CEILOMETER

CBME80B

User's Guide

CBME80B-BEAB218800-rev: 2.6.10
August 2022

CE

CONTENTS

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INTRODUCTION TO MANUAL

The purpose of this User's Guide is to be a general information source as well as a detailed operational guide for the user of Ceilometer CBME80B.

This document is divided into 10 chapters. Chapter 1 and 2 offer an overview and technical specifications of the CBME80B ceilometer. The following chapters 3 and 4 contain installation and start up instructions. Operational instructions with user commands and data messages descriptions are included in chapter 5. Chapter 6 includes functional and technical descriptions of the ceilometer. Chapter 7, 8 and 9 contains instructions for maintenance, troubleshooting and repair. Chapter 10 includes drawings.

VALIDITY OF THIS MANUAL

This manual covers ceilometer CBME80B in all its configurations as defined by the parts and options listed in *section 1.1*.

Differences between specific hardware revisions are clearly marked throughout the manual.

The functionality and default values of the software throughout this manual are reflecting software revision:

CBME80B-A1.08A-1966

Table 1 lists the revision history that may apply in comparison to other units in use:

Software revisions	Description
CBME80B-A1.08A-1966	See separate document

Table 1, Software Revisions

SAFETY SUMMARY

The following safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Björn Eliasson Ingenjörsfirma AB assumes no liability for the customer's failure to comply with these requirements.

LASER SAFETY

The CBME80B is officially certified as a Class 1M laser device in accordance with European standard IEC-60825-1 Edition 1.2, 2001-08. It is also classified in accordance with U.S. regulation ANSI Z136.1-2000 as a Class 1 laser device. This means that a CBME80B Ceilometer installed in a field environment with instrument covers on and pointed vertically or near-vertically poses no established biological hazard to humans.

The device is equipped with the following label at the bottom plate:

The instrument is intended for operation in an area restricted from public access and pointed up vertically or near-vertically. The following precautions are to be noted and followed during service and maintenance of the instrument:

- Never look directly into the Laser Transmitter with magnifying optics (glasses, binoculars, telescopes, etc.).
- When operating, avoid looking at the ceilometer from the beam direction. If the unit is tilted, make sure that it is not being viewed from the beam direction with magnifying optics.
- Only trained personnel should perform maintenance tasks.

EQUIPMENT GROUNDING

The ceilometer shall be grounded by a 16 mm^2 earth cable connected to one of the two bolts on the bottom plate; the other end of the grounding cable should be connected to earth rods driven into the ground.

POWER CONNECTION

The instrument is equipped with a AC power connector. The power cable must be installed into an approved three-contact (phase, neutral, protective earth) electrical outlet.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

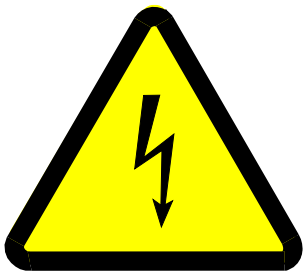
Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to a Manufacture office or authorized Depot for service and repair to ensure that safety features are maintained.

KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cable connected. To avoid injuries, always disconnect power.

High voltage will be accessible when the covers of the transmitter, receiver and power unit are removed and the ceilometer is connected to mains voltage or 12-volt DC power supply.

The Transmitter, Receiver and Power unit have the following warning label:

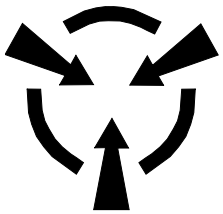


DANGEROUS PROCEDURE WARNINGS

Warnings, such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed:

WARNING

Dangerous voltages, capable of causing death, are present in this instrument. Use extreme caution when handling, testing, and adjusting.



CAUTION

The equipment contains parts and assemblies sensitive to damage by Electrostatic Discharge (ESD). Use ESD precautionary procedures when touching, removing or inserting.

RECYCLING

Recycle all applicable material.

Dispose of the unit according to statutory regulations.
Do not dispose of in regular household waste.

1. GENERAL INFORMATION

1.1 Product Overview

The CBME80B ceilometer measures cloud height or vertical visibility (if no clouds present) up to 7600 meters (25000 feet). The cloud height is measured continuously and can be displayed on several types of display units depending upon different needs.

The ceilometer can be used at airports, automatic weather stations, oil platforms, etc., either as stationary or mobile equipment because of its low weight.

The CBME80B functions according to the LIDAR principle (LIDAR = Light Detection And Ranging) where short laser pulses are sent out in a vertical direction and the time of the returned reflections are measured. The amplitude of the reflected light, the backscatter signal caused by haze, fog, mist, precipitation and clouds is measured as the laser pulses traverse the sky. The resulting backscatter profile, i.e. signal strength versus time, is stored and then processed to determine the height of cloud bases. Knowing the speed of light, the time delay between the launch of the laser pulse and the detection of its backscatter signal indicates the cloud base height.

$$\text{Cloudbase} = \frac{\text{Time} \times \text{Speed of Light}}{2}$$

The transmitter in the ceilometer is a semiconductor laser diode. The output power is limited to a level not dangerous for the human eyes provided that the emitted radiation is not concentrated and viewed with the aid of an optical system.

The CBME80B can detect up to three instant cloud bases simultaneously. Additionally, the sky coverage algorithm calculates up to four cloud layers and amount. Besides cloud bases, it detects whether there are other obstructions to vision i.e. vertical visibility. No adjustments in the field are needed. The embedded software includes service and maintenance functions and gives continuous status information from internal monitoring.

CBME80B consists of the following parts.

- Power unit
- Master unit
- Processor unit
- Power sensor
- Internal heaters
- Optics

The ceilometer is shipped with connectors for power and communications, and this CBME80B User's Guide.

In addition, the following options may be included in the delivery:

- Service cable (RS-232)
- External window blower unit CBFL40
- Sun shutter (needed for tropical areas)
- Local display
- Tilt
- Window contamination detection
- Stand
- PC presentation software “Cloud Presentation Suite”
- External numeric display
- FSK demodulator

1.2 Brief Function Description

The block diagram of *Figure 1-1* shows the principle of the ceilometer. The transmitter, a laser diode, emits very short light pulses with a repeat frequency of about 1 kHz under control of the microprocessor. The optic lens above the transmitter concentrates the light to a beam with small divergence. When the light pulses penetrate a cloud, some parts of the light are reflected straight back through an optic lens onto a photo diode in the receiver. After filtering and analog-to-digital conversion of the echo signal, the microprocessor calculates the time between the pulse transmission and the echo pulse reception. A time of 100 ns corresponds to about 15 m in cloud height.

The calculated cloud base heights are sent in a digital message (FSK-modulated signal or as RS-232/RS-485 or Ethernet) to central computers, display units, PC-presentation, data loggers etc.

In addition to the cloud measurement, the microprocessor controls and supervises the following functions:

- Laser diode temperature (Ltemp)
- Laser high voltage (LHV)
- Laser pulse current (LCU)
- Laser peak power (LPP)
- Receiver high voltage (DHV)
- Function of the receiver system (Sys_test)
- Equipment temperature (Rtemp)
- Reference voltage (Ref)
- Power supply unregulated voltage (+12V)
- Blower control (option)
- Window contamination (option)

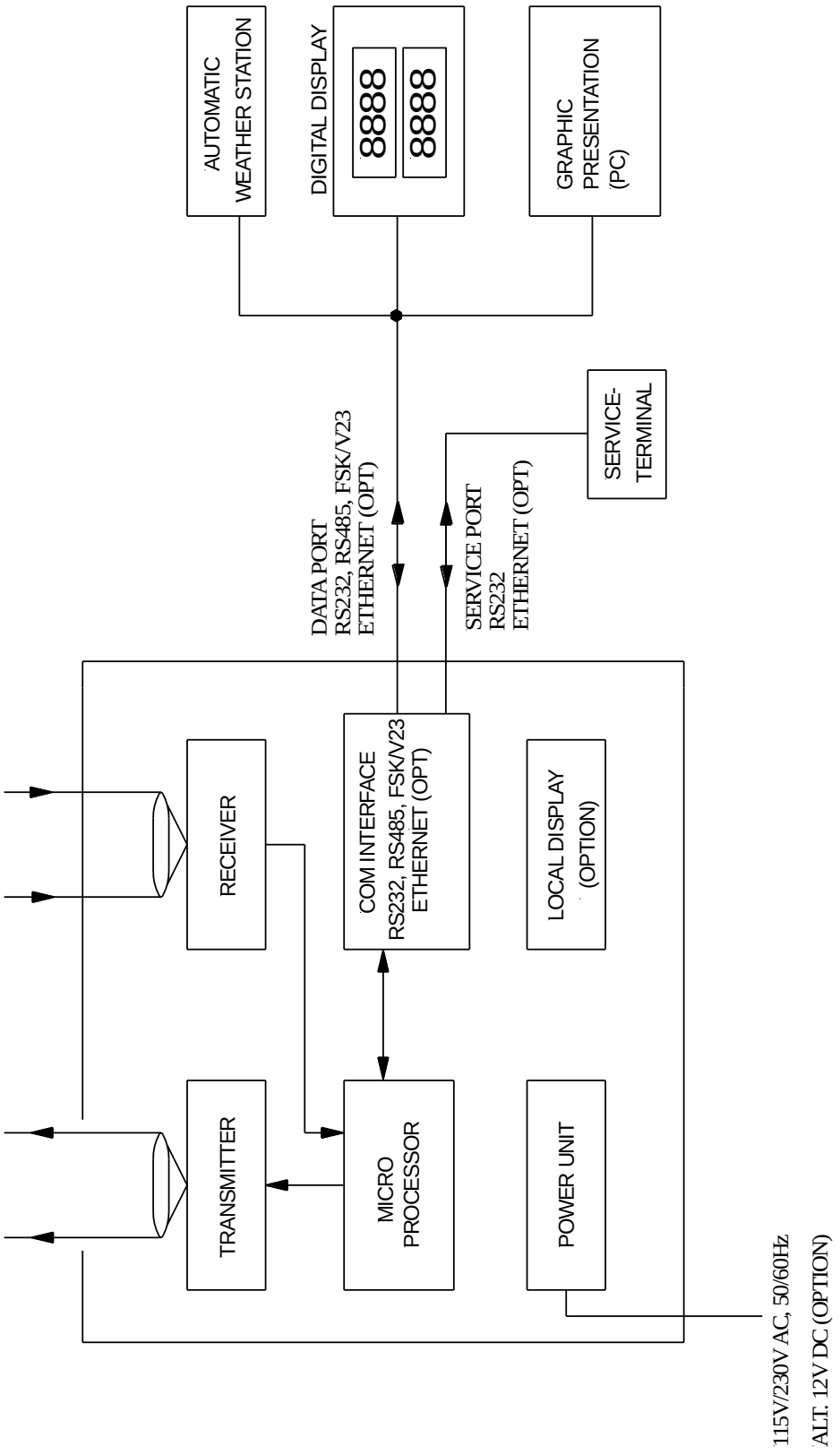


Figure 1-1 Block diagram CBME80B system

1.3 Specifications

1.3.1 Performance

Range:	0 – 7600 m (0 – 25000 feet)
Reporting resolution:	5 m / 10 feet
Accuracy:	Greater of ±5 m (±15 ft) or ±1% of height Measured against hard target.
Measuring interval:	Periodic (15 – 120 s), selectable Polling (any interval)
Output interface:	One service port: RS-232 One data port: FSK/V.23, RS-232, RS-485 (half duplex) Ethernet: Via data or service port
Data output:	Unit ID, diagnostic status, up to 3 cloud bases with penetration depth, vertical visibility, cloud amount and signal backscatter profile.
Local display: (option)	Presentation of lowest cloud base/vertical visibility

1.3.2 Transmitter

Type:	Fiber attached CVN – Laser
Pulse power:	50 W
Pulse length:	100 ns
Pulse frequency:	1000 Hz
Wavelength:	905 ± 5 nm
Optic:	1:2/200
Divergence:	2 mrad

1.3.3 Receiver

Detector:	Avalanche photo diode (APD)
Interference filter:	Center wavelength 906,5 nm typical (matched with laser wave length)
50% Pass Band:	7 nm
Transmissivity:	80 % typical, 70 % minimum
Optic:	1:2/200
Viewing angle:	2 mrad

1.3.4 Environmental

Ambient temp:	-40°C – +55°C (-40 ...+130 °F), or -50°C – +60°C (-60 ...+140 °F) (extended range) (option)
Humidity:	Up to 100% RH (non-condensing)
Vibration:	2.0 g 5 - 150 Hz
Wind:	Up to 65 m/s
Housing classification:	IP54, IP66 (option)
Mains:	115V / 230V AC ± 15%, 45 – 65 Hz, 12V DC (option)
Power consumption:	Electronics 30 W (typical) Heater 160 W (only when AC connected) Blower 250 W (option) (115V alt. 230V AC)

1.3.5 Mechanical

Dimension: (Width x Length x Height)	232 x 468 x 408 mm (9 x 18 x 16 inches)
Weight:	Ceilometer: 15 kg (32 lbs) Stand (option): 6 kg (13 lbs) Blower (option): 12 kg (26 lbs)
Transport container size (ceilometer):	400 x 600 x 610 mm (16 x 24 x 24 in.)
Transport container weight (ceilometer):	5 kg (10 lbs)

1.3.5.1 Connectors

A number of different connector arrangements for AC, DC, Blower and communication exist (for details se *section 3.8)*.

1.3.6 Verification reports

1.3.6.1 EMC & Climatic tests

Immunity according to	EN61000-6-2:2001
Emission according to	EN61000-6-4:2001
Dry heat according to	IEC68-2-2, Test Bd
Cold according to	IEC68-2-3, Test Ad
Damp Heat Steady State	IEC68-2-3, Test Ca
Ingress Protection	IEC60529:2001

1.3.6.2 Mechanical environmental tests

Free fall test according to	IEC60068-2-32/Ed
Bump test in packaging	IEC60068-2-29/Eb
Bump test	IEC60068-2-29/Eb
Sinus vibration test	IEC60068-2-6/Fe

1.3.6.3 Laser classification

Laser classification	Class 1M, according to IEC60825-1.1.2
Laser safety assessment	Laser safety assessment (US Air Force) AFRL-HE-BR-CL2003-0006 - Unaided Viewing: Class 1 - Aided Viewing: Class 3b

1.3.6.4 EC Declaration of Conformity

The ceilometer is in compliance with the following relevant community harmonization legislation:

EMC Directive	2004/108/EC
Low Voltage Directive	2006/95/EC
Restriction of the use of certain hazardous substances (RoHS II)	2001/65/EU
Waste electrical and electronic equipment directive (WEEE)	2012/19/EU

CE The ceilometer is CE-marked.

2. DESCRIPTION

2.1 Design

2.1.1 General

The ceilometer is designed for the outdoor environment.

The electronic circuits and the optic lenses are protected by a box consisting of a bottom plate, on which the electronic/optical unit is bolted, and a covering hood. The hood has a gasket for sealing against the bottom plate.

On the top of the hood there are two windows, one for the transmitter and one for the receiver. There is also a window for the local display (optional) to show the current lowest cloud base/vertical visibility or diagnostic status if an error situation exists. The hood has two handles for comfortable transportation.

The bottom plate is supplied with four feet and two bolts for mounting the ceilometer on a console or pedestal stand at fixed installation. Underneath the bottom plate there are connectors for mains, blower and communications (data port and service port). For the service port, there is also a connector (J6, DB25M) on the master unit.

NOTE

Different connector arrangements exist (see *section 3.8* for further information).

The electronic and the optical units are mounted on the bottom plate and consist of the following sub units (se *Figure 2-1 to Figure 2-4).*

- Hood
- Case
- Transmitter lens
- Receiver lens
- Mirror unit for transmitter
- Mirror unit for receiver
- Master unit
- Power sensor
- Power unit
- Heater
- Local display (option)

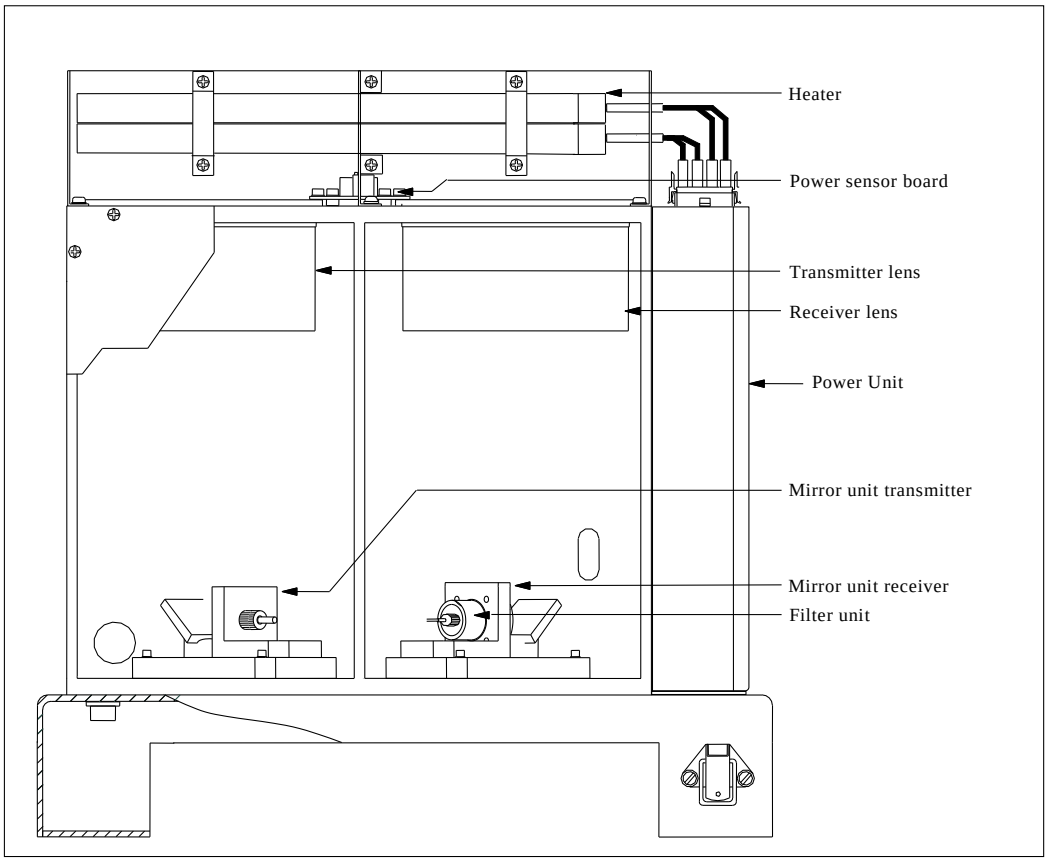


Figure 2-1 Side view CBME80B

2.1.2 Optics

The optic lenses of the transmitter and the receiver are mounted on the top of the aluminum case. At the bottom of the case, straight underneath the transmitter optic lens is the transmitter mirror unit, which reflects the laser pulse from the horizontal optical fiber connector from the laser diode. The receiver mirror unit, which is placed in the same way under the receiver optic lens, holds the filter module, which is connected to the receiver photo diode by an optical fiber. The filter module contains an optical filter that has a pass band corresponding to the wavelength of the laser light. The optical system is protected against dust etc. by an aluminum cover plate.

WARNING

The two mirror units together with the optics are adjusted in the factory. If any of these parts are loosened or moved from their original position, a new adjustment of the system must be done.

WARNING

The mirrors are very sensitive to dust, fingerprints and chemicals. Do not touch these mirrors (cleaning is not possible).

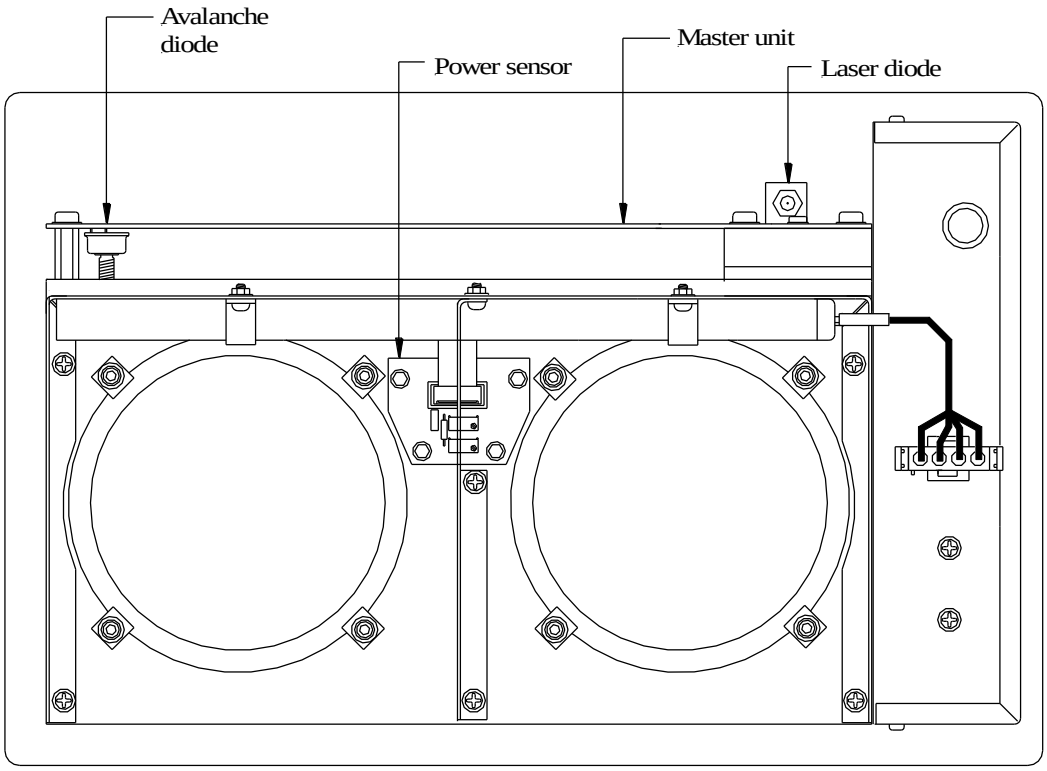


Figure 2-2 Top view CBME80B

2.1.3 Master unit

The master unit contains most of the electronic parts in the ceilometer including the laser diode and the avalanche diode. The unit consists of an electronic circuit board with a heating/cooling element (peltier) mounted on the back of the board. The laser diode is mounted on the peltier whose temperature is controlled by the microprocessor.

The optical fiber from the laser diode passes through a hole in the circuit board and through an opening in the case down to a connector at the mirror unit. The avalanche diode of the receiver is placed on the back of the circuit board. The optical fiber to the receiver comes from the filter unit through an opening in the case. The master unit is mounted on the case with screws and connected to the power unit and the power sensor with cable connectors. This straight forward mounting system for laser diode, avalanche diode and circuit board allow easy replacement of any item without the need for optical alignment or any special tools for removal or refitting.

2.1.4 Power sensor

The power sensor is a small circuit board mounted on the case between the lenses. It contains an IR diode for supervision of the receiver system (system test) and a photo diode to measure the output laser peak power (LPP).

The IR diode and the photo diode are on the back of the board.

Depending on configuration the board may be equipped with a photo diode for sensing the sun light intensity near the optics axis for sun shutter and/or contamination diode for detecting window contamination.

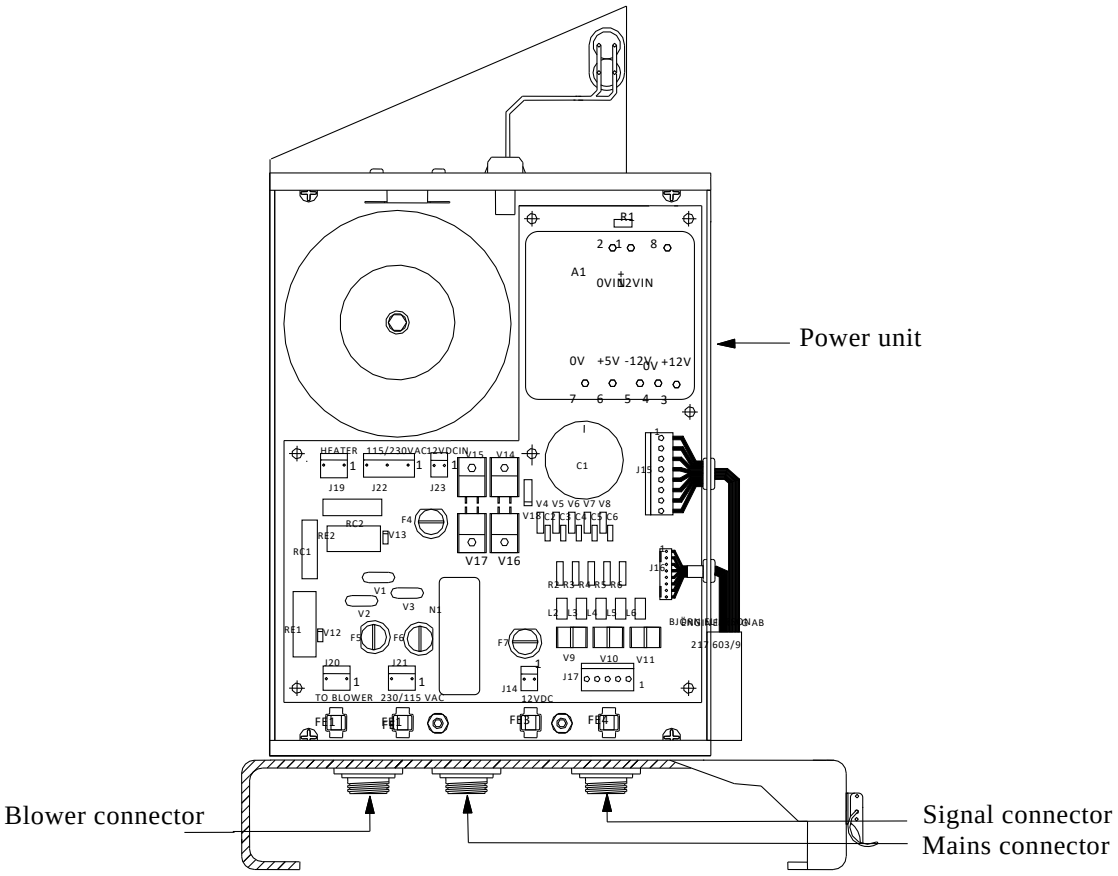


Figure 2-3 Short side view CBME80B

2.1.5 Power Unit

The power unit contains fuses, mains transformer, EMI filter, RF filters and over voltage protection for the communication and mains power lines. The unit also contains an AC/DC-converter and relays for controlling the window blower (option) and the heaters at the top of the case. The heater elements are connected to the power unit by a 4-pin connector (J8) at the top of the unit. DC power and communication lines are connected to the master unit by cables.

The optional Ethernet module may be installed inside the power unit.

2.1.6 DC Power Unit (option)

The unit is used when the ceilometer electronics is supplied by external 12V DC voltage. The DC Power unit contains fuses, EMI filter, RF filter and over

voltage protection. The main function is the same as for the Power unit except that no mains transformer exists.

For the standard 12V DC configuration AC power (115/230V) is still needed for heater and blower and should therefore be connected to the unit.

Alternative an all 12V DC configuration may be used for both electronics and heater. In this setup the heater elements are changed to 12V DC thermal resistors. No blower may be used in all 12V DC configuration.

2.1.7 Heater

To keep the windows on the hood free from moisture and ice, there are two heater tubes mounted on a plate on the top of the case, close to the windows in the top of the hood.

WARNING

The heater element can be very hot. If the hood is removed, disconnect the heater connector (J8) for safety before mains is connected to the ceilometer.

2.1.8 Local display (option)

The local display (option) is an integrated part of the master unit.

The display contains of 5 digits to show the lowest cloud base or, alternatively vertical visibility. In addition there are tree LED backlights indicating the units of the measurement and if the displayed value is cloud base or vertical visibility. If an error situation exists, the local display presents an error code (for details of the error code please read *section 5.9.3)*.

The local display layout is shown in *Figure 2-4*. Vertical visibility of 30 meters is displayed in the example. Measurement units and vertical visibility are indicated by the rectangular LED backlights.

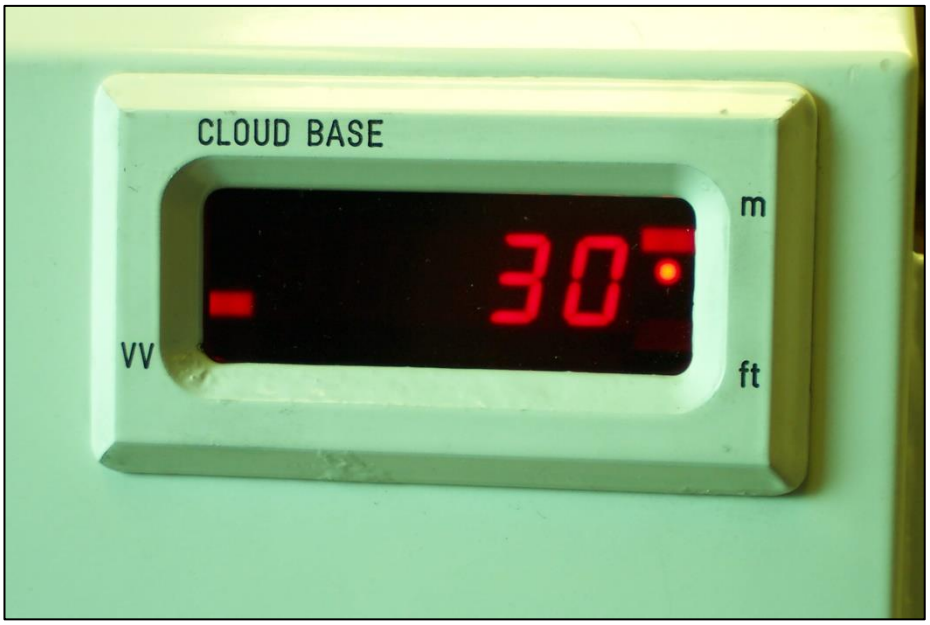


Figure 2-4 Local Display

2.1.9 Solar Shutter (option)

To prevent focusing the sunlight on the fiber ends when the sun is within approximately ±10 degree of the optics' vertical axis, the ceilometer is equipped with shutters to momentarily close the light path if the situation occurs when no clouds are present and the sun energy within ±10 degree is high enough.

During the time the path is blocked no measurements can be made and the ceilometer will indicate solar shutter activated in the status word. Because of the blocked light path, there will also be status indications for low power and system test during the time solar shutter is activated.

3. INSTALLATION

3.1 General

At delivery the ceilometer CBME80B is ready for installation including cable connectors for connection to signal cable and mains.

For installation of optional peripherals, displays, computers, etc. see manuals for these units.

WARNING

The equipment can be seriously damaged if it is stored without power or transported under severe environmental conditions e.g. high humidity without drying chemicals. In tropic areas, a sun shutter is required to protect the optical fibers from direct sunlight. **If a sun shutter is not installed in the ceilometer, do not aim the optics towards the sun to avoid damage on the optic fibers.**

When the ceilometer is placed outdoors it must be connected to mains or DC power to prevent condensing inside.

In areas with high wind speed (>40 m/s), it is recommended to use wire stays on the ceilometer stand.

3.2 Location

At location of the ceilometer, the following rules should be considered:

- The ceilometer must have free sight straight upwards.
- Do not locate the ceilometer in the vicinity of trees. Leafs and branches from the trees can fall down on the windows of the ceilometer and disturb the function.
- Avoid location in the vicinity of buildings.
- A shady location is to prefer to a location in direct sunshine, as the stress/aging of the components inside the ceilometer will be less on behalf of lower temperature.
- The "window side" of the hood should be faced from the sun to minimize the light noise.
- The ceilometer should be mounted straight vertical. If it inclines there will be a measuring error, which is negligible under 5° (+0.4%), but will be approximately 2% at 10° inclination.
- Avoid locations with lots of dust particles in the air that may cause increasing maintenance concerning window cleaning and filter replacement in blower unit CBFL40.

WARNING

If the ceilometer (without sun shutter option) is aimed at the sun the optical fibers can be damaged. At installation of the ceilometer (without sun shutter) steps must be taken to protect direct sun light from burning the optical fibers when tilting the ceilometer against the sun.

At installation of the ceilometer (without sun shutter) on board ship, steps must be taken to protect the instrument near tropic areas from sun light near the optic axes of the instrument. The ceilometer can be tilted towards the sun by roll and pitch.

3.3 Tilt (option)

Using the tilt option, it is possible to use the ceilometer in a tilted direction.

Normally the ceilometer should be tilted approximately 12 degrees to suppress reflections from large water drops with flat underside that may cause false detection under certain circumstances.

The tilt function also makes it possible to direct the laser beam towards a direction that better represents the approach area. This may be useful at sites where optimal position of the ceilometer is not possible.

To mount the ceilometer in a tilted position, perform the following steps:

- Mount the tilt 12-degree extension on the stand.
- Mount the ceilometer on the tilt extension.
- If the ceilometer is equipped with a blower, replace the blower air rubber pipe with the extended blower air rubber pipe supplied with the tilt extension.
- To avoid direct sun radiation, the ceilometer should be tilted away from the sun (i.e. to north in northern hemisphere and south in the south hemisphere).
- It is recommended to tilt the ceilometer forward. This way the windows will have a greater slope and any precipitation will disappear more quickly.

There is a built-in tilt angle sensor that measures the actual tilt angle, i.e. the deviation from the vertical axis and automatically compensates all the reported values.

For more information about the tilt option, see section 5.12.

3.4 Equipment Grounding

Equipment grounding protects the electronics of the ceilometer against lightning and prevents radio frequency interference.

The ceilometer shall be grounded by a 16 mm^2 earth cable connected to one of the two bolts on the bottom plate; the other end of the grounding cable should be connected to earth rods driven into the ground.

The grounding principals are:

- Install the earth rod as close as possible to the stand i.e. minimize the length of the earth cable.
- Earth rod length depends on local groundwater level. The lower end of the earth rod should continuously touch moist soil.

The quality of the grounding can be checked with a georesistance meter. Ensure resistance is according to national telecom standards, typical 5 ohms or less

3.5 Power Connection

The ceilometer is designed to be supplied from mains, 115V or 230V AC (see label at the power connector at the bottom of the equipment) or alternatively 12V DC (option). It is important that the connection is correct (see *section 3.8* for details).

At the connection of the ceilometer, consideration shall be taken to the following points:

- Power cable should be suitable for its purpose (environment, security requirements etc.).
- Check the mains voltage at the ceilometer.
- Protective earth shall be connected.

3.6 Blower Connection (option)

The blower unit is attached to the stand with bolts. The air outlet from the blower is connected with the air pipe on the ceilometer with a rubber pipe and two clamps. Connect mains to the blower from ceilometer blower connector.

See *section 3.8* for more information.

3.7 Signal Connection

Signal cable (e.g. normal telephone cable of voice grade) is connected to the signal connector.

For reliable data transmission the following requirements are recommended.

- Shielded and twisted pair cable
- Maximum cable length about 15 m for RS-232C
- Maximum cable length about 100 m for Ethernet
- Maximum cable length about 1 km for RS-485
- Maximum cable length about 10 km for modem line (FSK/V23)

3.8 Connectors Arrangements

All external connections to the CBME80B are located at the bottom. *Figure 3-1* to *Figure 3-7* shows the external connector alternatives and the wiring for the different connector arrangements possible in CBME80B.

For all arrangements suggested dimensions for the external cabling are:

Line Power Supply: 3 x 1.0 mm^2 (AWG 16)

Remote Communication: 0.22 mm^2 (AWG 24) twisted pair with shield.

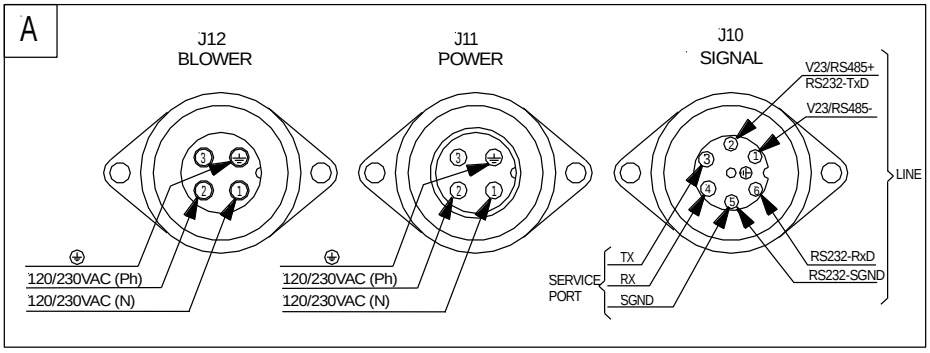


Figure 3-1 External connector arrangement A (standard)

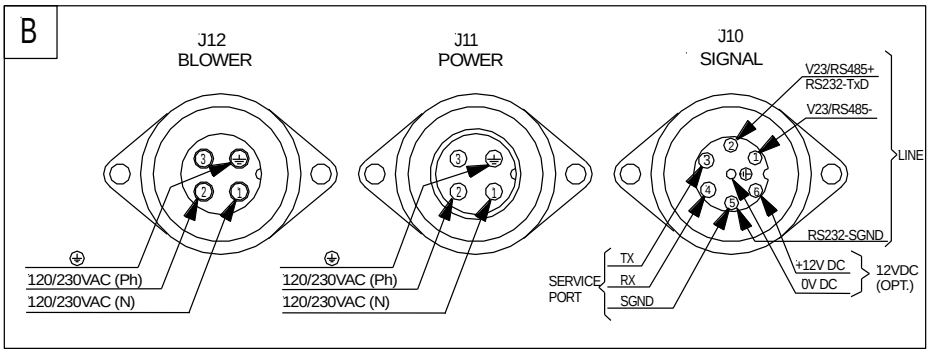


Figure 3-2 External connector arrangement B

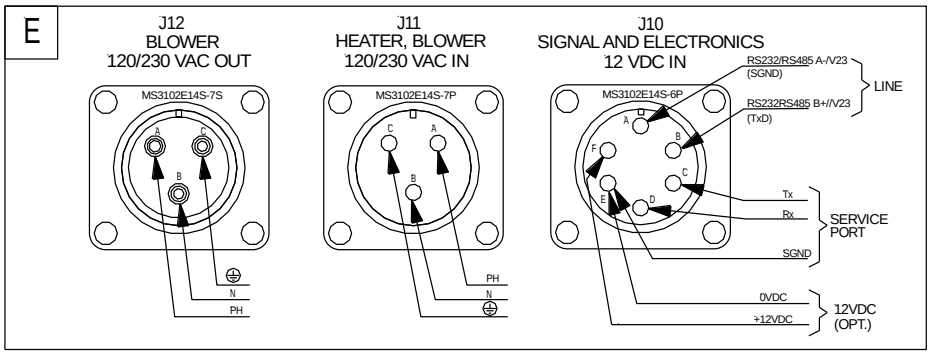


Figure 3-3 External connector arrangement E

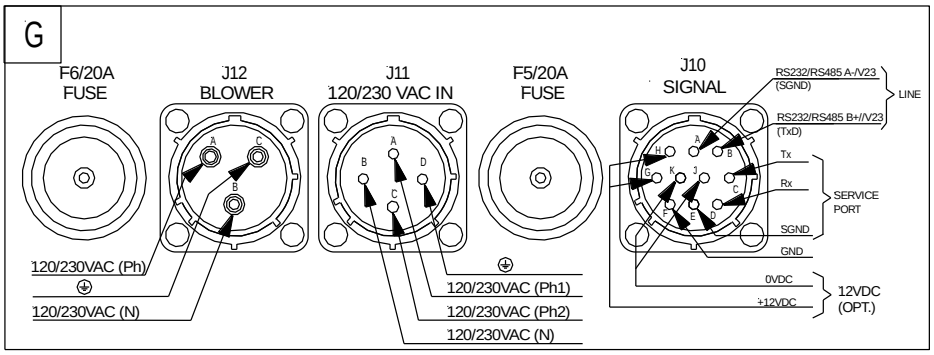


Figure 3-4 External connector arrangement G

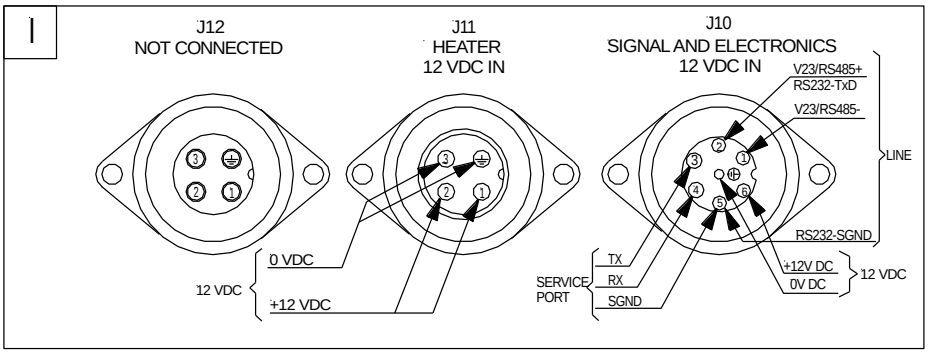


Figure 3-5 External connector arrangement I

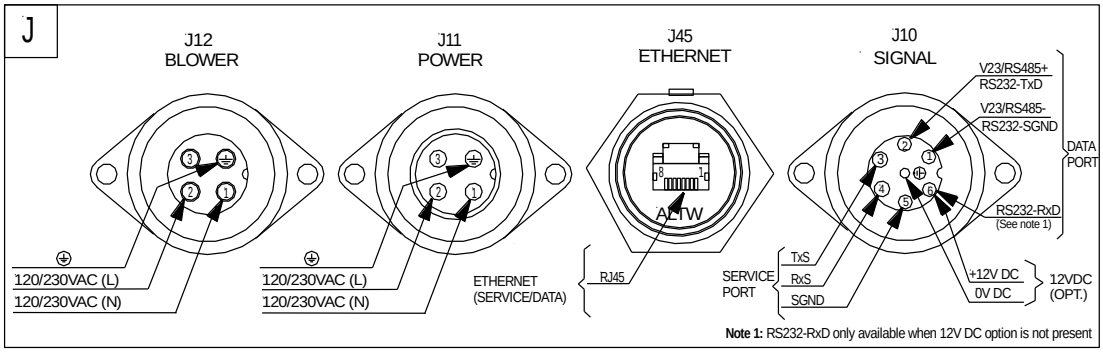


Figure 3-6 External connector arrangement J

3.9 Cable Glands Arrangements (option)

Cable glands can be used instead of connectors and may be suitable in harsher environments (i.e. oil platforms, ships, etc.).

All external cable glands to the CBME80B are located at the bottom. *Figure 3-7* shows the cable glands configuration. The cable wiring is detailed in chapter 3.9.2.

The cable glands are M16x1.5 supporting cables up to 10 mm in diameter.

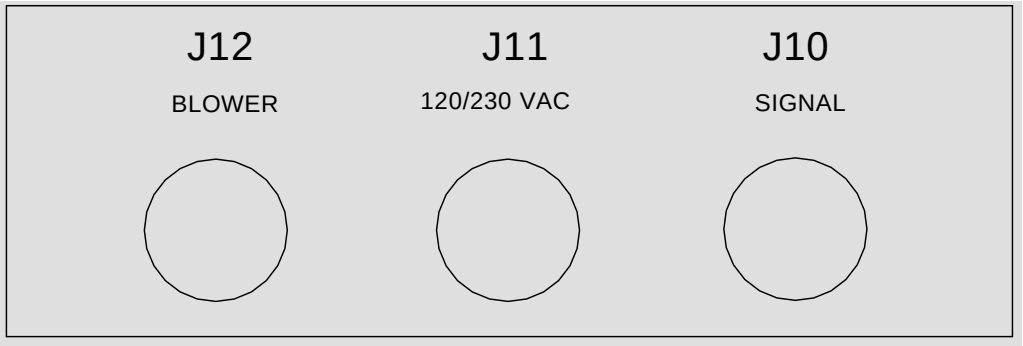


Figure 3-7 External cable glands arrangement

3.9.1 Cable types

Cable types used (unless otherwise specified) are:

Connection	*Specification*
J10 Signal	ÖLFLEX-PUR S27/03 5G0.75
J11 Mains	Helukabel H07 BQ-F 3G1.5
J12 Blower	Helukabel H07 BQ-F 3G1.5

Standard cable length is 3 meters.

3.9.2 Cable wiring

The following cable wiring is used for the cable glands option for installation:

Connection	*Cable wiring*
J10 Signal	J17:5 - Cable no. 1 (Data: FSK / TxD / RS-485+) J17:6 - Cable no. 2 (Data: FSK / SGND / RS-485-) J17:7 - Cable no. 3 (Service: RxS) J17:8 - Cable no. 4 (Service: TxS) GND - Cable green/yellow (Service: SGND)
J11 Mains	Brown – Phase Blue – Neutral Green/yellow – Protective earth/ground
J12 Blower	Brown – Phase Blue – Neutral Green/yellow – Protective earth/ground **Note**: When using cable glands for blower (J12) the blower should preferable also be configured with glands. For installation, please connect the J12 Blower (out) to the mains input on the blower using a junction box.

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4. START UP

4.1 Start-up procedure

The ceilometer is delivered ready for commissioning and set to factory defaults for message number (no2) and baud rate if not anything else is specified in the order.

The startup is done according to the following procedure:

- Install according to chapter 3.
- Prepare and connect data receivers, display units, etc. (if there are any) to mains and data line according to respective manual.
- Check that the mains voltage corresponds to the label on the ceilometer and blower unit (option).
- Connect data line to the ceilometer.
- Connect blower cable to ceilometer if optional blower unit exist.
- Connect power cable (optional power on switch may exist).

During the first 1 – 15 minutes from the connection of mains, depending of the ambient temperature, the laser temperature is adjusted to its set point value by the microprocessor. When the temperature is stable and within about ±1ºC from its set point the cloud measurement is started. During the startup time, the ceilometer sends data messages containing status errors at least every 30-second until all regulations has become ready.

If the output data are incorrect or there are no measured data due to status errors, an “E” (for error) followed by an error code is presented on the local display (option). For a description of the error codes see *section 5.9.3.*

4.2 Verification of Proper Operation

Proper operation of the Ceilometer can be checked by using any terminal emulation software such as Microsoft HyperTerminal.

Be sure that power is on to the ceilometer.

Attach the service cable to the service port (J6) located on the master unit, see *section 5.4.* The service port may be accessible at the bottom in some connector arrangements, see *section 3.8.*

The ceilometer should send message No 4 at least every 30 second in factory default configuration. Check that no status errors exist. If a solid cloud base is present, the cloud base shall be seen in the telegram. See *section 5.8.6* and *5.9* for details.

4.3 Settings for Normal Operation

Data message, interface, measurement interval and baud rate will be at factory default settings at delivery if nothing else was stated in the order. When required, the settings can be changed by commands in the service port with any terminal software.

During the factory alignment procedure, the optical adjustments are carefully carried out to fulfill the requirements and specifications of the instrument. Optical adjustments have been made at factory or depot, thus there is no need to readjust in the field.

4.4 Quick start configuration

The ceilometer is plug-and-play ready at delivery and configured with default telegram messages, interface and communication settings.

When deploying the ceilometer, typically the following settings may need to be changed:

- Communication settings:
  Baud rate etc.

- Telegram settings:
  Data message formats on the different ports

- Unit:
  Unit to use in output data from the ceilometer

- Height correction:
  Height correction for placement of ceilometer compared to runway

The rest of the settings may be kept as-is.

The above configurations can be done using any Terminal emulator software via the service menu.

4.4.1 Service menu

Perform the changes in the service menu.

1. Enter the service menu by entering `<ESC><ESC>` or `OPEN<ENTER>`.

2. Change the data channel settings by entering `1`

    a. Change the telegram format by entering `1` and selecting the desired format. Enter `q` to go back to the data channel menu.

    b. Change the baud rate by entering `2` and selecting the desired format. Enter `q` to go back to the data channel menu.

c. Change the parity and stop bit settings by entering `3` and selecting the desired format. Enter `q` to go back to the data channel menu.

d. Enter `q` to go back to the main menu.

3. Repeat the steps in point 2 for the service channel by entering `2` and repeat steps a. – d.

4. Change the individual site settings by going into the Site params by entering `3`

   a. Change the height offset by entering `4`

      i. Enter the height offset and end with Enter
      Note: The height offset should always be in meters regardless of selected unit.

      Enter `q` to go back to the Site params menu.

   b. Change the unit by entering `5`

      i. Select the unit to use by either entering `M` (for meters) or `F` (for feet).
      Enter `q` to go back to the Site params menu.

   c. Enter `q` to go back to the main menu

5. Enter `q` to exit the service menu.

All typical changes have now been configured and the ceilometer is ready for integration.

NOTE

If any of the communication settings has been updated, the ceilometer needs to be restarted.

Restart

Restart the ceilometer by either power-off/power-on, or by pressing the reset button on the masterboard, or by selecting reset from the service menu.

1. Enter the service menu by entering `<ESC><ESC>` or `OPEN<ENTER>`.

2. Go into special functions by entering `6`

3. Restart the ceilometer by entering `3`

The ceilometer restarts and the new communication settings are applied.

NOTE

If connected to the ceilometer and the settings for the port used for the connection has been updated, the terminal emulator communication settings also need to be updated to match the new configuration.

5. OPERATION

5.1 Operation Modes

The ceilometer can operate in three different modes. Only the normal mode is used for cloud measurements. The other modes (sys-test mode and alignment mode) are for maintenance purpose.

5.2 Communication Ports

There are two communication ports named Modem Port and Service Port. The ports are independent of each other concerning message type (no) baud rate, parity, etc. The Modem Port is intended for connecting to host computer systems and presentation units. The Service Port is normally intended for maintenance

5.2.1 Modem Port (V23/FSK, RS-232 or RS-485)

The Modem Port can be strapped to send data using one of the following communication standards:

- Modem signal (V23/FSK) for long distances (up to 10 km)
- RS-485 (2-wire half duplex) for medium distances (up to 1 km)
- RS-232 (full duplex) for short distances (typically 10 m)

Distances vary depending on damping on the communication line. RS-232 and RS-485 allows two-way communication.

