EC3-D72 / EC3-D73
Superheat & Digital Scroll Controller

D A T A S H E E T

The **EC3-D7x series** is a **stand-alone** universal **superheat controller with a built-in synchronization control for the Copeland Digital Scroll**. It is suitable for air conditioning, refrigeration and industrial applications such as chillers, industrial process cooling, rooftops, heat pumps, package unit, close control, cold room, food process and air driers. The EC3-D72 offers remote access with built-in TCP/IP Ethernet communications and WebServer functionality. Any standard Webbrowser (e.g. Microsoft Internet Explorer® or Mozilla Firefox) can be used for monitoring or parameter setting. The EC3-D73 is exactly the same in its functionality but has no external communications. It is only possible to program the parameters using the optional ECD-002 display unit.

EC3-D72/D73

Features EC3-D72

- Superheat control in conjunction with Alco Controls stepper motor driven Electrical Control Valves (EX4...EX6)
- Synchronization of the PWM solenoid valve used for variable capacity control of the Copeland Scroll Digital
- Limitation of evaporating pressure (MOP)
- Low and high superheat alarm
- Low pressure switch function/alarm
- Freeze protection function/alarm
- Pump down function
- Feed through of 4…20mA signal from the evaporator pressure sensor to analogue output. This may also be connected to pressure input of any other controller to avoid need for multiple pressure sensors.
- Monitoring of sensors and sensor wiring and detection of sensor and wiring failures
- Intelligent alarm management in order to protect the compressor i.e. fail safe operation
- Integral rechargeable battery to close the Electrical Control Valve in case of power loss
- Support of TCP/IP Ethernet technology with WebServer functionality allows monitoring and configuration of controllers through a standard WebBrowser (e.g. Internet Explorer® or Mozilla Firefox)
- Multiple language support
- Electrical connection via plug-in type screw terminal
- Aluminum housing for DIN rail mounting

Typical ordering package: refer to page 7 for details

Description	Type	PCN
Digital Superheat Controller with TCP/IP communication	EC3-D72	807 805
Terminal Kit	K03-331	807 648
Temperature sensor	ECN-N60	804 497
Electrical Control Valve	EX4, EX5, EX6	*
Pressure sensor		
- for R22/R124/R134a/R404A/R407C/R507C	PT5-07M	802 350
- for R410A & intermediate pressure applications	PT5-18M	802 351
- for R744	PT5-30M	802 352
Plug and cable assembly for pressure sensor	PT4-M60	804 805

*For further details refer to: EX4, EX5, EX6 Electrical Control Valves datasheet EX48_35008.pdf

Application

The EC3-D7x series can be applied into a number of different superheat applications in conjunction with either a single Copeland Digital Scroll™ or a tandem unit consisting of one fixed and one Copeland Digital Scroll:

- Superheat control of conventional evaporators such as shell and tube, plate heat exchanger, air coil etc.
- Superheat control of sub-coolers or economizers connected to suction pressure of compressor or intermediate pressure

Description of performance

EC3-D7x series controls the opening of electrical control valve according to desired superheat. As the Emerson Electrical Control Valves (ECV) are able to provide a better positive shut-off function than conventional solenoid valves, there will be no flow through Emerson ECV when the compressor(s) are not running. In the event of a cooling demand request from a third party controller and the Copeland Digital Scroll compressor starts-up, the EC3-D7x needs to be informed through a digital cooling demand input. In addition, upon receiving a capacity demand signal through the 0-10V input, the Digital Scroll will initially run at minimum capacity and will subsequently start to vary the capacity of the compressor. The EC3-D7x will start to control the refrigerant mass flow by precise positioning of the ECV under different operating conditions such as compressor start-up, start of second compressor, high head pressure, low head pressure, high load, low load and partial load operation.

EC3-D7x is capable of alarm handling and diagnostics. The alarm can be received via relay output, via TCP/IP network as well as optical LED/alarm code on ECD-002.

Algorithm

The superheat control algorithm is self-adapting so that it automatically adjusts itself to the characteristics of the evaporator at regular intervals. This guarantees optimal superheat control performance for different types of evaporators and even when the operating conditions of the evaporator change over time.

Superheat Control function

By receiving two measured values from Emerson pressure sensor PT5 and temperature sensor ECN-N60, the EC3-D7x calculates the actual superheat and compares to preset superheat. The EC3-D7x operates the Electrical Control Valve in order to keep superheat at desired setpoint under various operating conditions.

The superheat set point is adjustable in the range between 3K and 30K. If low superheat alarm function is disabled, it is possible to adjust the superheat set point below 3K down to 0.5K for special applications such as flooded evaporators.

