Characteristics briefly
- refrigeration controller for all applications of cold stores, freezers, shelfs, chest freezers...
- for use as a single controller or in a network
- 6 temperature sensors inputs, 6 relays, 4 digital inputs, analog output
- available in 3 standard housings for rail, panel and 19" mounting

Some Standard Functions
- LC-Display, dot-matrix, plain text, operation by 4 keys on the front
- Temperature control, multiple setpoints/setpoint layers, alarm thermostats
- Compressor Idle-Time, runtime monitoring of refrigeration
- Fan control with delay times for start and stop
- Roller blind control, frame heater control, pulsed, different for day/night
- Analog output usable for actual value image or for P, PI, PID-T1-control
- Adjustable Emergency Mode
- Door contact input
- Intelligent defrost control, able to learn (x140 only)

ELREHA

ELEKTRONISCHE REGELUNGEN GMBH

Technical manual **5310902-11/25e/00**

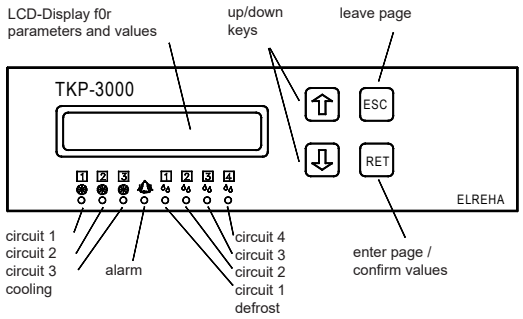
2018-05-30 tkd/jr

Cold Storage Controllers

from SoftwVers. **7.01 (Rev.P)**

Types: **TKP 3130 3130/1 3140** **TKC 5130 5140** **TKC 19130 19140**

Operating / Operating Elements



Operating Elements of the TKP 3130/3140 (The operating elements of all TKP/TKC-types look very similar).
The units can be operated by 4 keys, all parameters will be displayed in plain text on the backlighted LC-display. The TKP 3130/1 will be operated from keypad and display of the VPR Compound Control System.

Available Types

- **TKP 3130** ..... 230V, for DIN-rail
- **TKP 3130/1** ... without display and keys, TF-501 (Pt1000) probes only
- **TKP 3140** ..... like 3130 + intelligent defrost
- **TKP 23130** .... 115V, for DIN-rail
- **TKP 23140** .... like 23130 + intelligent defrost
- **TKC 5130** ..... 230V, panel mounting (front frame 96 x 96mm)
- **TKC 5140** ..... like 5140 + intelligent defrost
- **TKC 25130** .... 115V, panel mounting (front frame 96 x 96mm)
- **TKC 25140** .... like 25140 + intelligent defrost
- **TKC 19130** .... 230V, 19"-Al-cassette, 14 TE
- **TKC 19140** .... like 19130 + intelligent defrost
- **TKC 29130** .... 115V, 19"-Al-cassette, 14 TE
- **TKC 29140** .... like 29130 + intelligent defrost

Programming

All readable and adjustable values (parameters) of the **TKx** units are listed on several pages. While normal operation or if no key is pressed for about 3 minutes, the display shows the following information:

1. priority: current failure (only if there is a failure at the moment)
2. priority: controller states (e.g. if it is turned OFF by a digital input)
3. priority: the selected 'Basic Display'

Call up and changing of parameters:

Key	Action
ESC	.....If no pagename is displayed
⇧ ⇩	.....Select desired page
RET	.....Enter this page
⇧ ⇩	.....Select parameter
RET	.....Start programming, parameter name flashes. Eventually, the unit asks here for an access code
⇧ ⇩	.....Adjust desired value. Pressing and holding a key effects that the value will be incremented or decremented automatically faster and faster.
RET	.....Leave programming mode, confirm new value
ESC	.....Back to page overview.

Identification

If this display appears

```
Identification
Enter :> 0 <
```

then this parameter is protected by a password. The controller expects a code number. This code-no. (Code 1) is related from the actual time of the day as the sum of the **hour (0...23) plus 10**

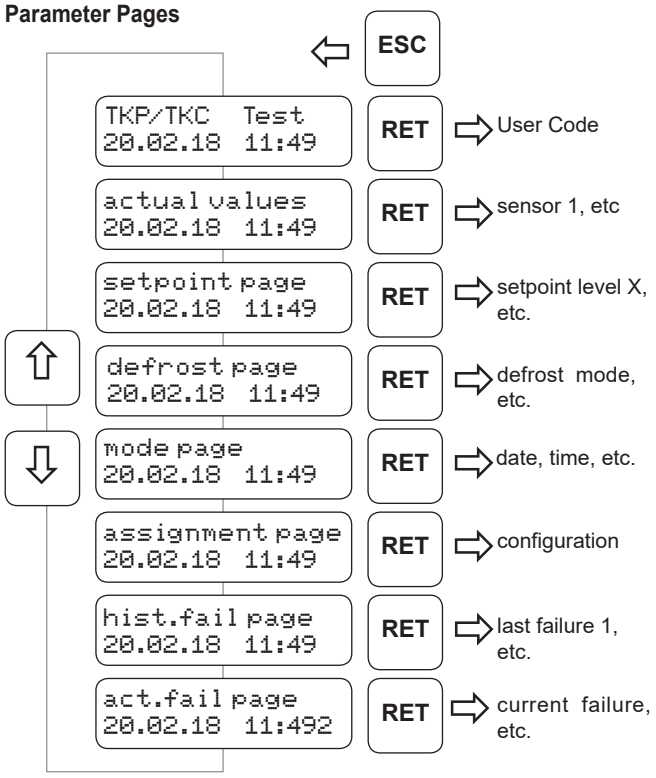
Changing User level

To change the user level do the following:
- Select "Basic Display", press key "RET"
- Enter code of the desired user level
  - Code for the service level is: (fixed) - **88** -
  - Code for the confoguration level: **month + hour + 20**

Manual defrost release

- Select "Defrost Page"
- Set parameter "manual defrost" to "start"

Parameter Pages



Please note Safety Instructions !

Caution

Notice

In controllers with older software versions some functions may be not available.

Software-Varities

Notice

In consequence of further development of the hardware and the different mounting forms the listed types differ a little bit.

At present, controllers are delivered with a software version 7.xx (add. info on the label: Rev.P). Some of the described functions are not available or different in older versions. Controllers of the TKC series can only delivered with software version 2.35.

The differences:

- Connection of a Remote Display:
  Only from Vers. 4.03 resp. 6.00 and only at the rail types "TKP".
- Error message "Hard" ,generated if the internal battery has low voltage:
  Vers. 6.xx only.
- Default value of the digital input 3 assigment is not "controller OFF", but "- - -": From Vers. 6.02 only.
- Intelligent Defrost: Only available with TKP/TKC x140 types.
- Data storage and real time clock see technical data

Technical Data

Supply voltage / Power consumption ... see 'Available Types' / max. 9VA
Ambient temperature .....0...+50°C
Ambient humidity .....max. 85% r.H., not condensing
Inputs.....6x temperature sensor, TF 201 (PTC) or TF 501 (Pt1000)
Measuring-/Display Range.....max. ± 100°C
(!! Please note the design caused temperature ranges of the sensors !!)
Accuracy .....±0.5K over the range -35..+25°C
for the ambient temperature range 10..30°C
Digital- (OC) inputs.....4x mains voltage, 3mA max.
Relay outputs .....6x SPDT, isolated, contact rating:
8A cosphi=1, 3A inductive / 250VAC
Analogue outputs (alternatively).....0...10V or
0/4...20mA (max. working resistance 500 ohms)
Ranges .....see parameter pages
Interfaces .....RS 232, RS 485,
Data storage..... typ. 3 years without mains voltage
Real time clock ..... x-tal, with automatic summer/winter switching
runtime (up to softw.vers. 6.9) typ. 3 years without mains voltage
(from softw.vers. 7.00) typ. 10 days without mains voltage
Housing TKP 31x0..... plastic, for 35mm DIN-rails
pluggable screw terminals, IP 30
TKP 3130-1 .....plastic, for 35mm DIN-rails, no display, no keys,
pluggable screw terminals, IP 30
TKC 51x0 .....plastic, panel mounting, frame
dimensions 96 x 96mm, pluggable
screw terminals, IP 54 from front
TKC 191x0 ..... 19"-Al-cassette, IP 30

Accessories

- Temperature sensors TF 201 or TF 501 (Pt1000)
- PC-Software "**COOLVision**"
  Software module "**COOLVision-MES**" for remote control/configuration
  Modules "**COOLVision-Analyse**" and "**COOLVision-SMM**" are used for value recording, graphical visualization and failure message forwarding.

CONNECTION INFORMATION & SAFETY INSTRUCTIONS

Notice

Product warranty does not cover damage caused by failure to comply with these operating instructions! Nor will ELREHA be held liable for any personal injury or damage to property caused by improper handling or failure to observe the safety instructions and recommendations contained in this or any other ELREHA supplied document related to this product! This manual contains additional safety instructions throughout the functional description. Please pay close attention to these instructions!

Danger

TO AVOID RISK TO HEALTH OR POSSIBLE LOSS OF LIFE, DO NOT OPERATE IF:

- The device has visible damage or doesn't work
- After a long storage period under unfavourable conditions
- The device is heavily soiled or wet
- When shipped under inadequate conditions

- Never use this product in equipment or systems that are intended to be used in applications or under circumstances that may affect human life. For applications requiring extremely high reliability, please contact the manufacturer before use.
- **This product may only be used in the applications described on page 1.**
- **Electrical installation and placement into service must be performed by qualified personnel only.**
- **To avoid the risk of Electrical Shock, all 'PE' terminals must be connected to ground. Without adequately grounding the unit, the internal noise filter will not work, which can cause faulty readings, or inaccurate displayed values to occur.**
- **Never operate the device without the supplied enclosure.**
- **To prevent electrical shock, the device may only be operated in a closed control cabinet or control box.**
- **Be sure to observe all local, state, or federal safety regulations in the location that the unit is installed.**

Caution

- Before installation, verify that the control specifications suit the application details. Damage may occur if the unit is operated outside of its specified limitations.
  Examples:
  - Supply voltage (printed on the type label).
  - Environmental limits for temperature/humidity.
  - Maximum current rating for the relays.
- Do not install sensor cables in parallel to high current cables. Shielding must be connected to PE at the end close to the controller. If not, inductive interferences may occur. The wire gauge should be no less than 0,5mm².
- Mounting the controller close to power relays is not recommended, due to the risk of strong electro-magnetic interference, which can cause the unit to malfunction!
- Ensure that the interface wiring meets all the necessary requirements.
- All used temperature sensors must be identical. Never use different types at the same time. This will not work.

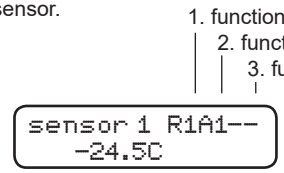
Notice

Cleaning
The use of a dry, lint-free cloth is sufficient to clean the product. Never use liquids or acidic fluids! Risk of damage!

Display of actual values and states

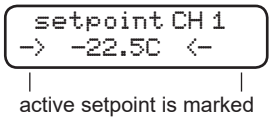
All actual values are shown on the '*actual values*' page.

Display of the temperatures
'*sensor1*' to '*sensor 6*' display their actual value in the range of -50 ... +100°C. At the same time, the display shows the functions which are assigned to the sensor.



Sensor corrections can be made by editing each individual sensor reading. The resulting correction factors are listed on the mode page (*corr sensor 1-6*).

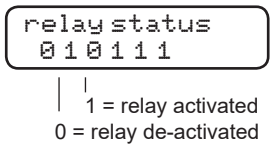
Setpoints:
The active day or night setpoints are indicated on the display by „->“ and „<-“.



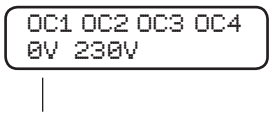
Information about delay times
On the actual values page you will find all remaining delay times, so it is easy to verify the points in time when specific functions must start.

Status Displays

Relay 1.....Relay 6



Digital Input 1.....Dig.Input 4



Temperature Sensors
There are two types of temperature sensors which can be used:
- **TF 201**, PTC sensor (2000 ohms@25°C), !! not 3130/1 !!
- **TF 501**, PT1000 sensor (1000 ohms@0°C) The type must be preset by '*sensor*' (mode page).

'Standard Display' - Function

After switching on the controller, the display will indicate the 'Standard Display' after some seconds (in case of a failure it will display the actual failure). factory set is the actual value of probe 1.
This will also displayed if you have selected any parameter and you haven't touch a button for more than 3 minutes. If you think that it is suggestive to show any sensor value as permanent parameter, do the following:

Change permanent parameter
- Select the parameter you want to have as 'Standard Display'
- Press "⇧" and "⇩ " simultaneaously. The display becomes dark for a moment, after that the selected parameter will be shown as the "standard display".

Failure Messages / Failure Memory / Failure Codes

All failures will be stored with date and time of their appearance. To display this messages, 2 pages exist:
- The "*Actual failures page*" contains all current failures in a short form. To make more than one current failure visible, use the 'up/down'-keys. If a sensor is short or broken, this message also appears on the actual value display.
- The "*Historic failures*" page contains the last **15** failures with date and time of their appearance.

Failure Codes

---- .....no failure
Init .....first initialisation of the controller or data lost
Hard .....- hardware failure (from SoftwVers. 6.xx): Internal battery voltage low
MOFF .....mains supply cut off
MON.....mains supply switched on
SiCh .....security chain open
SBr X .....sensor X broken
SSH X .....sensor X short

If a sensor is short/broken, a time delay of 5 seconds takes effect before an alarm will be activated.

HT X .....one of the alarm sensors of circuit X high temperature
LT X .....one of the alarm sensors of circuit X low temperature
MRC X cooling of circuit X has exceeded maximum runtime. (only active up to '*runtime mess at*').
OPC X .....alarm on digital (OC) input X, assigned as alarm input
DOR X .....door contact of circuit X open too long. (only active up to '*runtime mess at*').
DEF X .....number of defrost cycles without termination by temperature exceeded in circuit X, maybe too many ice or heater malfunction.
ASSI .....error on assignment page, e.g. function programmed too often
COon .....controller unit switched ON by interface or by digital input
COof .....controller unit switched OFF by interface or by digital input
OFF X .....circuit X switched off by interface or by digital input

Configuration Concept

The TKx controllers series has a ´**free configurable concept**', that means all in/outputs have no fixed functions. All inputs and outputs (*6 relays, 6 sensors, 4 digital (OC)-inputs, 1 analog output*) can be configured to work with any integrated control functions or all of the 4 control circuits.

Sensors
Each sensor is able to fulfill up to 3 functions at the same time (function sensor X a, function sensor X b, function sensor X c, X = sensor no.). *e.g.:*
1. control sensor and alarm sensor simultaneously
2. control sensor and defrost sensor simultaneously, e.g to control a chiller cabinet at the air outlet.

Virtual Sensors
Up to 6 probes can be combined to a "virtual" sensor, which allows an average determination with adjustable quantifying.

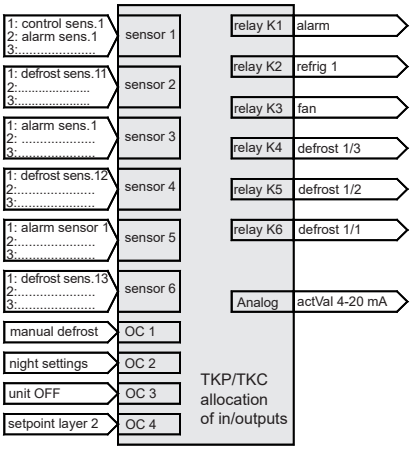
Digital Inputs (OptoCoupler Inputs)
Each digital input can be assigned to one of the possible functions.

Relay Outputs
Each relay can be used to control one of the possible functions. The same function can even be allocated to multiple relays.

Parameters
Parameters of functions which are not assigned will not appear in the parameter pages to improve survey.

Assignment
The function of each input and output can be preset on the 'assignment page'. The assignment can be done by the keys or via interface.

Example of a configuration for a freezer with 3 evaporators:



Process of configuration (Repeat this steps until all in/outputs are assigned to the desired functions)

Action	Key	Display	Remarks
Select assignment page	"⇧⇩"	assignment page date/time	
Enter assignment page	"**RET**"	function relay 1	
Select desired output	"**RET**"	Identification enter >0<	At the beginning of the config. only or after no key is pressed for 3 min.
Enter code depending on time	"⇧⇩"		
Confirm	"**RET**"	function relay 1 (flashing) - - -	
Select funtion for this output	"⇧⇩"	function relay 1 (flashing) alarm	
Confirm	"**RET**"	function relay 1 alarm	Flashing stops, relay already working
Select new in/output	"⇩"	function relay 2 - - -	
Prepare for configuration	"**RET**"	function relay 2 (flashing) - - -	
Select function for this output	"⇧⇩"	function relay 2 (flashing) refrig. 1	
Confirm	"**RET**"	function relay 2 refrig. 1	Flashing stops, relay already working
and so on...			

Parameter pages

Actual Values	Disp only	Level	Range	Factory setting
sensor 1 xxxxxx[x]		1	Temperature at this sensor, range -100/+100°C, calibration range here is +/- 10K [x] indicates the function assigned to this sensor: **Rx** = control sensor x, **Wx** = alarm sensor x, **DO** = display only sensor, **wx** = defrost demand sensor warm x, **cx** = defrost demand sensor cold x, **Dxy** = evap sensor, circuit x / no.y	calibr. = 0
sensor 2		1	dto.	calibr. = 0
sensor 3		1	dto.	calibr. = 0
sensor 4		1	dto.	calibr. = 0
sensor 5		1	dto.	calibr. = 0
sensor 6		1	dto.	calibr. = 0
sensor 7		1	virtual actual value, composed of actual temperature values and adjustable quantifying	
run time refr. 1	**X**	1	refrigeration runtime today	00:00
up to				
run time refr. 4	**X**	1		00:00
door open 1	**X**	1	total door open time today	00:00
up to				
door open 4	**X**	1		00:00
rem. door open 1	**X**	2	remaining time before alarm	
up to			("---" = door closed)	
rem. door open 4	**X**	2	h:min:sec	
remain alm delay	**X**	2	remaining time before temperature alarm	
remain defr time	**X**	2	remaining defrost time in mm:ss	
rem. defr pause 1	**X**	2	h:min:sec	
up to				
rem. defr pause 4	**X**	2		
remain fandelay 1	**X**	2	h:min:sec	
up to				
remain fandelay 4	**X**	2		
rem compr pause1	**X**	2	h:min:sec	
up to				
rem compr pause4	**X**	2		
rem strt sec ch(ain)	**X**	2	h:min:sec	
rem chck defrdem	**X**	2	min:sec	00:00:00
dem defr stored	**X**	2	yes, no	no
solenoid valve	**X**	2	enabled, off	
status	**X**	1	off circuit X	
night settings	**X**	1	day, night	
runtime relay 1		2	h:m:s (resettable only)	00:00:00
up to				
runtime relay 6		2		00:00:00
analog value	**X**	1	output is X% of the selected range	
OC1 OC2 OC3 OC4	**X**	1	voltage at this digital inputs	
relay status	**X**	1	state of relays 1-6 (1=ON/avtivated, 0=OFF/de-activated)	

Setpoint Page	Level	Range	Factory setting
setpoint layer	1	1, 2	1
setpoint Ch 1	1	-50/+50°C	-20°C
setpoint Ch 2	1	-50/+50°C	-20°C
setpoint Ch 3	1	-50/+50°C	-20°C
setpoint Ch 4	1	-50/+50°C	-20°C
2nd setp Ch 1	1	-50/+50°C	-20°C
2nd setp Ch 2	1	-50/+50°C	-20°C
2nd setp Ch 3	1	-50/+50°C	-20°C
2nd setp Ch 4	1	-50/+50°C	-20°C
alt setp Ch 1	1	-50/+50°C	-20°C
alt setp Ch 2	1	-50/+50°C	-20°C
alt setp Ch 3	1	-50/+50°C	-20°C
alt setp Ch 4	1	-50/+50°C	-20°C
alt 2nd setp Ch 1	1	-50/+50°C	-20°C
alt 2nd setp Ch 2	1	-50/+50°C	-20°C
alt 2nd setp Ch 3	1	-50/+50°C	-20°C
alt 2nd setp Ch 4	1	-50/+50°C	-20°C
warning offset	2	0...50K (relative to the active setpoint)	7 K
alt warn offset	2	0...50K (relative to the active setpoint)	7 K
warn low limit	2	-50/+50°C (absolute value, threshold for undertemperature limitation/alarm) **Cannot be switched OFF.**	- 22°C
alt warn low lim	2	-50/+50°C (dto.)	- 22°C
hysteresis	2	0,1...20K	2 K
PID propor band	2	0,1...30K	4 K
PID integr time	2	off, 00:00....10:00 min:sec	10 sec.
PID attack time	2	off, 00:00.....00:10 min:sec	off
PID delay	2	off, 0,1.....10 sec.	off
opto->analog val	2	0,0...100,0 %, voltage/current from analog output with activated digital (OC-) input	0%
fan start delay	2	0:00:00.....0:30:00 (h:min:sec, freeze-on time)	0:05:00
fan off delay	2	00:00.....30:00 min:sec	00:00
warning delay	2	0:00:00.....2:00:00 (h:min:sec)	0:45:00
cooling limit	2	0:00.....23:59 (h:min), off	off
door time limit	2	0:00.....23:59 (h:min), off	off
refrDlyAftMnsOff	2	0...30 min	0 min
compr. pause	2	00:00.....30:00 hh:mm	00:00
OC inp alm delay	2	00:00.....02:00 hh:mm	00:05
door alm delay	2	00:01.....04:00 hh:mm	00:05
sec chain delay	2	00:00.....01:00 min:sec	01:00

Parameters marked with "**Disp. only**" are for Information only and cannot be adjusted.

The numbers in column "**Level**" show the user level, where this parameters are displayed.

Defrost Page	Disp only	Level	Range	Dim.	Factory setting
defrost type (fan dur.defr.)		2	on, off		off
defrost mode		2	extern(al only), extern+intern, difference meth., dem def by opti, adaptive *		extern+intern
defrost time 1		1	00:00 - 23:59, off	hh:min	5:00
defrost time 2		1	00:00 - 23:59, off	hh:min	off
up to					
defrost time 6		1	00:00 - 23:59, off	hh:min	off
defr temp limit 1		2	(control circuit 1) 0,0°C....50,0°C	°C	14°C
up to					
defr temp limit 4		2	(control circuit 4) 0,0°C....50,0°C	°C	14°C
last defr cycle 1	X	2	(circuit 1) min:sec	mm:ss	00:00
up to					
last defr cycle 4	X	2	(circuit 4) min:sec	mm:ss	00:00
n/o defr ignored	X	2	0, 1, 2, 3, 4, 5, 6		0
demand defr diff		2	0,0...20,0K	K	5K
dem defr period		2	00:00...10:00 mm:ss	mm:ss	02:00
pulsedef. limit		2	-5,0...+50,0°C	°C	50,0°C
defr alarm delay		2	00:00....60:00	mm:ss	30:00
pause ahead defr		2	0...15 min	min	0
pause aft. defr		2	00:00....30:00	mm:ss	00:00
n/o.def.evnt > alm		2	Number of defrost cycles without alarm,	off, 1-15	3
max defrost time		2	00:00....4:00:00	mm:ss	45:00
manual defrost		1	start, finish		
* defrost forerun		2	00:00....00:15	hh:mm	00:03
* time (up) to defr	X	2	hh:min:sec		
* max time to defr		2	02:00....48:00	hh:mm	24:00

Mode Page	Disp only	Level	Range	Dim.	Factory setting
compound		2	1, 2, 3, none		1
fan operation		2	interval, permanent		interval
cooling mode		2	refrigeration, freezing		refrigeration
emergency operat		2	0...100%		0%
frame period		2	10:00...60:00 mm:ss		15:00 mm:ss
frame pulse day		2	0...100%		100%
frame pulse nigt		2	0...100%		100%
frame pulse act..	X		display of the actual frame pulse duration (evtl. shifted by the VPR-system)		
alm temp. low		2	yes, no		yes
night setp ON		2	0:00 thru 23:59, off		off
night setp OFF		2	0:00 thru 23:59, off		off
runtime mess at		2	0...23 h, off		6 h
corr sensor 1		2	calibration offset, adjustable +/-10 (actual value also adjustable)	K	0
up to					
corr sensor 6		2	calibration offset, adjustable +/-10 (actual value also adjustable)	K	0
sensor (type)		3	TF 201 (PTC), Pt1000 !! 3130/1=Pt1000 only, So1, So2		TF 501 (Pt 1000)
unit text		3	unit name as desired		TKP
operator layer		3	yes, no		no
program version	**X**	1	version no. of this program		
summer / winter		3	no, EU up to 1995, EU from 1996, variable		EU from 1996
actual time		2	h:min:sec		
actual date		2	day:month:year		
timezone offset		2	-720...720 min.		60 Min.
summerOn month		2	(for variable only) 1...12		3
summerOn day		2	(for variable only) 0(sunday)...6		0
summerOn x-day		2	(for variable only) 0...5(last), 0 = off		5
summerOn hour		2	(for variable only) 0...23		2
summerOff month		2	(for variable only) 1...12		10
summerOff day		2	(for variable only) 0(sunday)...6		0
summerOff x-day		2	(for variable only) 0...5(last), 0 = off		5
summerOff hour		2	(for variable only) 0...23		2
Sprache / language		2	deutsch, english, francais, netherlands		
baudrate		3	0= auto, 1=1200, 2=2400, 3=4800, 4=9600, 5=19200, 6=28800, 7=38400, 8=57600, 9=115200 (!! from SoftwVers. 7.00 '0= auto' is not longer available !!)	4 (9600)	
address in netwk		3	0 - 78		

Parameters marked with "**Disp. only**" are for Information only and cannot be adjusted.

The numbers in column "**Level**" show the user level, where this parameters are displayed.

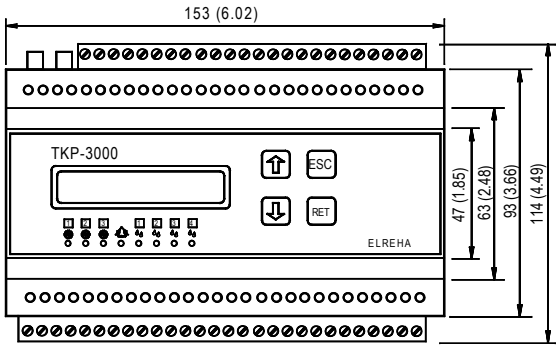
Assignment Page	Level	Range	Factory setting
function relay 1	3	--, on, refrig. 1....refrig.4 defrost11....defrost14, defr. 11....44, defrost21....24, defrost31....defrost34, defrost41....defrost44, fan 1....fan 4, unit on, alarm, frame heater, roller blind, light, heater 1, expansion valve 1 (defrost yz / y=circuit, z=evaporator), controller on	alarm
function relay 2	3	dto	refrigeration 1
function relay 3	3	dto	refrigeration 2
function relay 4	3	dto	frame heater
function relay 5	3	dto	defrost 21
function relay 6	3	dto	defrost 11
function Opto. 1	3	---, manual defrost, night settings, unit OFF actHigh, security chain, setpoint layer,	man. defrost
(digital input OC 1)		door contact 1...4, alarm input 1...4, circuit OFF 1 - - - up to circuit OFF 1 2 3 4, analog value, refLock actLow, refLock actHigh, refForce(/-release) actLow, refForce(/-release) actHigh, unit OFF actLow, circuit OFF 1 - - - up to circuit OFF 1 2 3 4, circ.OFF.low 1 - - - up to circ.OFF.low 1 2 3 4	
function Opto. 2	3	dto	night settings
function Opto. 3	3	dto	controller OFF
function Opto. 4	3	dto	- - -
funct. sensor 1a	3	- - - (sensor is switched OFF), control sensor 1 ... control sensor 4, defr sensor **x/x** = defrost sensor **circuit x** / **no. x,** demdefr sens co1, demdefr sens wa1, alarm sensor 1....4, disp only sens	control sens. 1
funct. sensor 1b	3	dto	alarm sensor 1
funct. sensor 1c	3	dto	- - -
weighting 1	3	0...100%, weighting for the virtual sensor	0%
funct. sensor 2a	3	dto	defr. sens. 1/1
funct. sensor 2b	3	dto	- - -
funct. sensor 2c	3	dto	- - -
weighting 2	3	0...100%, weighting for the virtual sensor	0%
funct. sensor 3a	3	dto	control sens. 2
funct. sensor 3b	3	dto	alarm sensor 2
funct. sensor 3c	3	dto	- - -
weighting 3	3	0...100%, weighting for the virtual sensor	0%
funct. sensor 4a	3	dto	defr. sens. 2/1
funct. sensor 4b	3	dto	- - -
funct. sensor 4c	3	dto	- - -
weighting 4	3	0...100%, weighting for the virtual sensor	0%
funct. sensor 5a	3	dto	disp only sens
funct. sensor 5b	3	dto	- - -
funct. sensor 5c	3	dto	- - -
weighting 5	3	0...100%, weighting for the virtual sensor	0%
funct. sensor 6a	3	dto	disp only sens
funct. sensor 6b	3	dto	- - -
funct. sensor 6c	3	dto	- - -
weighting 6	3	0...100%, weighting for the virtual sensor	0%
funct. sensor 7a	3	function (a) of the virtual sensor	- - -
funct. sensor 7b	3	function (b) of the virtual sensor	- - -
funct. sensor 7c	3	function (c) of the virtual sensor	- - -
analog function	3	0V, 4mA, 10V / 20 mA, act.img 0-10V, act.img 4-20mA, PID-T1 0-10V, PID-T1 4-20mA, PID-T1 10-0V, PID-T1 20-4mA, ExpValve 0-10V, ExpValve 4-20mA	act.img 0-10V
O 1/2 - O 3/4	2	state of the digital (OC)-inputs 1-4	
R 1/3 - R4/6	2	state of the relays 1-6	

defrost 11....44 means:
defrost yz -> y=circuit, z=evaporator

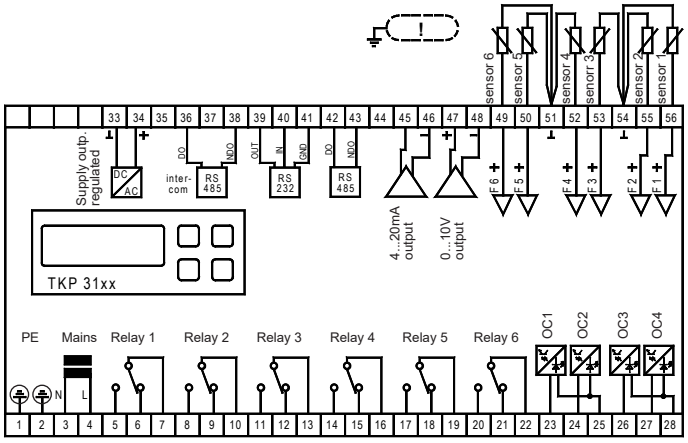
Parameters marked with "**Disp. only**" are for Information only and cannot be adjusted.

The numbers in column "**Level**" show the user level, where this parameters are displayed.

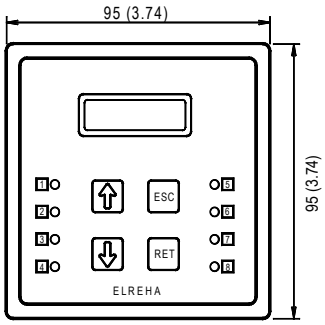
Dimensions / Connection TKP 3130 / 3130/1 and 3140

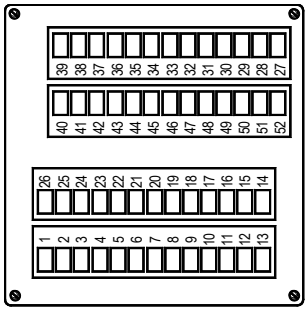


3130/1: Without display and operating keys

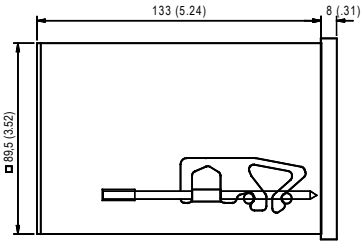


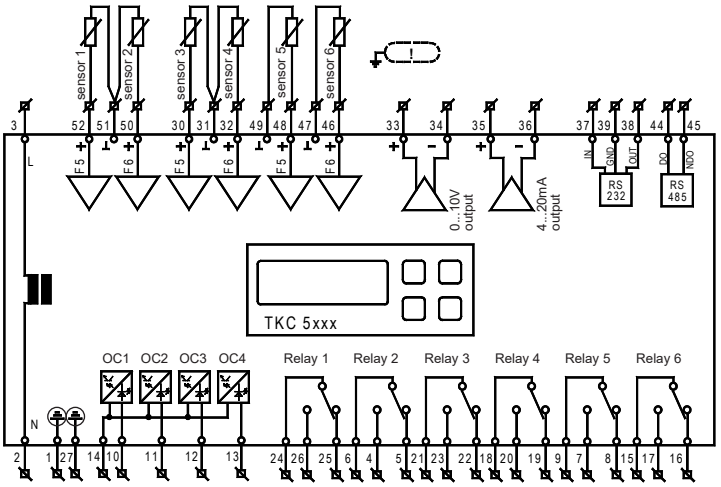
Dimensions / Connection TKC 5130 / 5140





rear view





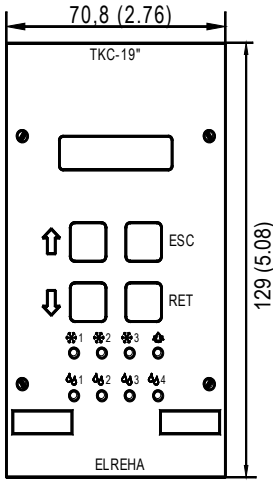
Note

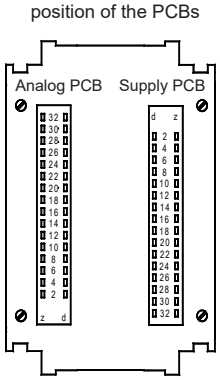
Protective Earth

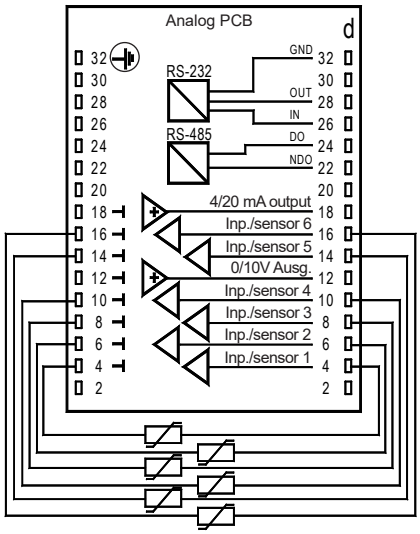
Earth

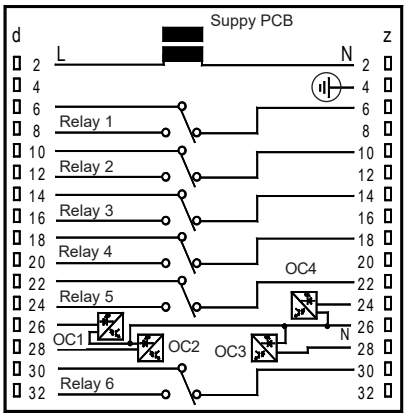
Dimensions in mm,
(in brackets = inches)

Dimensions / Connection TKC 19130 / 19140









This diagram shows a connector type "F", DIN 41612, rear view.

Access Protection / Unauthorized changing of parameters

User levels

To avoid parameter changing by unauthorized persons, 3 different user levels are available:

1. **Customer Level**
   In this level setpoints can be changed, but it is impossible to change the configuration of the unit.
2. **Service Level** (call-up with code 2)
   Here the service contractor finds parameters and information for start-up and service.
3. **Configuration Level** (call-up with code 3)
   Here you can change all parameters, even the fundamental functions to assign inputs and outputs.

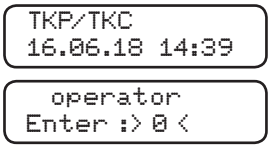
In the single levels only the accessable parameters will be displayed (marked by 'Level 1,2,3' on the parameter pages).

Using the Access Protection

The parameter „*operator layer*“ on Mode Page is factory set to „no“. Thus you will see all parameters, the same as if the 'Configuration-Level' would be active.
After start-up, you protect the controller unit effectively by changing parameter „*operator layer*“ (mode page) to „yes“. If you don’t touch any key for at least 3 minutes or if you switch off power for a moment, the protection will be activated. Thus only the parameters of the **Customer Level** can be displayed.
All other parameters are hidden now and can be accessed only by knowing the code.

To change from Customer Level to Service- or Configuration Level do as follows:

- Select 'basic Display',
- Press key "Prog",
- Enter code for desired level.



Change parameters

To change a parameter in the single user levels, the unit frequently expects an additional 'Identification Code'. (see right column).
As long as parameter "*operator layer*" is not set to "no", the unit changes to the **Customer Level** if no key is pressed for about 3 minutes.

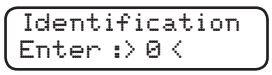
Codes for Customer Levels

Code 2: ..... Fixed Code: - **88** - (calls up Service Level)

Code 3: ..... **Month + Hour + 20**
(calls up Configuration Level)
Example: (Note: Real-time clock must be set to the right time and date before.)
You want to change a parameter at a day in june at 9:35 in the morning. Identification Code = 6 + 9 +20 = **35**.

Parameter Protection / Identificaton

Almost all parameters, except the temperature setpoints, are protected by a simple password.
If you have to change a parameter and you have pressed the "RET"-key, this display appears:



The controller expects now the input of a code-no. This code-no. (Code 1) is related from the actual time of the day as the sum of the

hour (0 to 23) plus 10

Example:
At 9:35 a.m. the code is 9 + 10 = 19.
At 21:35 (9:35 p.m.) the code would be 21 + 10 = 31.

If you have pressed no key for about 3 minutes, the parameters are locked again automatically.

Display Language

The language used on display can be changed by "*Sprache/Language*" (mode page) to german, english, french or dutch.

Unit Text

In the mode page you have the possibility to define a specific text (max. 16 characters) for the controller, e.g. „meat-store“. This name will be indicated on the screen of the VPR compound controller or on a PC with matching software.

Change text:

- select parameter „unit text“ (mode page)
- „**RET**“ Start programming, the first character position flashes (eventually, you must enter the access code before)
- "⇧ ⇩" change character
- „**RET**“ the next character flashes
- "⇧ ⇩" change character
  ....and so on
- press „**RET**“ to confirm the last character.

Changing the text can also be made by the software 'COOLVision' or 'CV-Scheduler'.

'Physical' and 'virtual' sensors

1. Each 'physical' (real) sensor is able to fulfill up to 3 functions at the same time (see Assignment Page), any sensor is able to do the same job.
Up to 6 control sensors can be assigned the same time. The warmest of them initiates the cooling function.

2. It is possible to create a 'virtual' sensor to realize different kinds of averaging, e.g. multiple sensors in a huge room or averaging of inlet and outlet sensor in a chest freezer. The 'virtual' sensor resp. value (**sensor 7**) follows from the selectable emphasis of the sensors which must have an effect on the result (**weighting 1-6**, Assignment Page). The functions assigned to this 'sensors' (**funct sens. 7a-c**, Assignment Page) are the same as the functions for the 'physical' sensors.
Example: If the 'physical' sensor 1 got the function "**con**" (control sensor) and also the 'virtual' sensor, then the warmer one initiates refrigeration.

- Selection of a "virtual sensor":
  - Assignment of a function by "**funct sens7a-c**"
- Selection of a 'physical' sensor which must have an effect on the result :
  - Activating of the sensor by assigning a function (e.g. display only sensor)
- Set weighting for the selected sensor (**weighting 1-6**).

The sum of all emphasis values must be 100%. *Example*:
If sensor 1 and sensor 2 must have an effect on the result and you set "**weighting 1**" to "30%" and "**weighting 2**" to "60%", then you get the error message "**SEL**" (assignment error).

Further causes for the error message "**SEL**"
- The sum of all emphasis parameters is 100%, but no virtual sensor function is selected
- All 4 emphasis values are set to '0' and a 'virtual' sensor function is assigned
- A physical sensor is switched off, but an emphasis value > 0 is selected.

Example 1, Chest Freezer:
For the detection of the actual value, inlet and outlet sensor must be used. Sensor 1 is mounted at the suction side (inlet) and must have an 60% influence on the result. Sensor 2 is mounted at the outlet and must have an 40% influence.
- set "**weighting 1**" to "60"
- set "**weighting 2**" to "40"
- set "**funct sensor 7a**" to "con" (control sensor)

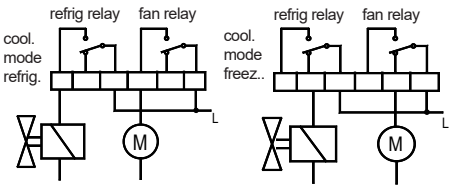
Example 2, huge room, standard application
Sensors 1-3 must measure the rooms temperature, an arithmetic average must be calculated, sensor 4 is the defrost limitation sensor in the evaporator.
- set "**weighting 1+2**" to "33" and "**weighting 3**" to "34"
- set "**funct sensor 7a**" to "con" (control sensor)
- set "**funct sensor 4a**" to "df1"

Special Function
If an emphasis parameter value is set to 100% (others to 0), up to 6 functions can be assigned to the corresponding physical sensor. This may be of interest for applications where more than 3 sensor functions are used.

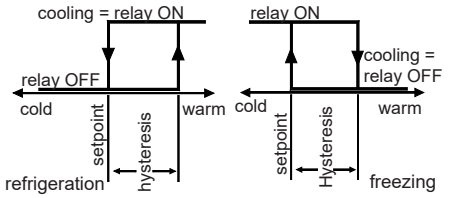
Cooling

Control circuits
This controller is able to control up to 4 independent cooling circuits, each with an own setpoint.

Cooling
Cooling is controlled by switching the output relay. In case of power loss or controller defects the contacts must switch in a position which is safe for the application. For this reason we are using the N/O-contact for refrigeration applications (fail-safe: open contacts). For freezing applications we use the N/C-contacts (fail-safe: closed contacts).



This can be set by parameter *"cooling mode"* (mode page). The point of cut-off is always the valid setpoint. The selection of this parameter also affects to the switching characteristic of the fan relay.



The refrigeration relay can be disabled via interface (see chapter "networking via E-Link").

Low temperature Limitation
Can be used e.g. for refrigerated shelfs with roller blinds to limit the temperature at the air outlet during night operation. When the temperature at the alarm sensor falls below the limit set by "*warn low limit*" (Setpoint page) cooling will switch off. This value is the threshold for the undertemperature alarm at the same time.

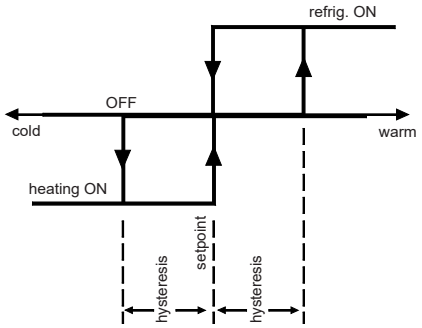
notice **The undertemperature limitation cannot be switched off and is also active with disabled low temperature warning.**

Refrigeration delay after power up
The start of refrigeration after power-up resp. mains loss can be delayed by parameter "*refrDlyAftMnsOff*" (Setpoint Page). In plants with many cold storages this function prevents that after power-up all solenoid valves open at the same time, even though not enough machine power is present yet.

Heating function

For one relay it is possible to assign the function of heating circuit 1. The setpoint is the cut-off of heating and cooling at the same time:

- for cooling at setpoint + hysteresis *and*
- for heating at setpoint - hysteresis.



Second setpoint (night operation)

For each of the 4 circuits a second setpoint is available (*2nd setp Ch X*). This can be used for night operation or other energy savings. The toggling between these setpoints can be made by the internal clock or by a digital input. The setpoint which is in use at the moment is marked by two arrows like: „—> -20,0°C <—". In the actual values page you see also if day or night setpoint is in use.

Internal toggling
The parameters „*night setpt ON*" (mode page) and „*night setpt OFF*" determine the period when the 2nd setpoint will be active. If the function 'night settings' is assigned to one of the digital inputs, it must be connected to mains phase. If the internal timer is not used, set '*night setp. ON*' and '*night setp. OFF*' times to „OFF".

External toggling
If the 'night settings' input is open, the 2nd setpoint is activated all time and the internal timer is disabled. With this digital input to mains phase, the normal (1st) setpoint is activated and internal timer is enabled.

Second Set of Setpoints

The controller offers two sets (layers) of setpoints, where the first layer of setpoint is used during normal operation and the alternative layer of setpoints with other temperatures is used e.g. for other products which will be stored only sometimes. For each layer there are parameters for the setpoints, the night setpoints, warning offsets and low temperature warning. The names of the second set parameters begin with '*alt*....'.

Toggling between the setpoint layers

1. internal: with parameter „*setpoint layer*"
2. external: assign function „setpoint layer" to a digital input. If connected to mains phase, the 2nd layer is in use.

Runtime Monitoring

The controller monitors the total running hours per day of the cooling outputs. This values are displayed under parameters „*run time refr. x*" for each circuit. One day counts from the time of the parameter „*runtime mess at*" (mode page) until the same time of the next day.

Example:
"*runtime mess at*" set to 11:00.
Monitoring time range is from 11:00 o'clock day 1up to 10:59 o'clock day 2.

The total runtime of the cooling relays over a day will be stored and displayed (*"runtime refr. 1-4"*, Actual Values).
A parameter „*cooling limit*" can be set to a reasonable value (hours per day) which, when exceeded on three days in a sequence, will cause an alarm at the hour programmed by „*runtime mess at*". Then the alarm relay will be de-activated and the alarm LED goes on.

This alarm will be cancelled automatically 1 hour later.

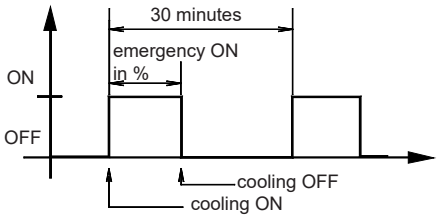
Operation with a single compressor

If a single compressor is controlled by a refrigeration relay, it is suggestive to have an idle time to prevent the machine from damages caused by short cycle operation. The compressor can restart only after the timer "*compr. pause*" (setpoint page) is run down. The remaining time up to the compressors restart can be read at "*rem.compr pause X*" (actual page).

Caution If a compressor must be controlled directly, never use the cooling mode 'freezing' to prevent compressor damages by continuous running!

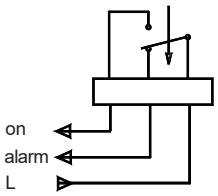
Emergency Operation

If all control sensors fail, the unit turns to an emergency mode automatically. The cooling relay cycles with a %-part ("emergency operat.", Mode Page) of the 30 minutes period.



Temperature Alarm

Any over- or undertemperature condition results in a temperature alarm which causes the normally energized alarm relay to de-energize. Hereby the N/O-contacts open and the N/C-contacts close.
To avoid an alarm for short irregular conditions there is a delay time („*warning delay*“, setpoint page). The alarm condition is indicated by a LED at the front of the controller. The alarm is cancelled automatically if the temperature comes back to normal. During defrost periods, temperature alarm will be suppressed. "*remain alm delay*" shows the remaining time up to an alarm occurs.



Overtemperature Alarm
It is possible to select max. 4 alarm sensors for a circuit (e.g. 4x "*alarm sensor 1*"). If the temperature at any of the alarm sensors gets higher than the effective setpoint plus the „*warning offset*“ setting, an alarm will be initiated after the delay time.

Low temperature Alarm
If the temperature at any alarm sensor gets lower than the „*warn low limit*“ setting, an alarm will come on with the delay explained above. This setting is an absolute value and does not refer to the control setpoint. The „*warn low limit*“ setting works as a threshold for the "Low temperature Limitation" function at the same time. Low temperature alarm can be disabled by "*alm temp low*" (mode page).

Supplementary warning delay during defrost
After a defrost cycle the temperature might take longer to stabilize and the normal warning delay turns out to be too short. For this reason the „*defrost alarm delay*“ (defrost page) setting adds on to the normal warning delay after defrost.

Digital inputs (Optocoupler Inputs)

Switching OFF Controller / Cooling Circuits
Sometimes it is necessary to switch off cold storages completely including the controller, but if this controller works in a network, the bus-master detects a malfunction and generates an alarm.

Controller Off
If a digital input is assigned to the function „*Unit OFF actHigh*“ and is connected to phase, all control functions are disabled. The display continues working, but no alarm will be activated. This is memorized in the list of the 'historical failures'. „*Unit OFF actLow*“ disables the functions with 0V at the digital input.

Circuit Off
Each digital input can be configured to switch off one ore more cooling circuits ("*circuit OFF X*"). If activated, all regulation and control functions and temperature alarms of the concerned circuits are disabled. Nevertheless the others are still working. This is memorized in the list of the 'historical failures'.

Relay function 'unit on'
The function 'unit on', assigned to an output relay, has the effect that this relay keeps switched on during normal operation and keeps switched off while the controller unit is disabled by digital input or by interface. So this relay can be used to switch a function which should be active while the controller unit does not work.

Safety Chain Monitoring
While using the controller for single compressor applications, one of the digital inputs can be used for monitoring the safety devices ("*security chain*") of the compressor. Normally the digital input is connected to phase. But if the input is open, the controller waits for the timer „*sec chain delay*“ (setpoint page) then cooling and fan are switched off, a running defrost period is terminated and a new defrost start is impossible. The alarm relay will be activated. Parameter "*rem strt sec ch*" shows the remaining time up to a controller unit response.

Door Contact Input
Each control circuit can get a a door contact input. If the door contact input is connected to phase, the fan of the circuit stops immediately. If the door is open **> 3 minutes**, cooling will stop too. Parameter "*status*" shows the circuit which is switched off. If the door is open > 5 minutes, the failure message "*door X*" will be generated. Cooling and fan will restart:
- if door is closed or
- if temperature exceeds the warning limits or
- if door opening exceeds the time set by „*door alm delay*“ (setpoint page). At the same time the alarm relay will be activated.

Exception: If no alarm sensor is assigned or if the temperature is above the alarm limit „*warning offset*“, then cooling continues without interruption. The cooling remains active and the fan starts again, so the door opening is ignored.

Door Open monitoring
Each time when door is open, the controller adds this time to the total opening time of that day „*door open x*“ (actual page). If the total opening time exceeds the time set by „*door time limit*“ (setpoint page) then an alarm will be generated. The failure message will be forwarded at the point in time determined by „*runtime mess at*“ (mode page) and is cancelled automatically 1 hour later. "*rem door open 1*" thru "*rem door open 4*" show the remaining time up to the alarm message.

Light
One of the relays can execute the function „*light*“, suitable to control lightings. In this case, the relay switches together with the night settings „*night setp. ON*“ and „*night setp. OFF*“ (mode page). During „day“ the relay is activated.

External Alarm
The digital inputs can execute the job „*alarm input x*“. While normal operation, the input is connected to mains phase. When the voltage drops down, a delay time starts „*OC inp alm delay*“ (setpoint page). After this timer is run down, a failure message will be generated.

Forced Refrigeration and Defrost Lock
See chapter 'Adding controller units'.

Analog Output

The controller contains an analog output which can be used for regulation or to provide a remote display with an actual value image. The signal is available as a DC-Voltage or a DC-Current-Signal.
Parameter „*analog value*“ (actual page) shows the current output signal as a %-part of the selected range, "*analog function*" (assignment page) determines the behaviour of the output:

Test functions (output delivers fixed values only)

0V = voltage = 0V, current = 0 mA
4mA = voltage = 2V, current = 4 mA
10V/20mA = voltage = 10V, current = 20mA

Transmission of actual values to remote displays or similar

act.img 0-10V =
The outputs provide an image of the value of refrig.sensor 1.
voltage: -50°C = 0V, +100°C = 10V
current: -50°C = 0mA, +100°C = 20mA

act.img 4-20mA =
The outputs provide an image of the value of refrig.sensor 1. .....
voltage: -50°C = 2V, +100°C = 10V
current: -50°C = 4mA, +100°C = 20mA

Control with the analog output signal (PI-control)

PID-T1 0-10V =
This PID-controller with 0-10V DC-signal is assigned to cooling circuit 1. The output signal represents an addition of the components P, I, D and T1.

PID-T1 4-20mA =
This PID-controller with 4/20mA-signal is assigned to cooling circuit 1. The output signal represents an addition of the components P, I, D and T1.

PID-T1 10-0V =
PID-controller like above, but with inverted voltage output (rising temperature = falling voltage).

PID-T1 20-4mA =
PID-controller like above, but with inverted 4/20 mA-output (rising temperature = falling current)

To adapt the controller to the process use the following parameters:

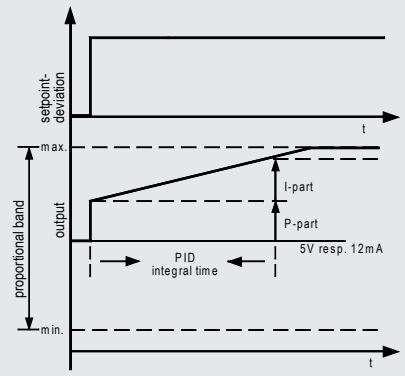
" PID propor band" ..... situated symmetrically to '*setpoint Ch 1*'
" PID integr time" ..... integral time (I-part)
" PID attack time" ..... derivative time (D-part)
" PID delay" ..... actuator response time (T1-part)

How to affect the analog output manually

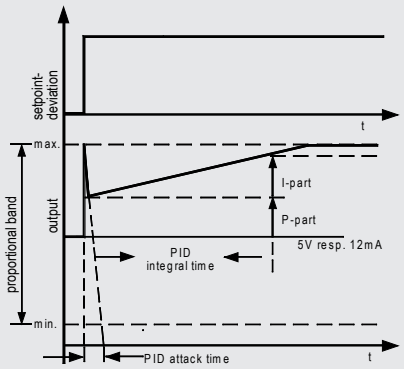
For certain operations it might be usefull to affect the output signal manually. Therefore the function „*analog value*“ (assignment page) can be assigned to one of the digital inputs.
Applying mains phase to a configured digital input the analog output will be forced to the value (in %) that is programmed by „*opto->analogout*“ (setpoint page). So e.g. a connected valve drive will be set to a specific position.

"*function Opto. x*" (Assignment Page)
= configuration of the digital (OK) input for this function
"*opto->analog val.*" (Setpoint Page)
= value of the output signal in %/V/mA, if the digital (OK) input has been activated

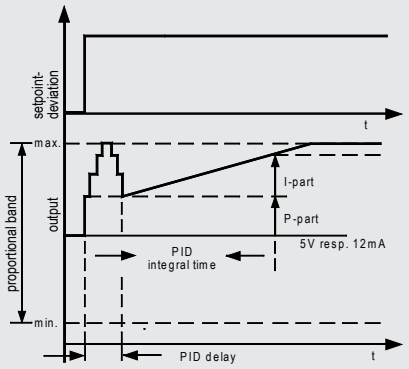
Control Characteristic



PI-control, D and T1-parts de-activated



PID-control, T1-part de-activated



PID-control, with T1-low-pass filter

Real Time Clock

The built-in real time clock is buffered for a period where mains voltage is switched off (3 years up to softw.vers. 6.9, appr. 10 days from softw.vers. 7.00). Date and Time can be set on the 'mode page'. Factory set is a GMT +01:00 ('timezone offset'= 60 min.), which is valid for mid europe. If the controller is used in other zones, the values can be readjusted.

Summer/Winter Time (Daylight Saving Time) Switching / Time Zones
An automatic summer / winter switching (parameter „*summer/ winter*“) considers the current EU-rules from 1996 (EU 96), but it can also switched off or set as necessary.

Variable Time Zones
By parameter "*timezone offset*" the summer/winter time switching can be adapted as necessary.

"*summerOn month*" (fact.set: march, 3rd)
The month before summertime begins
"*summerOn day*" (fact.set: 0, sunday)
The day of the week where summertime begins
"summerOn *x-day*" (fact.set: 5, last sunday)
The day no. x in the month set with "summerOn day"
"*summerOn hour*" (fact set: 2, (2:00 am))
The hour of the beginning of the summertime

"*summerOff month*" (fact.set: october, 10th)
The month of the end of the summertime
"*summerOff day*" (fact.set: 0, monday)
The day of the week where summertime ends
"*summerOff x-day*" (fact.set: 5, last sunday)
The day no. x in the month set with "*summerOff day*"
"*summerOff hour*" (fact.set: 2, 2:00 am)
The hour of the end of the summertime

All time settings are preset in winter time.

Defrost

The controller allows several, different defrost methods. This methods are available for each of the 4 possible control circuits, that means it is possible to assign 4 defrost channels, each with an own relay.

This relay output(s) are able to control an electric heater or fan for defrosting the evaporator(s).
Each evaporator with electric heater is monitored by a defrost sensor. According to the application, choose if the fan must stop or run during defrost (parameter „*defrost type*“ on or off).

- „*defrost mode*“ (defrost page) determines how defrost starts:
  - *extern(al)*
  defrost starts only when the digital input (OC-input) is activated
  - *extern+intern*
  defrost starts by digital input or by internal clock
  - *difference method*
  defrost on demand method which uses two supplementary sensors to measure the temperature difference across the evaporator
  - *dem defr by opti*(mization)
  defrost on demand method, defrost is started by the clock, but the pauses between the defrost cycles will be calculated
  - *adaptive*
  defrost control by the intelligent, adaptive function (only TKP/TKC x140, c.f. next pages)

An electric defrost heater is switched by the N/O-contact of the defrost relay independent from the application (refrigeration/freezing).
Cooling is disabled during defrost automatically.
"*last defr cycle 1*" thru "*last defr cycle 4*" (defrost page) show the expired defrost time of each circuit.

Defrost start by clock
A built-in timer allows you to set up to six (6) different times for defrosting within 24 hours („*defrost time 1*“ to „*defrost time 6*“, defrost-page). To disable these parameters, set them to „OFF“.
The defrost cycle starts only, if the temperature at one of the evaporator sensors is below the limitation setpoint "*defr temp limit X*".
If parameter „*defrost mode*“ on the mode page is set to „external“, the timer function is disabled.

Notice **Please note that this function differs with 'adaptive' defrost**

Remote Defrost Initiation
To start defrost by digital input, note that mains phase has to be applied for 2 seconds minimum and last not longer than the shortest possible defrost cycle.

Pause ahead defrost
The parameter '*pause ahead defr*' (Defrost Page) causes that the defrost heaters will switch on delayed at the beginning of a defrost cycle. This gives a chance to pumpdown the evaporators before heating. So the defrost heaters need less energy, because the evaporator is already warmed up.

Defrost termination by temperature
Defrost will be terminated (individually for each control circuit) by the corresponding defrost (evaporator) sensor. This sensors must be placed at a position where, by experience, ice remains the longest time.
If the temperature rises at that position, the ice in the evaporator is probably melted completely. A defrost cycle ends as soon as all defrost sensors have reached the defrost limitation temperatures „*defr temp limit X*“ (defrost page) or the safety time „*max defr Time*“ (defrost page) has been expired. If 2 defrost sensors are assigned to one circuit, both sensors must reach the limitation temperature to terminate defrost.

Defrost termination by time
In case that no defrost sensors are assigned or if they are out of order, the defrost cycle will be terminated if „*max defr Time*“ (defrost page) is achieved. Parameter „*remain defr time*“ (actual page) shows the time until expiration of this timer.

Defrost termination monitoring
Normally, a defrost period should be terminated if the temperature in the evaporator reaches the limitation setpoint. In case of bad working conditions like to many ice or a defect defrost heater, defrost is terminated by „*max defr time*“. If the number of defrost periods terminated by timer exceeds the number programmed by parameter „*n/o .def evnt>alm*“, a failure will be indicated.

Notice In case of defrost by airflow without evaporator sensor, this function has to be disabled („OFF“), because here every defrost cycle is terminated by the timer.

Cooling Delay (drain time)
With „*pause aft defr*“ (defrost page) you can set a duration where the solenoid valve(s) are disabled after defrost termination. The remaining times can be read at „*remain defr pause 1*“ up to „*remain defr pause 4*“ (actual values page).

Manual Defrost
A manual defrost initiation via button is possible and prior at any time.
Start : Select „*manual defrost*“ (defrost page).
Confirm „*start*“
Stop: Confirm „*finish*“.

Pulsed Defrost
To save energy and to avoid creating too much moisture it's possible to work with a pulsed (switched in intervals) defrost function.
If the evaporator temperature is between „*pulse def limit*“ (defrost page) and the limitation temperature (the value of „*pulse def limit*“ must be lower than limitation temperature), the controller determines about the optimal heat distribution in the evaporator depending on the gradients of the temperature. If the evaporator temperature reaches „*pulse def limit*“, the heater is not longer heating continually but will be switched on and off by the controller in calculated periods until the defrost limitation temperature is reached.

As a result of this procedure
- heat energy distribution in the evaporator is better
- the defrost limit temperature can be set lower
- ther is less fog / humidity in the chamber
- you are able to save energy because of the optimized temperature distribution and the lower limitation temperature.

To disable this function, set „*pulse defr limit*“ to a very high value.

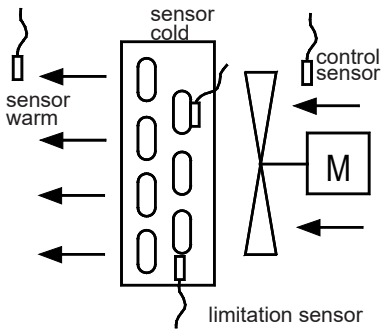
Defrost on demand - Standard methods

Optimiziation Method (for walk-ins/rooms)
With every requested defrost cycle the controller detects the actual period of time needed for melting the icing at the evaporator around freezing point (between -2°C and +2°C). This time has a dependent relationship on the number of defrosts needed per day or, with other words, how many of the programmed defrost cycles can be skipped. The result of this calculation is displayed under parameter „*n/o defr ignored*“ (defrost page).

Melting time	< 1 min	> 1 min	> 2 min	> 3 min	> 4 min	< 5 min	<10 min
Defrosts to be skipped	6	5	4	3	2	1	--

Defrost start will be initiated by the internal clock or a digital (OC)-input.
A manually initiated defrost cycle resets the 'skip' memory and starts a new calculation.

Defrost Demand by Differential Method
This defrost method uses two (2) additional sensors which sense the differential temperature across the evaporator. This difference increases with more icing.



At a preset amount of icing (temperature differential) which is set by parameter „*demand defr diff*“ (defrost page), the controller starts a measuring cycle for a certain amount of time which is set by parameter „*dem defr period*“.

If, during this period, the differential reading keeps its value above setting, the controller stores the need of defrost (displayed by „*dem defr stored*“).

Any stored defrost demand results in initiating a defrost cycle at the next available defrost time (timer) or upon activating the defrost signal input. For achieving good results with this demand defrost method, the two additional sensors must be placed carefully as explained in drawing.

Intelligent Defrost (adaptive defrost) for walk-ins *(TKP/TKC x140 only)*

Main Characteristics

This defrost control method, developed in co-operation with the '*GÜNTNER*' company, fits especially for **cold stores** and freezers which are closed (like walk-ins), but it is **less efficient** in applications where the limitation sensor is located in the airflow (e.g. open chest freezers).
This technique **reduces significantly the amount of energy** the refrigeration plant needs.
Especially while **difficult situations** (like high air-humidity, in cool-down chambers, while long opening times of the door of the cold storage room, uneven feeding of the cold storage room, etc.) the adaptive method protects the evaporator from glaciation safely.
Dynamic 'room-feeding' situations engage the controller to adapt itself to the new situation, without expensive adjustment by technical personnel.

Specialized sensors or additional probes are not required.

Parameterisation is very easy:

- set parameter „*defrost mode*" (defrost page) to „adaptive"
- set parameter „*max time to defr*" (defrost page) to a value which is 2 or 3 times the normal defrost interval. Within this period the device decides independently about the point in time to defrost.
- parameter „*time to defr*" (defrost page) shows the time up to the next defrost.
- parameters „*pulse defr limit*" and „*defr temp limit*" define the range within the heater will be pulsed.
- set parameter „*defrost forerun*" to several minutes, so the fan will be started before defrost heater starts.
- set parameter „*fan off delay*" (setpoint page) to the time that the fan will continue running after cut-off of the cooling relay.

Process Sequence

1. In the time period set by „*max time to defr*" the controller decides itself if and at which moment a defrost cycle is necessary. If icing is detected, the controller prepares defrost and begins either immediately or at the next allowed defrost time.
2. The fan runs while cooling is stopped and while the defrost heater is not yet switched on
3. The fan stops and the heater starts
4. Each evaporator is individually heated. The **leading evaporator** will be recognized automatically.
5. With working temperatures of [setpoint + hysteresis >= 2,5°C] the controller is able to save energy by increases using of the fan (**more circulating air**).
6. When the „*pulse defrost limit*" is achieved, the heater will be switched off/on in calculated periods (optimal heat distribution).
7. Defrost heater cut off, limit temp. is reached.
8. Cooling and fan remain still off (drain time).
9. Cooling starts, fan still off.
10. After end of „*fan start delay*" the fan restarts and normal refrigeration goes on.

Refrigeration
Even during normal operation the fan stays on after cut-off of cooling to reduce icing.

Recognition of icing
The more ice on the fins the more increases the difference of temperature between the room sensor and the evaporator sensor. The controller uses the value of these sensors, their difference, the historic curves of these values as well as curves and duration of the past defrostings to calculate the necessity of defrosting.

Use of latent energy by airflow
We recommend to use „*defrost forerun*" (defrost page) to switch on the fan several minutes ahead the defrost cycle, while cooling stops and the heater is not yet on. Additionally, the fan is switched on automatically at a certain difference between the sensors. By this, the „cooling-energy" is brought out of the evaporator and stored in the chamber. This helps also to reduce the amount of heat energy necessary to defrost.

Defrost start
If all six parameters „*defrost time ..*" are set to Off, the controller decides itself when it starts defrost.

- *Further time influence*
  If you want to prevent that defrost starts at certain day-times use all the „*defrost time..*" parameters and set them to points in time where defrost is allowed. If no icing is detected, these times will be ignored.
  On the other hand, once icing detected, the controller will wait for the next „*defrost time*" before starting defrost.
- *External command*
  Assign one of the digital inputs to „*manual defrost*". By applying voltage to that input it is possible to start defrosting at every moment.

Defrost heater
After the end of the "Fan OFF Delay", the defrost heater switches on up to the temperatur has been readed the value „*pulse defrost limit*". The heat energy of the heater will dissipate slowly and melt the ice. The length of the cut-off is calculated by the controller and as soon as some criteria are fulfilled, it will switch on the heater again. The heater will be pulsed until the temperature of the evaporator sensor reaches the value of „*defrost temp. limit*".

This procedure fits in the same way for the case of several evaporators in the chamber.

By this way a defrost period will take longer, but will be more efficient.

Special mode for roomtemperatures > 2,5°C
Evaporators can be de-iced already at temperatures from 2°C by forced air. When cooling stops, fans are turning on until ice and frost are melted.
Thus humidity stays in the chamber which will improve the quality of certain goods like meat or vegetables.
Additonally to the compulsatory "*fan off delay*" (fan is forced to continue turning after cooling reached the setpoint and stopped), the fan will turn from a specific temperature [setpoint + hysteresis => +2,5°C] until the evaporator sensor has reached a certain value.

- At room temperatures [setpoint+hysteresis => +2,5°C] notify to set parameter „*max time to defr*" to a higher value, because a defrost start is forced if this time is past.

Several evaporators in one chamber
For certain plants it is necessary to use several evaporators in one chamber. The controller is able to control up to 4 evaporators in one chamber. Even in this case one unique roomsensor is sufficient. E.g. for a chamber with 3 evaporators you need only 4 sensors:

- one controlsensor
- three defrost sensors (one for each evaporator)

If a defrost cycle is necessary, all evaporators will start defrost at the same time to avoid short circuit of air, when one is heating and the fan of the other is turning. So the one with the highest rate of icing determines the start of the defrost cycle.
The controller is able to **determine just this evaporator** and even to adapt it when conditions change. Thus always the evaporator with the most ice initiates defrost start, nevertheless the quantity of energy which is necessary to defrost will be calculated for each evaporator separately.
To finish defrost cycle all evaporators must have reached the defrost limitation temperature.

Emergency operation in case of bad conditions
In case recognizing extreme conditions, e.g.:

- charge of unusual very humid goods
- freezer door was open a very long time
- the evaporator is sprinkled with water
- sensor broken or shortened

the emergency operation starts.
To detect malfunction of the defrost control the unit uses the increasing of "*max. defrost time*".
If a defrost cycle is terminated by this time, the controller starts several defrosts with the interval which corresponds to one quarter (¼) of the time which is programmed by „*max time to defr*".

Therefore be careful in choosing the time for this parameter.

After the end of the disturbance the controller works on normally.

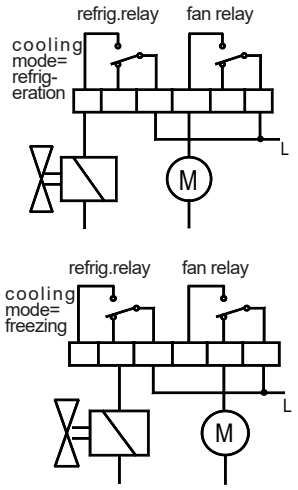
Example
Max time to defrost is set to 24 hours. If defrost is not terminated by the evaporator sensor, the controller will start defrost cycle every 24 / 4 = 6 hours until a cycle will be finished by the evaporator sensor and not by timer.
Independent from this procedure, a failure message will be initiated.

End of defrost
When the defrost sensor has reached the defrost limitation temperature, the heater stops and the controller waits until "*pause after defrost*" has expired, to allow the melted water to flow to the drainage. Then cooling starts now, but the fans still stay OFF until the "*fan start delay*" has expired to allow the evaporator to cool down and to prevent that the fans blow warm and humid air or water drops into the chamber.

Evaporator Fan Control

For one or all of the **4** circuits it is possible to assign a relay for the evaporator fan. The fan control depends on the following parameters:

- „*cooling mode*“ (mode page)
  The fan is controlled from the N/O-contact in refrigeration mode and from the N/C-contact in freezing mode.



- „*fan operation*“ (mode page)
  You can select either „permanent“, where the fan runs continously and stops only during electric defrost, or select „interval“, where the fan runs during cooling periods only.

- „*defrost type*“ (defrost page)
  If „on“: fan turns during defrost
  If „off“: fan ist stopped during defrost.

Fan off delay

To use latency energy of the ice and evaporator block the fan may run up to 30 minutes after the cut-off of valve or compressor („*fan off delay*“, set-point page).

Fan trailing delay

The start-up time delay for the fan after defrosting is set with parameter „*fan start delay*“ (setpoint page). This avoids that water drops will be blown into the chamber. The parameters "*rem fandelay 1*"..."*rem fandelay 4*" (actual page) show the remaining time up to the fans in the single circuits will be switched on.

Examples for fan operation modes

1. *fan in permanent mode*
   This mode is mainly used with refrigerated shelfs, refrigerated display counters and chest freezers, where the fan runs even during defrost. It is not necessary to connect the fans to a relay of the controller, fans run directly from mains voltage.
   "*fan operation*" is set to 'permanent', "*defrost type*" is set to 'on' and "*pause aft. defr*" is set to '0'.

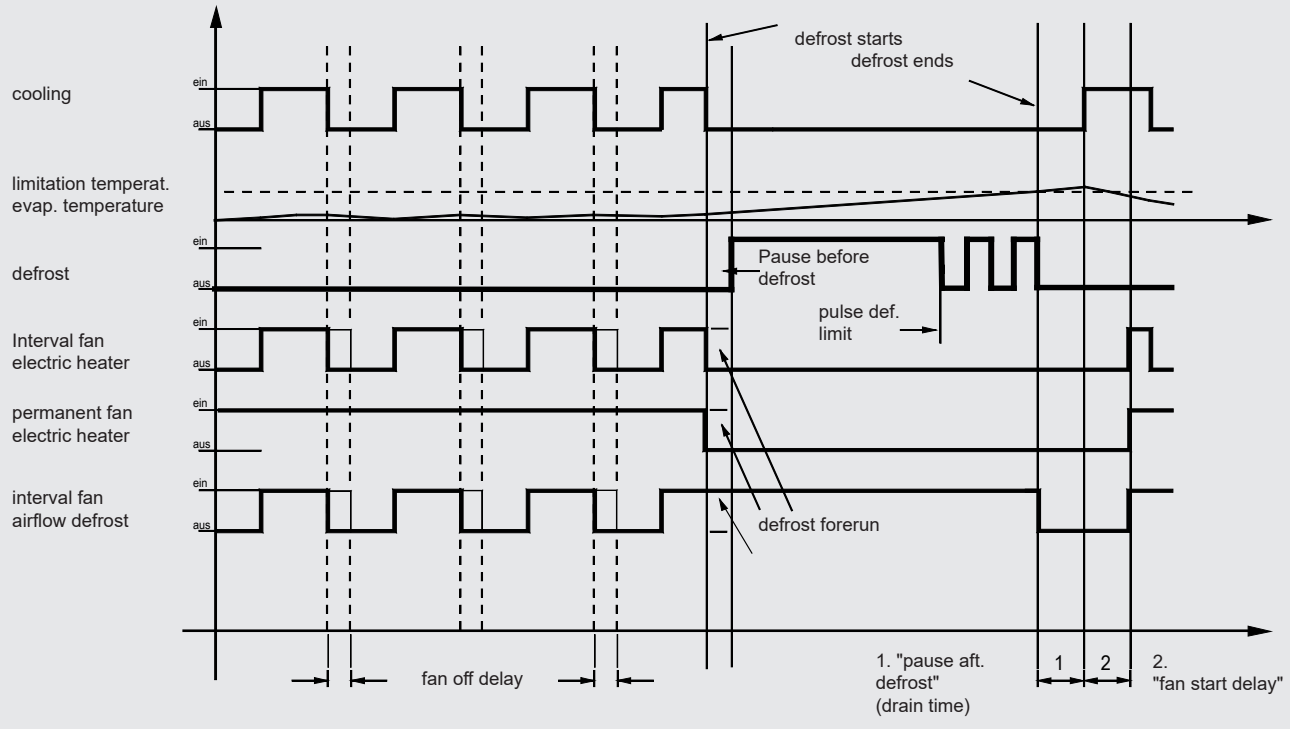
2. *fan in interval mode, defrost by fan*
   In use for cold storage chambers with higher temperatures. Use a relay output for the fan. In this case you select „*fan operation*“= 'interval' and „*defrost type*“='on'.

3. *fan in interval mode, defrost by electric heater/hot gaz:*
   In use for cold storage chambers with lower temperatures and freezers. Use a relay output for the fan. In this case you select „*fan operation*“='interval' and „*defrost type*“='off'. The fan runs when cooling is on. The fan is disabled during defrost periods and comes on after defrost with a time delay which is set by the „*fan start delay*“ parameter.

4. *fan in permanent mode and defrost by electric heater*
   Use a relay output for the fan. In this case you select „*fan operation*“='permanent' and „defrost type“='off'. Then the fan will run continously and stops during a defrost period only. The fan comes on after defrost with a time delay which is set by the „*fan start delay*“ parameter.

Please note that the fan relay contacts change with the application (refrigeration/freezing).

Fan operation modes, defrost termination using electric heaters



Roller Blind control

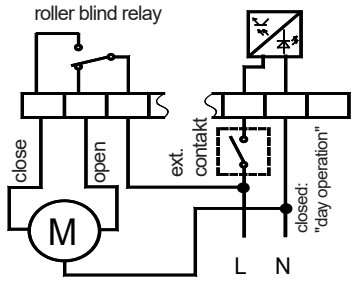
Selecting the „roller blind" function on the assignment page activates the relay output for opening and closing the roller blind(s) automatically. A defrost overrides this function and opens the roller blind(s) for the defrost period.

Internal control

- Therefore don't use a digital input assigned with the function „night settings" or the digital input must be connected to mains voltage (= day operation).
  The timer parameters „*night setp ON*" and „*night setp OFF*" (mode page) are activating not only the secondary setpoint(s) but have also an effect on the roller blind.
  The ON setting activates the roller blind relay and runs the roller blind in closed position via N/O-contact. The OFF setting time deactivates the relay thus opening the roller blind again.

External control

- Therefore use a digital input and assign it to the function „*night settings*". If the digital input is connected to mains voltage (phase), the unit works in day-mode.

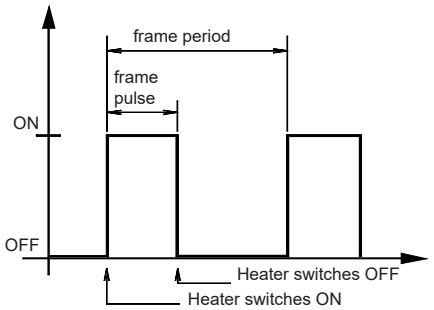


This results in de-energizing the relay when „roller blind" is selected and running the blind(s) open via the N/C-contact.
An open input means night-mode and runs the roller blind(s) shut via the N/O-contact.

Frame Heater control

Frame heaters are used for freezers to avoid the door freezing onto the door frame. In addition it prevents condensing water around the door or on top of the frames of open chest freezers.
If one of the relays is assigned to „frame heater" this will control the energy to the frame heater with a certain frequency and pulse-width. For day and night operation you can choose different values to save energy. The corresponding parameters on the mode page are:

- „*frame period*":
  defines the duration of the cycle,
- „*frame pulse day*" defines the percentage of heating during day operation within each cycle.
  100% = continuous heating, 0% = off
- „*frame pulse night*" defines the percentage of heating during night operation within each cycle.
  100% = continuous heating, 0% = off
- „*frame pulse act*" shows the current active frame period (which can be shifted by a VPR host system)



Energy Optimization
To optimize the demand for energy of the attached heaters, the controller adapts (within specified limts) the frequency ratio to the air humidity (e.g. in a market). The information about the market temperature and the air humidity is delivered from a host system (VPR 52xx), to allow the controller to calculate the absolute humidity.

Limits - Temperature .....19-24°C
- Humidity .....40-70% r.H.

At the upper limits, the frequency ratio is equivalent to the values set by „*frame period*" and „*frame pulse....*", at the lower limit the pulse width will be reduced by half.

Adding controller units to extend cold storages

If one controller unit has not enough ressources to control a cold storage, you can add one or more units. The necessary communication is made by the digital inputs (This function is only possible with control circuit 1).

Any digital inputs can be assigned to the following functions:

Refrigeration Lock

Refrigeration Lock (active low):
Cooling function of the unit is disabled if no voltage is present at the digital input.
Refrigeration Lock (active high):
Cooling function of the unit is disabled if the digital input is connected to mains phase.

If the refrigeration is locked, at the same time an overtemperature alarm is disabled for 4 hours.

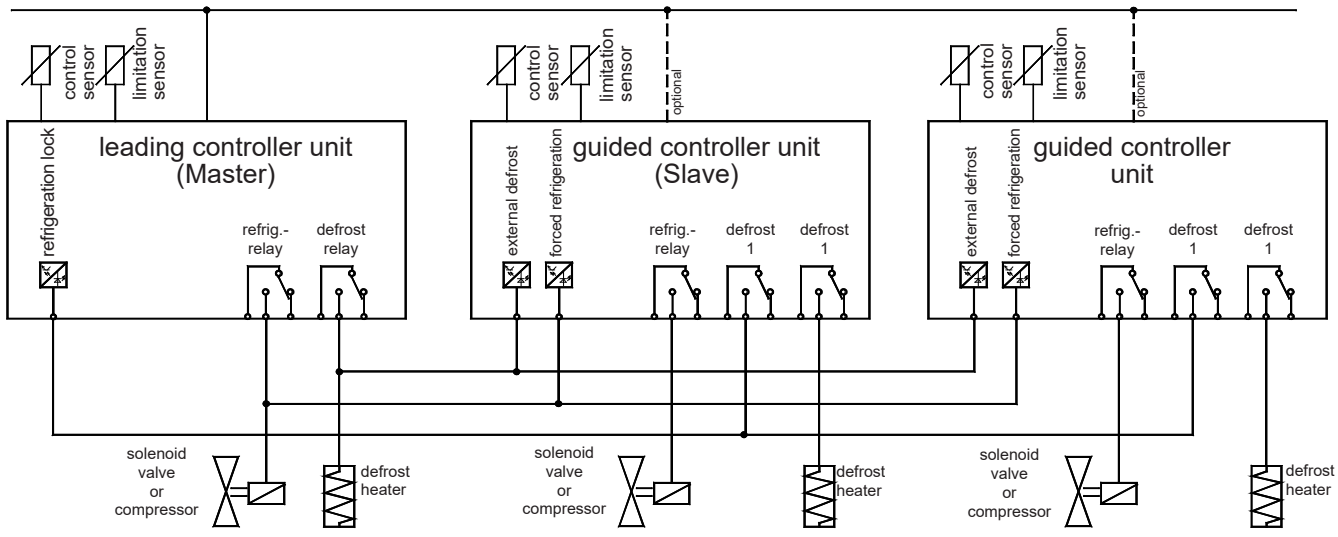
Forced(/-Released) Refrigeration

Forced(/-Released) Refrigeration (active low):
Cooling function of the controller is released if no voltage is present at the digital input.
Forced(/-Released) Refrigeration (active high):
Cooling function of the controller is released if the digital input is connected to mains phase.

If no control sensor is selected at a slave module, the refrigeration always switches with the digital input.

If a control sensor is connected and selected, the digital input only releases the refrigeration function and the measured values are used to control.

Principle of adding controller units



The leading unit releases the cooling function of the 'slave'-units via their digital input 'Forced(/-Released) Refrigeration'. The 'slave'-units disable the cooling function of the 'master'-unit via its digital input 'Refrigeration Lock', as long as a defrost function works.

Networking by RS-485-Bus *(E-LINK-Protocol)*

All TKx controllers can be networked together with other ELREHA-control devices. For this duty ELREHA has developed E-LINK, a transmission protocol, which will be transmitted on a two-wire bus-system based on the RS-485-Standard. With E-LINK, up to **78** controllers are able to communicate.
Each controller in a network has its individual address („*adress in netwk*“, mode page). This adress is necessary for selecting the right controller while a data package is transmitted on the network bus. If the controllers are used outside a network, the address and the parameter „*compound*“ are of no importance.

Caution **Never use address 64 !!**

Remote control with SMZ
The TKx can be remote controlled by a SMZ frontend. In this case all display information and keypresses will be transmitted.

Configuration / Service via PC
The controllers can be linked via RS 232 or RS 485 interface to a PC where a matching the EL-REHA-software runs. From there you can change parameters, save them to the hard disk (download) and send it to other controllers (upload).

Communication with VPR systems
The TKx controller can be used as intelligent cold storage controller in co-operation with the compound control system VPR. In this case, it is controlled by the VPR. So the TKx need an individual address („*adress in netwk*“, mode page)

Each controller can be assigned to a certain compound (Refrigeration or Freezing, „*compound*“, mode page). This enables the VPR to transmit specific information to the cold storage controllers assigned to the compound while a failure occurs.
More detailed information you will find in the technical manual of the VPR compound system.

Behavior in case of the VPR-function 'Low Power Optimization'

If this feature is used in the VPR-system, the VPR can disable the refrigeration functions of the TKx for a certain time, even though the refrigeration setpoint is increased. The fans and the heating continues working, they will be disabled in case of compound failure only.

Behavior in case of compound failure

If a TKx is assigned to a certain compound and a disturbance occurs, the unit responds as follows:
- The solenoid valves will be closed
- The fan switches off
- A defrost cycle will be terminated.
  A new defrost cycle is only possible when the compound problem is solved.
  To see if this function is released, look at „*solenoid valve*“ (actual values page).

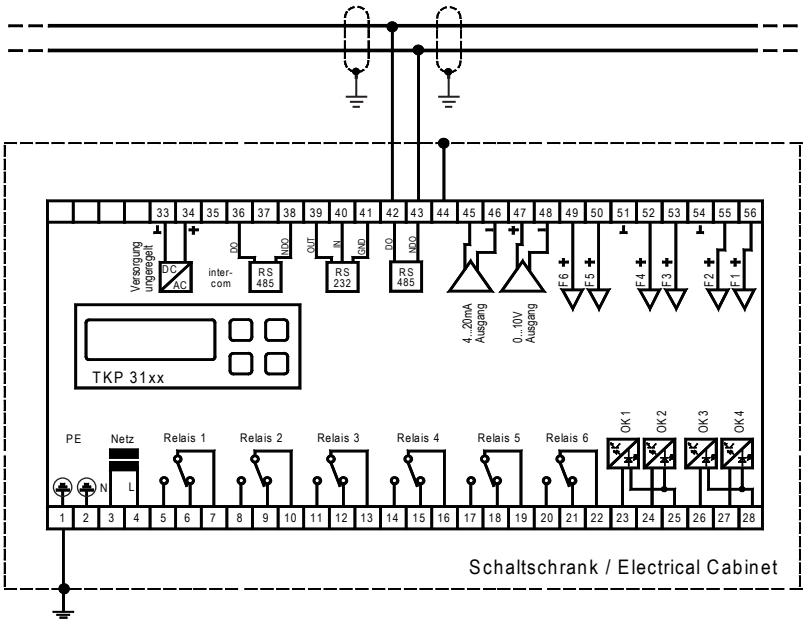
Data transmission disturbances

If the controller gets no new information from the VPR, it continues working with the actual settings.
If there was an order from the VPR to close the solenoid valves and a technical defect interupts the data transmission for more than 30 minutes, the TKx ignores this order and starts working normally.
When data transmission is restored, the TKx will work again immediately according to the commands of the VPR.

Wiring of data lines

The Line-Interface resp. Line-Bus (RS-485) allows to connect the controller to a central unit.
Configuration:

- Use standard "twisted pair" data cable
- Each module/controller gets an individual address
- The best signal-to-noise ratio you get when each PE connector is grounded the shortest way
- The unshielded part of the data cable must be as short as possible.



Connection of Remote Displays

The controllers of the TKP 31xx series (from Soft.Vers. 4.03) are prepared for connecting the series TAA xx15 Remote Displays.
These displays are able to display the values of all 6 connectable sensors alternatively.
The TAA display must be connected to the RS-485-interface "intercom".
Up to 6 TAA xx15 can be connected, each TAA is able to display any sensor value.

Power Supply
The TAA can be supplied by the TKP-controller or by an external transformer.

Notice **The controllers of the series TKP are able to supply 2 TAA Remote Displays max.!**

Parameterizing
The TKP controller needs no special settings. At the TAA the # of the sensor to display must be set by an incremental switch at the rear side of the housing.

Display while a defrost cycle
If the controller works in a defrost cycle, the TAA Remote Display holds the last temperature value, measured at the beginning of the defrost.

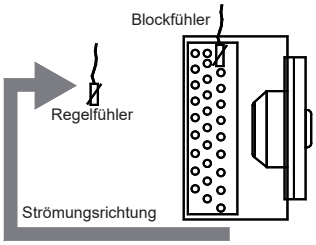
After termination of the defrost event, a real temperature value will be displayed after the following preconditions:

- The measured actual value is less than the displayed value + 2K
- After the alarm delay extension is run down

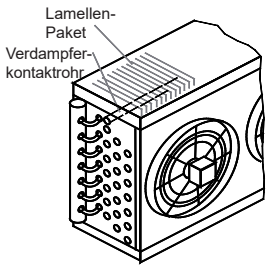
For further information please read the manual of the used TAA Remote Display.

Sensor Positions

The controller needs correct temperature input information to work correctly, but in standard applications, sensor positions are not critical.
The **control sensor** for regulation or **alarm sensor** has to be fixed behind the evaporator (air inlet) or at a representative place in the chamber, but not in the air outlet.



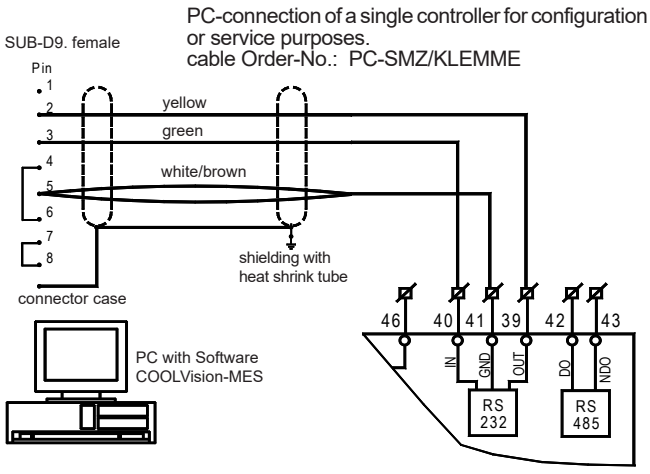
The second sensor (**defrost sensor** or **evaporator sensor**) should be assembled in the tube which is factory provided for this purpose. If the evaporator has not such a tube, assemble it between the fins in the upper part and assure a good thermal exchange. It should be placed at the position where the icing stays the longest time while defrosting. This depends of type and manufacturer of the evaporator, so use your experience.



Make sure that the sensor doesn't touch the heater or any piping with hot gas defrost, it must have some distance to these heat sources. We indicate that remaining ice in an evaporator even after a defrost period is due to sensors which have not enough thermal contact or which are installed at a wrong place. If you encount icing you should place the defrost sensor to this area.

Demand Defrost Method (TKP x140 only)
To detect icing with the Demand Defrost Method the TKP x140 does not need additional sensors. The control sensor and the defrost sensor are sufficient. Please note that the emergency defrost operation of this method cannot avoid a slow icing of the evaporator as a result of a wrong sensor position. In case of ice headings, the evaporator sensor must be replaced (after complete melting) to that position.

Note **After Start-up:**
Please check the position of the evaporator probe!



Installation / Start-Up

A few seconds after power-up the display shows type, date and time or the parameter selected as permanent display. Any key turns the backlight on. If the device is switched on the first time, you are now invited to change or confirm the language.

Start-up course
- check and/or set the actual time and date of the controller
- determine the function of all inputs and outputs on the assignment page. (only possible in the 'configuration level', which is the factory setting. See also page 3). Unless you haven't done this, you will not see all necessary parameters on the other pages!
- select type of used temperature sensors („*sensor*", mode page).
- correct the displayed temperature values if necessary („*corr sensor..*", mode page).
- select the desired „*defrost mode*" (defrost page) and select if the fan should turn during defrost or not.
- select cooling mode on mode page (note: will influence the electrical connection of the relay.)

These are the most important steps for a basic configuration. Upon that, adapt the other parameters like temperature setpoint, hysteresis, delay times.... Refer to the previous chapters in this manual.

Start-up in a data network
- set the address of the controller (mode page)
- verify the baudrate (mode page)
- Load the parameters from the PC to the controller (upload).

Start-up with a PC/Laptop
The start-up of the controller can be much easier by using a PC and the software "COOLVision-MES". In this case the controller will be connected via the RS-232 interface.

- set the adress of the controller (mode page)
- operate the unit from the PC remotely

The controller gives you an overview about the controlled unit on the "*Actual Values*" page:
- temperatures (all sensors)
- analog value
- state of the relais
- remaining delay times
- state of the digital inputs
- actual and historic failures

If failures are present, they are listed on the "act.failure page"

Basic Configuration of TKP 3130/1
Because the TKP 3130/1 has no own operating elements and no display, the basic configuration must be done in a special way.

- **Note:** The network adress of the cntroller unit ("*adress in netwk*", Mode Page) is factory set to '78'.
- Prepare VPR-System
- Connect a single TKP 3130/1 to the RS-485-Line interface. Also multiple controller units can be connected to the line-interface, but it makes sense that only one of this owns the adress '78', because the configuration function transmits the new data only to units with the factory set adress '78'. Connecting multiple new TKP 3130/1 at the same time doesn't work.
- Open subpage "Service Data" at the VPR-Display.
- Set desired network adress for the TKP at parameter "*Change CST adress*".
- The new adress will be transmitted to the TKP.
- As usual, the TKP can be inserted and programmed on the CST-pages of the VPR-System.
- Connect next controller to the interface and repeat procedure.

With this controller type, only sensors of the TF 501 series (Pt1000) can be used.

Final decommissioning and disposal
The symbol indicates that this product should not be treated as normal household waste.
It can be dropped at a collection point for the recycling of electrical and electronic equipment.

Battery disposal
The types TKC 5130/5140 (plastic housing) and TKC 19130/19140 (aluminum housing) contain batteries that must not be disposed of with normal household waste. You can return the batteries to a public collection point or wherever batteries of this type are sold.

Battery removal
To remove batteries, the housing must be opened.
There are two socketed blocks, the higher one contains the battery.
It can be easily removed and disposed of.

EC Declaration of Conformity

CE

*For the devices **TKP 3130, TKP 3130-1** and **TKP 3140** we state the following:*
*When operated in accordance with the technical manual, the criteria have been met that are outlined in the EMC Directive **2014/30/EC** and the Low Voltage Directive **2014/35/EC**. This declaration is valid for those products covered by the technical manual which itself is part of the declaration.*

Following standards were consulted for the conformity testing to meet the requirements of EMC and Low Voltage Guidelines:

EN 55011:2016+A1:2017, EN 61010-1:2010, EN 61326-1:2013 **CE marking of year: 2018**

This statement is made for the manufacturer / importer *by:*

ELREHA Elektronische Regelungen GmbH **Werner Roemer, *Technical Director***
D-68766 Hockenheim
www.elreha.de **Hockenheim** .....**2018-05-24**.....
(*Name / Address*) *City* *Date* *Signature*

EC Declaration of Conformity

CE

*For the devices **TKC 5130** and **TKC 5140** we state the following:*
*When operated in accordance with the technical manual, the criteria have been met that are outlined in the EMC Directive **2014/30/EC** and the Low Voltage Directive **2014/35/EC**. This declaration is valid for those products covered by the technical manual which itself is part of the declaration.*

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EC Declaration of Conformity

CE

*For the devices **TKC 19130** and **TKC 19140** we state the following:*
*When operated in accordance with the technical manual, the criteria have been met that are outlined in the EMC Directive **2014/30/EC** and the Low Voltage Directive **2014/35/EC**. This declaration is valid for those products covered by the technical manual which itself is part of the declaration.*

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This manual, which is part of the product, has been set up with care and our best knowledge, but mistakes are still possible. Technical details can be changed without notice, especially the software. Please note that the described functions are only valid for units containing the software with the version-number shown on page 1 of this manual. Units with an other version number may work a little bit different.