1. Standard *ECONOMIC* NT installation

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Parts 1, 2 and 3 of this chapter describe the installation instructions and connections for the basic components of an *ECONOMIC* NT system. These are the workstation, base station, control station and DSATs. The connections between these various components are detailed in part 4. Once these connections have been made, the *ECONOMIC* NT system is ready to run.
Parts 5 and 6 deal with the connections from the sensors and interfaces to the DSAT. The DSAT is taken as the starting point in these explanations. Chapter 10 concentrates on the sensors and interfaces.
Part 7 details installation advice intended to prevent damage by lightning strike or static discharge.

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:

- *ECONOMIC* NT control station type ERS-1 (part of chapter 2)

1. General provisions

1. The installation must be monitored by the installer in accordance with the guidelines laid down by Hoogendoorn and described in this service manual.

2. The electrical installations must comply with Dutch standard NEN 1010 and any local regulations.

3. In our view the installer must be aware of the following (normal) risks:
   a. Mechanical damage to the equipment during installation work.
   b. Electrical damage to the equipment caused by a failure to carry out the prescribed monitoring procedures or inadequately carrying out such procedures.
   c. Damage to, for example, valve systems by the incorrect connection and/or adjustment of the limit switches or a failure to monitor the motors' direction of rotation.
   d. Crop damage by the incorrect connection of switchgear cabinets or equipment connected to them such as motors and valves (for example, 'open' and 'closed' interchanged), a failure to monitor the functioning of connected equipment (such as jammed or unlocked valves), the connection of the wrong equipment (caused by the lack of a clear name, particularly on valves in boilerhouses) or the incorrect connection and/or monitoring of the alarm system.
   e. All other normal risks associated with electrical installations.

4. The system can generally only be commissioned once all the connections to the control station, the base station and the DSATs are complete and have been checked.

5. Other conditions, which have to be approved in writing by Hoogendoorn Automatisering B.V., may apply for special installations.

6. A number of precautionary measures relating to electrostatic discharge (ESD) are necessary if the control station is to be serviced or has developed a fault.
   a. Always transport the circuit boards in their original packaging.
   b. All work on the base and control stations must be carried out on a conductive mat which is earthed. The service technician shall be connected to the conductive mat via a wristband during such work, i.e. when removing boards from the system, unpacking and packing boards etc.
   c. Service work on base and control stations may only be performed by service technicians who have been trained by Hoogendoorn.

   These measures relating to ESD must be strictly complied with as the warranty can otherwise be invalidated.
   These measures are also important for preventing faults in the system.

7. You are urgently requested not to install or run your own software on the *ECONOMIC* NT unless this software is explicitly labelled by Hoogendoorn as: "Suitable for *ECONOMIC* NT".

8. Connecting *ECONOMIC* NT to an existing or new permanent network may only be carried out by specially trained and authorised personnel of Hoogendoorn or their dealers.

Hoogendoorn disclaims all liability for the possible consequences of failure to comply with items 7. and 8.

Notes:

2. *ECONOMIC* NT workstation and equipment

An *ECONOMIC* system consists of a workstation containing a control station, a base station and a printer.

Installation instructions

The workstation must be installed in a separate room which complies with the following ambient conditions:

a) Maximum ambient temperature 30°C, with the *ECONOMIC* NT out of direct sunlight.
b) Minimum ambient temperature 10°C.
c) Reasonably dust-free, but absolutely soot-free.
d) Maximum humidity with equipment switched on 90% RH.
e) Maximum humidity with equipment switched off 75% RH (the equipment should be switched off as little as possible once it has been commissioned).
f) No dripping or splashing water. No chemicals may be kept in the same room!
g) The building must conform to standard building regulations.
h) The minimum dimensions for the computer room shall be 3x3x2 metres.

Strict compliance with the above conditions is required as failure to do so can invalidate the warranty.

Connections

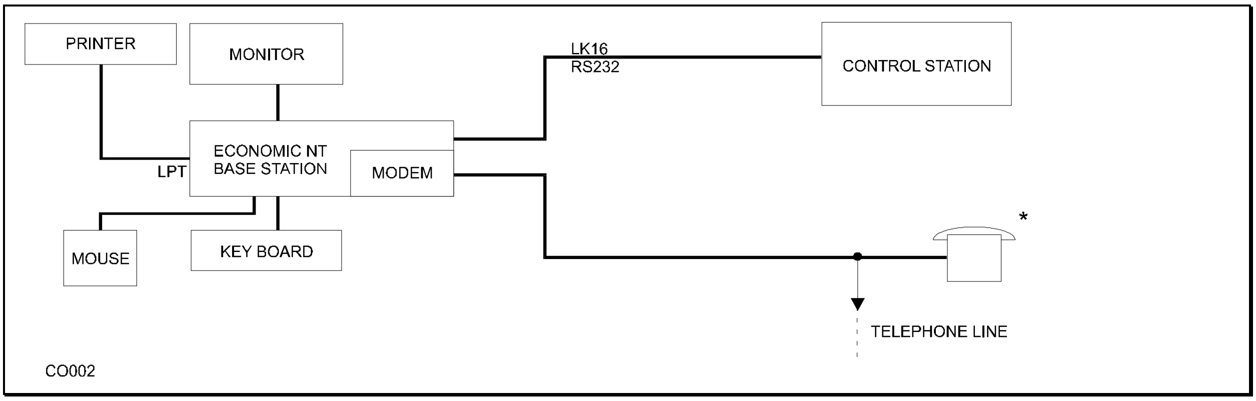
The control station, base station and printer must be connected to a 220/230 V source with a proper earth connection in accordance with local regulations. The mains voltage must be free of interference (caused, for example, by thyristor-controlled equipment and motors which are suddenly switched on). The computer system must be connected to a separate group.
If the local voltage is lower than 220/230 V, e.g. 208 V, it is recommended that the voltage of the separate computer group be increased by means of a central transformer.

The control station is made up of a rack containing individual boards installed on a bus board. The connections with the base station and the DSAT circuit are at the rear of the rack.

The base station has connections for the control station (serial COM port), printer (parallel LPT port), mouse, keyboard and monitor located at the rear. The terminals are indicated by stickers on the various connectors.

The control station comes in two types: ERS-1 and ERS-2.
Apart from having a different design, these control stations also have a different means of communicating with the base station: ERS-1 communicates via an RS232 interface, while the ERS-2 uses an Ethernet network.

Type with ECONOMIC control station 1 (ERS-1)

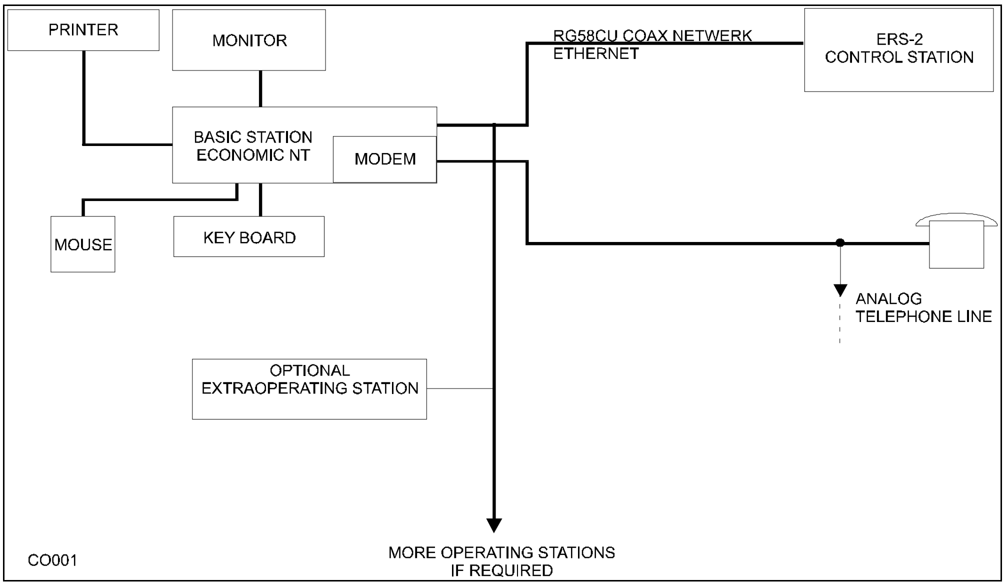


Type with ECONOMIC control station 2

Important: Each station on the network must be assigned a unique IP address.

The ERS-2 control station in the workplace is therefore given a standard IP address. This is the basis for an IP address setup program on the base station. The control station must be configured using this program. This program's Help function gives the necessary information on the procedure to follow.

One complication in this regard is that whenever a loan control station is returned from a user, the standard IP address must first be entered again via the RS232 interface before the control station can be used again.



Instructions for fitting the Ethernet cable

1. It is essential for the Ethernet cable to be of the 50 ohm type (RG58CU). 75 ohm TV coax is **absolutely forbidden.**
2. The maximum length of an Ethernet section is 180 metres. If greater distances have to be bridged, up to a maximum of 4 repeaters may be used. In the event of even greater distances a solution using fibre-optic materials should be considered. Consultation with Hoogendoorn Automation B.V. is recommended in such specialised cases.
3. A T-connector may only be provided directly on the network card.
4. The cable ends must be fitted with 50 ohm terminators.
5. A short connection must be made between the Ethernet section in one place and the greenhouse structure to prevent damage by induction as a result of lightning. The easiest solution uses a special 50 ohm terminator fitted with an earth wire and an eye bolt.
6. If a network extends into another building, careful consideration must be given to means of equalising the voltage: the cable must be passed through a metal tube which is connected at both ends to the metal of the building structure to prevent problems. This connection must be very solid and sized to cope with a large current (approx. 100 A). A fibre-optic connection can sometimes offer a solution for larger distances or ambient conditions with a great deal of interference. Please consult Hoogendoorn Automation B.V. for more information in such cases.

Modem connection instructions

The internal modem in the base station is used for remote control and remote servicing. The preferred option is for the modem to be connected to a dedicated **analog** telephone line to which no other equipment (such as telephone, fax and similar) is connected. This minimises the chance of interference when making a remote connection. If, however, an alarm indicator and a telephone handset have to be connected to the same telephone line, the following must be borne in mind.

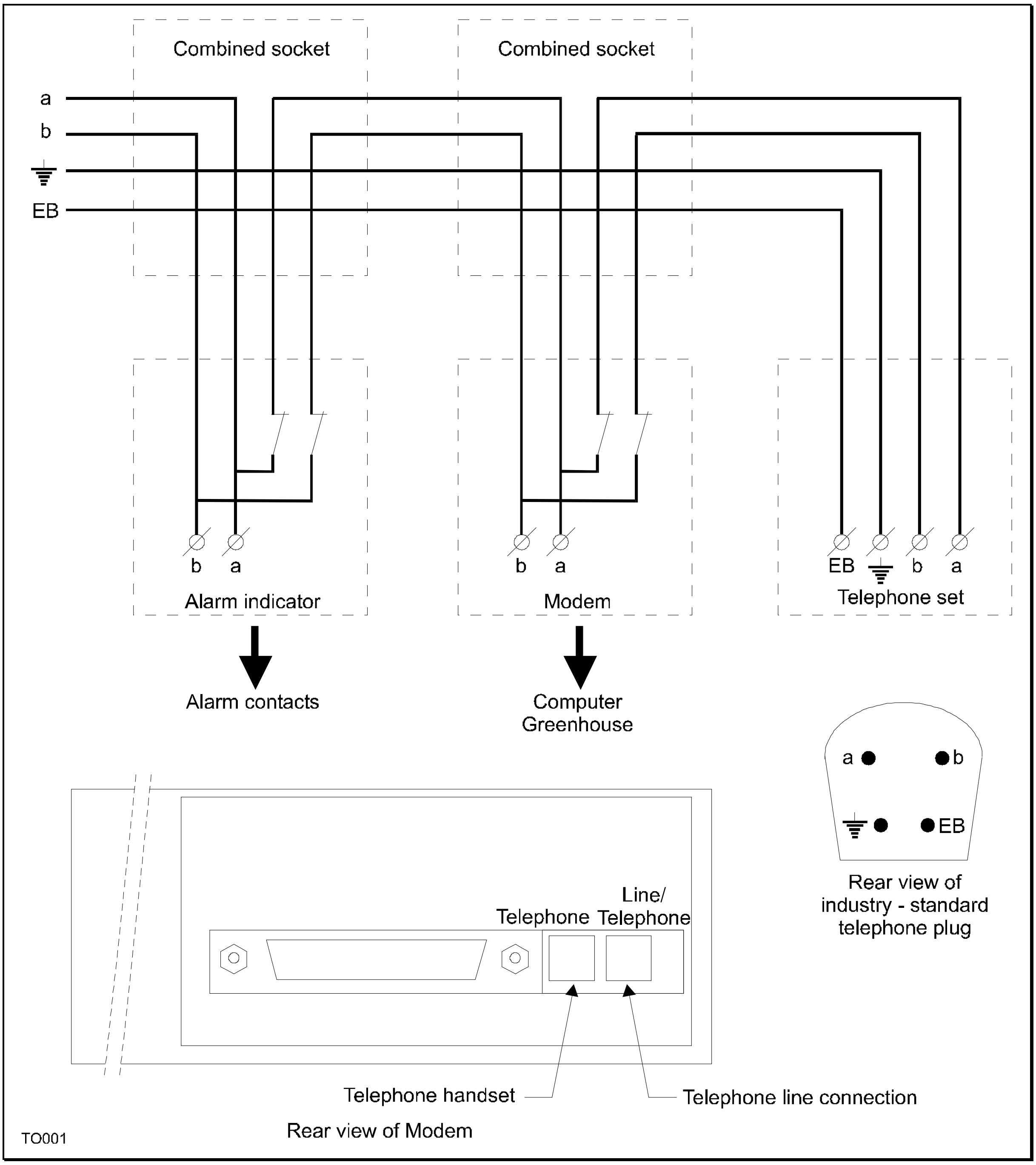
- The alarm indicator has to be connected first, i.e. directly to the telephone socket , followed by the modem and then a telephone handset.

