DRIVER
FOR ELECTRONIC EXPANSION VALVES
TM168DEVCM

USER MANUAL

Summary

1 Generalities

TM168DEVCM is a stand-alone driver for electronic expansion valves.
The instrument has:

- 1 measurement input for pressure transducers 4-20 mA (evaporation probe)
- 1 measurement input for NTC probes (intake probe)
- 1 high voltage digital input (functioning consent)
- 2 low voltage digital inputs (functioning consent and state of the back-up battery charge)
- 1 power supply input coming from the back-up battery
- 1 digital output (relay), 5 A resistif. @ 250 VDC, for alarm output control
- 1 serial port with MODBUS communication protocol
-

The device can function only with the Alco Control valves belonging to the EXM, EXL, EX4, EX5, EX6, EX7, EX8 and EX9 ranges.
The device is in 4 modules DIN module. The user interface is made up from a custom display with 4 digits (with function icons) and 4 keys (set, up, down and escape).

Among the many features, the following are also indicated:

- front panel protection rating IP54
- management of high over-heating and low over-heating alarms
- MOP function (Maximum Operating Pressure)
- LOP function (Lowest Operating Pressure).

2 Technical features

2.1 Connections

Power supply:
TM168DEVCM is powered by an alternating current equal to 24 V. The maximum length of the power supply connection cables is 1 m. The TM168DEVCM power supply is not isolated; therefore **it must be galvanically isolated from other devices**.

Connection of the analogue inputs:
TM168DEVCM has two analogue inputs, one for NTC temperature probe and one for pressure transducer 4-20 mA. The pressure transducer can be powered via a 12 VDC unstabilised voltage, available on an instrument clamp. The maximum length of the analogue input connection cables is 3 m.

Connection of the digital inputs:
TM168DEVCM has three digital inputs of which two low voltage (functioning consent and back-up battery charge state) non optoisolated and one in high voltage (functioning consent). The maximum length of the digital input connection cables is 3 m.

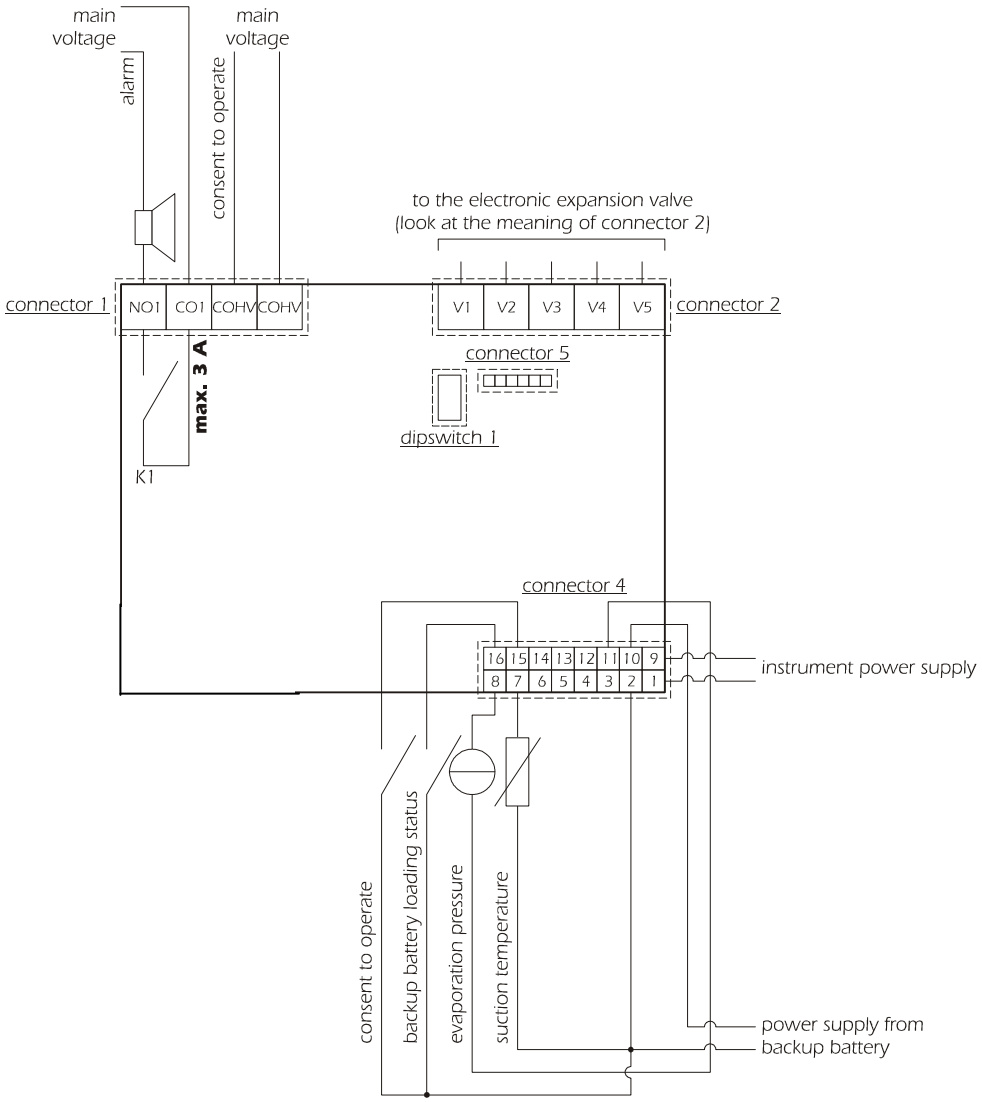
Connection of the digital outputs:
TM168DEVCM has one digital output with electro-mechanical relay. The maximum length of the output connection cables is 10 m.

Connection of the electronic expansion valve:
The maximum length of the electronic expansion valve connection cables is 6 m.

Precautions
The indications regarding the maximum lengths of the connections imply that a series of precautions are respected.
To prevent immunity problems, it is good practice to comply with the following indications:
- avoid places with antennas
- do not wire probe inputs with relay outputs; generally, prevent mixing low and high voltage signals
- do no wind cables around power components

2.2 TM168DEVCM electric connection

Below find the TM168DEVCM connection layout with relative table regarding the meaning of inputs and outputs.



Connector 1: functioning consent relay output and digital input (high voltage).

Code	Description
NO1	K1 relay normally open contact
CO1	K1 common relay
COHV	Functioning consent digital input (230 VDC ± 15%)
COHV	Functioning consent digital input (230 VDC ± 15%)

Connector 2: electronic expansion valve.