MOP function

To avoid overload of the compressor motor, the MOP function of the EC3-D7x limits the evaporating pressure to a pre-determined value, which can be adjusted to match the safe operating envelope of the compressor. MOP setpoints are entered as saturation temperature values to match published safe operating data of compressor manufacturer and to avoid unnecessary manual conversions from temperature into pressure values. The MOP function may be totally disabled, when not needed.

Low superheat alarm

Liquid flooding may lead to serious damage of compressors and must be avoided. The built-in low superheat alarm function of the EC3-D7x detects low superheat conditions and deactivates the alarm relay. If the alarm relay is wired into the serial safety loop of the system controller, the compressor will be switched off when a low superheat alarm occurs and the ECV will close.

High superheat alarm

If this function is enabled, it detects longer lasting high superheat conditions (adjustable) and triggers the high superheat alarm and the ECV will close.

Digital input status (factory setting)

The digital input is the interface between EC3-D7x and system controller. The digital status is dependant on the operation of system's compressor/thermostat. The Copeland Digital Scroll should always be regarded as the base load; compressor 1.

System Operating condition	Digital Inputs	0-10V input from third party controller
Comp. 1 & Comp.2 in stop mode	"Cooling demand" open (0V) "Comp 2 Running" open (0V)	ECV remains closed irrespective of voltage input value
Comp. 1 in run & Comp.2 in stop mode)	"Cooling demand" closed (24V) / "Comp 2 Running" open (0V)	ECV active Input =0V: digital valve capacity at 10% default capacity. When the digital comp. is in by-pass the ECV will: Close when capacity is <70% Be inhibited when the capacity is >70%
Comp 1 & Comp. 2 in run mode	"Cooling demand" closed (24V) / "Comp 2 Running" closed (24V)	ECV active The ECV will always modulate even when the digital compressor is in by-pass mode.
Comp.1 in stop and Comp. 2 in run mode starts	"Cooling demand" open (0V) / "Comp 2 Running" closed (24V)	ECV remains closed irrespective of voltage input value

Shut-off function

When the cooling demand digital input is open (0V), the EC3-D7x will drive the electrical control valve to closed position. Due to the positive shut-off capabilities of the EX4/5/6 valves a separate liquid line solenoid valve is not required. The shut-off function is guaranteed in case of power loss due to built-in internal battery.

⚠ If this function is disabled, the user must ensure appropriate safety precautions are in place to protect the system against damage caused by a power failure. Refer to operating instructions

Analogue output (4-20mA signal) function

EC3-D72 requires the outlet pressure level of evaporator for superheat and MOP control. The output signal from the PT5 is

used by EC3-D7x and again provided as 4 to 20mA signal (galvanized) for connection to any other third party controller, which can receive a 4 to 20 mA signal. Please see the wiring diagram for more details. If system controller does not have capability of using this signal, the terminal will not be wired to any other device.

Pump-down function

When the pump-down function is active, the electrical control valve will close in event of no demand i.e. the digital input is 0V (open), but the Digital Scroll compressor will keep running to perform a pump down of the refrigeration system until the pump-down threshold pressure (adjustable) is reached. If after a time delay (adjustable) the pump-down setpoint is not reached, the output pump-down relay trips to stop the compressor and an alarm is indicated. This relay must be wired into the Digital Scroll compressor control wiring.

Low pressure switch function/alarm

The use of low-pressure switch is very common for preventing of compressor running in event of refrigerant charge loss and alarming. When the low pressure function is active, a software routine detects excessively low pressure level (adjustable) and after a time delay (adjustable) output alarm relay trips and the ECV will close.

Freeze protection function/alarm

This feature permits the elimination of a separate freeze protection thermostat in a water chiller application. When the freeze protection function is activated, the evaporating temperature is constantly monitored and if it drops below the freeze protection threshold, the freeze protection alarm triggers the alarm relay and the ECV will close.

Safety / internal battery function

In event of power failure to the entire system, the stepper motor driven valve would not be able to move. Due to the differential pressure between condenser and evaporator, the refrigerant could continue to flow through the valve if the valve is open. The compressor must be protected after power recovery against wet running. EC3-X32 contains an internal rechargeable battery and smart battery charge control to automatically close the valve in case of power failure. Whilst the battery is maintenance free, the life expectancy will depend upon the working ambient; as the temperature increases the life expectancy reduces.

It is recommended to replace the battery annually to maintain the system in optimum operating condition.

⚠ If the output relays are not utilized, the user must ensure appropriate safety precautions are in place to protect the system against damage caused by a power failure

Alarm and maintenance functions

EC3-D7x provides several alarms to facilitate diagnosis as well as shut down of compressor/system if alarm relay is wired into the serial safety loop. Built-in diagnostics routines constantly monitor the battery health, sensors, the Electrical Control Valve and the associated wiring for open and short circuits. When such errors are detected, the controller goes into an alarm condition and closes the valve.

Additional to hardware errors also EC3-D7x will monitor the minimum operating superheat. If the superheat drops below 0.5K for continuous period of one minute, the low superheat alarm will occur. The low superheat alarm can be disabled for applications such as flooded evaporator, which lower operating superheat is required.

There are several other alarms such as low pressure alarm, freeze protection alarm and high superheat alarm if they are enabled.

In case of alarm, EC3-D7x will close the valve and the alarm relay will be deactivated. All alarms are automatically cleared after correction. Battery alarm, low superheat alarm, freeze protection alarm and low pressure alarm can be modified for manual reset.

Alarm relay function (factory setting)

Alarm relay contains a SPDT contact. If the relay is wired to system controller, it is possible to stop compressor/system. The alarm relay is activated during normal operation and deactivated during alarm conditions as well as supply power interruption.

Start-up configuration function

Built-in valve opening (%) at start-up for certain period of time helps the compressor's start-up and prevents erratic low pressure cut-out for the following cases:

- Operation of systems with air cooled condenser in low ambient temperatures
- Compressor start-up after long period standby time in low ambient environment
- Start-up of very large single stage compressor capacity

Emerson Pressure Sensor PT5 function

The pressure sensor measures the saturation pressure at the outlet of the evaporator. The output signal is 4 to 20 mA corresponding to a pressure range. Based on type of refrigerant and system, different types of pressure sensor are needed.

- PT5-07M for evaporators operating with R22/R124/R134a/R404A/R407C refrigerants
- PT5-18M for evaporators operating with R410A refrigerant
- PT5-30M for evaporators operating with R744

Every type of pressure sensor is calibrated in temperature range for the above specified applications. The feature set and performance of the PT5 Series is a perfect match for the EC3-D7x. Other pressure sensors are not released for use with EC3-D7x and when applied, may lead to poor performance.

Emerson temperature sensor ECN-N60 function

The temperature sensor measures the refrigerant temperature at the outlet of the evaporator. It is important to use only this dedicated temperature sensor because the ECN-N60 has the right performance such as desired time constant and tolerance compensation within the specific working range. The use of other temperature sensors is not recommended/released. The sensor is hermetically sealed for high reliability and long life. The sensor has metal housings for optimal thermal conductivity.

Setting and visualising Data via WebPages

The EC3-D72 has a TCP/IP Ethernet communication interface enabling the controller to be directly connected to a network or a PC via the standard Ethernet port. The EC3-D72 controller has embedded WebPages to enable the user to visualise the parameter lists using real text labels.

To view WebPages on the PC, a standard WebBrowser like Internet Explorer® or Mozilla Firefox and JRE Java Runtime Environment is needed. JRE can be downloaded at no charge from the Emerson website; www.emersonclimate.eu

List of adjustable parameters

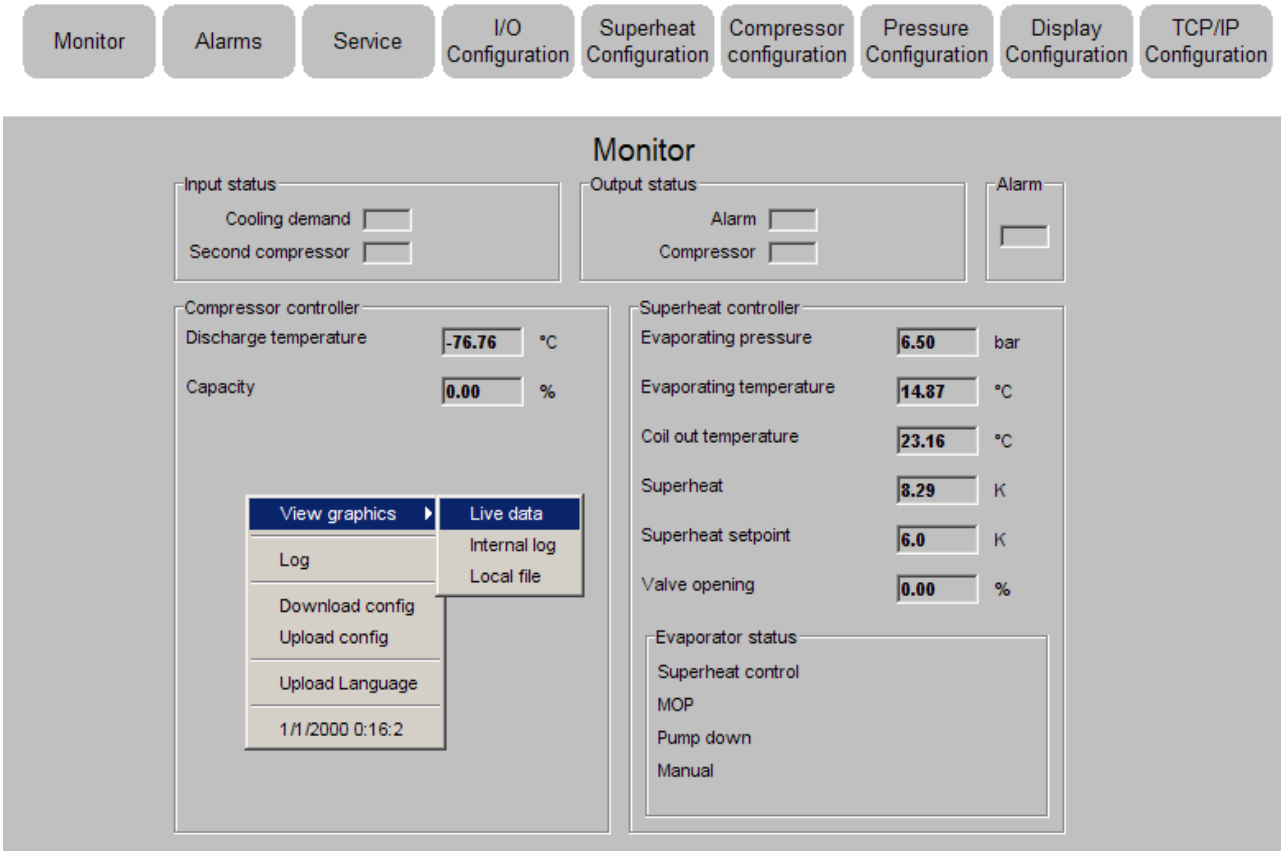
- Superheat set point and mode
- Low superheat function
- MOP function and set point
- Type of refrigerant and required pressure sensor
- Type of Electrical Control Valve
- Valve start opening and duration
- Unit conversion
- Value to display
- Battery error management
- Password
- User name (only via web page)
- Low pressure alarm: cut-out/cut-in and time delay
- Freeze protection alarm: cut-out/cut-in and time delay
- High superheat alarm: Cut-out and time delay
- Pump down cut-out and duration
- Manual control of valve (only via web page)
- TCP/IP configuration (only via web page)
- Others

WebServer function of the EC3-D72 with TCP/IP Ethernet networking capabilities

All relevant parameters and modes are visible on a single WebPage simultaneously. For even more details and for setup and maintenance a click on one of the screen tabs calls up a WebPage dedicated to specific task. The next page shows the homepage of an EC3-D72 with the monitoring WebPage of the controller.

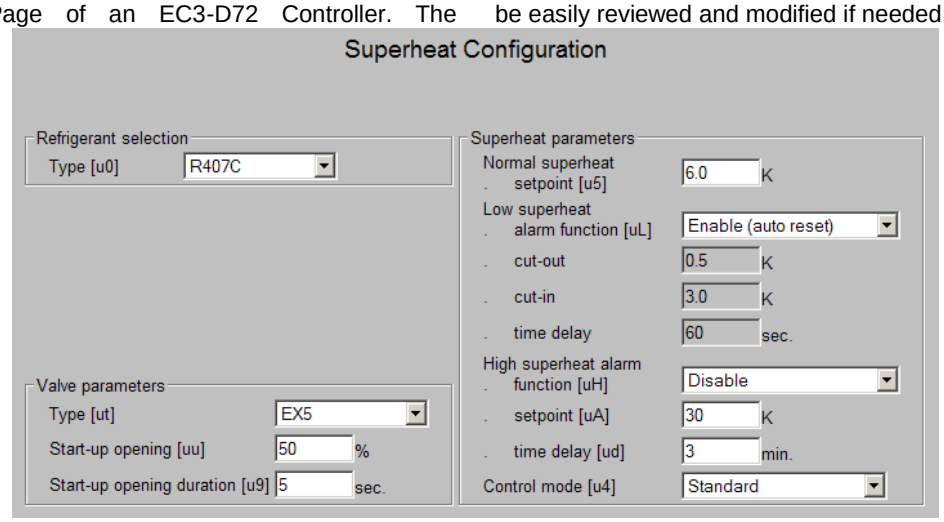
EC3-D72 features multi-language WebPages. Two languages are always available in the controller. English is the default language and is permanently stored. When delivered from the factory, the second language is German. Customers who desire to use an alternative second language can download language files for the most common European languages from the www.emersonclimate.eu website and upload one of them into the EC3-D72. This action will overwrite the German language with the customers' language choice.

Examples Webpages:



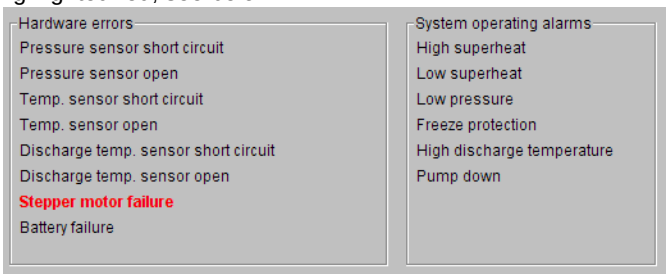
The top fields indicate the status of the controller. When alarms occur, they will be shown in red. The fields below show temperature and pressure of all sensors attached to the controller as well as the superheat setpoint, the measured superheat and the valve opening. The evaporator status field on the right hand side shows the operating modes. The active mode is shown in blue.

All WebPages, which allow the change of controller parameters are password protected. Below is the example for the superheat configuration WebPage of an EC3-D72 Controller. The setpoints for superheat, low and high super-heat alarms as well as the refrigerant and the Electrical Control Valve selected can be easily reviewed and modified if needed:



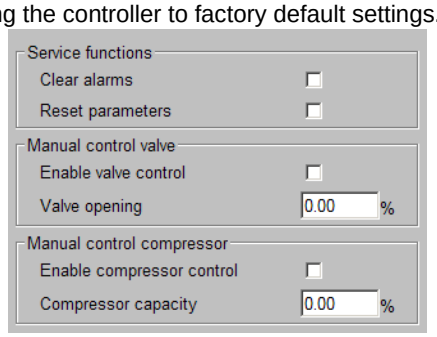
Alarms

The monitoring WebPage shows all alarms in text form. All possible alarm messages are visible, active alarms are highlighted red, see below:

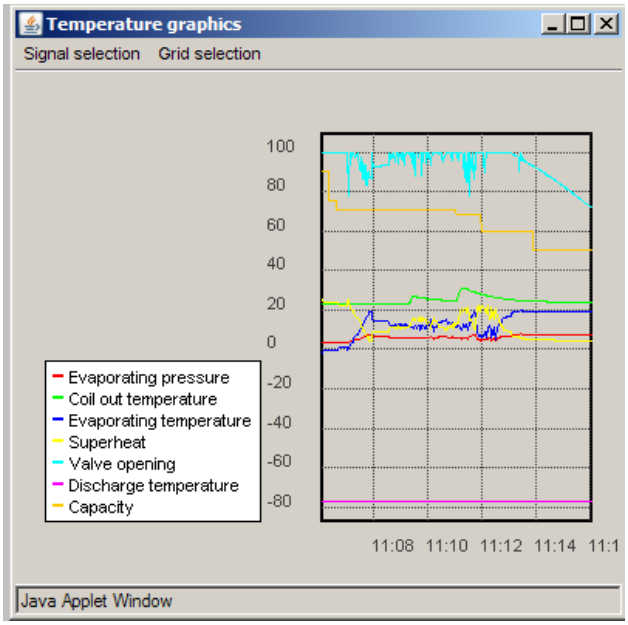


Service Functions

Particularly useful facilities are the service functions, which enable the engineer to manually control the system during commissioning. They include manual operation of the Electrical Control Valve, clearing alarms which require a manual reset and resetting the controller to factory default settings.



A rolling graph with superheat, evaporating pressure, evaporating temperature, valve opening and coil out temperature data over a period of approximately 10 minutes can be displayed:



A logfile can be stored on the PC. The file format of the datalog is text with semicolon (;) separated fields. On the picture below is a sample log file from an EC3-D72 imported in Microsoft Excel®:

Microsoft Excel - EC3-D72 sample data.xls

File Edit View Insert Format Tools Data Window Help Adobe PDF

C12

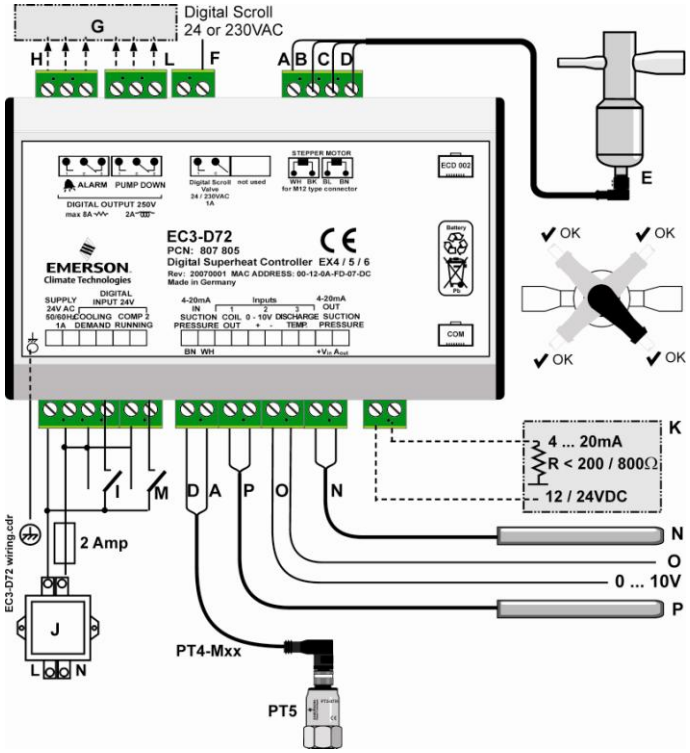
	A	B	C	D	E	F	G	H
1	Time	Evaporating pressure	Coil out temperature	Evaporating temperature	Superheat	Valve opening	Discharge temperature	Capacity
2	23:52:56	5.39	19.49	9.84	9.64	52.75	-76.76	50.31
3	23:52:57	5.39	19.49	9.84	9.64	52.75	-76.76	50.31
4	23:52:58	5.50	19.49	10.40	9.09	48.24	-76.76	50.31
5	23:52:59	5.64	19.49	11.09	8.91	51.74	-76.76	50.31
6	23:53:00	5.85	19.49	12.02	7.46	45.66	-76.76	50.31
7	23:53:01	5.85	19.49	12.02	7.46	52.61	-76.76	50.31
8	23:53:02	5.66	19.49	11.06	8.42	57.14	-76.76	50.31
9	23:53:03	5.32	19.49	9.29	8.99	59.36	-76.76	50.31
10	23:53:04	5.12	19.49	8.53	10.92	57.40	-76.76	50.31

Optional ECD-002 display/keypad unit

The ECD-002 can be used as an option for service purposes for the EC3-D72 but is the only means of visualizing the parameters for the EC3-D73. ECD-002 may be connected or removed from EC3-D72 at any time. The display unit can be switched from K/bar/°C to R/psig/°F. Indicator LEDs show the status of valve opening, valve closing, demand and alarm.

Wiring Diagram

Permanent



A: White wire **B**: Black wire **C**: Blue wire **D**: Brown wire

E: Plug cable assembly EXV-Mxx for connection to EX4/EX5/EX6

F: Output for Copeland Digital Scroll solenoid valve

G: Remote control panel, system controller

H: Alarm relay, dry contact. Relay coil is not energized at alarm condition or power off

⚠ The use of the relay is essential to protect the system in case of power failure if the communications interface or the ECD-002 are not utilized

Temporary for set-up, start-up and service

Direct connection via cross over cable

Connection via Router

I: Digital input 1: “Cooling demand”; Digital Scroll compressor is running: 0V/open = Stop; 24V/closed = Start)

J: Transformer Class II, 24VAC secondary / 25VA

K: Third party controller (can use the analog output signal from EC3)
Note: The internal resistor of third party controller must fulfill the following conditions:
R ≤ 200 Ω if the supply voltage is 12VDC
R ≤ 800 Ω if the supply voltage is 24VDC

L: Pump down relay, dry contact. Relay is energized during normal operation

M: Digital input 2: “Comp. 2 running”;
0V/open = Comp2 stop; 24V/closed = Comp2 running.

N: Discharge Temp. Sensor

O: 0-10V Digital Scroll capacity demand signal from system controller

P: ECN-N60 Coil out sensor

Ordering

Description	Type	Part No.
Digital Superheat Controller with communication; **Complete kit for 7bar applications**	**EC3-D72**	**808 042**
Digital Superheat Controller without communication; **Complete kit for 7bar applications**	**EC3-D73**	**808 041**

Kit consists of: Controller, Terminal kit, Pressure transmitter inc. 6.0m cable, 6.0m Temp. sensor, 60VA transformer

Description		Type	Part No.
Digital Superheat Controller EC3-D72		EC3-D72	807 805
Digital Superheat Controller EC3-D73		EC3-D73	807 804
Digital Superheat Controller EC3-D72 (24 V)		EC3-D72	807 808
Digital Superheat Controller EC3-D73 (24 V)		EC3-D73	807 809
Terminal Kit for EC3-X32		K03-331	807 648
Pressure Sensors	-0.8…7bar	PT5-07M	802 350
	0…18bar	PT5-18M	802 351
	0…30bar	PT5-30M	802 352
	0…50bar	PT5-50M	802 353
Cable Assembly for PT5	1.5m cable length	PT4-M15	804 803
	3.0m cable length	PT4-M30	804 804
	6.0m cable length	PT4-M60	804 805
NTC Temperature sensors	3m cable length	ECN-N30	804 496
	6m cable length	ECN-N60	804 497
	12m cable length	ECN-N99	804 499
Display/keypad unit (opt.)		ECD-002	807 657
Connection cable EC3 to ECD-002	1,0 m	ECC-N10	807 860
	3,0 m	ECC-N30	807 861
	5,0 m	ECC-N50	807 862
Transformer 230VAC Input, 24V output, Din rail mounting			
For one set of controller and valve	25VA	ECT-323	804 424
For two sets of controllers and valves	60VA	ECT-623	804 421
Replacement battery kit			807 790

ECT-323

Suitable valves for connection to EC3-D7x series

Valve	Capacity range kW *	Refrigerant	Capacity regulation
EX4	2 ... 20	**R 22**	10 -100%
EX5	5 ... 50		
EX6	12 ... 120		
EX4	2 ... 21	**R 407C**	
EX5	5 ... 53		
EX6	13 ... 126		
EX4	2 ... 15	**R 134a**	
EX5	4 ... 39		
EX6	10 ... 93		
EX4	2 ... 14	**R 404A/ R507**	
EX5	4 ... 35		
EX6	9 ... 84		

Valve	Capacity range kW *	Refrigerant	Capacity regulation
EX4	3 ... 23	**R 410A**	10 - 100%
EX5	6 ... 58		
EX6	14 ... 140		
EX4	1 ... 11	**R 124**	
EX5	3 ... 28		
EX6	6 ... 67		
EX4	3 ... 33.5	**R 744**	
EX5	10 ... 102		
EX6	24 ... 244		

*) Nominal rating conditions:

Refrigerant	Evaporating temperature	Condensing temperature
R22, R134a, R404A, R507C, R407C, R410A	+4°C	+38°C
R744	-40°C	-10°C
R124	+20°C	+80°C

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Technical Data

EC3-D7x series

Supply voltage	24V AC ±10%, 50/60Hz, 1A
Digital input	24V AC ±10%, 50-60HZ 24V DC ±10%
Power consumption	25VA max. including connected ECV and display/keyboard
Internal battery charging time	Approximately 2 hours if battery is fully empty
Plug-in connector size	Removable screw version wire size 0.14 … 1.5mm^2
Ground connection	6.3mm spade earth connector
Applied directive EMC LVD RoHS	 EN 61326, EN 50081, EN 61000-6-2, EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-5, EN 61000-4-6, EN 61000-4-11
Marking	CE
Protection class	IP 20
Vibration	4g, 10-1000Hz
Temperature storage operating	 -20 … +65°C 0 … +60°C 1….+25°C for optimum battery life
Humidity	0 … 80% r.h. non condensing
Weight	~ 800g
Mounting	DIN rail mounted

ECD-002 Display Unit

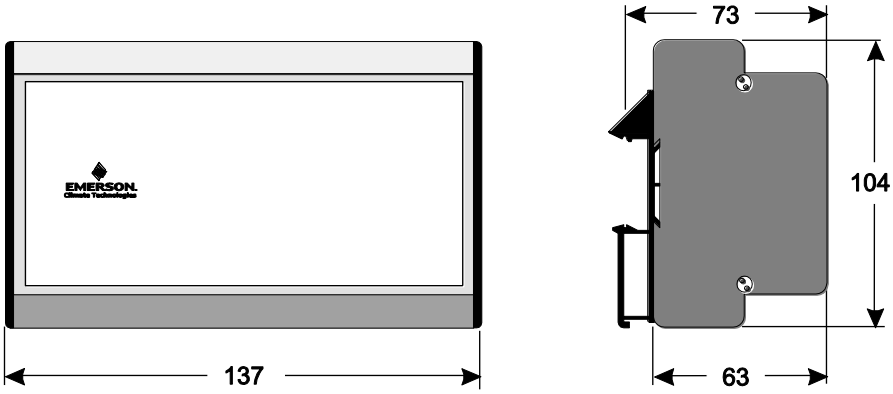
Supply	From EC3 Series Controller via connecting cable
LED indicators	Valve opening, valve closing, alarm, demand
Display LED	Numeric segmental display, 2½-digits, red, with automatic decimal point betw. ±19.9, switchable between °C and °F
Connecting cable	ECC-Nxx or standard CAT5 patch cord with RJ45 connectors
Protection class	IP 65 (front protection with gasket)
Humidity	0 … 80% r.h. non condensing
Temperature storage operating	 -20 … +65°C 0 … +60°C
Weight	~ 52g
Mounting	Panel mount (71 x 29 mm cutout)

Input and Output, EC3-D7x series Controller

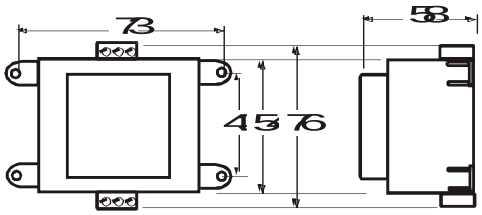
Description	Specification (PCN 807 805, 807 804)	Specification (PCN 807 808, 807 809)
Temperature input	ECN-Nxx: 10kΩ @ 25 °C, Range: -50 … 50 °C	
Pressure sensor input	PT5-07M/18M/30M: 24VDC, 4 … 20mA	
Analog input Digital Scroll capacity demand from system controller	0-10VDC with maximum load current 2mA. Absolute maximum voltages: -0.7V min / 10.7V max	
Analog output (evaporating pressure fed-through signal) Deviation from input signal	4 … 20mA Requires 12 or 24 VDC ±8% max	
Digital input Cooling demand Comp.2 running	0/24 VAC/DC	
Output relay Alarm/Pumpdown Digital Scroll solenoid Spare relay	SPDT contacts, AgCdO, Max. rating: Inductive 2Amp, Resistive 8 Amp @ 250V Solid state relay, Max rating 1Amp @ 240VAC with 1.6 voltage drop. Minimum switching current 22mA Maximum off state leakage current 1.5mA SPST: not used	SPDT contacts, AgCdO, Max. rating: Inductive 2Amp, Resistive 8 Amp @ 24V Solid state relay, Max rating 1Amp @ 24VAC with 1.6 voltage drop. Minimum switching current 22mA Maximum off state leakage current 1.5mA SPST: not used
Stepper motor output	For EX4 … EX6 Electrical Control Valves	
Connection to ECD-002	RJ45	
TCP/IP connection	RJ45	

Physical Dimensions Drawings (mm)

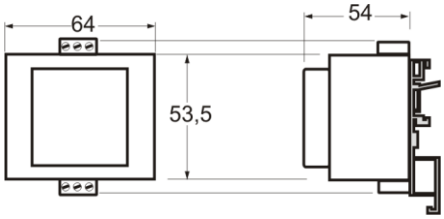
EC3-D72 Controller



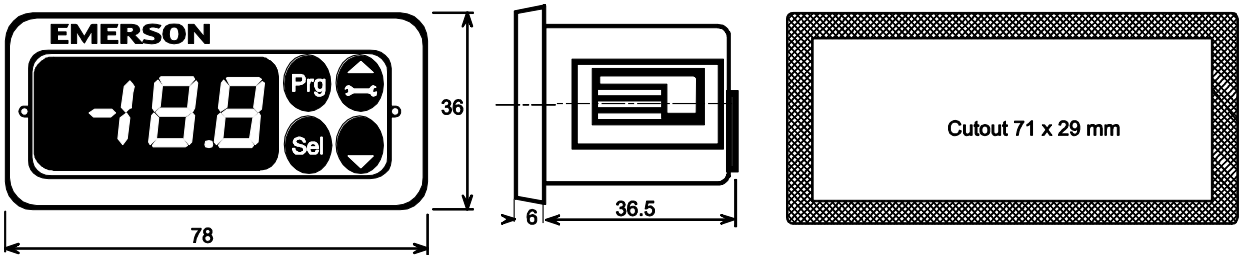
ECT-623 Transformer



ECT-323



ECD-002 Display Unit



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This document replaces all earlier versions.

Emerson Climate Technologies GmbH
Holzhauser Straße 180
13509 Berlin
Germany

www.emersonclimate.eu

	Phone:	**Fax:**
Benelux	+31 (0)77 324 0 234	+31 (0)77 324 0 235
Germany, Austria & Switzerland	+49 (0)6109 6059 -0	+49 (0)6109 6059 40
France, Greece, Maghreb	+33 (0)4 78 66 85 70	+33 (0)4 78 66 85 71
Italia	+39 02 961 781	+39 02 961 788 888
Spain & Portugal	+34 93 41 23 752	+34 93 41 24 2
UK & Ireland	+44 (0) 1635 876 161	+44 (0) 1635 877 111
Sweden, Denmark, Norway & Finland	+49 (0)2408 929 0	+49 (0)2408 929 528
Eastern Europe & Turkey	+49 (0)2408 929 0	+49 (0)2408 929 525
Poland	+48 (0)22 458 9205	+48 (0)22 458 9255
Russia & Cis	+7 495 981 9811	+7 495 981 9816
Balkan	+385 (0) 1560 38 75	+385 (0) 1 560 3879
Romania	+40 364 73 11 72	+40 364 73 12 98
Ukraine	+38 44 4 92 99 24	+38 44 4 92 99 28