2. Peripheral equipment

This chapter describes the sensor devices and interface boards which can be connected to a DSAT. By contrast with the components described in chapter 9, the components from this chapter are not always present in an *ECONOMIC* NT system. This depends on the configuration / program modules which have been initiated.
The first section describes three general interface boards. Section 2 explains the sensors and boards with reference to the climate control program. The third section deals with energy control, and the fourth section with watering. The connections and installation instructions for each component are specified. Information is also given on how to monitor the connections.
The 2nd, 3rd and 4th sections start with an overview drawing showing how many cores are required as a minimum for the sensors and relay boards.

Comment:
This manual for the *ECONOMIC* NT is especially to be used by companies outside the Benelux.
Some parts of the manual are not applicable, because the software is not available in those countries.
These are:

- paragraph 4.4.2. and 4.4.3. EC-sensors
- paragraph 4.9. Level Tray

1. General peripherals

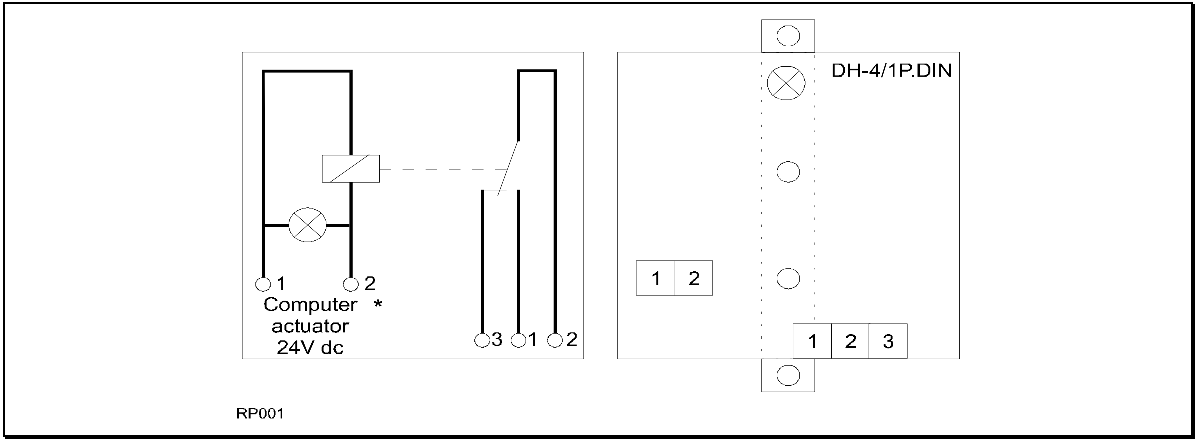
1.1 DH / DC / FH boards

The DH, DC and FH boards consist of a 24 V relay circuit with a suppressor diode and LED indicator. These boards are often connected to the DSAT actuator output. They can also be connected to a DSAT sensor input.
The DH and DC boards are single relay boards, the FH board comprises 10 relay circuits.
The DH and FH boards have one-pin relay contacts, while the DC has a two-pin relay contact.
The contacts of the three boards are all designed as make-and-break contacts.

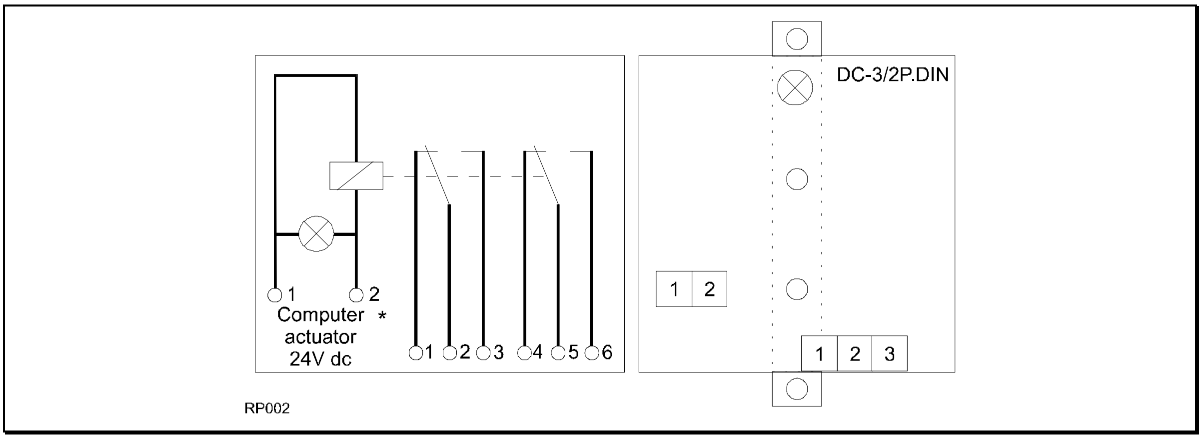
The maximum loads on the DH, DC and FH actuator boards are specified in the table below.

Box/board	**Normal power (VA)**	**Max. power (VA)**	**Duration (minutes)**	**Application**
DH/DC/FH	100	250	1	Miscellaneous

Normal power refers to the most commonly occurring load in practice.
The maximum power must never be exceeded. Duration refers to the maximum connected time during which the board may be subject to maximum loading.



DH board



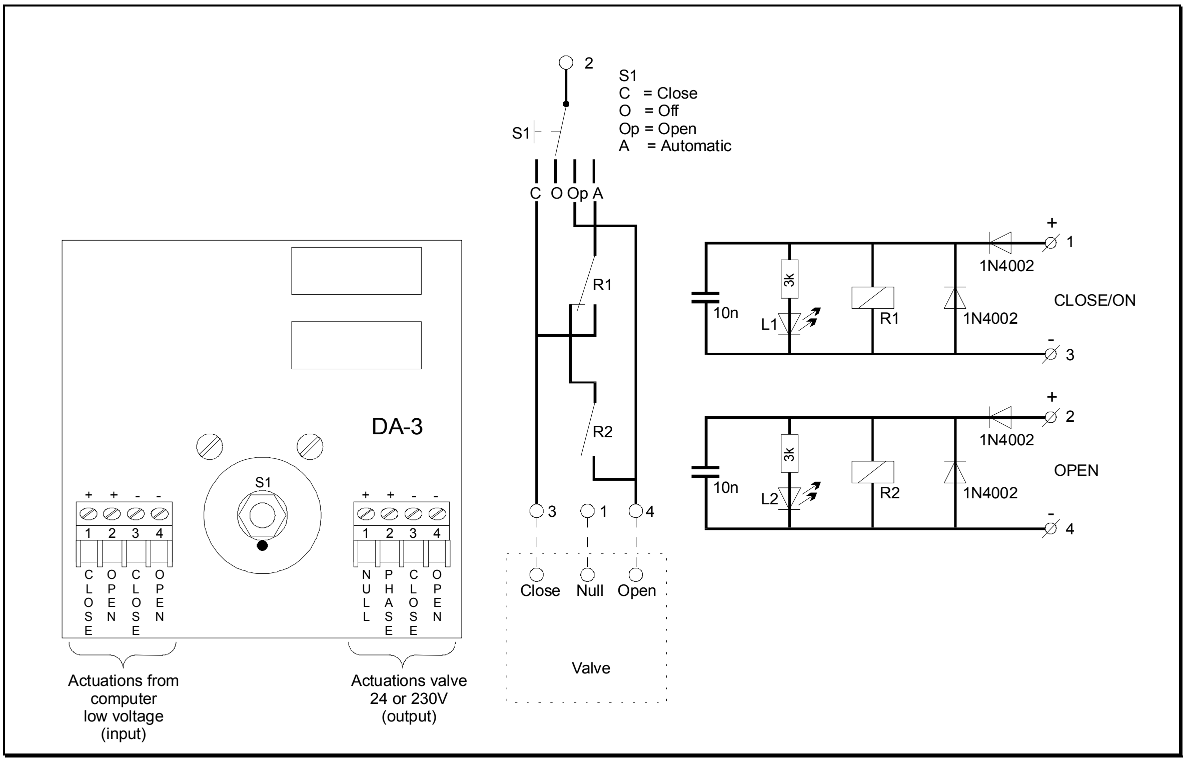
DC board

* Connecting the actuator to the DH and DC boards is unaffected by the polarity (+ and -). The two boards are fitted with a suppressor diode.

Notes:

1.2 DAM / DAH

The DA board consists of two 24 volt relays with a suppressor diode. The relays are connected as ‘open’ and ‘close’ actuators. A switch is provided to select from ‘Computer’, ‘Off’, ‘Opened’ or ‘Close’. The DA board is mounted in a box with a transparent front: the DAM box. The drawing below shows the principle and the connections of the DAM box.
A DAH box is a simple version of the DAM box. It does not include the ‘open’ actuator. The ‘close’ actuator now serves as an ‘on’ actuator.



DA3 board

The maximum loads on the DAM and DAH boxes are specified in the table below.

Box/board	Normal power (VA)	Max. power (VA)	Duration (minutes)	Application
DAM / DAH	100	250	1	Miscellaneous

Normal power refers to the most commonly occurring load in practice.
The maximum power must never be exceeded. Duration refers to the maximum connected time during which the board may be subject to maximum loading.

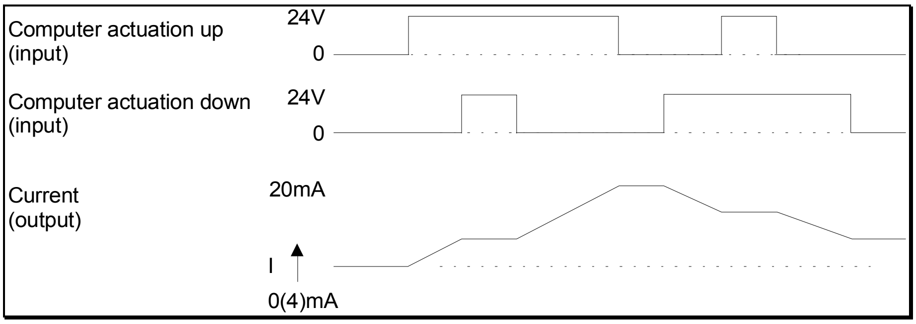
Monitoring connections
The connection of a DAM box can be monitored by manually carrying out an open and close actuation. The open and close computer actuations can be monitored with the test phase (- connection on the HX board in the DSAT).

1.3 GU-4 board

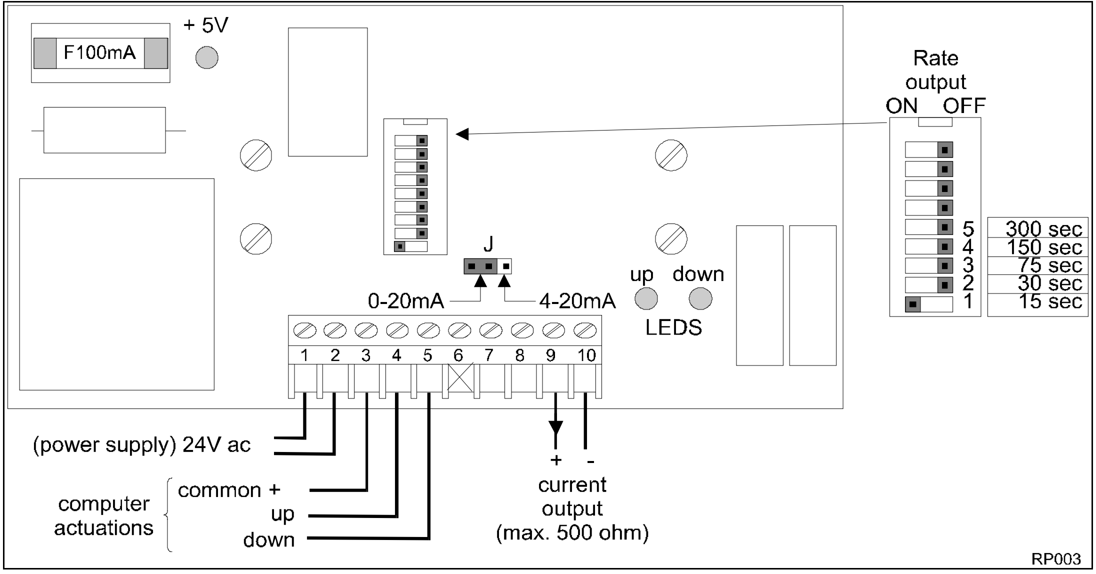
The Hoogendoorn DSAT uses 24 volt dc actuators. However, some equipment has to be actuated with a current actuation of 0 to 20 mA or 4 to 20 mA. Examples of such devices include speed-controlled pumps or fans. (0 mA represents stationary/zero speed and 20 mA is maximum speed.) The interface board which converts the voltage actuation to a current actuation is the GU-4 board.

Features of the GU-4 board:

- 24 volt ac supply voltage
- approx. 2.5 VA power consumption
- mounting with DIN rail clamps
- can be mounted in Sarel type 356 housing
- actuator inputs metallically isolated by relays
- 5-speed actuation possible
- output adjustable from 0 to 20 mA or 4 to20 mA (jumper)
- maximum resistance 500 ohms (voltage from 0 to 10 V)



GU-4 board operation

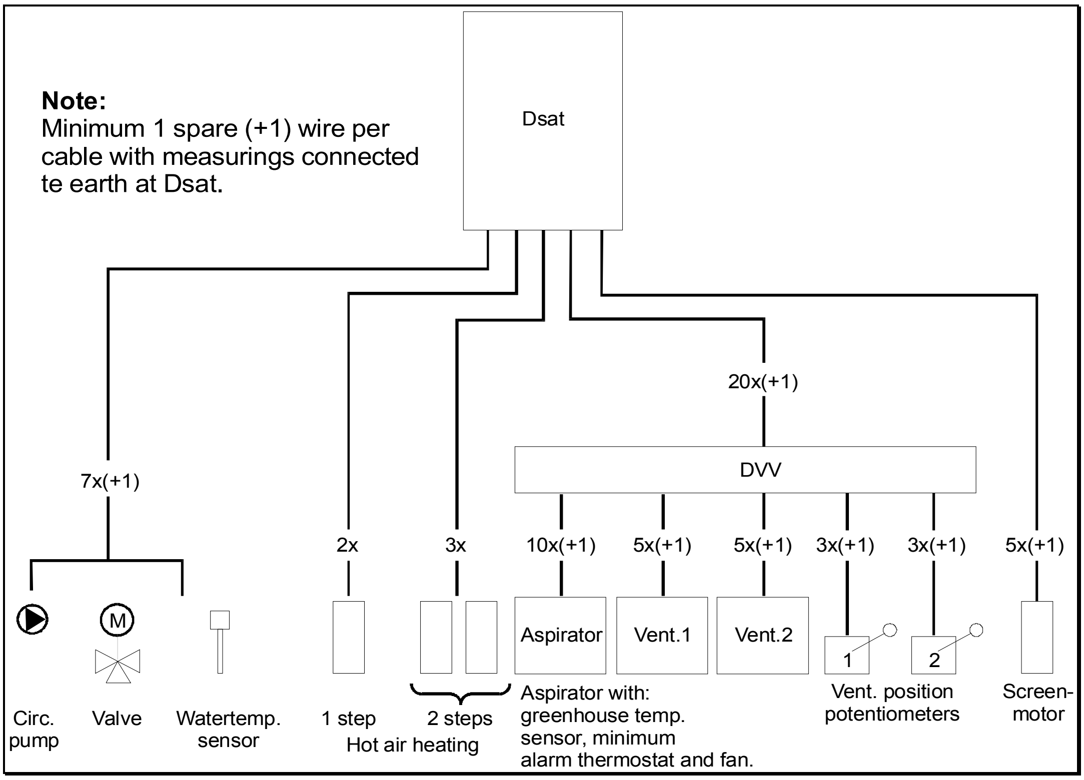


GU-4 board connections and settings

*: Actuation speed: The mini-switches can be used to set the time needed to allow the current actuation to increase from 0 to 20 mA. A choice of five durations is available. Choose the appropriate one by setting one mini-switch to ‘ON’.

2. Climate

2.1 Overview of climate, use of minimum number of cores per cable

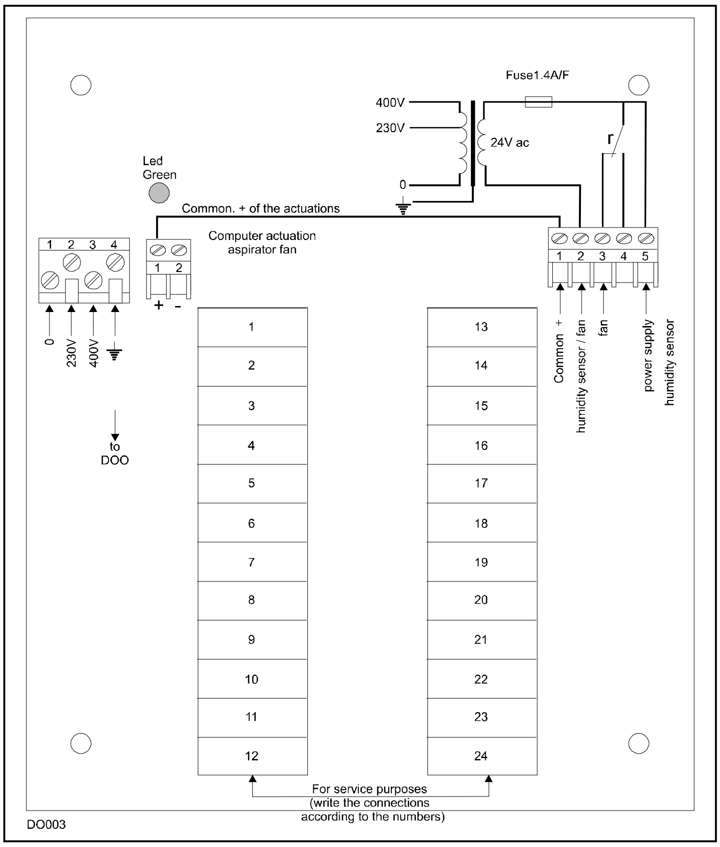


Overview of climate control and use of minimum number of cores per DSAT

2.2 DVV

The various measurement devices and actuators from one climate group are connected in a DVV box before continuing to the DSAT in a 24-core cable.
The DVV incorporates a 24 V ac transformer for the aspirator fan and electronic RH sensor. This transformer can take a 380 V or 230 V supply.
A relay in the DVV enables 24 V to be output to the aspirator fan. This is used for the spraying program.

The drawing below shows how the DVV has to be connected. If the DVV is used in combination with a DOO, the DVV supply (0, 380 V and 'Earth' terminals) can be connected to the extra 'S', 'T' and 'Earth' terminals in the DOO (see para. 2.4).
A mains voltage of 230 V is connected to the 0, 230 V and 'Earth' terminals as the supply for the DVV.



A drawing showing the terminal numbers 1-24 with the wire colours and applications should be included in the DVV box.

Monitoring connections
The 24 V can be monitored with a multimeter. The off actuation of the aspirator fan can be monitored with the test phase. To do so, connect the actuator to the - (= test phase) on the HX board in the DSAT.

2.3 Aspirator

The aspirator enables the greenhouse temperature and relative humidity to be measured. The measurements are conducted with two PT500 temperature sensors (greenhouse temperature and RH using wet and dry bulbs) or one PT500 (greenhouse temperature) and an electronic RH sensor. These sensors are located in a current of greenhouse air which is drawn through the aspirator by a fan. A minimum alarm thermostat is incorporated in the aspirator as external protection (outside the computer). The thermostat contact is broken if the temperature falls below the preset minimum. The thermostat contact is included in an external alarm circuit (see the description of the HE board in the previous chapter *Installation Part I*).

Positioning the aspirator
The aspirator is located in a bay in consultation with the user. Points to bear in mind:

- ∆ The location is sufficiently representative for the whole bay.
- ∆ Do not locate in the direct vicinity of a convector heater or heating pipes.
- ∆ Not right under an air vent
- ∆ The aspirator is suspended with its front facing away from the sun (towards the north).
- ∆ At the right height (usually as close as possible to the growing point of the crop).

Connecting the aspirator
The aspirator is connected in the DVV box with a 12x0.8 cable. The spare cores are earthed in the DSAT via the DVV. The aspirator drawings include the connections for the PT500 sensors, the fan and the alarm thermostat.

The RH sensor outputs a voltage of 0 to 1 V (at an RH of 0 to 100%) measured between the blue and yellow wires of the RH meter. This voltage is connected to the integral FL-2 board and converted into two voltages, viz. 0-100 mV and 0-4 V. The 0-4 V output is always used for the *ECONOMIC* NT. The 0-4 V voltage is connected to the HZ board in the DSAT as per the drawing opposite.

Electronic RH sensor installation instructions

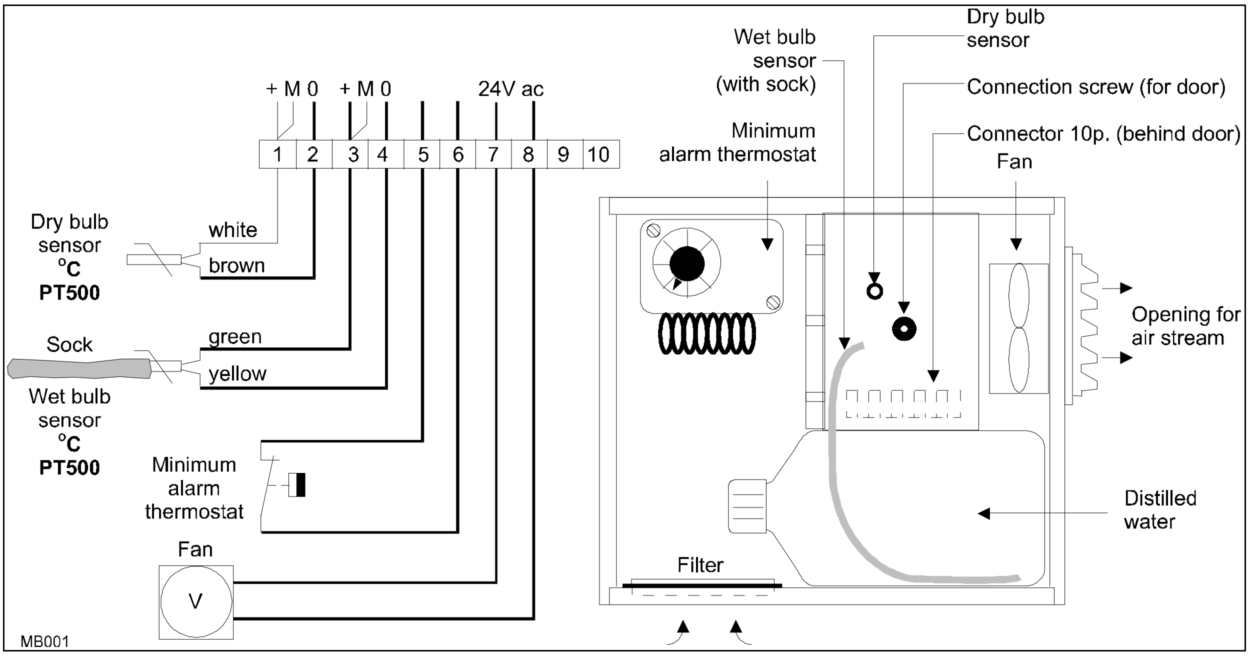
- ∆ The FL-2 board must never be removed from the RH sensor.
- ∆ The supply for the electronic RH sensor comes from the DVV. One electronic RH sensor may be connected to each DVV.
- ∆ If an electronic moisture sensor is temporarily removed to calibrate it, it must be returned to the same system.