Code (Alco reference)	Description for EXM-246 / EXL-246 [(1)]valves
V1	Shield
V2 (2B)	White wire
V3 (2A)	Orange wire
V4 (1B)	Blue wire
V5 (1A)	Yellow wire
Code (Alco reference)	**Description for EX4 / EX5 / EX6 / EX7 / EX8 / EX9 valves**
V1	Shield
V2 (2B)	White wire
V3 (2A)	Black wire

V4 (1B)	Blue wire
V5 (1A)	Brown wire

(1) The red wire and the brown wire are not used.

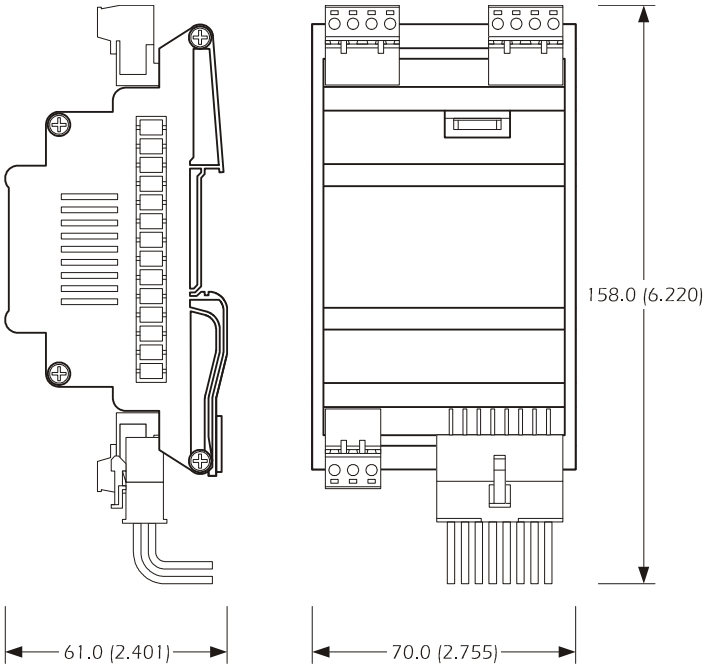
Connector 4: instrument power supply, back-up battery power supply, measurement inputs, digital inputs.

Code	Description
1	Instrument power supply (24 VDC)
2	Common analogue and digital inputs
3	Common analogue and digital inputs
4	Common analogue and digital inputs
5	Not used
6	Not used
7	Analogue input 2 (NTC temperature probe)
8	Analogue input 1 (pressure transducer 4-20 mA)
9	Instrument power supply (24 VDC)
10	Back-up battery power supply (12 VDC)
11	Pressure transducer power supply (12 VDC)
12	Not used
13	Not used
14	Not used
15	Functioning consent digital input
16	Back-up battery charge state digital input

Connector 5: to the TTL / RS-485 interface.

2.3 TM168DEVCM dimensions and installation

The mechanical dimensions of TM168DEVCM are given below; the measurements are expressed in mm (in).

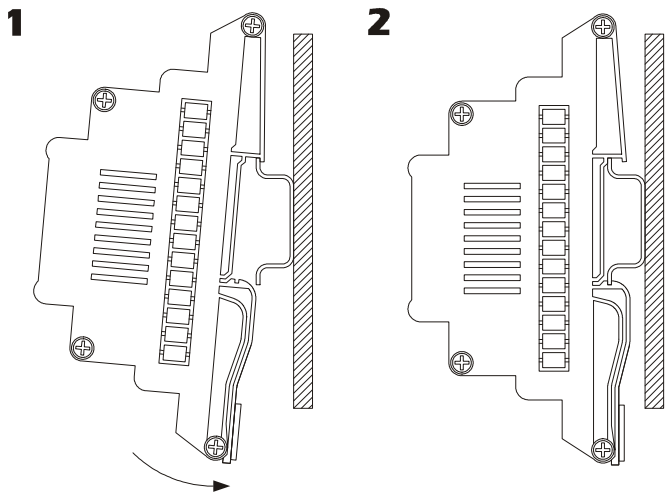


Installation recommendations:

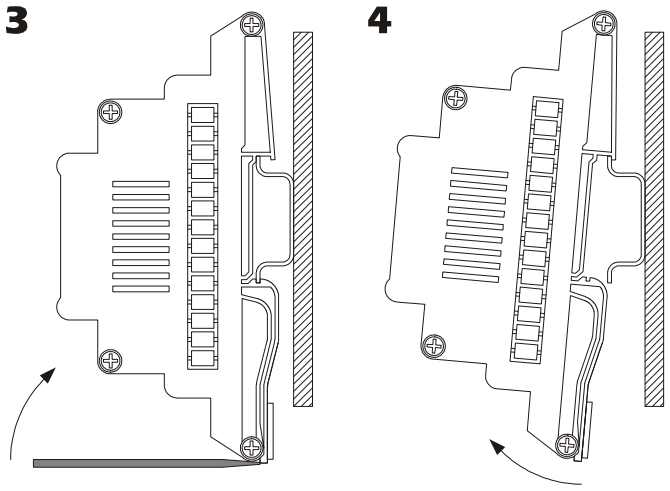
- make sure that the work conditions (temperature of use, humidity, etc.) lie within the limits indicated in the technical data

- do not install the instrument in proximity of heat sources (resistances, hot air pipes etc.) appliances with strong magnets (large diffusers etc.), places subject to direct sunlight, rain, humidity, excessive dust, mechanical vibrations or shocks
- in compliance with Safety Standards, the protection against any contact with the electric parts must be ensured via correct installation of the instrument. All parts that ensure protection must be fixed in a way such that they cannot be removed without the aid of a tool

To install TM168DEVCM, operate as indicated in the diagrams (points 1 and 2).



To remove TM168DEVCM, use a screwdriver and operate as indicated in the diagrams (points 3 and 4).



2.4 General features

Reference Standards regarding safety	EN60730-1
Purpose of the device	Electronic expansion valve driver
Storage conditions	-10T65 °C non-condensing R.H.<80%
Functioning conditions	0T50 °C non-condensing R.H.<80%
Class according to the protection against electric shocks	Control device to be integrated; assumes the classification of the appliance with which it is integrated
Type of disconnection	Reduced interruption (relay contacts)
PTI of the insulating materials	>=250V
Container	Assembly on omega guide
Type of actions	1C
Pollution	Normal
Class of software	A
Period of the electric stress of the insulating parts	Long
Front panel protection rating	IP40

2.5 Technical features

Connection for low voltage signals	Mini-Fit 16-way
Power connector	Phoenix disconnectable terminal board
	Cable section > 0.75mm^2
IntraBus serial port connection	Phoenix disconnectable terminal board
Connection for the parameters key, TTL serial output for RS-485 module, interface for Flash programming	6-way AMP micro-maTch

SPECIFICATIONS OF THE 16-WAY MINI-FIT CONNECTOR		
SUPPLIER	CONNECTOR CODE	CONTACTS CODE
Note: use the appropriate tool for crimping		
CVILUX	CP-01 116010 (V2) CP-01 116020 (V0)	CP-01 1000102 (AWG16÷24)
SELECOM	6137R16WO (V2)	6137TR1 (AWG16÷20) 6137TR2 (AWG22÷26)
JUSCOM	1090-557-162 (V2)	1150-156-012 (AWG18÷22) 1150-156-002 (AWG22÷26)
CONEXCON	6740-1161 (V2) 6740-1160 (V0)	6744-2000 (AWG18÷22)
MOLEX	39-01-2160 (V2) 39-01-2165 (V0)	39-00-0038 (AWG18÷24) 39-00-0046 (AWG22÷28)

2.6 Electric features

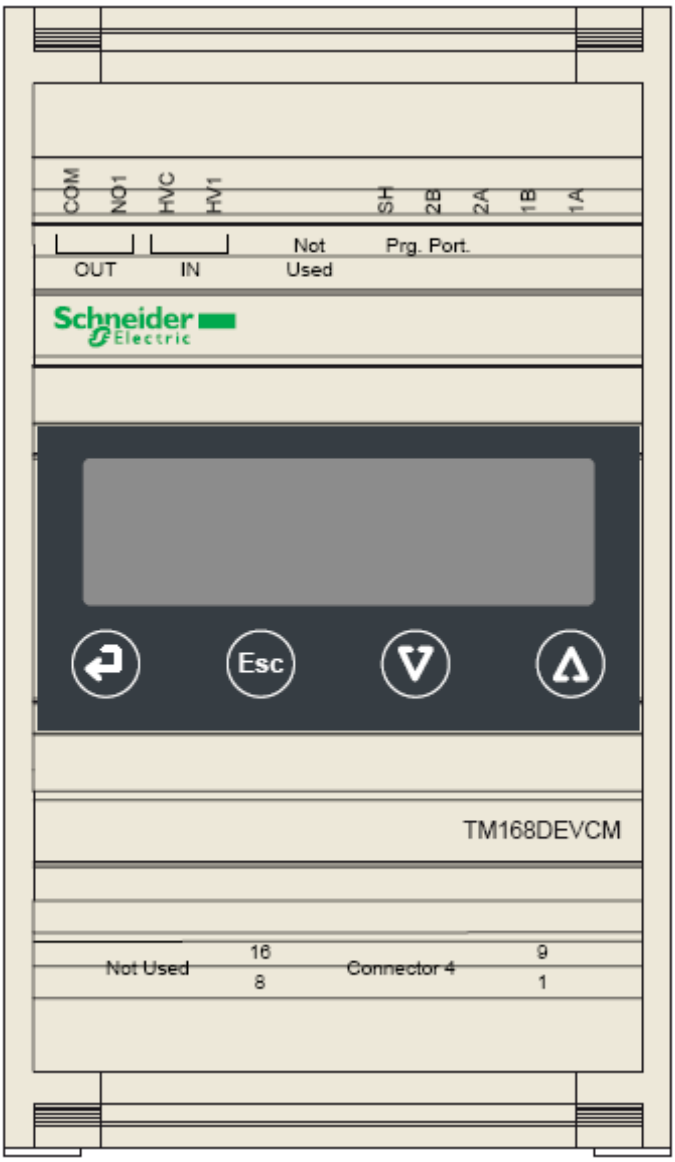
Power supply	Voltage	24 VDC
	Range	-10% +15%
	Frequency	50/60Hz
	Maximum power absorbed	30VA
	Protection fuse	External
Digital outputs	Number	1
	Type	Electro-mechanical relays
	Maximum contact current at 250Vdc	3 (1) A
	Number of manoeuvre cycles	100.000
	Minimum interval between switch-overs	20s
	Type of micro switch interruption action	1C
	Insulation between the relay and low voltage	Reinforced
Valve motor outputs	Number	1
	Type	Step-by-step motor driver
	Power supply	Generated inside the module
Digital inputs in low voltage	Number	2
	Type	Potential-free contact
	Current on the closing contact towards earth	2mA
	Maximum closure resistance	100Ω
	Detection time from OFF to ON	100ms
	Detection time from ON to OFF	100ms
Digital inputs in high voltage	Number	1
	Type	Optoisolated
	Voltage range	230 VDC ± 20 %
	Min. detection time from OFF to ON	100ms
	Min. detection time from ON to OFF	100ms
Analogue inputs for NTC probes	Number	1
	Type	NTC (10 KOhm ± 1 % @ 25 °C)
	NTC measurement range	-50°C ÷ 50°C in fluid -50°C ÷ 105°C in air
Analogue inputs for pressure transducers	Number	1
	Type	Current
	Current measurement range	4-20 mA
	Power supply	8 ... 30 VDC
	Input resistance	< 200 Ohm
Back-up battery power supply input back-up	Voltage	12 VDC
	Type of battery	lead, 12 V, 2 ...6 Ah
	Battery charger	I max = 150 mA, V max = 13 V
	Maximum power absorbed	30VA
	Protection fuse	External

The high voltage digital output and the digital input have reinforced insulation with respect to the remaining I/O.

3 User interface

3.1 Display and keyboard

The built-in interface on the controller is made up from a 4 digit custom display (for displaying quantities), 4 keys (for surfing) and 16 icons (for immediate and intuitive representation).

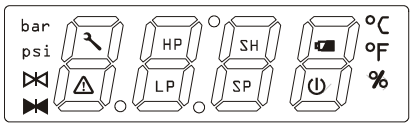


Main functions that can be activated using the keys:

Key pressed	Function
DOWN during lamp test from power-on	Display version/firmware revision
DOWN for 2 seconds	Quantity temporary display
SET/ENTER for 2 seconds	Display/ over-heating set-point modification (PH30=0 disables the possibility for modification)
DOWN + UP for 4 seconds	Display/modify/reset parameters
UP	Alarms display

for 2 seconds	
ESC for 2 seconds	Display /modify % valve output n manual mode
SET/ENTER + DOWN for 2 seconds	Block/Release keyboard

Meaning of the icons:



Icon	Colour	Function
bar	Green	Identifies the unit of measurement selected. If on, it indicates that the pressure is expressed in bar
psi	Green	Identifies the unit of measurement selected. If on, it indicates that the pressure is expressed in psi
⋈ valve closed	Green	Identifies the valve state (closing): Off: the valve is closed or off or <5% On: the valve is open at a value > 95 % Flashing: the valve is working
%	Amber	If on, it indicates that the % opening of the valve is being displayed
°F	Red	Identifies the unit of measurement selected. If on, it indicates that the temperature is expressed in °F-°R
°C	Red	Identifies the unit of measurement selected. If on, it indicates that the temperature is expressed in °C-°K
maintenance	Red	Identifies the request for maintenance. If on, the valve is operating in manual mode.
⚠ alarm	Red	Identifies the presence or not of alarms. Alarms are present if it is on, otherwise it remains off.
HP (MOP)	Green	It is active when the MOP function is activated Off: function not active On: MOP function enabled Flashing: MOP alarm
LP (LOP)	Green	It is active when the LOP function is activated Off: function not active On: Low pressure alarm Flashing: LOP alarm
SH	Green	It is active when the SH function is activated Off: function not active On: function on (I am viewing the SH value) Flashing: LSH, HSH alarm
SP	Green	Identifies that a set-point is being displayed. Flashing: the set-point is being modified.

Back-up battery	Green	Battery state (DI2) Off: Battery charged On: Back-up battery being charged or back-up module disconnected
on/stand-by	Red	Identifies the state of the valve Off: valve on (enabled) On: valve off (disabled) Flashing: valve in start-up
central decimal point higher	Red	Identifies the Intrabus communication state Off: No communication On: Communication error Flashing: Communication OK

3.2 Main page

The main screen changes according to the state of the valve: if the valve is not enabled (vale open and regulation deactivated) OFF is shown and the relative icon (stand-by) is on; if the valve is enabled (valve closed and regulation activated) the values selected by the PdIS parameter is selected (or an error label). The relative icon (stand-by) is off (an icon corresponds to the quantity displayed).

3.3 Temporary display of the quantities

Operate as indicated:
- press the DOWN key for 2 seconds: the SH label is displayed
- press the SET/ENTER key to display the over-heating value measured
- press the UP or DOWN key to change the default display according to the following table:

SH	Over-heating value measured
PrES	Pressure value measured
PErC	% valve opening
TEMP	Temperature value measured
TSAT	Temperature value calculated (from the pressure)
SHSP	Over-heating set-point value
SEtP	Set of parameters currently selected

To exit the procedure:
- press SET or do not operate for 60 seconds or press UP or DOWN until the display shows the quantity established by the PdIS parameter or press the ESC key.

3.4 Setting the work set-point

Operate as indicated:
- make sure that the machine is on, that the keyboard is not blocked and that no procedure is in progress
- press the SET/ENTER key for 1 s: the display will show the current over-heating set-point
- press the UP or DOWN key within 15 s
- press SET/ENTER or do not operate for 15 s.

Using parameter PH30 it will be possible to block the possibility of modifying the set point; in his case, if you try to modify the set-point, LOC is shown for 2 s.

3.5 Setting the configuration parameters

This paragraph presents the menus found in the application. The main menu is divided into two levels (user and installer).
The installer level is protected by a password.
The range of values for those that can be set for the password is -99 / 999 (default = –19).
After 1 minute that no key is pressed, the password expires and must be set again.
To access the procedure, operate as indicated:
- make sure no procedure is in progress

- press the UP and DOWN key for 4 s the display will show a label.

To select a parameter:
- press the UP or DOWN key.

To modify a parameter:
- press the SET/ENTER key
- press the UP or DOWN key within 15 s
- press the SET/ENTER key or do not operate for 15 s.

To access the installer level:
- press the UP or DOWN key to select PA.
- press the SET/ENTER key
- press the UP key or the DOWN key within 15 s to set the password defined with the "PASS" parameter (default -19)
- press the SET/ENTER key or do not operate for 15 s
- press the UP and DOWN key for 4 s the display will show a label.

To exit the procedure:
- press the UP and DOWN key for 4 s or do not operate for 60 s.

Cut off the power supply to the instrument after modification of the parameters.

3.6 Restore the default value of the configuration parameters

Operate as indicated:
- make sure no procedure is in progress
- press the UP and DOWN key for 4 s the display will show a label
- press the UP or DOWN key to select PA
- press the SET/ENTER key
- press the UP or DOWN key within 15 s to set 743
- press the SET/ENTER key or do not operate for 15 s
- press the UP and DOWN key for 4 s the display will show dEF.
- press the SET/ENTER key
- press the UP or DOWN key within 15 s to set 149
- press the SET/ENTER key or do not operate for 15 s: the display will show flashing dEF for 4 seconds, after which the instrument will exit the procedure
- cut the instrument power supply off.

Make sure that the default value of the parameters is appropriate.

3.7 Main menu

It is possible to enter/display this menu holding the UP+DOWN keys down for 4 seconds.
The first variable displayed is rI00 (evaporation pressure); pressing SET/ENTER, the value is displayed. Using the UP or DOWN keys, scroll the list of VCM variables in reading only mode.
To exit the procedure: press UP+DOWN for 4 seconds or do not operate for 60 seconds or press the ESC key.

3.8 Display of firmware identification

On switch-on, during the lamp test phase, holding the DOWN key, the project identification is displayed for about 2 seconds. The information regarding the versions/revisions of the project is displayed in sequence. The procedure is exited automatically at the end of the lamp test.

4 List of parameters

Below find the list of all parameters managed by the application. A brief description, the range of acceptable values, unit of measurement, the default value and the menu in which it is found is supplied for every parameter. The menus are structured according to the following logic: user menu (UT) allows to modify the overheating set-point. Installer menu (IS) allows to modify all parameters; only if the installer menu is protected by a password.

Code	Parameter description	Default	Min	Max	U.M.	Menu	Notes
	FUNCTIONING MODE						
SEtP	Functioning mode	1	1	3	-	IS	1 = Parameters Set1 2 = Parameters Set2 3 = Parameters Set3
	SET1 (chiller)						
PC01	Set Point Superheat Chiller	6	0.5 (1.0)	30.0 (50.0)	K (°R)	UT	SP Over-heating SET1
PC02	Set Point Low Superheat Chiller	2	0.5 (1.0)	30.0 (50.0)	K (°R)	IS	
PC03	SP Superheat Chiller High alarm	30	0.5 (1.0)	50.0 (90.0)	K (°R)	IS	
PC04	LOP Chiller Temperature	-30	-40.0 (-40.0)	40.0 (100.0)	°C (°F)	IS	
PC05	MOP Chiller Temperature	30	-40.0 (-40.0)	40.0 (100.0)	°C (°F)	IS	
PC06	Valve opening duration from start-up	5	1	30	s	IS	
PC07	Valve opening % from start-up	50	10	100	%	IS	
	SET2 (heat pump)						
PP01	HP Set Point Superheat	6	0.5 (1.0)	30.0 (50.0)	K (°R)	UT	SP Over-heating SET2
PP02	Set Point Superheat HP	2	0.5 (1.0)	30.0 (50.0)	K (°R)	IS	
PP03	SP Superheat HP High alarm	30	0.5 (1.0)	50.0 (90.0)	K (°R)	IS	
PP04	LOP HP temperature	-30	-40.0 (-40.0)	40.0 (100.0)	°C (°F)	IS	
PP05	MOP HP temperature	30	-40.0 (-40.0)	40.0 (100.0)	°C (°F)	IS	
PP06	Valve opening duration from start-up	5	1	30	s	IS	
PP07	Valve opening % from start-up	50	10	100	%	IS	
	SET3 (defrost)						
Pd01	Set Point Superheat Def	6	0.5 (1.0)	30.0 (50.0)	K (°R)	UT	SP Over-heating SET3
Pd02	Set Point Low Superheat Def	2	0.5 (1.0)	30.0 (50.0)	K (°R)	IS	
Pd03	SP Superheat Def High alarm	30	0.5 (1.0)	50.0 (90.0)	K (°R)	IS	
Pd04	LOP temperature Def	-30	-40.0 (-40.0)	40.0 (100.0)	°C (°F)	IS	
Pd05	MOP temperature Def	30	-40.0 (-40.0)	40.0 (100.0)	°C (°F)	IS	
Pd06	Valve opening duration from start-up	5	1	30	s	IS	
Pd07	Valve opening % from start-up	50	10	100	%	IS	
	PROTECTIONS						Note: Parameters common

	ALARMS						to the various parameters SET
PA01	Enable communication alarm	0	0	1	-	IS	0 =disabled 1 = standard enabled
PA02	Communication alarm delay T.	30	5	200	s	IS	
PA10	Enable Low Superheat Alarm	0	0	1	-	IS	0 =disabled 1 = enabled
PA11	Low Superheat alarm hysteresis	3	0.5 (1.0)	30.0 (50.0)	K (°R)	IS	
PA12	Low Superheat alarm delay T.	3	0	250	min	IS	
PA20	Enable High Superheat Alarm	0	0	1	-	IS	0 =disabled 1 = enabled
PA21	High Superheat alarm hysteresis	3	0.5 (1.0)	30.0 (50.0)	K (°R)	IS	
PA22	High Superheat alarm delay T.	3	0	250	min	IS	
PA30	Enable Low Pressure Alarm	0	0	1	-	IS	0 =disabled 1 = enabled
PA31	SP Low Pressure alarm	0	-0.8 (-10.0)	50.0 (700.0)	Bar (psi)	IS	
PA32	Low Pressure alarm hysteresis	0,3	0.1 (0.1)	1.0 (15.0)	Bar (psi)	IS	
PA33	Low Pressure alarm delay T.	3	0	250	min	IS	
PA40	Enable LOP Protection Alarm	0	0	1	-	IS	0 =disabled 1 = enabled
PA41	LOP alarm hysteresis	3	0.1 (0.1)	15.0 (30.0)	°C (°F)	IS	
PA42	LOP alarm delay T.	3	0	250	min	IS	
PA50	Enable MOP Protection Alarm	0	0	1	-	IS	0 =disabled 1 = enabled
PA51	MOP alarm hysteresis	3	0.1 (0.1)	15.0 (30.0)	°C (°F)	IS	
PA52	MOP alarm delay T.	3	0	250	min	IS	
	DISPLAY						
PdIS	Value to show on the display	0	0	6	-	IS	0 = Over-heating value (K or R) 1 = Evap. pressure measured (bar/psi) 2 = % valve opening 3 = Intake temp. measured (°C/°F) 4 = Saturate gas (°C/°F) calculated (from P) 5 =SP overheating value 6 =SEtP selected parameters
	VALVE AND DRIVER ENABLING						
Pr02	Enables manual functioning of the valve	0	0	2	-	IS	0 = No 1 = Yes, manual 2 = Debug
Pr03	If in Manual func. mode, set the valve output %	0	0	100	%	IS	
Pr04	Enables valve forcing with probe error	0	0	1	-	IS	0 = No 1 = Yes
Pr05	% valve in case of probe error	0	0	100	%	IS	

Pr06	Enabling mode for valve regulation	0	0	3	-	IS	0 = From digital input DI1 1 = From digital input DIHV 2 = From serial IntraBus 3 = ModBus
Prd0	Step rate	10	1	200	-	IS	Step rate (ms) = Prd0 * 100
Prd1	% minimum opening	0	0	Prd2	%	IS	
Prd2	% maximum opening	100	Prd1	100	%	IS	
	BACKUP						
Pb01	Back-up battery	0	0	1	-	IS	0 = absent 1 = present
	VARIOUS						
PH01	Enable alarm relay	0	0	2	-	IS	0 = disabled 1 = enabled from any alarm 2 = enabled only for probes error
PH02	Relay logic alarm	0	0	1	-	IS	0 = normally unexcited 1 = normally excited
PH10	Sets the D11 digital input logic	0	0	1	-	IS	0: Normally open NO 1: Normally closed NC
PH11	Sets the D12 digital input logic	1	0	1	-	IS	0: Normally open NO 1: Normally closed NC
PH12	Sets the D1HV digital input logic	0	0	1	-	IS	0: Normally open NO 1: Normally closed NC
PH20	Sets the pressure unit of measurement:	0	0	1	-	IS	0: Bar 1: psi
PH21	Sets the temperature unit of measurement:	0	0	1	-	IS	0: °C 1: °F Note K-R for over-heating
PH22	Sets the display of the Schneider Electric icon	1	0	1	-	IS	0: NO 1: YES
PH30	Disables set-point modification from keyboard using SET/ENTER key	0	0	1	-	IS	0: block function disabled 1: block function enabled
PSPI	Sets clock frequency of the SPI serial	2	0	3	Khz	IS	0 = 3.9 Khz 1 = 8.9 Khz 2 = 15.6 Khz 3 = 17.8 Khz
	SERIAL NETWORK (MODBUS)						
Mod5	Board Modbus Address	1	1	247	n	IS	
Mod6	Board communication Baud Rate	2	0	3	n	IS	0 = 2400 1 = 4800 2 = 9600 3 =19200
Mod7	ModBus Parity	2	0	2	n	IS	0 = none 1 = Odd 2 = Even
Mod8	StopBit ModBus	0	0	1	n	IS	0 = 1bit 1 = 2bit
	PASSWORD						
PASS	Installer level password	-19	-99	999	n	IS	

The following parameters are those managed by the VCM module

After modification of the PI00, PI07 and/or PI08 parameter, the VCM module forces a reset.

Code	Parameter description	Default	Min	Max	U.M.		Notes
PI00	Type of refrigerant	1	0	7	-		0 = R22 1 = R134A 2 = R507

							3 = R404A 4 = R407C 5 = R410A 6 = R124 7 = R744
PI03	Superheat control mode	0	0	2	-		0 = Standard 1 = Slow 2 = Reserved
PI07	Type of valve	2	1	7	-		1 = EX4 Alco 2 = EX5 Alco 3 = EX6 Alco 4 = EX7 Alco 5 = EX8 Alco 6 = EX9 Alco 7 = EXM-246 or EXL-246
PI08	Type of pressure transducer (evaporation probe)	0	0	3	-		0 = EVPT530K00 (4-20 mA, 0 ... 7 bar relative) 1 = PT4-18S (4-20 mA Alco, 0 ... 18 bar relative) 2 = EVPT530K01 (4-20 mA, 0 ... 30 bar relative) 3 = PT4-50S (4-20 mA Alco, 0 ... 50 bar relative)
PI09	Reserved						
PI10	Reserved						
PI11	Reserved						

The following parameters are however available in reading mode only, at user level.

Code	Parameter description		Min	Max	U.M.		Notes
rI00	Evaporation pressure				bar (psi)		From evaporation probe
rI01	Evaporation temperature		-50	50	°C		From evaporation pressure (internal table)
rI02	Intake temperature		-50	50	°C		From intake probe
rI03	Superheat Value		-50	50	K		
rI04	Valve opening percentage value		0	100	%		
rI05	Pressure probe error		0	2	-		0 = correct functioning 1 = sensor short circuit 2 = sensor open
rI06	Temperature probe error		0	2	-		0 = correct functioning 1 = sensor short circuit 2 = sensor open
rI07	Step-by-step motor error		0	1	-		0 = correct functioning 1 = in error mode
rI08	Unit alarms from VCM		0	7	-		Alarm bit state
rI12	Digital inputs state		0	2	-		
rI15	VCM module revisions						

5 Functioning

5.1 Preliminary considerations

The points that qualify an electronically-piloted thermostatic valve with respect to a mechanical thermostatic valve are the following:

- compatibility with every type of refrigerant (or however with many types of refrigerant)
- very large regulation range
- microprocessor regulation and therefore total flexibility.

The first two points constitute a noteworthy advantage for the producer of machines or plants because they simplify the logistics due to the consequent reduction of the codes and material to be managed and held in the warehouse. The extended regulation range also allows to guarantee excellent over-heating stability also in conditions (condensation pressure, evaporation pressure, over-heating value) distant from those of the project. mechanical thermostatic "works" well around the project nominal conditions: shifting from these conditions, the over-heating value changes and in some conditions becomes unstable. Because variability in the conditions of use is normal for cooling machines (consider an air-cooled chiller), the thermostatic cannot guarantee the constant over-heating value and often, in order to keep over-heating values acceptable also in day-to-day functioning it is forced to increase over-heating in greater functioning conditions at the expense of plant efficiency.
The microprocessor regulation is a formidable potential that opens the doors of any innovation in the strategy of regulation and use.
Some main features (and/or functionalities) of the electronic valves are: brief opening/closure times, high regulation resolution, shut/off functionality, continuous flow modulation, "correct" stress in the cooling circuit.

5.2 Enabling mode for valve regulation

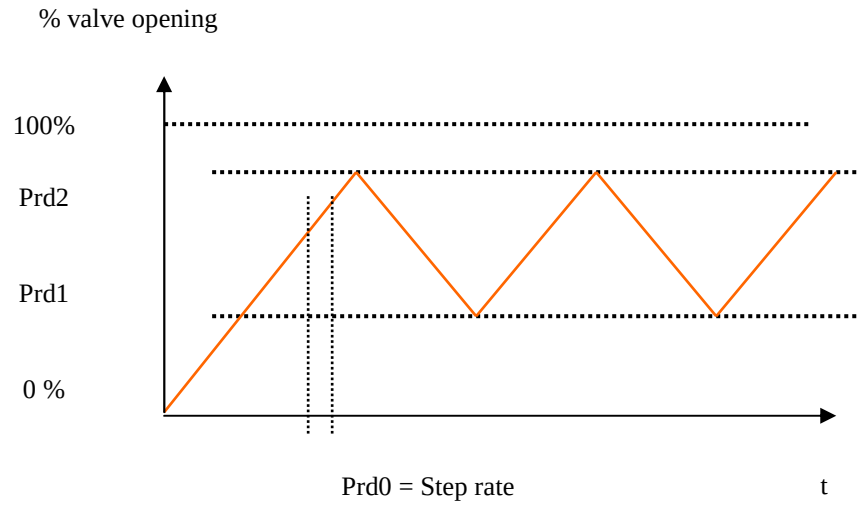
If the valve is closed (disabled and regulation deactivated), the display will show OFF and the on/stand-by icon is on.
The valve can be opened (enabled and regulation activated) in one of the two following ways (selectable from parameter Pr06):

- from digital input (stand-alone functioning enabled from parameter Pr06=0 or 1): in this case, it can be enabled from optoisolated digital input (DIHV, Pr06=1) or from non-optoisolated digital input (DI1, Pr06=0). A typical application is the use of an optoisolated digital input (230VAC) connected in parallel to compressor (therefore the valve regulates when the compressor is on, otherwise it is off).
- from IntraBus serial (function enabled by parameter Pr06=2): in this case, it can be enabled via the Intrabus serial. A typical application is a chiller/heat pump that uses *c-pro* range controllers. This serial works with settings relative to fixed communication and allows the use of two valves at a maximum
- from ModBus serial (function enabled by parameter Pr06=3).

Whatever the enabling mode may be, there is a start-up procedure that keeps the valve open at a certain percentage (from parameter Px07, where x = C, P or d) for a certain period of time that can be set (from parameter Px06); the on/stand-by icon highlights the state. The display normally shows the quantity selected by the PdIS parameter + the icon that indicates the unit of measurement of the quantity displayed.

5.3 Manual functioning mode

The program allows to set manual functioning for the valve. In this way, the over-heating algorithm is by-passed.
Manual functioning of the devices is useful when functional tests must be performed on the machine in order test the integrity and correct functioning. Therefore, using the local keyboard, it is possible to enable the manual function and set the valve output %; the same could be performed from the serial.
For reasons of safety and to prevent possible damage, the valve must be On (enabled) in order to operate in manual mode.
The maintenance icon switches on during manual functioning. Forcing is performed via relevant parameters Pr02, Pr03. In particular, with Pr02=0 the manual functioning is disabled. With Pr02=1 the manual functioning is enabled and Pr03 represents the % value that the valve output must assume. With Pr02=2 a particular manual command is enabled for inspections where the valve output assumes a trend as represented in the figure; for every Prd0*100ms the valve output % is increased or decreased between a value minimum Prd1 and a maximum value Prd2.



It is possible to operate in manual mode during normal valve functioning; this allows to test the behaviour of the chiller where the valve has been inserted. Errors continue to be detected during this functioning. After a power cut, the valve starts to function in manual mode.
During manual functioning, by pressing the ESC key for about 2 seconds, the % value that the valve output must assume is displayed and set quickly.

5.4 Valve state

The valve can be in one of the following states (visible also from relevant icons).

State	Description	Icon	Display
OFF	Valve closed (mechanical stop)	On/stand by	OFF
ON_START	Valve in start mode	On/stand-by + valve	(PdIS)
ON	Valve is keeping the	valve position	(PdIS)
ON	Valve opening	valve position	(PdIS)
ON	Valve closing	valve position	(PdIS)
ON-MAN	Valve in manual mode	maintenance	(PdIS)
OFF_ALL	Valve closure following an alarm	alarm	OFF (Blink)
ON_ALL	Valve forced following an alarm	alarm	(PdIS)

The quantity established with the PdIS parameter is shown on the display.

5.5 Functioning mode (selection from the parameters set)

Three parameters set are envisioned to satisfy the regulation requirements of the more complex machines. Each parameters set includes the start-up parameters (time and opening value), the SH set-point, SH high/low alarm set, the LOP set and the MOP set.
The parameters set (or functioning mode) will be selected using the SEtP parameter. As an example, the three sets could represent the parameters for functioning as chiller or as heat pump or as defrost.

6 Diagnostics

The application can manage a series of alarms relative to the valve. On the basis of the various types of alarms, it is possible to configure any signalling delay.
The icon flashes when one or more alarms are active.
In order to display the various alarms, press the UP key from the main page for about 2 seconds; the first alarm present is displayed; using the UP or DOWN keys, scroll all of the alarms present. If there are no alarms, pressing the UP key for two seconds has no effect.
When the causes of the alarm have disappeared, the instrument will go back to normal functioning.
All of the digital inputs relative to the alarms (e.g.: battery charger input) are managed by an Alarms Logic parameter that has the following meaning:

- if set at NO, the inputs will be normally unexcited (open).
- if set at NC, the inputs will be normally excited (closed).

6.1 Probe alarms

In the case of a probe alarm, the VCM module closes the valve. The two parametersPr04, Pr05can be used to enable forcing of the valve (manual functioning) to a pre-defined value in order to allow temporary functioning.

6.2 Alarm relay

The program has the possibility of managing an alarm relay (parameter PH01). Via the relative parameter PH02 it is possible to establish the polarity (NO or NC) of the alarm output. With PH01=0 the relay is disabled; with PH01=1 the relay is enabled for all alarms envisioned (excluding the signalling only ones); with PH01=2 the relay is enabled only for the probe errors detected by the VCM module.

6.3 Alarms table

Below is a list of all alarms managed by the application. The order of presentation is the same as the order with which the alarms are presented when active.

Code	Alarm description	Consequence	Notes
ESPI	Communication error with VCM controller		Fixed delay
ECom	Communication error with main controller	The valve closes completely.	PA01, PA02
EPr1	Pressure transducer faulty or disconnected	The valve closes completely	
EPr2	Temperature probe faulty or disconnected	The valve closes completely	
ALSm	Valve step-by-step motor error		
ALHS	High over-heating	The SH LED flashes	PA20, PA21, PA22
ALLS	Low over-heating	The SH LED flashes	PA10, PA11, PA12
ALLP	Low pressure	The LP LED switches on	PA30, PA31, PA32, PA33
LOP	LOP	The LP LED flashes	PA40, PA41, PA42
MOP	MOP		PA50, PA51, PA52
PFIr	Problems with the electric mains (displayed only if back-up battery is present)		

7 List of the ModBus variables

7.1 Introduction

This document describes the resources of the device that can be accessed via the serial port. The protocol is MODBUS RTU.

7.2 Addressing conventions

Please note that according to MODBUS specs:

- the first register is called register 1
- register x must be read ad address x-1

7.3 Implemented ModBus function codes

Command	Function Code	Notes
READ HOLDING REGISTERS	$03	Maximum 95 registers at once
WRITE SINGLE REGISTER	$06	
WRITE MULTIPLE HR	$10	Maximum 95 registers at once

7.4 Data exchange examples

Example 1:

Reading Holding Register at address $0601 (the SEtP parameter, function modality). Note that according to MODBUS that is register 1538

	Slave Address	Function Code	High Starting Address	Low Starting Address	High Quantity of Register	Low Quantity of Register	Low CRC	High CRC
TX	$F7	$03	$06	$01	$00	$01	$C1	$D4

	Slave Address	Function Code	Byte Count	High Register value	Low Register value	Low CRC	High CRC	
RX	$F7	$03	$02	$00	$01	$B1	$91	

the value is 1.

Example 2:

Reading Holding Register at address $FF08, representing the FW.ID field (FirmWare IDentifier).

	Slave Address	Function Code	High Starting Address	Low Starting Address	High Quantity of Register	Low Quantity of Register	Low CRC	High CRC
TX	$F7	$03	$FF	$08	$00	$01	$21	$4A

	Slave Address	Function Code	Byte Count	High Register value	Low Register value	Low CRC	High CRC	
RX	$F7	$03	$02	$01	$8D	$B1	$A4	

The value is $018D = 397

Example 3:

Writing two Holding Registers starting at address $0607 (parameters PC06 and PC07) with values 10 and 100.

	Slave Address	Function Code	High Starting Address	Low Starting Address	High Num HR	Low Num HR	Byte cnt	Data1 High	Data1 Low	Data2 High	Data2 Low	CRC High	CRC High
Tx	$F7	$10	$06	$07	$00	$02	$04	$00	$0A	$00	$64	$A5	$8B

	Slave Address	Function Code	High Starting Address	Low Starting Address	High Num HR	Low Num HR	CRC High	CRC High
Rx	$F7	$10	$06	$07	$00	$02	$E4	$17

7.5 Holding register adresses table

Description		Index	Access	Notes
PROBES				
	Suction pressure in mA	$0201	R	2 decimal digits
	Coil out temperature	$0202	R	1 decimal digit (*)
	Saturation temperature from suction pressure	$0203	R	1 decimal digit (*)
	Suction pressure in Bar/psi	$0204	R	1 decimal digit (**)
DIGITAL OUTPUTS				
	Relay status	$0181	R	Bit0 = Alarm relay status
APPLICATION COMMANDS				
	Load parameters in EV-KEY	$0470	W	1= store data in EV-KEY
CONTIGUOUS INFORMATIONS ABOUT INSTRUMENT STATUS				
	Digital inputs/output	$0550	R	Bit0 = di1 Bit1 = battery status Bit2 = diHV Bit3 = reserved Bit4 = reserved Bit8 = Alarm relay status
	Suction pressure in mA	$0551	R	2 decimal digits
	Coil out temperature	$0552	R	1 decimal digit (*)
	Saturation temperature from suction pressure	$0553	R	1 decimal digit (*)
	Suction pressure in Bar/psi	$0554	R	1 decimal digit (**)
	Superheat value [K]	$0555	R	1 decimal digit
	Valve opening in %	$0556	R	1 decimal digit
	Alarms	$0557	R	([1])
	Flag status 1	$0558	R	([2])
	Flag status 2 (MSB) Valve status (LSB)	$0559	R	([3])
	Mode configuration (SEtP parameter)	$055A	R	
	Superheat set point	$055B	R	
VALVE STATUS				
	Valve status	$0502		0: off 1: starting 2: running 3: close (<5%) 4: open (>95%)

	LOP temperature set point	$0510		
	MOP temperature set point	$0511		
	Set point super heat	$0512		
	Length of valve initialization	$0513		
	Percent opening during valve initialization	$0514		
	Set point low superheat alarm	$0515		
	Set point high superheat alarm	$0516		

(*) the measure unit depend on parameter PH21 (0:°C, 1:°F)
(**) the measure unit depend on parameter PH20 (0:Bar, 1:psi)

Description		Index	Access	Notes
PARAMETERS				
	Number of parameters	$0600	R	81 parameters
	SEtP	$0601	R/W	
	PC01	$0602	R/W	
	PC02	$0603	R/W	
	PC03	$0604	R/W	
	PC04	$0605	R/W	
	PC05	$0606	R/W	
	PC06	$0607	R/W	
	PC07	$0608	R/W	
	PP01	$0609	R/W	
	PP02	$060A	R/W	
	PP03	$060B	R/W	
	PP04	$060C	R/W	
	PP05	$060D	R/W	
	PP06	$060E	R/W	
	PP07	$060F	R/W	
	Pd01	$0610	R/W	
	Pd02	$0611	R/W	
	Pd03	$0612	R/W	
	Pd04	$0613	R/W	

	Pd05	$0614	R/W	
	Pd06	$0615	R/W	
	Pd07	$0616	R/W	
	PA01	$0617	R/W	
	PA02	$0618	R/W	
	PA10	$0619	R/W	
	PA11	$061A	R/W	
	PA12	$061B	R/W	
	PA20	$061C	R/W	
	PA21	$061D	R/W	
	PA22	$061E	R/W	
	PA30	$061F	R/W	
	PA31	$0620	R/W	
	PA32	$0621	R/W	
	PA33	$0622	R/W	
	PA40	$0623	R/W	
	PA41	$0624	R/W	
	PA42	$0625	R/W	
	PA50	$0626	R/W	
	PA51	$0627	R/W	
	PA52	$0628	R/W	
	PdIS	$0629	R/W	
	Pr02	$062A	R/W	
	Pr03	$062B	R/W	
	Pr04	$062C	R/W	
	Pr05	$062D	R/W	
	Pr06	$062E	R/W	
	Prd0	$062F	R/W	
	Prd1	$0630	R/W	
	Prd2	$0631	R/W	
	Pb01	$0632	R/W	
	PH01	$0633	R/W	

	PH02	$0634	R/W	
	PH10	$0635	R/W	
	PH11	$0636	R/W	
	PH12	$0637	R/W	
	PH20	$0638	R/W	
	PH21	$0639	R/W	
	PH22	$063A	R/W	
	PH30	$063B	R/W	
	PSPI	$063C	R/W	
	Mod1	$063D	R/W	
	Mod2	$063E	R/W	
	Mod3	$063F	R/W	
	Mod4	$0640	R/W	
	Mod5	$0641	R/W	
	Mod6	$0642	R/W	
	Mod7	$0643	R/W	
	Mod8	$0644	R/W	
	PASS	$0645	R/W	
	PI00	$0646	R/W	
	PI03	$0647	R/W	
	PI07	$0648	R/W	
	PI08	$0649	R/W	
	PI09	$064A	R/W	
	PI10	$064B	R/W	
	PI11	$064C	R/W	
	PI12	$064D	R/W	
	PI13	$064E	R/W	
	PI14	$064F	R/W	
	PI15	$0650	R/W	
	Kbd lock	$e053	R	1= keyboard locked
INFO				
	Driver Identifier A: same as $FF08 (397)	$ff02	R	

	Driver Identifier B: same as $FF09	$ff03	R	
	Firmware ID	$ff08	R	
	Firmware Variation/revision	$ff09	R	

([1]) **Alarms:** at address $0557 :

Alarms	Mask value	
Low superheat	$0001	
High superheat	$0002	
LOP	$0004	
MOP	$0008	
SPI comunication error	$0010	
Battery status	$0020	1: battery embty or charging
Low pressure	$0040	
Electrical net status	$0080	1: electrical net is active
Pressure probe failure	$0100	
Temperature probe failure	$0200	
Motor failure	$0400	

([2]) **Regulator flags (2):** at address $0558:

Flag	Mask value	
Manual function activated	$0001	
Enabling input status	$0002	
Input HV	$0008	
Manual function activated during probe failure	$0010	
Remote valve enabling	$0020	
On/Off status	$0040	0: Off 1: On
VCM module compatibility	$0100	

([2]) **Regulator flags (3):** at address $0559:

Flag	Mask value	
Power failure occurred	$0001	

Instrument configuration varied	$0002	
No new info to read	$0010	
New info to read	$0020	

PAY ATTENTION:

ALL THE ADDRESSES NOT MENTIONED EXPRESSLY IN THIS DOCUMENT MUST BE CONSIDERED RESERVED. **ALL THE ADDRESSES INDICATED AS RESERVED MUST NOT BE READ OR WRITTEN**; IF YOU DO NOT RESPECT THIS CONDITION, YOU COULD ALTER THE OPERATION OF THE INSTRUMENT.