



TECHNICAL REFERENCE
FOR
CAREL DCM CONTROLLERS

DIGITAL COMPRESSOR MODULE

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Retain instructions with unit and maintain in a legible condition.
Please give model number and serial number when contacting
factory for information and/or parts.

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YOU HAVE RESPONSIBILITIES TOO

This installation, operation and maintenance manual cannot cover every possibility, situation or eventuality. Regular service, cleaning and maintaining the equipment is necessary. If you are not capable of performing these tasks, hire a qualified service specialist. Failure to perform these duties can cause property damage and/or harm to the building occupants and will void the manufacturers' warranty. This technical manual is intended to be used as an operating guide, and shall be used with the Installation, Operation and Maintenance Manual(s) supplied with the equipment.

SAFETY PRECAUTIONS

Read, understand and follow the complete manual before beginning the installation, including all safety precautions and warnings.

Warning:

Improper installation, adjustment, alteration, service or maintenance can cause property damage, injury or death. Read the installation, operating and maintenance instructions thoroughly before installing or servicing this equipment.

Warning:

This unit is connected to high voltages. Electrical shock or death could occur if instructions are not followed. This equipment contains moving parts that can start unexpectedly. Injury or death could occur if instructions are not followed. All work should be performed by a qualified technician. Always disconnect and lock out power before servicing. DO NOT bypass any interlock or safety switches under any circumstances.

INTRODUCTION

The Digital Control Module DCM is a packaged controller that enables and modulates a single digital scroll compressor with an optional 2nd stage constant capacity compressor. The control package includes Carel pCO5 Digital Control Module (DCM) and a Carel Electronic expansion Valve Driver (EVD). The DCM modulates the capacity of the digital scroll compressor while monitoring various safeties. The EVD controls the electronic expansion valve to meter refrigerant to the evaporator at various loading conditions. The DCM and EVD controllers communicate directly through a pLAN communication protocol.

CONTROLLER SPECIFICATIONS

The controller requires 24 VAC.

The controller may be installed in a control enclosure with operating ranges from -20°F to 150°F with non-condensing humidity levels. The control enclosure must be heated in colder than -20°F environments.

COMMON TERMINOLOGY

Digital Control Module (DCM): Name of digital scroll compressor program.

Electronic Expansion Valve (EEV): A stepper motor valve that controls the flow of refrigerant to the evaporator coil.

Expansion Valve Driver (EVD): Carel controller that modulates the EEV to maintain the required superheat.

PCO controller: Carel controller that controls the compressor and processes data from the EVD controller.

pLAN network: Carel proprietary communication protocol. Carel PCO and EVD boards communicate with each other via pLAN.

pGD user interface: Graphical display on the PCO controller that lets user scroll through information menus and change variables.

Mask: A graphical interface on the Carel display (PGD) that allows the user to select and change parameters. Masks are display pages and are arranged in sections called loops. There are several loops of masks that may be accessed. The up/down buttons are used to maneuver through different masks in a loop.

Loop: Menu structure that allows user to scroll through masks.

Inputs/Outputs (I/O): Pins on the controller where analog and digital I/Os are connected and allow controller to process data and control devices.

Duty cycle: Cyclic operation of a device or machine that operates intermittently rather than continuously.

Solid State Relay (SSR): An electronic (non-mechanical) switching device that switches on/off when a voltage is applied across its control terminals.

Compression ratio: ratio of the absolute discharge pressure to absolute suction pressure.

Superheat: Number of degrees a vapor is above its saturation temperature at a particular pressure.

UNDERSTANDING DIGITAL SCROLLS

A Digital scroll compressor is a variable capacity scroll compressor that consists of fixed and orbiting scrolls. When the solenoid valve is de-energized (closed), pressure around the piston is discharged and spring force ensures that the scrolls are loaded. When the solenoid valve is energized (open), discharge gas in the modulation chamber is relieved to low pressure and compressor is unloaded.

The DCM program uses a 12 second duty cycle. This indicates that there is an on/off cycle every 12 seconds. If the compressor is 100% loaded the ON cycle is 12 seconds, and the OFF cycle is 0 seconds (compressor always on). If the compressor is 50% loaded, the ON cycle would be 6 seconds and the OFF cycle would be 6 seconds. The loading and unloading of the compressor is managed by a small solenoid valve. Larger compressors have an internal solenoid valve and smaller compressors have an external solenoid valve. The solenoid valve is specifically designed for the extreme number of on/off cycles. The first relay output (refer to internal wiring diagram) of the controller must be a Solid State Relay (SSR) to tolerate the high number of cycles. The SSR on the DCM control is pilot duty, and is used to drive a larger current rated external SSR.

Electronic Expansion Valve (EEV)

The electronic expansion valve package includes an EVD stepper motor driver, pressure transducer(s), suction temperature sensor(s) and an EEV. The EVD controller modulates the expansion valve to control superheat. EVD controllers can be Single or Twin. Single EVDs are used for a single digital scroll system, and Twin used for two staged systems when the second stage requires an EEV.

OPERATING CHARACTERISTICS

Unloading Noise

When the solenoid is energized and the scroll sets are allowed to separate, there may be a loud hiss as the discharge gas rushes into the low pressure regions of the scroll. Depending on compression ratio this can be a very noisy mechanical separation. The scroll is still orbiting but does not seal so it cannot compress refrigerant.

Loading Noise

When the solenoid is deactivated and the scroll sets are allowed to reseal, there can be an initial mechanical noise in addition to a hissing noise as the compressor starts to compress refrigerant again. Depending on the compressor model and operating pressure, the overall noise ranges from a simple “snick” to very loud hissing and mechanical clanks when the compressor loads and unloads. Unusual noise is typically a function of the compressor design and does not necessarily indicate mechanical failure.

Pressure

The system pressures will fluctuate as the compressor loads and unloads. The amount of pressure fluctuation will vary depending on the refrigerant type, system load and duration of the compressor cycles. There must be sufficient head pressure for the compressor to operate; low head pressure can be detrimental to compressor life.

Superheat

The fluctuation of pressure makes the measurement of superheat extremely difficult. The EVD controller uses algorithms to filter pressure readings allowing the valves to react to average superheat and not instantaneous superheat. Superheat readings on the DCM information masks will fluctuate as a function of compressor loading. After large load changes the superheat may take several minutes to stabilize.

Charging

Digital scroll compressors must be charged when operating at 100% capacity. Charge until the liquid line sight glass is clear. Refrigerant is added slowly using standard charging procedures by qualified personnel. When the compressor is operating with some degree of unloading, it is not unusual to see bubbles in the liquid line sight glass.

NOTE: The sight glass cannot be used to check refrigerant charge unless the compressor is operating at full load with stabilized operation.

Oil Return

Oil only travels through the system when the compressor is loaded. The oil level should be maintained at mid-point of the sight glass. Standard oil return guidelines should be followed for all refrigerant piping.

The digital scroll program incorporates additional oil return control by increasing the digital scroll compressor capacity to a threshold capacity (min. 50%) for a short period of time if it has been running below the threshold capacity for an extended amount of time. This feature is factory enabled by default.

Suction Accumulator

Suction accumulators are required on all digital scroll compressor circuits. When the compressor unloads, oil and liquid refrigerant may collect in traps and low areas of the tubing. When the compressor loads, this can come back as a slug of liquid. A suction accumulator helps protect the compressor.

Power

The required compressor power is a function of the mass flow of refrigerant. When the compressor unloads and loads, the compressor amperage also fluctuates.

Power Factor

During loaded state, the digital scroll compressor operates at full capacity and the power factor is the same as a standard scroll. However, when the scrolls are unloaded, the power factor is much lower.

Accessories and Controls

Because of the extreme number of pressure cycles produced during operation, care must be taken in selecting refrigeration accessories used in the circuit. Accessories that **SHOULD NOT** be used with Digital scroll circuits include:

- Standard fan cycling pressure switches
- Bellows style pressure controls
- Standard TX and hot gas bypass valves
- Pilot operated liquid solenoid valve

COMMUNICATION SETUP

All programming parameters for both the pCO and EVD controller can be accessed and set through the pCO built in display. A separate display for the EVD is not required. The pCO controller communicates with the EVD controller through pLAN communication protocol and wiring. The communication wire must use shielded wire with the shield connection grounded at one end only (typically control panel end).

- The pCO controller address is 1.
- The EVD network address is 30.

If the two controllers use different power supplies, they must use isolated transformers. The EVD controller **MUST** be grounded at the flag pin. Refer to equipment specific wiring diagram.

CONTROLLER BASICS

The digital scroll controller features a multiline display, providing real time information about the operation of the system and allowing settings to be configured. The display is navigated using the six buttons located on the face plate:

- Alarm
- Program (PRG)
- Escape (ESC)
- Up
- Enter
- Down

These buttons are used to move through the different screens (masks) and loops to access information and setup parameters for the controller.

Masks

The DCM display masks are organized into loops. The **PRG** button will display a menu showing other available loops. The loops are highlighted using the **Up/Down** buttons, and accessed with the **Enter** button. Pressing **ESC** will move back one menu page. The following summarizes the available loops.

Main Status Loop

The main status loop Provides information about the specific system such as set point, temperature, compressor status, TX valve operation, etc. From the main status loop if the PRG button is used the following loops are available:

A On-Off

This mask allows the user to configure what turns the unit on and off. There is also status on what is controlling the machine at the moment.

B Setpoint

This mask allows the adjustment of any user defined set points (if enabled).

C Clock/Scheduler

This mask is used to set the current time and date for the controller. If enabled in manufacturing, preprogrammed schedules can be set for the system; however scheduler function is disabled in the DCM program.

D Input/Output

This Mask allows the user to see the status of all of the I/O points for the controller.

G Service

The service menu is protected by a passcode. The service passcode (7263) is provided to allow qualified personnel to change some operating set points and control parameters. System information available includes operating hours, program information, operating set points, superheat settings,

sensor calibration. Settings in this loop should only be changed by qualified service personnel as incorrect settings may cause system damage or malfunction.

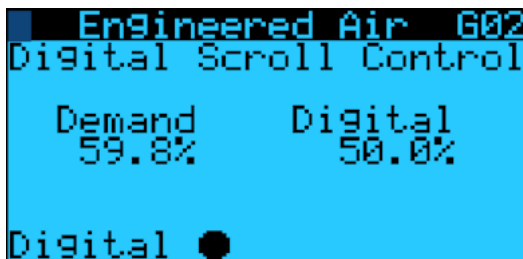
H Manufacturer Menu

This section is protected by a password. This section is used to configure the controller to set up component specifics to the particular equipment in the system. Electronic expansion valves (EEVs), safety set points, and all the other parameters relating to the safe operation of the system will be set here. Once the controller is configured to the system, the manufacturing data is saved as a manufacturing default so the controller can be returned to these values if required. The data in this loop is not intended to be adjusted or changed outside of the factory environment. Any user adjustable set points and configurable variables are available in the service menu.

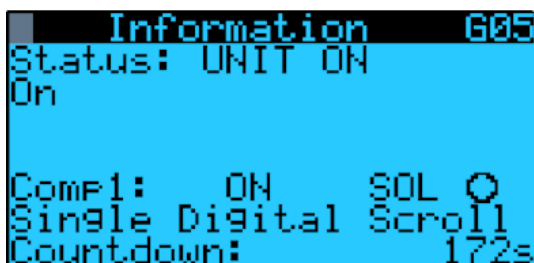
DCM DISPLAY

Main Status Masks

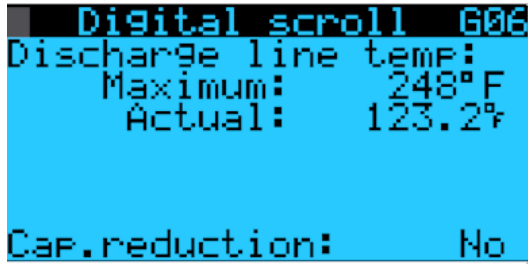
The Main Status masks are accessible using the UP and DOWN arrow buttons. The status masks are designed to display information. There are no user adjustable parameters on these masks. They are designed to give real time information about the system allowing service personnel to troubleshoot any problems. Masks can be identified by a unique reference number location on the top right of every mask. Make a note of the mask reference number in question when speaking with a service representative.



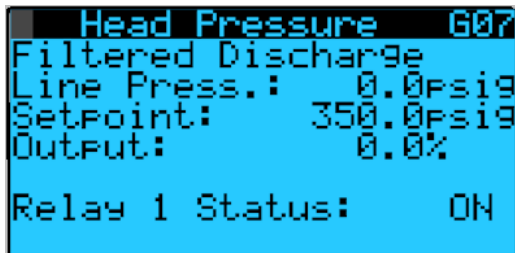
The main display indicates requested demand, and Digital output capacity. If a second compressor is enabled, the display will show when it is running.



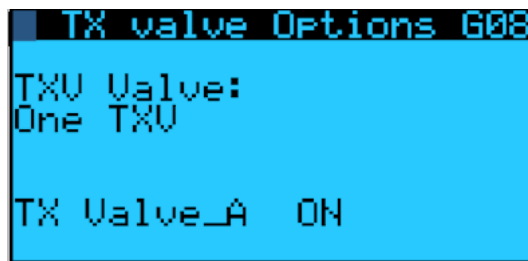
Information about unit status, interstage timing, antishort cycle timing and minimum run times are indicated on this mask.



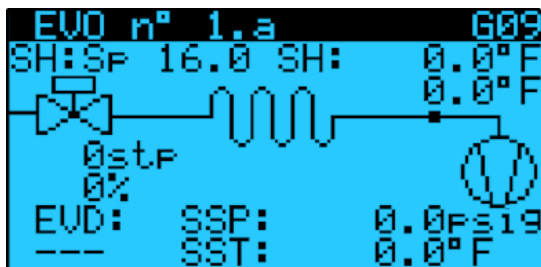
The discharge line temperature is displayed. If capacity reduction is shown to be on (yes), the controller will reduce capacity to prevent compressor overheating.



This mask is visible if head pressure control is enabled. Filtered discharge pressure, pressure set point, analog output capacity, and relay status are shown.



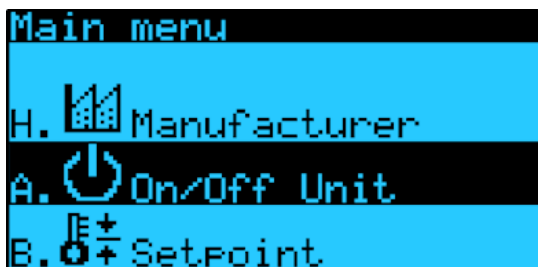
EEV status is displayed. When a Twin EVD is used, information for both valves is displayed.



Operation status of the EVD controller is displayed. Superheat, suction pressure/temperature and valve information is provided. When a Twin EVD is used, information for both valves is displayed.

Main Menu

To access the main menu from the main status masks press the PRG button once. To return to the main status masks from anywhere in the menu structure press the ESC button until main status masks appear.

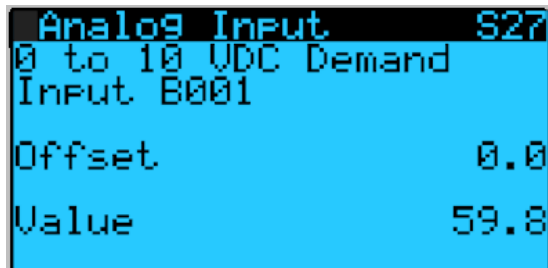
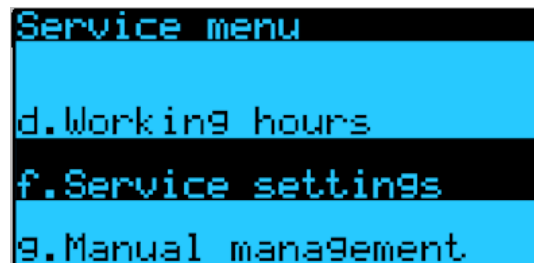


Main Menu shows Available Loops

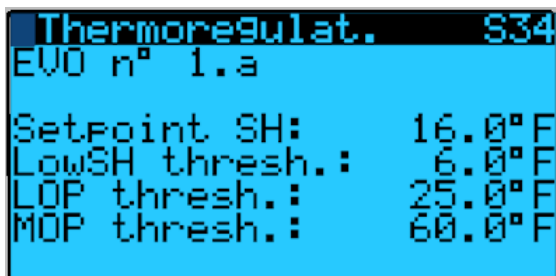
- A On/off Unit
- B Set point
- C Clock Scheduler
- D Input output
- G Service
- H Manufacturer

Service Menu

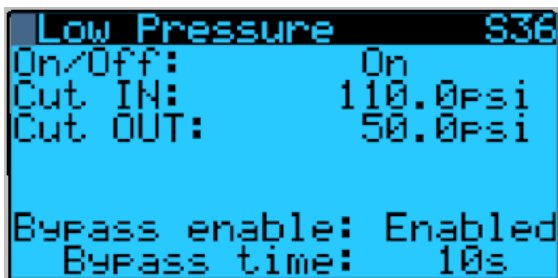
The service menu contains all the important information and adjustable setting for the DCM controller. The “Service settings” in Service Menu is protected by password (7263) and should only be accessed by qualified personnel.



Analog inputs can be calibrated with offset values when a sensor error is found.



Superheat and other adjustable EVD setpoints are available. Superheat control is critical to the operating life of a digital compressor. Only qualified personnel should adjust these settings.



Low pressure control cut in and cut out set points are adjustable. The bypass timer mitigates nuisance trips caused by normal pressure fluctuations with digital systems. Low pressure allows three trips in a one hour period before requiring a manual reset.

```

High Pressure S37
Option: Off
Cut out: 600.0Psi
Cut in: 400.0Psi
    
```

High pressure control cut in and cut out set points are adjustable. This pressure control can be set as manual reset, auto reset, or three auto trips over a selecteble time.

```

Head Pressure S38
Option: Analog+Relay
Setpoint: 350.0Psi

Pressure: -81.2Psi
Filter: 0.0Psi
Output: 0.0%
    
```

There are several head pressure control options available. The specific option can only be changed from the manufacturing menu with individual settings able to be adjusted from the service menu. There are 6 different head pressure options which have different standard settings.

```

Head Pressure S39
Relay 1 cut in: 400.0
Relay 1 cut out: 300.0
Relay 2 cut in: 450.0
Relay 2 cut out: 350.0
Values above in PSI
Relay 1 Status: OFF
Relay 2 Status: OFF
    
```

1. **Water Valve:** Relay 1 is use to enable water valve when compressor is enabled
2. **Relay 1:** Relay acts as CFC w/ cut in & cut out settings
3. **Relay 1 +2:** Relays act as CFCs w/ cut in & cut out settings
4. **VFD:** Relay 1 always on
5. **VFD w/ Relay 1:** Relay 1 used as VFD start/stop contact.
6. **VFD w/ Relay 1 + 2:** Relay 1 used as VFD start/stop contact. Relay 2 acts as CFC w/ cut in & cut out settings

```

HP Device S40
Time to open to full: 95s
Start Position: 50.0%
Minimum Output: 10.0%
Maximum Output: 100.0%
Deadband: 10.0Psi
    
```

Water Valve and VFD options use a 0-10 Vdc analog signal. The start position, minimum and maximum output and deadband are adjustable.

```

Oil Management S42
On/off: On
Check Interval: 4Hr
Cycle Duration: 5Min
Threshold: 50.0%
    
```

Oil control parameters can be modified. The oil return cycle will occur at every check interval. The compressor capacity will rise to the threshold capacity if the capacity is found to be below this capacity

User Save

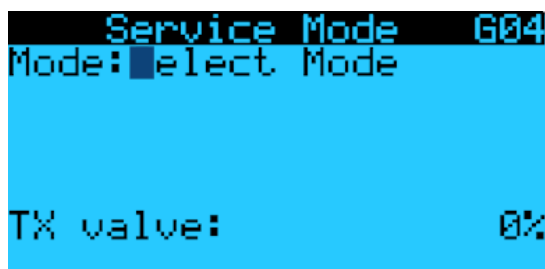
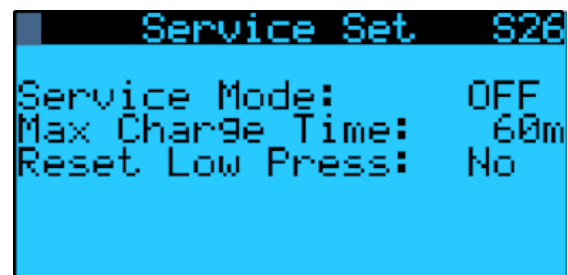
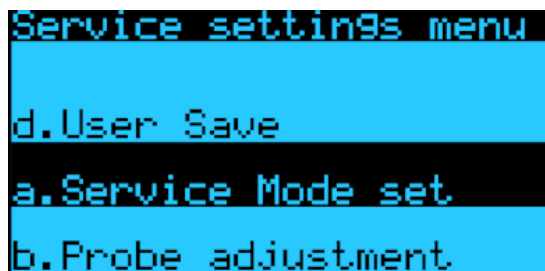


Allows user settings to be saved. When the pCO controller is powered up it will use variables from the last saved user input.

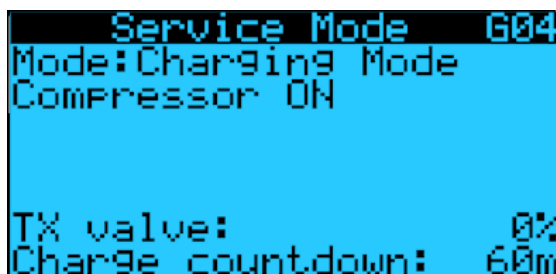
Service Save and Manufacturer Save all have defaults in memory; if settings become problematic the program can be restored to the last User, Service or Manufacturer defaults.

Service Mode

The service mode features can be used when charging or evacuating the digital compressor circuit. Safety features remain but control parameters are adjusted to allow easier charging or evacuation. To use, enable service mode and return to main mask to select mode.



Service mode selection available from Main Status Mask. When service is complete, ensure to exit Service Mode.



While using Charging Mode, the EEV is enabled, compressor operates at 100%, and low pressure cut out set to 5 PSI. Charging mode will automatically exit when countdown has ran out (default 60 minutes).

```
Service Mode G04
Mode:Evacuation Mode
Compressor OFF

TX valve: 0%
```

While using Evacuation Mode the EEV opens to 100% (may delay depending on previous compressor state), compressor is locked out.