Type of measurement device
Type of measurement device (jumper on HA board, see part I, para. 6.3) for the aspirator sensors:

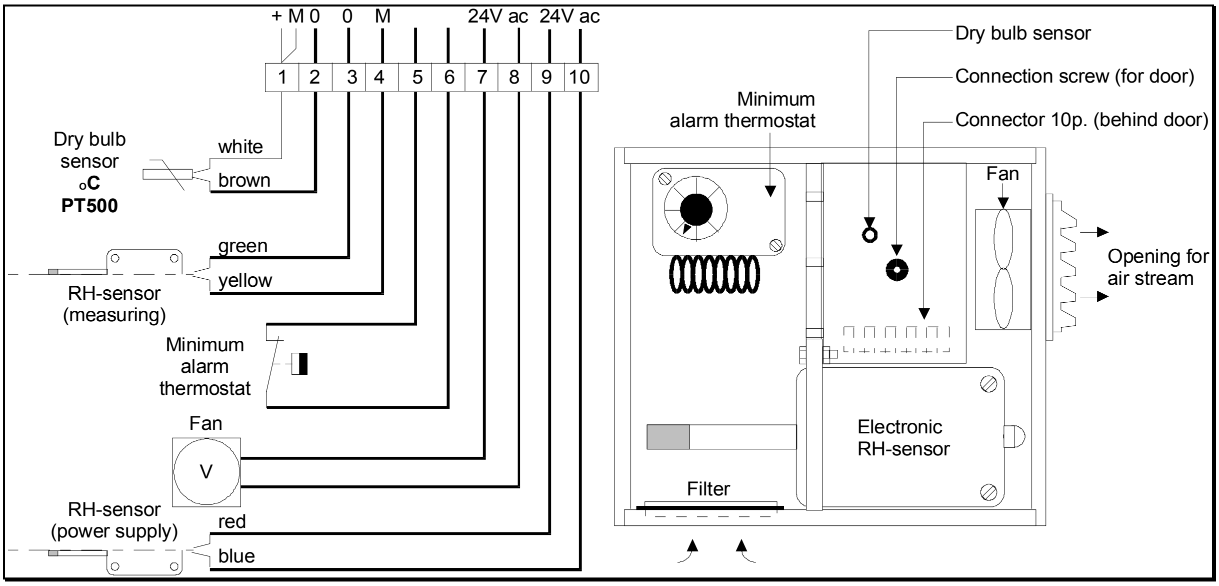
- ∆ dry and wet bulb sensor: type PT500
- ∆ electronic RH sensor standard type

Monitoring connections
The connection of the PT500 sensors can be monitored by measuring the voltage at the connection terminals in the DSAT (HZ board) (see para.6.3 from part I).
The electronic RH sensor outputs a voltage of between 0 and 4 volts corresponding to a relative humidity of 0 to 100%. The voltage can be read between 0 and M on the DSAT's HZ board as per the following table.

RH (%)	Voltage (V)
0	0
50	2
100	4



Aspirator with dry and wet bulb sensor



Aspirator with dry bulb and electronic RH sensor

2.4 DOO

A DOO box is used to actuate an electric motor for an air vent or a curtain. The switch on the DO board switches a three-phase power current on and off and can also invert it. This means that the electric motor can turn in both directions and can therefore open and close the vent or curtain. A DOO box is fitted with a switch for Manual mode, Off or Computer.

Connecting a DOO
See the drawing below

Installation instructions for DOO
A DOO must always be connected via an external motor circuit-breaker or overload switch (thermal and magnetic).

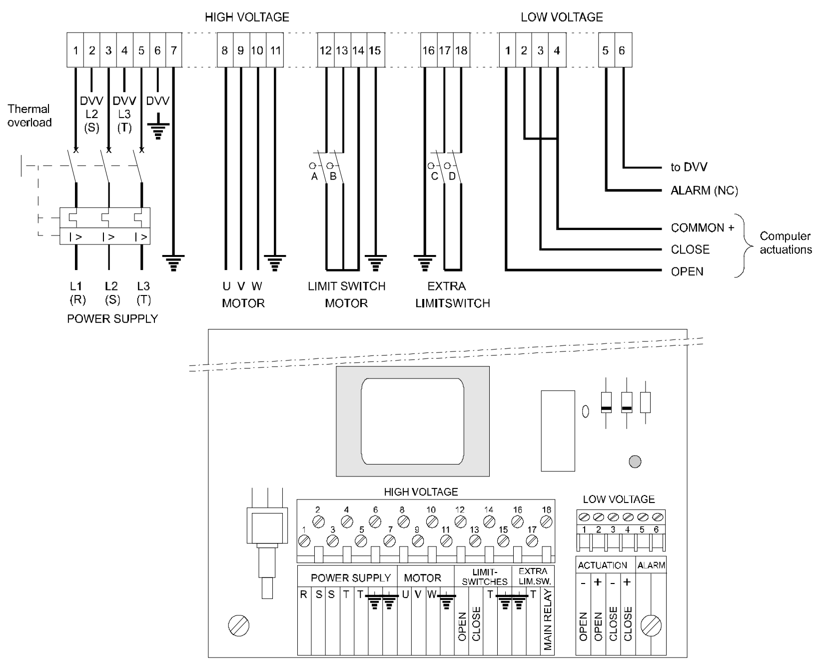
Monitoring the connection
The open or close direction of rotation can be monitored using manual mode.
The computer actuations can be monitored using the test phase. To do so, connect the actuators to the - (test phase) on the HX board in the DSAT.
The limit switch must, of course, be adjusted first to prevent damage to the greenhouse.

The maximum loads on the DOO are specified in the table below.

Box/board	Normal power (VA)	Max. power (VA)	Duration (minutes)	Application
DOO	750	1250	10	Ventilation/ curtain operation

Normal power refers to the most commonly occurring load in practice.
The maximum power must never be exceeded.
Duration refers to the maximum connected time during which the board may be subject to maximum loading.

The coil voltage of the magnetic relays used on the DO board is 380 / 400 V. The coils of the magnetic relays are connected between the connection terminals of two phases on the DO board.

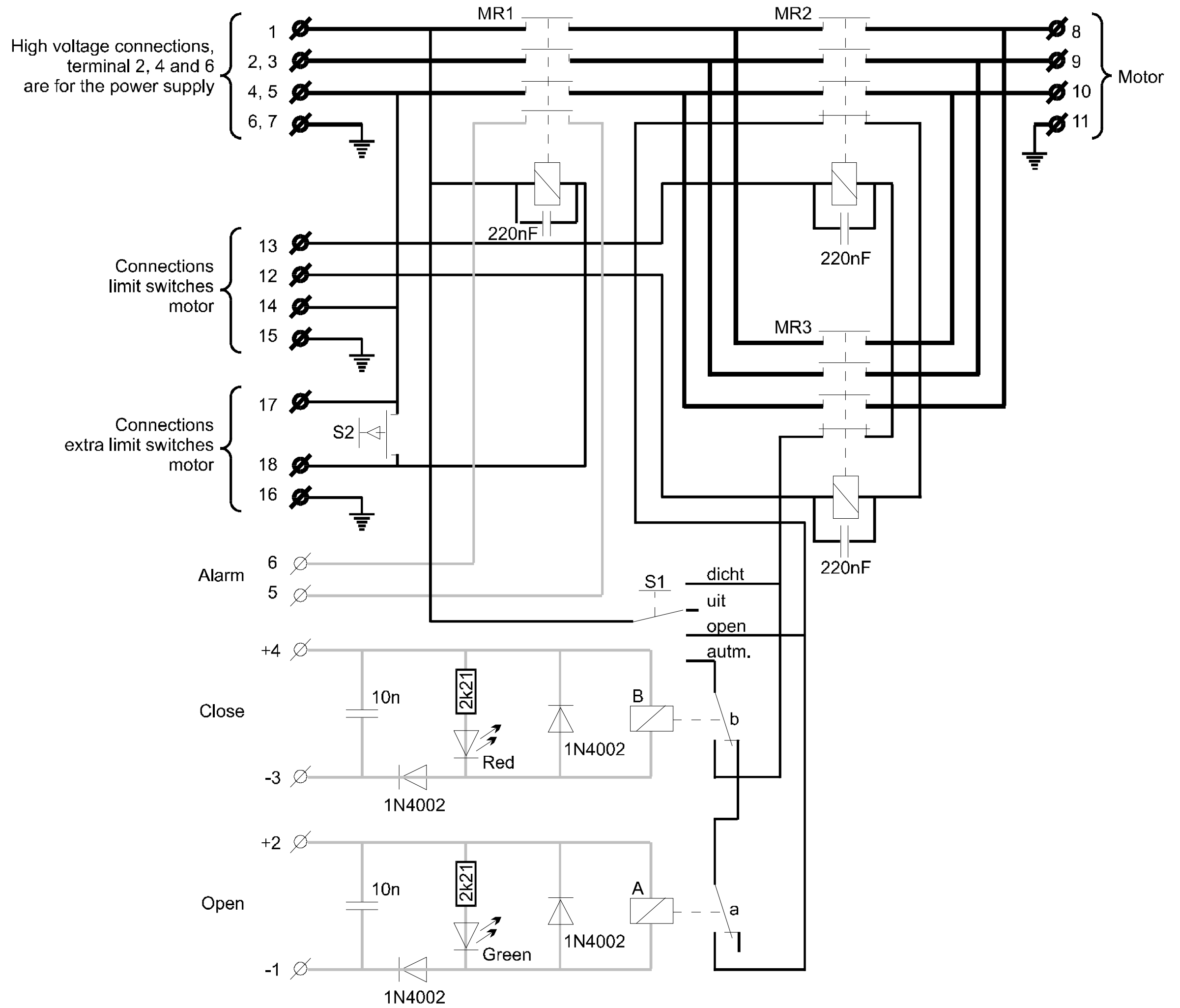


DO002

DOO Connections

DO board limit switches

There are a number of connections for limit switches on the DO board which are connected as protection for the motor. Two limit switches are actuated when the curtain or vent is fully open or closed. In addition, there are often one or two extra limit switches. These are actuated if one of the normal limit switches fails to work and therefore function as a backup protective system. The extra limit switch switches the main magnetic relay off. The *ECONOMIC* NT can then no longer operate the motor. This is signalled via an alarm contact. A bypass switch is fitted to the extra limit switch so that the motor can be operated by pressing this switch even if the extra limit switch has been actuated.



Ø : High voltage terminals
∅ : Low voltage terminals

S1 : Switch
S2 : Override pushbutton extra limit switches

MR1 : Magn. relay B6-30-10-P
MR 2, 3 : Magn. relay B6-30-01-P
A, B : Relay 24V dc 1xW
220nF : Condenser (500V ac)

Do001

2.5 Gable wall or roller curtain

If this curtain has a 3-phase motor, a DOO box can be used to actuate it. In the case of a 230 V motor (phase - null) a DAM box can be used provided the motor does not have too high a power rating (consult the paragraph relating to DAM / DAH).

Installation instructions
With a roller curtain system it is recommended that a motor circuit-breaker in the form of a timer be fitted. If the opening or closing of the curtain takes too long because, for example, the curtain is soiled or because it has jammed, the timer must switch the motor off after a preset time. This circuit-breaker must be able to work in both manual mode and if computer-actuated.

2.6 Vent position sensor

The vent position sensor is used to measure the position of the air vent, 0 - 100%. The device used for the sensor is a 500 ohm potentiometer, or possibly 1 kohm. There are two types of vent position sensor, i.e. integral and vent-mounted. The integral sensor is a 10-stroke potentiometer and is mounted on the electric motor. The potentiometer is turned by two gearwheels. Choose the size of the gearwheels such that 9 of the potentiometer’s 10 strokes are used when the vent moves from 0 to 100%.
The vent-mounted sensor is a separate box which is mounted on a representative air vent by means of a bracket. This is a 1-stroke potentiometer.

Installation
For a ‘Ridder’ type motor. RW45/RW250/RW400/RW600 are special mounting kits available with various gearwheels, a connector and a potentiometer bracket. The mounting instructions are contained in a manual in the packaging. Loose brackets and gearwheels have to be purchased for other types of motor.

Connecting the vent position sensor
Please refer to para. 6.3 in the previous chapter, *Installation Part I*.

Monitoring the connection
Please refer to para. 6.3 in the previous chapter, *Installation Part I*.

2.7 DSS/HSS

The DSS box is used to actuate an electric motor for a circulation pump and a mixing valve. For the circulation pump a 380 / 400 V alternating current is switched on and off. For the mixing valve a 24 volt alternating current is supplied to the DS board with which the valve is opened or closed. A switch is available allowing manual operation or computer actuation for both the circulation pump and the mixing valve.
A 230 V ac mixing valve is connected to the HSS box.
The ‘Circulation pump off’ computer actuation is performed by activating the relay (24V). If there is a power failure to the computer, the circulation pumps will continue to run.

Connecting a DSS/HSS
See the drawings below.

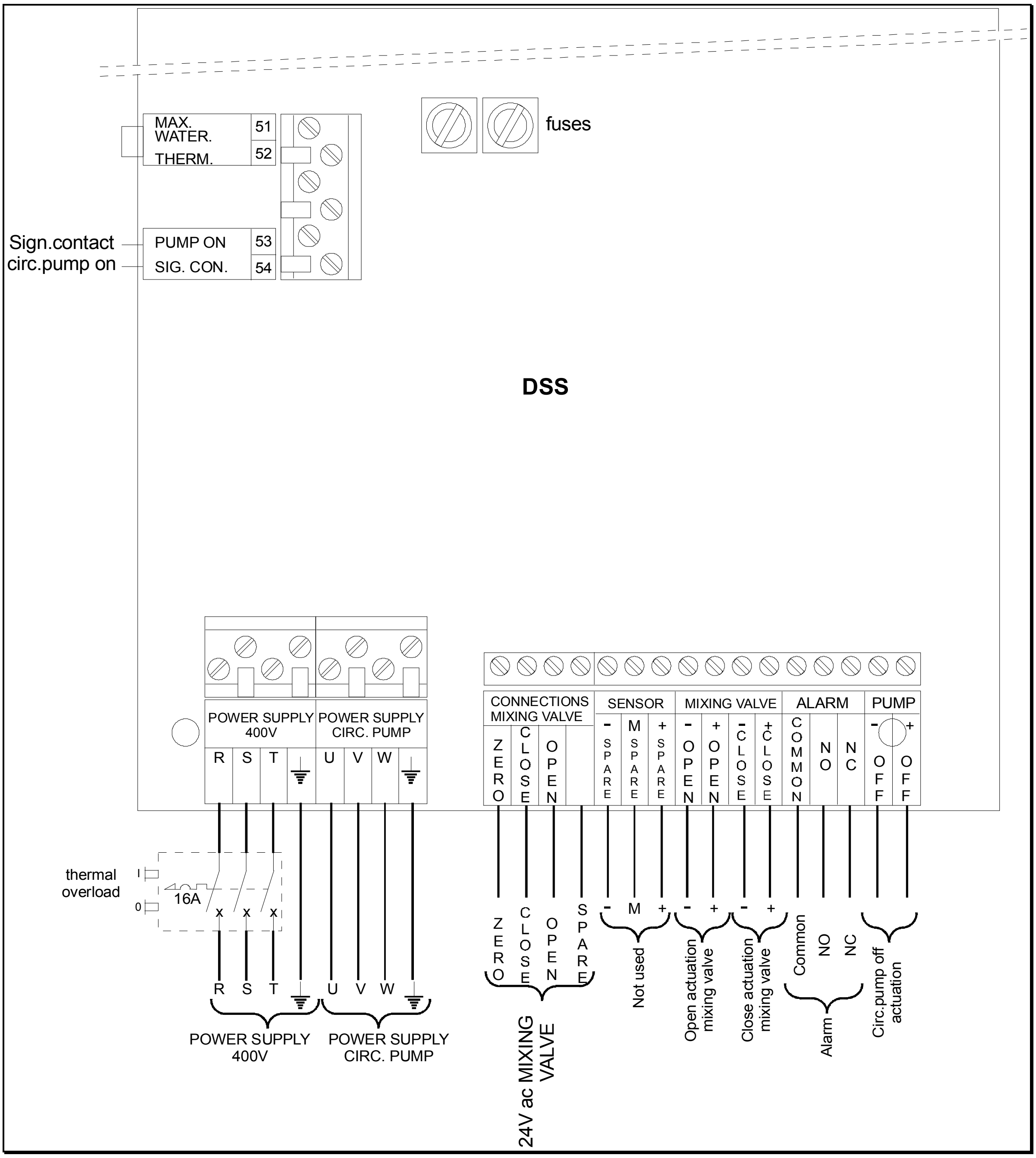
DSS/HSS installation instructions
A DOO must always be connected via an external motor circuit-breaker or overload switch (thermal and magnetic).

Monitoring the connection
The open or close direction of rotation can be monitored using the mixing valve manual mode. The on/off operation can be monitored using the circulation pump manual mode.
The computer actuations can be monitored using the test phase. To do so, connect the actuators to the - (test phase) on the HX board in the DSAT. The pump must be switched off by an active actuation of the circulation pump (24 V).

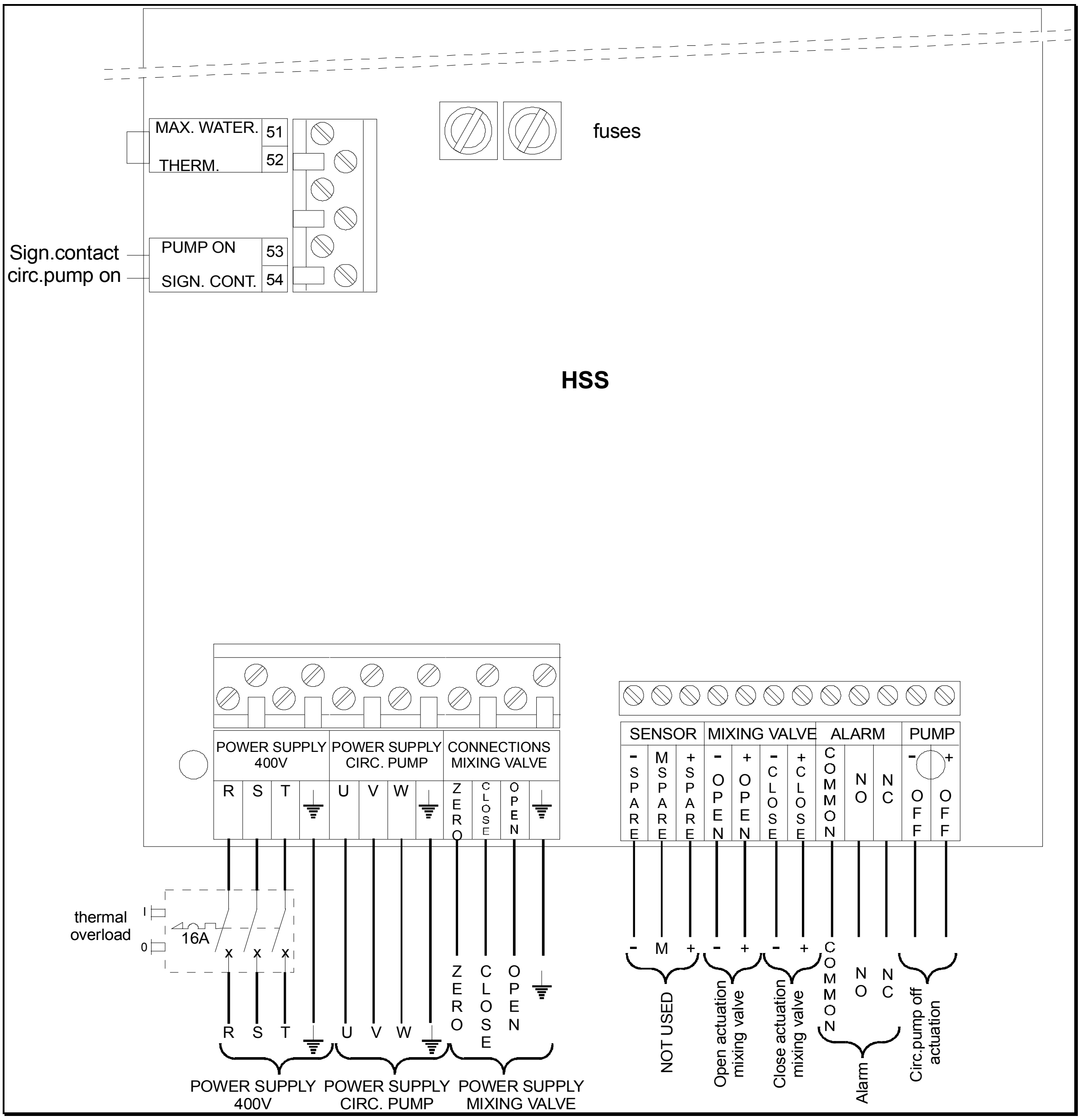
The maximum loads on a DSS/HSS are specified in the table below.

Box/board	Normal power (VA)	Max. power (VA)	Duration (minutes)	Application
DSS/HSS module circ. pump	500	750	Continuous	Circ. pumps
DSS module mixing valve	20	30	10	24 V ac mixing valve
HSS module mixing valve	60	90	10	230 V mixing valve

Normal power refers to the most commonly occurring load in practice.
The maximum power must never be exceeded.
Duration refers to the maximum connected time during which the board may be subject to maximum loading.


fuses
MAX. WATER. THERM.
51
52
Sign.contact circ.pump on
PUMP ON
SIG. CON.
53
54
DSS
POWER SUPPLY 400V
POWER SUPPLY CIRC. PUMP
R S T
U V W
CONNECTIONS MIXING VALVE
ZERO
CLOSE
OPEN
SENSOR
- SPARE
M SPARE
+ SPARE
MIXING VALVE
- OPEN
+ OPEN
- CLOSE
+ CLOSE
ALARM
COMMON
NO
NC
PUMP
- OFF
+ OFF
thermal overload
16A
POWER SUPPLY 400V
POWER SUPPLY CIRC. PUMP
ZERO CLOSE OPEN SPARE
24V ac MIXING VALVE
Not used
Open actuation mixing valve
Close actuation mixing valve
Common
NO
NC
Alarm
Circ.pump off actuation

DSS board


MAX. WATER.
THERM.
51
52
Sign.contact
circ.pump on
PUMP ON
SIGN. CONT.
53
54
fuses
HSS
POWER SUPPLY 400V
POWER SUPPLY CIRC. PUMP
CONNECTIONS MIXING VALVE
R S T
U V W
ZERO CLOSE OPEN
SENSOR
MIXING VALVE
ALARM
PUMP
- SPARE
M SPARE
+ SPARE
- OPEN
+ OPEN
- CLOSE
+ CLOSE
COMMON
NO
NC
- OFF
+ OFF
thermal overload
I
0
16A
x x x
R S T
U V W
ZERO
CLOSE
OPEN
POWER SUPPLY 400V
POWER SUPPLY CIRC. PUMP
POWER SUPPLY MIXING VALVE
- M +
- +
- +
COMMON
NO
NC
NOT USED
Open actuation mixing valve
Close actuation mixing valve
Alarm
Circ.pump off actuation

HSS board

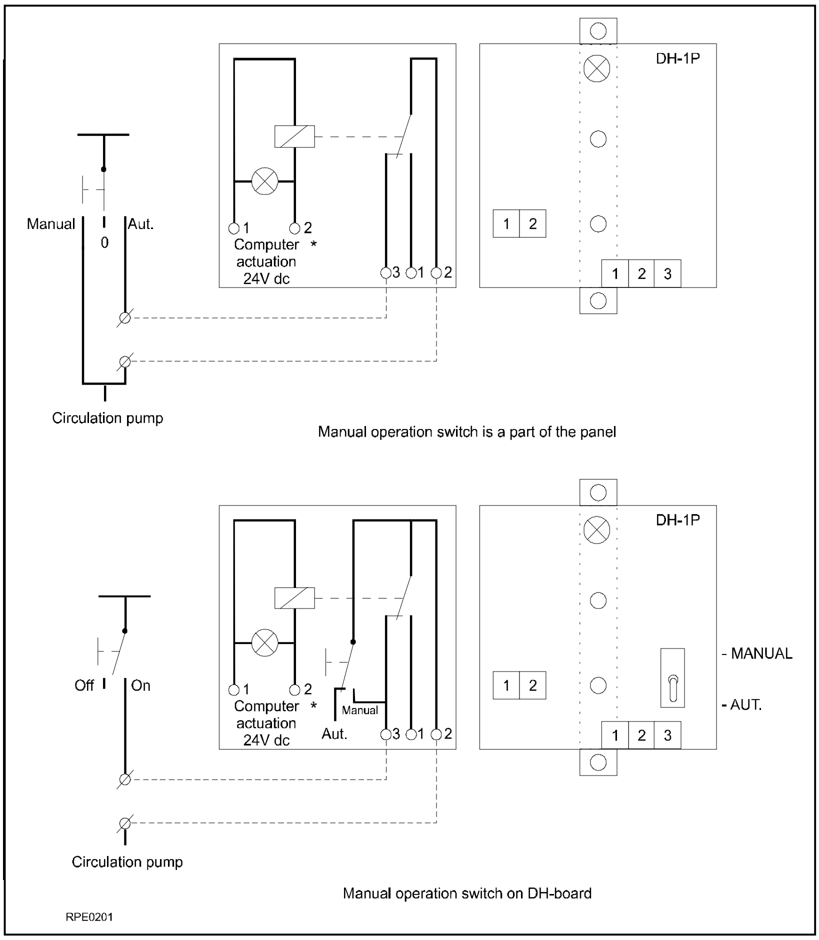
2.8 Separate mixing valve and circulation pump

If the circulation pump is connected in a pump panel, no DSS or HSS box is necessary. The pump can then be actuated by the computer with the aid of a DH relay. In this case the mixing valve is connected via a DAM box.

