-KONTROLLELEKTRONIK-
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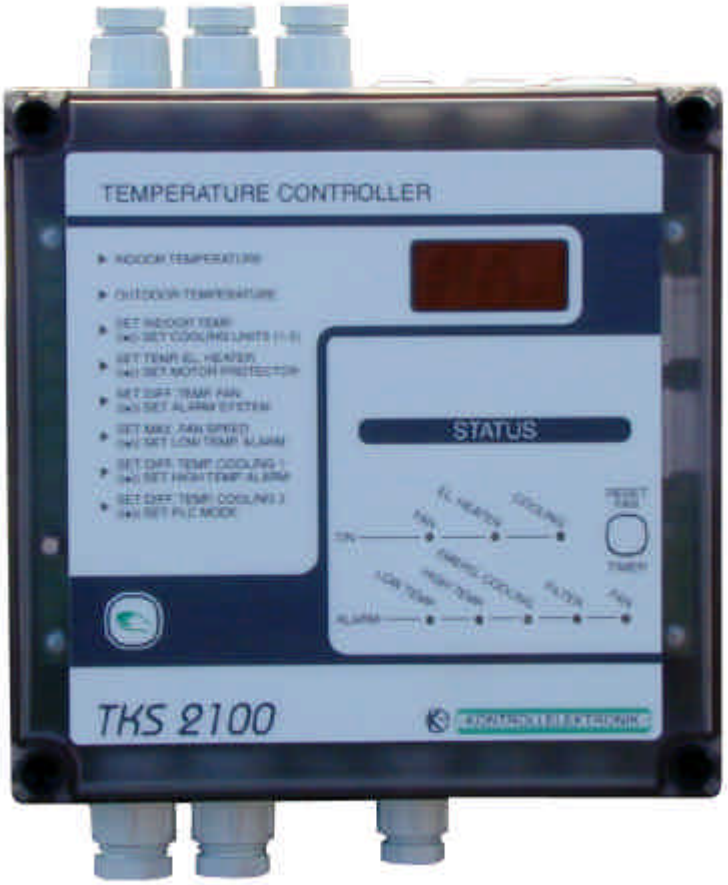
PRODUCT DESCRIPTION

TKS2100



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1. Operation

1.1 Introduction

Temperature controller TKS 2100 is designed for maintaining desired temperature in radio base stations. To ensure correct temperature management fan, cooling units and electric heating are utilized. By monitoring the outdoor air temperature the controller can determine if free cooling (fresh air blown in by fan) is sufficient to maintain desired station temperature or if the cooling unit or heating is required.

Twelve parameter settings enable the user to configure TKS 2100 for optimal operation in any radio base station.

TKS 2100 is designed to manage 0-2 cooling units. The number of units to be utilized is selected by the switch on the pcb, thus allowing the controller to choose the correct algorithm. If two cooling units are connected they are operated in sequence, meaning that one unit is in operation until more cooling is required whereupon the second unit is initiated The load point for each unit can be individually set. Starting order is alternated each time a unit is started or has been active for more than 12 hours to ensure that the units operate an equal amount of time in the long run.

TKS 2100 is complete for control via PLC. The switch found on the pcb must be set to PLC to allow for software adaptation. In this mode TKS 2100 does not control the cooling units nor the electric heating, however additional functions (alarms, timer etc) are operating normally.

TKS 2100 can be remotely read. The control signal to fan, low and high temperature alarms as well as motor and filter alarms are remote signals.

SPC (timer, 20 minutes) is initiated by a push button. In this mode the fan is stopped and only the cooling units and the electrical heater are allowed to operate. Set point for electric heating is increased to +20° and room set point is increased, if necessary, so that a blind zone is ensured between cold and heat. If PLC is connected TKS 2100 will, in this mode, only stop the fan.

Two types of motor alarms can be used, separate thermal contact (motor protector) or current sensing. Type of motor alarm used is set by switch on the pcb.

TKS 2100 is equipped to manage two different temperature alarm systems, Standard or AKA. TKS 2100 is also equipped with output for fire alarm. A triggered alarm will cause fan, cooling units, electric heating and damper to be switched off.
Alarm relays are available as normally open or normally closed.

