EC2 Series
Display Case Controllers

D A T A S H E E T

The EC2-Series form a state of the art generation of electronic controllers for refrigeration and air conditioning. The controllers combine in the small industry standard housing maximum functionality such as **superheat,** temperature and defrost controller with **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.

Several versions are available:

- EC2-35/37x Series Case Controllers (EXV, press. / temp.)
- EC2-31/39x Series Case Controllers (EXV, temp. / temp.)
- EC2-21/29x Series Case Controllers (TXV)
- EC2-11x Series Universal Controllers

EC2 Series
Display Case Controller

Features

- Superheat control with self-adapting algorithm and driver circuit for a pulse-width modulated EX2 Electrical Control Valve (EC2-35/37x & EC2-31/39x)
- Air temperature control
- Defrost and fan management (besides EC2-111/-112)
- Limitation of evaporating pressure (MOP) (EC2-35/37x & EC2-31/39x)
- 4 Relay/Triac outputs for valve, compressor, fan and defrost
- 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 Emerson Monitoring Server EMS.
- Alarm messaging by email (EC2-xx2)
- Electrical connection via plug-in type screw terminals
- 2½ digit LED display with automatic decimal point
- Indicator LEDs for compressor, fan, heater and alarm
- Standard 71 x 29 mm cut-out dimensions
- IP 65 protection class when mounted in front panel

Typical ordering package (EC2-312)

- EC2-312 Case Controller with K02-000 Terminal Kit
- EX2-I00 Electrical Control Valve with EXO-003 Orifice 3, ASC 24V Coil and ASC-N15 Cable
- ECT-323 Transformer
- ECX-N60 Ethernet Cable
- 2 x ECN-N30 Air Temperature Sensors
- 2 x ECN-P30 Pipe Temperature Sensors
- ECN-F60 Fin Temperature Sensor

Selection Table

	TCP/IP Ethernet			LON® FTT		
Description	Type	Part No. single unit	Part No. Kit*	Type	Part No. single unit	Part No. Kit*
Temperature/pressure superheat control for EX2	**EC2-352**	**807 772**	**808 009**	**EC2-351**	**807 771**	**808 008**
version for use with a compressor pack system	**EC2-372**	**807 688**	**808 011**	**EC2-371**	**807 689**	**808 010**
Temperature/temperature superheat control for EX2	**EC2-312**	**807 682**	**808 005**	**EC2-311**	**807 681**	**808 004**
version for use with a compressor pack system	**EC2-392**	**807 692**	**808 007**	**EC2-391**	**807 691**	**808 006**
TXV superheat control	**EC2-212**	**807 482**	**808 001**	**EC2-211**	**807 481**	**808 000**
version for use with a compressor pack system	**EC2-292**	**807 672**	**808 003**	**EC2-291**	**807 671**	**808 002**
Universal Controller	**EC2-112**	**807 472**		**EC2-111**	**807 471**	

*) Kits partlist see page 7

Introduction

The **EC2-3xx** Series Controllers are for use in commercial refrigeration systems, primarily to control the refrigeration circuit of display cases. This includes the control of the refrigerant flow to optimize superheat, maintain air temperature and the defrost management. An Alco Controls EX2 Electrical Control Valve must be used in conjunction with the **EC2-3xx** unit to modulate refrigerant flow.

The **EC2-2xx** Series are used in more traditional refrigeration systems where Thermo® Expansion Valves are used to control superheat.

Two separate control loops are coordinated in the **EC2-3xx** Series: One senses evaporating conditions 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 EC2 Controllers can operate as stand alone devices, they are best suited to networked solutions, which take advantage of the monitoring capabilities.

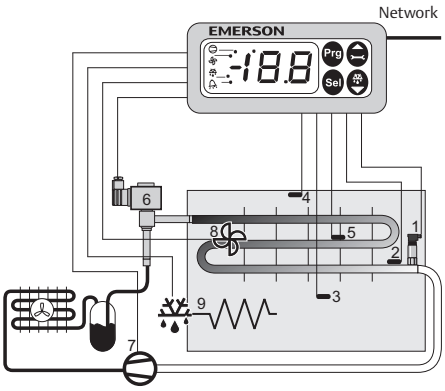
The **EC2-11x** model is a universal controller that may be used in a wide variety of applications. It is particularly useful in applications where auxiliary systems are used such as integral sandwich display cases or kitchen equipment, which require the control temperature to be monitored in the overall system. It is possible to monitor three temperatures as well as controlling / monitoring two digital inputs and 4 relay outputs.

The EC2 Series Case 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 EC2 Series Display Case Controllers are described in the functional diagrams below:

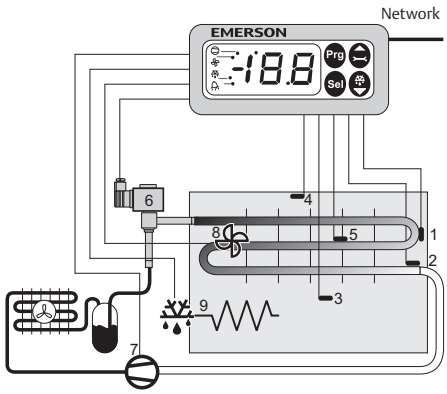
EC2-35x



With coil out temperature (2) and evaporating pressure (1) the superheat is calculated to define the opening of the Electrical Control Valve (6). Superheat can be set to a fixed value or an adaptive mode may be used. Air-in temperature sensor (3) and air-out temperature sensor (4) are part of the temperature control loop. The defrost heater (9) can be activated locally by fixed timing intervals or remotely through the communications port. For defrost end termination the fin temperature sensor (5) or the air-out temperature sensor (4) can be used. Fan (8) and compressor (7) are controlled as well. In case of power loss the Electrical Control Valve closes to avoid flooding of the compressor. A separate liquid line solenoid valve is not required.

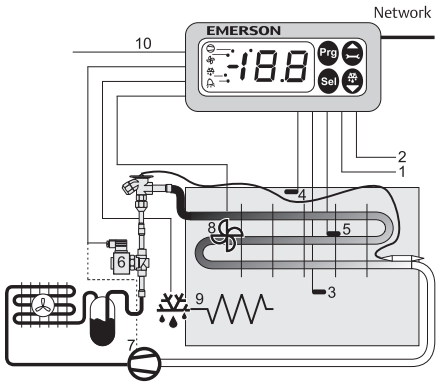
EC2-31x

In the EC2-31x Controllers superheat is calculated by measuring coil-in temperature (1) and coil-out temperature (2). All other functions are identical to the EC2-35x Series as described above.



EC2-21x

The **EC2-21x** model is a traditional case controller with a thermostat for temperature control used in conjunction with conventional solenoid valve and TXV. All functions and features except electronic superheat control are identical to the EC2-3xx Series.



Two volt free digital inputs of the EC2-211 LON® FTT-10 version may be logically bound using any LON management software such as ANL-220 to the digital output. This function is also possible with the EC2-212 when utilising the SNMP protocol. Switching the lights on/off is one such application for the additional inputs & output.

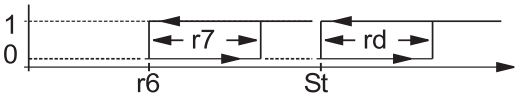
Superheat Control

The EC2-3xx Series controls evaporator superheat by varying the mass flow through the Electrical Control Valve (ECV). The controller automatically calculates the valve opening time required for the correct refrigerant mass flow by measuring pressure and temperature at the evaporator output (EC2-35x) or by measuring coil-in temperature and coil-out temperature (EC2-31x). ECN-Pxx pipe type temperature sensors and PT4 pressure transmitters from ALCO Controls must be used.

The controller works in two operating modes: **fixed superheat** and **adaptive superheat**. In the “fixed” mode, the superheat setpoint is fixed to a user-defined value. In the “adaptive” mode the controller varies superheat setpoints in the range between 3K and 15 K 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 (besides EC2-111/-112)

The ECN-Sxx air sensors are used for temperature control of the display case. The **dead band** control function is described in the diagram below:

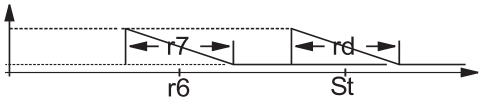


The horizontal axis represents the temperature, with St the setpoint for day operation and rd the difference at day, while r6 is the setpoint for night operation and r7 the difference at night. The vertical axis represents cooling operation (1 = cooling, 0 = no cooling).

A control parameter allows switching off the evaporator fan during “no cooling”.

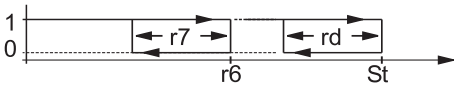
Depending on the application, air temperature control may be tied to the air-in or the air-out temperature sensor or a virtual air temperature sensor with the weighted average of air-in and air-out temperatures.

A more precise temperature control can be achieved (EC2-3xx only) 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 setpoint 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 setpoint 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 setpoint has been reached and the rack will automatically pump down if there is insufficient demand from the rest of the refrigeration system.

Defrost

EC2 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.

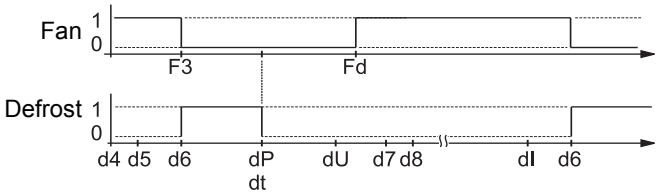
Two basic defrost modes are possible:

Natural Defrost

For medium temperature applications without defrost heaters. In this mode the evaporator fans are turned on during the defrost period.

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 or alternatively by the air-off temperature sensors ECN-Sxx.

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.

Display and Keypad

With the 2½ digit display temperatures within ±199°C can be shown with a resolution of 1°C. The resolution improves to 0.1°C within a range of ±19.9°C. The display unit can be switched from °C to °F. When displaying °F the same resolution as above applies.

Indicator LEDs show the status of compressor, fan, defrost and alarm. A blinking LED indicates that the EC2 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.

Operation and Commissioning

Setup and commissioning of an EC2 Series 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 EC2.
- Remotely via the EMS Server connected to the LON® port of an EC2.
- Locally through the 4-button keypad.

For initial commissioning of a new installation depending on the networking technology of the EC2 the first two options are the most appropriate. Commissioning is done via dedicated menus with meaningful default values, which make commissioning an EC2 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.

WebServer function of the EC2 with TCP/IP Ethernet networking capabilities

Though the actual status of the controllers can be viewed on the local display, 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 EC2-312 with the monitoring WebPage of the controller.

Echelon LON® Networking Capabilities of the EC2

The remote access, viewing and monitoring features of the LON® version EC2 Series Controllers match and exceed the capabilities of their TCP/IP counterparts. Though remote access requires the use of the Emerson EMS Monitoring Server or special third party LON® compliant hardware and software, many more additional functions and features are available.

The LON® version EC2 Controllers are equipped with 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 EC2 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.

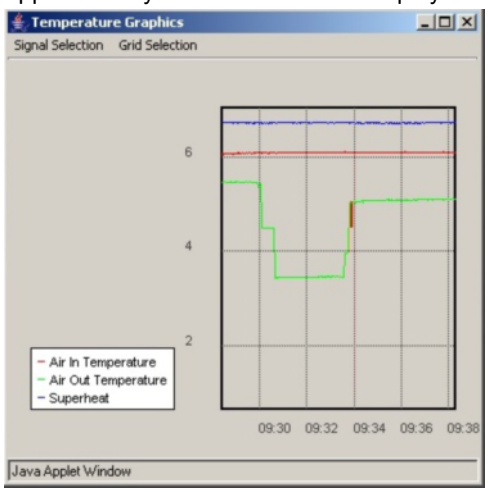
Where to apply TCP/IP Ethernet vs. LON® Controllers

In general TCP/IP Ethernet controllers are more applicable for small and medium 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.

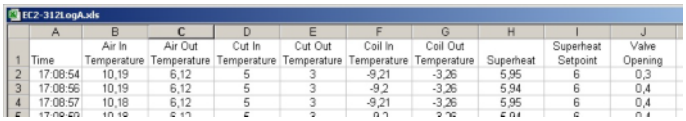
In larger installations LON® has its merits. Network wiring is easier and less costly. Peer-to-peer communication is another benefit of LON® and data retrieval and storage are very easily achievable. These advantages come at a price however: a monitoring and server device like the Emerson EMS is needed 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 status of compressor, defrost heater and fan (left) and a general alarm (right). The fields below show temperatures, pressure (EC2-352 only) of all sensors attached to the controller as well as the setpoints for air temperature and superheat. The actual value for superheat and the valve opening are displayed too. 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:

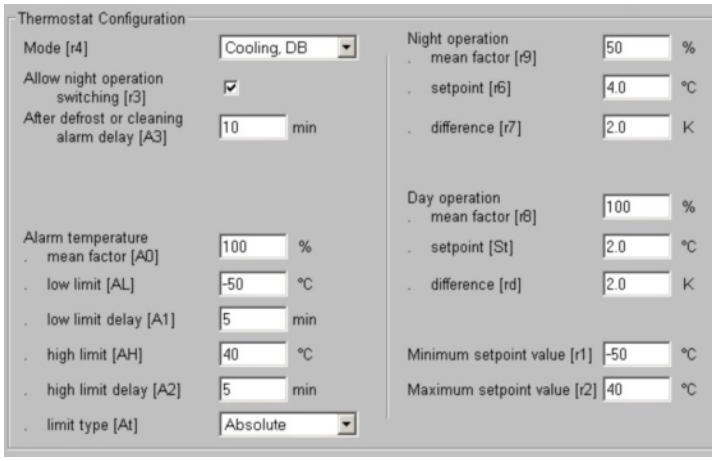


A logfile can be stored on the PC. The file format of the datalog is text with semicolon (;) separated fields. On the picture below is a sample log file from an EC2-312, imported in Microsoft Excel®:



	A	B	C	D	E	F	G	H	I	J
1	Time	Air In Temperature	Air Out Temperature	Cut In Temperature	Cut Out Temperature	Coil In Temperature	Coil Out Temperature	Superheat	Superheat Setpoint	Valve Opening
2	17:08:54	10,19	6,12	5	3	-9,21	-3,26	5,95	6	0,3
3	17:08:56	10,19	6,12	5	3	-9,2	-3,26	5,94	6	0,4
4	17:08:57	10,18	6,12	5	3	-9,21	-3,26	5,95	6	0,4

All WebPages, which allow the change of controller parameters, are password protected. Below is the example for the thermostat configuration WebPage of an EC2-312 Controller. The set points of day and night operation, as well as the settings which will initiate an alarm can be easily reviewed and modified if needed:



Alarm / maintenance functions

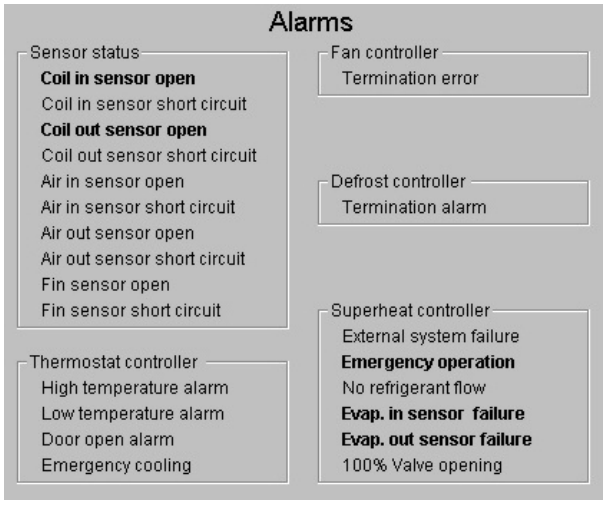
EC2 Series Controllers provide many alarm codes to facilitate diagnosis.

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

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 EMS monitoring server.

The TCP/IP Ethernet versions EC2 Controllers have the capability to send alarm messages directly by email.

While the display 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:

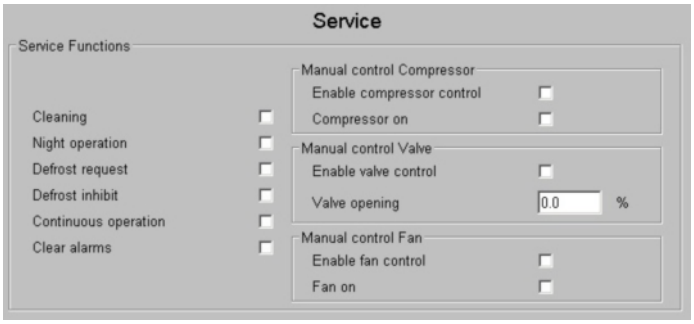


Safety Functions

Various safety functions are available for use particularly when the EC2 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.

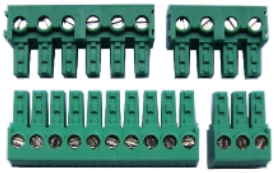
Particularly useful facilities are the service functions, which enable the engineer to manually control the system during commissioning. They include manual operation of compressor, fan and Electrical Control Valve, or special operating modes of system for cleaning, permanent night operation, manual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



Electrical Connection

For electrical connection removable screw connectors can be used. This allows the electrical wiring to be completed at the display case manufacturer and the controller is simply plugged-in on site when necessary. The terminal Kit must be ordered separately

For TCP/IP controllers an Ethernet cable must be used. The assembled cable ECX-N60 comes with RJ45 connector on one side and the 4-pin screw connector at the other.



Typical Screw Connctor Kit

EC2-312, Rear side

Accessories

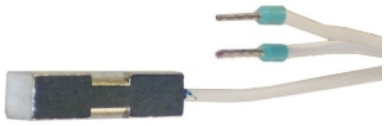
Terminal Kits and Cables

	Type	Part No.
Terminal Kit for EC2-35x / -37x / -31x / -39x	K02-000	800 050
Terminal Kit for EC2-21x / -29x / -11x	K02-211	807 647
Ethernet cable (TCP/IP, RJ45/4-pin-conn.) 6,0m	ECX-N60	804 422

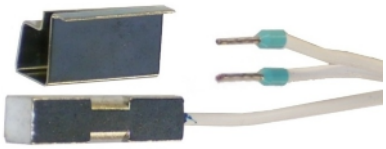
Pulse Width Modulated Electrical Control Valves (for details see datasheet EX2)

Nominal capacity R404A	0,06 to 12,1kW	EX2-I00	801 090
Orifice 4	0,7 to 7,7kW	EXO-004	801 089
Orifice 3	0,5 to 5,1kW	EXO-003	801 088
Orifice 2	0,3 to 3,0kW	EXO-002	801 087
Orifice 1	0,2 to 2,3kW	EXO-001	801 086
Orifice 0	0,1 to 1,1kW	EXO-000	801 085
Orifice X	0,06 to 0,6kW	EXO-00X	801 084
Coil 24VAC		ASC 24V	801 052
Cable and connector assembly for EX2	1.5m length	ASC-N15	804 570
	3m length	ASC-N30	804 571
	6m length	ASC-N60	804 572

ECN-Sxx Air Sensor



ECN-Pxx Pipe Sensor



ECN-Fxx Fin Sensor

NTC Sensors (Air type) (10kΩ at 25°C)	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) (10kΩ at 25°C)	3m cable length	ECN-P30	804 280
	6m cable length	ECN-P60	804 281
	8m cable length	ECN-P80	804 282
NTC Sensors (Fin type) (10kΩ at 25°C)	6m cable length	ECN-F60	804 283

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
	3m cable length	PT4-M30	804 804
	6m cable length	PT4-M60	804 805

PT5-07M Pressure Transmitter with Cable Plug Assembly PT4-Mxx

Transformers Class II	230VAC Input, 24V output, 25VA, DIN	ECT-323	804 442
	115-230VAC Input, 12/24V output, 20VA	ECT-523	804 332

ECT-323

ECT-523

Kits Parts List:

		PCN	808 000	808 001	808 002	808 003	808 004	808 005	808 008	808 009	808 010	808 011	808 006	808 007
		Kit	EC2-211 Ctr. Kit LON	EC2-212 Ctr. Kit TCP/IP	EC2-291 Ctr. Kit LON	EC2-292 Ctr. Kit TCP/IP	EC2-311 Ctr. Kit LON	EC2-312 Ctr. Kit TCP/IP	EC2-351 Ctr. Kit LON	EC2-352 Ctr. Kit TCP/IP	EC2-371 Ctr. Kit LON	EC2-372 Ctr. Kit TCP/IP	EC2-391 Ctr. Kit LON	EC2-392 Ctr. Kit TCP/IP
Terminal Kits														
K02-000	800 050						1	1	1	1	1	1	1	1
K02-211	807 647		1	1	1	1								
Sensors														
ECN-F60	804 283		1	1	1	1	1	1	1	1	1	1	1	1
ECN-P60	804 281				2	2	2	2	1	1	3	3	4	4
ECN-S60	804 284		2	2			2	2	2	2				
Transformers														
ECT-523	804 332		1	1	1	1	1	1	1	1	1	1	1	1
Pressure Transmitter														
PT5-07M	802 350								1	1	1	1		
Cable Assembly PT4														
PT4-M60	804 805								1	1	1	1		

Technical Data

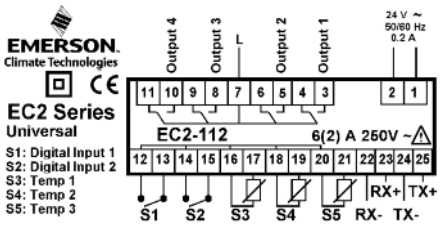
Supply Voltage Power Consumption	24VAC ± 10% 50/60 Hz 4VA max (EC2 only) 20VA max including EX2
Plug-in connector size	Removable screw version wire size 0.14 … 1.5mm^2
Communication	TCP/IP Ethernet (EC2-xx2) LON® FTT-10 (EC2-xx1)
Display	2½ digits red LED -199 to +199 with decimal point Switchable between °C & °F 4 indicator LEDs
Temperature storage operating	 -20 … +65° 0 … +60°C
Humidity	0 … 80% r.h. non condensing
Protection class	IP65 (front protection with gasket)
Weight	~ 150g
Mounting	Panel mount (71 x 29mm cutout)
Marking	AB28

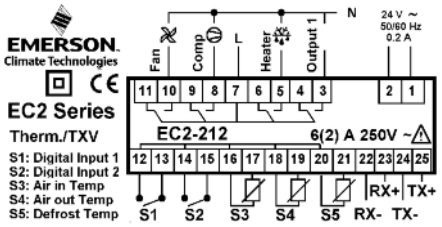
Input and Output Configuration

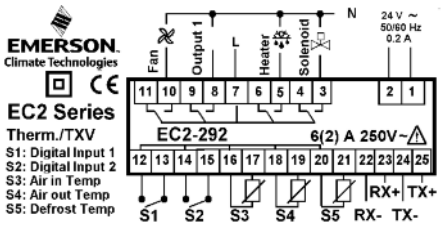
	EC2-11x	EC2-21x / -29x	EC2-31x	EC2-39x	EC2-35x	EC2-37x
Temperature Inputs 10kΩ @ 25°C, -50…50°C	3	3	5	5	4	4
Pressure Transmitter Input 24VDC, 4…20mA					1	1
Digital Inputs, configurable Volt free contact 5V / 0,1mA	2	2		1		1
Output relays, AgNi Inductive (AC15) 250V / 2A Resistive (AC1) 250V / 8A			3	3	3	3
Resistive (AC1) 250V / 6A	4	4				
Output Triac for EX2 coil 24VAC 0,1…1A			1	1	1	1
Digital output configurable	4	1		1		1
Communication TCP/IP or LON®	Ethernet 10Mbit/sec. FTT10					

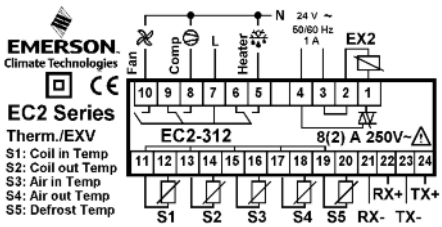
Wiring Diagrams

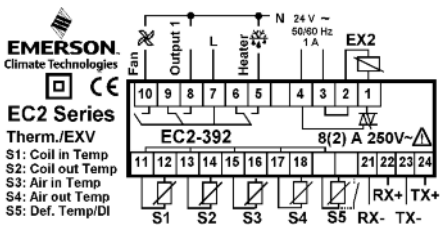
TCP/IP:

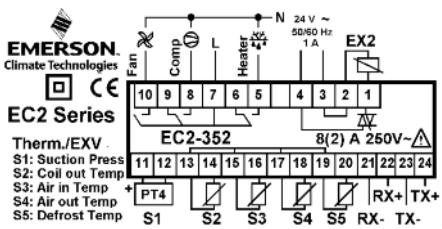


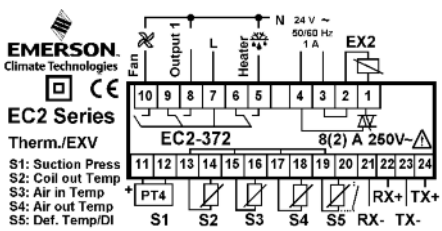




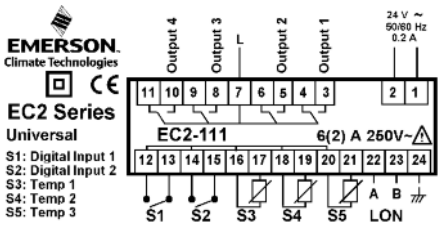


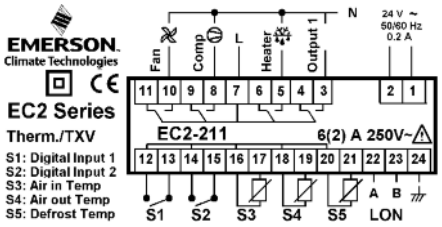


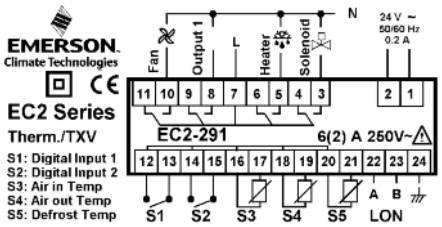


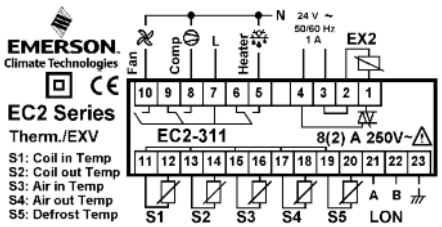


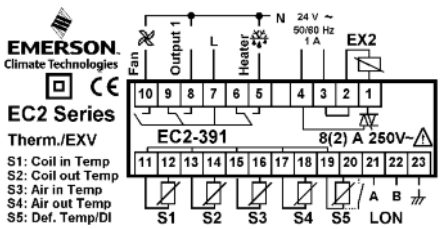
LON:

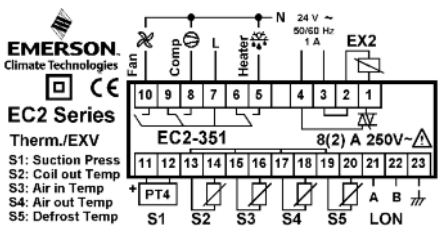


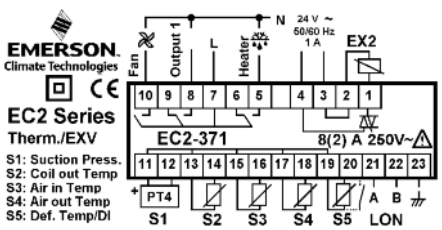






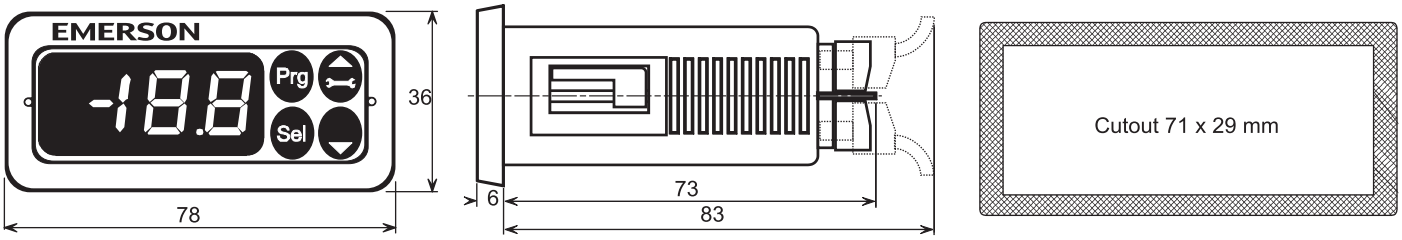




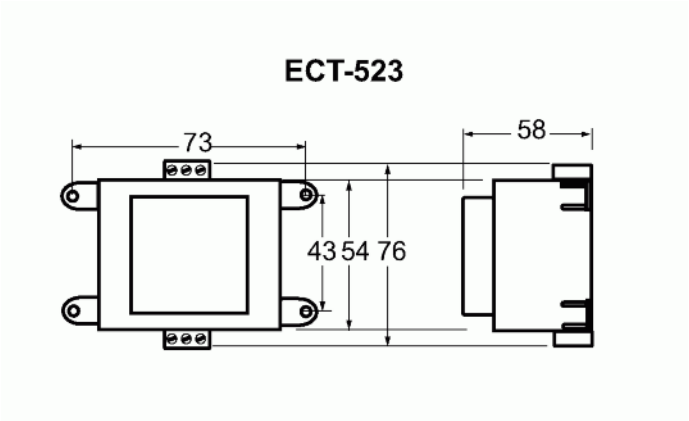


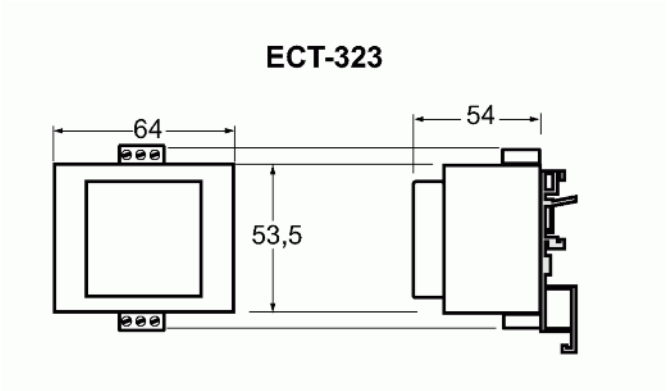
Physical dimensions, drawings

EC2-3xx, -2xx, -1xx



Transformers





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