Connecting the pump

There are two options, i.e. manual operation of the switch is either included or not included on the pump panel. In the first case the pump can be actuated by the computer with a standard DH board. In the second case a DH board with a switch must be used. The connections for both options are shown in the drawing. In both situations the switch is incorporated in a light-current actuation circuit and not in the power-current circuit.

*: Connecting the actuator to the DH board is unaffected by the polarity (+ and -). The DH board is fitted with a suppressor diode.

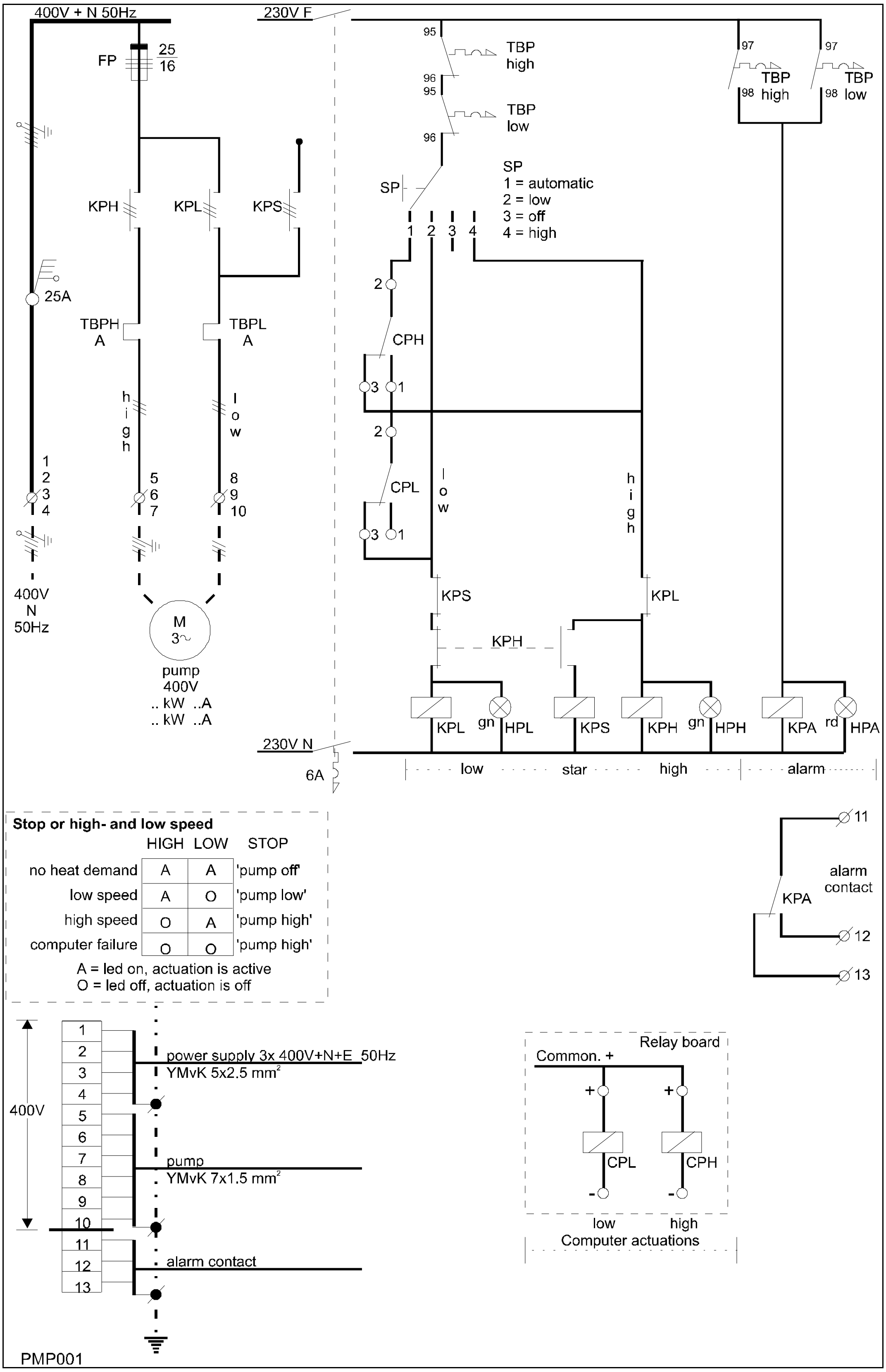


Pump actuation via the DH board

Connecting the mixing valve to the DAM box

The mixing valve can be connected to a DAM box (description of DAM box: para. 1.2). The switch on the DAM box enables the user to choose manual opening or closing, off or actuation via the computer. Note: the supply for the valve is not incorporated in the DAM box.

2.9 Two-speed pump



Stop or high- and low speed

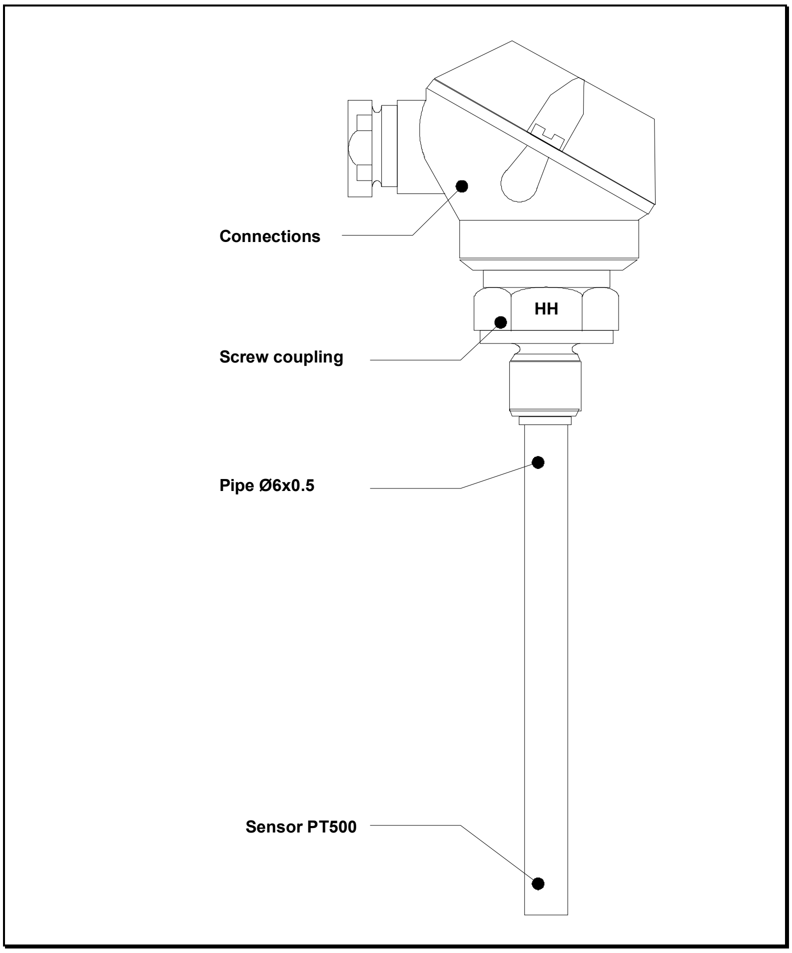
	HIGH	LOW	STOP
no heat demand	A	A	'pump off'
low speed	A	O	'pump low'
high speed	O	A	'pump high'
computer failure	O	O	'pump high'

A = led on, actuation is active
O = led off, actuation is off

A two-speed pump is actuated by the computer with low-speed and high-speed actuators. A DSS or HSS box cannot be used in this case. The circuit diagram below gives an example of a box / panel with which a two-speed pump can be connected. Two assumptions in this diagram: the computer actuations are ‘off actuations’ (low-speed actuation: 0V means that low speed is active) and in the event of a mains power failure the system defaults to high speed. In this case the mixing valve is connected via a DAM box.

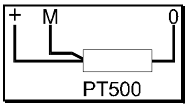
2.10 Water sensor

The water sensor is a temperature sensor which measures the water temperature of, for example, one circuit of the overall heating system. It can be installed in the heating pipe in one of two ways, either directly via a socket or in an immersed tube. A water sensor in an immersed tube can be replaced without having to drain the heating circuit. The distance between the circulation pumps and water sensor must be 2 to 3 metres.



Type of measurement device
Type of measurement device (jumper on HA board, see para.6.3 in the previous chapter) of a water sensor: PT500

Connection
A water sensor is connected to the HZ board in the DSAT. The cable used is a 4x0.8 with one spare core connected to earth in the DSAT. A multicore 0.8 cable with a few more measurement devices can, of course, also be used. The connection procedure is identical to that of the temperature sensors in the aspirator.



Monitoring connections
The connections of the water sensors can be monitored by measuring the voltage at the connection terminals in the DSAT (HZ board) (see para.6.3 in the previous chapter).

2.11 CO_2 supply unit

The CO_2 supply unit is responsible for supplying CO_2 to the greenhouse. CO_2 is produced by the boiler as a combustion by-product. The BBKs include terminals for connecting the CO_2 supply unit. There are two situations, 'CO_2 allowed' and 'CO_2 must'. CO_2 allowed: if the boiler is burning as a result of a heat demand from the greenhouse, CO_2 may also be supplied. CO_2 must: even in the absence of a heat demand, the boiler is operated to supply CO_2 to the greenhouse.

Connecting the CO_2 contact

The CO_2 contact in the BBKs is a make-contact which is short-circuited in the manual mode setting. If the CO_2 panel is integrated in the burner panel, the BBK's standard terminal numbering can be retained. If the panels are separate, the layout of this panel must be established to define how the contact is to be connected.

The CO_2 sensor (see next paragraph) is fitted with a minimum and maximum CO_2 alarm contact. It is important to connect the maximum CO_2 contact to the CO_2 panel. This is because the CO_2 supply unit must also be shut down at a maximum level in the case of manual operation or in the event of a computer fault to prevent too high a CO_2 concentration occurring in the greenhouse.

2.12 CO_2 sensors

Both a linear and a non-linear (logarithmic) CO_2 meter can be connected to an *ECONOMIC* NT. The installation instructions and connection data are based on sensors manufactured by Siemens (linear type: M52080-A74-A ... and non-linear type: ZFP-DZ) and type 3600 manufactured by MSA.

CO_2 sensor installation instructions

1. The ambient conditions for the CO_2 sensor are:
   a) Maximum ambient temperature 40°C
   b) Minimum ambient temperature 5°C
   c) Maximum relative humidity with sensor enabled 90%
   d) The sensor must be suspended such that it is unaffected by direct thermal radiation, hot air or water.
   e) Do not install in locations where condensation and similar can be expected.
   f) Do not install in locations where vibrations can occur.
   The durability and reliability of the sensor depend greatly on compliance with the points specified in item 1.

2. Remove the internal transport packaging (a piece of foam rubber).

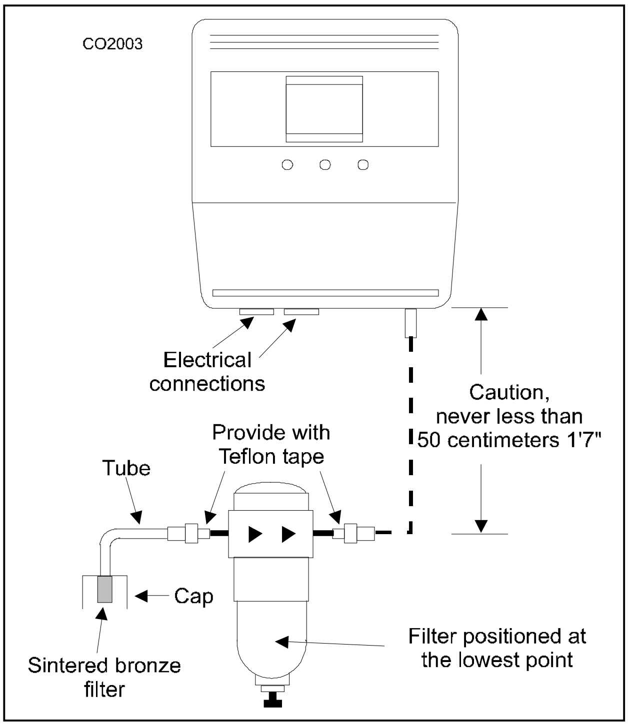
3. The CO_2 sensor's input and output must be sealed from contact with the direct environment during transport to prevent contamination of the meter's internal circuit.

4. A flexible 230 V mains cable (3-core) must be used to connect to the mains. The output signal must be connected using a 2-core 2x0.8 mm cable. Do not lay the output signal cable parallel to the mains power cable.

5. The sampled-gas connection is suitable for line dimensions of 4-6 mm (inside/outside diameter).
   A condensation trap always has to be included in the CO_2 sensor for the sampled-gas connection.
   This must be mounted at least 50 cm below the CO_2 sensor so that no condensation can be entrained from the CO_2 sensor by the pump.

6. The inlet filter must always be fitted at the sampling inlet for the sampling line with the linear CO_2 meter, type M52080-A74-A.

7. The start of the sampling line must be among or just above the crop to ensure that the CO_2 level is measured in the active section of the plant. A dust filter with a red condensation cap must be placed at the beginning of the sampling line. You are advised against using a sampling line longer than 60 metres.

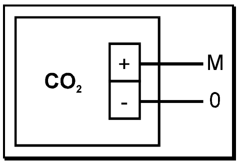


8. Take care that the sampling line cannot be pinched.

Type of measurement device
Type of measurement device (jumper on HA board, see previous chapter, para. 6.3) for the CO_2 sensor: standard type

Connecting the CO_2 sensor

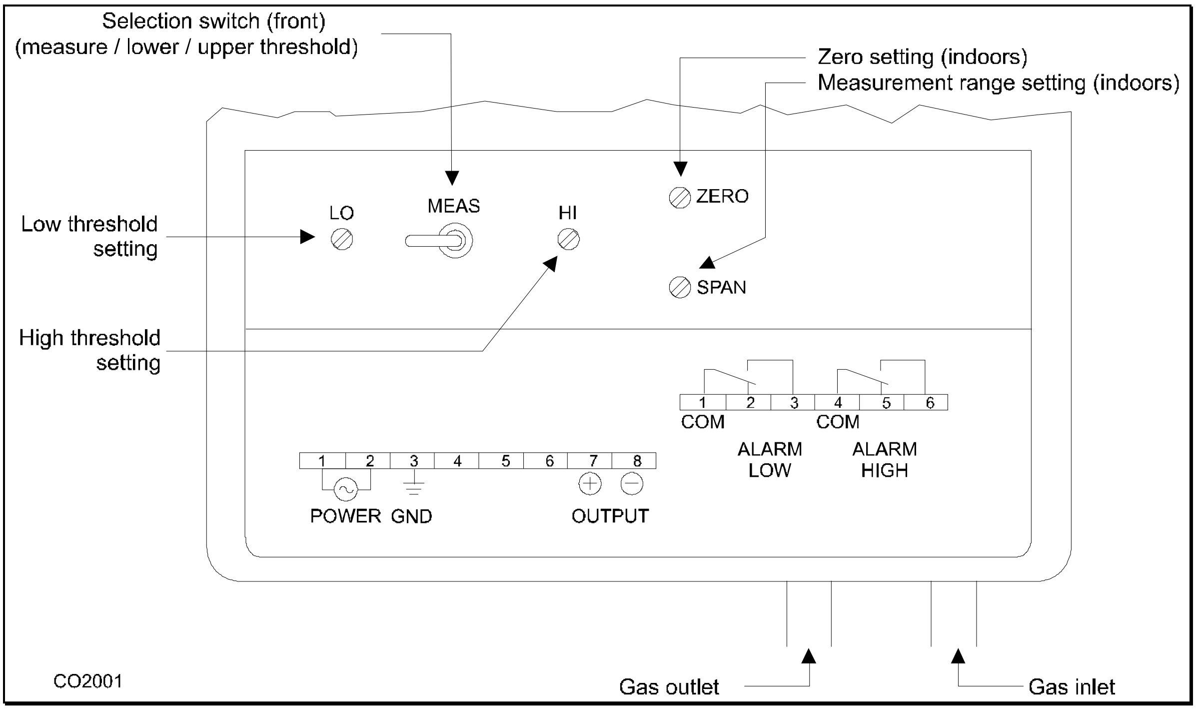
The CO_2 sensor output is connected to the HZ board in the DSAT as per the drawing on the right. The output voltage varies from 0 to 100 mV. A Siemens CO_2 sensor has a default output signal of 0-20 mA. This signal is converted to the desired 0-100 mV by fitting a 5 ohm resistor (10 ohms parallel to 10 ohms) in the DSAT across 0 and M.



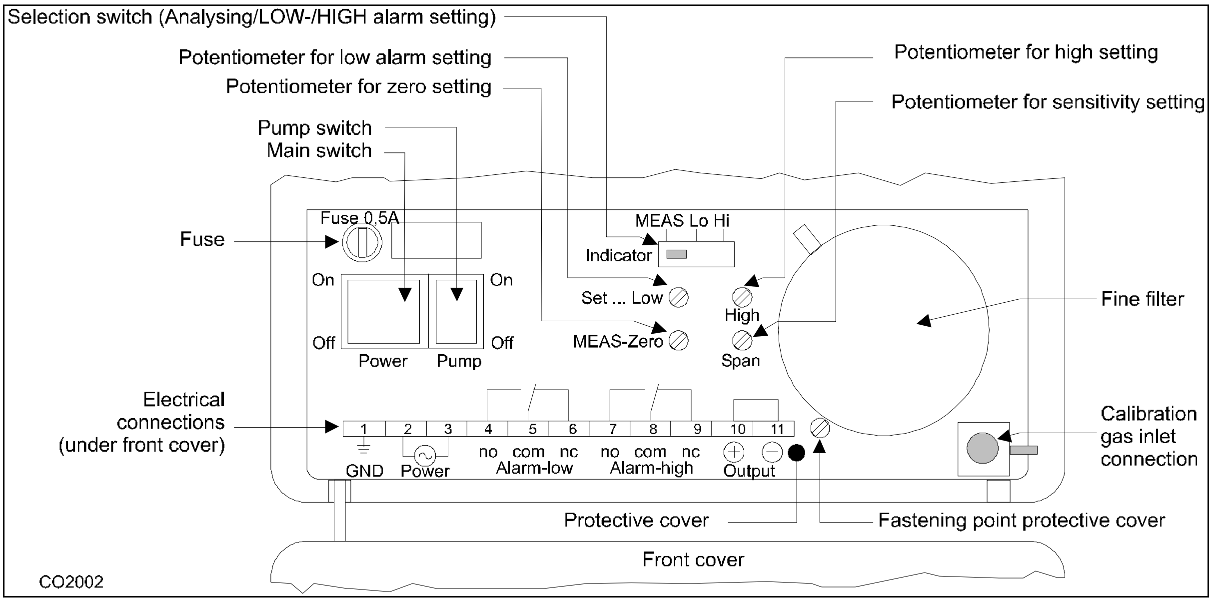
The cable to the CO_2 sensor must be shielded. The shielding must be connected to the greenhouse structure at one location.
It is recommended that the CO_2 sensor be located close to the DSAT to which it is connected. Whether or not this recommendation is followed, the CO_2 sensor and the DSAT must be connected to the same voltage group with the same earth. These measures ensure that the CO_2 sensor is protected against voltage differentials between the various earth connections.

Monitoring the connection

After installation or if the CO_2 sensor has been out of service for some time it must be adjusted and monitored. It can only be adjusted once it has been turned on for at least 30 minutes. This warm-up time is needed to ensure a reliable measurement.



The description below refers to the type ZFP-DZ CO_2 sensor. Type M52080-A74-A can be adjusted in the same way. However, this type has no PUMP switch and no separate calibration input. The connections and the various potentiometers, switches, inlets etc. for both types of CO_2 sensor are shown in the two drawings.



1. Zero setting
   Ensure that the PUMP switch is set to ON.
   The zero-setting gauge unit is connected to the sampling inlet. The indicator has to move to zero within approx. half a minute. If not, turn the zero setting (ZERO potentiometer) in the direction of the zero indication on the meter.

2. Measurement range setting
   Ensure that the PUMP switch is set to OFF. Calibration with 1000 ppm or 1300 ppm CO_2 calibration gas. Nothing is now connected to the measurement inlet. The can containing the calibration gas is connected to the calibration inlet under the cover. Then press the can for two seconds and wait until the measurement is stable. If the reading is anything other than 1000 ppm or 1300 ppm, SPAN has to be adjusted. Note that the pump should still be off! Restart the pump for normal operation and place the cap on the calibration inlet!!

3. Adjustment of the threshold settings
   Set the switch to ‘LO’, this is the lower threshold. The meter deflects to a fixed position of, for example, 1000 ppm (0.1 scale deflection). Turn the LOW potentiometer and check whether the resistance changes. Set this to the desired lower threshold. Move the switch to ‘HI’, this is the upper threshold. The sensor now indicates a different position which ought to be higher than the lower threshold. Turn the HIGH potentiometer and set this to the desired upper threshold. Now set the switch to the MEAS position.
   The upper and lower thresholds differ for different crops. A user often also has his own opinion on this subject so adjust these settings in consultation with the user.

Maintenance

1. Replacement of the membrane filter paper (only applicable to type ZFP-DZ)
   The membrane filter paper has to be replaced every 6 months. First set the pump switch to the ‘OFF’ position before the paper is replaced. After unscrewing the 3 screws on the filter, remove the filter cover. Withdraw the O-ring together with the filter paper. Note the order, which must not be changed. Place a new filter in the holder. Put the O-ring and the filter holder back in place and screw them down until the filter housing is firmly sealed again. Note that the positions of the filter paper and the O-ring must not be interchanged.

2. Calibration
   Calibration of the CO_2 sensor with the calibration gas must be carried out every 6 months in principle, or sooner if necessary in the event of doubts. The zero setting can be monitored weekly to ensure accurate measurements. Draw the user’s attention to this point also.

3. Condensation traps
   Check the condensation traps every day for condensation. If there is too much water in the condensation trap, it is entrained by the CO_2 sensor meter, and this will damage the sensor. Draw the user’s attention to this point also.

2.13 CO_2 selector (channel selector)

A CO_2 selector allows the operator to carry out measurements at several sampling points with one CO_2 sensor. The various sampling points in the greenhouse come together in the selector via the sampling lines. In the selector the sampling lines are linked one by one with the central sampling line via solenoid valves. This central line is then connected to the CO_2 sensor. The speed of switching between the various measurement channels can be set with a potentiometer in the selector. The selector outputs a measurement signal to the *ECONOMIC* NT system which indicates which measurement channel is active.

Various selector types can be used with an *ECONOMIC* NT system. The Siemens type S5/S8 selector is described in greater detail.

CO_2 selector installation instructions

1. The ambient conditions for the selector are:
   a. Maximum ambient temperature 40°C
   b. Minimum ambient temperature 5°C
   c. Maximum relative humidity with selector enabled 90%
   d. The selector must be suspended such that it is unaffected by direct thermal radiation, hot air or water.
   e. Do not install in locations where condensation and similar can be expected.

The durability and reliability of the selector depend greatly on compliance with the points specified in item 1.

2. Remove the transport packaging from the pump. This is a piece of plastic foam under the pump.

3. The mains voltage is connected to a connector in the selector with a 3x1.5 mm cable.

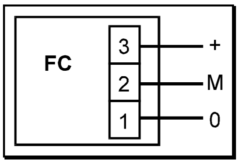
4. The computer measurement device is connected to the board in the cover using a 3x0.8 mm cable.

5. The sampling lines are connected to the underside of the channel selector. The connections are suitable for line dimensions of 4-6 mm (inside/outside diameter). The sampling line must be fitted with a dust filter at its end, located among or just above the crop.
   You are advised against using sampling lines of 60 metres or more in length.

6. The CO_2 sensor and channel selector(s) must be mounted as close to each other as possible. The condensation trap has to be positioned at least 50 cm below the CO_2 sensor.

Type of measurement device
Type of measurement device (jumper on HA board, see previous chapter, para. 6.3) for the CO_2 sensor:
standard type

Connecting the CO_2 selector



There are two selector models, viz. a 5-channel (S5) and an 8-channel selector (S8). The selector has an integral FC board. The FC board output is connected to the HZ board in the DSAT as per the drawing below.

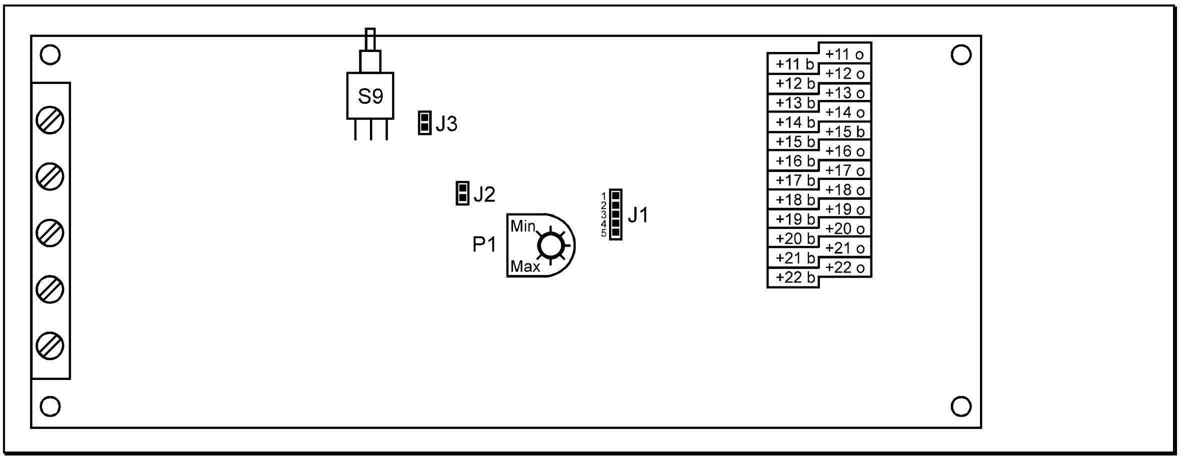
Monitoring the connection

Use a multimeter to check the voltage between 0 and M on the HZ board in the DSAT.

Channel number	Voltage (mV)
1	approx. 92
2	approx. 183
3	approx. 274
4	approx. 364
5	approx. 454
6	approx. 546
7	approx. 637
8	approx. 727

Setting the selector

The adjustable resistor P1, in the centre of the board, is used to set the switchover time from one solenoid valve to the next. The minimum time is to the left. If this minimum time is too long, remove the green jumper J2 and the switchover time becomes 10x shorter. There are two rows of LEDs on the selector cover.



J1 : only fitted with multiple selectors
1 + 2 shunt : duo
3 +4 shunt : master
4 +5 shunt : slave
J2 : shunt : running time 30-180 sec.
J3 : shunt : CO_2 contact closed
S9 : reset switchover time
P1 : switchover time

The bottom row indicates which solenoid valve is switched on. An LED lights up on the top row if the CO_2 contact is closed while the relevant solenoid valve is switched on. In this position an accompanying output contact is also closed, and this contact remains in this position until another measurement is conducted. The sampled air passes through the pump, exits the selector and continues via a condensation trap to the CO_2 sensor.

2.14 Lighting systems

There are two types of lighting system, viz. assimilation and cyclical lighting.
With assimilation lighting the lamps burn constantly throughout a portion of the day.
ECONOMIC NT uses one actuation to operate a lighting group.
With cyclical lighting the lamps are actuated in cycles per actuation with a fixed frequency.
There are now a number of actuations, for example 6 actuations of 5 minutes for 6 sections.
The cycle is repeated after half an hour.

Connection
The DSAT actuators can be connected to the lighting panel using type DH relay boards. One DH per actuation. For assimilation lighting, therefore, one DH board per group of lamps is sufficient. For cyclical lighting 6 DH boards are needed for a group of lamps (based on the example used above).

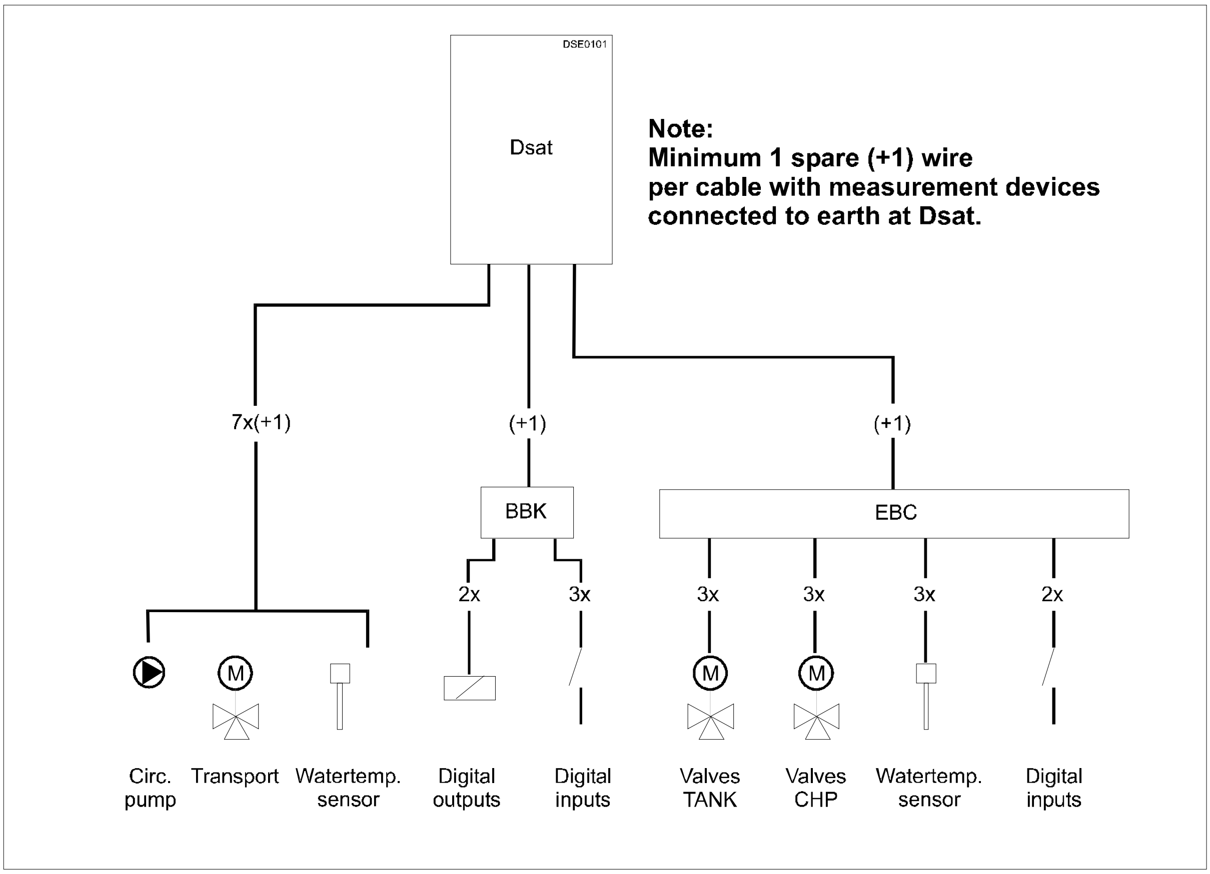
Installation instructions
In the case of cyclical lighting systems it is recommended that an external safety system be installed (outside the computer). If too few lamps are burning (e.g. if lamps, fuses or magnetic relays are defective), it must be possible for a signal to be given to indicate this.

Monitoring the connection
The computer actuations can be monitored using the test phase. To do so, connect the actuators to the - (test phase) on the HX board in the DSAT. The lamps must then come on.
NB: Assimilation lamps age quickly if switched on and off in quick succession.
When testing, therefore, take your time (at least half an hour, for example).

Notes:

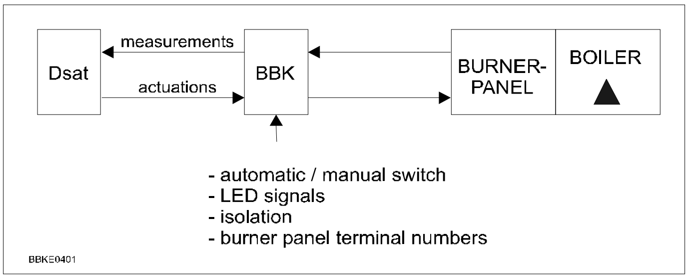
3. Energy control

3.1 Overview of energy control, use of minimum number of cores per cable



Overview of energy management and use of minimum number of cores per DSAT

3.2 BBKs



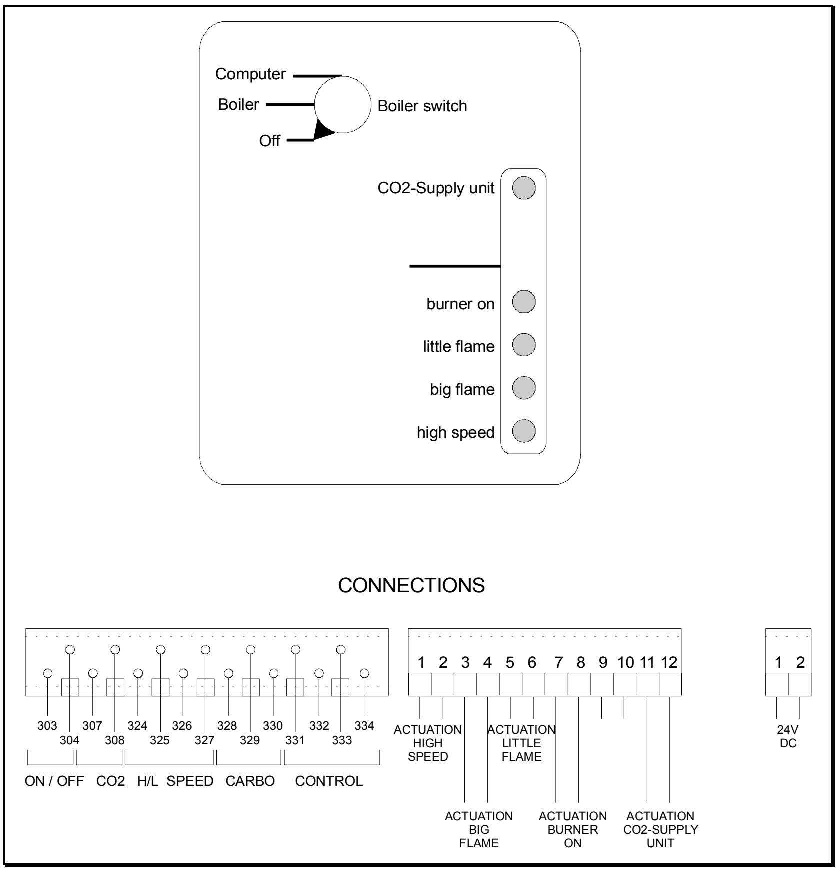
BBK is the abbreviation of the Dutch term for Burner Control Box. A BBK is the interface between the computer (DSAT) and the boiler (burner panel).
There are four types of BBK. Which box has to be installed depends on the type of burner control.

1. BBK-S (**S**witching burner control)
2. BBK-M (**M**odulating burner control)
3. BBK-E (**E**lectronic burner control)
4. BBK-F (computer-actuated burner control, Fiduface)

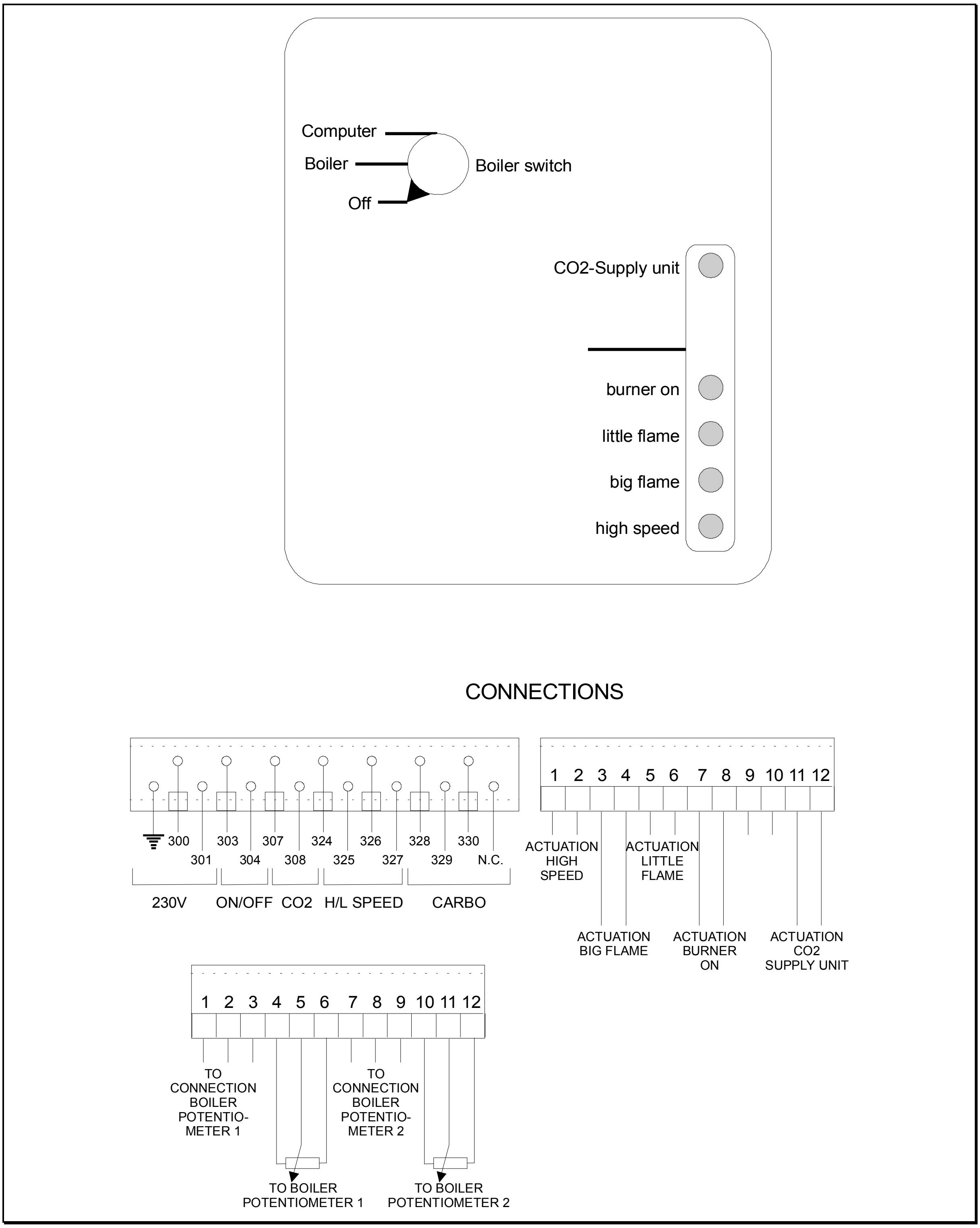
The terminal strips in the BBKs are numbered in accordance with a standard. The numbering of the terminal strips on the burner panel must match that of the BBKs. The BBKs are fitted with a switch with the options ‘Computer’, ‘Boiler’ and ‘Off’. When in the ‘Computer’ position, the boiler is controlled by the *ECONOMIC* NT system. In the ‘Boiler’ position, the *ECONOMIC* NT has no influence, and the boiler is controlled by means of its own thermostats. To provide measurements for the boiler control by the *ECONOMIC* NT system a water sensor is placed on the hottest section, the top of the boiler.
Recommendation: connect a minimum alarm thermostat. In the event of a fault in the BBK or incorrect installation, an alarm is given if the boiler temperature is too low. The contact of this thermostat can be incorporated in an external alarm circuit.

Connecting a BBK
Consult one of the four drawings.

BBK-S

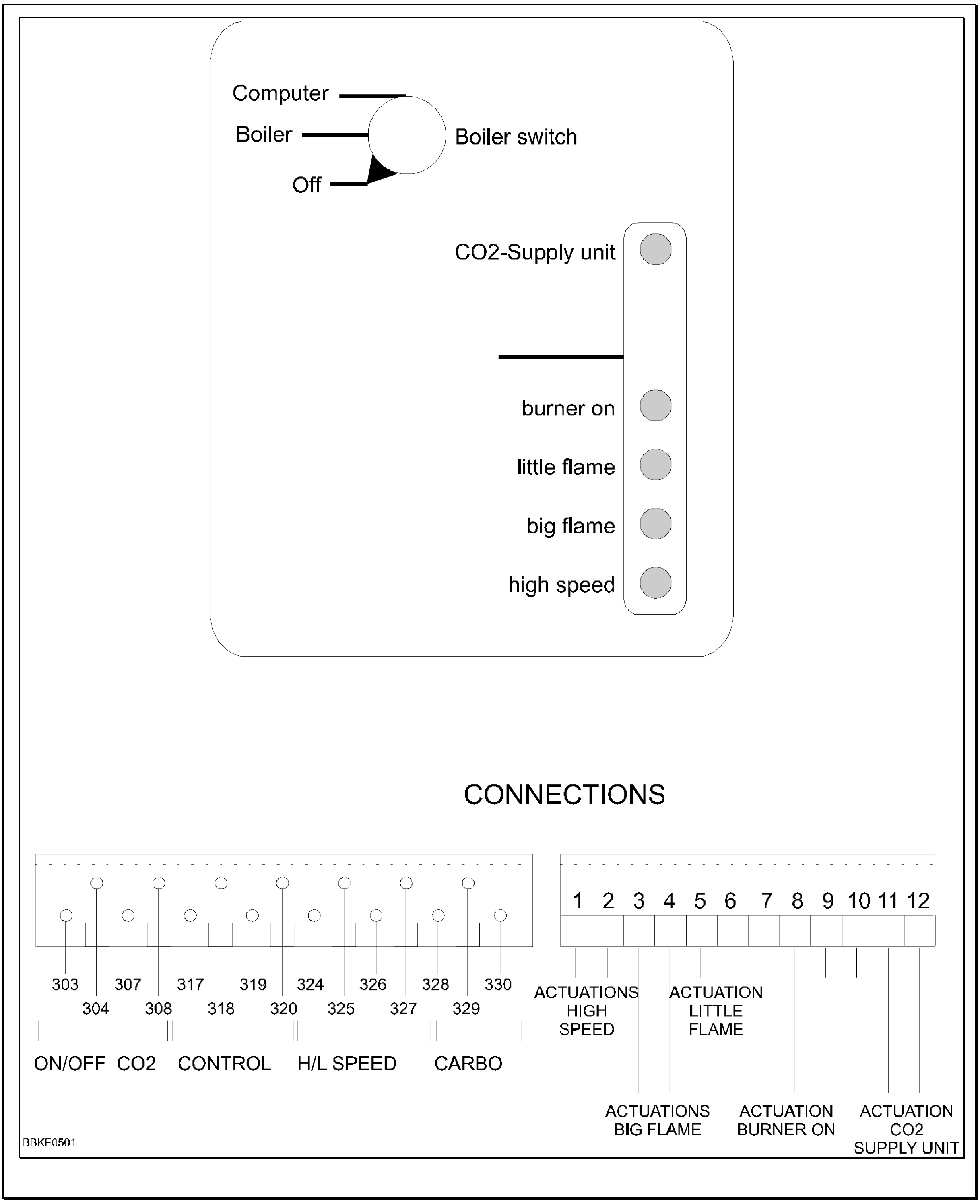


BBK-M

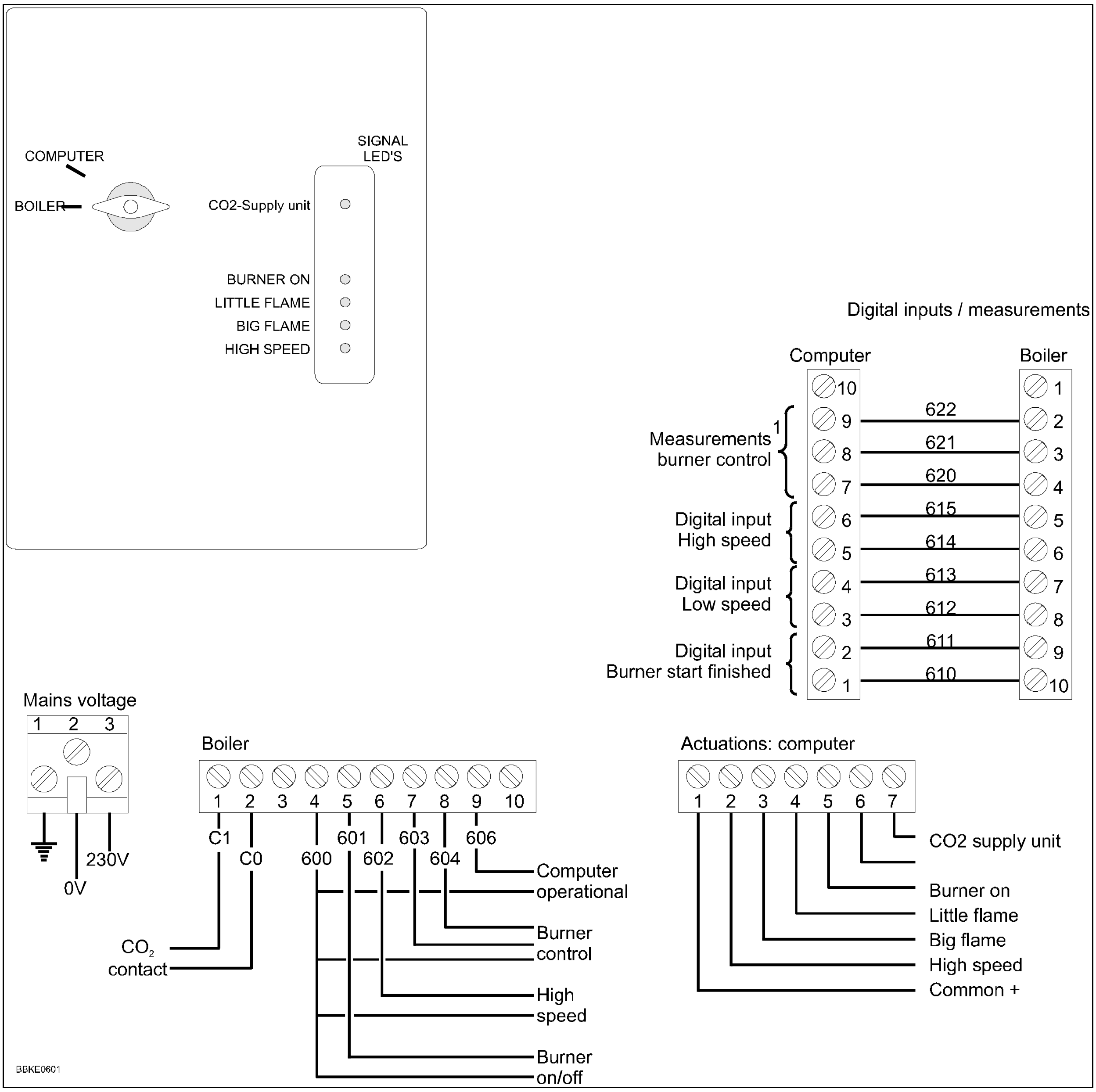


Important! Contacts 309 and 310 must led interconnected in the burner panel.