- The alarm indicator and the modem must be connected as shown in the diagram below. A combined socket is a telecommunications-industry-standard feed-through plug where ‘a’ and ‘b’ can be interrupted by the connected equipment, and ‘earth’ and EB (EB is an abbreviation in Dutch, it means extra ring) are looped through. In this way the alarm indicator can switch off the modem and telephone handset, and the modem can switch off the telephone handset.

If in doubt as to whether the industry-standard feed-through plug is wired as a combined socket or 1 to 1, open the plug and check the wiring against the diagram below.

The combined socket can also be incorporated in the modem. In this case there are two connections on the rear panel of the modem: **Line/Phone** and **Phone.** The Line/Phone connection is intended for the connection to the wall socket. The Phone connection is intended for a telephone handset (which can be switched off by the modem). Please also see the ‘Rear view of modem’ drawing.

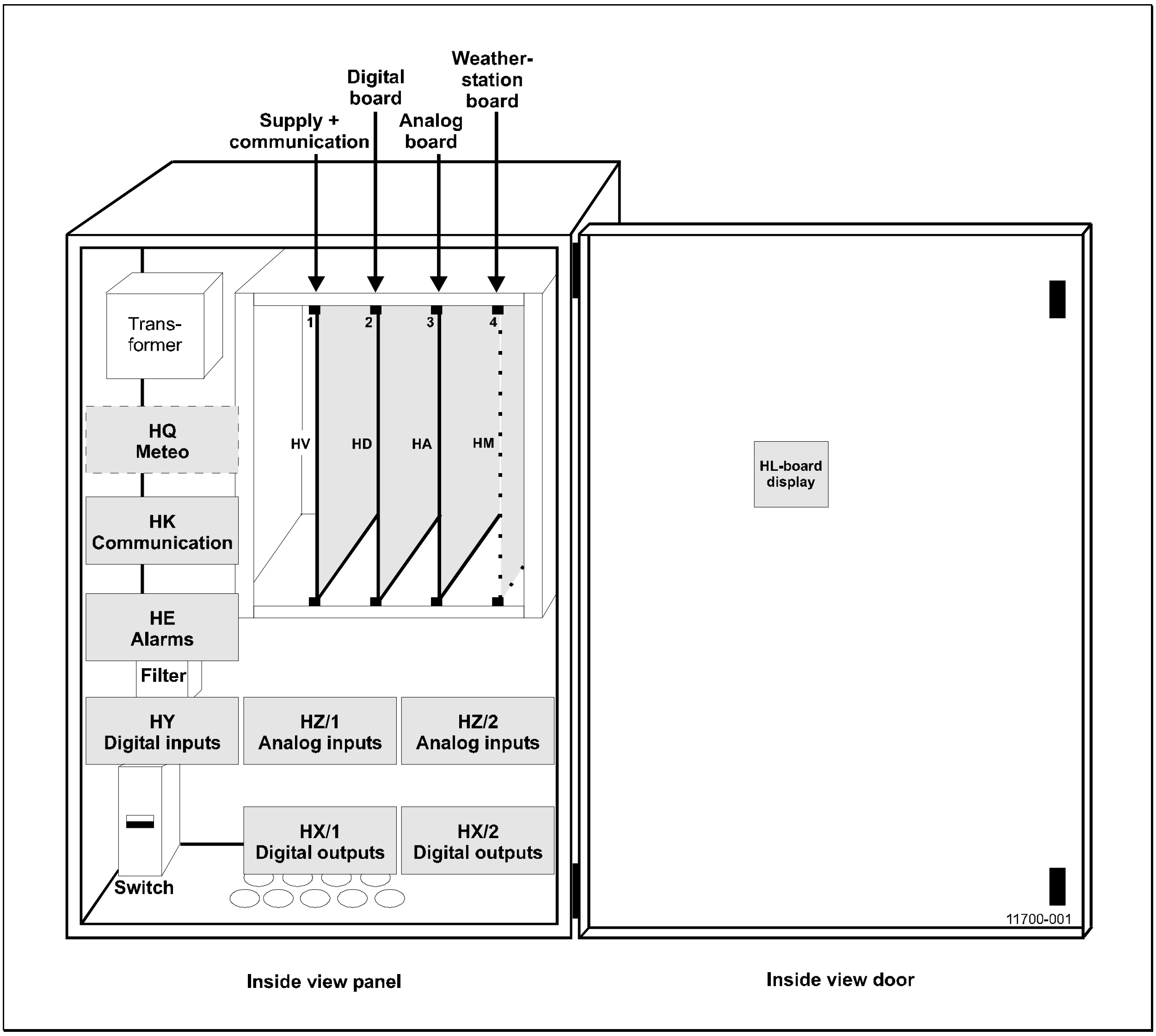
- You are **very strongly** advised against connecting any further equipment to a telephone line (fax, 2nd modem, switchboard etc.). The situation described above with an alarm indicator, modem and telephone handset is the maximum which should be considered. An extra telephone line is always preferable. If an extra line is available, it should be used for the modem.


Combined socket
Combined socket
a
b
EB
b
a
Alarm indicator
b
a
Modem
EB
b
a
Telephone set
Alarm contacts
Computer
Greenhouse
a
b
EB
Rear view of
industry - standard
telephone plug
Line/
Telephone
Telephone
Telephone handset
Telephone line connection
Rear view of Modem
TO001

Notes:

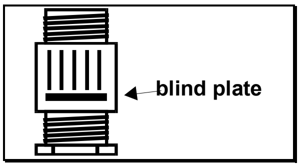
3. DSAT

The DSAT (digital satellite) is a box measuring 60x40 cm. It is the input/output interface of the *ECONOMIC* NT. Measurement and actuation equipment is connected in the DSAT.



The DSATs must be connected to a mains voltage of 230 V, 208 V or 110 V in accordance with local standards, with a reliable earth. The appropriate mains voltage can be selected via the connection terminals on the DSAT transformer. The mains voltage must be free of interference (caused, for example, by thyristor-controlled equipment and motors which are suddenly switched on). The DSATs must be connected to the same group.
The external alarm circuits have to be explained on the sticker on the inside of the door (see also External alarm paragraph later in this chapter). If an external alarm occurs, the text on the sticker must indicate which system component has the fault. The DSAT swivel plate is drawn on the same sticker. It is possible to specify where the cable goes for each swivel (and which connections are used). Filling in the sticker consistently and correctly saves time when troubleshooting.
Inside view door sticker

All DSATs must be easily accessible from the ground. After connection of the DSAT, the swivels must be sealed using a sealant such as Wijmaplast to make them splashproof. Unused swivels must be sealed with a blind plate.



DSAT ambient conditions:

The DSATs must be mounted such that the following conditions are met:

a. Maximum ambient temperature 40°C, with the DSAT out of direct sunlight.
b. Minimum ambient temperature 0°C, with the DSAT switched on.
c. Reasonably dust-free, but absolutely soot-free.
d. Maximum humidity with DSAT switched on 90% RH.
e. Maximum humidity with DSAT switched off 75% RH (the DSAT should be switched off as little as possible once it has been commissioned).
f. No dripping or splashing water. Avoid keeping chemicals in the direct vicinity!

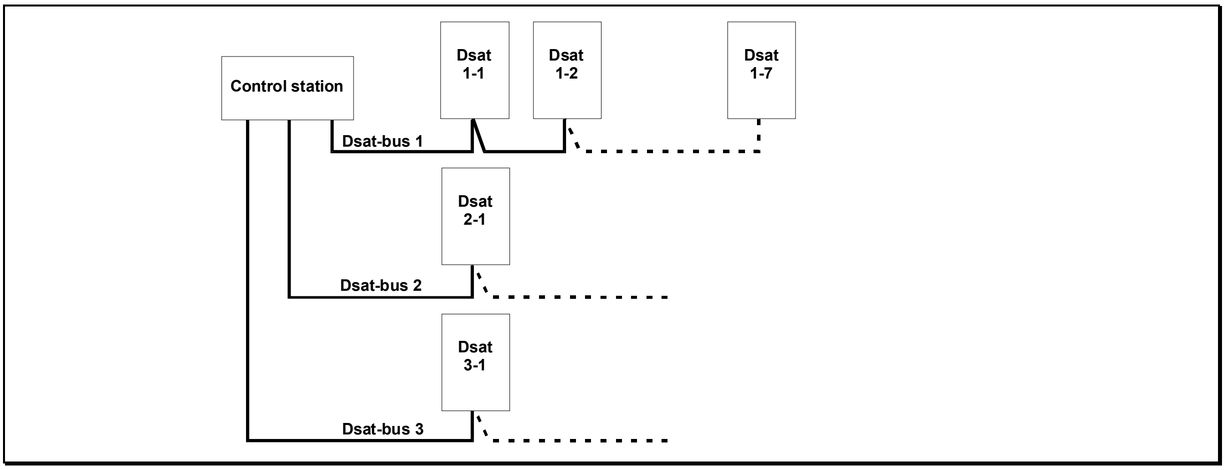
Strict compliance with these conditions is required as failure to do so can invalidate the warranty.

4. DSAT circuit and alarm circuit

A 4-core wall cable (with the solid cores having a diameter of 0.8 mm) must be used for the DSAT bus (the connection between the control station and DSATs). You are strongly advised against joining DSAT cables. The total length of the DSAT cable may not exceed 1000 metres per DSAT circuit .
If DSAT cables are laid underground, a shielded underground cable is obligatory. The outer shield is earthed at both ends.

The alarm circuit between the DSATs uses a 2x0.8 wall cable.

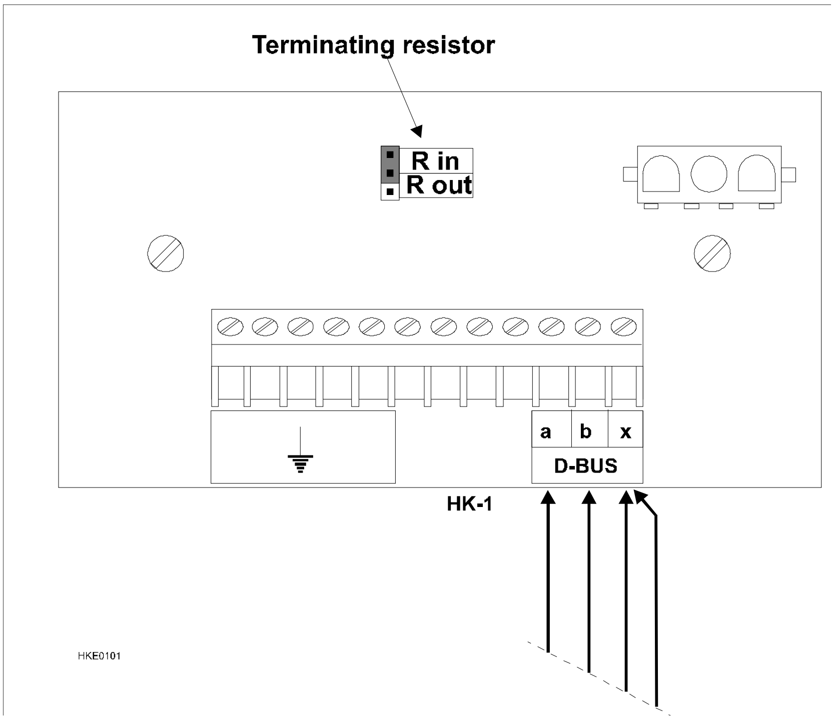
4.1 DSAT circuit (HK board)



***ECONOMIC* NT DSAT buses**

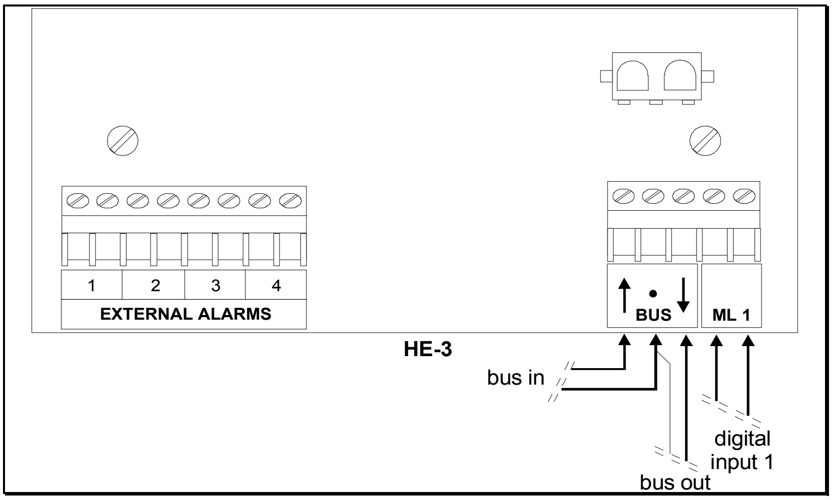
This diagram shows the DSAT cable in line, i.e. from the control station to the 1st DSAT, then the 2nd DSAT and so on. This is the correct way to do it. Using a star connection often causes communications faults and is therefore strongly discouraged.

The DSAT bus is connected to the HK board.
This board contains a jumper for the terminating resistor of the DSAT bus. This terminating resistor must be set to 'IN' at the end of a DSAT cable in one DSAT. This must be the DSAT which is furthest from the control station. This is not by definition the DSAT with the highest number. With three DSAT circuits, therefore, there are three DSATs with the terminating resistor set to 'IN'.
In the rest of the DSATs the terminating resistor is set to 'OUT'.

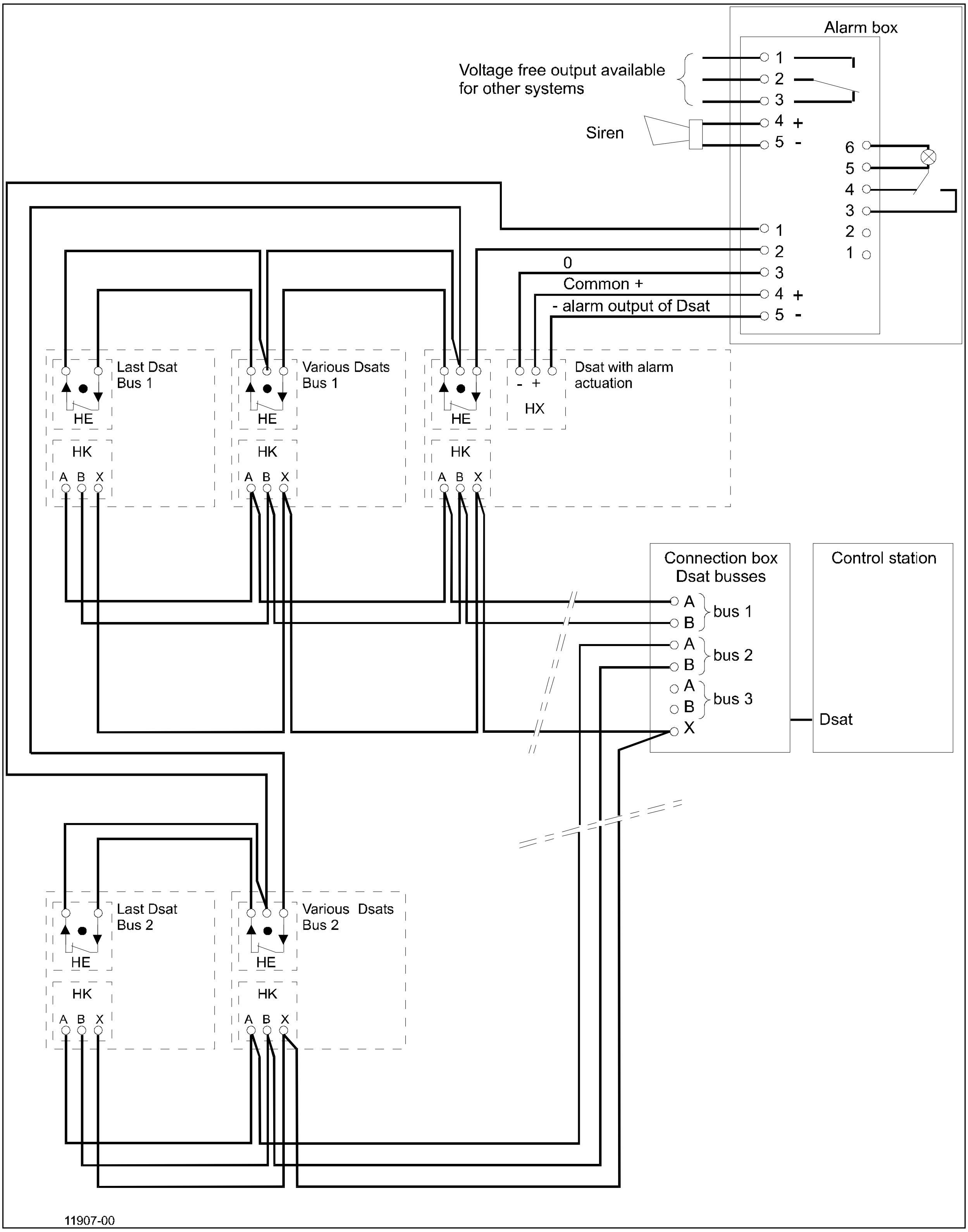


4.2 Alarm circuit (HE board)

The three CIRCUIT connections are for an alarm circuit outside the entire computer system so that an alarm is given even if, for example, the power to the entire computer system fails.



4.3 Connection of the DSATs, control station and alarm box



Use a separate cable for each DSAT circuit. The location for the siren must be chosen such that it can be heard throughout the site.

4.4 Initiation of a DSAT

Once the DSATs have been connected to the control station via the DSAT bus, they can be started up.
If everything is properly connected, the display on the DSAT will extinguish after the initiation phase, and the green lamp next to the display will light up.
If the green lamp does not light up, one of the following codes can appear on the display:

0: DSAT initiation phase
1: during initialisation of meters; then green "In operation" LED comes on
2: EPROM error
3: RAM error
4: supply defective; this can be: 5 V too low, approx. 15 V too low/defective or 24 V internal too low/defective (also possible that analog card is not present)
5: analog card defective
6: extra card defective
7: reserved
8: reserved
9: no communication between DSAT and control station
E: external alarm; this can be: one or more external alarms active or 24 V EXT defective
- : test mode (off-line)

An alarm is given if the DSATs fail to communicate or communicate only poorly with the control station (code 9 on the DSAT display).

Check whether all the supply LEDs on the DSAT HV board are lit up. If one or more LEDs has extinguished, check the fuses on the HV board.

5 Weather data

5.1 General

The installation of the weather sensors can be split into 3 sections:
1. Wind speed, wind direction and outdoor temperature
2. Solarimeter
3. Rain sensor

Each section has its own installation instructions. The three sections can be located together or separately, depending on the local situation.
The instructions are outlined below for each section together with a sample installation.
The starting points for the choice of installation are:
- ∆ Service-friendliness, the sensors must have good accessibility.
- ∆ Measurements must be representative.

A light sensor is sometimes installed as an alternative to the solarimeter.

5.2 Wind direction, wind speed and outdoor temperature

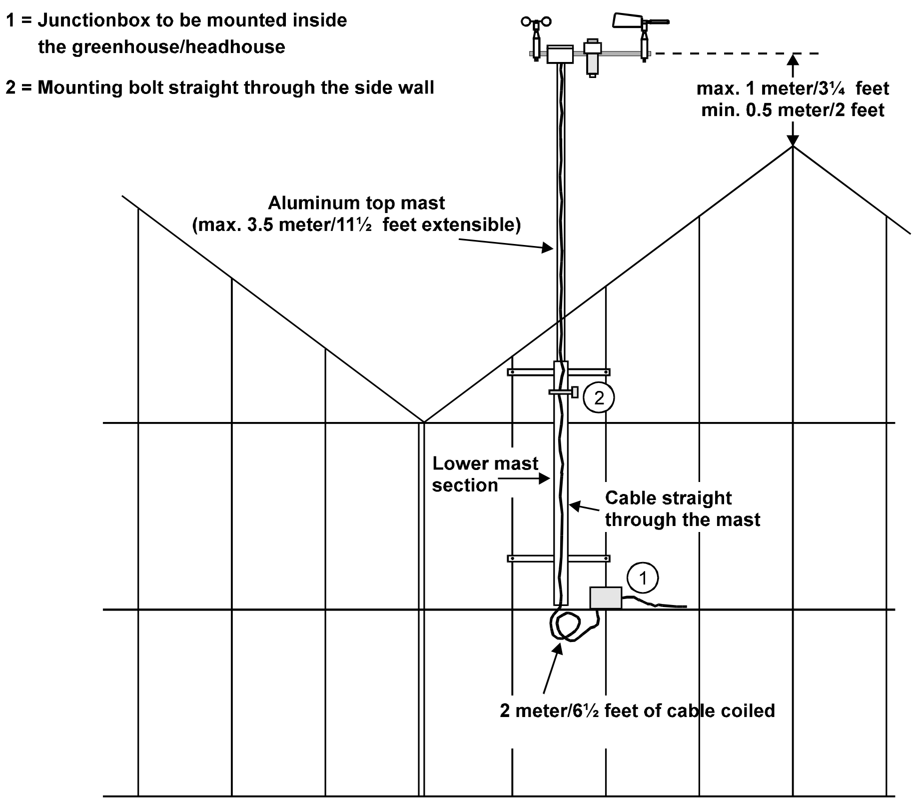
These three sensors are permanently mounted on the weather-station mast. The weather-station mast must be positioned high enough. Mounting it on the greenhouse is the preferred option because the weather measurements are intended for the house. At least 1½ metres above the ridge because heat is emitted from the house. If mounted on the packhouse, allow the mast to extend at least 50 cm and at most 1 metre above the ridge. The position of the weather-station mast must therefore be selected such that greenhouses, packhouses, smoke from the chimney, trees etc. in the direct vicinity cannot have any effect on the measurements.

Position the lower mast section as low as possible and, if mounted on the face end, as close as possible to the gutter. This enables the full length of the upper mast section to be used. In the event of servicing of the sensors, this can therefore take place as close as possible to the ground.

Pass the cable through the lower and upper mast sections rather than fasten it on the outside. A 2-metre length of cable must be coiled at the bottom of the mast. In other words, it must be possible to lower the upper mast section without problems.

Wind vane:
The wind vane has to be mounted with the black strip or the nipple on both sections of the vane facing northwards. Use a compass to check this.