TKS 2100 can communicate by RS 232. Complete status containing current temperature readings and current settings as well as working status can be retrieved.

Before TKS 2100 can be started it must be stored in room temperature for at least 2 hours. This must be done in to dry out any condensation.

1.2 Start-up

When starting TKS 2100 a first internal test is made of all inputs and outputs. All parameters are read, temperatures are calculated, alarms tested and correct control initiated.
These tests and calculations are of utmost importance to ensure correct processor initiation in order to achieve optimum operation.

The start-up procedure takes approx. 30 seconds during which the display is blank. As soon as a value is displayed start-up is completed and TKS 2100 is operative.

1.3 Settings

A control panel is used for setting or monitoring parameter values according to figure 1 below.

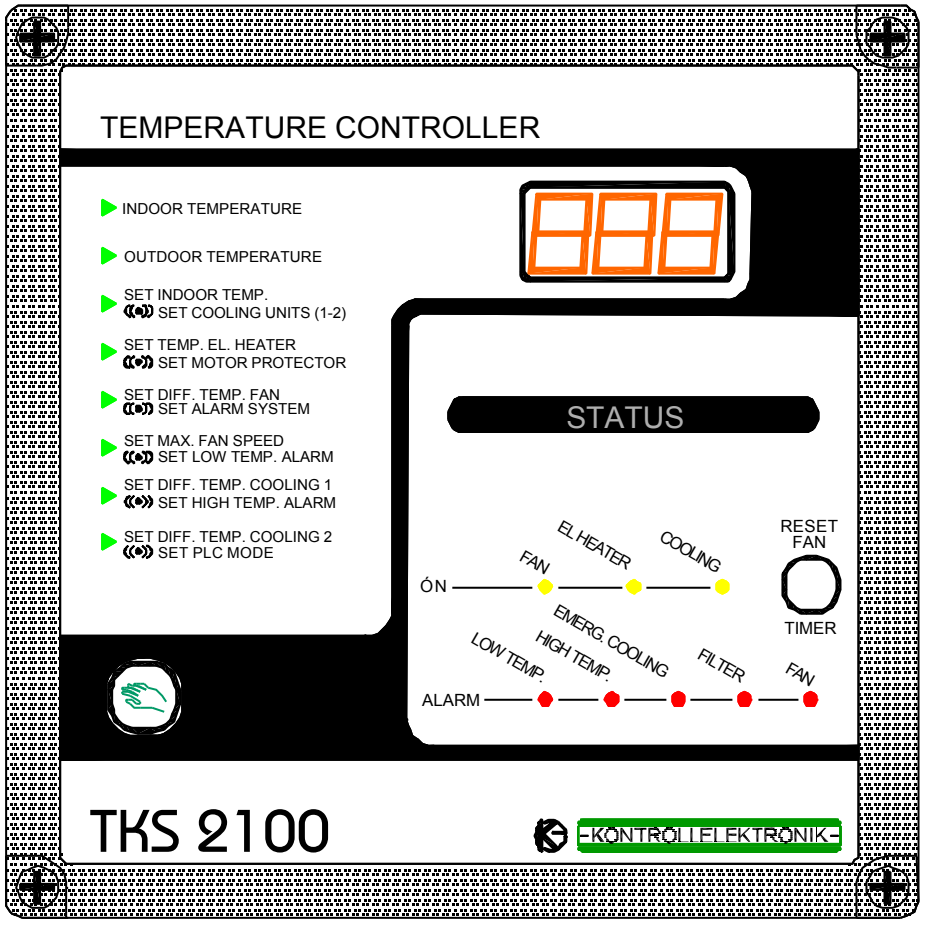


Figure 1. Control Panel

LED indicators indicate which parameter value is shown on the display. By pressing the press-button the user can step through and check all parameters.
To change a parameter value, step to the parameter to be changed and then adjust the corresponding adjusting knob. **New value will not be shown unless absolutely constant.**

Therefore it is important to wait after every adjustment to allow for new readings. The adjusting knobs are located under the cover to prevent undesired changes. If the user by mistake should turn an incorrect adjusting knob, i.e. a knob for a parameter not shown on the display, the change will not be activated in the controller unless the user then steps to the parameter corresponding to the turned knob. **That is to say changes can only be activated when the actual parameter has been chosen and is shown on the display.** At start-up, after e.g. reset, all the parameters will be retrieved once again, thus the user does not have to step through all parameters.