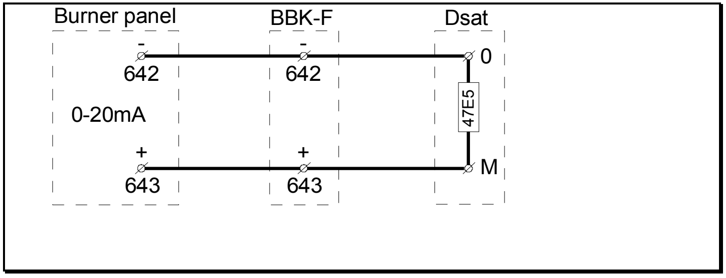
BBK-E


Computer
Boiler
Off
Boiler switch
CO2-Supply unit
burner on
little flame
big flame
high speed
CONNECTIONS
303
304
307
308
317
318
319
320
324
325
326
327
328
329
330
ON/OFF
CO2
CONTROL
H/L SPEED
CARBO
1 2 3 4 5 6 7 8 9 10 11 12
ACTUATIONS HIGH SPEED
ACTUATION LITTLE FLAME
ACTUATIONS BIG FLAME
ACTUATION BURNER ON
ACTUATION CO2 SUPPLY UNIT
BBKE0501

BBK-F



[1]. The burner position measurement device can be in the form of a linear potentiometer (terminal 620, 621, 622) or a linear current of 0-20 mA (terminals 642 (-) and 643 (+)) on the burner panel. If terminals 642 and 643 are connected to the *ECONOMIC* NT, a 47E5 resistor must be placed over the analog input signal in the DSAT.



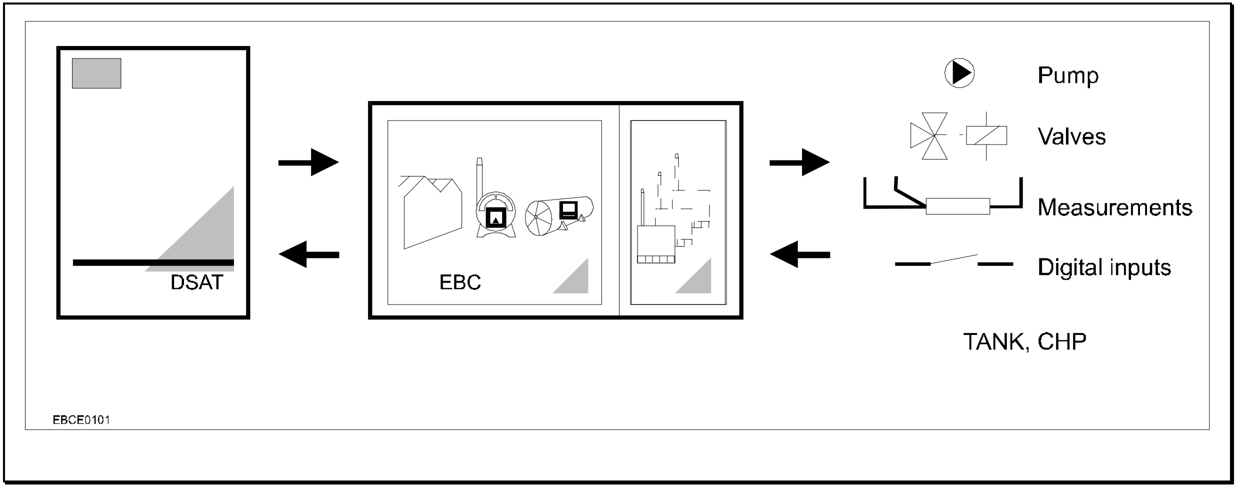
3.3 Heat storage and CHP

Heat storage
The boiler must burn in order to be able to supply CO_2. This usually occurs at times when no heat is required. When heat is required, such as at night, there is no demand for CO_2. A heat storage tank is provided to resolve this contradiction. This is a large buffer of hot water. When the boiler is operated for CO_2 production and there is no heat demand, the hot water is stored in the hot water storage tank. This tank is emptied again once there is a heat demand but no requirement for CO_2.

CHP
CHP stands for combined heat and power. A CHP system produces heat and electrical power. The heat energy is intended for the greenhouse, and the electrical power for the public grid. The heat storage tank is used in CHP systems to balance out the conflicting requirements of heat demand and electricity demand.

Installation instructions
In a heat storage tank the water temperature sensors must be placed in immersed tubes. This makes it possible to replace defective water sensors without major consequences (draining the tank).
The water sensors (4 or 9 units) must be mounted throughout the storage tank such that every temperature measurement relates to the same quantity of water.

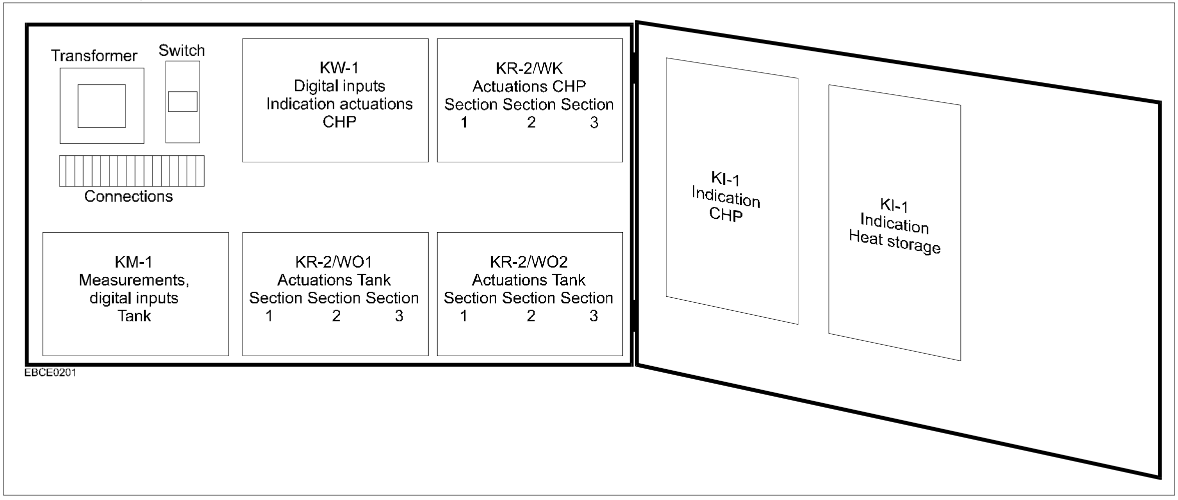
Connecting an EBC



DSAT, EBC, tank, CHP block diagram

The Energy Control Centre (known by its Dutch abbreviation EBC) is the interface between the DSAT of the *ECONOMIC* NT system and the heat storage tank (and CHP).
All the actuation and measurement systems relating to the heat storage tank are connected and adjusted in the EBC. A general mimetic diagram which indicates the relationship between the boiler, heat storage tank and heat transfer to and from the greenhouse is mounted on the front of the EBC. This diagram represents the computer actuations of the valves and pumps using LEDs. The nomenclature used on the diagram for the valves is standardised.

The EBC can be expanded to include a CHP module.
The box then incorporates a few more boards, and the right front panel of the door is replaced by the CHP front panel.



Breakdown of EBC, version incorporating heat storage and CHP

The properties and connections of the KR, KM, KW and KI boards are explained below for the individual boards.

KR board

There are 2 or 3 KR boards in an EBC:

KR-2/WO1	(heat storage KR board no. 1)
KR-2/WO2	(heat storage KR board no. 2)
KR-2/WK	(CHP KR board no. 3)

There are three equal sections on the KR board. One or two actuators can be connected to each section. The switches enable you to choose between the following for each section: Automatic, Actuator 1, Off and Actuator 2.

KR board measuring points and connections

	Connection actuations:		Connection valve/pump/CHP:		Position of switches
KR-2/WO1					
Section 1	1 2 3 4 5 - - + - + - C C O O	Actuation emptying valve	1 2 3 Z C O	Emptying valve	aut - close - off - open
Section 2	- - + - + - C C O O	Actuation boiler closing valve	1 2 3 Z C O	Boiler closing valve	aut - close - off - open
Section 3	- - + - + - C C O O	Actuation filling valve	1 2 3 Z C O	Filling valve	aut - close - off - open
KR-2/WO2					
Section 1	1 2 3 4 5 - - + - + - A A	Actuation filling pump	1 2 3 N A	Filling pump	aut - - - off - on
Section 1	- - + - + - H H L L	Actuation filling pump with low/high speed	1 2 3 N H L	Filling pump with low/high speed	aut - high - off - low
Section 2	- - + - + - C C O O	Actuation tank closing valve	1 2 3 N C O	Tank closing valve	aut - close - off - open
Section 3 (CHP)	- - + - + - Ta Ta Tu Tu	Actuation switch valve	1 2 3 N Ta Tu	Switch valve	aut - tank - off - tube
KR-2/WK					
Section 1	1 2 3 4 5 - - + - + - A A	Actuation CHP 1	1 2 3 N A	CHP 1 (*)	aut - on - off - (**)
Section 2	- - + - + - A A	Actuation CHP 2	1 2 3 N A	CHP 2 (*)	aut - on - off - (**)
Section 3	- - + - + - A A	Actuation CHP 3	1 2 3 N A	CHP 3 (*)	aut - on - off - (**)

(*) Connect to EBC connection terminals.
(**) 3-position switch.

- ∆ One or two relays and the test phase (general minimum) must be connected for each section. The test phase must come from the same DSAT as the actuator(s).
- ∆ Manual mode is only possible if the relays and (-) are connected and the DSAT is on.
- ∆ There are two filling pump variants: ‘On’ actuation or ‘High/low speed’ actuation. This, of course, depends on the type of pump.
- ∆ Depending on the valve type, a 24 volt ac or 230 volt ac output signal can be selected. This selection can be made for each section using the two block-like connectors. Both connectors, the supply and the dummy versions, must always be connected.
  In the case of a 380 / 400 V filling pump the computer actuation must be connected via the EBC to an external switchgear cabinet which actuates the filling pump.
- ∆ The earth wires of the valves and pump must be connected directly (not via the KR board) to the central earth terminals in the EBC.
- ∆ In an EBC system incorporating the heat storage option, the space above the KR-2/WO1 and KR-2/WO2 which is situated next to the installation unit, must remain empty. If the system is expanded to include CHP, this space will house two extra boards.

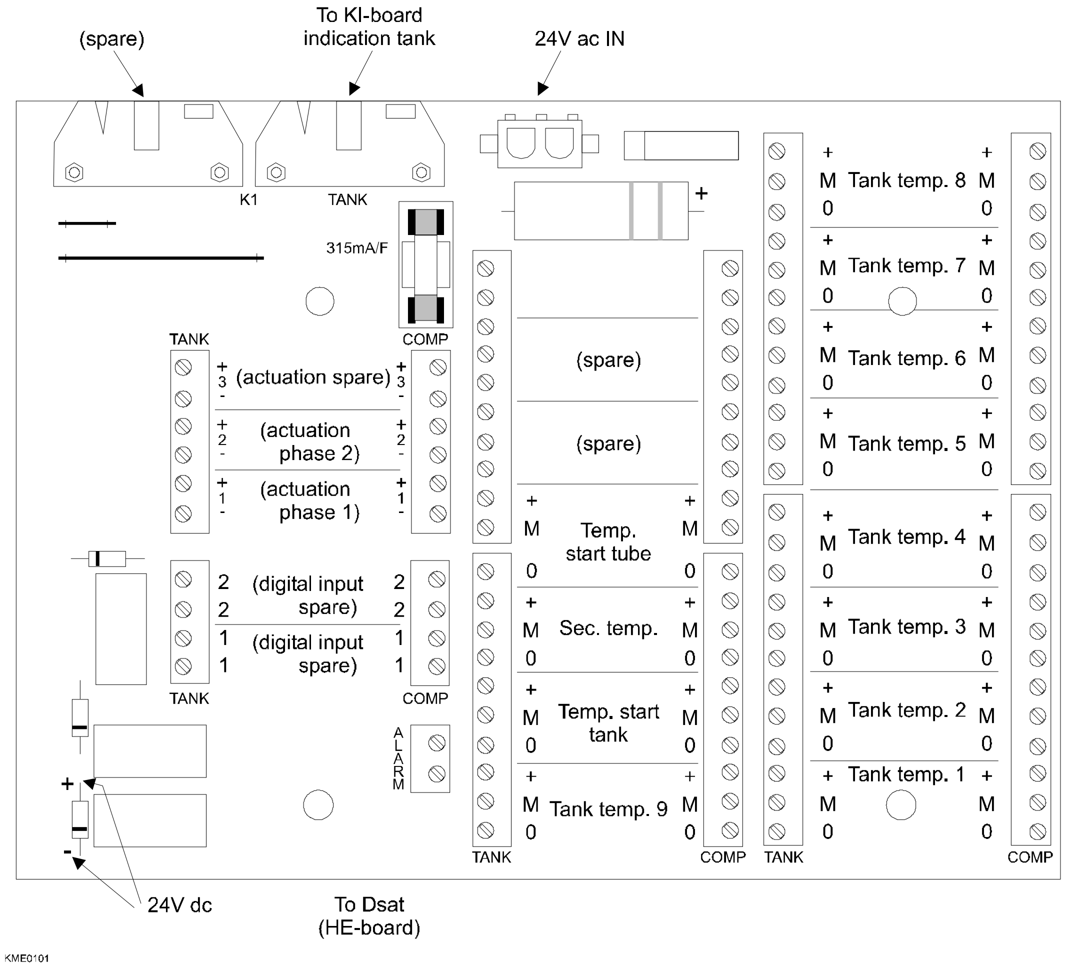
KM board

The KM board has various functions:

Δ It indicates the presence of the EBC supply.
Δ It indicates phase actuations.
Δ All measurements relating to the tank are centrally connected.
Δ Connection of the alarm contact for the external alarm circuit.

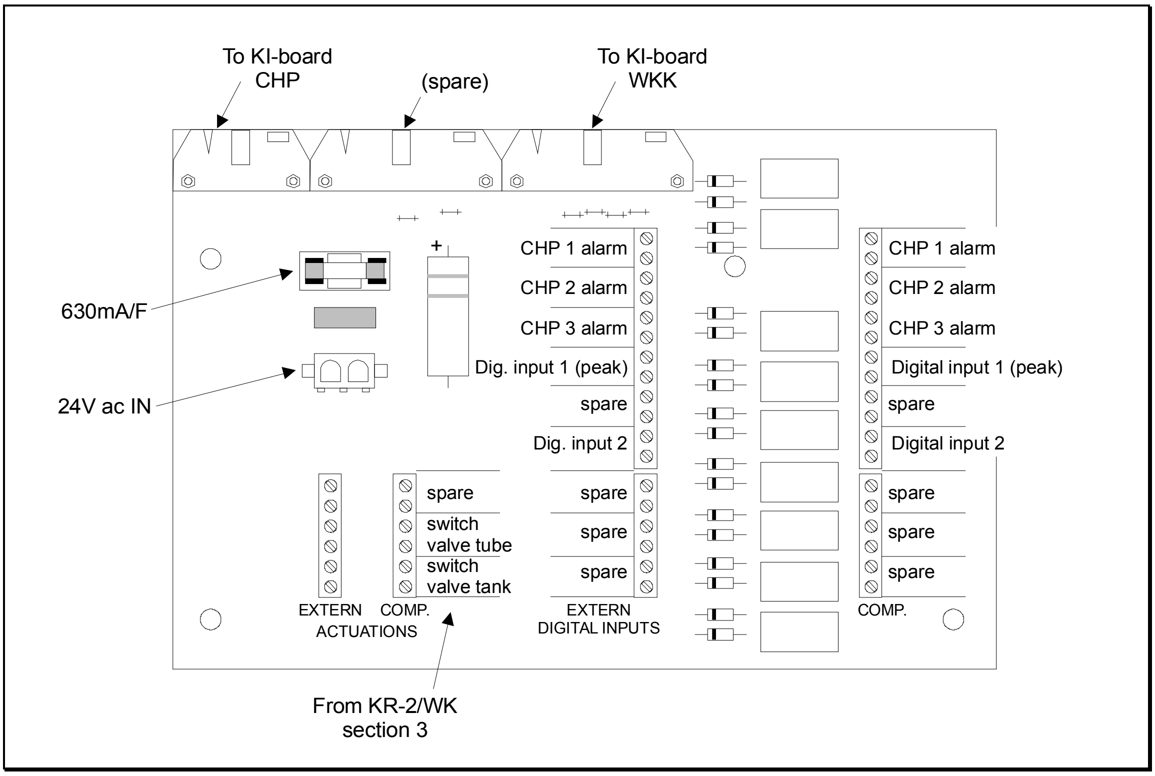
The KM board has to be connected as follows:

KM board connection



KW board

The KW board enables detection and actuation equipment relating to a CHP system to be represented.

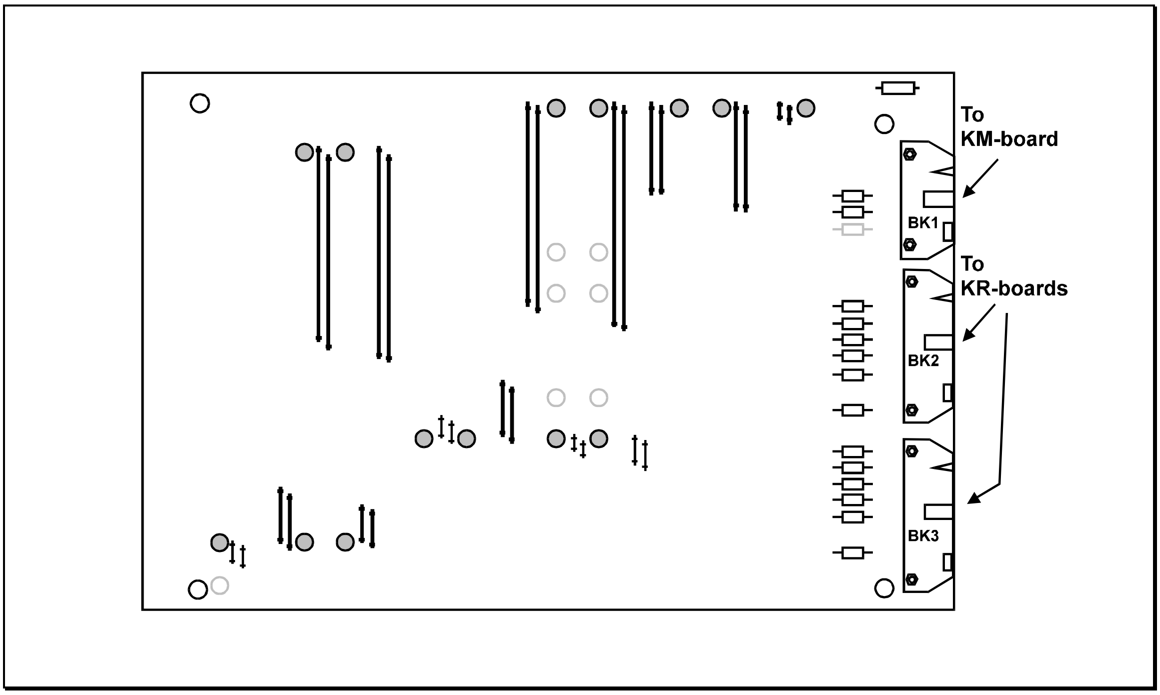


KW board connections

KI board

There are two KI board versions:

1. Tank
2. CHP



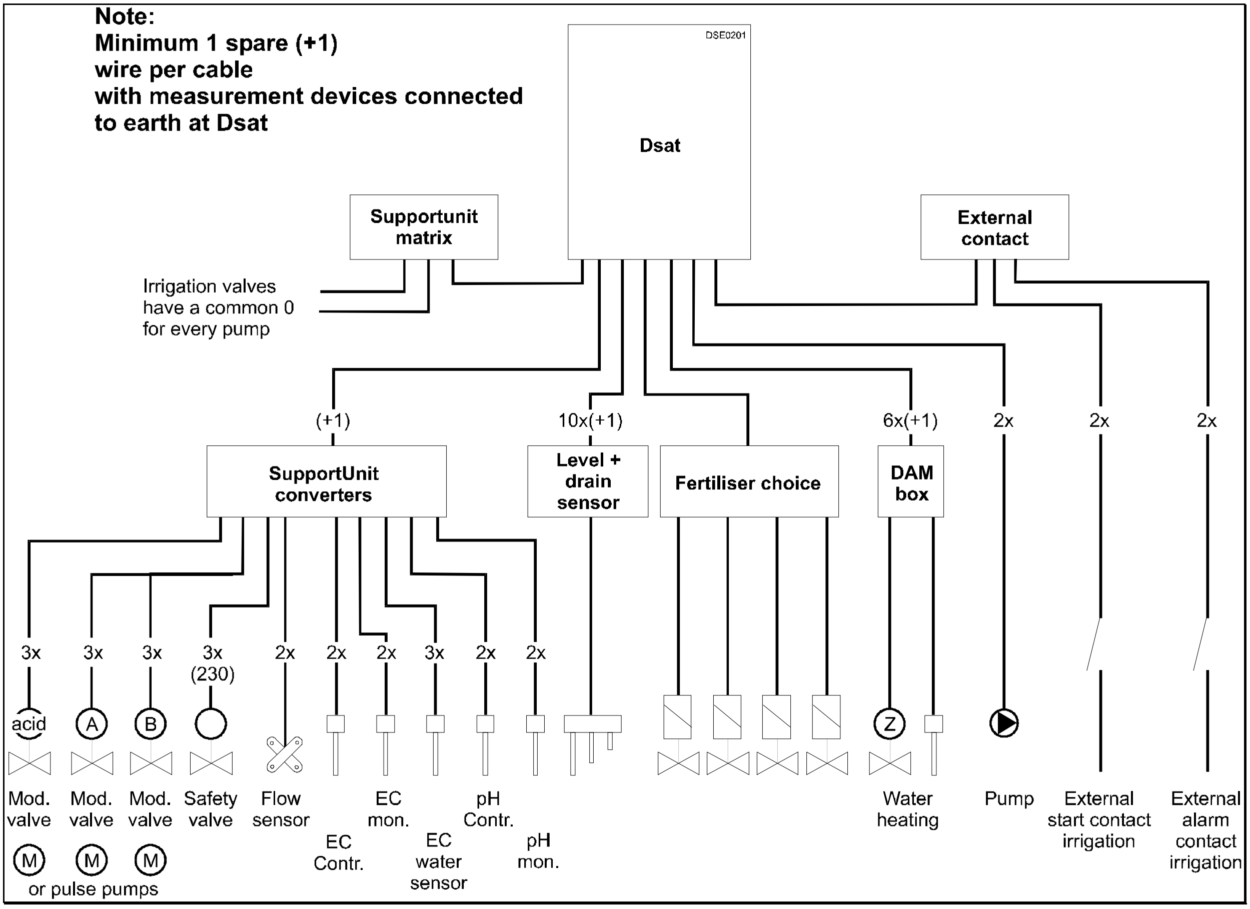
The KI boards are mounted in the door of the EBC and provide the LED indicators on the front panel. They are connected to the KR and KM boards via ribbon cables.