The wind speed, wind direction and outdoor temperature sensors are connected to a junction box at the bottom of the mast. This box must be mounted on a wooden board in the greenhouse / packhouse.



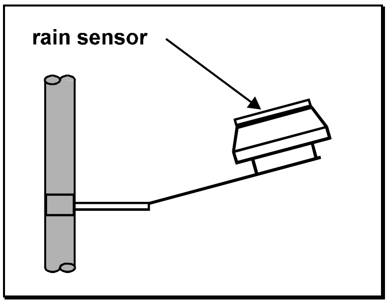
5.3 Rain sensor-plus

The rain sensor-plus comprises two parts, the rain sensor and the associated box. The sensor is made up of two adjacent copper strips. When it rains, the water causes a short-circuit between the two copper strips. In dry weather the resistance between the two copper strips will be infinite. The sensor is heated so that the last raindrops quickly evaporate from the surface during the transition from wet to dry weather.
The rain sensor is connected to the signal converter. The functions and properties of this box are: to signal rain with an LED, adjustable sensor sensitivity, to provide the adjustable heating voltage for the sensor, and adjustable delay time for the end of the rain.

Rain sensor

a. The rain sensor must be mounted at an angle of approx. 30 degrees to the ground. The surface of the sensor must face in the direction of the prevailing wind and rain. In the Netherlands, for example, this is the north-west.

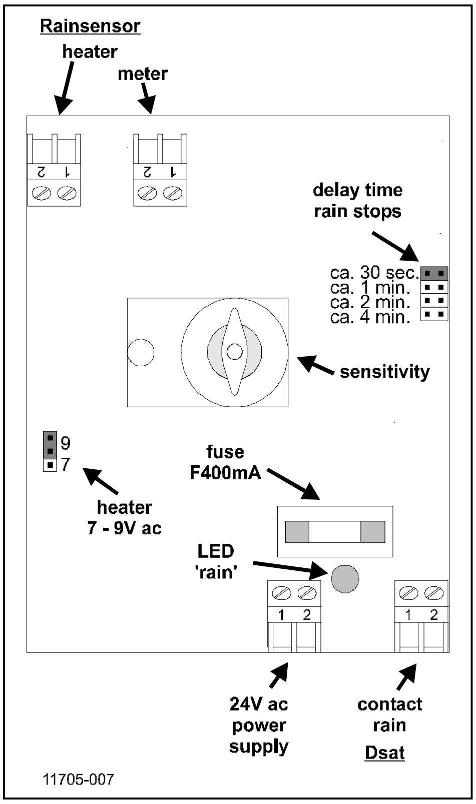
b. Important: drops from, for example, the ridge of the packhouse or the greenhouse after a rain shower must not be allowed to give a false reading.



c. he maximum length of the cable from the rain sensor to the signal converter box is 30 metres because of voltage losses for heating.

d. The rain sensor must be regularly cleaned with a detergent. Do not use a spirit-based substance or an abrasive cleaner. The user can, of course, carry out this cleaning operation himself; his attention must be drawn to this.

e. The rain sensor must be mounted in an easily accessible location so that the maintenance outlined in item d. can be carried out.



Rain sensor-plus box
The box requires a 24 V ac power supply. The output signal (a contact) is connected to the HQ board in the DSAT.

Note: The sensor cannot function without the box. It is recommended that the sensitivity potentiometer be turned to a mid-position initially. The 'maximum sensitivity' setting means that 'each' raindrop is detected, while 'minimum sensitivity' registers only a rain shower. Set the heating voltage of the rain sensor to 9 V ac initially and the delay time rain stops to 30 seconds.

5.4 Solarimeter

a) Select the location for the solarimeter such that no shadow can fall on the meter. This applies from the first to the last sunlight (i.e. from morning till evening). Take account of adjacent greenhouses, packhouses, trees, chimneys and the location of the weather-station mast relative to the solarimeter. The south side of the packhouse or greenhouse is often the most ideal location.

b) Select the location of the solarimeter such that there cannot be any reflections on the meter from any light-coloured surfaces in the vicinity or any effect from outside lighting or assimilation lighting. In this regard too, therefore, take the location of the greenhouse or packhouse relative to the solarimeter into account.

c) The solarimeter must be mounted such that it is level. With solarimeter type CM6 the integral spirit level can be used to ensure this.
Note that, when adjusting, (one of) the three setscrews is/are not screwed right to the end. This adversely affects accuracy.

d) The solarimeter is placed on a bracket which is attached to the solarimeter mast.
The solarimeter mast can be mounted on the lower mast section of the weather-station mast or directly on the greenhouse or packhouse. This depends on whether the position of the weather-station mast complies with the installation instructions for the solarimeter (a. and b.) and the height of the lower section of the weather station mast. The mount must be stable enough to maintain the level setting (c.).

e) The cable connection must face north.

f) The cable attached to the solarimeter may not be shortened.
If the cable is too short, extend it using a shielded cable. If the solarimeter is mounted on the weather-station mast, the junction box must be used to extend the solarimeter cable.

g) Check regularly whether the solarimeter glass is clean.
If not, it must be cleaned so that all the sunlight can be transmitted again.

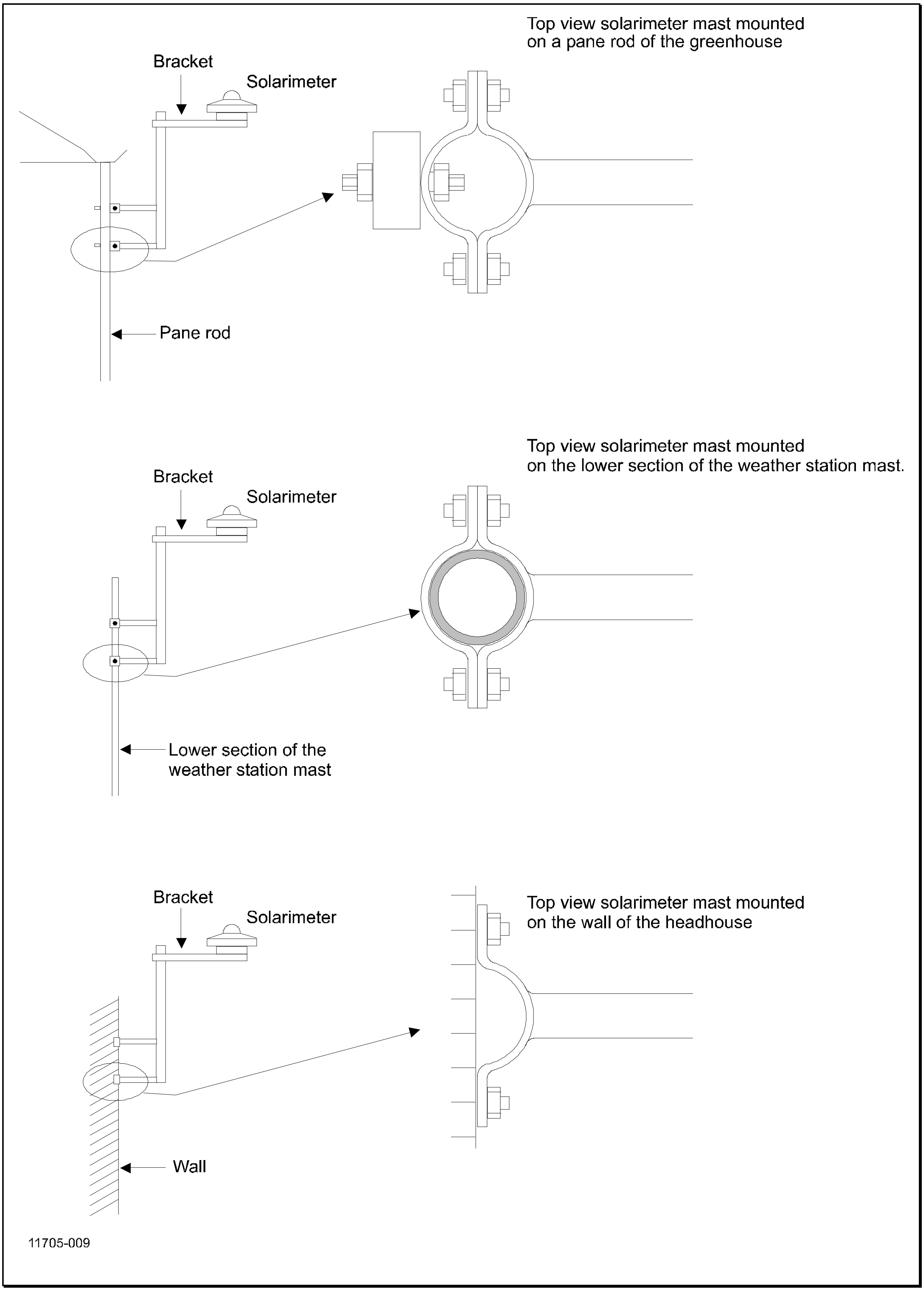
h) Check regularly whether the desiccant granules are still usable.
They must be blue and glassy. If they are pink/transparent, they must be replaced.

i) The solarimeter mast plus solarimeter must be mounted in an easily accessible location. This is to facilitate the maintenance as described in items g. and h. The choice of this location must not, of course, be at the expense of the other installation instructions.

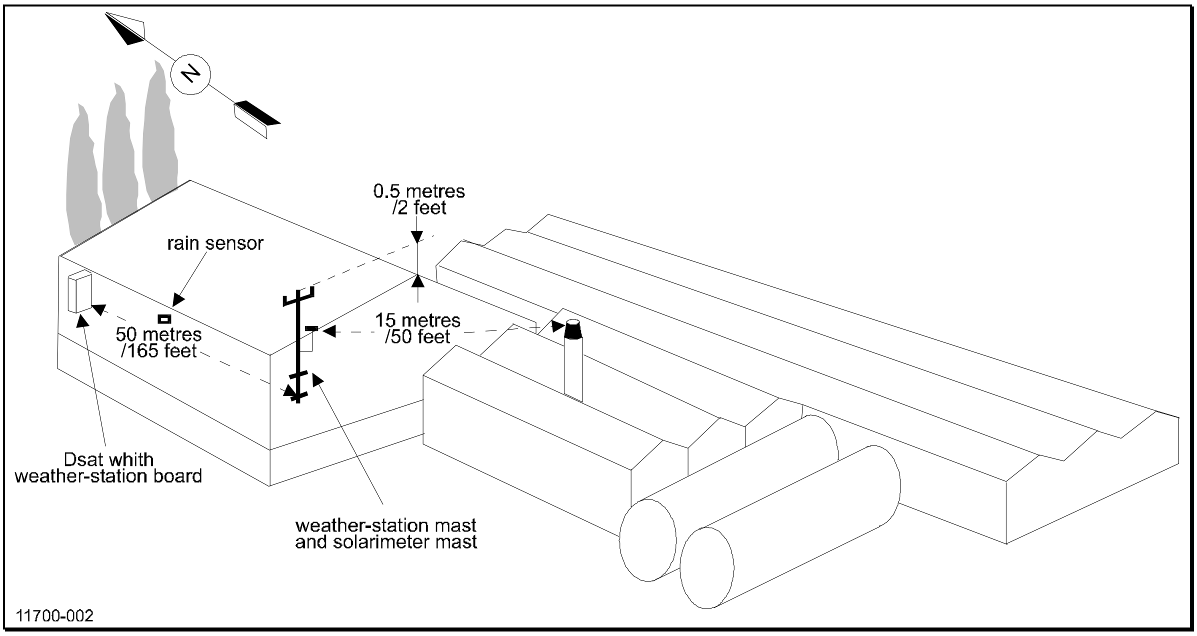
j) The stainless steel attachment bolts of the CM6 solarimeter must be mounted, using the insulation set supplied, such that they are electrically insulated from the aluminium housing in order to prevent contact corrosion.

Items g. and h. can also be carried out by the user. The user must be advised as appropriate.

5.5 Solarimeter mast mounting methods



5.6 Sample installation

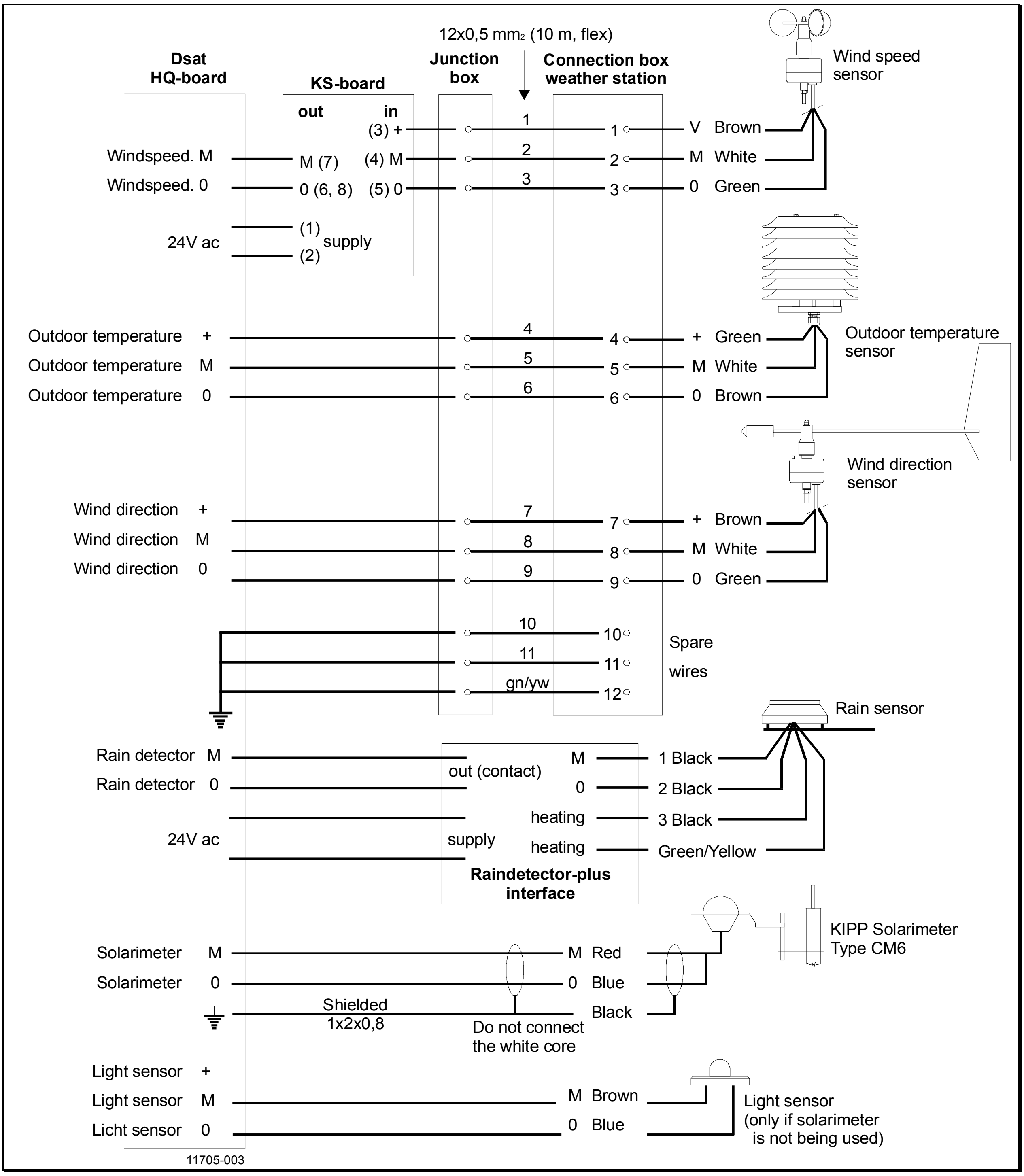


Notes:
- ∆ The rain sensor is separate from the weather-station mast because in this case the distance between the rain sensor-plus box and the weather-station mast is greater than 30 metres.
- ∆ The weather-station mast is located at a sufficient distance from high trees and the boilerhouse chimney.
- ∆ The sensors are half a metre above the packhouse ridge. This is sufficient because the packhouse does not have any ridge ventilation.
- ∆ The solarimeter mast can be mounted on the lower section of the weather-station mast because this is on the south side.
- ∆ No shadow can fall on the solarimeter caused by a house or greenhouse.

5.7 Earthing provisions for the weather-station system

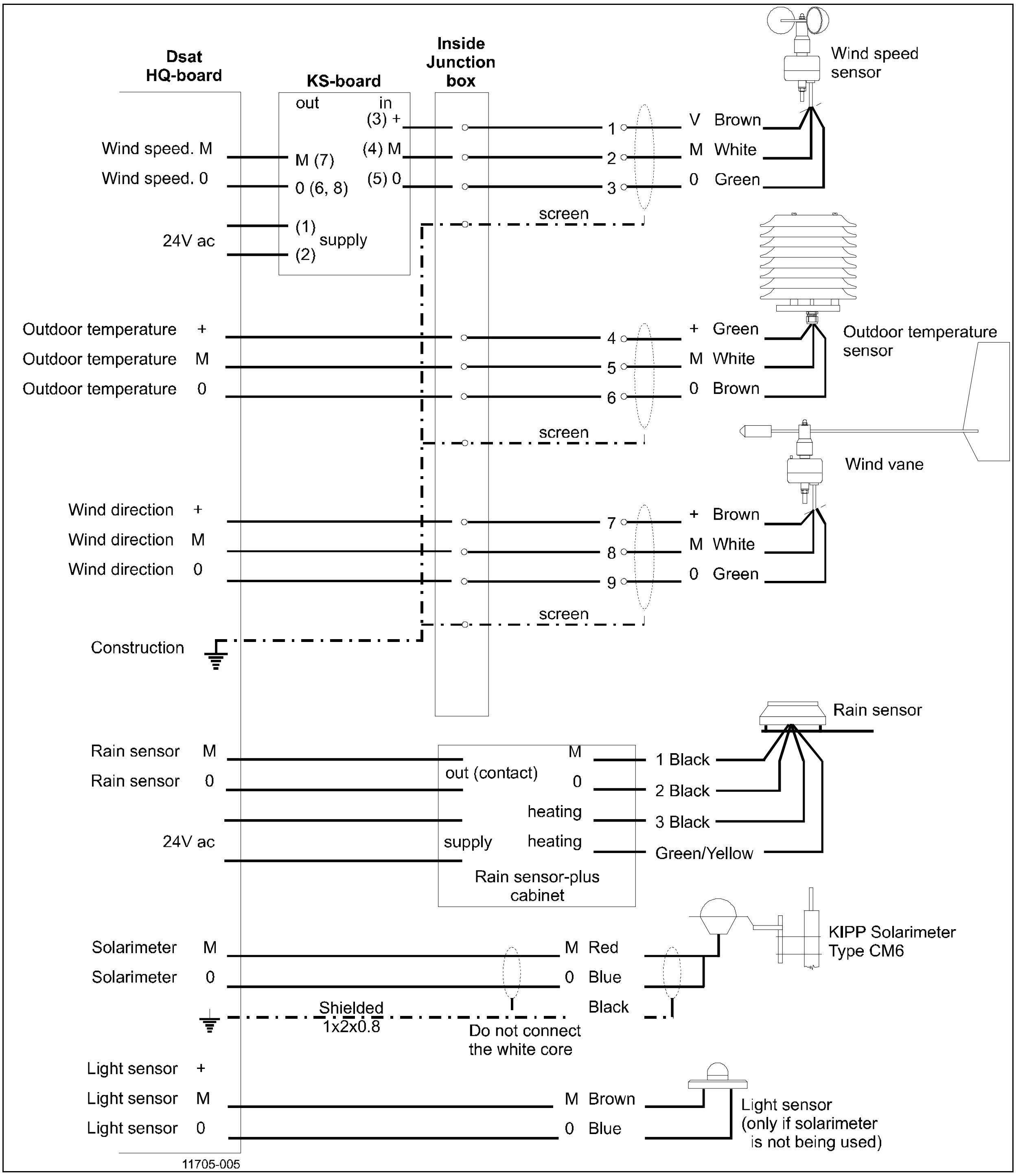
Earthing, particularly of the weather-station system, is vital to limit or prevent damage by lightning. It should be noted that little can be done against a direct lightning strike. However, it is possible to prevent or limit damage in the event of indirect strikes.
It has proved in practice that a solid connection between the weather-station mast and the greenhouse structure prevents a great deal of damage. It is important, however, that the connection is solid (capable of withstanding a high current).
The current design of the weather-station system uses separate shielded cables. There is then no junction box on the weather-station mast. The shields (from the junction box on the inside) must also have a short and solid connection to the greenhouse structure.
These measures have been taken to improve the system’s resistance to lightning.

5.7.1 Connection diagram for the weather-station system with a mast-mounted junction box



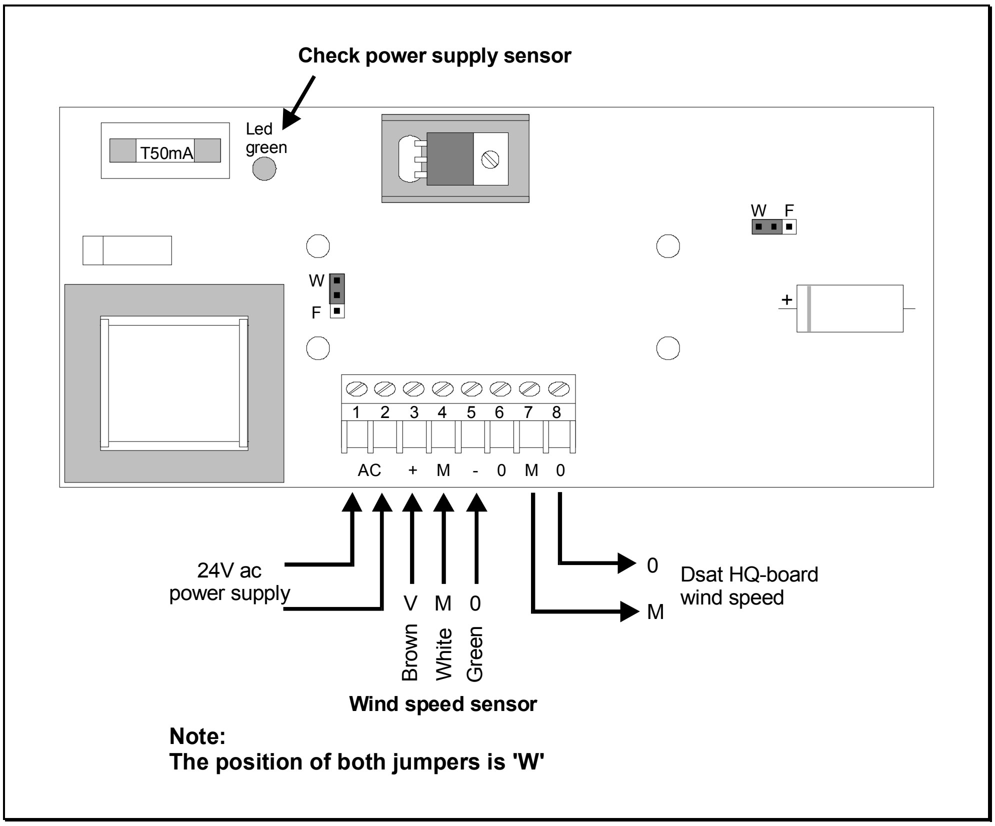
*: The HM board in the DSAT must be of modification level 3 so that a type 96 light sensor can be connected.

5.7.2 Connection diagram for the weather-station system without a mast-mounted junction box



*: The HM board in the DSAT must be of modification level 3 so that a type 96 light sensor can be connected.

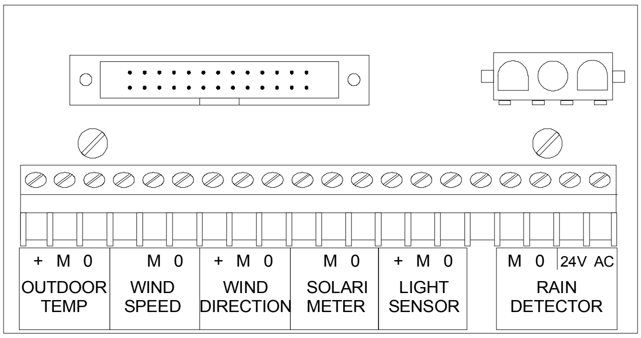
Apart from the rain sensor-plus cabinet (see description in ‘5.3 Rain sensor-plus’), a converter board for the wind speed sensor is also included in the connection diagram: the KS board.
The wind speed is measured with an anemometer to which a generator is connected. The type 95F sensor emits a series of pulses as a signal. Their frequency represents the wind speed.
The pulse series is converted into a direct current via the KS board. The figure below indicates the connections and jumper settings of the KS board. The KS board is mounted on the floor of the DSAT box with the weather-station board.



The weather-station connection diagram shows both the solarimeter and also its alternative, the light sensor.
The light sensor is a photovoltaic element. It outputs a voltage which is a function of the quantity of light. The light sensor is connected between 0 and M. The 0 connection on the light sensor’s HQ board is on the right next to the M connection (see the ‘HQ board connection’ section in this chapter). An HM board with modification level 3 must be used for a type 96 light sensor.
The light sensor must be positioned so that no shadow can fall on it at any time during the day. The south side is often the most ideal location. The light sensor must be positioned horizontally.

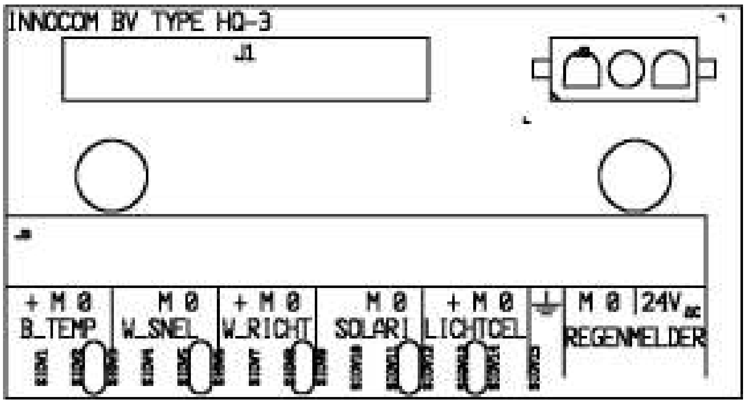
5.8 HQ board

The measurement signals from the weather sensors are connected to this DSAT board. This board is only present in the DSAT with the weather-station board (HM board). The sensors are connected in accordance with the texts shown on the HQ board.



HQ-2

Improved version: HQ-3



The HQ-3 is the successor to the HQ-2 and is designed to offer better protection against the effects of lightning in the neighbourhood. The earth connection is very important: the extra varistors **only provide protection if the earth connection is solidly affixed.**
The HQ-3 is necessary when using the current plastic wind vane and anemometer.
Thus, whenever an old metal wind vane or anemometer is replaced by the current plastic model, it is essential for an HQ-3 board to be fitted. Any HQ-2 present must be replaced.

5.9 Monitoring weather sensors

Wind speed sensor
The output voltage of the wind speed sensor is connected to the KS board and then the HQ board via the weather-station junction box. Use a multimeter to check the voltage between 0 and M against the following table.

Wind speed (m/s)	Voltage (V)
0	0
5	1.3
10	2.9
15	4.4
20	5.9
40	12.1

Wind vane
The wind direction is measured with a wind vane incorporating a 360° 10 kohm potentiometer.
The wind vane is connected to the HQ board via the weather-station junction box.
Use a multimeter to check the voltage between 0 and M against the following table.

Wind direction	Voltage (V)	Resistance (ohm) *
N	0-0.6	approx. 800
NE	0.6-1.1	approx. 2300
E	1.1-1.7	approx. 3700
SE	1.7-2.3	approx. 5100
S	2.3-2.9	approx. 6500
SW	2.9-3.4	approx. 8100
W	3.4-4.0	approx. 9200
NW	4.5-5.0	approx. 10000

*: the resistance of the potentiometer between 0 and M if this is **NOT** connected.

Outdoor temperature
The temperature sensor is a PT500 resistance sensor; this means that the resistance of the sensor is 500 ohms at 0°C. The resistance increases by 2 ohms for each one-degree increase in temperature. At 20°C, therefore, the sensor resistance is 540 ohms.
Use a multimeter to check the voltage between 0 and M against the following table.

Temperature (°C)	Voltage (V)
0	0.54
10	0.55
20	0.56
40	0.57
60	0.59
80	0.61

Rain sensor
The rain sensor is made up of two adjacent copper strips. When it rains, the water causes a short-circuit between the two copper strips. The resistance of this circuit is a function of the intensity of the rain and of the degree of contamination of the rainwater. The dirtier the water, the better the conductivity (absolutely pure water is an insulator).

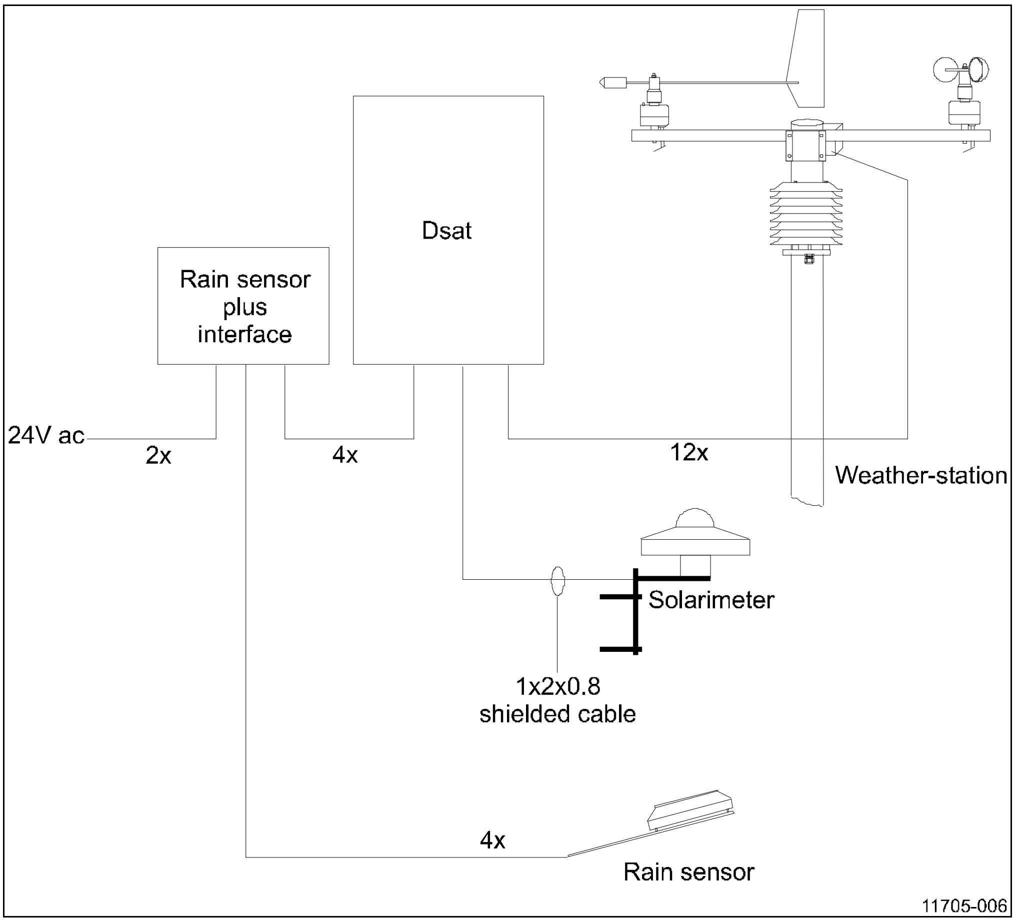
The wiring and the operation of the rain sensor-plus can be monitored by measuring the voltage between 0 and M on the HQ board in the DSAT against the following table using a multimeter.

Conditions	Voltage (V)
Dry	2 V ac
Rain	0 V ac

Solarimeter
The solarimeter outputs a voltage which is a function of the quantity of solar radiation. This voltage varies between 0 and approx. 20 mV and is measured between 0 and M on the HQ board.

5.10 Overview of the minimum number of cores

Note: At least 1 spare core per cable with measurements. Earth the spare cores in the DSAT.



HOOGENDOORN
GROWTH MANAGEMENT

Notes:

6 DSAT connections

6.1 General guidelines

1. Connectors with wire protectors must be used to connect **all** light-current cables. Soldering is recommended when interconnecting measurement sensors in the aspirators, particularly in areas with high relative humidity. The reason for this is to keep the contact resistance of the joint as low as possible in order to avoid adversely affecting the measurement. The soldered joint must be mounted in the connector to prevent leakage.

2. The following applies to the connection cables for the measurement and actuation equipment:
   - ∆ The minimum diameter of the cores is 0.8 mm.
   - ∆ Route over the baseplate of the DSAT as far as possible and <u>not</u> over the connection boards.
   - ∆ Use for other signals (dual function) is not permissible.
   - ∆ Keep the distance to power-current cables as large as possible.
   - ∆ Joining of cables is only admissible in waterproof boxes, using terminals with wire protectors. It is not permissible to twist wires together and then insulate them.
   - ∆ It is sometimes necessary to use shielded cable (e.g. for thyristor-driven controls).
   - ∆ Provide at least one spare core in each cable. This must be earthed in the DSAT.

   (Please see para. 6.6 ‘Spare cores’ in this regard.)

6.2 Actuators

6.2.1 Direct-current outputs

1. DSAT 24 volt external:
   The 24 volt external supply of a DSAT may not be used as a supply for large external loads. The guideline is that one extra load with a current of up to 100 mA is permissible for each DSAT.

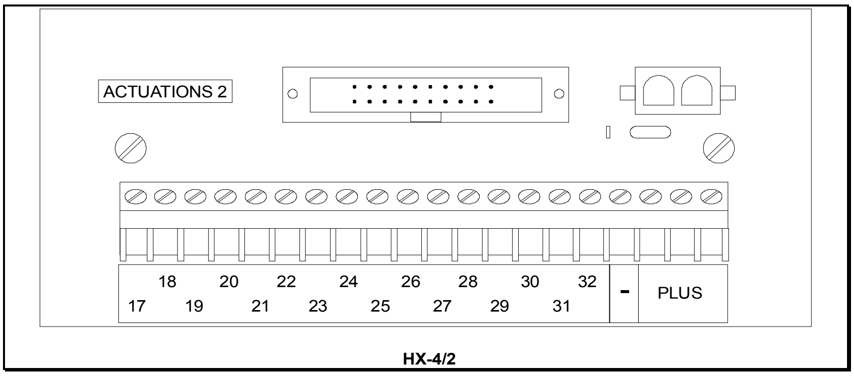
2. Joint live and neutral:
   The joint live and neutral of a DSAT may not be connected to another DSAT.

3. Type of relay:
   Relays actuated by the DSAT must have a coil voltage of 24 V dc and must not consume more than 40 mA.
   The consequence of this is that a maximum of 2 Hoogendoorn DC boards may be connected per actuator.

4. Suppressor diodes:
   Relays actuated by the DSAT must always be fitted with suppressor diodes. Type 1N4002 (or 1N4004, 1N4007 or other equivalent diode) is used as a suppressor diode. This diode is connected across the relay coil in the relay circuit. The anode of the diode is connected to the - of the 24 V dc relay, and the kathode of the diode is connected to the + of the 24 V dc relay.

HX board

This is the board to which the actuators are connected. Each DSAT incorporate two HX boards. HX/1 for actuators 1 to 16 and HX/2 for actuators 17 to 32. The actuators (24 V dc) are connected with the negative to the actuator output and the positive of the actuator output to the common plus connection. The ribbon cable connector is connected to the HD board. Take note of the next for actuators 1 and 2.



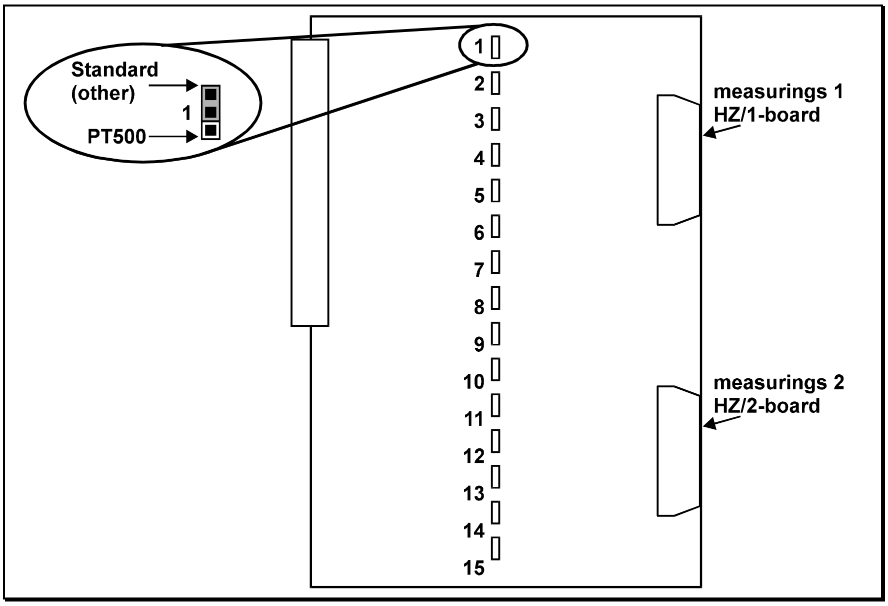
6.3 Measurement devices

6.3.1 HA board

This board converts the analog measurement signals from the sensors into a digital signal. The HA board has 15 channels for a maximum of 15 sensors. A distinction is drawn between two types of sensor:

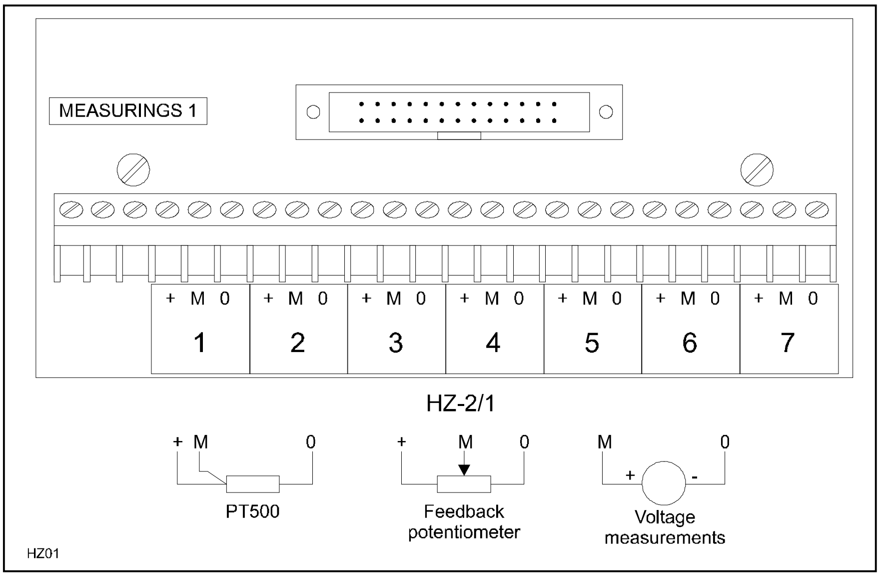
PT500	= type PT500 temperature sensor
Standard	= all other sensors

The type of measurement device can be set with a jumper (see drawing). The jumpers can be set simultaneously in one action using the connection documentation (see para. 6.7). If no sensor is connected to the input, the jumper position ‘Standard’ must be chosen.



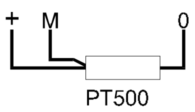
6.3.2 HZ board

The measurement sensors are connected to this board. There are two HZ boards. HZ/1 for measurement devices 1 to 7 and HZ/2 for measurement devices 8 to 15. The HZ board is connected to the HA card with a ribbon cable. Note the text for measurement devices 1 and 2 to ensure that these are correctly connected.
The sensors are connected as per the figure opposite.



6.3.3 Temperature sensors

The temperature sensors are PT500 resistance sensors; this means that the resistance of the sensor is 500 ohms at 0°C. The resistance increases by 2 ohms for each one-degree increase in temperature. At 20°C, therefore, the sensor resistance is 540 ohms.

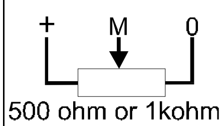


temperature [°C]	voltage [V]
0	0.54
10	0.55
20	0.56
40	0.57
60	0.59
80	0.61

PT500-01

The sensor is connected to the HZ board as per the drawing opposite. Set the jumper on the HA board to the 'PT500' position for this measurement device. Use a multimeter to check the voltage between 0 and M against the table opposite.

6.3.4 Feedback device



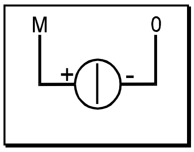
Position [%]	500 ohm potentiometer voltage[V]	1 kohm potentiometer voltage [V]
0	0	0
25	0.14	0.18
50	0.27	0.35
75	0.41	0.53
100	0.54	0.70

500ohm01

The feedback device, for example a vent position sensor or burner position sensor is a potentiometer with a range of 0 to 500 ohms. A 1 kohm potentiometer may also possibly be used. The feedback device is connected to the HZ board in the DSAT as per the diagram below:
The connections can be monitored by measuring the voltage between 0 and M (on the HZ board) using a multimeter. The voltages which should be measured with a 500 ohm feedback device are different from those with a 1 kohm feedback device (see table).

6.3.5 Voltage measurement

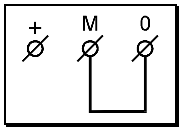
For the voltage measurement, the computer measures a voltage output by a measurement sensor. This voltage varies as a function of the reading that the measurement sensor records.



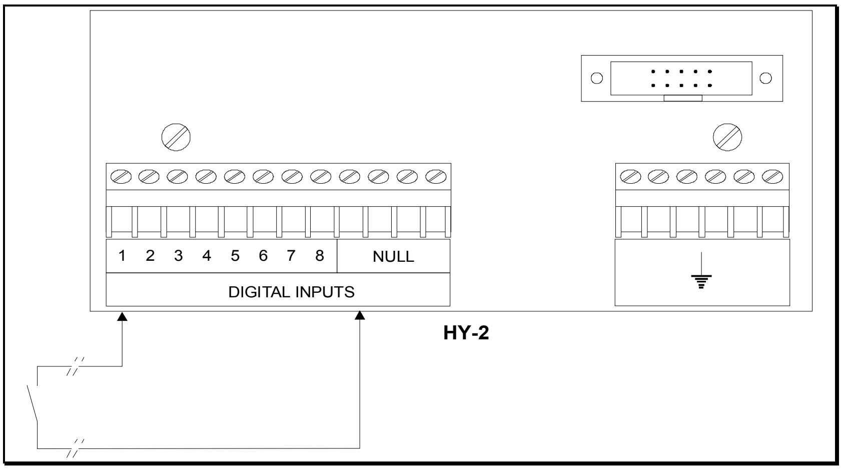
The various types of measurement sensor have different output voltages. The description of the climate and water peripherals (see chapter 10 of this manual) indicates how these output voltages should be monitored.

6.3.6 Unused measurement devices

All initiated measurement inputs which are not connected **must** be interconnected to neutral, and the jumper (HA board) must be set to ‘Standard’. This is because an open measurement input can seriously interfere with connected measurement devices.



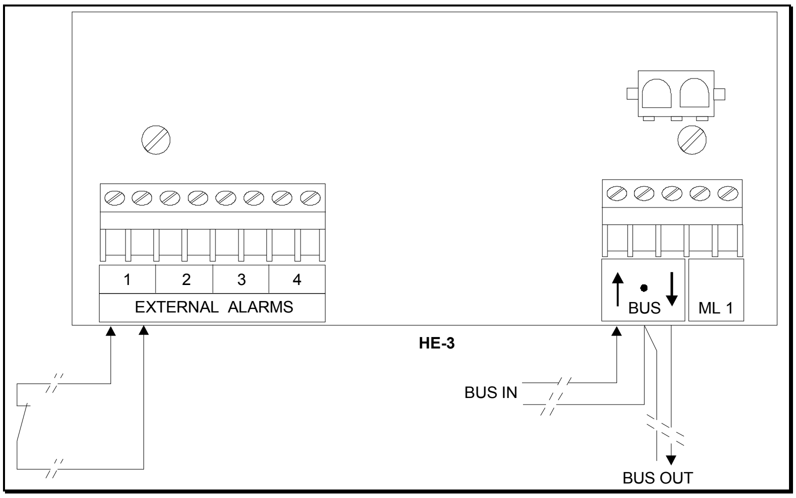
6.4 Detectors



HY board
The digital detectors can be connected to this board. The connected detectors must be clean, i.e. metallically isolated, de-energised and non-earthed. Detector no. 1 is reserved for the alarm circuit and is already connected.

6.5 External alarm

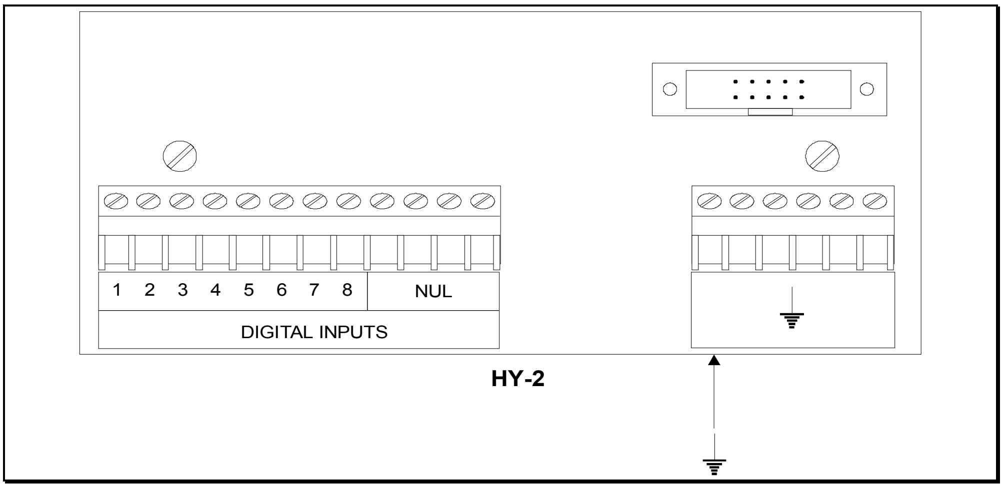
The system contains a large number of connections for external alarm contacts (DOO, DSS, matrix). These are potential-free contacts which must be interrupted if a fault occurs. These contacts can be connected separately or in series with each other to the 'external alarm circuits' in the DSATs.



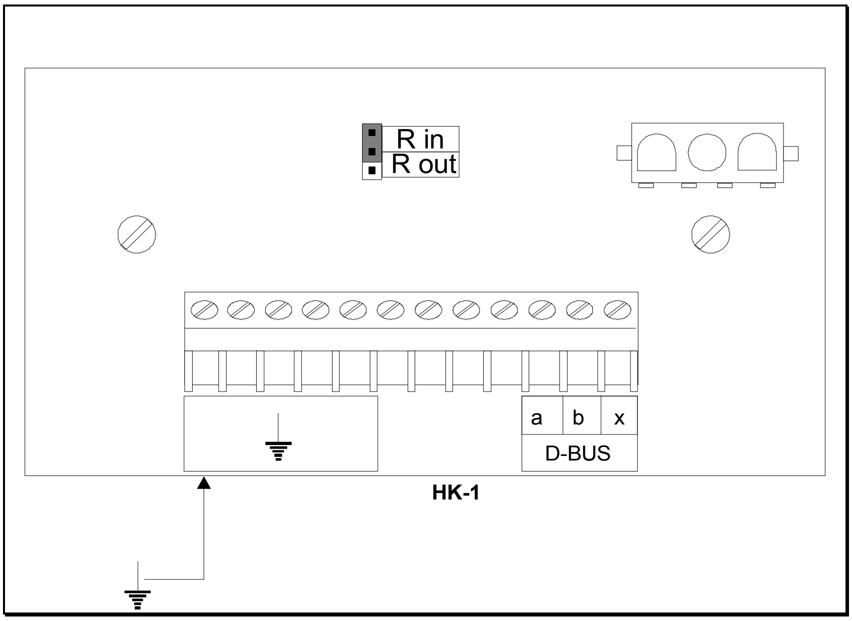
HE board
The alarm detectors are connected to this board. The alarm detectors of, for example, a limit switch, air-operated motor or alarm thermostat are connected to the connector with EXT.ALARMS. This must be a de-energised contact. Any unused circuits must be provided with a through-connection. The three CIRCUIT connections are outside the entire computer system for the alarm circuit so that an alarm is given even if, for example, the power to the entire computer system fails.
The circuits can be monitored by manually inducing a fault. In many cases this can be done by switching off the power to the module in which the external alarm circuit is connected.

6.6 Spare cores

The spare cores of the measurement cables or other spare cores must be connected to the earth connector of the HY board.



A number of terminals are also available on the HK-1 board for connecting spare cores.



The purpose of connecting the spare cores to earth in the DSAT is to create a shield against external interference.

An additional advantage of having several spare cores in a cable is that it is possible to expand the system later without requiring new cabling.

There must always be at least 1 spare core present per cable.

6.7 Connection documentation

The connection documentation indicates which control, measurement, actuation and detection devices are initiated in the *ECONOMIC* NT and where they are connected.

6.7.1 Cover page

The first page of the connection documentation can look as follows:

Name	: A. Grower
Address	: 34 Greenhouse Road
Town/city	: Anytown
Country	: England
Tel	: 01234-567890

System	: *ECONOMIC* NT
Config. no.	: 3050

System installation date	: 01-11-97
Program release date	: 10-6-98
Current program version	: Hedera 1.3
Previous program version	: Hedera 1.1

Satellite	Free MT	Free ST	Free ML
1-1	2	7	3
1-2	3	5	7

Free MT means: of free analog inputs
Free ST means: of free digital outputs
Free ML means: of free digital inputs

6.7.2 Configuration and address tables

Page 2 onwards contains the tables that indicate which items are started up in the configuration and the accompanying address tables. The first table can look as follows:

General	00
Weather data	Y
Solarimeter	Y
Alarm program	Y
2nd alarm actuator	Y
Depth reports	Y
Long-term readings	Y
Group sets	Y

General	00
ME outdoor temperature	1102
ME wind speed	1103
ME wind direction	1104
ME rain sensor	1108
ME solarimeter	1105
SE alarm hooter	011201

This table contains the addresses, where:

ME = weather (fixed connections in DSAT)
SE = actuator (1-32)
MT = measurement device (1-15, measurement 0 for DSAT)
PO = detection devices (2-8, detection device 1 for alarm circuit)

The address comprises two or three numbers:

EXAMPLE 1:
ME outdoor temperature 1102
In which: 11 = circuit number 1, DSAT number 1
02 = terminal number

EXAMPLE 2:
SE alarm hooter 011201
In which: 01 = number of actuators
12 = circuit number 1, DSAT number 2
01 = terminal number

EXAMPLE 3:
MT greenhouse temperature 1112
In which: 11 = circuit number 1, DSAT number 1
12 = terminal number

EXAMPLE 4:
PO curtain detector 1 2102
In which: 21 = circuit number 2, DSAT number 1
02 = terminal number

The next table can look as follows:

Climate control	01	02	03	04
Greenhouse temperature measurement	Y	Y	Y	Y
Aspirator fan	Y	Y	Y	Y
Wet bulb measurement	Y	Y	Y	Y
Heating circuit 1	Y	Y	Y	Y
GT transport circuit 1	0	0	0	0
GT main boiler circuit 1	1	1	1	1
GT TE circuits	0	0	0	0

In which: GT = transport group number

The relevant address table is then given again:

Climate control	01	02	03	04
MT greenhouse temperature	1202	1203	1301	1302
SE aspirator fan	011202	011203	011301	011301
MT wet bulb temp	1204	1205	1303	1304
MT water temp. circuit 1	1206	1207	1208	1209
SE mixing valve/pump circuit 1	031204	031207	031210	031213

6.7.3 Tables per group

These tables record the measurement devices, detectors and actuators for each group. A table can look as follows:

Climate control table	Group 05	
MT greenhouse temperature	Group 5	1-2.02 PT500
MT wet bulb temp.	Group 5	1-2.04 PT 500
MT water temp. circuit 1	Group 5	1-1.06 PT 500
SE mixing valve/pump circuit 1	Group 5	1-1.12 Mixing valve open
SE mixing valve/pump circuit 1	Group 5	1-1.13 Mixing valve closed
SE mixing valve/pump circuit 1	Group 5	1-1.14 Circulation pump off
SE mixing valve/pump circuit 1	Group 5	1-1.15 Second stage pump off

The column on the right contains the type of measurement device or detector plus a description after the terminal number. This list enables the jumpers of the measurement devices on the HA board to be set to the correct position (see para.6.3 measurement devices)

6.7.4 Tables per DSAT

These tables provide a breakdown for each DSAT. A table in this report can look as follows:

Satellite 1-1

ME outdoor temperature	Group 0	1-1.02	
ME wind speed	Group 0	1-1.03	
ME wind direction	Group 0	1-1.04	
ME solarimeter	Group 0	1-1.05	
ME rain sensor	Group 0	1-1.08	
MT greenhouse temperature	Group 1	1-1.01	PT-500
MT greenhouse temperature	Group 2	1-1.02	PT-500
MT greenhouse temperature	Group 4	1-1.03	PT-500
MT wet bulb temp	Group 1	1-1.04	PT-500
MT wet bulb temp	Group 2	1-1.05	PT-500
SE alarm hooter	Group 0	1-1.01	Alarm hooter in general
SE aspirator fan	Group 1	1-1.02	Off

Notes:

7 Installation advice re equipotential bonding

Computer systems in agriculture and horticulture have become extremely reliable in many areas in the last few years. Nonetheless, insurers among others have noticed that quite some damage still occurs as a result of lightning strikes or static discharge.

Despite the measures already incorporated by Hoogendoorn in its equipment there are, unfortunately, circumstances in which the system cannot be adequately safeguarded.

We have conducted an analysis of this damage and the installation conditions where such damage mainly occurs. The results and recommendations which have emerged from this are given below. Although the recommendations made are not a guarantee that damage can never occur again, it may be anticipated that the risks in such systems have been substantially reduced.

It has emerged from the analysis of the relevant cases that they almost always involve sites where the greenhouses are not joined together but are separated by, for example, a track or a piece of open land. Furthermore, the power supply to the system in these cases very often comes from more than one connection from the utility company with the relevant earth (either an electrode or a supplied earth). Since the earth's surface is not an ideal conductor, very large potential differences can occur between the various system modules during thunderstorms. Because the computer system extends across the entire site, signal cables form the connections across which these potential differences can be equalised. In satellite systems the satellite cable is a clear example, while in other systems the effect is often caused by a large number of long signal cables. The equipment connected to these signal cables cannot, of course, always withstand the very high voltages and currents which can occur in these situations, and this results in damage.

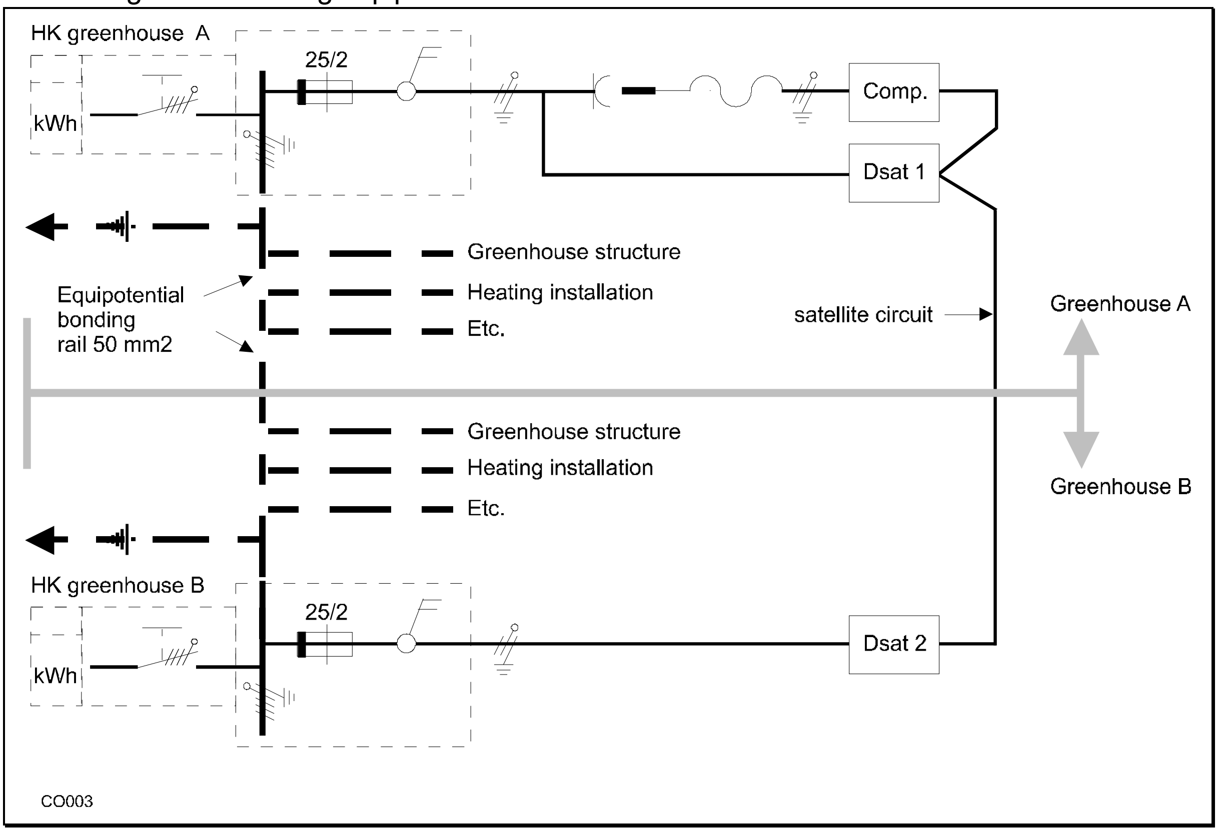
One effective measure in these cases is to use equipotential bonding. This can be achieved by laying an equipotential bonding rail in the form of a continuous (bare) 50 mm^2 core which connects the earths with each other. The conductive parts of the greenhouse structure, the heating system, concrete reinforcement etc. must be firmly connected to this rail.

If the satellite cable is laid underground, a sturdy double-shielded underground cable must be used to prevent moisture ingress and to ensure mechanical strength. The outer shield must be earthed at both ends as considerable potential differences can also occur in the ground.
The above measures are specified in Dutch standards NEN 1014 and NEN 1010 as protection against lightning strikes.

We are aware that these measures drive costs up. In the light of our experience and the advice of outside experts in the field, however, we feel that this increase in costs is a responsible step, particularly if the measures are implemented when the computer system is installed. It must be borne in mind that the costs associated with material damage from a lightning strike can be considerable, particularly if product damage occurs as a result of a computer failure or an incorrectly functioning computer. The costs of retrospective measures can also be substantial. This is in the interest of neither the user nor the installer. It should be noted, though, that equipotential bonding alone is no absolute guarantee against damage resulting from a lightning strike. Supplementary measures can also be required, but it has been shown that equipotential bonding is the first task to be tackled.

We should also like to point out the following, at the risk of stating the obvious:

- Δ Equipotential bonding protects not only the computer system but also all the other electronic equipment on the site.
- Δ Equipotential bonding is important for every project, i.e. not just in the case of multiple electricity supply points and/or earthing points.
- Δ Equipotential bonding measures must be carried out in compliance with the regulations of the local utility companies with regard to the connection of protective earthings and the earthing of water and gas pipes.



The above drawing shows an example of a computer system which extends over two separate parts of a site. Major potential differences can occur between the earth electrodes during thunderstorms and these will be equalised via the satellite cable, which can cause damage to the satellites and the computer.
The installation of an equipotential bonding rail in the form of a continuous 50 mm^2 bare core between the earth electrodes means that it is no longer possible for large potential differences to occur. The conductive parts of the greenhouse structure, the heating system, any concrete reinforcement etc. must also be connected to this ‘rail’.