A blinking LED indicated that the second position is being read-in.

Parameter values are shown in table 1 below.

PARAMETER	***FUNCTION***	***RANGE***	***R/W*** [1]
INDOOR TEMPERATURE	Indoor temperature	0 – +40 °C	R
OUTDOOR TEMPERATURE	Outdoor temperature	-30 – +30 °C	R
SET INDOOR TEMP.	Set point indoor temp.	+20 – +30 °C	R/W
SET TEMP. EL. HEATER	Set point el. heater	+5 – +20 °C	R/W
SET DIFF. TEMP. FAN	Working area free cooling fan	2 – 10 °C	R/W
SET MAX. FAN SPEED	Max. fan speed	50-99%	R/W
SET DIFF. TEMP. COOLING 1	Operating area AC unit 1	2 – 5 °C	R/W
SET DIFF. TEMP. COOLING 2	Operating area AC unit 2	2 – 5 °C	R/W
SET COOLING UNITS (1-2) [2]	Number of AC units	1-2	R/W
SET MOTOR PROTECTOR	Select motor protector	0/1 (TK/M.C)	R/W
SET ALARM SYSTEM	Select alarm system	0/1 (STD/AKA)	R/W
SET LOW TEMP. ALARM [3]	Low temp. alarm	0-40°C	R/W
SET HIGH TEMP. ALARM	High temp. alarm	0-40°C	R/W
SET PLC MODE	PLC mode	INT/PLC	R/W [4]

[1] Read/Write
[2] A short-cut at outdoor temperature sensor means 0 cooling units.
[3] If AKA is specified alarm system, low temperature alarm functions as high/low temperature alarm.
[4] Write originates from PLC.

Table 1 TKS 2100 parameter values.

During operation without PLC, the display will be blank for parameters SET, PLC, and MODE.

If PLC is connected the display will be blank for the following parameters: SET INDOOR TEMP. SET TEMP. EL. HEATER, SET DIFF TEMP. FAN, SET DIFF. TEMP. COOLING 1, SET DIFF. TEMP. COOLING 2 and SET COOLING UNITS (0-2). These parameters are not included in the functions of TKS 2100 when controlled from PLC. Additional parameters are included in PLC and are in effect as if during normal operations.

Please observe! All adjustments made must be confirmed on the display before being in effect. Exception to the above is SET PLC MODE which is continually updated independently of menu position to ensure that the control signal is updated during PLC operation.

1.3.1 Factory settings

PARAMETER	*RANGE*	*FACTORY SETTING*
SET INDOOR TEMP.	+20 – +30 °C	+23°C
SET TEMP. EL. HEATER	+5 – +20 °C	+15°C
SET DIFF. TEMP. FAN	2 – 10 °C	4°C
SET MAX. FAN SPEED	50-99%	99%
SET DIFF. TEMP. COOLING 1	2 – 5 °C	2°C
SET DIFF. TEMP. COOLING 2	2 – 5 °C	3°C
SET COOLING UNITS (1-2)	1-2	1
SET MOTOR PROTECTOR	0/1 (TK/M.C)	TK (0)
SET ALARM SYSTEM	0/1 (STD/AKA)	STD (0)
SET LOW TEMP. ALARM***	0-40°C	+5°C
SET HIGH TEMP. ALARM	0-40°C	+35°C
SET PLC MODE	INT/PLC	INT

Table 2 Default settings – TKS 2100

Table 2 illustrates the settings made at delivery of TKS 2100.

1.4 Operating and alarm indicators

ON – FAN:	Indicates free cooling operation (or will start within 30 seconds)
ON – EL HEATER:	Indicates electric heater operation
ON – COOLING:	Indicates the operation of at least 1 cooling unit.
ALARM – LOW TEMP:	Indicates low temperature alarm
ALARM –HIGH TEMP:	Indicates high temperature alarm
ALARM – EMERG. COOLING:	Indicates emergency cooling (fan and cooling units operate simultaneously)
ALARM – FILTER:	Indicates filter alarm
ALARM – FAN:	Indicates fan alarm current/elapsed

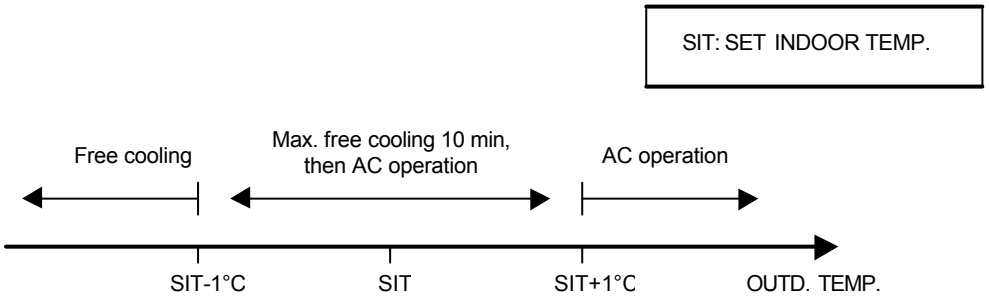
2. TKS 2100 Controlling functions

The controlling functions of TKS 2100 can be separated into two different conditions due to whether or not PLC is connected. If TKS 2100 is to be PLC operated the switch must be set to the PLC position or if it is to operate as an independent unit the switch must be in position INT.

2.1 Controlling functions in TKS 2100 without PLC

The ratio between outdoor temperature and room set point (see figure below) determines which unit (free cooling or cooling units) will operate if cooling is required.

Ratio between outdoor temperature and set point room:



When the outdoor temperature is below or equal to SET INDOOR TEMP. -1°C free cooling is in operation. The outdoor air temperature contains enough cooling capacity to maintain radio base station climate at the desired temperature.

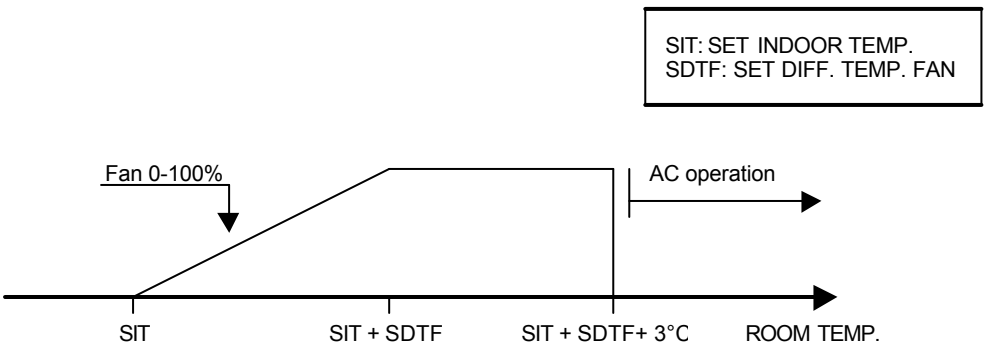
If the outdoor temperature is above or equal to SET INDOOR TEMP. +1°C cooling unit operation is initiated. The outdoor air does not contain enough cooling capacity to cool the radio base station to the desired level.

Should the outdoor temperature be equal to SET INDOOR TEMP. free cooling is initially initiated. After the fan has been operating at maximum for more than 10 minutes it is switched off and cooling unit operation is initiated. Cooling units continue to operate until the outdoor temperature drops or according to cooling unit algorithm (see below).

If not any cooling units are connected the controller will not initiate cooling unit operation.

The description below illustrates how each unit (fan, cooling units, and electric heating) operates when cooling is required;

2.1.1 Free cooling operation



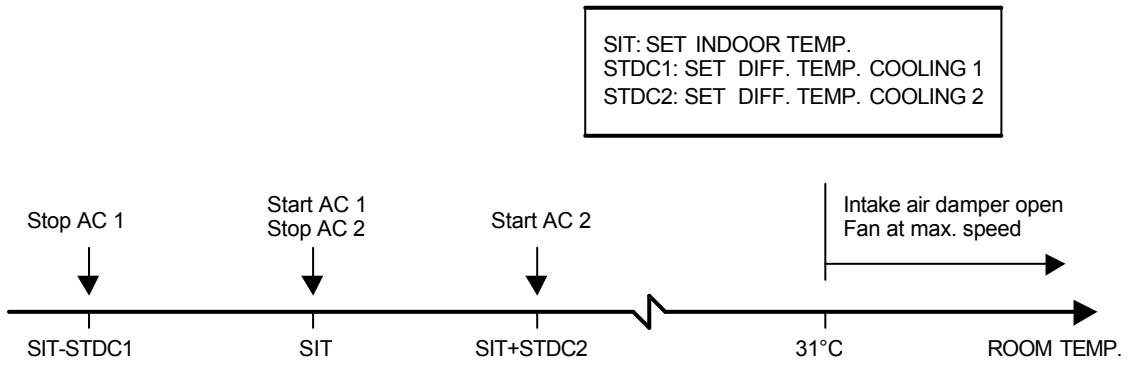
When the outdoor temperature is below SET INDOOR TEMP. (SIT) the fan operates to cool the room controlled by 3-10 V analog signal (approx. 80-230Vac) across set working range according to figure above. Intake air damper is open and mixing damper is regulated depending upon outdoor temperature (see 3,1).

If the temperature continues to increase, even though the fan is operating at full speed, cooling unit operation will be initiated. The fan will be switched off when the temperature exceeds SIT +3°C. However, if the temperature exceeds +38°C the fan will start to operate at full speed similar to normal cooling unit operation, see below.

When cooling unit operation has reduced the temperature to below SIT +3°C, free cooling is again allowed to start and the cooling units are switched off providing that the outdoor temperature indicates free cooling. In this mode, the micro controller allows free cooling to operate for 3 minutes before a switching to cooling unit operation. This allows free cooling of the room during periods of extensive heat radiation as well as if TKS 2100 is started with a high indoor temperature and low outdoor temperature.

If no cooling units are connected the above condition will never occur and free cooling operates with fan at maximum speed.

2.1.2 Cooling unit operation



Cooling units are started in sequence, according to figure above. Cooling unit 1 is initiated when room temperature reaches SIT and is stopped when the temperature has fallen to SIT-STDC1. Cooling unit 2 is initiated when the room temperature reaches SIT+STDC2 and is stopped when the room temperature has fallen to set point.

The term cooling unit 1 and cooling unit 2 does not pertain to any particular unit but designates place in starting order sequence. Starting sequence is alternated each time both units have been switched off or whenever one unit has been in continuous operation for 12 hours. When switching units operating range will follow assigned unit.

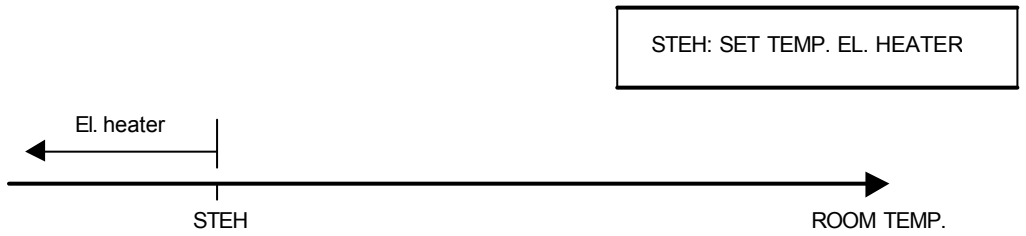
If only one cooling unit is connected it will be controlled as cooling unit 1 according to the figure above without starting sequence. In this case the cooling unit must be connected to output for cooling unit 1(marked COOLING 1).

If the temperature exceeds 31°C the intake air damper is opened and the fan operates at maximum speed. Emergency cooling is indicated. Cooling units are assumed to be malfunctioning.

Cooling units are equipped with a 3-minute start-up delay estimated from the time they were last switched off. This is applicable regardless of operating mode.

If no cooling units are connected this operating mode will never be initiated.

2.1.3 Electric heater operation



If the room temperature falls below SET TEMP.EL: HEATER the electric heating is initiated. This occurs regardless of outdoor temperature.

2.2 Controlling functions in TKS2100 with PLC

TKS 2100 is equipped to be controlled with PLC. In order for TKS 2100 to recognize that PLC is connected, a switch on the pcb must be set to PLC.

The fan is controlled 0-100% (approx. 80-230 Vac.) by an analog signal (3-10V). In this mode TKS 2100 only controls the fan according to given signal but does not control cooling units or electric heating.

However, all other functions operate in the same way as for independent operation without PLC. That is, alarms, SPC and remote reading (see below) function whether or not PLC is connected.

When fan operation is initiated a start-up delay of 30 seconds is commenced. This is to ensure that the damper is completely opened before the fan begins operating and always occurs when the fan has been switched off (PLC-signal indicates 0%).

3. Additional TKS 2100 functions

3.1 Damper

Intake air damper is opened during free cooling operation. A start-up delay is incorporated in the fan to allow damper to be opened before fan operation is initiated.

3.2 Remote reading

TKS 2100 remote readings are possible independent of PLC connection.

Control signal to fan (0-10V), low and high temperature alarm, motor alarm and filter alarms are transmitted for remote reading.

3.3 Timer

To provide a suitable working environment during a limited period of time (20 minutes) for service personnel in a radio base station a push button (RESET FAN/TIMER) is supplied. By pushing on the button until the display goes out the timer is activated/deactivated.

The timer function is applicable for the following two illustrations:

Without PLC:

Electric heating set point is automatically increased to +20°C. If room set point is below +25°Cit will be increased to 25°C, thus ensuring a neutral zone between hot and cold.

During timer operation the fan is not allowed to operate. If cooling units are connected these are controlled according to normal algorithm as is the electric heating.

With PLC:

If PLC is connected TKS 2100 stops fan from operating.

The timer function is active for 20 minutes; thereafter standard operation is utilized. Remaining amount of time is shown on the display. If the user wishes to adjust or check a parameter value during this time the value will be shown on the display for 15 seconds after each new parameter selection. Return to standard operation can also be initiated manually, before the 20 minutes have elapsed, simply by again pressing the same push button used for timer activation.

3.4 Motor alarm

Two different types of motor alarms can be utilized depending upon the type of motor connected. Regardless of type of motor alarm used, potential cooling units connected, undertake cooling operation in all applications where fan should have been operating. However, the same algorithm applies as for normal operation.

Separate thermal contact (motor protector):

The thermal contact is connected between TK1 and TK2 and the TK alternative is indicated to the micro controller by a switch on the pcb. 00 is shown on the display if this alternative is selected.

When the alarm has been activated the fan stops operating and the damper closes. Motor alarm is indicated via output relay. This condition is static (TK1-TK2 open) until alarm is

inactivated. When alarm is inactivated (TK1-TK2 closed) the micro controller delays fan start-up for an additional 10 minutes if fan operation and cooling is required.

Motor alarm is indicated even after mains failure, until it is manually reset (see below).

Current sensing:

The thermal contact is integrated in the motor and is not removable. Current sensing indicates alarm. A switch on the pcb must be set to M.C. Input for thermal contact (TK1-TK2) can remain open.

When alarm has been activated output signal to fan is stopped and the damper closes. Motor alarm is indicated via output relay. When alarm is inactivated (TK1-TK2 closed) the micro controller delays fan start-up for an additional 12 minutes if fan operation and cooling is required.

Motor alarm indication remains even after mains failure, until it is manually reset (see below).

Motor Alarm Reset

Pressing the push button (RESET FAN/TIMER) until the LED for motor alarm goes out resets alarm.

If current sensing (M.C) is utilized and TKS 2100 has not tested if alarm is reset. Even if conditions for fan start have not been registered the fan will be started for test of motor current for a period of 1 minute. This is to reset the motor alarm.

If the alarm does not reset the micro controller has not registered instructions to do so.

3.5 Cooling unit testing function

Cooling units that have been inactive for more than 10 days will be started for a 5-minute testing function. Fan and electric heating will not be in effect during this time.

3.6 Alarm systems STD or AKA

TKS 2100 can be configured for two differing temperature alarm systems:

STD (Standard)

Low temperature alarm is indicated when the indoor temperature is below set value for SET LOW TEMP ALARM.

High temperature alarm is indicated when the indoor temperature is above set value for SET HIGH TEMP ALARM.

AKA

Low temperature alarm acts as a high-low temperature alarm and indicates alarm when the indoor temperature exceeds set value for SET LOW TEMP. ALARM.
High temperature alarm is indicated when the indoor temperature exceeds set value for SET HIGH TEMP ALARM.

Regardless of system used low temperature alarm can never be set higher or equal to the high temperature alarm or vice versa

3.7 Fire alarm

TKS 2100 is equipped with input for fire alarm and is connected between SD-SD. This input is normally closed. If it is open the micro controller registers this as a fire alarm.

Fire alarm indication results in a total stoppage of fan, cooling unit (s) and electric heating and damper closes. Fire alarm is indicated by both high and low temperature alarms that are activated/inactivated in 2-second intervals. The display is blank during fire alarm.

3.8 Internal control of I/O:s, SELF TEST

The internal self-test is initiated by pressing the button “RESET MOTOR/TIMER” for approx. 5 seconds or until display shows 0.

The micro controller will then carry out the self-test according to the table shown below.

By again pushing the button the user can manually move to the next step without delay. The test can at any time be discontinued simply by pressing the button for approx. 5 seconds or until the display shows a two-digit number.

TEST PHASE	TEST	TIME
0	Electric heating active	90 s
1	Intake damper open	30 s
2	Fan starts, 0-35s=>0-100%, 35-40s=100%	40 s
3	Fan reduces to 0%	30 s
4	Room sensor tested (see below)	10 s
5	Outdoor sensor tested (see below)	10 s
6	Low temperature alarm active	10 s
7	High temperature alarm active	10 s
8	Cooling unit 1 active(if AC units=1 or 2)	30 s
9	Cooling unit 2 active (if AC units =2)	30 s

Sensor test:

A minus sign indicates that the sensor lies outside the measuring range. On which end of the measuring range the sensor is located is indicated by LOW TEMP ALARM or HIGH TEMP ALARM according to the following:

LOW TEMP ALARM:	Sensor indicates very cold. (short circuit)
HIGH TEMP ALARM:	Sensor indicates very warm (interruption, or disconnection)

For reliable test results, the test must be run without manual stepping.

If a motor alarm arises during test run the fan will be switched off and the test run continued as normal. Motor alarm cannot be reset until test run is completed.

4. Serial communication with RS232

TKS 2100 can communicate by RS 232. Complete status with current temperature readings and current settings as well as working status can be retrieved.

4.1 Communication Syntax

TKS 2100 operates with the following communication parameters:

- Baud rate 9600 bps
- Parity No
- Data bits 8
- Stop bits 2

TKS 2100 always operates as slave and can never initiate communication.
The same frame is used for communication (exception is when current Id-number is retrieved). The frame consists of 8 bytes where the first two indicate Id-number and the last indicates checksum. Both master and slave use this frame. The slave will not accept larger or smaller frames. The master is not addressed, the slave answers with its individual Id-number.

The **checksum** is selected so that Byte 8 = 256 – (byte 1 + byte 2 + byte 3 + byte 4 + byte 5 + byte 6 + byte 7). Byte 1-7 is summated without carry.

The master must transmit bytes 1-8 to the slave no slower than 100 ms. however; the slave may take up to 1 second before responding.

Please observe! Bytes 1-8 transmitted by the master must have a minimum time interrupt of at least 1/9600-sec. (approx. 0.105 ms) between each byte.

4.2 Addressing

Each unit can be assigned an individual Id-number (1-65535). The Id-number is set via serial communication.

5. Description of all in and outputs to and from TKS 2100

Input and output 230V~

L, N, PE Mains voltage:

Mains voltage (230 V~) connects to L, N, PE.

V1, V2, PE Fan output (max 5A):

V1, V2 and PE connect to L1, L2 and PE on the fan.

Before the fan is switched on a start-up delay of 30 sec. is initiated to allow for the damper to be opened.

See TKS 2100 control functions for description of fan operation.

E1 E2, PE Electric heater:

Electric heater is connected to E1, E2, PE.

See TKS 2100 Control functions above heater for operational conditions.

D1, D2, D3, PE Damper output (ON/OFF):

Damper actuator (Belimo NM 230) is connected as follows:
D1 – N (1)
D2 – L1 (2)
D3 – L2 (3)
PE - PE

The damper opens when fan starts to operate. Before the fan is switched on a start-up delay of 30 sec. is initiated to allow for the damper to be opened.

C11, C12, PE and C21, C22, PE Cooling units:

CX1 and CX2 are connected to the starting circuit (230V ~, max 1A) and PE connects to PE on the cooling unit. CX1 and CX2 open when TKS 2100 starts cooling unit and close when the cooling unit is switched off.
(X = 1 or 2)

The cooling unit must be switched off for a minimum of 3 minutes before restart. This is obligatory for the first start up regardless of operational functions. Additional start and stop functions are described in section *TKS 2100 Control Functions* above.

Input and output, extra-low voltage

PB1, PB2, RESET MOTOR/TIMER:

A closing, push button is connected between PB1 and PB2. When the button is pushed in PB1 and PB2 are short-circuited and when the button is released the closing is opened between PB1 and PB2.

For description of timer function see points 3.3 and 3.4.

TK1, TK2 Input thermal contact (motor alarm):

A thermal contact can be connected between TK1 and TK2. The contact must be normally opened and closed at alarm.

Y1, M1 control signal to fan:

Y1: control signal to fan 0-10 V
M1: GND

Actual control signal to fan is continually shown between Y1 and GND. Lower limit of control signal is approx. 3V. The fan is linearly controlled 3-10V. (0 V means that the fan is inactive and that the damper is closed).

The fan is equipped with a start-up time delay of 30 seconds. During this time the damper is opened.

GT1, M2 Room temperature sensor:

Room temperature sensor is connected between GT1 and M2.

Room sensor: 0 - 40°C.

GT2, M2 Outdoor temperature sensor:

Outdoor temperature sensor is connected between GT2 and M2.

Outdoor sensor: -30 - +30°C.

FI1, FI2 input alarm filter monitor

Filter switch is connected between FI1 and FI2 as follows:

FI1 – P1
FI2 – P2

At filter alarm FI1 and FI2 are open.

Relay outputs

All relay outputs are available both as normally open or normally closed.

Fno/Fnc, F-c, Output filter alarm monitor:

Fno - F-c: Normally open, closes at alarm.
Fnc – F-c: Normally closed, opens at alarm.

Mno/Mnc, M-c Output motor alarm:

Mno – M-c: Normally open, closes at alarm.

Mnc – M-c: Normally closed, opens at alarm.

Eno/Enc, E-c Output emergency cooling

Eno – E-c: Normally open, closes at alarm.
Enc – E-c: Normally closed, opens at alarm.

Lno/Lnc, L-c Output low temperature alarm:

Lno – L-c: Normally open, closes at alarm.
Lnc – L-c: Normally closed, opens at alarm.

Hno/Hnc, Hc Output high temperature alarm:

Hno – H-c: Normally open, closes at alarm.
Hnc – H-c: Normally closed, opens at alarm.

6. Mounting

Before TKS 2100 is started it must be stored in room temperature at least 2 hours before use, as all condensation must dry out.