The **EC3-33x** Series form a new generation of electronic controllers for refrigeration and air conditioning.

The controllers feature a DIN rail mounted housing and a separate optional display unit in the small industry standard housing form factor. They offer maximum functionality such as **superheat, temperature and defrost controller** with built-in **TCP/IP Ethernet** communications and WebServer functionality. Any standard WebBrowser (e.g. Internet Explorer® or Mozilla Firefox) can be used for monitoring or parameter setting.

The version with **Echelon LON®** network interface is for use in more complex systems, where different controllers must communicate with each other.
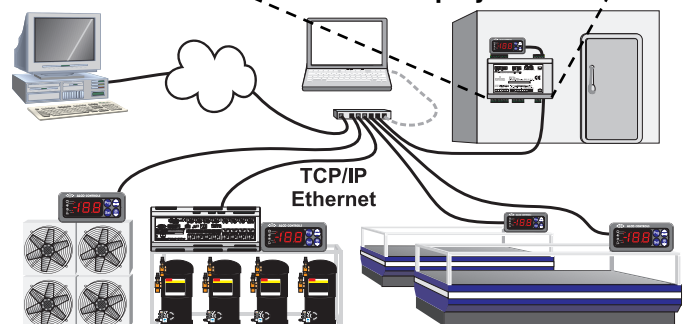
## Features

- Superheat control with self-adapting algorithm and driver circuit for stepper motor driven Electrical Control Valves EX4 … EX8
- Air temperature control
- Defrost and fan management
- Limitation of evaporating pressure (MOP)
- Feed-through of 4 … 20mA signal of evaporating pressure transmitter to analogue output to operate multiple controllers with a common pressure transmitter
- 2 digital inputs for compressor safety loop and coldroom door contact
- 4 relay outputs for compressor, fan, defrost and alarm
- Support of two network technologies:
  **TCP/IP Ethernet** with **WebServer** functionality allows monitoring and configuration of controllers through a standard **WebBrowser** (e.g. Internet Explorer® or Mozilla Firefox)
  or **Echelon FTT10 LON® technology** for monitoring and configuration through a supervisory system such as the ALCO Monitoring Server EMS
- Alarm messaging by email (EC3-332)
- Integral backup battery to close Electrical Control Valve in case of power loss
- Electrical connection via plug-in type screw terminals
- Aluminum housing for DIN rail mounting

## Features ECD-001 Display Unit

- Front panel mounted human interface for parameter and status read-out and controller setup via keypad
- 2½ digit LED display with automatic decimal point
- Indicator LEDs for compressor, fan, heater and alarm
- Connection to EC3 Series via ECC-N10 or standard CAT5 patch cord with RJ45 connectors.
- Standard 71 x 29 mm cut-out dimensions
- IP65 protection class when mounted in front panel

**EC3 Series Coldroom Controller with ECD-001 Display Unit**

**TCP/IP Ethernet**

### Typical ordering package:

- EC3-332 Coldroom Controller with K03-330 Terminal Kit
- EX5-U21 Electrical Control Valve with EX5-N30 Cable
- ECD-001 Display Unit with ECC-N10 Cable
- ECT-323 Transformer
- PT5-07M Pressure Transmitter with PT4-M30 Cable
- ECN-S30 Air Temperature Sensor
- ECN-N30 Pipe Temperature Sensor
- ECN-F60 Fin Temperature Sensor

## Selection Table Coldroom Controller

| Description | TCP/IP Ethernet | | | LON® FTT | | |
| --- | --- | --- | --- | --- | --- | --- |
| | Type | Part No. single unit | Part No. Kit* | Type | Part No. single unit | Part No. Kit* |
| Coldroom Controller ECV Stepper Motor Drive | **EC3-332** | 807 632 | 808 013 | **EC3-331** | 807 631 | 808 012 |

*) Kit contains terminal kit, pressure transmitter PT5-07M with cable assembly, transformer 25VA, NTC sensors 6m fin, pipe and single insulated version

## Introduction

The EC3-33x series Controllers are for use in commercial refrigeration systems, primarily to control the refrigeration circuit of coldrooms. This includes the control of the refrigerant flow to optimize superheat, maintain air temperature and the defrost management. Alco Controls EX4…EX8 Electrical Control Valves must be used in conjunction with the EC3-33x units to modulate refrigerant flow.
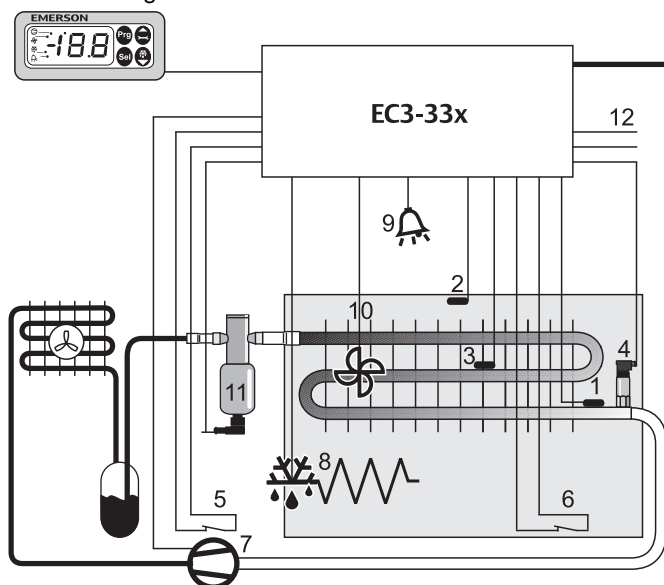
Two separate control loops are coordinated in the device: one senses evaporating pressure and temperature to maintain optimum superheat, while the other loop controls air temperature.

Other functions include the management of defrost schedules and sequences, data monitoring and alarm handling. Though EC3 Controllers can operate as stand alone devices, they are best suited to networked solutions, which take advantage of the monitoring capabilities.

The EC3-33x Controllers are members of the range of EC2 and EC3 devices, which can be easily assembled into complete control systems for commercial refrigeration. They all share the benefits of remote access and data communication. Please refer to specific datasheets for details.

## Application

The functions of the EC3-33x Controllers are described in the functional diagram below:



With coil out temperature (1) and evaporating pressure (4) the superheat is calculated to define the opening of the Electrical Control Valve (11). Superheat can be set to a fixed value or an adaptive mode may be used. Temperature sensor (2) is part of the temperature control loop. The defrost heater (8) can be activated locally by fixed timing intervals or remotely through the communications port. For defrost end termination the temperature sensor (3) can be used. Fan (10) and compressor (7) are controlled as well. One digital input is allocated to the compressor safety loop (5). Another digital input monitors the door switch (6), which will activate an alarm if the door is not closed within a specified time. The analog output (12) feeds the evaporating pressure transmitter signal to a 2$^{nd}$ EC3-33x or other Controller on the same suction line thus eliminating the need for a second pressure transmitter.

In case of power loss a battery built in the EC3-33x will close the Electrical Control Valve (11) and avoid flooding of the compressor. Due to the positive shut-off capabilities of the EX4 … 8 valves a separate liquid line solenoid valve is not required.
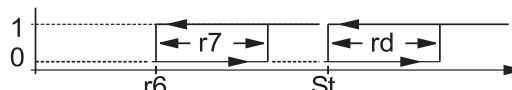
## Superheat Control

The EC3 Series controls evaporator superheat by varying the mass flow through the Electrical Control Valve (ECV). The controller automatically calculates the number of steps required for the correct valve opening by measuring pressure and temperature at the evaporator output. PT5-07M pressure transmitters and ECN-Pxx pipe type temperature sensors from EMERSON must be used.

The controller works in two operating modes: **fixed superheat** and **adaptive superheat**. In the "fixed" mode, the superheat set-point is fixed to a user-defined value. In the "adaptive" mode the controller varies superheat set-points in the range between 3K and 15K depending on system conditions to maintain stable operation. The pressure drop through a distributor or the glide associated with certain refrigerants (e.g. R407C) can be compensated in the controller.
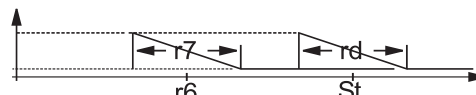
## Temperature Control

The ECN-Sxx air sensor is used for temperature control of the coldroom. The **dead band** control function is described in the diagram below:



The horizontal axis represents the temperature, with St the set-point for day operation and rd the difference at day, while r6 is the set-point for night operation and r7 the difference at night. The vertical axis represents cooling operation (1 = cooling, 0 = no cooling).
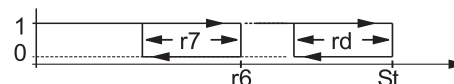
A control parameter allows to switch off the evaporator fan during "no cooling".

A more precise temperature control can be achieved by using the **modulating** temperature mode as shown below:



The horizontal axis represents the temperature, the vertical axis the superheat setting. At high temperatures, the controller works with minimum superheat. St is the set-point for day operation, at which the superheat is already increased. rd specifies the proportional band in which the superheat is modulated. Equivalent is r6, the set-point for the night operation and r7 the width of the proportional band at night. At a temperature of St minus ½*rd (day) or r6 minus ½*r7 (night) the valve is closed.

In case the controller should be used in a heat pump for **heating**, the function of the temperature controller can be inversed:



When used with a standard condensing unit, the compressor relay can be used to switch the coil of power contactor. The compressor relay is not used in a refrigeration system with a rack controller. In this application, the electrical control valve closes when the thermostat set-point has been reached and the rack will automatically pump down if there is insufficient demand from the rest of the refrigeration system.
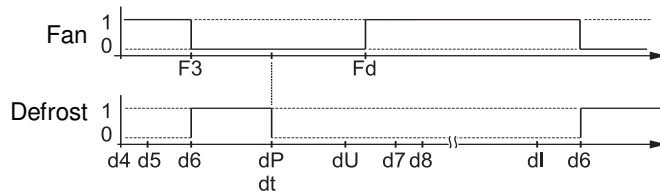
## Defrost

EC3-33x Series controllers allow local defrost management through the built-in defrost timer but also permit remote defrost scheduling through the networking connection. For remote defrost details please consult the operating instructions.

Two basic defrost modes are possible:

## Electrical / hot gas defrost

All timing parameters can be selected to cover specific defrost modes, see the diagrams below for the function of defrost output and fan output at defrost:



Defrost can be activated after power up (d4 flag) and the delay (d5). Delay (d6) allows for pump down. The defrost will end either when the defrost termination temperature (dt) has been exceeded or after the maximum defrost duration (dP). Other delays take care for synchronization of multiple evaporators in the same system (dU), for drain (d7) and for injection (d8). The next defrost will occur after the specified defrost interval (dI).

Fans can be switched off at defrost (F3 flag) and switched on after defrost and drip time delay (Fd).

End of defrost is detected by the dedicated defrost temperature sensor ECN-F60.

## Natural Defrost

Though natural defrost is possible with the EC3-33x Series, it is unlikely that such a defrost method is used in a coldroom. Since the EC3-33x Series is also applicable for other refrigeration applications, natural defrost may well be applicable there.

## Sensors

Low cost NTC sensors are available with different cable lengths to meet specific customer's requirements for optimal positioning of the sensors. All sensors are hermetically sealed for high reliability and long life. Air sensors have a plastic housing, pipe and fin sensors have metal housings for optimal thermal conductivity and the fin sensor has an additional mounting clip.

## Operation and Commissioning

Operating and commissioning of an EC3-33x Controller may be performed by using one of the following options:

- Locally or remote with a PC connected to the TCP/IP Ethernet port of the EC3-332.
- Remotely via the AMS Server connected to the LON® port of an EC3-331.
- Locally through the 4-button keypad of an optional ECD-001.

For initial commissioning of a new installation depending on the networking technology of the EC3-33x the first two options are the most appropriate. Commissioning is done via dedicated menus with meaningful default values, which make commissioning an EC3-33x a plug-and-play type of job. Anybody who is familiar with Microsoft Windows® based programs and WebBrowsers should find it very intuitive without the need for special training.

## Optional ECD-001 Display Unit

The ECD-001 may be attached to the EC3 Series Controller to provide a local display of system parameters, most commonly temperatures. With the 2½ digit display temperatures within ±199℃ can be shown with a resolution of 1℃. The resolution improves to 0.1℃ within a range of ±19.9℃. The display unit can be switched from ℃ to ℉. When displaying ℉ the same resolution as above applies.

Indicator LEDs show the status of compressor, fan, defrost and alarm. A blinking LED indicates that the EC3 Controller is trying to fulfill a task but is prevented from doing so by another restraint in the system. An example of this would be the minimum compressor run time.

## WebServer function of the EC3-332 with TCP/IP Ethernet networking capabilities

Though the actual status of the controllers can be viewed on the optional ECD-001 Display Unit, it is much more convenient to do the viewing on a PC. 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. All of this can be done with a standard WebBrowser like the Internet Explorer®, the Mozilla Firefox or others. The picture on page 4 shows the homepage of an EC3-332 with the monitoring WebPage of the controller.

## Echelon LON® Networking Capabilities of the EC3-331

The remote access, viewing and monitoring features of the LON® version EC3 Series Controllers match and exceed the capabilities of their TCP/IP counterparts. Though remote access requires the use of the EMS Monitoring Server or special third party LON® compliant hardware and software, many more additional functions and features are available.

The EC3-331 Controllers are equipped with LON-FTT10 (free topology) transceiver types. This offers the installer greatest flexibility in the way the controllers are connected to the LON® network in addition to offering higher communication transmission rates.

When connected to the LON® network, the individual EC3 Series controllers may be bound together through peer-to-peer communication to form self-contained control loops for applications such as synchronised defrosting.

Retrieval and download of setups and data is very comfortable and easily achievable in LON® systems.

Refer to the "Alco Networking Application" sheets for further details.

## Where to apply TCP/IP Ethernet vs. LON® Controllers

In general TCP/IP Ethernet controllers are more applicable for smaller refrigeration systems with only a few pieces of refrigeration equipment. No special hardware or special software is needed and whoever can set up a small PC network has all the necessary know-how to set up and operate EC2 and EC3 TCP/IP Ethernet controllers.

In larger installations LON® has its merits. Network wiring is easier and less costly. Peer-to-peer communication is another benefit of LON® and data retrieval and storage are very easily achievable. These advantages come at a price however: a monitoring and server device like the EMERSON EMS is needed along with some special know-how in LON® technology. The associated cost therefore makes LON® technology primarily applicable in large refrigeration plants with many pieces of refrigeration equipment like Supermarkets or large cold storage facilities.
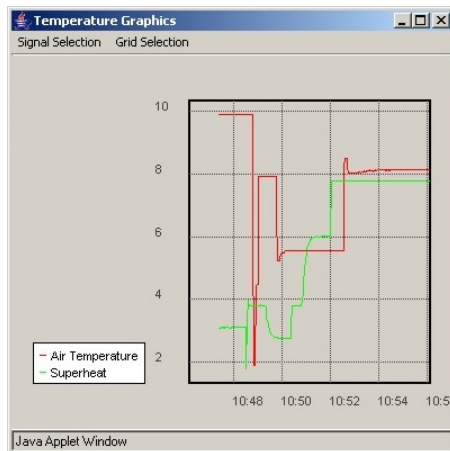
The top fields indicate the status of compressor, defrost heater, fan and alarm output relay (left) and the status of compressor alarm loop and door switch inputs (right). The fields below show temperatures and pressure of all sensors attached to the controller as well as the setpoints for air temperature and superheat. The coil-in temperature is calculated from the saturation pressure of the used refrigerant. All status messages (thermostat, defrost and evaporator) are displayed in the lower section with normal font, all active messages are in bold letters.

A rolling graph with air temperature and superheat 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 EC3-332 imported in Microsoft Excel[®]:



All WebPages, which allow the change of controller parameters are password protected. Below is the example for the thermostat configuration WebPage of an EC3-332 Controller. The setpoints of day and night operation, as well as the settings which will initiate an alarm can be easily reviewed and modified if needed:

## Alarm and Maintenance Functions

EC3-33x provides many alarm codes to facilitate diagnosis.

Limit violation alarms are associated with temperature and pressure set point (high alarm, low alarm, sensor failure).

The serial alarm loop of the compressor can be connected to a digital input. It will monitor compressor operation and signal shutdown in case the serial alarm loop is open due to high motor temperature or excessive pressure etc.

Alarm management includes the issuing of an alarm message through the network and to show the alarm code on the controllers display. The priorities and subsequent actions can be individually defined for each alarm when connected to a PC or an AMS monitoring server.

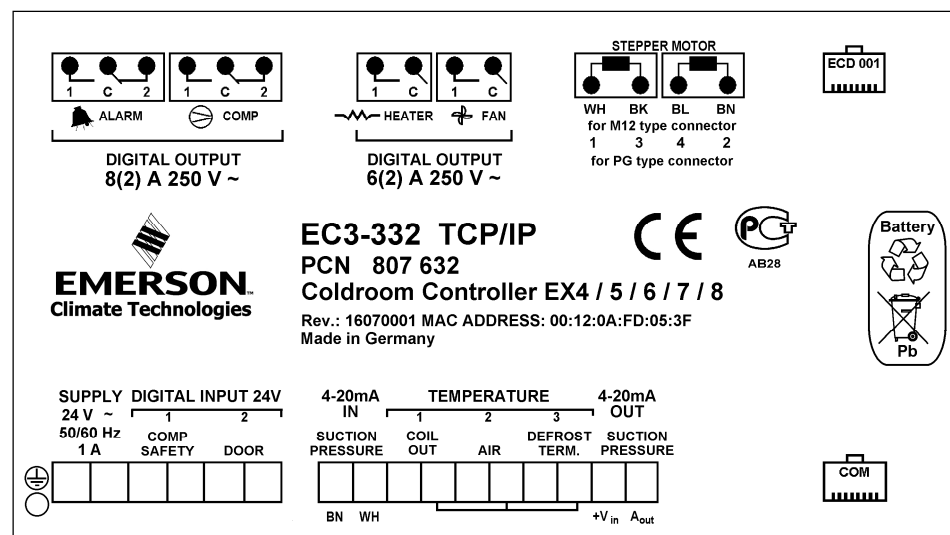The EC3-332 has the capability to send alarm messages directly by email.

While the attached Display Unit ECD-001 indicates alarms as blinking symbols only, the monitoring WebPage shows all alarms in text form. All possible alarm messages are visible, active alarms are highlighted bold, see below:



## Safety Functions

Various safety functions are available for use particularly when the EC3-33x is controlling the compressor directly. These safety features are used to prevent compressor damage and include: Limitation of maximum evaporating pressure (MOP), delay of compressor start after control reset, minimum time between two starts, minimum compressor off time, minimum compressor run time.

Safe operating modes allow the system to continue to operate safely even when the signal is lost from a defective or disconnected sensor.

Particularly useful facilities are the service functions, which enable the engineer to manually control the system during commissioning. They include manual operation of compressor, fan and Electrical Control Valve, or special operating modes of system for cleaning, permanent night operation, manual defrost or others, see below:



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. EC3-33x 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 alarm relay is not utilized, the user must ensure appropriate safety precautions are in place to protect the system against damage caused by a power failure.

## Wiring Diagram



**EC3-33x Coldroom Controller for Electrical Control Valves EX4 … EX8**

## Accessories

### Terminal Kits for EC3 Series:

| | | Type | PCN. |
|---|---|---|---|
| Terminal Kit for EC3-33x series | | K03-331 | 807 648 |



**K03-331**

### ECD Series Display Unit:

| | | Type | PCN. |
|---|---|---|---|
| Display for EC3-33x | | ECD-001 | 807 641 |
| Connection cable EC3 to ECD | 1.0 m | ECC-N10 | 807 860 |
| | 3.0 m | ECC-N30 | 807 861 |
| | 5.0 m | ECC-N50 | 807 862 |



**ECD-001**

### Electrical Control Valves with Stepper Motor Drive*

| | | Type | PCN. |
|---|---|---|---|
| Nominal capacity R404A | 1 … 11,5kW | EX4-I21 | 800 615 |
| | 1 … 11,5kW | EX4-M21 | 800 616 |
| | 4 ... 35kW | EX5-U21 | 800 618 |
| | 10 ... 84kW | EX6-I21 | 800 620 |
| | 10 … 84kW | EX6-M21 | 800 621 |
| | 25 … 230kW | EX7-I21 | 800 624 |
| | 25 … 230kW | EX7-M21 | 800 625 |
| *) see datasheet EX48_35008.pdf for details | 60 … 613kW | EX8-M21 | 801 964 |
| | 60 … 613kW | EX8-U21 | 801 970 |
| Cable and connector assembly for EX4 / EX5 / EX6 / EX7 | 1,5m cable length | EX5-N15 | 804 650 |
| | 3m cable length | EX5-N30 | 804 651 |
| | 6m cable length | EX5-N60 | 804 652 |
| low temp. | 6m cable length | EX5-L60 | 804 655 |



**EX5**



**ECN-Sxx**

| | | Type | PCN. |
|---|---|---|---|
| NTC Sensors (Air type) (10 kΩ at 25℃) | 1,5m cable length | ECN-S15 | 804 304 |
| | 3m cable length | ECN-S30 | 804 305 |
| | 6m cable length | ECN-S60 | 804 284 |
| NTC Sensors (Pipe type) (10 kΩ at 25℃) | 3m cable length | ECN-N30 | 804 496 |
| | 6m cable length | ECN-N60 | 804 497 |
| | 12m cable length | ECN-N99 | 804 499 |
| NTC Sensors (Fin type) (10 kΩ at 25℃) | 6m cable length | ECN-F60 | 804 283 |



**ECN-Nxx**



**ECN-Fxx**

| | | Type | PCN. |
|---|---|---|---|
| Pressure Transmitter | -0.8…7bar | PT5-07M | 802 350 |
| | 0…18bar | PT5-18M | 802 351 |
| 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 |



**PT5-07M with PT4-Mxx**

| | | Type | PCN. |
|---|---|---|---|
| Transformer Din rail mounting, Class II 230VAC Input, 24V Output | 25VA | ECT-323 | 804 424 |
| | 60VA (EX8 only) | ECT-623 | 804 421 |



**ECT-623**        **ECT-323**

## Technical Data

### EC3 Series Controller

| | |
|---|---|
| Supply voltage | 24VAC ±10%, 50/60Hz Class II only 6.3mm spade earth connector |
| Power consumption | 25VA max. including EX4 … EX7 28VA max. including EX8 |
| Plug-in connector size | Removable screw version wire size 0.14 … 1.5mm$^2$ |
| Communication | TCP/IP Ethernet        (EC3-332) LON$^®$ FTT-10          (EC3-331) |
| Temperature    storage    operating | -20 … +65℃     0 … +60℃     1….+25℃ for optimum battery life |
| Humidity | 0 … 80% r.h.  non condensing |
| Protection class | IP20 |
| Weight | ~ 800g |
| Mounting | DIN rail mounted |

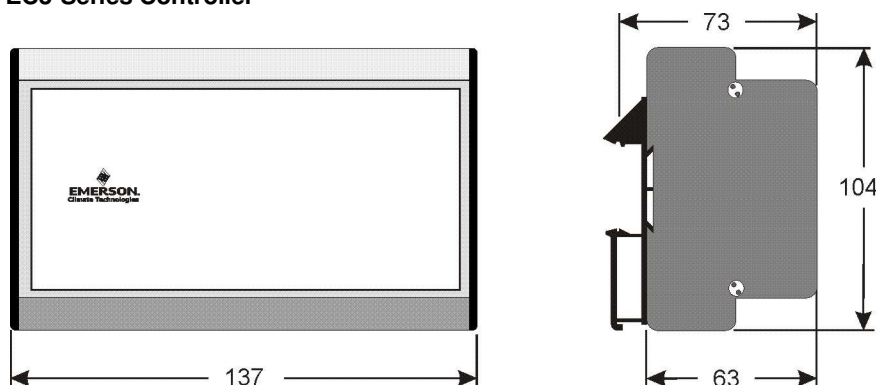### ECD-001 Display Unit

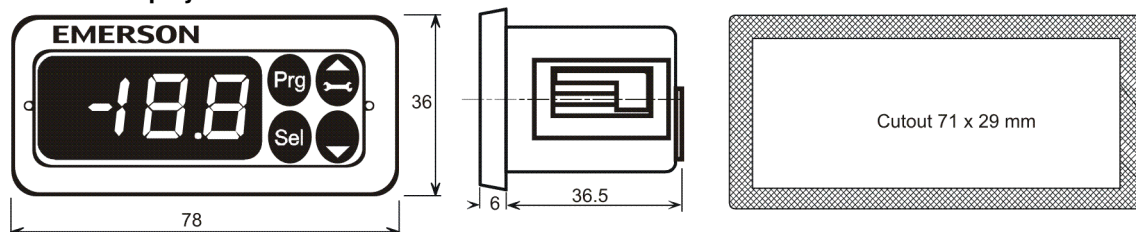| | |
|---|---|
| Supply | From EC3 Series Controller via connecting cable |
| LED indicators | Compressor, Fan, Defrost, Alarm, LON-Service pin, IR status |
| Display LED | Numeric segmental display, 2½-digits, red, with automatic decimal point betw. ±19.9, switchable between ℃ and ℉ |
| Connecting cable | ECC-Nxx cables or standard CAT5 patch cord with RJ45 connectors |
| Temperature    storage    operating | -20 … +65℃     0 … +60℃ |
| Humidity | 0 … 80% r.h.  non condensing |
| Protection class | IP 65 (front protection with gasket) |
| Weight | ~ 52g |
| Mounting | Panel mount (71 x 29 mm cutout) |

## Input and Output Configuration EC3-33x Controller

| Description | I/O Specification | |
|---|---|---|
| Temperature inputs (3) | 10kΩ @ 25 ℃, -50 … 50 ℃ | Coil out temperature, Air temperature, Defrost termination |
| Pressure transmitter input | 24VDC, 4 … 20mA | Evaporating pressure |
| Analog output (evaporating pressure feed-through signal) Deviation from input signal | 4 … 20mA Requires 12 or 24 VDC ±8% max | Evaporating pressure |
| Digital inputs (2) | 24VAC/DC | Compressor Safety, Door contact |
| Output relays (4) | SPDT contacts, AgNi Inductive (AC15) 250V / 2A, Resistive (AC1)  250V / 8A | Compressor Alarm |
| | SPST contacts, AgNi Inductive (AC15) 250V / 2A, Resistive (AC1)  250V / 6A | Heater Fan |
| Stepper motor output | For EX4 … EX8 Electrical Control Valves | |
| Communications | RJ45 10MBit/sec. Ethernet or LON$^®$ FTT10 | |

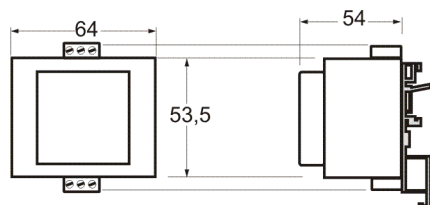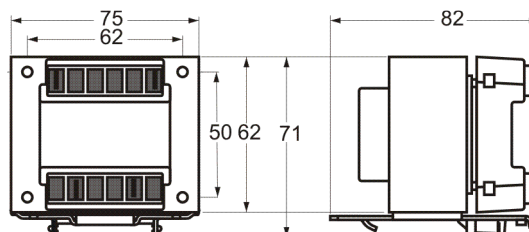## Physical Dimensions Drawings (mm)

### EC3-Series Controller

73

104

137

63

### ECD-001 Display Unit

-18.8

Prg

Sel

36

78

6

36.5

Cutout 71 x 29 mm

### ECT-323 Transformer

64

54

53,5

### ECT-623 Transformer

75

62

82

50 62   71

EMERSON is not to be held responsible for erroneous literature regarding capacities, dimensions, applications, etc. stated herein. Products, specifications and data in this literature are subject to change without notice. The information given herein is based on technical data and tests which EMERSON believes to be reliable and which are in compliance with technical knowledge of today. It is intended only for use by persons having the appropriate technical knowledge and skills, at their own discretion and risk. Our products are designed and adapted for fixed locations. For mobile applications failures may occur. The suitability for this has to be assured from the plant manufacturer which may include making appropriate tests.

This document replaces all earlier versions.