

E3 Controller CO₂ (R-744) Suction Group Rack Control

Overview

The CO₂ Suction Group application is a new rack control application specifically for CO₂ (R-744). The CO₂ Suction Group application performs special control functions and alarm monitoring that is required for transcritical CO₂ booster refrigeration systems, such as load management, enhanced compressor superheat management (for example, liquid and/or hot gas injection), oil management control, and parallel/intermediate stage compression and coordination with flash tank bypass gas.

The CO₂ Suction Group application is based on the Enhanced Suction Group application and includes all the new CO₂ system functionality. There will be a CO₂ Suction Group application instance for each rack in a booster system thus the medium temperature (MT) and low temperature (LT) applications must be associated together. Much of the CO₂ specific logic, for example Load Management, is controlled from the application instance that is controlling the Medium Temperature rack. The MT keeps track of specific alarms from the LT for load management. The Rack use role will be automatically set by Association of the two applications. The MT and LT can also be coordinated such that the MT will turn ON if the LT needs to be ON.



CO₂ Related Control Points

- CO₂ Suction Group - Controls an MT, LT, or intermediate (IT) suction group
- Load Management
- CO₂ System Related Alarms
- Liquid Injection
- Hot Gas Injection
- Oil Dump Interval
- IT-Parallel Compression Enable

Functionality

Load Management

The Load Management algorithm manages how refrigeration loads are enabled/disabled depending on the status of system pressures and compressors. It will disable all loads in the case of power loss or system shutdown (Rack Fail) and will stage loads back on as the system restarts. It will also disable certain loads in the case of certain user defined alarm thresholds.

Loads are divided into groups so that they may be enabled into the system in a sequence from most critical to least critical. The Load Enable outputs serve to enable each circuit group ON in sequence at startup, alternating between MT loads and LT loads. Each output has a programmable delay time from the previous group to space out the circuit loads being introduced. The system designer will determine how to divide up the specific circuits, how many groups will be needed, and which circuits/cases will be part of each group.

All Load Management functions are configured from the MT CO₂ Suction Group application. Load Management looks at the alarms in the MT and LT racks to decide if loads need be disabled to control the amount of load that is presented to the system. Each threshold specified is associated with an advisory, which when signaled, can be set to disable any load group. Disabled loads, who's alarms have returned to normal, are cycled back ON one at a time, in the same order as startup, from most to least critical, observing the same delay time assigned to the output.

Load Enables Tab

The user sets the number of MT/LT groups and connects the outputs to the required Circuits Enable inputs. The enable outputs are numbered from 1 to 8 with the highest priority circuits being connected to the lowest numbered outputs.

POINT NAME	VALUE	POINTER
Load Management State	Startup	
Next Load Enable	00:00:44	
Num Load Enables	3	
MT Load Enable 1	ENABLED	Multiple
LT Load Enable 1	ENABLED	15_16 RI ICRN → LOAD ENABLE
MT Load Enable 2	ENABLED	Multiple
LT Load Enable 2	DISABLED	Multiple
MT Load Enable 3	DISABLED	02 WALK-IN CLR → LOAD ENABLE
LT Load Enable 3	DISABLED	01 WALK-IN FRZR → LOAD ENABLE
Enable Discharge Sensing	DISABLED	

Figure 1 - Load Enables Tab

The **Load Management State** output will indicate the current state. In Startup or Restart, the **Next Load Enable** output will count down for the load groups programmed enable delay – this indicates when the next load will be enabled. Once all loads are enabled, this output will be hidden.

Each load enable output can be set to disable on any of the CO₂ alarms. All loads are disabled in the event of Rack Fail of the MT rack. If only the LT Rack fails, only the LT loads will be disabled.

POINT NAME	VALUE	POINTER
LT Load Enable 1	ENABLED	
TARGET	15_16 RI ICRN	PROPERTY: LOAD ENABLE
In Override	OFF	
Enabled	OFF	
LT Delay Load Enable 1	00:02:15	
LT Load Enable 1 Alarms	MT-Hi Suction Pressure 2 MT-Hi Discharge Pressure 2 Hi Flash Tank Pressure 1 LT-Hi Suction Pressure 2 LT-Low Superheat 2	

Figure 2 - LT Load

Enable Discharge Sensing

This control setpoint parameter is a feature that does not generate an alarm as do the other parameters under this tab, but instead provides the ability for users to turn OFF a load to reduce the pressure of the system if the threshold has been exceeded.

Load Enable Alarms

Because CO₂ is dynamic, the CO₂ Alarms also serve to control the system pressure by disabling cases. An active CO₂ Alarm will result in loads being disabled and the advisory serves as notification. Thus, the CO₂ Alarms also serve as setpoints that regulate as well as provide safety checks for the system.

The user can select specific CO₂ Alarms for each Load Enable output on this tab. If the load on the system results in exceeding a CO₂ Alarm setpoint that triggers the alarm, not only will the alarm be reported but loads can be disabled. Set each Load Enable for the appropriate CO₂ Alarms in the list so that the MT can control the loads.

The alarm parameters on the CO₂ Alarms tab are used as part of the control setpoints to help the system react faster when the pressure is increasing faster than the compressors can manage. The ability to turn off loads is important if the flash tank pressure becomes too high or out of range.

Liquid/Hot Gas Injection

If the MT rack superheat needs to be reduced or increased with liquid or hot gas injection, respectively, there are two outputs used to actuate valves for liquid and hot gas injection. Each can be controlled by their own delta temp setpoint.

Oil Separator Dump Valve

This function creates a pulse for the oil separator valve. The pulse width and interval are user configurable. By default, it is set to a 5-second pulse every 3 minutes. The timing is active only when any rack stage is ON and suspended when all stages are OFF. The timing resumes when any stage is cycled back ON. This function is available for all CO₂ Suction Group Instances.

CO₂ Alarms/Alarms tabs

In addition to the standard suction group alarms a set of CO₂ specific alarms are provided. All the advisories are configured in both the MT and LT application instances.

Auto Setpoints for LT

On association of two CO₂ Suction Group applications, each application will be auto assigned to its rack use role (MT or LT). The **Rack Use** parameter will indicate "Medium Temperature" or "Low Temperature". The MT application will already be set to the default setpoints for a Medium Temp rack. The application that is assigned to be the LT will have its setpoints updated to the required values for a Low Temp rack. The setpoints that are changed will be reverted to their original defaults should the application be disassociated from the MT instance.


Parallel Operation

The IT CO₂ Suction Group application can be used for Intermediate Temperature control (parallel compression). In this role, the CO₂ Suction Group works with the iPro HPV/BGV controller to provide parallel compression as needed.

Setting up the CO₂ Suction Group in the Supervisory Controller for Transcritical Booster Systems

Step 1 - Add the CO₂ Suction Group application to the controller.

Note! The CO₂ Suction Group application is a licensed feature and will require that license key be added for each controller.

From the Control Inventory page  under **Refrigeration**, go to the **Control** drop-down menu and choose **CO₂ Suction Group** to add. *Note that renaming each application from the default names once added in the system is beneficial for determining which application is the MT rack and which is the LT rack. For example, "CO₂MT" and CO₂LT.*

Two CO₂ applications must be set up - one for Medium Temp (MT) and the other for Low Temp (LT). Each application represents one rack. The LT is dependent on the MT. *Reminder: Load Management functionality is targeted for the MT role.*

Step 2 - Associate the CO₂ Suction Group applications

Associations are done from the perspective of the MT application.

Once the applications have been added, they must be associated with each other.

Click the wrench icon  to open the **Association** window without leaving the **Control Inventory** screen.



Figure 3 - CO₂ Suction Group

Once you have associated the MT and LT applications, click **OK** and **Save**. The **Association** column will show the associations.

Navigate to the MT application page and check under the **Association** tab. The Low Temp-CO₂ Group should be set to the LT CO₂ Group instance.



Figure 4 - Low Temp CO₂

Note that you can quickly switch between the MT and LT applications by clicking the snowflake icon:

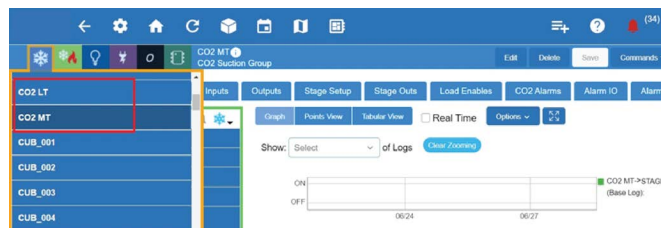


Figure 5 - CO₂LT and CO₂MT

General Tab

1. Check that the CO₂ Suction Group instances are set to Low Temperature and Medium Temperature as appropriate.
2. Change any default parameters to values that are needed for proper operation. This can also be changed later.

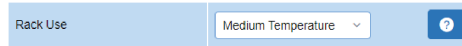


Figure 6 - Rack Use

The **Rack Use** parameter: This parameter is set automatically by the Associations Code when associating the MT and LT together. The **Rack Use** property needs to be set to IT (parallel compressor) manually if the CO₂ Group is to be used for parallel compression.

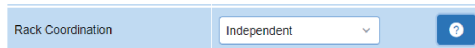


Figure 7 - Rack Coordination

The **Rack Coordination** parameter: This controls how the LT and MT run. If set to Coordinated, the LT will turn ON stages only if the MT has at least one stage ON. If MT rack is OFF, the LT requests the MT to turn ON a stage. Once the LT sees that the MT is running, the LT will begin to cycle ON its stages. The MT will also not completely shut down if the LT is running. If set to Independent, the two racks will run as needed. This parameter defaults to Independent and can only be set from the LT application instance. When set, the MT's parameter will be automatically updated to match.

Load Enables Tab

Set the number of load groups required. Then connect the individual load enable outputs to the circuits/cases for each group. Each group has certain alarm conditions that will force it to be disabled. The load outputs will be cycled ON one at a time, each after its enable delay has expired. Expand each output group and check/set as required.

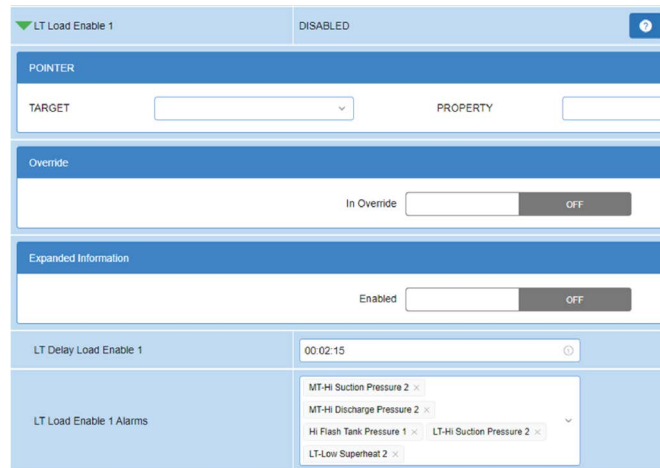


Figure 8 - LT Enables Tab

Part Numbers for Ordering

Part Number	Description
860-1306	E3 Controller, RX-CO ₂
860-1311	E3 Controller, RXe-CO ₂
860-1326	E3 Controller, CX-CO ₂
860-1331	E3 Controller, CXe-CO ₂
860-1226	Site Supervisor, RXe-CO ₂
860-1266	Site Supervisor, CXe-CO ₂

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