KI board connections

4. Watering

4.1 Overview of water control, use of minimum number of cores per cable

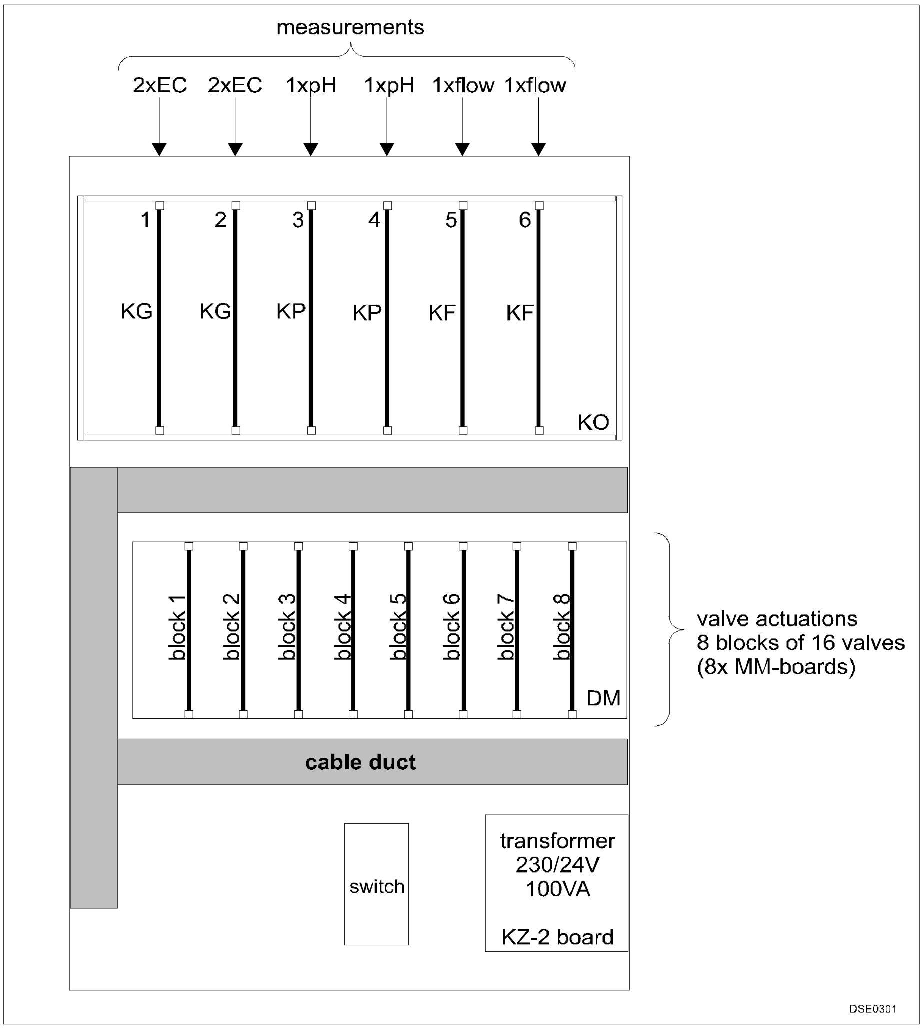
Overview of water control, use of minimum number of cores on DSAT

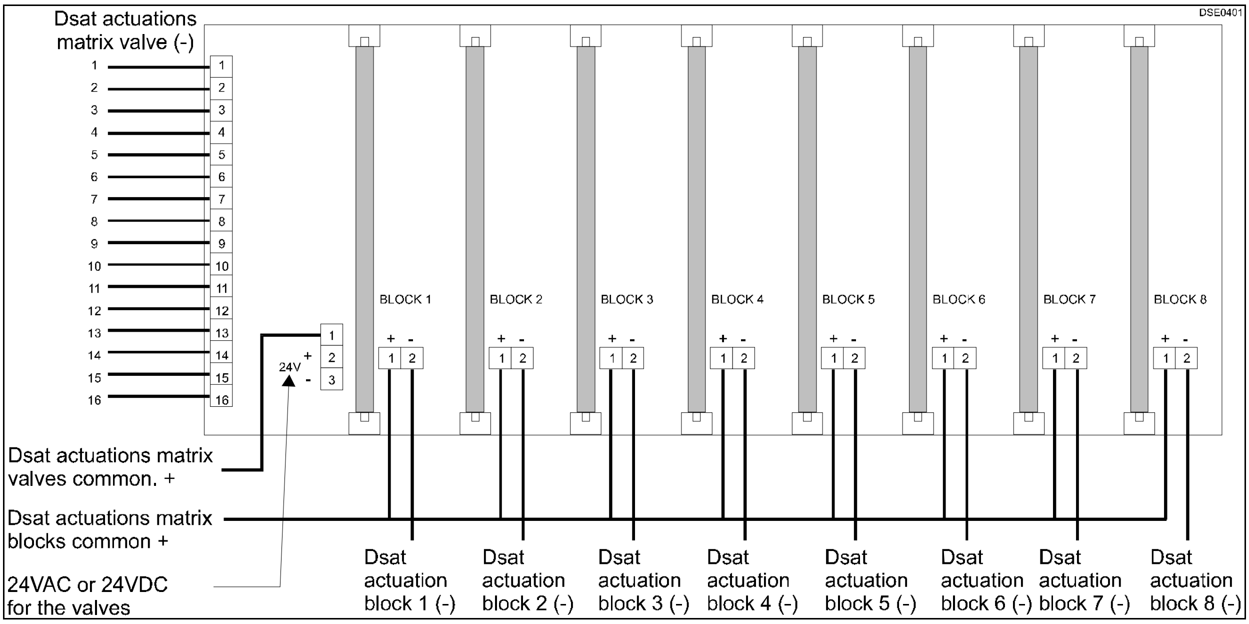


4.2 *ECONOMIC* NT SupportUnit

The *ECONOMIC* NT SupportUnit is a box in which sprinkling valves and EC, pH and flow sensors are connected. The SupportUnit is the switch between the DSAT and the sensors / valves. The drawing below shows how the SupportUnit box is made up. The following pages of this manual give information on connection data, installation instructions and monitoring of measurements for each board and type of sensor.

SupportUnit installation instructions
Lay the cables from the sensors, the converter boards (to the DSAT) and valve actuators (from the DSAT) in the cable duct. Connect cables from the matrix to the valves outside the cable duct.

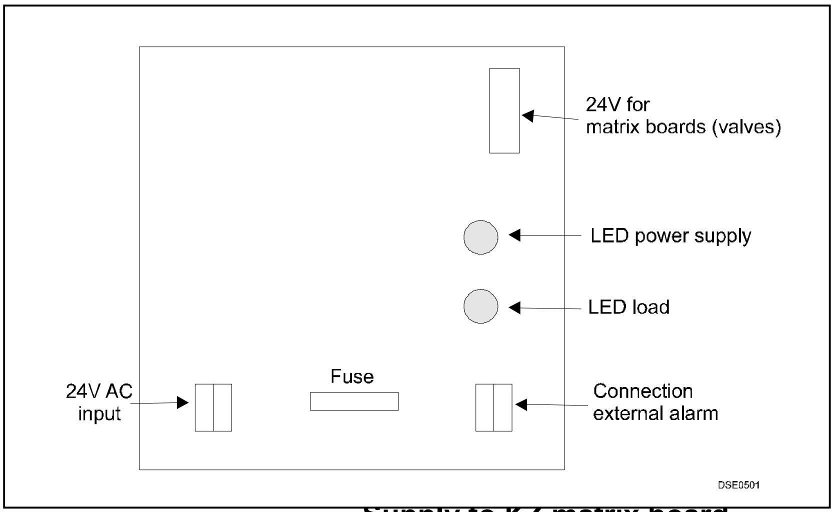




4.2.1Valves (matrix rack)

The matrix rack is used to actuate the valves for sprinkling, substrate or ebb and flow. The idea of the matrix principle is to actuate more valves with fewer actuations.
The supply for the valve actuators is provided by a transformer in the SupportUnit. This supply can be 24 V dc or 24 V ac. This is determined by the type of KZ board. Thus, the supply for the valves does **not** come from the DSAT. This prevents any interference voltages from the valves interfering with the DSAT.

Connection
The DSAT actuators of the valves and blocks are connected as per the above drawing. Sixteen valves can be connected to the cards in the rack (terminals 1 to 16), while the neutral of the valves is connected to the last two terminals (17+18).



Supply to KZ matrix board

Supply to KZ matrix board

Monitoring
Connect the actuators to the external 24 V of the DSAT. There are two LEDs on the KZ board. The power supply LED lights up if the 24 volt (ac or dc) supply is present. The load LED lights up if a valve is energised. If this LED is not lit up, therefore, the valve is not energised.

4.2.1 Converter board for EC, pH, flow

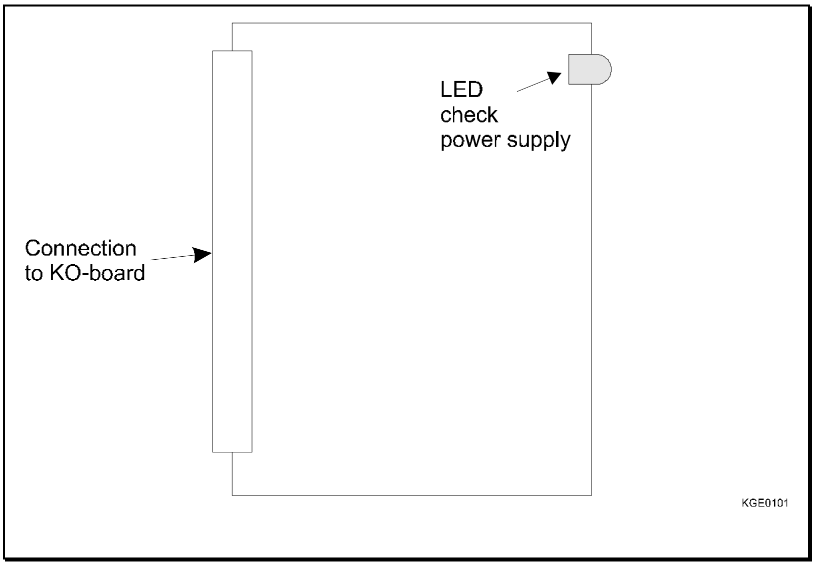
The EC, pH and flow sensors are connected in the SupportUnit (converter box). The measurement signals are adjusted by three converter boards:

- ∆ KG board for 2 EC sensors
- ∆ KP board for 1 pH sensor
- ∆ KF board for 1 flow sensor

These 3 boards are connected to the converter bus board (KO) using a plug-in system (comparable to the matrix relay cards). The sensors are connected to the KO board as an input signal. The adjusted measurement signals, or the outputs of the KO board, are connected to the DSAT.

KG board for EC

One KG board can be used for two EC sensors.



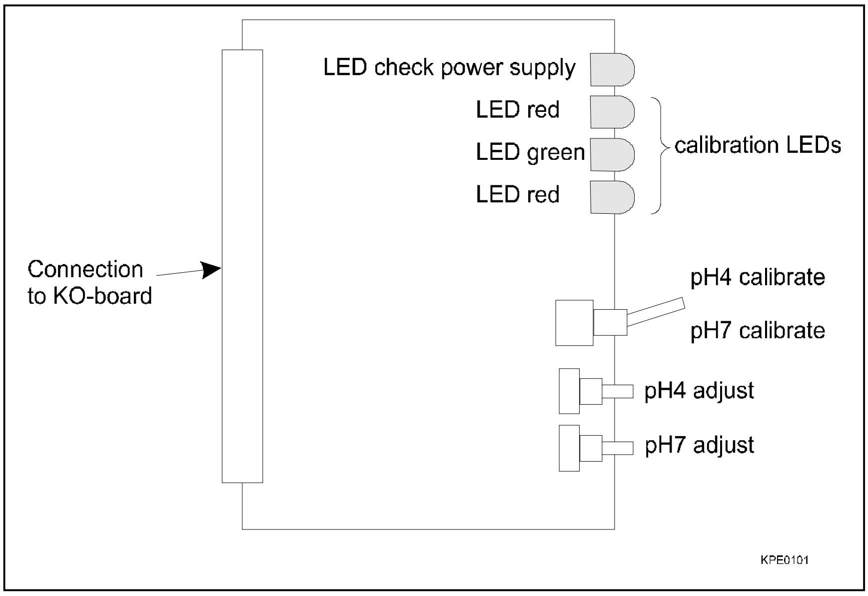
Two types of this KG board are available:

- Standard for the HH EC measuring cell
- Modified for the EC measuring tube

The latter has 5 resistors more than the former. The two KG board versions are not interchangeable.

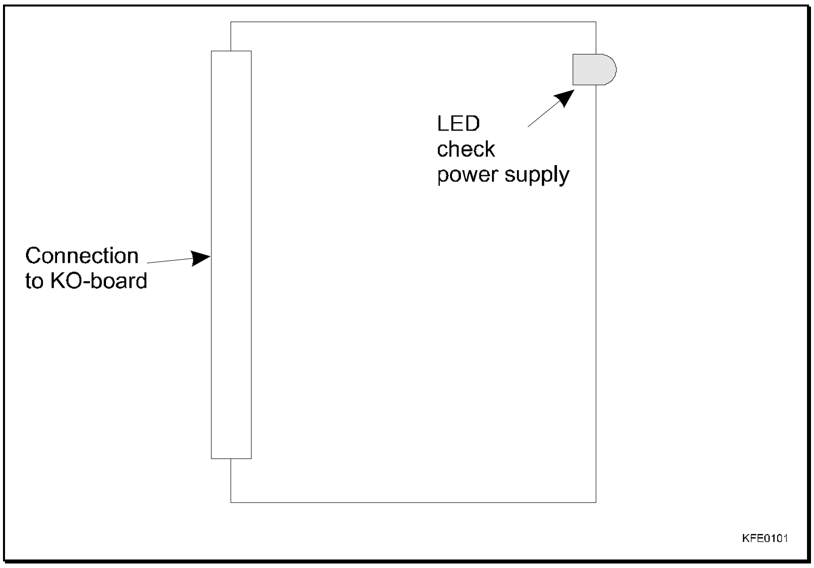
KP board for pH

One pH sensor can be used with each KP board.



The functions of this board are: to amplify the measurement signal, to calibrate the pH sensor and provide metallic isolation between the sensor and earth.

KF board for flow sensor

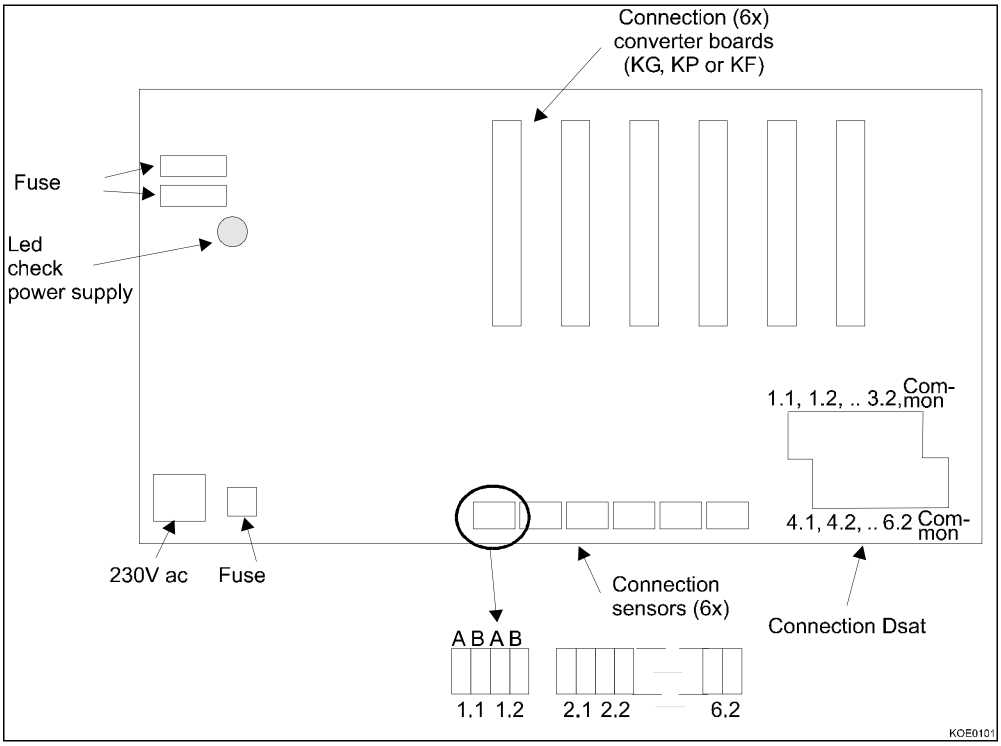


One flow sensor can be used with each KF board.

KO converter bus board

Six converter boards can be plugged into the converter bus board (KO). The 2nd function of the KO board relates to the power supply to the converters.

The KP board (for pH measurement) must always be located in slot 3 and/or 4. The KG and KF boards can be located in any of slots 1, 2, 5 or 6.

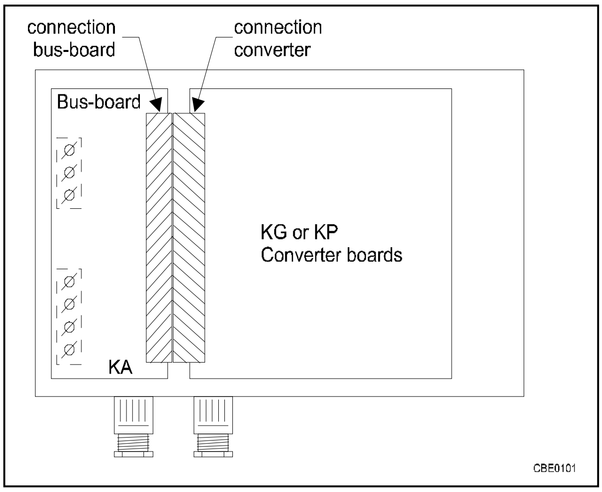


Connecting the sensors to the KO board and the DSAT connections are explained in the following paragraphs for each sensor type.

4.3 Converter box

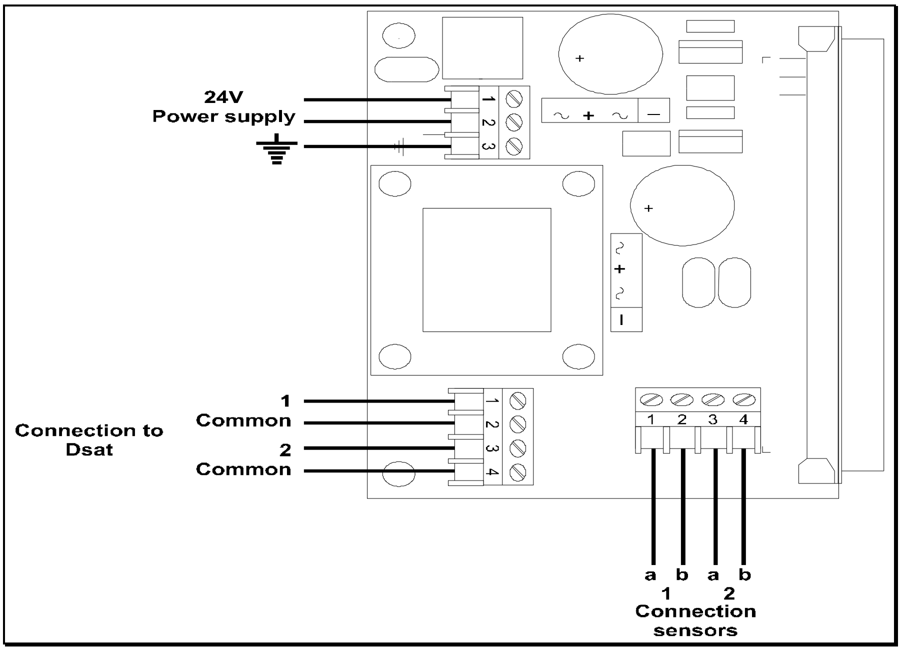
4.3.1 EC, pH

The application for registering and reusing drainage water does not use a complete SupportUnit but rather a converter box with one converter board (EC or pH). The connections of the sensor and DSAT are then on the KA bus board. This bus board uses a 24 V ac power supply. This voltage is available in the DSAT (a maximum of 3 KA boards can be connected). An external 24 V ac transformer can, of course, also be used.



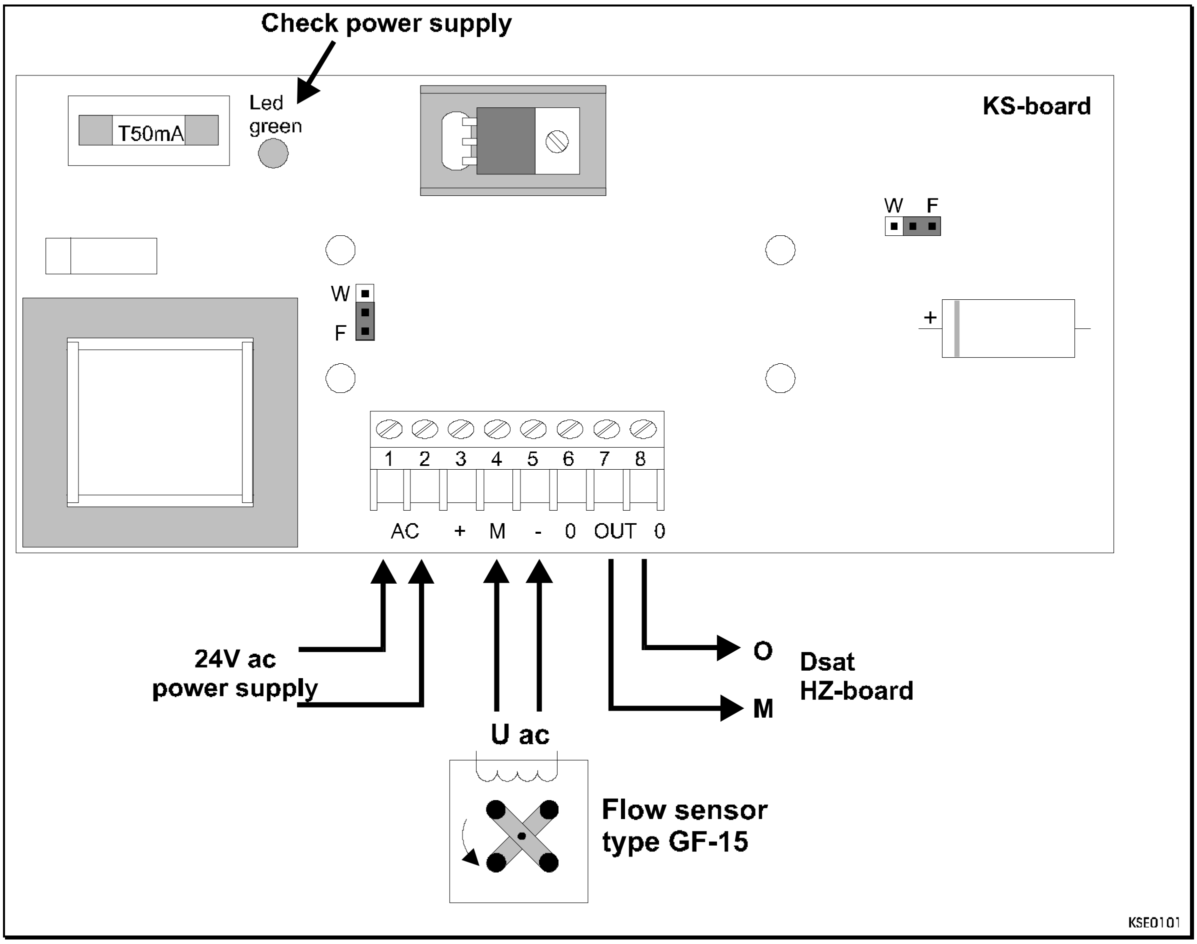
Converter board

One pH sensor can be connected to one pH converter board. Two EC sensors are possible with one EC converter board.



KA board connections

4.3.2 Flow



The KS board is used to connect a flow sensor without a SupportUnit.

Note: Both jumpers must be in the ‘F’ position.

4.4 EC sensors

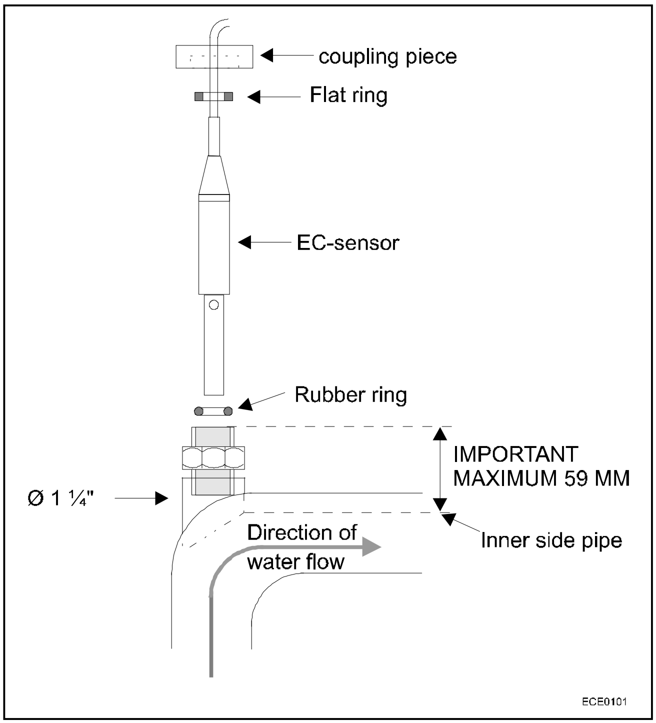
4.4.1 Yokogawa

The EC sensor is a conductivity cell. At least two EC sensors are present in the watering unit as standard, i.e. the control sensor and the monitoring sensor.
The EC sensor is connected in the SupportUnit. The converted measurement signal (KG board output) is a voltage which varies from 0 to 4 volts at an EC of 0 to 10 mS. The EC sensor is installed on the water side with a specially made metal fitting.

Installation instructions:

∆ The EC sensor cables must **NOT** be lengthened or shortened. The position of the SupportUnit must be chosen such that the cable length is sufficient.

∆ The EC sensor must be installed against the water's direction of flow (see drawing). The hole in the side of the EC sensor must be located in the direction of flow of the water.

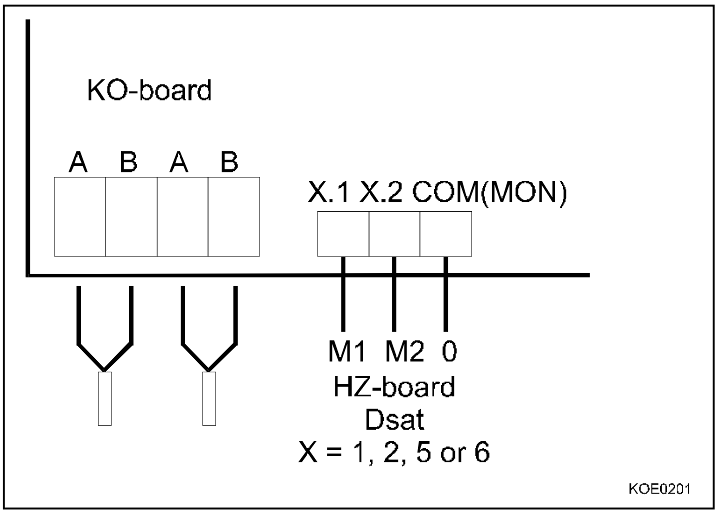


Connection:

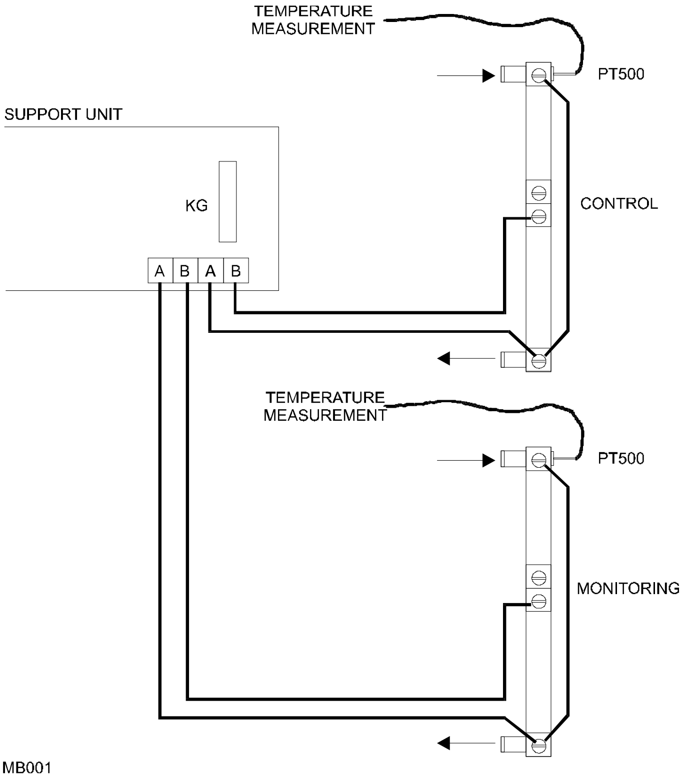
The EC sensor is connected to the KO board in the SupportUnit as per the drawing below. The KO board output (a voltage of 0 to 4 volts at an EC of 0 to 10 mS) is connected to the HZ board in the DSAT.

Type of measurement device:
Type of measurement device (jumper on HA board, see previous chapter, para. 6.3) for the EC sensor:
standard type

Monitoring:
The EC measurement signal converted in the SupportUnit varies from 0 to 4 V at an EC of up to 10mS. This voltage can be monitored by measuring it at the HZ connection terminals in the DSAT.



4.4.2 Connecting EC measuring tubes



MB001

To prevent measurement differences, both tubes must be connected in the same way (i.e. with the ends of the tube connected to the A terminal of the SupportUnit).

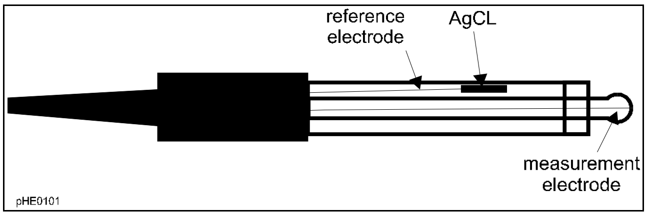
4.4.3 Adjustment of EC measurement

The KG-2 boards used for the EC measuring tube are adjusted to the nominal cell constant of these (blue Indal) measuring tubes. In practice, however, other measuring tubes with slightly different cell constants can also be found (Brinkman, Priva).
These can be adjusted by specifying 2 points in the measurement characteristic. To do so, water with a low (and constant) EC value must first be passed through the unit while this EC value is measured with a calibrated hand-held meter. This point must be specified in the measurement characteristic.
Then water with a high EC value must be passed through the unit while the above procedure is repeated. Please refer to the relevant Help screens for precise details of the settings involved.

4.5 pH sensor

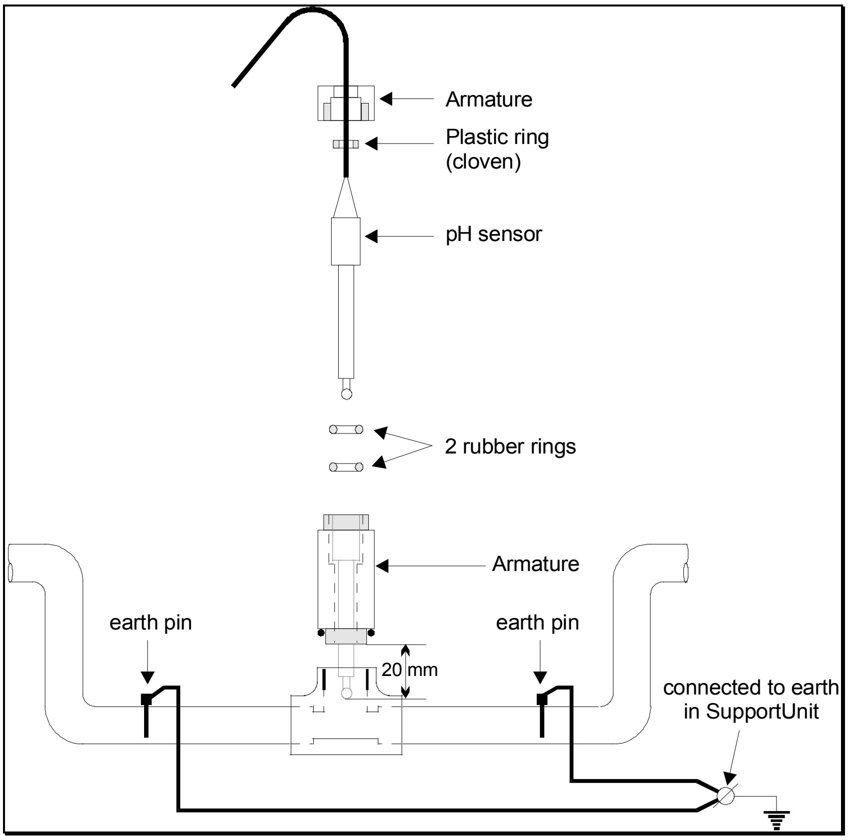
The pH sensor measures the acidity of the water. It is made of glass. The sensor contains two electrodes, a measuring electrode and a reference electrode. The pH measurement is based on the occurrence of a voltage differential between the two electrodes corresponding to the pH value of the liquid to be measured. The measurement signal is connected to a converter board in the SupportUnit. The pH sensor is installed on the water side with a specially made plastic fitting.
It is calibrated using pH4 and pH7 calibration solutions (calibration procedure: see *ECONOMIC* NT manual). This calibration procedure has to be regularly repeated since the calibration of the pH sensor gradually fades. The sensor is regarded as worn-out when calibration can no longer be carried out successfully. A worn-out pH sensor cannot be repaired. The average lifetime of a pH sensor is 1.5 to 2 years. A pH sensor's service life depends on:

- ∆ contamination of sensor (maintenance)
- ∆ composition of the liquid to be measured
- ∆ clarity of the liquid



pH sensor

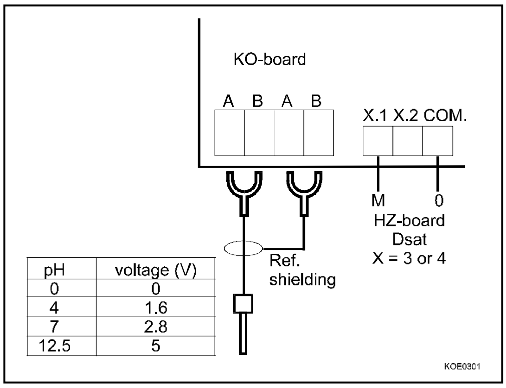
Installation instructions:



- ∆ The tip of the pH electrode must always be immersed in water. It is therefore necessary to install it in a U-shaped pipe (see drawing).
- ∆ Mount in a bypass.
- ∆ Avoid vibrations.
- ∆ Maximum pressure: 10 [atm]
- ∆ Maximum flow rate: 1 [m/sec] (in a pipe with a diameter of 25 mm)
- ∆ An earthing point must be mounted in the bypass line before and after the pH sensor.

Note: The lifetime of pH sensors is substantially reduced if the mains power supply of the SupportUnit with pH converter boards is of poor quality. By this is meant a mains power supply with brief peaks and troughs. This can be improved by using a voltage stabiliser.

Connection:
The pH sensor is connected to the KO board in the SupportUnit as per the drawing below. The KO board output is connected to the HZ board in the DSAT.



pH	voltage (V)
0	0
4	1.6
7	2.8
12.5	5

Type of measurement device:
Type of measurement device (jumper on HA board, see previous chapter, para. 6.3) for the pH sensor: standard type

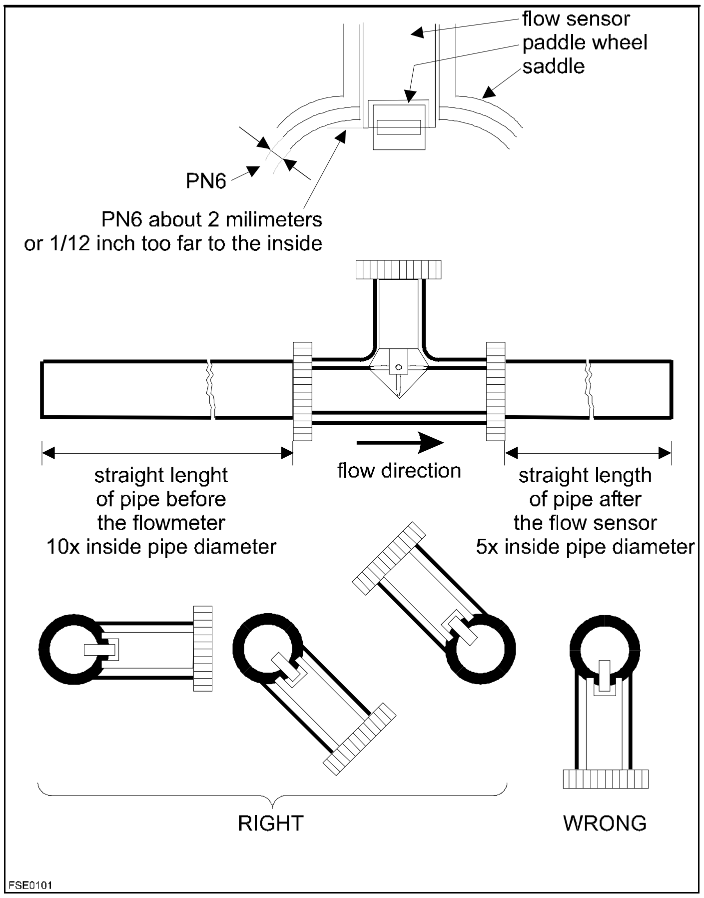
Monitoring:
The converted measurement signal (KP board output) can be monitored by measuring the voltage between 0 and M (HZ board on the DSAT) with a multimeter and comparing it with the table. To do so, use the pH4 and pH7 calibration solutions.

4.6 Flow sensor

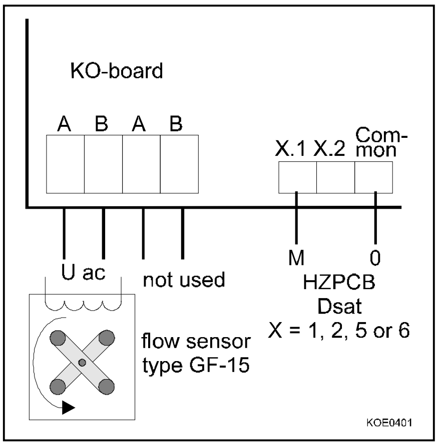
Water is pumped through the pipes. GF15 flow sensors (from George Fisher) are used to enable the relevant volumes to be measured.
The flow sensor outputs an alternating current whose frequency is the measurement signal. The flow sensor is connected to the KO print in the SupportUnit. The converted measurement signal (KF board output) is a direct current.

Installation instructions:

1. The flow sensor must be mounted in a type PN16 pipe. The use of a PN6 pipe, whether or not in combination with spacer rings, results in inaccurate readings. If the installation uses PN6 pipes, a piece of PN16 pipe must be added to this line as an alternative.
2. In the case of pipes with an external diameter of up to 63 mm inclusive, the flow sensor must be mounted with a T-piece. With larger diameters a saddle piece is used.
3. It is unnecessary to use spacer rings or similar with PN16 pipes.
4. Upstream of the flow sensor the pipe length must be at least 10x the inside diameter of the pipe. Downstream of the flow sensor the pipe length must be at least 5x the inside diameter of the pipe.
5. The flow sensor must be mounted in the pipe at an angle of 45 degrees or more (to combat air bubbles). See drawing.
6. The pipe data (outside and inside diameters) must be established before installation. These data are important for setting up the flow meter (once everything is bonded together, it is no longer possible to obtain these data).
7. The pipe diameter at the flow sensor must be chosen such that the flow rate of the water is greater than 1 m/s but less than 5 m/s. Consult the flow sensor documentation in this regard.



Connection:
The flow sensor is connected to the KO board in the SupportUnit as per the drawing below. The KO board output is connected to the HZ board in the DSAT. The KO board output (a direct current of 0 to 5 volts depending on the flow) is connected to the HZ board in the DSAT.



Type of measurement device:
Type of measurement device (jumper on HA board, see previous chapter, para. 6.3) for the flow sensor:
standard type

Monitoring:
The converted measurement signal (KF board output) can be monitored by measuring the voltage between 0 and M (HZ board on the DSAT) with a multimeter. This voltage varies between 0 and 5 volts depending on the flow.

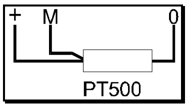
4.7 Water temperature sensor

The water temperature is measured with a water sensor which is mounted in the watering unit. This measurement is used, among other things, to enable the EC measurement to be corrected, as this is a function of the water temperature.

Installation instructions:
The water sensor is positioned such that it measures the temperature of the water that also flows past the EC sensor(s).

Versions:
There are two versions in use: a standard version with a 1/2" thread for use in systems with a Yokogawa sensor, and a version with an M8 thread for use in systems with EC measuring tubes.
When EC measuring tubes are used, the standard NTC sensor is removed from the EC measuring tube and replaced by the PT500 with an M8 screw thread. There is, therefore, no need for sawing and bonding!

Connection
A water sensor is connected to the HZ board in the DSAT. The cable used is a 4x0.8 with one spare core connected to earth in the DSAT. A multicore 0.8 cable with a few more measurement devices can, of course, also be used.



Type of measurement device
Type of measurement device (jumper on HA board, see previous chapter, para. 6.3) for a water sensor: PT500

Monitoring connections
The connections of the water sensors can be monitored by measuring the voltage at the connection terminals in the DSAT (HZ board) (see para.6.3 from the previous chapter).

4.8 External contacts

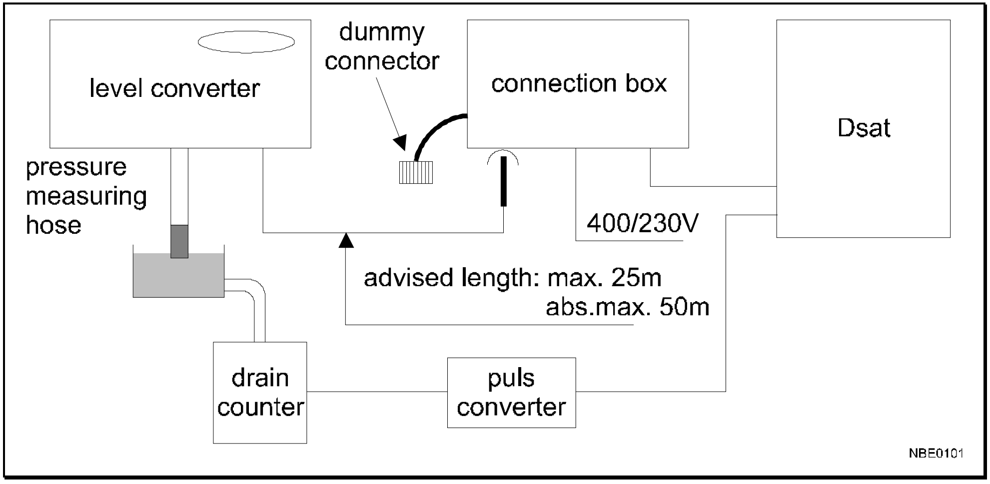
An external contact is a detection device for the *ECONOMIC* NT. For example, watering can be initiated with an external contact (Normally Open).

Connection:
An external contact is connected as a detection device to the HY board in the DSAT. Consult para. 6.4 in the previous chapter.

Installation instructions:
External contacts, connected at the DSAT, must be ‘clean’, i.e. metallically isolated, de-energised and non-earthed.

4.9 Level tray and drain counter

The figure below schematically represents the level sensor system as a whole (including the drainage sensor device):



Note: The signals from the drainage sensor system are added to the level sensor signals in one (12-core) cable. This covers both the level converter to the connection box section and the connection box to the DSAT section.

4.9.1 Level sensor

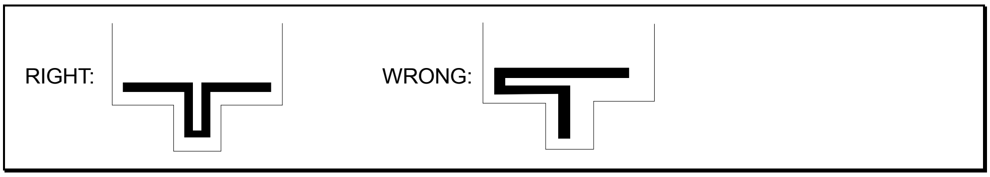
The water level in the level tray is measured with a pressure sensor. The pressure sensor is connected to the GP board (level converter). The GP board output signal varies from 1 to 2.5 V at a water level of 0 to 7.5 cm.

Level sensor installation instructions:

1. The level tray must be positioned such that it gives an average, representative picture of the plants in the level tray with reference to the entire valve section. For this reason, do not position the level tray directly beside a path or a gable wall.

2. The level tray must be positioned such that it is precisely horizontal in both a longitudinal and a transverse plane.

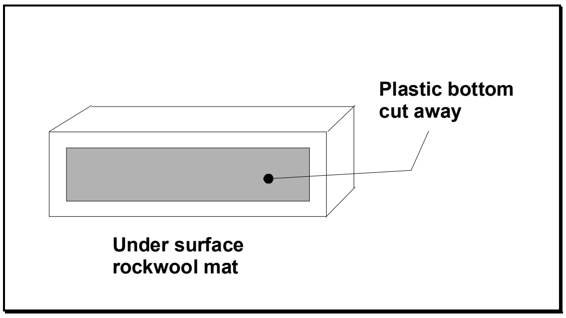
3. The absorbent mat (irrigation mat) must be laid in the level tray with the plastic layer on the underside as follows:



Lay the absorbent mat in the tray a little distance from the measurement station so that no roots can grow into the measurement station.

4. We recommend a ‘Hoogendoorn-type’ absorbent mat. There are commercially available types which cannot be guaranteed to work well in the level tray.
   When placing your order, please specify the bag dimensions (200x16, 200x21, 200x35 or 225x16).
   If a different absorbent mat is used, there will certainly be problems (for example, with too little drainage, inaccurate registration of water absorption and therefore incorrect operation of Agronaut).

5. The entire underside of the rockwool mat cover must be opened up so that the substrate mat and the absorbent mat are in contact with each other.



6. A hose with a T-piece must be connected to the discharge valve (pressure compensation).

7. The level converter should not be exposed to direct sunlight.
   For this purpose, the level tray is supplied with a cover with stainless steel nuts and bolts. Only these stainless steel materials should be used.

8. The maximum distance between the level tray and the level connection box is 50 metres. Hoogendoorn recommends maintaining a maximum of 25 metres to ensure that measurements are as stable as possible. The cable between the level tray and level connection box must be of a flexible type with 12 cores, e.g. Jobarco flex C. This cable is connected to the drain counter and level converter on the level tray side and is soldered to a supplied 12-pin connector on the side of the level connection box. This cable may not contain any joints.

9. If the level converter is detached from the level connection box, the terminating connector must be fitted to the connection box. This is necessary to bridge the alarm - contact and to connect the measuring device to null.

10. The power supply to the level connection box is 220 V/230 V or 380 V/400 V with earth. This power supply must be continuously available. If a DOO or DVV is branched, therefore, no motor circuit-breaker may be used here.

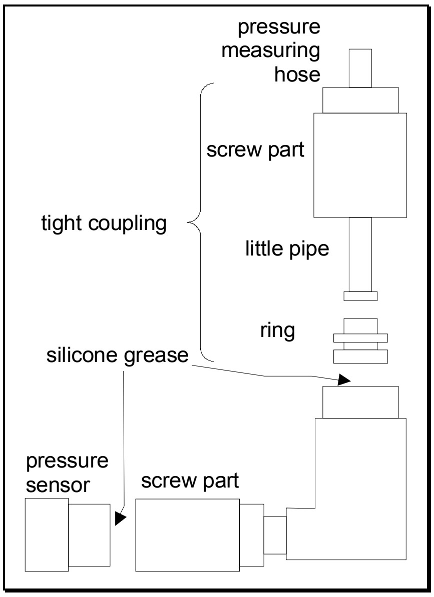
11. A 12 x 0.8 mm wall cable is recommended from the level connection box to the DSAT. Any unused cores are earthed in the DSAT.

12. The alarm for the minimum water level in the level tray by means of the alarm pin must be provided outside the computer. Use the HE board (External alarms) of the DSAT for this purpose.
    Connect the alarm contact using a timer switch to prevent false alarms. It is quite possible for the level tray to dry out deliberately for a time during the 24-hour period (e.g. overnight) because no dripping cycles occur. Do not use a switching contact in the computer but rather a separate timer switch.

13. The connection of the pressure-measuring hose to the level tray and the converter must be very accurate. It is important for these connections to be airtight, so a little silicone grease should be used.

    A plastic bored-out elbow piece is used for the connection to the converter.

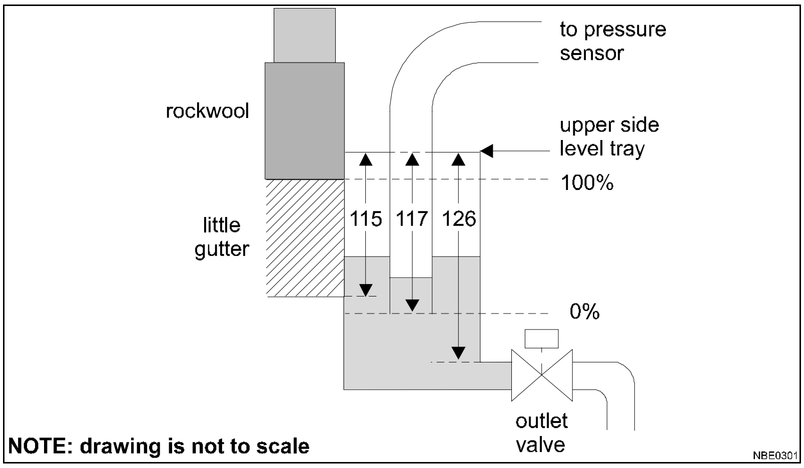
    Connection to the level tray is by means of an interference-fit joint which may only be used once. This is because the ring and the pipe are deformed during the tightening process (it is not sufficient to tighten the joint manually, a spanner must be used!).



    Slide the screw part over the hose, then insert the pipe into the hose and, finally, slide the ring over the hose. Then press the ring with the pipe a little way into the screw part.

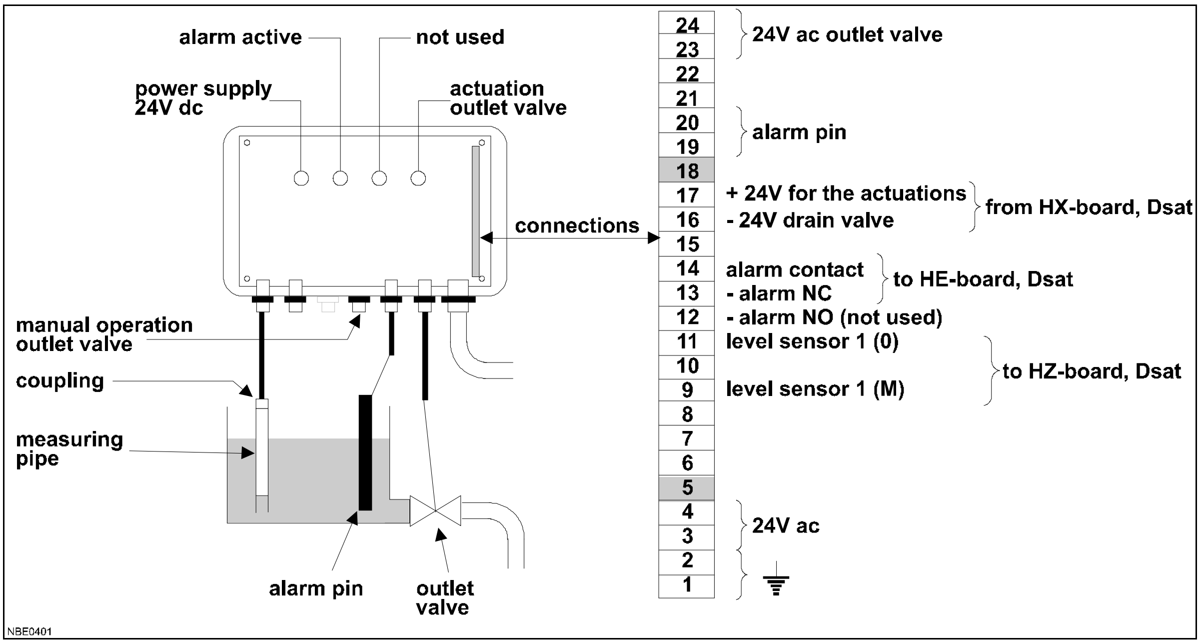
    Take care that the pipe does not move from its position in the hose. Then screw the screw part onto the level tray nipple. Lead then the hose to the level tray without having water in the level tray.

14. The level tray can only work properly if the following dimensions are achieved in the system itself:



Connection of the level sensor:

The drawing shows the connections for the GP board.



Type of measurement device:

Type of measurement device (jumper on HA board, see previous chapter, para. 6.3) for the level sensor:
standard type

Monitoring connections:

The GP board’s output signal varies between 1 and 2.5V at a water level of 0 to 7.5 cm in the level tray gutter. This voltage can be monitored at the HZ board’s terminals in the DSAT. Actuation of the discharge valve can be monitored using the test phase. To do so, connect the actuator to the - (test phase) on the HX board in the DSAT.

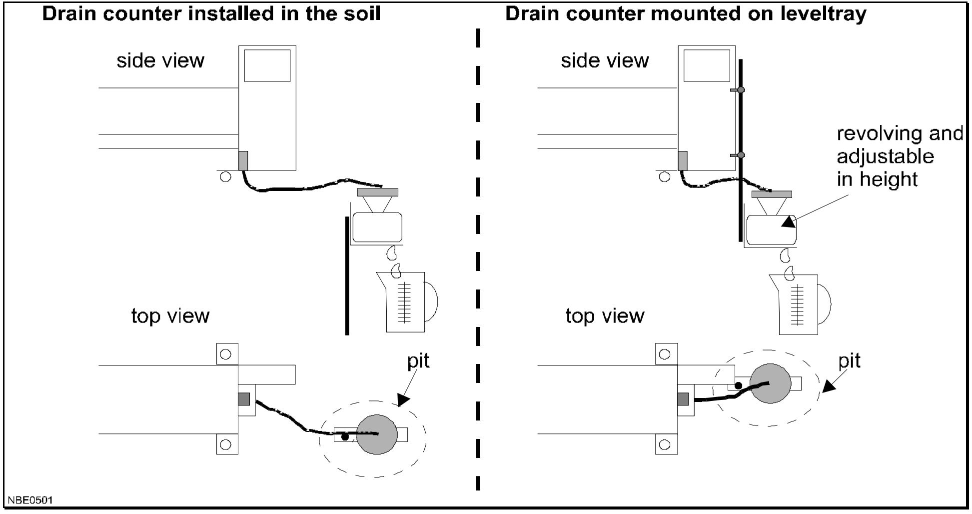
4.9.2 Drain counter

The drainage water from the level tray flows out of the tray via the discharge valve. This valve is actuated by the *ECONOMIC* NT system. The drainage quantity is measured by a drain counter. This measuring instrument is based on a spoon with a capacity of 5 to 6 cc. Once the spoon is full it turns over and a pulse is emitted.

Drain counter installation instructions

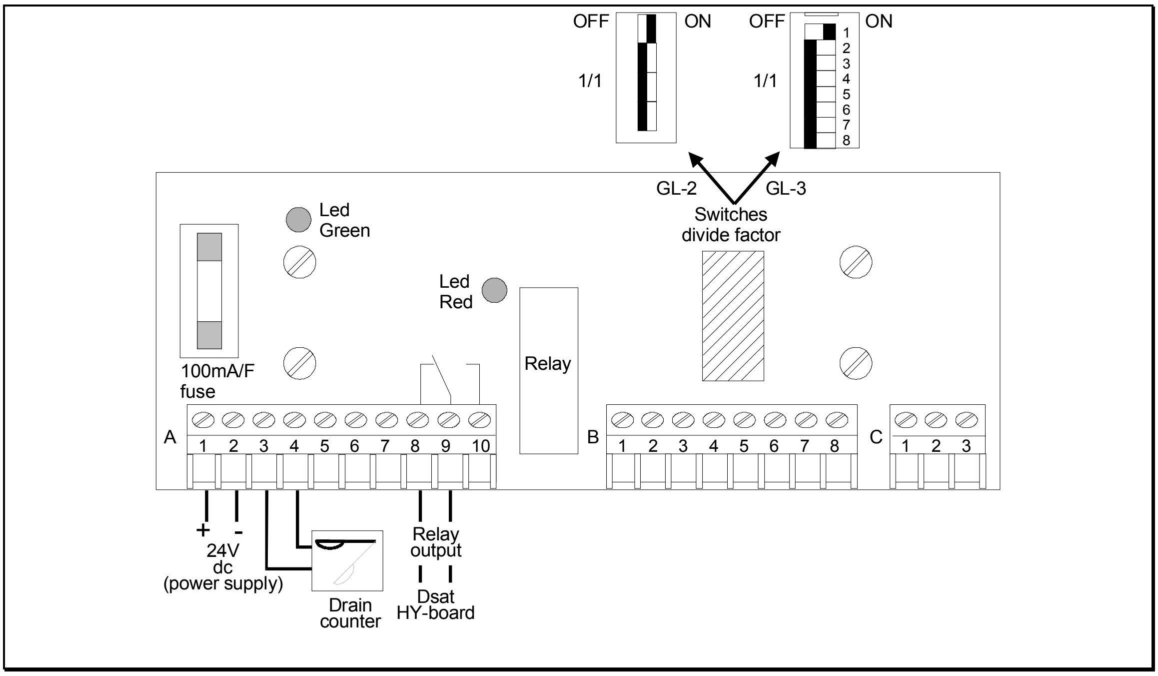
1. The drain counter must be placed under the measurement station of the level tray, i.e. not under just any mat in the greenhouse.
2. The drain counter signals are added to the level measurement signals to the 12-core cable in the level converter box. Use the available connection terminals 5 and 6 on the GP board for this.
3. The dividing factor of the pulse converter (GL board) must be set to 1 in an *ECONOMIC* NT.
4. The pulse converter (GL board) must be mounted in a Sarel box close to the DSAT.
5. The ‘spoon capacity’ setting is different for each drain counter. The exact horizontal position is also a factor in this setting. Always determine the ‘spoon capacity’, therefore, after installation.
   It is important to determine this setting accurately. Please refer to the Water Control chapter of the Service manual for details of the correct adjustment procedure.
   Do not adjust using the drain counter setscrew, if present.
6. The drain counter must be positioned upright. Once this has been done, determine the ‘spoon capacity’ and then do not move it again.
   It must be possible to remove and reposition a measurement beaker under the drain counter without moving or turning the drain counter. The pit must, therefore, be made large enough.
7. Drain counters cannot withstand immersion in water so the pit must be well drained.
8. The drain counter has a filter. If no drainage is registered any more, check whether the filter needs to be cleaned. When removing the cover of the funnel, ensure that the position of the drain counter is not changed.

Note: The drain counter bracket can be either placed in the ground or attached to the level tray.
Mounting on the level tray is preferred in the interests of drain counter stability, thereby ensuring that the ‘spoon capacity’ does not vary. However, depending on the position of the pit, this is not always possible (see drawing).



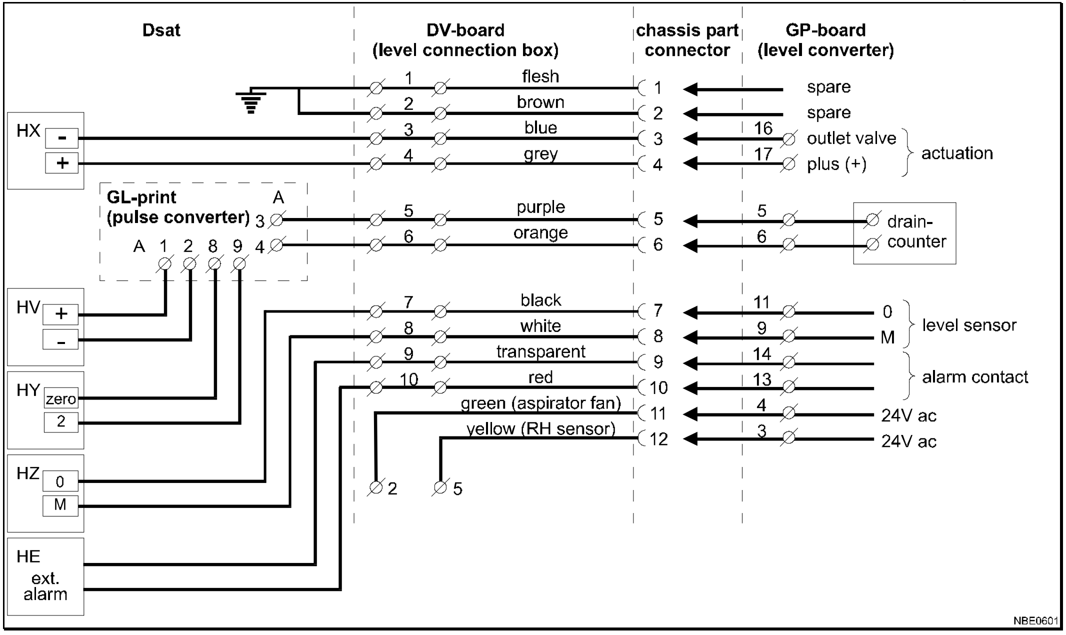
Connecting the drain counter

The drainage quantity is measured by a drain counter. Every 5 to 6 cc drainage causes a pulse. The drain counter is connected via a GL board (pulse converter) to the HY board (detectors) of a DSAT. The GL is supplied with 24 V dc from the HV board of the DSAT.



GL board connections

4.9.3 Complete overview of connections for level sensor plus drainage sensor



This drawing shows all the components with connections from the level tray and drain counter to and with the DSAT.

Complete overview of connections for level sensor plus drainage sensor

4.10 Tank level measurement

The level in a recirculation break tank is measured by a level sensor. The measurement principle is based on a pressure measurement. The sensor is placed at the bottom of the tank. The water in the tank causes a pressure which varies with the height of the water column. Low water level → low pressure; full tank → higher pressure. The pressure sensor is in the form of a tube-shaped rubber housing approx. 10 cm in length and 4 cm in diameter. The level sensor is connected via a converter box.

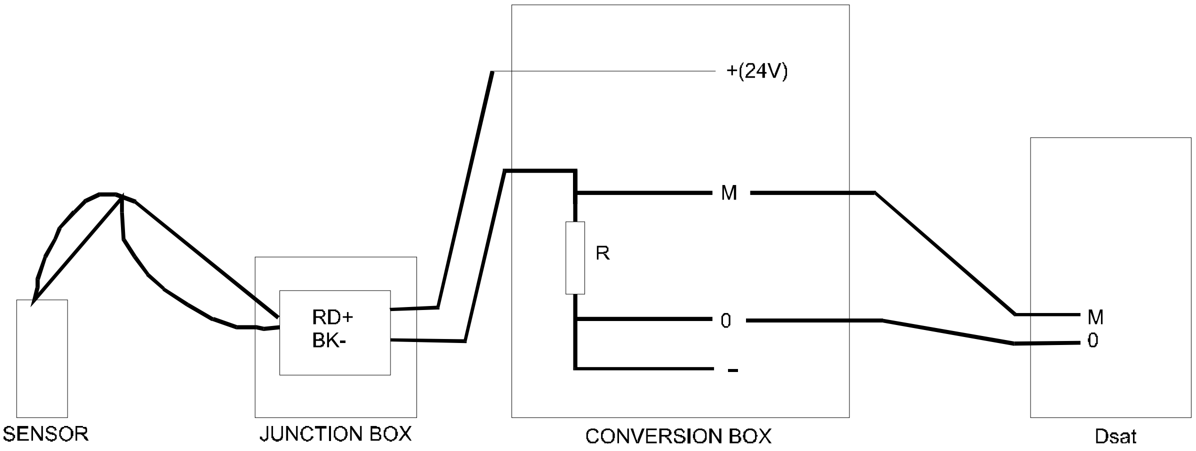
Installation instructions:

- Mount the sensor in or on a PVC tube. Place this vertically in the tank. The sensor must be just (approx. 5 cm) above the base of the tank. Attach the top of the PVC tube to the edge of the tank. This means that it is easy to remove the sensor from the water for servicing.
- Use a junction box to extend the sensor cable. For indoor installations use a splashproof junction box, and for outdoors a waterproof junction box.
- The sensor is fitted with a hose for air pressure equalisation. This hose must not be submerged or blocked.
- The 24 V supply from the converter box may not be used for other purposes to avoid any effects on the tank level measurement.

Connection:

The connection cable is 5 metres long. The sensor outputs a measurement signal of 4-20 mA → 0-1 bar → 0-10 metres water column. The supply voltage is 24 V dc. A modified DVV box (converter box) is used to convert the measurement signal to a voltage, to provide the 24 V dc supply and to connect the sensor.

- The 24 V dc power supply is provided by a modified DVV with a direct current circuit.
- The 4-20 mA measurement signal is converted via a 39E2 resistor to a measurement voltage which is suitable for the *ECONOMIC* NT. This resistor is fitted in the modified DVV.



Type of measurement device:

Type of measurement device (jumper on HA board, see previous chapter, para. 6.3) for the tank level sensor: standard type.

Monitoring:

Table with readings:

Measured current [mA]	*Measured voltage [mV]*	*Height [m]*
4	approx. 160	0
8	approx. 310	2.5
12	approx. 470	5
16	approx. 630	7.5
20	approx. 790	10

These measured voltages can be monitored by measuring them at the HZ board connection terminals in the DSAT.

4.11 Tensiometers

A tensiometer consists of a hollow, water-filled tube with a porous stone plug at the end. The meter is placed in the soil. The degree of transmission of water from the tensiometer to the soil is a measure of the soil's moisture content. Three or four tensiometers are placed at various depths in the soil at one location in the greenhouse. The tensiometer is connected via a converter box.

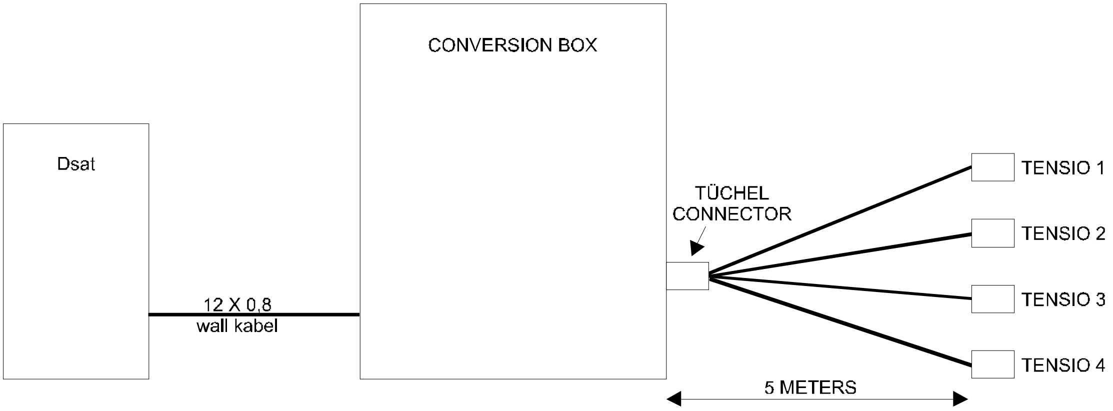
Installation instructions:

- Position tensiometers in a location in the greenhouse which is representative for the entire crop section in consultation with the user.
- Tensiometers are positioned in one location at four different depths (e.g. 10, 20, 35 and 50 cm). Bury the tensiometer cable at a sufficient depth. Clearly indicate the exact position of the tensiometers with a peg or something similar in order to avoid damage by, for example, a rotary cultivator.
- Attach the converter box to a greenhouse stanchion, a maximum of 4 metres cable distance from the tensiometers (the tensiometer cable is 5 metres long).
- Shield the converter box with a plastic screen to protect against irrigation water.
- Use a 12x0.8 wall cable between the converter box and the DSAT; 8 cores for the four tensiometers, with the remaining 4 cores earthed in the DSAT.
- The 24 V supply from the converter box may not be used for other purposes to avoid any effects on the tensiometer signal.
- Number the four tensiometers 1 to 4 on the cable above ground (tensiometer no. 4 is placed the deepest).
- The tensiometer contains boiled demineralised water. If the measurement is greater than approx. 500 hPa, this water must be topped up. This must be done once every six months / year (depending on how dry the soil is).

Connection:

The tensiometer outputs a measurement current of 4-20 mA, corresponding to a pressure differential of 0-1000 hPa. Wet soil → measurement signal is 4 mA; the drier the soil, the higher the measurement current. The tensiometers have a 24 V dc power supply. A modified DVV box (converter box) is used to convert the measurement signal to a voltage which is suitable for the DSAT, to provide the 24 V dc supply and to connect the tensiometers.

Δ The 4-20 mA measurement signal is converted via a 221 ohm resistor to a measurement voltage which is suitable for the DSAT. These resistors are fitted in the converter box.
Δ The 24 V dc power supply is provided by a modified DVV with a direct current circuit.
Δ Four tensiometers can be connected to each converter box.
Δ Set the HA board jumpers of the timer switch to standard (voltage measurement).
Δ The tensiometers are connected by a connector which enables the sensors to be removed easily. Topping up the sensors or cultivating the soil is easily possible as a result.



Solder the 4 tensiometers to the tüchel at the front of the converter box:
→ tensio1 white = connector pin 1, tensio1 brown = connector pin 2
→ tensio2 white = connector pin 3, tensio2 brown = connector pin 4
→ tensio3 white = connector pin 5, tensio3 brown = connector pin 6
→ tensio4 white = connector pin 7, tensio4 brown = connector pin 8

4.12 Scales

Scales are used to measure the weight of a substrate mat with its plants. The measurement signal can be connected to an *ECONOMIC* NT as a level tray sensor or a Uni-switch (measurement device type: level sensor). It is then possible to record the results in the form of a graph and initiate a watering cycle. In the case of a Uni-switch an external start contact to which the Uni-switch actuator is connected can be initiated.
If the scales are connected to a Uni-switch and a level tray is present, both measurements can be initiated. For example, the scales overnight and the level tray during the day.
The description refers to SUBSTRA scales.

Installation instructions:
Δ Approximately determine the maximum plant weight to be weighed. New scales are adjusted as a default for a maximum weight of 50 kg. If this weight is greater, the scales must be re-adjusted. Please refer to the manual which accompanied the scales.
Δ Place the scales on a raised area so that the junction box and the electronics do not come into contact with the drainage water.

Connection:
The scales have a 24 volt supply. The scales' interface board outputs a measurement signal of 4 - 20 mA. This is converted with the aid of a 221 ohm resistor to a measurement voltage of approx. 1 - approx. 5 volts, which is suitable for the type of level sensor.

Interface board terminal strip:
Δ 24 volt supply: terminal 2 (earth) and terminal 1 (+24V)
Δ Measurement signal 4-20 mA: terminal 3 (earth) and terminal 4 (I-out) R = 221 ohms
Δ Scale signals (load cell): terminal 7 (SIG -, white) and terminal 8 (SIG +, green)
terminal 9 (EX -, black) and terminal 6 (EX +, red)

Type of measurement device:
Type of measurement device (jumper on HA board, see previous chapter, para. 6.3) for the scale measurement: standard type.

Notes: