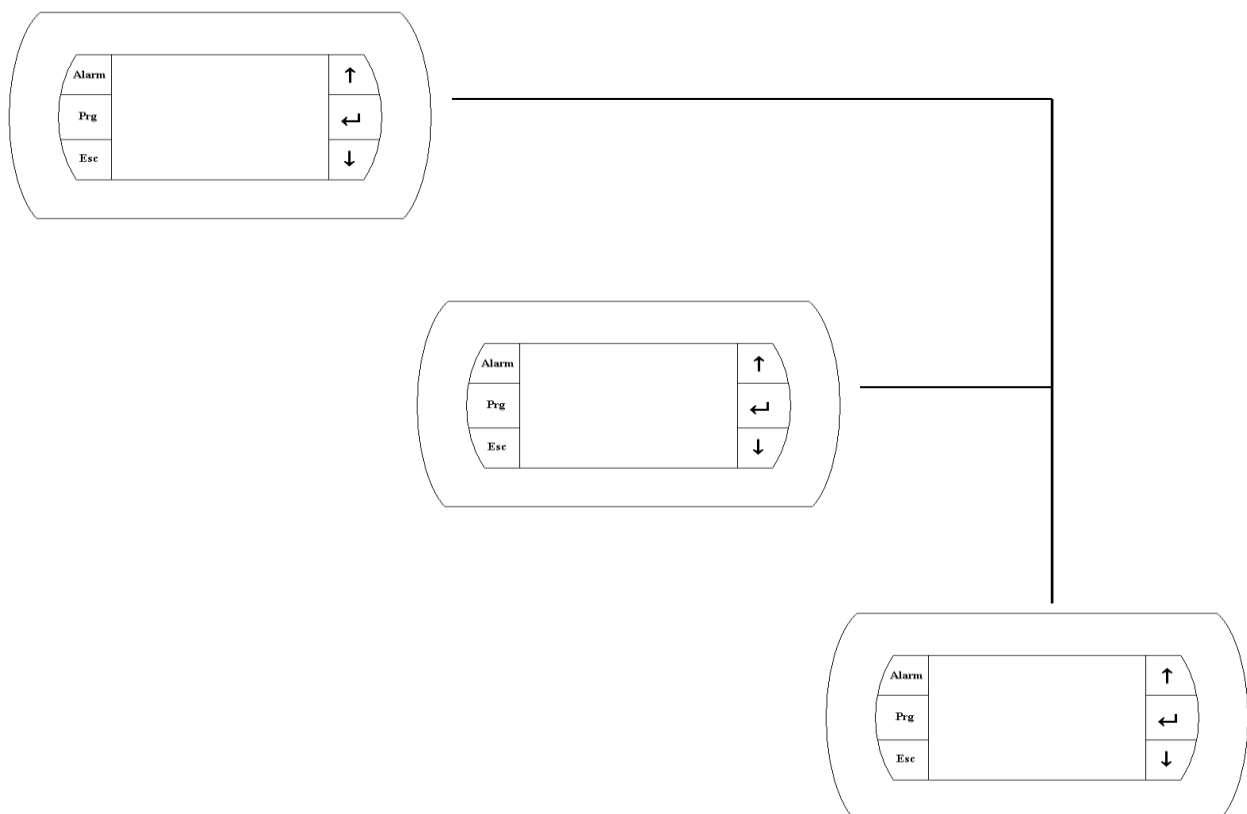# MasterLan

INSTRUCTION MANUAL

pCO5/PGD1 DIGITAL CONTROLLER

HEAT PUMPS
MasterTherm

TABLE OF CONTENTS:

1   Introduction

MasterLan is used for control of the multiple units installation. MasterLan requires specific hardware and software configuration.

2   Terms definition

Explanation of some important terms and names used in the MasterLan description.

pCO5:
PLC controller used in the MasterTherm CZ heat pumps.

pGD1:
Semigraphical terminal used for communication with user. (pCO Graphic Display).

pLAN:
Carel based protocol dedicated for communication between pCO controllers and pGD displays. (pCO Local Area Network). Principle of data transmision is based on RS485 standard.

pLAN address:
Address of each unit in the pLAN. Each pCO controller and pGD terminal has its own pLAN address.

MasterLan:
MasterTherm heat pumps hardware and software solution used for multiple heat pumps installation. Control is based on Master/Slave principle. One unit is configured like Master and all other units are configured like Slaves. Maximum 16 compressor circuits could be controlled in the MasterLan.

Single controller machine:
Heat pump with one refrigerant circuit and one pCO5 controller.

Double controller machine:
Heat pump with 2 compressor circuits, 2 controllers and 1 pGD terminal. **Switching of the display between 2 controllers is made by pressing PRG and ENTER keys simultaneously**

3   Hardware configuration

Each compressor of the heat pump circuit is controlled by one pCO5 controller.
Single controller heat pump is also equipped with single pGD terminal. Double controller heat pump is equipped with 2 pCO5 controllers and single pGD display, which is used for communicating with both compressor circuits of the unit. **Switching of the display between 2 controllers is made by pressing PRG and ENTER keys simultaneously**. In the double heat pump 2 controllers are already interconnected with pLAN protocol. Connection is made by 3 wires between terminals 61(Rx-/Tx-), 62(Rx+/Tx+) and 63(GND). Terminals are interconnected with J11 pLAN connector of pCO5.

IMPORTANT: BEFORE ADDRESS SETTING IT IS ABSOLUTLY NECESSARY TO DISCONNECT J11 pLAN CONNECTOR FROM ALL CONTROLLERS.

3.1 pLAN address table

Single compressor units:

Unit type	pCO controller pLAN address	pGD terminal pLAN address
Master	*1*	*32*
Slave 1	2	31
Slave 2	3	30
Slave 3	4	29
Slave 4	5	28
Slave 5	6	27
Slave 6	7	26
Slave 7	8	25

This text type is default factory setting.

Double compressor units:

Unit type	pCO controller pLAN address	pGD terminal pLAN address
Master	*1*	*32*
Slave 1	*2*	*-*
Slave 2	3	31
Slave 3	4	-
Slave 4	5	30
Slave 5	6	-
Slave 6	7	29
Slave 7	8	-

This text type is default factory setting.

3.2 Setting of the pCO pLAN address

IMPORTANT: BEFORE ADDRESS SETTING IT IS ABSOLUTLY NECESSARY TO DISCONNECT J11 pLAN CONNECTOR FROM ALL CONTROLLERS.

- Disconnect J11 connector from all pCO controllers
- Power ON the pCO controller
- Enter menu "Protocol Set"
- Set the address according to the table
- Repeat this procedure for all units controllers

3.2.1 Protocol Set menu

List password mask and enter the OEM Expert password code. Enter menu and list "Protocol Set", confirm ENTER and find following mask using UP key.

Jump with cursor to "pCO Address" and set address according to table above. Address is changed immediately.
Use ESC to return to the menu.

3.3 Setting of the pDG pLAN address

Each pCO controller and pGD display address must be set according to the table above.
- Connect pGD display to the pCO controller
- Power ON pCO
- Press "UP"+"ENTER"+"DOWN" keys simultaneously until following display appears

- Use keys "UP"/"DOWN" to change address of the pGD according to the table above.
- Confirm selection pressing „ENTER" key

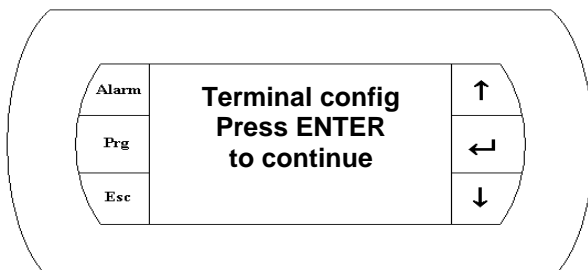## 3.4 Setting communication between pCO and pGD

This procedure requires correct setting of the pCO according to the pLAN address table.
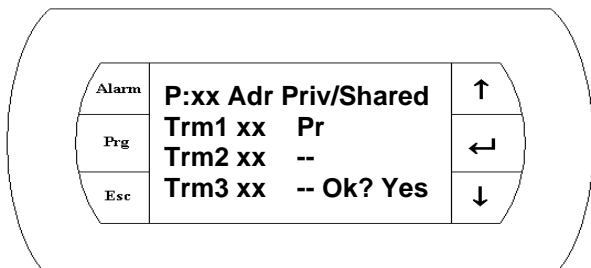
3.4.1 Single controller unit

- Connect the pGD to the pCO controller
- Power ON the pCO, wait for pCO initialization, it takes cca 1 minute.
- Press "UP"+"ENTER"+"DOWN" keys simultaneously until following display appears

```
Alarm   Display address        ↑
        Setting…………..: xx
Prg                            ↵
Esc     I/O Board address:xx   ↓
```

- Use keys "UP"/"DOWN" to change address of the pGD according to the pLAN address table
- Confirm selection pressing „ENTER" key
- Wait until I/O Board address appears beside "--" symbol
- Confirm pressing ENTER key, following screen will appear

```
Alarm         Terminal config      ↑
              Press ENTER
Prg           to continue          ↵
Esc                                ↓
```

- Pressing ENTER key, following screen will appear

```
Alarm   P:xx Adr Priv/Shared   ↑
        Trm1 xx    Pr
Prg     Trm2 xx    --          ↵
Esc     Trm3 xx    -- Ok? Yes   ↓
```

- Set Trm1 address according to the unit You are setting, confirm ENTER
- Set type of terminal to "Pr", confirm ENTER until You reach Yes/No array
- Change array to "Yes" and confirm ENTER

3.4.2 Double controller unit

Do procedure as for single compressor circuit, but set type of terminal to Shared, "Sh". You have to do it for both controllers in the unit.

3.5 Setting summary

- Disconnect all J11 terminals from all controllers
- Set pCO address for all controllers
- Set pGD address for all pGDs
- Set commincation between pCO and pGD
- Switch all controllers OFF
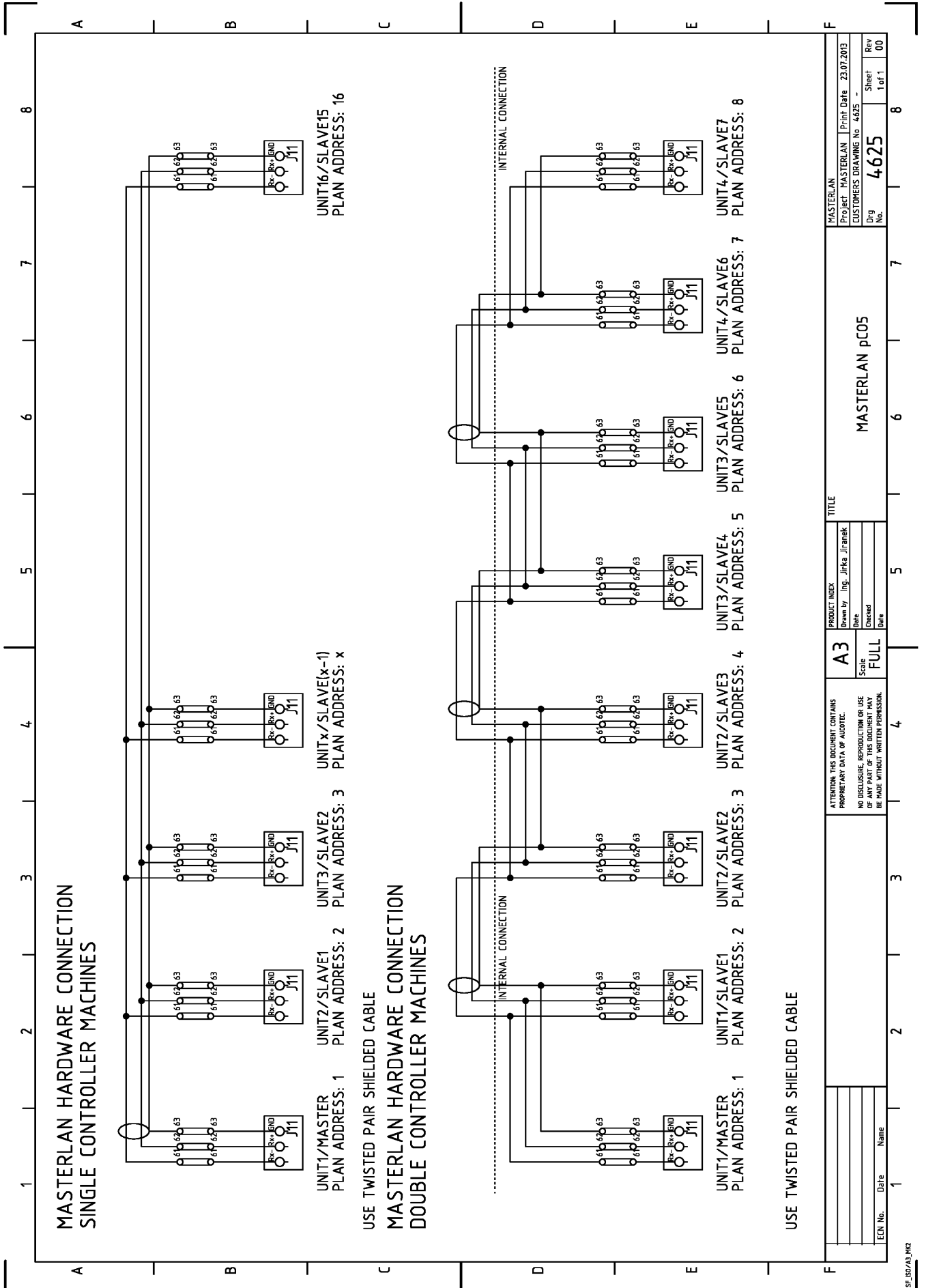- Return J11 connectors to the pCO controllers

3.6 Wiring

For correct function make wiring connection using twisted pair shielded cable between 61, 62 and 63 terminals of all electric control boards.

NOTE: For correct pLAN function at least one pGD must be installed.

Please see following wiring diagram for proper installation.

3.6.1 MasterLAN wiring diagram

MasterLAN wiring diagram

4 Software configuration

For the access to the MasterLAN configuration You have to enter the OEM password.

4.1 Main Menu mask

MasterLAN masks could be found in the main mask loop, using the UP and DOWN keys from „ICON" mask.

Master   Slaves 1 to 7

Compressor
status

Heater/Cooling*
status

0 - OFF
1 - ON
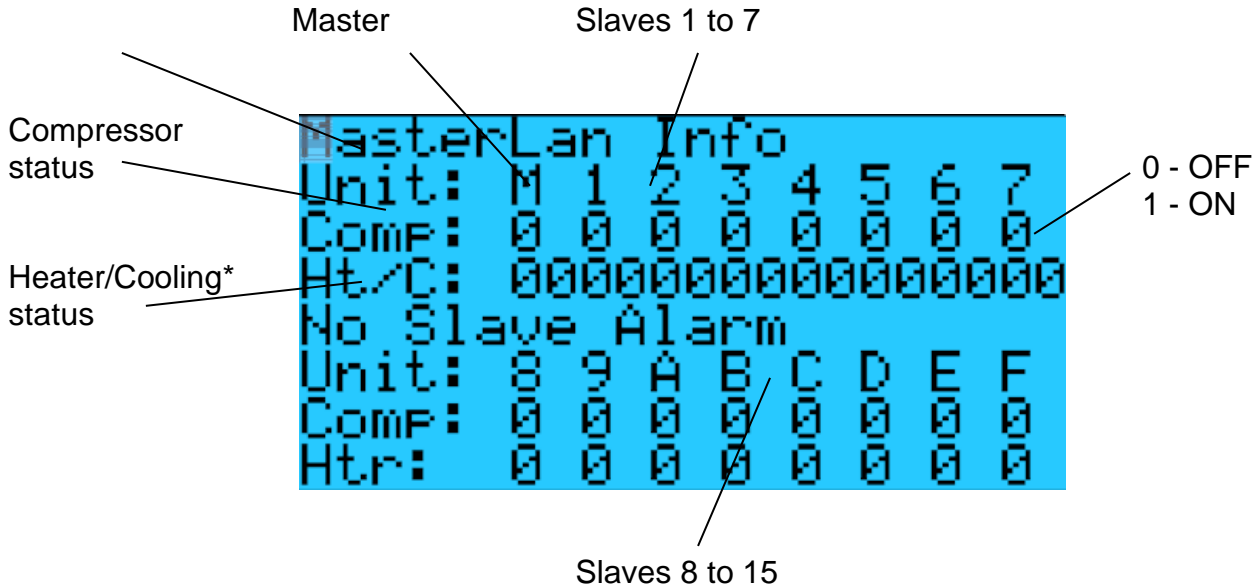
Slaves 8 to 15

* Visible when H&C mode enabled, see chapter 4.2.5, Cooling status of Slave 8 to 15 is mirror to Master and Slave 1 to 7.

4.2 Setting masks

To enter MasterLAN setting displays please press PRG button on the main MasterLAN display.

4.2.1 Master/Slave setting mask

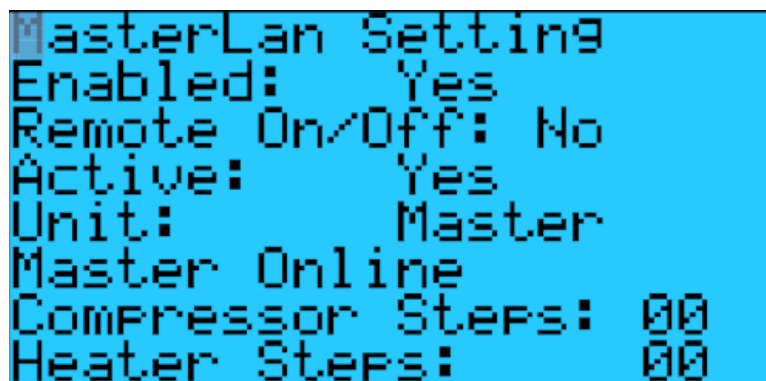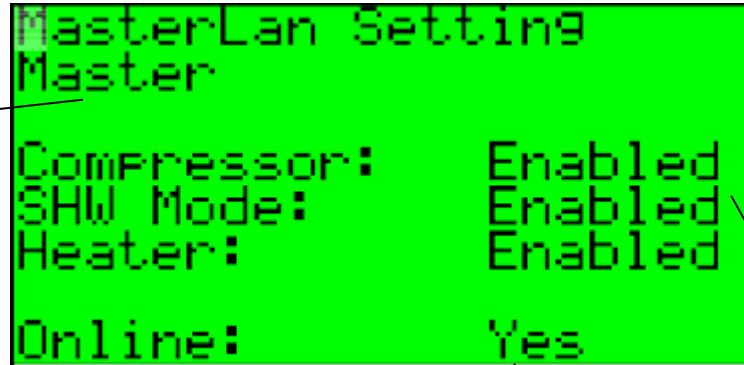| Parameter:	SP	Range/F.:	Unit	Description
Enabled	D502	0/1 (No/Yes) F: 0 (No)	-	Enabling MasterLAN control in general
Remote On/Off	D178	0/1 (No/Yes) F: 0 (No)	-	Enable external On/Off control from Master unit to the Slaves (it must/could be enabled separately for each Slave unit)
Unit	-	Master-Slave15 F: -	-	Info about unit assignment in the MasterLAN.
Master	D470	Offline/Online (0/1) F: -	-	Shows if Master is present/online in the MasterLAN.
Compressor Steps	I134	0-99 F: -	-	Informs how many units/compressors are configured in MasterLAN
Heater Steps	I132	0-99 F: -	-	Informs how many units/heaters are configured in MasterLAN

You can Enable or Disable MasterLAN control on this mask.
Press ESC key for return to the main mask loop.

4.2.2 Master setting masks

Using keys UP and DOWN you have access to the following masks.

Unit in the MasterLAN system

Master/Slave1/Slave2 /........./Slave15

```
MasterLan Setting
Master

Compressor:    Enabled
SHW Mode:      Enabled
Heater:        Enabled

Online:        Yes
```

Yes/No   Enabled/Disabled

Parameter:	SP	Range/F.:	Unit	Description
Compressor	B440 -455	Enabled/Disabled F: Enabled	-	Allows compressor to be controlled by MasterLAN control in Heating/Cooling mode.
SHW Mode	-	Enabled/Disabled F: Enabled	-	Unit is enabled for SHW Mode. When Disabled, unit will not run in SHW Mode.
Heater	B460 -475	Enabled/Disabled F: Enabled	-	Enabling heater for MasterLAN control in heating mode.
Online	-	Yes/No	-	If the unit is communicating in MasterLAN network (unit is present and online).

Similar masks appearing for each unit ....
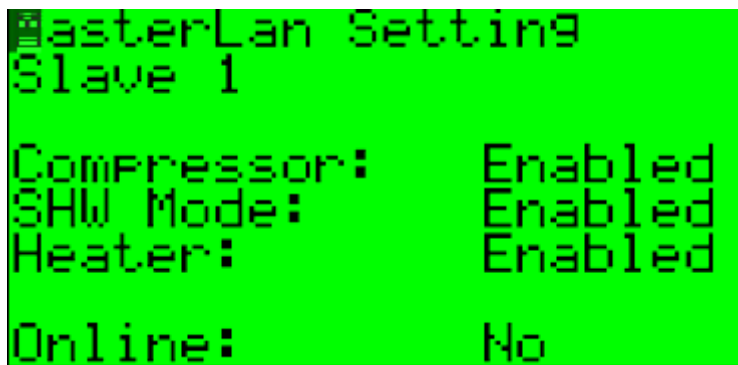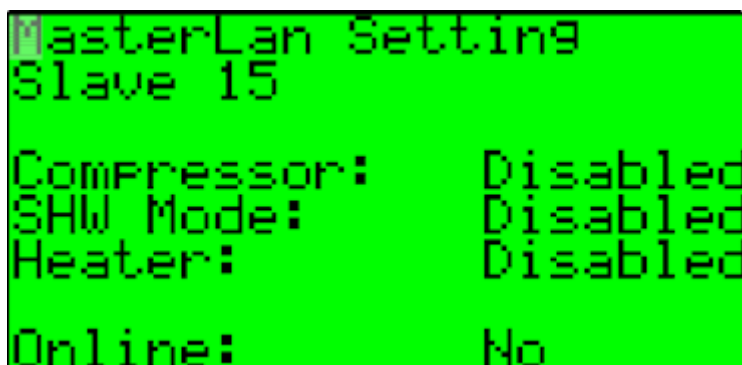
```
MasterLan Setting
Slave 1

Compressor:    Enabled
SHW Mode:      Enabled
Heater:        Enabled

Online:        No
```

.
.
.

```
MasterLan Setting
Slave 15

Compressor:    Disabled
SHW Mode:      Disabled
Heater:        Disabled

Online:        No
```

Parameter:	SP	Range/F.:	Unit	Description
Ctrl.Probe	-	B1-B5/pCO5, B1-B4/pCOe F: Not Used-	-	Control probe assignment, when control probe in heating buffer tank is used. When se to Not Used, Master unit heating control probe is used – requires pernament pump operation.
Compressor Control	I133	P, PI, PID F: P	-	Compressor control mode.
Proportional Band	A94	0.0-99.9 F: 3.0	°C	Control proportional band.
Integration Time	I135	0-9999 F: 0	s	Integration time of PI or PID control mode
Derivative Time	I137	0-9999 F: 0	s	Derivative time of PID control mode

Parameter:	SP	Range/F.:	Unit	Description
Rotation	B409	FIFO/LIFO F: FIFO	-	Compressor rotation system FIFO = first in, first out LIFO = last in, first out
1 Compressor Off Time	I139	0-999 F: 360	s	Minimum compressor Off time. Minimum time compressor must stay Off before starting after stop command.
1 Comprressor On Time	I141	0-999 F: 10	s	Minimum time compressor must stay On after start command.
2 Compressors Off Start	I143	0-999 F: .30	s	Minimum time between starts of 2 different compressors.
1 Compressor Off Start	I145	0-999 F: .360	s	Minimum time between 2 starts of the same compressor.

Parameter:	SP	Range/F.:	Unit	Description
Heater Control	I134	P, PI, PID F: P	-	Auxiliary heater control mode.
Proportional Band	A95	0.0-99.9 F: 3.0	°C	Heater Control proportional band.
Integration Time	I136	0-9999 F: 0	s	Integration time of PI or PID heater control mode
Derivative Time	I138	0-9999 F: 0	s	Derivative time of PID heater control mode

Parameter:	SP	Range/F.:	Unit	Description
Rotation	-	FIFO/LIFO F: FIFO	-	Heater rotation system FIFO = first in, first out LIFO = last in, first out
1 Heater Off Time	I140	0-999 F: 360	s	Minimum heater Off time. Minimum time heater must stay Off before starting after stop command.
1 Heater On Time	I142	0-999 F: 10	s	Minimum time heater must stay On after start command.
2 Heaters Off Start	I144	0-999 F: .30	s	Minimum time between starts of 2 different heaters.
1 Heater Off Start	I146	0-999 F: .360	s	Minimum time between 2 starts of the same heater.

4.2.3 Source Control Masks

Source control allows cascade control according to the source temperature as well.

Parameter:	SP	Range/F.:	Unit	Description
Source Control Enabled	D458	Yes/No F: No	-	Enabling Source Control
Source Control Active	D429	Yes/No	-	Source Control Active, Enabled + Probe OK
Control Probe	-	B1-5/pCO5 B1-4/pCOe F: Not Used	-	Choice of Source Control probe.
Setpoint	A434	-99.9 / +99.9 F: 5.0	°C	Source Control Setpoint
Real Temperature	A433	-99.9 / +99.9	°C	Real Source Temperature
Compressors H	I411	0-99	°C	Requested Compressors Heating
Compressors S	I412	0-99	°C	Requested Compressors Source

Parameter:	SP	Range/F.:	Unit	Description
Source Control	I410	P, PI, PID F: P	-	Compressor Source control mode.
Proportional Band	A529	0.0-99.9 F: 5.0	°C	Source Control proportional band.
Integration Time	I408	0-9999 F: 0	s	Integration time of PI or PID Source control mode
Derivative Time	I409	0-9999 F: 0	s	Derivative time of PID Source control mode

4.2.4 Simultaneous Heating + Cooling

Mode, where units are operating for heating and cooling tank and only in case of overheating or subcooling of tanks, rejected heat/cold is wasted into water/ground loop.

```
MasterLan Setting
H+C Control Simul.
Enabled: No
SHW Disable: No
Hset/H:  45.0 / 05.0 °C
Cset/H:  00.0 / 05.0 °C
HR/P:Relay 6/pCO5  / 0
CR/P:Relay 7/pCO5  / 0
```

Parameter:	SP	Range/F.:	Unit	Description
Enabled	D457	No/Yes (0/1) F: No	-	Enabling simultaneous H+C ***Note:*** *To enable this mode "Source Control" must be enabled as well (see 4.2.3)*
SHW Disable	D478	No/Yes (0/1) F: No	-	Disables H+C control principle in case/time of Hot Water generation. *It is required for some hydraulic configurations.*
Hset/H	A204/ A205	-99.9/99.9 F: 45.0/5.0	°C	Setpoint / Hysterezis (negative) in the heating water buffer/tank. Above this setpoint, rejected heat is redirected to the water/ground loop. ***Note:*** *When higher temperature is required by the weather compensation, setpoint is automatically increased.*
Cset/H	A206/ A193	-99.9/99.9 F: 0.0/5.0	°C	Setpoint / Hysterezis (positive) in the cooling water buffer/tank. Below this setpoint, rejected cold is redirected to the water/ground loop. ***Note:*** *When lower temperature is required by the weather compensation, setpoint is automatically decreased.* ***Note:*** *Please carefully consider setpoint according to water/antifreeze used.*
HR/P	-/D27	Relay 1-5/pCO5 Relay 1-4/pCOe F: Not Used 0/1 F:0	-	Heat Rejection relay assignment / Polarity of the relay. Output used to reject the heat (pump/valve).
CR/P	-/D28	Relay 1-5/pCO5 Relay 1-4/pCOe F: Not Used 0/1 F:0	-	Cold Rejection relay assignment / Polarity of the relay. Output used to reject the cold (pump/valve).

H+C information screen:

Parameter:	SP	Range/F.:	Unit	Description
RealH/C	A203/ A433	-99.9-99.9 F: -	°C	Real Temperature in the Heating and Cooling buffer/tank.
ReqH/C	A503/ A504 (sw58+)	-99.9-99.9 F: -	°C	Requested Temperature in the Heating and Cooling buffer/tank from weather compensation
Comps H/C	I411/ I412	0-16 F: -	-	Requested units/compressors to run for Heating and Cooling to reach the setpoint.
SetH/C	A206/ A193	-99.9/99.9 F: 45.0/0.0	°C	Setpoint in the heating/cooling water buffer/tank to reject heat/cold. Please see previous table for details.
OutH/C	D459/ D476	No/Yes(0/1) F: -	-	Heat/Cold Rejection relay activation.

4.2.5 Heating & Cooling Mode

Mode, where some units are operating for heating and some for cooling, although rejected heat/cold is always wasted into water/ground loop.

Parameter:	SP	Range/F.:	Unit	Description
Enabled	D172	No/Yes (0/1) F: No	-	Enabling H&C mode. *Note: To enable this mode "Source Control" must be enabled as well (see 4.2.3)*
Priority	D173	Heating/Cooling (0/1) F: Heating	-	Due to the working principle, it could be a situation, when all units must be working in Heating or Cooling, due to high load. In this case, none unit is able to work in the other mode. Therefore more important mode is preset by this parameter.
SHW Disable	D478	No/Yes (0/1) F: No	-	Disables H+C control principle in case/time of Hot Water generation. *It is required for some hydraulic configurations.*

| HR/P | -/D27 | Relay 1-5/pCO5
Relay 1-4/pCOe
F: Not Used
0/1
F:0 | - | Heat Rejection relay assignment / Polarity of the relay.
Output used to reject the heat (pump/valve). |
| CR/P | -/D28 | Relay 1-5/pCO5
Relay 1-4/pCOe
F: Not Used
0/1
F:0 | - | Cold Rejection relay assignment / Polarity of the relay.
Output used to reject the cold (pump/valve). |

H&C information screen

Parameter:	SP	Range/F.:	Unit	Description
RealH/C	A203/ A433	-99.9-99.9 F: -	°C	Real Temperature in the Heating and Cooling buffer/tank.
ReqH/C	A503/ A504 (sw58+)	-99.9-99.9 F: -	°C	Requested Temperature in the Heating and Cooling buffer/tank from weather compensation
Comps H/C	I411/ I412	0-16 F: -	-	Requested units/compressors running for Heating and Cooling to reach the setpoint.
Cooling C	I48	0-16 F: -	-	Requested units/compressors for Cooling only to reach the setpoint. *Note: It depends on preset priority, if all requested compressors are really running for Cooling.*
M/S Cool	D510/ D518	No/Yes (0/1)	-	Demand for Cooling for Master / Slave unit.
OutH/C	D459/ D476	No/Yes(0/1) F: -	-	Heat/Cold Rejection relay activation. *Note: For H&C mode the OutH is opposite to Out C*

4.2.6 Heating Or Cooling Mode

In this mode, all units work for Heating or Cooling, depending on the preset priority. When setpoint is reached, the opposite operation is activated.

Parameter:	SP	Range/F.:	Unit	Description
Enabled	D508	No/Yes (0/1) F: No	-	Enabling H or C mode. *Note: To enable this mode "Source Control" must be enabled as well (see 4.2.3)*
Priority	D173	Heating/Cooling (0/1) F: Heating	-	Due to the working principle, priority for more important mode is preset by this parameter.
SHW Disable	D478	No/Yes (0/1) F: No	-	Disables H or C control principle in case/time of Hot Water generation. *It is required for some hydraulic configurations.*
Hyst H/C	A205/ A193	-99.9-99.9 F: 5.0/5.0	°C	Hysterezis of the Heating / Cooling setpoints in the buffers/tanks. Negative for Heating and Positive for Cooling.
HR/P	-/D27	Relay 1-5/pCO5 Relay 1-4/pCOe F: Not Used 0/1 F:0	-	Heat Rejection relay assignment / Polarity of the relay. Output used to reject the heat (pump/valve).
CR/P	-/D28	Relay 1-5/pCO5 Relay 1-4/pCOe F: Not Used 0/1 F:0	-	Cold Rejection relay assignment / Polarity of the relay. Output used to reject the cold (pump/valve).

Heating Or Cooling information screen

Parameter:	SP	Range/F.:	Unit	Description
RealH/C	A203/ A433	-99.9-99.9 F: -	°C	Real Temperature in the Heating and Cooling buffer/tank.
ReqH/C	A503/ A504 (sw58+)	-99.9-99.9 F: -	°C	Requested Temperature in the Heating and Cooling buffer/tank from weather compensation
Comps	I411	0-16 F: -	-	Requested units/compressors running for Heating or Cooling to reach the setpoint.
M/S Cool	D510/ D518	No/Yes (0/1)	-	Demand for Cooling for Master / Slave unit.
OutH/C	D459/ D476	No/Yes(0/1) F: -	-	Heat/Cold Rejection relay activation. **Note:** *For H or C mode the OutH is opposite to Out C*

4.2.7 OFFLINE configuration

In case, unit losses bus communication with Master unit, it starts working in OFFLINE mode, according to actual settings. It is possible to choose relay, activated in case of OFFLINE situation.

Parameter:	SP	Range/F.:	Unit	Description
Master Online Delay	I406	0-999 F: 60	s	Delay of MasterLAN control activation, after Master unit is Online.
Master Offline Delay	I407	0-999 F: 60	s	Delay of MasterLAN control deactivation, after Master unit is Offline.
Rele	-	Relay 1-8/pCO5 Relay 1-4/pCOe F: Not Used	-	Choice of relay activated, in case Master is Offline.
P	-	0/1 F: 0	-	Master Offline Relay polarity
Online	B480	Yes/No	-	Master Online
Active	B427	Yes/No	-	Master Online and MasterLAN control active

4.2.8 Remote Functions

This is the setup of services used on Slave unit provided remotely by Master unit. Each Slave could be set separately.

Parameter:	SP	Range/F.:	Unit	Description
Outdoor Probe:	B203	0/1 (No/Yes) F: 0 (No)	-	No = Slave unit uses own outdoor temperature probe (recommended) Yes = Slave unit uses outdoor temperature probe from Master unit
Value:	-	-	°C	Shows actual Master value
SHW Probe:	B204	0/1 (No/Yes) F: 0 (No)	-	No = Slave unit uses own Hot Water temperature probe Yes = Slave unit uses Hot Water temperature probe from Master unit
Value:	-	-	°C	Shows actual Master value
SHW Mode:	B205	0/1 (No/Yes) F: 0 (No)	-	This function is usable, when each unit has its own Hot Water 3way valve or charging pump. No = Slave unit activates Hot Water mode by its own control
Active	-	0/1 (No/Yes)	-	Yes = Slave unit activates Hot Water mode according to order from Master unit and by its own control, if it is configured. Shows actual Master value

4.3 Control principle

Control automaticaly balances the operating hours and sequence of the compressors. MasterLAN setpoint for compressors and heaters are automatically transferred from Master unit. Although Slaves are switched On and Off via MasterLAN, they still keep they own setting. Therefore Slaves setpoints must be highest possible for heating mode and lowes possible for cooling mode.

4.3.1 Proportional control (recommended)

Proportional control works very simply. Proportional band is divided between compressor steps. Proportional control is stable but always works with steady state error, so the system is not able to reach exactly the setpoint. This is not a problem, cause compressors are controlled by On/Off principle. Disadvantage is, that "band"is relatively big, cause You can not set band per one compressor less than 1K. This could be the problem for more than 4 compressors.

Example:

Compressors:	4	-
Proportional band:	4	-
Requested temperature:	40	°C

Starting temperature: *30*   *°C*
All compressors are running.

When the temperature reaches 37°C, 1st compressor is switched Off.
When the temperature reaches 38°C, 2nd compressor is switched Off.
When the temperature reaches 39°C, 3rd compressor is switched Off.
When the temperature reaches 40°C, the last compressor is switched Off.

Starting temperature: *40*   *°C*
All compressors are Off.

When the temperature reaches 39°C, 1st compressor is switched On.
When the temperature reaches 38°C, 2nd compressor is switched On.
When the temperature reaches 37°C, 3rd compressor is switched On.
When the temperature reaches 36°C, the last compressor is switched On.

4.3.2 PI control

PI control is able to work almost without steady state error, but it's more sensible for unstability. It requires more time during commisioning for proper setting of the P and I constants.

4.3.3 PID control

This is the best control method for the more than 4 compressors in the MasterLAN. In reality You are able to have almost continuous and very accurate control of the requested water temperature. Begin with the setting of the P/I/D = 50K / 100s / 10s.
If the systém is not stable, increase P.
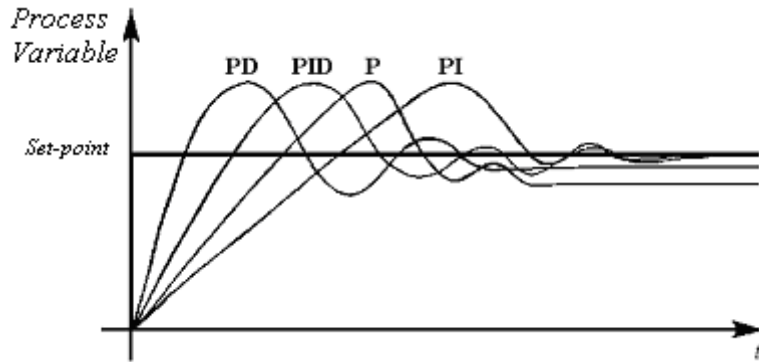
5 Alarms MasterLAN masks

To find information about Slaves alarms, press ALARM button on the MasterLAN mask.

Press ALARM button to see Slaves alarm status......

Pressing the ENTER key You can edit and change Slave unit. After change for the Slave unit please wait some time to allow the system to read the data from the Slave unit (30s recommended).
If You press ALARM button on this mask, Master will send RESET command to all Slaves.

6 Additional notes

- For heating mode all Slaves must have maximum water requested temperature settings in the menu "Heating Set", 47.5°C recommended both for point A and B.
    - this is not neccessary from SW revision 33 (document revision 12)
- For cooling mode all Slaves must have minimum water requested temperature settings in the menu "Cooling Set", 14.5°C recommended both for point A and B.
    - this is not neccessary from SW revision 33 (document revision 12)
- Control of the Sanitary Hot Water must be performed by Master unit only.
    - this is not neccessary from SW revision 33 (document revision 12)
    - see chapter 4.2.8
- All requested temperature settings must be done in the Master unit ONLY. ("Master" displayed in the right top corner of the display in the ICON mask.
- Internet connection if it is used, must be in the Master unit.

7 Revision history

REV.10
REV 11
> Source Control Mode
> OFFLINE Management

REV 12
> Remote Functions
> Automatic maximum setpoint activation for slave units

REV 13
> H+C, H&C and H or C control modes.

NOTES: