates that that load step is unsafe to use!	

Fnct	Register	Units	Description/Use	Common Tag Name
03	40645…	HP	**Only read as many as needed.** Then look at values of 32-bit Floats to see if any are too high (overloaded) or too low (under loaded) for driver. If any, drop them.	LoadArray()
03	40843	HP	Overloading and underloading are driver (engine/motor) related issues rather than compressor-related issues. Thus, if limiting load more than via the Max and Min allowed torque settings allow, then that will need to be handled via the PLC.	

Fnct	Register	Units	Description/Use	Common Tag Name
03	40845…	MMscfd	**Only read as many as needed.**	FlowArray()
03	41043	MMscfd		

Fnct	Register	Units	**Description/Use --** Add 60 for each additional stage.	Common Tag Name
03	41059	#	Stage Compression Ratio	StageArray()
03	41065	HP	Stage Load	
03	41067	MMscfd	Stage Flow	
03	41089	DegR	Cylinder Discharge Temperature (°R, not °F)	

Fnct	Register	Units	**Description/Use --** Add 60 for each additional throw.	Common Tag Name
03	**41405**	**%**	Gas Rod Loads – Compression (Most Low-speed units)	**ThrowArray()**
03	**41407**	**%**	Gas Rod Loads – Tension (Most Low-speed units)	
03	**41413**	**%**	Net Rod Loads – Compression (High-speed units)	
03	**41415**	**%**	Net Rod Loads – Tension (High-speed units)	
03	**41443**	**#**	Degrees of Pin Reversal in Compression	
03	**41445**	**#**	Degrees of Pin Reversal in Tension	

Fnct	Register	Units	**Description/Use --** Add 80 for each additional cylinder.	Common Tag Name
03	**42011**	**DegF**	Cylinder End Estimated Discharge Temperature	**CylHEArray(), and for**
03	**42017**	**%**	Suction Volumetric Efficiency	**CylCEArray() – add 800**
03	**42033**	**HP**	Cylinder End Load	**to register numbers**

Fnct	Register	Units	Description/Use	Common Tag Name
03	**43605**	**psiG**	Min Allowed Suction Pressure	**Ranges**
03	**43607**	**psiG**	Max Allowed Suction Pressure	
03	**43609**	**psiG**	Min Allowed Discharge Pressure	
03	**43611**	**psiG**	Max Allowed Discharge Pressure	
03	**43613**	**rpm**	Min Allowed Speed	
03	**43615**	**rpm**	Max Allowed Speed	
03	**43617**	**%**	Min Allowed Torque	
03	**43619**	**%**	Max Allowed Torque	
03	**43621**	**DegF**	Min Allowed Ambient Temperature	
03	**43623**	**DegF**	Max Allowed Ambient Temperature	
03	**43625**	**DegF**	Min Allowed Stage-1 Gas Temperature	
03	**43627**	**DegF**	Max Allowed Stage-1 Gas Temperature	
03	**43629**	**DegF**	Min Allowed Stage-2 Gas Temperature	
03	**43631**	**DegF**	Max Allowed Stage-2 Gas Temperature	
03	**43633**	**DegF**	Min Allowed Stage-3 Gas Temperature	
03	**43635**	**DegF**	Max Allowed Stage-3 Gas Temperature	
03	**43637**	**DegF**	Min Allowed Stage-4 Gas Temperature	
03	**43639**	**DegF**	Max Allowed Stage-4 Gas Temperature	
03	**43641**	**DegF**	Min Allowed Stage-5 Gas Temperature	
03	**43643**	**DegF**	Max Allowed Stage-5 Gas Temperature	
03	**43645**	**DegF**	Min Allowed Stage-6 Gas Temperature	
03	**43647**	**DegF**	Max Allowed Stage-6 Gas Temperature	

eRCM Express™

Modbus Registers

Full Write/Read List

List of All Active Writes:

NAME	ADDRESS	Item Description	Notes
CurrLS	40001	Current Load Step	These are the basic values the control panel needs to send to eRCM Express.
PsG	40003	Inlet Pressure (psig) into the **first** stage	
PdG	40005	Discharge Pressure (psig) out of the **last** stage	
CurrSpeed	40007	Operating Speed (rpm)	
Ts1F	40009	Suction Gas Temperature into the **first** stage	
Ts2F	40011	Suction Gas Temperature into the **second** stage (after any cooler)	
Ts3F	40013	Suction Gas Temperature into the **third** stage (after any cooler)	
Ts4F	40015	Suction Gas Temperature into the **fourth** stage (after any cooler)	
Ts5F	40017	Suction Gas Temperature into the **fifth** stage (after any cooler)	
Ts6F	40019	Suction Gas Temperature into the **sixth** stage (after any cooler)	
Cyl1_Pd	40021	These item are used for Condition Monitoring. The indicated pressures (psig) are to be taken at **each** cylinder's discharge flange, and the indicated temperature (F) are to be taken at **each** cylinder's discharge flange. If discharge flange pressures and discharge flange temperatures are not available, then the Condition Monitoring results will be of limited value or even incorrect. Suction pressures to each cylinder can be the stage pressure leading to that cylinder. Suction temperatures to each cylinder can the stage temperature (after and	These items are only used when doing Condition Monitoring.
Cyl1_Td	40023		
Cyl2_Pd	40025		
Cyl2_Td	40027		
Cyl3_Pd	40029		
Cyl3_Td	40031		
Cyl4_Pd	40033		
Cyl4_Td	40035		
Cyl5_Pd	40037		
Cyl5_Td	40039		
Cyl6_Pd	40041		
Cyl6_Td	40043		
Cyl7_Pd	40045		
Cyl7_Td	40047		
Cyl8_Pd	40049		
Cyl8_Td	40051		
Cyl9_Pd	40053		
Cyl9_Td	40055		
Cyl10_Pd	40057		
Cyl10_Td	40059		
Stage 1 Ps	40061	In Special 2-Stage mode, use Stage1 Pd for setting interstage pressure.	
Stage 1 Pd	40063		
Stage 2 Pd	40065		
Stage 3 Pd	40067		
Stage 4 Pd	40069		
Stage 5 Pd	40071		
Stage 6 Pd	40073		
ForceERCMExpressCalculations	40075	Force eRCM Express to run performance and safety calculations.	Set this to a "1" to force recalculations of all perf. Items.
SetViewerFile	40101	1..9 => Specific Filename starting with that digit.	Not needed if only **one** modeling file being used.
SetDriverMaxHP	40103	Allows for overriding model's Max Driver Load (HP)	
LSSelectionMode	40105	Number from 0 to 100. Should really be changed in model, not via PLC.	
CheckSafeStartUp	40107	0=Normal Operations. 1=Request Safe Start Up Load Step	Check SafeLoadStepStartup for the load step to use.
TorqSP	40109	Set Current Max Allowed Torque (percent)	Cannot be set higher than upper limit defined in model.
LSMode	40111	Always set to 0.	
TambF	40113	Set to current Ambient Temperature (degF)	Used only for models derating engine on Ambient Temps.
IgnoreNonCriticalErrors	40115	0=Normal Mode. 1=Allow Load Steps with non-critical issues.	Used during starting or stopping. Limit use to < 240 secs.
MinLoadFlowPercChange	40117	Set Min % of load (or flow) to consider for Next Step Up or Down.	Values from 0.5 to 10 (%) allowed.
MaxLoadPercChange	40119	Set Max % of load to consider for Next Step Up or Down.	Values from 2 to 80 (%) allowed.
ForceCondMonitoringCalcs	40121	Set to 1 after setting all required items for Condition Monitoring.	Resets back to 0 after calculations are complete.
ForceLivePressures	40123	Set to 1 after setting all required items for Live Pressures.	Resets back to 0 after calculations are complete.
SS12	40141	SetSideStreamVolumeINOUT1-2: Set the side stream volume (MMscfd).	These items are only used when Side Streams are present.
SS23	40143	SetSideStreamVolumeINOUT2-3: Set the side stream volume (MMscfd).	
SS34	40145	SetSideStreamVolumeINOUT3-4: Set the side stream volume (MMscfd).	Use a negative number for side streams OUT, and a positive
SS45	40147	SetSideStreamVolumeINOUT4-5: Set the side stream volume (MMscfd).	number for side streams IN, between stages.
SS56	40149	SetSideStreamVolumeINOUT5-6: Set the side stream volume (MMscfd).	
SSDegFin12	40151	SetSideStreamIN_Temperature1-2 (degF)	Set the temperature of the side stream IN between
SSDegFin23	40153	SetSideStreamIN_Temperature2-3 (degF)	the indicated stages.
SSDegFin34	40155	SetSideStreamIN_Temperature3-4 (degF)	
SSDegFin45	40157	SetSideStreamIN_Temperature4-5 (degF)	
SSDegFin56	40159	SetSideStreamIN_Temperature5-6 (degF)	
ForceERCMExpressCalculations	40273	Force eRCM Express to run performance and safety calculations.	Set this to a "1" to force recalculations of all perf. Items.

List of All Active Reads:

COMMON CONTROL ITEMS:

NAME	ADDRESS	Long Name	Description
KrnlBusy	40275	IsKernelBusy	Returns a one (1) that indicates if the eRCM Express computational engine is currently busy doing calculations. A zero (0) indicates that it is safe to poll for information as calculations are complete.
WDPulse	40277	eRCMExpressWatchdogPulse	Returns a unique number (from 0 to 6 million) that changes every time new operating conditions are processed by eRCM Express. Helps PLC determine if the full loop of communication/calculations is being implemented.
NextLSUp	40279	NextLoadStepUp	Relative to Current Operating Conditions and Current Load Step, this register contains the Next Safe Up (increased load). If there is no safe load step with higher load, then a -1 is returned.
NextLSDown	40281	NextLoadStepDown	Relative to Current Operating Conditions and Current Load Step, this register contains the Next Safe Down (decreased load). If there is no safe load step with lower load, then a -1 is returned.
NSU_Perc	40283	NextLSUpPercentChange	Returns the percent of load change from Current Load Step to Next Step Up, relative to maximum allowed load at the current speed. If there is no safe load step up, then this function returns 999999 as the percent change.
NSD_Perc	40285	NextLSDownPercentChange	Returns the percent of load change from Current Load Step to Next Step Down, relative to maximum allowed load at the current speed. If there is no safe load step down, then this function returns 999999 as the percent change.
MinRPM	40287	MinSpeedCurrentLS	For the Current Load Step, returns the lowest speed (rpm) for which unit can be adjusted without causing safety issues.
MaxRPM	40289	MaxSpeedCurrentLS	For the Current Load Step, returns the highest speed (rpm) for which unit can be adjusted without causing safety issues.
MinPs1	40291	MinSuctPressureCurrentLS	For the Current Load Step, returns the lowest suction pressure (psiG) for which unit can be adjusted without causing safety issues.
MaxPs1	40293	MaxSuctPressureCurrentLS	For the Current Load Step, returns the highest suction pressure (psiG) for which unit can be adjusted without causing safety issues.
OptimalLS	40295	FindOptimalLoadStep	Returns the ideal Load Step to which to load, to fully load the unit. This is for reference only as the unit's/PLC's goals may not always be to maximize unit's load. **Additionally, this registers return a value of -1 if all load step are invalid.**
CurrTorq	40297	CurrentTorque	For the Current Load Step, returns the Current Torque (%).
IsenEff	40299	IsentropicEfficiency	Returns unit's efficiency (measure of how efficient the compressor is at current operating point).
FuelRate	40301	FuelRate	Returns fuel rate (scf/hr) based on current load and current speed.

COMMON COMPARISON ITEMS: These items are **not** used for controls, but rather for helping customer better understand the potentials of their unit, versus how those units are being utilized.

MaxHPLS	40307	MaxLoadLS	Returns LS# of load step with Maximum Load (HP). If none, then -1.
MinHPLS	40309	MinLoadLS	Returns LS# of load step with Minimum Load (HP). If none, then -1.
MaxCAPLS	40311	MaxFlowLS	Returns LS# of load step with Maximum Flow (MMscfd). If none, then -1.
MinCAPLS	40313	MinFlowLS	Returns LS# of load step with Minimum Flow (MMscfd). If none, then -1.

GENERAL ITEMS: Useful items related to compressor's configuration, Start Up, and such.

NAME	ADDRESS	Description
GetMinPercChange	40325	Returns Minimum Percent of Load (or flow if LSSonFlow is one of the flow methods) to consider when looking for Next Step Up or Down.
GetMaxPercChange	40327	Returns the Maximum Percent of **load** to consider when looking for Next Step Up or Down.
LStoSetforSU	40329	Use CheckSafeStartup to force a calculation of this item. If value= -1, then there are no safe load steps for which to start the unit.
AuxLoad	40331	Returns the Auxiliary Load plus any Frame Friction Load (HP).
BHPMax	40333	Returns the driver's maximum load (HP).
BHPMax at TorqSP	40335	Returns current Max Allowed Load (HP) based on current torque setting, rated load, current speed and T-Amb (if emissions engaged).
Elevation	40337	Returns the elevation (ft) used for compressor modeling.
AtmPress	40339	Returns Atmospheric Pressure (psiA).
NumCyls	40341	Returns number of cylinders modeled in the current model.
NumLSs	40343	Returns number of load step defined in the mode.
NumStgs	40345	Returns number of compression stages used in the current model.
NumThrws	40347	Returns number of throws modeled in the current model.
OEM ID	40349	Returns ID Number indicating the OEM of the frame/unit being modeled. (See eRCM Software for list of OEM IDs.)
MechEff	40351	Returns mechanical efficiency used to convert indicated horsepower to brake horsepower.
MaxDischF	40353	Returns the average Maximum Discharge Temperature (degF) allowed for all modeled cylinders on the unit.
RelHumid	40355	Returns Relative Percent Humidity of Initial Inlet Gas being modeled, from 0 to 100 (%).
eRCMExpressVER	40357	0=Initial Release, otherwise a number such that its digits are YYYYMMDDR. 201811243 means 2018-Nov-24 Rev3.

OFFLINE VALIDATION LIMITS: These are useful if communications with eRCM Express are lost.

OfflineMinSafePs1	40359	If PLC losses communications with eRCM Express, then if PLC keeps compressor at current Load Step and at Current Speed, and if the Ts's do not vary by more than +/-10 degF, then unit will be safe as long as current 1st stage suction pressure (Ps) and last stage discharge pressure (Pd) meet the following criteria: Unit is Safe If and Only If: **((OfflineMinSafePs1 <= Ps <= OfflineMaxSafePs1) AND (OfflineMinSafePd1 <= Pd <= OfflineMaxSafePd1)) OR** **((OfflineMinSafePs2 <= Ps <= OfflineMaxSafePs2) AND (OfflineMinSafePd2 <= Pd <= OfflineMaxSafePd2))** *AND PLC does not change Load Step, and PLC does not change speed, and Ts's do not vary more than +/-10 degF.*
OfflineMaxSafePs1	40361	
OfflineMinSafePd1	40363	
OfflineMaxSafePd1	40365	
OfflineMinSafePs2	40367	
OfflineMaxSafePs2	40369	
OfflineMinSafePd2	40371	
OfflineMaxSafePd2	40373	

USER MODEL ID NUMBER: Allows PLC to better verify eRCM model loaded is the model of interest.

UserModelID	40375	Y	A number from 1 to 2,000,000 (inclusive) set by user in eRCM to uniquely identify this file to the PLC. If 0, then ID # never set.

CONDITION MONITORING ITEMS: These are used to help diagnose issues with valves and rings.

NAME	ADDRESS	CM?	Description
UnitSlip	40385	Y	Cummulative effect of all valves (all stages and all cylinders) on the unit's flow as a whole.
CylSlip.C01	40387	Y	Effect of valve and ring leakage for each particular cylinder on that cylinder's effective flow rate. Customer can develop their own limits for when results trigger need to review cylinder's valves and rings, but: Results < -0.08 are very bad — Results > 0.08 are very bad Results between -0.08 and -0.04 are bad — Results between 0.04 and 0.08 are bad Results between -0.04 and -0.02 are of some concern — Results between 0.02 and -0.04 are of some concern **Results between -0.02 and +0.02 are normal**
CylSlip.C02	40389	Y	
CylSlip.C03	40391	Y	
CylSlip.C04	40393	Y	
CylSlip.C05	40395	Y	
CylSlip.C06	40397	Y	
CylSlip.C07	40399	Y	
CylSlip.C08	40401	Y	
CylSlip.C09	40403	Y	
CylSlip.C10	40405	Y	
CylTdF.C1	40407	Y	Based on supplied/measured pressures, theoretically, these are what the discharge temperatures per cylinder should be.
CylTdF.C2	40409	Y	
CylTdF.C3	40411	Y	
CylTdF.C4	40413	Y	
CylTdF.C5	40415	Y	
CylTdF.C6	40417	Y	
CylTdF.C7	40419	Y	
CylTdF.C8	40421	Y	
CylTdF.C9	40423	Y	
CylTdF.C10	40425	Y	

ERROR ARRAY:

NAME	ADDRESS	NAME	ADDRESS	NAME	ADDRESS	NAME	ADDRESS
Err.LS.01	40445	Err.LS.26	40495	Err.LS.51	40545	Err.LS.76	40595
Err.LS.02	40447	Err.LS.27	40497	Err.LS.52	40547	Err.LS.77	40597
Err.LS.03	40449	Err.LS.28	40499	Err.LS.53	40549	Err.LS.78	40599
Err.LS.04	40451	Err.LS.29	40501	Err.LS.54	40551	Err.LS.79	40601
Err.LS.05	40453	Err.LS.30	40503	Err.LS.55	40553	Err.LS.80	40603
Err.LS.06	40455	Err.LS.31	40505	Err.LS.56	40555	Err.LS.81	40605
Err.LS.07	40457	Err.LS.32	40507	Err.LS.57	40557	Err.LS.82	40607
Err.LS.08	40459	Err.LS.33	40509	Err.LS.58	40559	Err.LS.83	40609
Err.LS.09	40461	Err.LS.34	40511	Err.LS.59	40561	Err.LS.84	40611
Err.LS.10	40463	Err.LS.35	40513	Err.LS.60	40563	Err.LS.85	40613
Err.LS.11	40465	Err.LS.36	40515	Err.LS.61	40565	Err.LS.86	40615
Err.LS.12	40467	Err.LS.37	40517	Err.LS.62	40567	Err.LS.87	40617
Err.LS.13	40469	Err.LS.38	40519	Err.LS.63	40569	Err.LS.88	40619
Err.LS.14	40471	Err.LS.39	40521	Err.LS.64	40571	Err.LS.89	40621
Err.LS.15	40473	Err.LS.40	40523	Err.LS.65	40573	Err.LS.90	40623
Err.LS.16	40475	Err.LS.41	40525	Err.LS.66	40575	Err.LS.91	40625
Err.LS.17	40477	Err.LS.42	40527	Err.LS.67	40577	Err.LS.92	40627
Err.LS.18	40479	Err.LS.43	40529	Err.LS.68	40579	Err.LS.93	40629
Err.LS.19	40481	Err.LS.44	40531	Err.LS.69	40581	Err.LS.94	40631
Err.LS.20	40483	Err.LS.45	40533	Err.LS.70	40583	Err.LS.95	40633
Err.LS.21	40485	Err.LS.46	40535	Err.LS.71	40585	Err.LS.96	40635
Err.LS.22	40487	Err.LS.47	40537	Err.LS.72	40587	Err.LS.97	40637
Err.LS.23	40489	Err.LS.48	40539	Err.LS.73	40589	Err.LS.98	40639
Err.LS.24	40491	Err.LS.49	40541	Err.LS.74	40591	Err.LS.99	40641
Err.LS.25	40493	Err.LS.50	40543	Err.LS.75	40593	Err.LS.100	40643

Bit Directory:

Bit 00 / Discharge Pressure Exceeded	Bit 16 / Max Pressure Differential Exceeded
Bit 01 / Discharge Temperature Exceeded	Bit 17 / Estimated Cylinder Discharge Temperatures are High
Bit 02 / Gas Rod Loads Exceeded	Bit 18 / Low Compression Ratio
Bit 03 / Net Rod Loads Exceeded	Bit 19 / High Compression Ratio
Bit 04 / Low Volumetric Efficiency	Bit 20 / Ariel Gas Rod Load Exceeded
Bit 05 / Throttling Occurred	Bit 21 / BHP per Throw Limit Exceeded
Bit 06 / Z-Factor Out Of Range	*Bit 22 / Reserved*
Bit 07 / Invalid Suction Pressure	*Bit 23 / Reserved*
Bit 08 / Invalid Discharge Pressure	*Bit 24 / Reserved*
Bit 09 / RESERVED (should always be 0)	*Bit 25 / Reserved*
Bit 10 / Failed Rod Reversal	*Bit 26 / Reserved*
Bit 11 / Pin Reversal Exceeded	*Bit 27 / Reserved*
Bit 12 / API618 3%-Rule Violated	*Bit 28 / Reserved*
Bit 13 / Non-obtainable Goal	*Bit 29 / Reserved*
Bit 14 / Blank Off Occurred	*Bit 30 / Reserved*
Bit 15 / Liquids May Be Forming	*Bit 31 / Reserved*

LOAD ARRAY:

NAME	ADDRESS	NAME	ADDRESS	NAME	ADDRESS	NAME	ADDRESS
Load.LS.01	40645	Load.LS.26	40695	Load.LS.51	40745	Load.LS.76	40795
Load.LS.02	40647	Load.LS.27	40697	Load.LS.52	40747	Load.LS.77	40797
Load.LS.03	40649	Load.LS.28	40699	Load.LS.53	40749	Load.LS.78	40799
Load.LS.04	40651	Load.LS.29	40701	Load.LS.54	40751	Load.LS.79	40801
Load.LS.05	40653	Load.LS.30	40703	Load.LS.55	40753	Load.LS.80	40803
Load.LS.06	40655	Load.LS.31	40705	Load.LS.56	40755	Load.LS.81	40805
Load.LS.07	40657	Load.LS.32	40707	Load.LS.57	40757	Load.LS.82	40807
Load.LS.08	40659	Load.LS.33	40709	Load.LS.58	40759	Load.LS.83	40809
Load.LS.09	40661	Load.LS.34	40711	Load.LS.59	40761	Load.LS.84	40811
Load.LS.10	40663	Load.LS.35	40713	Load.LS.60	40763	Load.LS.85	40813
Load.LS.11	40665	Load.LS.36	40715	Load.LS.61	40765	Load.LS.86	40815
Load.LS.12	40667	Load.LS.37	40717	Load.LS.62	40767	Load.LS.87	40817
Load.LS.13	40669	Load.LS.38	40719	Load.LS.63	40769	Load.LS.88	40819
Load.LS.14	40671	Load.LS.39	40721	Load.LS.64	40771	Load.LS.89	40821
Load.LS.15	40673	Load.LS.40	40723	Load.LS.65	40773	Load.LS.90	40823
Load.LS.16	40675	Load.LS.41	40725	Load.LS.66	40775	Load.LS.91	40825
Load.LS.17	40677	Load.LS.42	40727	Load.LS.67	40777	Load.LS.92	40827
Load.LS.18	40679	Load.LS.43	40729	Load.LS.68	40779	Load.LS.93	40829
Load.LS.19	40681	Load.LS.44	40731	Load.LS.69	40781	Load.LS.94	40831
Load.LS.20	40683	Load.LS.45	40733	Load.LS.70	40783	Load.LS.95	40833
Load.LS.21	40685	Load.LS.46	40735	Load.LS.71	40785	Load.LS.96	40835
Load.LS.22	40687	Load.LS.47	40737	Load.LS.72	40787	Load.LS.97	40837
Load.LS.23	40689	Load.LS.48	40739	Load.LS.73	40789	Load.LS.98	40839
Load.LS.24	40691	Load.LS.49	40741	Load.LS.74	40791	Load.LS.99	40841
Load.LS.25	40693	Load.LS.50	40743	Load.LS.75	40793	Load.LS.100	40843

FLOW ARRAY:

NAME	ADDRESS	NAME	ADDRESS	NAME	ADDRESS	NAME	ADDRESS
Flow.LS.01	40845	Flow.LS.26	40895	Flow.LS.51	40945	Flow.LS.76	40995
Flow.LS.02	40847	Flow.LS.27	40897	Flow.LS.52	40947	Flow.LS.77	40997
Flow.LS.03	40849	Flow.LS.28	40899	Flow.LS.53	40949	Flow.LS.78	40999
Flow.LS.04	40851	Flow.LS.29	40901	Flow.LS.54	40951	Flow.LS.79	41001
Flow.LS.05	40853	Flow.LS.30	40903	Flow.LS.55	40953	Flow.LS.80	41003
Flow.LS.06	40855	Flow.LS.31	40905	Flow.LS.56	40955	Flow.LS.81	41005
Flow.LS.07	40857	Flow.LS.32	40907	Flow.LS.57	40957	Flow.LS.82	41007
Flow.LS.08	40859	Flow.LS.33	40909	Flow.LS.58	40959	Flow.LS.83	41009
Flow.LS.09	40861	Flow.LS.34	40911	Flow.LS.59	40961	Flow.LS.84	41011
Flow.LS.10	40863	Flow.LS.35	40913	Flow.LS.60	40963	Flow.LS.85	41013
Flow.LS.11	40865	Flow.LS.36	40915	Flow.LS.61	40965	Flow.LS.86	41015
Flow.LS.12	40867	Flow.LS.37	40917	Flow.LS.62	40967	Flow.LS.87	41017
Flow.LS.13	40869	Flow.LS.38	40919	Flow.LS.63	40969	Flow.LS.88	41019
Flow.LS.14	40871	Flow.LS.39	40921	Flow.LS.64	40971	Flow.LS.89	41021
Flow.LS.15	40873	Flow.LS.40	40923	Flow.LS.65	40973	Flow.LS.90	41023
Flow.LS.16	40875	Flow.LS.41	40925	Flow.LS.66	40975	Flow.LS.91	41025
Flow.LS.17	40877	Flow.LS.42	40927	Flow.LS.67	40977	Flow.LS.92	41027
Flow.LS.18	40879	Flow.LS.43	40929	Flow.LS.68	40979	Flow.LS.93	41029
Flow.LS.19	40881	Flow.LS.44	40931	Flow.LS.69	40981	Flow.LS.94	41031
Flow.LS.20	40883	Flow.LS.45	40933	Flow.LS.70	40983	Flow.LS.95	41033
Flow.LS.21	40885	Flow.LS.46	40935	Flow.LS.71	40985	Flow.LS.96	41035
Flow.LS.22	40887	Flow.LS.47	40937	Flow.LS.72	40987	Flow.LS.97	41037
Flow.LS.23	40889	Flow.LS.48	40939	Flow.LS.73	40989	Flow.LS.98	41039
Flow.LS.24	40891	Flow.LS.49	40941	Flow.LS.74	40991	Flow.LS.99	41041
Flow.LS.25	40893	Flow.LS.50	40943	Flow.LS.75	40993	Flow.LS.100	41043

STAGE ARRAY:

NAME	STAGE-1	STAGE-2	STAGE-3	STAGE-4	STAGE-5	STAGE-6
Stage-Item.01	41045	41105	41165	41225	41285	41345
Stage-Item.02	41047	41107	41167	41227	41287	41347
Stage-Item.03	41049	41109	41169	41229	41289	41349
Stage-Item.04	41051	41111	41171	41231	41291	41351
Stage-Item.05	41053	41113	41173	41233	41293	41353
Stage-Item.06	41055	41115	41175	41235	41295	41355
Stage-Item.07	41057	41117	41177	41237	41297	41357
Stage-Item.08	41059	41119	41179	41239	41299	41359
Stage-Item.09	41061	41121	41181	41241	41301	41361
Stage-Item.10	41063	41123	41183	41243	41303	41363
Stage-Item.11	41065	41125	41185	41245	41305	41365
Stage-Item.12	41067	41127	41187	41247	41307	41367
Stage-Item.15	41073	41133	41193	41253	41313	41373
Stage-Item.16	41075	41135	41195	41255	41315	41375
Stage-Item.17	41077	41137	41197	41257	41317	41377
Stage-Item.21	41085	41145	41205	41265	41325	41385
Stage-Item.22	41087	41147	41207	41267	41327	41387
Stage-Item.23	41089	41149	41209	41269	41329	41389
Stage-Item.26	41095	41155	41215	41275	41335	41395

Items

Item 1: Suction Pressure at Gage (psig)
Item 2: Discharge Pressure at Gage (psig)
Item 3: Suction Temperature (°F)
Item 4: Adiabatic Discharge Temperature (°F)
Item 5: Z-Suction Compressibility Factor
Item 6: Z-Discharge Compressibility Factor
Item 7: Gas K-Value
Item 8: Compression Ratio
Item 9: Suction Pressure at Flange (psig)
Item 10: Discharge Pressure at Flange (psig)
Item 11: Load (BHP) per stage
Item 12: Flow (MMscfd) per stage
Item 13 (reserved)
Item 14: (reserved)
Item 15: Compressibility Factor at current Base Conditions
Item 16: Specific Gravity of gas being compressed via this stage
Item 17: Mole Weight of gas being compressed via this stage
Item 18: (reserved)
Item 19: (reserved)
Item 20: (reserved)
Item 21: Base Temperature for Base Conditions (°F)
Item 22: Discharge pressure reflecting pressure drops up to the cylinder flange (psiA)
Item 23: Discharge Temperature at cylinder flange (°R)
Item 24: (reserved)
Item 25: (reserved)
Item 26: Suction pressure reflecting pressure drops up to the cylinder flange (psiA)
Item 27: (reserved)
Item 28: (reserved)
Item 29: (reserved)
Item 30: (reserved)

THROW ARRAY:

NAME	Throw-1	Throw-2	Throw-3	Throw-4	Throw-5	Throw-6	Throw-7	Throw-8	Throw-9	Throw-10
Throw-Item.01	41405	41465	41525	41585	41645	41705	41765	41825	41885	41945
Throw-Item.02	41407	41467	41527	41587	41647	41707	41767	41827	41887	41947
Throw-Item.03	41409	41469	41529	41589	41649	41709	41769	41829	41889	41949
Throw-Item.04	41411	41471	41531	41591	41651	41711	41771	41831	41891	41951
Throw-Item.05	41413	41473	41533	41593	41653	41713	41773	41833	41893	41953
Throw-Item.06	41415	41475	41535	41595	41655	41715	41775	41835	41895	41955
Throw-Item.07	41417	41477	41537	41597	41657	41717	41777	41837	41897	41957
Throw-Item.11	41425	41485	41545	41605	41665	41725	41785	41845	41905	41965
Throw-Item.12	41427	41487	41547	41607	41667	41727	41787	41847	41907	41967
Throw-Item.13	41429	41489	41549	41609	41669	41729	41789	41849	41909	41969
Throw-Item.14	41431	41491	41551	41611	41671	41731	41791	41851	41911	41971
Throw-Item.15	41433	41493	41553	41613	41673	41733	41793	41853	41913	41973
Throw-Item.16	41435	41495	41555	41615	41675	41735	41795	41855	41915	41975
Throw-Item.17	41437	41497	41557	41617	41677	41737	41797	41857	41917	41977
Throw-Item.18	41439	41499	41559	41619	41679	41739	41799	41859	41919	41979
Throw-Item.19	41441	41501	41561	41621	41681	41741	41801	41861	41921	41981
Throw-Item.20	41443	41503	41563	41623	41683	41743	41803	41863	41923	41983
Throw-Item.21	41445	41505	41565	41625	41685	41745	41805	41865	41925	41985
Throw-Item.22	41447	41507	41567	41627	41687	41747	41807	41867	41927	41987
Throw-Item.23	41449	41509	41569	41629	41689	41749	41809	41869	41929	41989
Throw-Item.24	41451	41511	41571	41631	41691	41751	41811	41871	41931	41991
Throw-Item.25	41453	41513	41573	41633	41693	41753	41813	41873	41933	41993
Throw-Item.26	41455	41515	41575	41635	41695	41755	41815	41875	41935	41995
Throw-Item.27	41457	41517	41577	41637	41697	41757	41817	41877	41937	41997
Throw-Item.29	41461	41521	41581	41641	41701	41761	41821	41881	41941	42001
Throw-Item.30	41463	41523	41583	41643	41703	41763	41823	41883	41943	42003

Items Item 1: Compression Forces based on Gas Pressures at Flanges (% of Allowed Limit)
Item 2: Tension Forces based on Gas Pressures at Flanges (% of Allowed Limit)
Item 3: Compression Forces based on Internal Gas Pressures (% of Allowed Limit)
Item 4: Tension Forces based on Internal Gas Pressures (% of Allowed Limit)
Item 5: Compression Forces based on Internal Gas Pressures and Reciprocating Weights (% of Allowed Limit)
Item 6: Tension Forces based on Internal Gas Pressures and Reciprocating Weights (% of Allowed Limit)
Item 7: 1=Passed Pin Reversals, 0=Failed Pin Reversals (1 or 0)
Item 8: (reserved)
Item 9: (reserved)
Item 10: (reserved)
Item 11: Compression Forces based on Gas Pressures at Flanges (Allowed Limit, lbf)
Item 12: Tension Forces based on Gas Pressures at Flanges (Allowed Limit, lbf)
Item 13: Compression Forces based on Internal Gas Pressures (Allowed Limit, lbf)
Item 14: Tension Forces based on Internal Gas Pressures (Allowed Limit, lbf)
Item 15: Compression Forces based on Internal Gas Pressures and Reciprocating Weights (Allowed Limit, lbf)
Item 16: Tension Forces based on Internal Gas Pressures and Reciprocating Weights (Allowed Limit, lbf)
Item 17: True (-1) if a Tandem cylinder is present on this throw, otherwise False (0) is returned.
Item 18: Cylinder Number of cylinder on this throw, or the cylinder number of the Outboard Cylinder if a tandem is present. If cylinder number not found, then a 0 is returned.
Item 19: Cylinder Number of cylinder on this throw, or the cylinder number of the Inboard
Item 20: Degrees of Crank Angle in Compression. (From 0° to 360°)
Item 21: Degrees of Crank Angle in Tension.
Item 22: Reciprocating Weights used on this throw for Rod Load Inertia forces. (lbm)
Item 23: Reversal Weight used on this throw for Pin Load Inertia forces and Degrees of Pin Reversal. (lbm)
Item 24:: Gas-at-Flange Rod Load Compression forces (lbf)
Item 25: Net Rod Load Compression forces (lbf)
Item 26: Net Rod Load Tension forces (lbf)
Item 27: Gas-at-Flange Rod Load Tension forces (lbf)
Item 28: (reserved)
Item 29: Internal Gas-Only Rod Load Tension forces (lbf)
Item 30: Internal Gas-Only Rod Load Compression forces (lbf)

CYL_HE ARRAY:

NAME	CylHE-1	CylHE-2	CylHE-3	CylHE-4	CylHE-5	CylHE-6	CylHE-7	CylHE-8	CylHE-9	CylHE-10
CylHE-Item.01	42005	42085	42165	42245	42325	42405	42485	42565	42645	42725
CylHE-Item.02	42007	42087	42167	42247	42327	42407	42487	42567	42647	42727
CylHE-Item.03	42009	42089	42169	42249	42329	42409	42489	42569	42649	42729
CylHE-Item.04	42011	42091	42171	42251	42331	42411	42491	42571	42651	42731
CylHE-Item.05	42013	42093	42173	42253	42333	42413	42493	42573	42653	42733
CylHE-Item.06	42015	42095	42175	42255	42335	42415	42495	42575	42655	42735
CylHE-Item.07	42017	42097	42177	42257	42337	42417	42497	42577	42657	42737
CylHE-Item.08	42019	42099	42179	42259	42339	42419	42499	42579	42659	42739
CylHE-Item.09	42021	42101	42181	42261	42341	42421	42501	42581	42661	42741
CylHE-Item.10	42023	42103	42183	42263	42343	42423	42503	42583	42663	42743
CylHE-Item.11	42025	42105	42185	42265	42345	42425	42505	42585	42665	42745
CylHE-Item.12	42027	42107	42187	42267	42347	42427	42507	42587	42667	42747
CylHE-Item.13	42029	42109	42189	42269	42349	42429	42509	42589	42669	42749
CylHE-Item.14	42031	42111	42191	42271	42351	42431	42511	42591	42671	42751
CylHE-Item.15	42033	42113	42193	42273	42353	42433	42513	42593	42673	42753
CylHE-Item.16	42035	42115	42195	42275	42355	42435	42515	42595	42675	42755
CylHE-Item.17	42037	42117	42197	42277	42357	42437	42517	42597	42677	42757
CylHE-Item.18	42039	42119	42199	42279	42359	42439	42519	42599	42679	42759
CylHE-Item.19	42041	42121	42201	42281	42361	42441	42521	42601	42681	42761
CylHE-Item.20	42043	42123	42203	42283	42363	42443	42523	42603	42683	42763
CylHE-Item.21	42045	42125	42205	42285	42365	42445	42525	42605	42685	42765
CylHE-Item.22	42047	42127	42207	42287	42367	42447	42527	42607	42687	42767
CylHE-Item.23	42049	42129	42209	42289	42369	42449	42529	42609	42689	42769
CylHE-Item.24	42051	42131	42211	42291	42371	42451	42531	42611	42691	42771
CylHE-Item.25	42053	42133	42213	42293	42373	42453	42533	42613	42693	42773
CylHE-Item.26	42055	42135	42215	42295	42375	42455	42535	42615	42695	42775
CylHE-Item.27	42057	42137	42217	42297	42377	42457	42537	42617	42697	42777
CylHE-Item.28	42059	42139	42219	42299	42379	42459	42539	42619	42699	42779
CylHE-Item.29	42061	42141	42221	42301	42381	42461	42541	42621	42701	42781
CylHE-Item.33	42069	42149	42229	42309	42389	42469	42549	42629	42709	42789
CylHE-Item.38	42079	42159	42239	42319	42399	42479	42559	42639	42719	42799

Items	Item 1: Suction Pressure into cylinder (psig)	Item 21: Cylinder Friction (fraction)
	Item 2: Discharge Pressure out of cylinder (psig)	Item 22: Cylinder Slippage (fraction)
	Item 3: Suction temperature of gas into cylinder (°F)	Item 23: Deactivation Pressure source used (0=Suction, 1=Discharge)
	Item 4: Estimated discharge temperature of cylinder (°F)	Item 24: Cylinder MAWP (or max allowed pressure set in eRCM model) (psiG)
	Item 5: Z-Suction Compressibility Factor	Item 25: Suction Valves being Used in Active Compression Mode
	Item 6: Z-Discharge Compressibility Factor	Item 26: Discharge Valves being Used in Active Compression Mode
	Item 7: Suction Volumetric Efficiency (%)	Item 27: Suction Valves being Used in Deactivated End Mode
	Item 8: Discharge Volumetric Efficiency (%)	Item 28: Discharge Valves being Used in Deactivated End Mode
	Item 9: Fixed clearance (%) of cylinder end	Item 29: Throw Number on which this cylinder is located.
	Item 10: Effective clearance (%) of cylinder end	*Item 30: (reserved)*
	Item 11: Isentropic Efficiency (%) per end	*Item 31: (reserved)*
	Item 12: Adiabatic horsepower (BHP) used to compress gas per end	*Item 32: (reserved)*
	Item 13: Valve loss (BHP) used to move gas through valves	Item 33: Maximum allowed Discharge Temperature for this cylinder (°F)
	Item 14: Parasitic loss (BHP) used when end is deactivated	*Item 34: (reserved)*
	Item 15: Total load (BHP) used per end	*Item 35: (reserved)*
	Item 16: Flow (MMscfd) per end	*Item 36: (reserved)*
	Item 17: Which Stage of compression this cylinder serves	*Item 37: (reserved)*
	Item 18: Bore Diameter (in)	Item 38: Length of the Stroke for the VVCP on this cylinder end. (in)
	Item 19: Rod Diameter (in)	*Item 39: (reserved)*
	Item 20: End Active (1=Active, 0=Deactivated)	*Item 40: (reserved)*

CYL_CE ARRAY:

NAME	CylCE-1	CylCE-2	CylCE-3	CylCE-4	CylCE-5	CylCE-6	CylCE-7	CylCE-8	CylCE-9	CylCE-10
CylCE-Item.01	42805	42885	42965	43045	43125	43205	43285	43365	43445	43525
CylCE-Item.02	42807	42887	42967	43047	43127	43207	43287	43367	43447	43527
CylCE-Item.03	42809	42889	42969	43049	43129	43209	43289	43369	43449	43529
CylCE-Item.04	42811	42891	42971	43051	43131	43211	43291	43371	43451	43531
CylCE-Item.05	42813	42893	42973	43053	43133	43213	43293	43373	43453	43533
CylCE-Item.06	42815	42895	42975	43055	43135	43215	43295	43375	43455	43535
CylCE-Item.07	42817	42897	42977	43057	43137	43217	43297	43377	43457	43537
CylCE-Item.08	42819	42899	42979	43059	43139	43219	43299	43379	43459	43539
CylCE-Item.09	42821	42901	42981	43061	43141	43221	43301	43381	43461	43541
CylCE-Item.10	42823	42903	42983	43063	43143	43223	43303	43383	43463	43543
CylCE-Item.11	42825	42905	42985	43065	43145	43225	43305	43385	43465	43545
CylCE-Item.12	42827	42907	42987	43067	43147	43227	43307	43387	43467	43547
CylCE-Item.13	42829	42909	42989	43069	43149	43229	43309	43389	43469	43549
CylCE-Item.14	42831	42911	42991	43071	43151	43231	43311	43391	43471	43551
CylCE-Item.15	42833	42913	42993	43073	43153	43233	43313	43393	43473	43553
CylCE-Item.16	42835	42915	42995	43075	43155	43235	43315	43395	43475	43555
CylCE-Item.17	42837	42917	42997	43077	43157	43237	43317	43397	43477	43557
CylCE-Item.18	42839	42919	42999	43079	43159	43239	43319	43399	43479	43559
CylCE-Item.19	42841	42921	43001	43081	43161	43241	43321	43401	43481	43561
CylCE-Item.20	42843	42923	43003	43083	43163	43243	43323	43403	43483	43563
CylCE-Item.21	42845	42925	43005	43085	43165	43245	43325	43405	43485	43565
CylCE-Item.22	42847	42927	43007	43087	43167	43247	43327	43407	43487	43567
CylCE-Item.23	42849	42929	43009	43089	43169	43249	43329	43409	43489	43569
CylCE-Item.24	42851	42931	43011	43091	43171	43251	43331	43411	43491	43571
CylCE-Item.25	42853	42933	43013	43093	43173	43253	43333	43413	43493	43573
CylCE-Item.26	42855	42935	43015	43095	43175	43255	43335	43415	43495	43575
CylCE-Item.27	42857	42937	43017	43097	43177	43257	43337	43417	43497	43577
CylCE-Item.28	42859	42939	43019	43099	43179	43259	43339	43419	43499	43579
CylCE-Item.29	42861	42941	43021	43101	43181	43261	43341	43421	43501	43581
CylCE-Item.33	42869	42949	43029	43109	43189	43269	43349	43429	43509	43589
CylCE-Item.38	42879	42959	43039	43119	43199	43279	43359	43439	43519	43599

Item		
	Item 1: Suction Pressure into cylinder (psig)	Item 21: Cylinder Friction (fraction)
	Item 2: Discharge Pressure out of cylinder (psig)	Item 22: Cylinder Slippage (fraction)
	Item 3: Suction temperature of gas into cylinder (°F)	Item 23: Deactivation Pressure source used (0=Suction, 1=Discharge)
	Item 4: Estimated discharge temperature of cylinder (°F)	Item 24: Cylinder MAWP (or max allowed pressure set in eRCM model) (psiG)
	Item 5: Z-Suction Compressibility Factor	Item 25: Suction Valves being Used in Active Compression Mode
	Item 6: Z-Discharge Compressibility Factor	Item 26: Discharge Valves being Used in Active Compression Mode
	Item 7: Suction Volumetric Efficiency (%)	Item 27: Suction Valves being Used in Deactivated End Mode
	Item 8: Discharge Volumetric Efficiency (%)	Item 28: Discharge Valves being Used in Deactivated End Mode
	Item 9: Fixed clearance (%) of cylinder end	Item 29: Throw Number on which this cylinder is located.
	Item 10: Effective clearance (%) of cylinder end	*Item 30: (reserved)*
	Item 11: Isentropic Efficiency (%) per end	*Item 31: (reserved)*
	Item 12: Adiabatic horsepower (BHP) used to compress gas per end	*Item 32: (reserved)*
	Item 13: Valve loss (BHP) used to move gas through valves	Item 33: Maximum allowed Discharge Temperature for this cylinder (°F)
	Item 14: Parasitic loss (BHP) used when end is deactivated	*Item 34: (reserved)*
	Item 15: Total load (BHP) used per end	*Item 35: (reserved)*
	Item 16: Flow (MMscfd) per end	*Item 36: (reserved)*
	Item 17: Which Stage of compression this cylinder serves	*Item 37: (reserved)*
	Item 18: Bore Diameter (in)	Item 38: Length of the Stroke for the VVCP on this cylinder end. (in)
	Item 19: Rod Diameter (in)	*Item 39: (reserved)*
	Item 20: End Active (1=Active, 0=Deactivated)	*Item 40: (reserved)*

RANGES:

ITEM	ADDRESS	Item Description
Range-01	43605	01. Suction Pressure (psiG) Min
Range-02	43607	02. Suction Pressure (psiG) Max
Range-03	43609	03. Discharge Pressure (psiG) Min
Range-04	43611	04. Discharge Pressure (psiG) Max
Range-05	43613	05. Speed (RPM) Min
Range-06	43615	06. Speed (RPM) Max
Range-07	43617	07. Torque (%) Min
Range-08	43619	08. Torque (%) Max
Range-09	43621	09. Ambient Temperature (°F) Min
Range-10	43623	10. Ambient Temperature (°F) Max
Range-11	43625	11. Stage 1 Suction (°F) Min
Range-12	43627	12. Stage 1 Suction (°F) Max
Range-13	43629	13. Stage 2 Suction (°F) Min
Range-14	43631	14. Stage 2 Suction (°F) Max
Range-15	43633	15. Stage 3 Suction (°F) Min
Range-16	43635	16. Stage 3 Suction (°F) Max
Range-17	43637	17. Stage 4 Suction (°F) Min
Range-18	43639	18. Stage 4 Suction (°F) Max
Range-19	43641	19. Stage 5 Suction (°F) Min
Range-20	43643	20. Stage 5 Suction (°F) Max
Range-21	43645	21. Stage 6 Suction (°F) Min
Range-22	43647	22. Stage 6 Suction (°F) Max

eRCM Express™

Sample Pseudo

Start Up Code

This is just pseudo code for understanding concepts and order. Actual code, syntax, optimization, calls, etc. are handled by the PLC programmers.

```
// ======================================
// Modbus Block Section References
// Used by PLC routines interacting with eRCM Express
// ======================================
eRCM_CommonWritesStart    = 40001
eRCM_CommonWritesLen      = 10
eRCM_SetViewerFileStart   = 40101
eRCM_SetViewerFileLen     = 1
eRCM_ForceCalcsStart      = 40273
eRCM_ForceCalcsLen        = 1
eRCM_CheckSafeStartUp     = 40107
eRCM_CheckSafeStartUpLen  = 1
eRCM_LStoSetforSU         = 40329
eRCM_LStoSetforSULen      = 1

eRCM_IsKernelBusyStart    = 40275
eRCM_IsKernelBusyLen      = 1
eRCM_CommonReadsStart     = 40277
eRCM_CommonReadsLen       = 13
eRCM_CommonFixedDataStart = 40325
eRCM_CommonFixedDataLen   = 26

eRCM_ErrorArrayStart      = 40445
eRCM_LoadArrayStart       = 40645
eRCM_FlowArrayStart       = 40845
// Make the ArrayLen equal to the max number of Load Steps from all model files!
eRCM_ArrayLen             = 30

eRCM_StageInfoStart       = 41045
eRCM_StageInfoPerStageLen = 30
eRCM_ThrowInfoStart       = 41405
eRCM_ThrowInfoPerThrowLen = 30
eRCM_HECylInfoStart       = 42005
eRCM_HECylInfoPerHECylLen = 40
eRCM_CECylInfoStart       = 42805
eRCM_CECylInfoPerCECylLen = 40
eRCM_RangeInfoStart       = 43605
eRCM_RangeInfoLen         = 22

eRCMExpressCount as Integer
// ======================================
```

```
// ======================================
// Compressor is warmed up, and we are ready to bring compressor online.
// First, load in the correct eRCM Viewer model, and then verify it.
// ======================================

  // Load in the correct file
  Modbus.NumberOfDataValues = eRCM_SetViewerFileLen
  Modbus.Address = eRCM_SetViewerFileStart
  Modbus.Data(1) = 2     // Load in the "2Two-stg Injection.rvf" file
  Modbus.Write()
  Sleep 500 ms

  // Verify that this file is correct. If should be a 2-stage unit with 6 throws,
  // 6 cylinders, and 23 load steps.
  Modbus.NumberOfDataValues = eRCM_CommonFixedDataLen
  Modbus.Address = eRCM_CommonFixedDataStart
  Modbus.Read()
  // All must be true, else wrong file!
  // NumStgs=2 AND NumCyls=6 AND NumThrows=6 AND NumLSs=23
  IF Modbus.Data(11)=2 AND Modbus.Data(9)=6 AND _
     Modbus.Data(12)=6 AND Modbus.Data(10)=23 AND
     Modbus.Data(26)=123321 THEN    ' 123321 is User ID value for this model.
     MESSAGE "Correct eRCM Viewer model loaded."
  ELSE
     ALARM "Wrong eRCM Viewer model in eRCM Express. Stop unit!"
     SHUTDOWN
     END
  END IF

  // Check to see if we can force unit to start in the safest load step.
  // This is only practical if access to the unit's final discharge pressure
  // is known. Unit's "actual" discharge pressure is likely about the same as
  // suction pressure since we are in bypass mode.
  IF (Field Discharge Pressure is Known) THEN

    Modbus.NumberOfDataValues = eRCM_CommonWritesLen
    Modbus.Address = eRCM_CommonWritesStart
    Modbus.Data(1) = UnitABC.CurrentLoadStep
    Modbus.Data(2) = UnitABC.Stage1.Ps_PSIG
    Modbus.Data(3) = UnitABC.Station.Pd_PSIG      // This item is SPECIAL!
    Modbus.Data(4) = UnitABC.Driver.CurrentRPM
    Modbus.Data(5) = UnitABC.Stage1.Ts_F
    Modbus.Data(6) = UnitABC.Stage2.Ts_F
    Modbus.Data(7) = 0
    Modbus.Data(8) = 0
    Modbus.Data(9) = 0
    Modbus.Data(10) = 0
    Modbus.Write()

    Modbus.NumberOfDataValues = eRCM_CheckSafeStartUpLen
    Modbus.Address = eRCM_CheckSafeStartUp
    Modbus.Data(1) = 1    // The "1" tells eRCM Express to return Safe Start Up LS
    Modbus.Write()

    Modbus.NumberOfDataValues = eRCM_ForceCalcsLen
    Modbus.Address = eRCM_ForceCalcsStart
    Modbus.Data(1) = 1  // Force a calculation of the compressor model
```

```
    Modbus.Write()
```

TWO OPTIONS - DO ONE OR THE OTHER.

```
    // Wait for eRCM Express to finish calculation (make a subroutine!)
    // This fully guarantees that the data being read back is appropriate for
    // the operating data sent to the eRCM Express.
    Modbus.NumberOfDataValues = eRCM_IsKernelBusyLen
    Modbus.Address = eRCM_IsKernelBusyStart
    eRCMExpressCount = 0
    DO
      Sleep 20 ms
      Modbus.ReadData()       // Read data in the "IsKernelBusy" register.
      If Modbus.Data(1) = 0 Then Exit DO     // If 0, calculations now complete.
      eRCMExpressCount = eRCMExpressCount + 1
    LOOP UNTIL eRCMExpressCount > 10         // Prevent Infinite Loop
    IF eRCMExpressCount > 10 THEN
      MSG "CRITICAL ISSUE: eRCM Express Unit does not appear to be returning
data."
      // NOTE: If gateway device used, you may need to wait longer for updates.
      EXIT
    END IF
```

```
    // This method avoids needing to poll the IsKernelBusy register until it goes
    // back to zero (0). Most calculations will complete in 150 ms. Thus, simply
    // wait a long enough period to guarantee calculations are complete.
    // However, for some models, you may need to wait 250-350 ms for completion.
    Sleep 150 ms
```

```
    Modbus.NumberOfDataValues = eRCM_ LStoSetforSULen
    Modbus.Address = eRCM_ LStoSetforSU
    Modbus.ReadData()
    IF Modbus.Data(1) <> -1 THEN
      CurrentLoadStep = Modbus.Data(1)
    ELSE
      // No safe load step found! Not good.
      // Company needs to decide if unit should NOT be allowed to go ONLINE, or
      // if they want to force a default load step to use instead.
      CurrentLoadStep = -1
    ENDIF

    Modbus.NumberOfDataValues = eRCM_CheckSafeStartUpLen
    Modbus.Address = eRCM_CheckSafeStartUp
    Modbus.Data(1) = 0    // The "0" tells eRCM Express to stop determining Safe
Start Up LS
    Modbus.Write()

  ELSE

    // If we do not have access to final discharge pressure, then it is not clear
    // which (if any) load step to implement to bring unit online safely. Thus,
    // based on OEM, Operators, Engineering, the load step to use during closing
    // of the Bypass Valve has been determined to be "???". Thus, implement this
    // step.
    CurrentLoadStep = 23    // For Two-stage injection, use last load step, LS#23.

  ENDIF
```

```
  IF CurrentLoadStep > 0 THEN
    IMPLEMENT_LoadStep // Call routine to physically implement current load step
  ELSE
    MSG "CRITICAL ISSUE: No safe load steps found for Start Up. Shut Down!"
    EXIT
  END IF

// ======================================
```

The code below is relevant to AFTER the unit is online.

```
// ======================================
// Compressor is now online - Bypass Fully Closed.
// ======================================

  // Now, pass data to eRCM, get results back and take actions accordingly

    // Pass the current operating data
    Modbus.NumberOfDataValues = eRCM_CommonWritesLen
    Modbus.Address = eRCM_CommonWritesStart
    Modbus.Data(1) = UnitABC.CurrentLoadStep
    Modbus.Data(2) = UnitABC.Stage1.Ps_PSIG
    Modbus.Data(3) = UnitABC.Stage2.Pd_PSIG
    Modbus.Data(4) = UnitABC.Driver.CurrentRPM
    Modbus.Data(5) = UnitABC.Stage1.Ts_F
    Modbus.Data(6) = UnitABC.Stage2.Ts_F
    Modbus.Data(7) = 0
    Modbus.Data(8) = 0
    Modbus.Data(9) = 0
    Modbus.Data(10) = 0
    Modbus.Write()

    Modbus.NumberOfDataValues = eRCM_ForceCalcsLen
    Modbus.Address = eRCM_ForceCalcsStart
    Modbus.Data(1) = 1  // Force a calculation of the compressor model
    Modbus.Write()

    // Wait for eRCM Express to finish calculation (Choose one of two options)
    Sleep 150 ms // May need to be set higher (i.e. 250-350 ms for some models)

    // Get results back
    Modbus.NumberOfDataValues = eRCM_CommonReadsLen
    Modbus.Address = eRCM_CommonReadsStart
    Modbus.Read()
    UnitABC.NSU       = Modbus.ReadData(2)
    UnitABC.NSD       = Modbus.ReadData(3)
    UnitABC.NSU_Perc  = Modbus.ReadData(4)
    UnitABC.NSD_Perc  = Modbus.ReadData(5)
    UnitABC.MinSpeedCurrLS = Modbus.ReadData(6)
    UnitABC.MaxSpeedCurrLS = Modbus.ReadData(7)
    UnitABC.MinPsCurrLS    = Modbus.ReadData(8)
    UnitABC.MaxPsCurrLS    = Modbus.ReadData(9)
    UnitABC.OptimalLS     = Modbus.ReadData(10)
    UnitABC.CurrTorq_Perc = Modbus.ReadData(11)
    UnitABC.UnitEff_Perf  = Modbus.ReadData(12)
```

```
UnitABC.FuelRate       = Modbus.ReadData(13)

Modbus.NumberOfDataValues = eRCM_ArrayLen
Modbus.Address = eRCM_ErrorArrayStart
Modbus.Read()
FOR I = 1 TO UnitABC.NumLoadSteps
  UnitABC.ErrorArray(I) = Modbus.ReadData(I)
NEXT I
Modbus.Address = eRCM_LoadArrayStart
Modbus.Read()
FOR I = 1 TO UnitABC.NumLoadSteps
  UnitABC.LoadArray(I) = Modbus.ReadData(I)
NEXT I
Modbus.Address = eRCM_FlowArrayStart
Modbus.Read()
FOR I = 1 TO UnitABC.NumLoadSteps
  UnitABC.FlowArray(I) = Modbus.ReadData(I)
NEXT I

// This remaining data is useful for display, but does not normally need to be
// retrieved each cycle. Rather, only retrieve it when needed for display.
// ---------------------------------

Modbus.NumberOfDataValues = eRCM_StageInfoPerStageLen
Modbus.Address = eRCM_StageInfoStart
FOR I = 1 TO UnitABC.NumStages
  Modbus.Read()
  FOR N = 1 to eRCM_StageInfoPerStageLen
    UnitABC.StageArray(I, N) = Modbus.ReadData(I)
  NEXT N
  Modbus.Address = Modbus.Address + 2*eRCM_StageInfoPerStageLen
NEXT I

Modbus.NumberOfDataValues = eRCM_ThrowInfoPerThrowLen
Modbus.Address = eRCM_ThrowInfoStart
FOR I = 1 TO UnitABC.NumThrows
  Modbus.Read()
  FOR N = 1 to eRCM_ThrowInfoPerThrowLen
    UnitABC.ThrowArray(I, N) = Modbus.ReadData(I)
  NEXT N
  Modbus.Address = Modbus.Address + 2* eRCM_ThrowInfoPerThrowLen
NEXT I

Modbus.NumberOfDataValues = eRCM_HECylInfoPerHECylLen
Modbus.Address = eRCM_HECylInfoStart
FOR I = 1 TO UnitABC.NumCylinders
  Modbus.Read()
  FOR N = 1 to eRCM_HECylInfoPerHECylLen
    UnitABC.HECylArray(I, N) = Modbus.ReadData(I)
  NEXT N
  Modbus.Address = Modbus.Address + 2*eRCM_HECylInfoPerHECylLen
NEXT I

Modbus.NumberOfDataValues = eRCM_CECylInfoPerCECylLen
Modbus.Address = eRCM_CECylInfoStart
FOR I = 1 TO UnitABC.NumCylinders
  Modbus.Read()
```

```
      FOR N = 1 to eRCM_CECylInfoPerCECylLen
        UnitABC.CECylArray(I, N) = Modbus.ReadData(I)
      NEXT N
      Modbus.Address = Modbus.Address + 2*eRCM_CECylInfoPerCECylLen
    NEXT I
    // ---------------------------------


    // Act on those results
    … Expertise of the automation/control team …

    // Compressor Errors for Unit (Compressor and Driver) Errors
    // The ErrorArray only returns errors associated with the compressor
    //   being unsafe. Overloading and/or underloading a driver (engine or motor)
    //   can lead to issues. Thus, if you want to invalidate load steps based on
    //   driver issues, the PLC needs to do that.
    // Next Step Up, Next Step Down, and OptimalLS are based on compressor safety
    //   and on over/under loading of driver, and on making sure that load step
    //   changes are not so larger that the change in load can lead to the engine
    //   surging and/or shutting down.

    // IF need for more load and NSU<>-1 THEN Load up to NSU…

    // IF need for less load and NSD<>-1 THEN Load down to NSD…

    // CRITICAL CHECK
    // ==============================
    // IF NSU=-1 AND NSD=-1 AND ErrorArray(CurrentLS) <> 0 THEN SHUT DOWN! No safe
load steps!
    // ==============================

    // Display desired items of interest on various screens…

// ======================================
```

eRCM Express™

Modbus Registers - Reference Changes when Replacing Older Units

When replacing an older eRCM Express unit (one with an industrial PC as its platform) with an eRCM Express with an mCore SDR as its platform, some Modbus register numbers will need to be changed, and a few other changes in the PLC and/or gateway devices will also need to be implemented.

- When a recalculation of compressor performance and safety is desired, then after sending the operating conditions, a value of one (1) needs to be set in the **ForceERCMExpressCalculations** register and sent to eRCM Express.
  - Note: There are two (2) registers named ForceERCMExpressCalculations. The Reg#40075 is more ideal for users only using the Quick Write List so that the entire group of registers can be written in one Modbus block. Nevertheless, setting either register to a one (1) will direct eRCM Express to recalculate the compressor performance based on latest inputs.

- Interpretation of the bits in the ErrorArray() is still the same. However, retrieving the data for that array is a bit different now:
  - Previous: The registers were retrieved as FLOATS, which had to be converted to INTEGERs within the PLC before inspecting the bits.
  - New: The registers for (only) this array must now be retrieved directly as INTEGER, and thus no conversion is required before inspecting the bits.

To help with the updating of Modbus registers, the following tables show the previous Modbus register used, and its new corresponding register value in the mCore SDR unit:

eRCM Express - PC Platform (Old)	
NAME	ADDRESS
CurrLS	40005
PsG	40009
PdG	40011
RPM	40013
Ts1F	40015
Ts2F	40017
Ts3F	40019
Ts4F	40021
Ts5F	40023
Ts6F	40025
Next Viewer File Request	42799
DriverMaxBHP	42801
LSSelectionOnFlow	42723
CheckSafeStartup	42725
TorqSP	40001
LSMode	40003
TambF	40007
MinLoadFlowChangeAllowed	42719
MaxLoadChangeAllowed	42721

eRCM Express - mCore Platform (New)		
NAME	ADDRESS	
CurrLS	40001	
PsG	40003	
PdG	40005	
CurrSpeed	40007	
Ts1F	40009	
Ts2F	40011	
Ts3F	40013	
Ts4F	40015	
Ts5F	40017	
Ts6F	40019	
SetViewerFile	40101	
SetDriverMaxHP	40103	
LSSOnFlow	40105	
CheckSafeStartUp	40107	
TorqSP	40109	
LSMode	40111	
TambF	40113	
SetMinPercChange	40117	
SetMaxPercChange	40119	
ForceERCMExpressCalculations	40273	Must be set to "1" to force recalculations.

KrnlBsy	40027
WDPulse	40075
NxtLSUP	40031
NxtLSDN	40033
NSU_Perc	40071
NSD_Perc	40073
MinRPM	40035
MaxRPM	40037
MinPs1	40039
MaxPs1	40041
OptmLS	40029
CurrTorq	40047
IsenEff	40053
SafeLoadStepStartup	42727
AuxLoad	40045
BHPMax	40049
BHPMax at TorqSP	40055
Elevation	40051
Patm	40043
NumCyls	40061
NumLSs	40063
NumStgs	40065
NumThrws	40067
OEM ID	40069
MechEff	40059
MaxDischF	40057
RelHumid	40077

KrnlBsy	40275
WDPulse	40277
NxtLSUP	40279
NxtLSDN	40281
NSU_Perc	40283
NSD_Perc	40285
MinRPM	40287
MaxRPM	40289
MinPs1	40291
MaxPs1	40293
OptmLS	40295
CurrTorq	40297
IsenEff	40299
LStoSetforSU	40329
AuxLoad	40331
BHPMax	40333
BHPMax at TorqSP	40335
Elevation	40337
AtmPress	40339
NumCyls	40341
NumLSs	40343
NumStgs	40345
NumThrws	40347
OEM ID	40349
MechEff	40351
MaxDischF	40353
RelHumid	40355

ERROR ARRAY:			
40101	to	40199	
LOAD ARRAY:			
40201	to	40299	
FLOW ARRAY:			
40301	to	40399	
STAGE ARRAY:			
40401	to	40651	
THROW ARRAY:			
40653	to	41171	
HE_CYL ARRAY:			
41173	to	41791	
CE_CYL ARRAY:			
41793	to	42411	

RANGES:	
PsMin	42413
PsMax	42415
PdMin	42417
PdMax	42419
RPMmin	42421
RPMmax	42423
TorqMin	42425
TorqMax	42427
AmbTempMin	42429
AmbTempMax	42431
TsStg1Min	42433
TsStg1Max	42435
TsStg2Min	42437
TsStg2Max	42439
TsStg3Min	42441
TsStg3Max	42443
TsStg4Min	42445
TsStg4Max	42447
TsStg5Min	42449
TsStg5Max	42451
TsStg6Min	42453
TsStg6Max	42455

ERROR ARRAY:				
Err.LS.01	40445	to	40643	New unit provides 100 Load steps instead of only 50 for older units
LOAD ARRAY:				
Load.LS.01	40645	to	40843	New unit provides 100 Load steps instead of only 50 for older units
FLOW ARRAY:				
Flow.LS.01	40845	to	41043	New unit provides 100 Load steps instead of only 50 for older units
STAGE ARRAY:				
Stage-Item.01	41045	to	41403	Sub Items use same indexes
THROW ARRAY:				
Throw-Item.01	41405	to	42003	Sub Items use same indexes
HE_CYL ARRAY:				
CylHE-Item.01	42005	to	42803	Sub Items use same indexes
CE_CYL ARRAY:				
CylCE-Item.01	42805	to	43603	Sub Items use same indexes

RANGES:	
Range-01	43605
Range-02	43607
Range-03	43609
Range-04	43611
Range-05	43613
Range-06	43615
Range-07	43617
Range-08	43619
Range-09	43621
Range-10	43623
Range-11	43625
Range-12	43627
Range-13	43629
Range-14	43631
Range-15	43633
Range-16	43635
Range-17	43637
Range-18	43639
Range-19	43641
Range-20	43643
Range-21	43645
Range-22	43647

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Changes to Manual

by Version

From Version 2019-Feb-1 to Version 2019-Jul-1:

- Updated manual to reflect the new web interface implemented by Monico.
- **Changes**: If a Torque Setpoint of zero (0) is sent, then eRCM Express will set the Torque Setpoint to use as the Max Allowed Torque Setpoint defined in the model.

From Version 2018-Aug-20 to Version 2019-Feb-1:

- A few minor corrections and typos.
- Added notes/text for features new to Version 0.5.1 of the eRCM Express Firmware
- Checklist now added to shipping contents.

From Version 2018-Mar-5 to Version 2018-Aug-20:

- Multiple minor corrections.
- Adding of Addendums, I, II, III, and IV.
- Some additional notes/images for installation of device, for local testing and field use.
- Some small changes to pseudo code examples.
- Description of using timers in PLC rather than polling for **IsKernelBusy** register.

From Version 2018-Feb-16 to Version 2018-Mar-5:

- Update of general images and rewording of some text. No technical information changed.

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ADDENDUM I

Load Step

Selection Modes

Reciprocating compressors allow for significant loading and unloading of the driver (engine or motor) based on actuating/de-actuating devices (such as clearance pockets and end deactivators).

At times, multiple hardware configurations may require the same power requirements but generate different flow rates. As such, at times configuration X will require less load than configuration Y, but then at a different compression ratio configuration X can require more load than configuration Y. When this happens, it is commonly known as "curve-crossing".

Ideally, when a PLC requests NSU (Next Step Up) it will be a load step that will increase load (or increase flow) on the unit, not decrease load (or flow). Thus, when curve-crossing is present, the complexity of selecting the NSU and NSD increases somewhat.

Furthermore, end-users do not generally desire lots of unloading devices to engage at once. If the control lines have insufficient actuation pressure, then the result can be multiple devices actuating late (2 seconds later after others). This can cause the dynamic load on the driver to jump up and down. Often, some engines cannot handle too much jumping of load and will shut down. Thus, part of picking the NSU and NSD may involve consideration for load step efficiency, and number of devices engaging at the same time.

Different types of unloading sequences relative to the unit's operating map are better handled by different load step selection methodologies. One method does not handle all unit arrangements. Thus, eRCM Express provides multiple methods for load step selection. The Applications Engineer that created the eRCM Viewer model for use in the eRCM Express should have reviewed the load steps, the operating map, and any concerns, and subsequently set the model to use the best load step selection method for it.

Currently, eRCM provides nine (9) load step selection modes. Each one has its own pros and cons.

Option #31 and Option #41 cannot be changed via the PLC, as these modes are for specific hardware implementations.

When in doubt, set unit to **Load Step Selection Mode** to **3**, and set the **MinLoadFlowPercChange** to **1** (1%). These settings are good, albeit not necessarily most efficient, for most (but not all) models.

eRCM Provides the following Load Step Selection Modes:

Option 1: Flow with Optimization

Description: Selects most efficient load steps based on a minimum flow rate change between load steps.
Pro(s): This is usually the best way to control a reciprocating compressor.
Con(s): May skip load steps (at times potenitally too many load steps) and cause too many unloading devices to actuate at once.

Option 2: Flow without Optimization

Description: Selects load steps based on a minimum flow rate change between load steps.
Pro(s): Skips unnecessary steps as needed based on a minimum flow rate change.
Con(s): May increase (decrease) flow rate while simultaneously decreasing (increasing) load.

Option 3: Flow based on following the Load Step Sequence

Description: Selects load steps based on following load step sequence until a positive and a negative flow rate are identified.
Pro(s): Faithfully follows load step sequence, and only skips steps as needed based on safety and increasing/decreasing flow rates.
Con(s): May select inefficient load steps, and/or cause unit load to jump up and down.

Option 11: Load with Optimization

Description: Selects most efficient load steps based on a minimum load change between load steps.
Pro(s): This is a very common way to control a reciprocating compressor.
Con(s): May skip load steps (at times potenitally too many load steps) and cause many unloading devices to actuate at once.

Option 12: Load without Optimization

Description: Selects load steps based on a minimum load change between load steps.
Pro(s): Skips unnecessary steps as needed based on a minimum load change.
Con(s): May increase (decrease) load while simultaneously decreasing (increasing) flow rate.

Option 13: Load based on following Load Step Sequence

Description: Selects load steps based on following load step sequence until a positive and a negative load change are identified.
Pro(s): Faithfully follows load step sequence, and only skips steps as needed based on safety and increasing/decreasing loads.
Con(s): May select inefficient load steps, and/or cause unit flow rates to jump up and down.

Option 21: Follow Load Step Sequence

Description: Simply selects NSU and NSD based strictly on the load step sequence, skipping steps only due to safety.
Pro(s): Ideal for units with well-defined, well-spaced, no curve-crossing of load steps, and very few safety issues limiting load steps.
Con(s): Can cause unit to jump up and down in load and/or flow if load steps and load step sequence are not well-defined (see above).

Option 31: Use when ALL unloading is via parallel Automated Variable Volume Clearance Pockets (VVCP)

Description: When safe, NSU and NSU will always differ by one (1) from the current load step.
Pro(s): NSU and NSD are always one load step away (when safe). Allows for easy control of units using aVVCP on all cylinders with unloading.
Con(s): Do NOT use this option unless unit unloading meets the specifications reqiuired for Option 31. *** Mode CANNOT be changed via PLC. ***

Option 41: Use when ONLY one (1) Automated VVCP is used with Fixed Clearance and End Deactivation Unloading Devices

Description: Tries to adjust aVVCP first. If either NSU or NSD not successful, then for that item leaves aVVCP as-is and selects complementing step.
Pro(s): Ideal option for handling multiple fast actuation devices (pockets and unloaders) with a slow actuating aVVCP.
Con(s): Do NOT use this option unless unit unloading meets the specifications reqiuired for Option 41. An aVVCP can lead to cases where unit's full load cannot be achieved (without unloading the aVVCP first). *** Mode CANNOT be changed via PLC. ***

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ADDENDUM II

Notes for Manual

Mode Operations

Most PLCs will provide a Manual Mode for controls. This mode is often critical when the unit is unhealthy, and needs locked in to a certain load step, when an analyst is collecting data and unit needs to hold load step and speed during tests, and when an operator needs to set the unit to a specific load step for review.

Nevertheless, even in Manual Mode, the eRCM Express should be consulted for unit safety. Operators should not be allowed to load/unload to any unsafe load steps. Also, if the current load step becomes unsafe, then the control panel must change to a safe load step (even in Manual Mode) or Shut Down.

If the Load Step Selection Mode is not the simple **Load via Load Step Sequence** method, then some safe load steps may potentially be skipped over. This is ideal for normal operations as inefficient or inappropriate load steps should normally be skipped over. However, this can be problematic if the operator's/analyst's goal is to set the unit on one of the load steps that is being skipped over.

Thus, when the unit is put in Manual Mode, it may be prudent to change the Load Step Selection from the current method to **Load via Load Step Sequence**. In this mode, eRCM Express will select NSU and NSD (**N**ext **S**tep **U**p, and **N**ext **S**tep **D**own) strictly by following the defined load step sequence, only skipping load steps if they are unsafe. Keep in mind, that in this mode, the NSU can actually lead to "lower load". However, this method will generally allow the operator/analyst to achieve the load step they desire.

Upon leaving Manual Mode, RESET the Load Step Selection Mode back to the original method of the unit – simply write a zero (0) to the Load Step Selection register. Otherwise, future data will not be appropriate for controls.

Overview:

- User opts to enter Manual Mode:
  - Write a "21" to LoadStepSelectionMode (Reg#40105) to tell eRCM Express that subsequent NSU and NSD values to be chosen via that method.
    - Method 21 is the generic **Follow Load Step Sequence** method, and as such, NSU/NSD will tend to follow the defined load step sequence in order, only skipping load steps due to safety issues.
    - This method is the one most likely to allow an operator/analyst to load to a particular load step and then stop it there for review/testing.
- User exits Manual Mode:
  - Write a "0" to LoadStepSelectionMode (Reg#40105) to tell eRCM Express to return to its original method for determining NSU and NSD values.

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ADDENDUM III

Allowing Load Steps

With Non-critical

Errors

If a reciprocating compressor has a lot of clearance pockets, then at medium to higher compression ratios, it is not uncommon for many of the lower-load load steps to be clipped due to Low Volumetric Efficiency issues.

Thus, trying to bring the unit online, or even performing a normal stop, can be troublesome as the power change on the engine or motor between safe load steps may be too large. eRCM Express will not select safe Next Steps Up/Down if they result in too large of a load change on the driver.

However, certain load steps, such as those determined to have Low Volumetric Efficiency (LowVE) issues and/or Predicted High Discharge Temperature (HiTd) issues, can be used as transitional load steps. That is, it is generally ok to transverse through these types of load steps, but the unit cannot run (cumulatively) in them for more than a few minutes.

- Some units have experienced serious cylinder damage due to running in LowVE after only about ten (10) minutes. Other units run in LowVE areas for hours and days without issues (other than cylinder getting hot, but not too hot). Thus, the amount of safe time needs to be determined by the end-user.
    - Generally, running in LowVE less than 2-3 minutes is not an issue.

Thus, for some end-users, they may need to set the **IgnoreNonCriticalErrors** register (Reg#40115) to a 1 during Normal Start Up and Normal Stopping. This allows the unit to load smoother, albeit it may select certain load steps that put the unit in LowVE or HighTd. However, if the total time for these events is short (0-3 minutes), then no real concerns are raised.

- After the end-user's specified time limit, if loading/unloading goals are not achieved, then **IgnoreNonCriticalErrors** register must be set back to 0. If no safe load steps are then determined, then Shut Down is the prudent action to take.

Alternative use of **IgnoreNonCriticalErrors**:

- If during normal operations, OptimalLS ≠ -1 and OptimalLS ≠ CurrLS, but NextStepUp = -1, then this means that there is an opportunity to load the unit up more, but the potential load change from CurrLS to OptimalLS is too large to take.
    - By electing to ignore some non-critical safety issues for a few minutes, the unit may be able to step though some transitional load steps to reach OptimalLS.

eRCM Express™

ADDENDUM IV

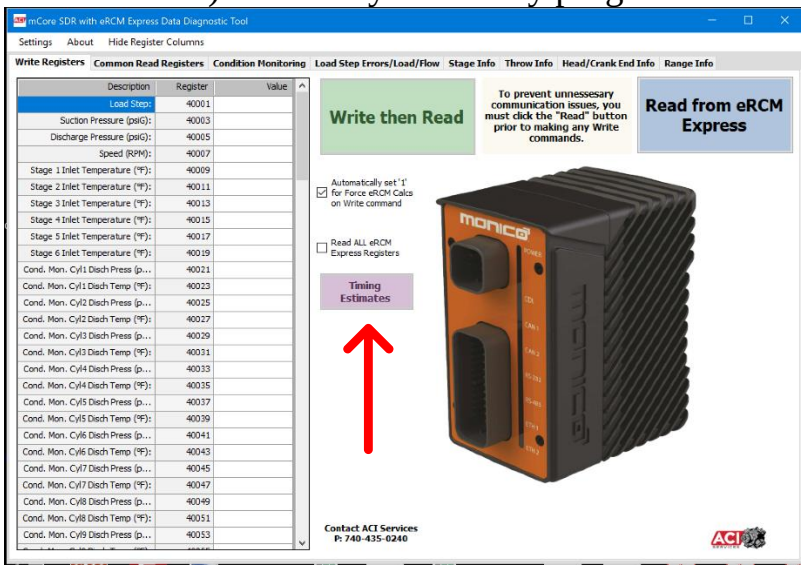
Determining

Calculation

Times

To make sure the PLC is waiting long enough to allow the eRCM Express to calculate all performance data, do the following:

1. Connect a PC to the eRCM Express.
2. Run the eRCM Express Diagnostic Software on the PC.
3. Select the correct type of eRCM Express.
4. Specify which modeling file to use.
5. Select the option to run performance timings.
    a. Specify option for data block sizes: Minimum, Normal, Everything
        i. Minimum: Typical if only using the Quick List for Writes and Reads
        ii. Normal: Typical if limiting data based on number of load steps, number of stages, number of throws, and number of cylinders.
        iii. Everything: Reads back **all** data registers. If using a gateway (ProSoft Card or Red Lion) then many users may program those to read back all data.



6. Wait until performance timings are complete.
    a. Average Time to Send Write Data to eRCM Express
    b. Average Time to Calculate Results within eRCM Express
    c. Average Time to Retrieve Read Data back from eRCM Express
7. In the PLC, after writing the data to eRCM Express, wait "*Average Time to Calculate Results*" plus 50 ms before reading data back from the eRCM Express.
    a. For most units, this will likely be around 100-150 ms.
    b. For more complex units, this may be in the 150-350 ms range.
8. If there are multiple models in the eRCM Express, then each one should be checked separately. The PLC code might then use a common wait time for all models (if they all have similar times), or set the wait time uniquely per model (if their times tend to differ a lot).

eRCM Express™

ADDENDUM V

mCore Operations

Manual

Tel 281•350•8751 Fax 888•418•5955
www.monicoinc.com

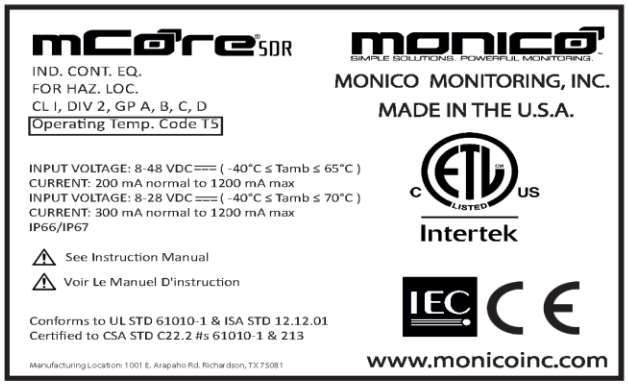
mCore® SECURE DATA ROUTER - ADVANCED PROTOCOL CONVERTER

Thank you for purchasing mCore® SDR (Secure Data Router). Your device comes preconfigured and ready to install.

Prior to use, thoroughly read the instructions in this manual to connect and use this product correctly. Please retain this manual for future reference and make sure that this manual is available to all users. To ensure the safety and proper operation of the device and any connected equipment, installation or relocation should be performed by qualified personnel only.

IND. CONT. EQ.
FOR HAZ. LOC.
CL I, DIV 2, GP A, B, C, D
Operating Temp. Code T5

Conforms to UL STD 61010-1 & ISA STD 12.12.01
Certified to CSA STD C22.2 #s 61010-1 & 213



SAFETY PRECAUTIONS

Thoroughly read and follow the safety precautions and operating instructions listed in this manual before using the product. After reading, retain this manual for future reference.

- Do not use or mount the product in any manner or location not intended.
- This manual should be available for anyone operating, repairing or relocating the product.
- The product should be installed, repaired or removed by qualified personnel only.
- Do not disassemble or modify the product. Improper installation or repair may cause injury, damage, electric shock or fire.
- To ensure proper operation and avoid damage to the product, use appropriate tools along with recommended connectors and recommended wire gauge.
- Do not open or break the seal between the housing and the connector header.
- Do not operate a unit that has been damaged.
- Extended environmental conditions: wet location, outdoor use, ambient temperature - 40°C and 70°C, and altitude up to 2000m.

WARNINGS

WARNING – EXPLOSION HAZARD. DO NOT CONNECT OR DISCONNECT WHEN ENERGIZED.
AVERTISSEMENT – RISQUE D'EXPLOSION. NE PAS BRANCER OU DÉBRANCHER LORSQUE LE CIRCUIT EST SOUS TENSION.
WARNING – EXPLOSION HAZARD. DO NOT DISCONNECT WHILE THE CIRCUIT IS LIVE OR UNLESS THE AREA IS FREE OF INGNITIBLE CONCENTRATIONS.
AVERTISSEMENT – RISQUE D'EXPLOSION. NE PAS DÉBRANCHER SI LE CIRCUIT EST SOUS TENSION, À MOINS QUE LE MILIEU SOIT LIBRE DE SUBSTANCES INFLAMMABLES CONCENTRÉES.
WARNING – EXPLOSION HAZARD. DO NOT REMOVE OR REPLACE BATTERIES OR PLUG-IN MODULES (AS APPLICABLE) UNLESS POWER HAS BEEN DISCONNECTED OR THE AREA IS FREE OF IGNITIBLE CONCENTRATIONS.
AVERTISSEMENT – RISQUE D'EXPLOSION. NE PAS RETIRER OU REMPLACER DES BATTERIES OU DES MODULES DE PLUG-IN (COMME APPLICABLES) À MOINS QUE LA PUISSANCE A ETE DÉCONNECTEE OU LA ZONE EST LIBRE DE CONCENTRATIONS IGNITIVE.
WARNING – DO NOT REMOVE THE AMPSEAL CONNECTORS UNLESS THE EQUIPMENT NEEDS TO UNDERGO REPAIR OR MAINTENANCE. AFTER REPAIR OR MAINTENANCE HAS BEEN DONE, PLEASE CHECK THE BARE PINS ON THE EQUIPMENT TO ENSURE THERE IS NO DUST OR WATER PRESENT. IP RATING OF THE EQUIPMENT IS ONLY MAINTAINED WITH THE AMPSEAL CONNECTORS ATTACHED TO THE EQUIPMENT.
AVERTISSEMENT - NE RETIREZ PAS LES CONNECTEURS AMPSEAL À MOINS QUE L'ÉQUIPEMENT NE SOIT RÉPARÉ OU ENTRETENU. UNE FOIS LA RÉPARATION OU L'ENTRETIEN EFFECTUÉE, VÉRIFIEZ LES BROCHES NUES SUR L'ÉQUIPEMENT POUR VOUS ASSURER QU'IL N'Y A PAS DE POUSSIÈRE OU D'EAU PRÉSENTE. LA CLASSIFICATION IP DE L'ÉQUIPEMENT EST UNIQUEMENT ENTRETENUE AVEC LES CONNECTEURS AMPSEAL ATTACHÉS À L'ÉQUIPEMENT.
WARNING – TO MAINTAIN CLASS 1, DIVISION 2 RATING, THE UNIT MUST BE INSTALLED IN A TOOL-SECURED ENCLOSURE USING ONE OF THE NEC WIRING METHODS THAT IS OUTLINED IN THIS MANUAL.
AVERTISSEMENT - POUR MAINTENIR L'INDICE DE CLASSE 1, DIVISION 2, L'UNITÉ DOIT ÊTRE INSTALLÉE DANS UN BOÎTIER SÉCURISÉ EN UTILISANT L'UNE DES MÉTHODES DE CÂBLAGE NEC DÉCRITES DANS CE MANUEL.

FOR CONFIGURATION AND OR INSTALLATION ASSISTANCE PLEASE CONTACT MONICO AT 281-350-8751 – OPTION 1

GETTING STARTED

mCore® SDR is designed for industrial applications requiring protocol translation between CDL (CAT® Data Link), S.A.E. J1939, Modbus RTU, and Modbus TCP. Each unit comes to you preconfigured and ready to install.

The mCore® SDR is easy to mount, with two mounting options, and environmentally sealed to protect against dust ingress and temporary immersion in up to 1 meter of water (IP66 & IP67). It was designed specifically for industrial mobile, mining, marine, and off-road applications. The device displays LED indicating lights configured to provide positive confirmation of power, connectivity, and data transmit/data receive.

Figure 1
Weight: 2.0 lbs. (.907 Kg)

CONNECTING MCORE

The unit should be connected to the desired ports according to the pinout below using the recommended connectors shown in Table 1 on the last page of this manual.

The pin numbers are labeled on each AMPSEAL key connector to ensure proper connection.

Pin 1 Blank	Pin 2 Blank	Pin 3 Blank
Pin 4 Reset (+)	Pin 5 Reset (-)	
Pin 6 Key Switch	Pin 7 Battery (-)	Pin 8 Battery (+)

Pinout for Key Connector A

** Please carefully review the Input Power Requirements on the next page. **

Pin 1 RS485 (-)	Pin 2 RS485 (+)	Pin 3 CDL (+)	Pin 4 J1939 #2 Term	Pin 5 J1939 #2 Term	Pin 6 J1939 #1 Term	Pin 7 J1939 #1 Term	Pin 8 J1939 #1 Comm	Pin 9 Ethernet 1 Rx (+)	Pin 10 Ethernet 1 Rx (-)	Pin 11 Ethernet 2 Rx (-)	Pin 12 Ethernet 2 Rx (+)
Pin 13 RS232 Comm	Pin 14 RS485 Comm	Pin 15 CDL (-)	Pin 16 J1939 #2 High	Pin 17 J1939 #2 Low	Pin 18 J1939 #1 High	Pin 19 J1939 #1 Low	Pin 20 Ethernet 1 Tx (+)	Pin 21 Ethernet 1 Tx (-)	Pin 22 Ethernet 2 Tx (-)	Pin 23 Ethernet 2 Tx (+)	
Pin 24 RS232 Tx	Pin 25 RS232 Rx	Pin 26 CDL Comm	Pin 27 J1939 #2 Comm	Pin 28 Blank	Pin 29 Blank	Pin 30 Blank	Pin 31 Blank	Pin 32 Blank	Pin 33 Blank	Pin 34 Blank	Pin 35 Blank

Pinout for Key Connector B

Pinout is depicting the female header connectors and respective key orientations on your mCore® SDR that will mate to the male connectors shown in Table 1. Be sure to follow the AMPSEAL "How-to Instructions" located at:

laddinc.com > resources > how-to-instructions > ampseal-connectors

laddinc.com > resources > how-to-instructions > ampseal-16-contact-crimping

These instructions include steps for proper inserting, crimping, and removing of wires into the pin connectors. For proper hand crimping, an AMPSEAL 2119118-1 hand crimping tool (not included) must be used.

mCore® SDR is approved for Class I Div 2 Group A, B, C and D. In order to maintain this rating the unit must be installed in a separate tool secured enclosure and comply with the one of the following NEC wiring methods:

1. Extra-hard usage cord – Section 501.140 of the NEC and Rule J18-160 of the CE Code Part I;

2. Instrumentation tray cable (Type ITC or CIC) – Section 501.10(B) and 501.105(B)(6) of the NEC and Rule J18-152 of the CE Code Part I;

3. Power-limited tray cable (Type PLTC) – Article 725 of the NEC; and

4. Tray cable (Type TC) installed per Article 336 of the NEC and Rule 12-2202 of the CE Code Part I.

FOR CONFIGURATION AND OR INSTALLATION ASSISTANCE PLEASE CONTACT MONICO AT 281-350-8751 – OPTION 1

INPUT POWER REQUIREMENTS

mCore® SDR power is supplied through Pins 7 and 8 on Key Connector A (see Table 1). Pins 7 and 8 can be located on the Pinout Guide under "Connecting mCore". The input voltage requirements are 8–48 VDC for operating temperatures between -40°C and +65°C. The input voltage requirements are limited to 8–28 VDC for operating temperatures between -40°C and +70°C. mCore® SDR has internal reverse polarity protection, but will not operate under reverse polarity conditions.

In addition to the battery positive and battery negative leads, there is a key switch wire that must be wired into the positive terminal of the power source or wired to a switch connected to the positive terminal of the power source.
mCore® SDR will not boot if key switch is not powered.

MOUNTING mCORE®

Surface-Mount: The unit should be mounted securely against a flat surface, using two ¼" fasteners (not provided), to a suitable location as close to the engine as possible. DO NOT mount directly to the engine block. The unit should be mounted, as shown in Figure 1 on page 2, either horizontally or vertically. Horizontal is the optimal mounting orientation considering LED visibility and heat dissipation. However, other mounting orientations are acceptable.

DIN Rail Mount: The mCore® SDR unit should be mounted vertically on a horizontal DIN rail. Tilt the unit to a 45-degree angle and insert the top lip of the DIN rail bracket onto the DIN rail. Then attach the bottom lip to the DIN rail to snap the unit into place (illustrated in Figure 2). A minimum of 1" of space should be maintained on all sides of the unit to ensure proper heat regulation.

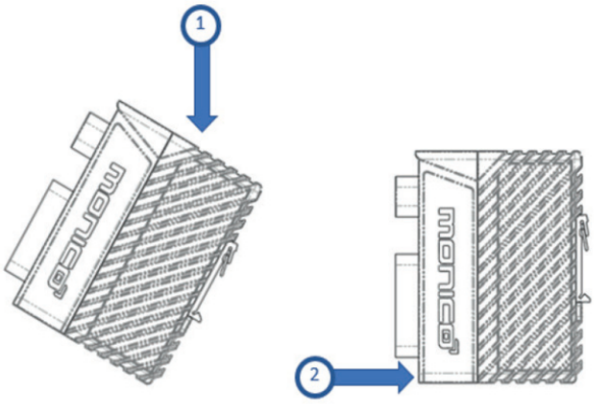


Figure 2

To remove the unit from the DIN rail, push down on the unit until the bottom lip is clear from the rail. Then pull out from the bottom. The unit should remove with ease.

GROUNDING mCORE®

After mounting and connecting mCore® SDR, the unit must be grounded in compliance with local and national electrical codes. It must be externally grounded using a customer-supplied ground wire before any power is applied. Contact the appropriate electrical inspection authority if you are uncertain that suitable grounding is available.

TOOLS REQUIRED:

QTY: 1	Grounding Lug (included)
QTY: 1	6-Gauge Ground Wire (not included)
QTY: 1	Nut Driver (not included)
QTY: 1	Pliers or Crimping Tool (not included)

PROCEDURE:

Step 1: Use the Pliers or Crimping Tool to crimp the 6-Gauge Ground Wire to the Grounding Lug.
Step 2: Connect the Grounding Wire to the mCore™ SDR Grounding Lug connection point, shown below in Figure 3.
Step 3: Place the Grounding Wire over the Grounding Lug and tighten these components using a nut driver. Tighten to 9.6 in-lbs.
Step 4: Connect the other end of the wire to a reliable earth ground if possible. For most effective grounding, use the grounding standards listed below.

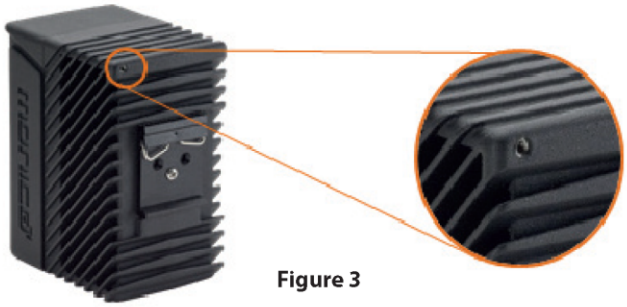


Figure 3

* Safety guidelines for proper grounding are outlined in OSHA Standard 1926.962.
* National standards for proper grounding are outlined in IEEE Standard 142.

POWER DISCONNECT

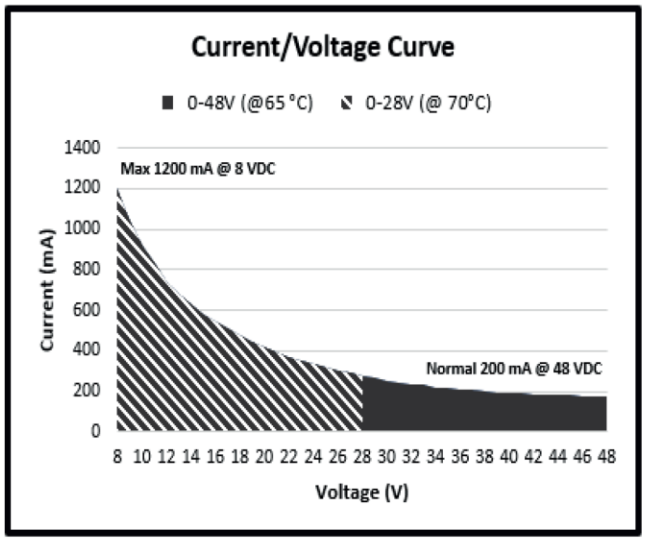
To disconnect power to mCore® SDR lift the locking ear on the side of Key Connector A using a flat blade screwdriver and pull gently. The locking ear is shown below in Figure 4.

Failure to protect mCore® SDR or use in any manner not specified may result in damage.

Figure 4

FOR CONFIGURATION AND OR INSTALLATION ASSISTANCE PLEASE CONTACT MONICO AT 281-350-8751 – OPTION 1

CURRENT/VOLTAGE REQUIREMENTS



** User is required to install a 2 Amp fast blow fuse rated for at least 50VDC (or the maximum voltage of the supplied power) to protect against short circuit. **

Table 1

mCore Mating Connector Options (*AMPSEAL*)

Item	Description	AMPSEAL Part Number
	Plug, Key Connector A	776286-1
	Plug, Key Connector B	776164-1
	Sealing Plug	770678-1
	Backshell	776463-1 and 776464-1
	Connector	770854-1

* Connectors are AMPSEAL available through LADD Industries

mCORE® LED INDICATOR GUIDE

	Solid Green	Blinking Green	Blinking Amber	Solid Red	Blinking Red	No LED
Ethernet 1	Connected	Passing Traffic, 100MB	Passing Traffic, 10MB	Not Connected		Not Configured
Ethernet 2	Connected	Passing Traffic, 100MB	Passing Traffic, 10MB	Not Connected		Not Configured
CDL		Receiving Packets as Expected	100% Passive Data	Bad Data/Reverse Polarity	No Traffic	
CAN 1	Good Connection	Valid Data		Bad Connection or No Data		Not Configured
CAN 2	Good Connection	Valid Data		Bad Connection or No Data		Not Configured
RS485	Good Connection	Valid Data		Bad Connection or No Data		
RS232	Good Connection	Valid Data		Bad Connection or No Data		
Power	Power Good; Setup Files Present	Power Good; No Setup Files			Controlled Shutdown State	

FOR CONFIGURATION AND OR INSTALLATION ASSISTANCE PLEASE CONTACT MONICO AT 281-350-8751 – OPTION 1