Select communication standard by setting the jumpers on the master unit to one of RS-232, V23/FSK or RS-485.

NOTE

There are three jumpers to change (one group of 2x3 for Tx and one group of 1x3 for Rx).

The factory default settings for Modem Port are:

Baud rate	1200
Data bits	8
Stop bits	1
Parity	None
Interface	V23/FSK
Message	No 2

5.2.2 Service Port (RS-232)

The Service Port only has the capability of RS-232 and is normally used for maintenance. Note that if the Service Port is used for data communications, the output message is always message no 4 (service) for two minutes after start up, regardless of chosen message in parameter EE56.

The factory default settings for service port are:

Baud rate	2400
Data bits	8
Stop bits	1
Parity	None
Interface	RS232
Message	No 4

5.3 Ethernet (option)

An Ethernet port is also available as an option. The Ethernet port can be connected to either the service port or data port for full flexibility.

NOTE

When the jumpers are in setting Data the Data channel cannot be used in J10 and similarly when the jumpers are in setting Service the Service channel cannot be used in J10 or in J6.

The Ethernet option is provided by a third-party converter, the Moxa NPort. The reason for including a third-party converter is to allow full support for drivers for all operating systems including Microsoft Windows operating systems as well as Linux operating systems.

This allows for full flexibility in the IP based communication.

Support for serial device server using either virtual communication ports (with drivers for all relevant operating systems, including Linux kernels (Ubuntu Linux) and Windows kernels (Windows 10) and more.

In addition, the Ethernet also supports TCP or UDP client/server or Ethernet modem mode allowing for standard network API. SNMP network monitoring is also supported.

For full information on all configurable options, see the Moxa NPort 5000 series User's Manual.

See below for typical and recommended settings

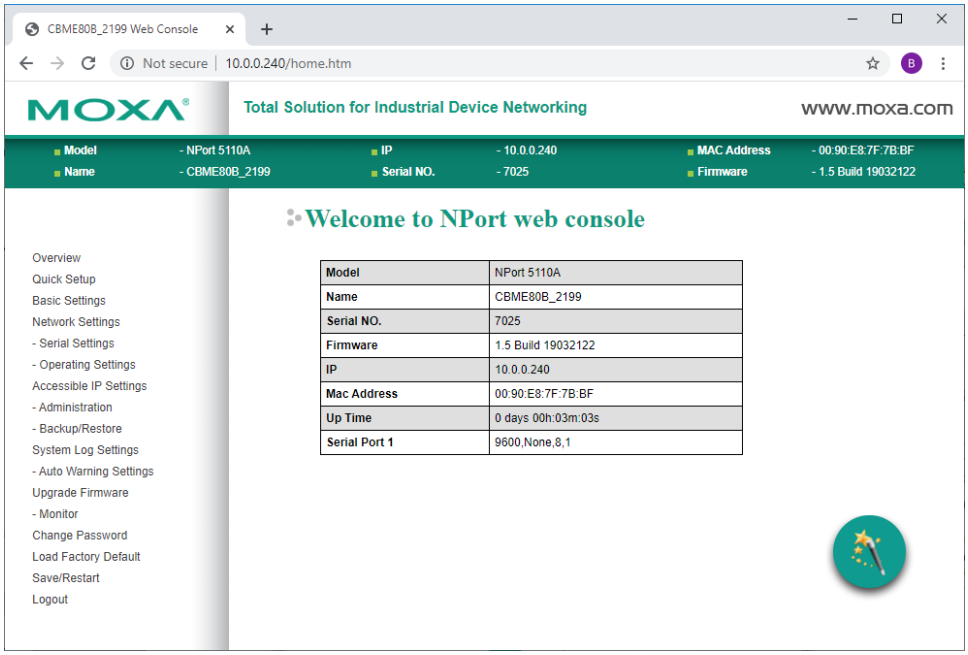
Access

Configuration of the Ethernet settings is done via a web interface. The web interface can be accessible using the following static IP address:

Web access: `http://192.168.127.254`

Please use any recent web browser to access the web interface.

Note: The IP address may be configured to be either static or dynamic using DHCP. See 5.3.1 for information on how to configure the IP address.



Use the following login information:

```
Default username: admin
Default password: eliasson
```

After successful login the welcome screen will be shown. The name of the device is `CBME80B_<SerialNo>`.

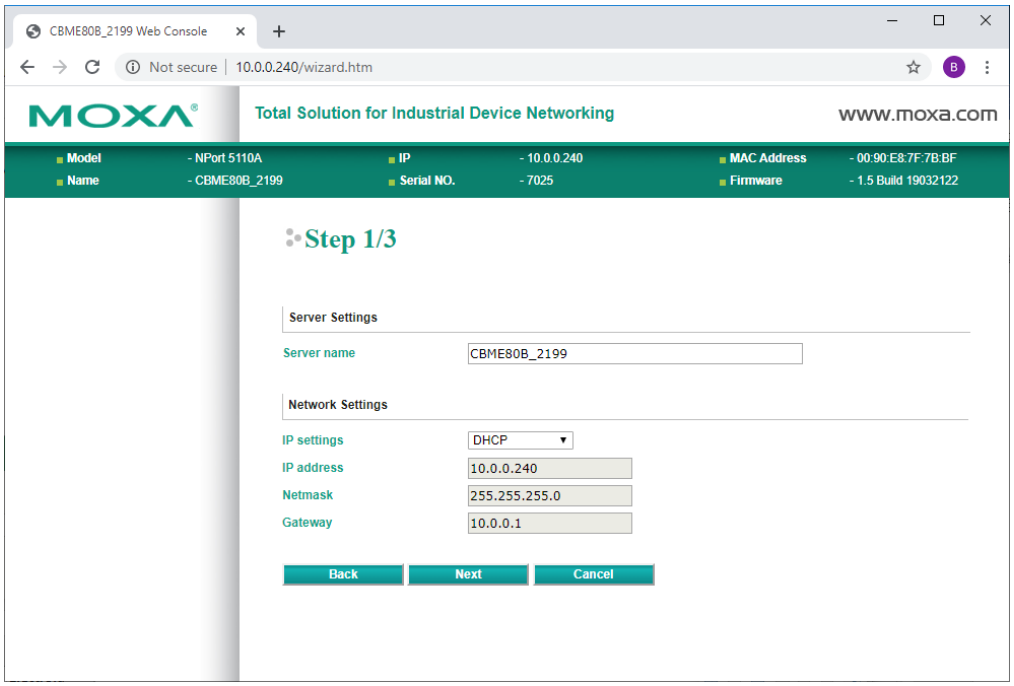
NOTE

At the first login, please make sure to change the password and make a note of the new password. Changing password is done by clicking on "Change Password" in the Navigation frame to the left.

5.3.1 Ethernet Quick Setup

After the password has been updated, please run the Quick Setup guide by clicking on "Quick Setup" in the Navigation frame to the left.

This will make all settings required for full functionality of the Ethernet interface.



In the first step the Network settings are configured.

By default, a fixed IP address of `192.168.127.254` is used. This should be updated to match the actual network settings in the deployment network.

IP Settings

Type of IP address.

- DHCP
  Use DHCP for Dynamically assigned IP address

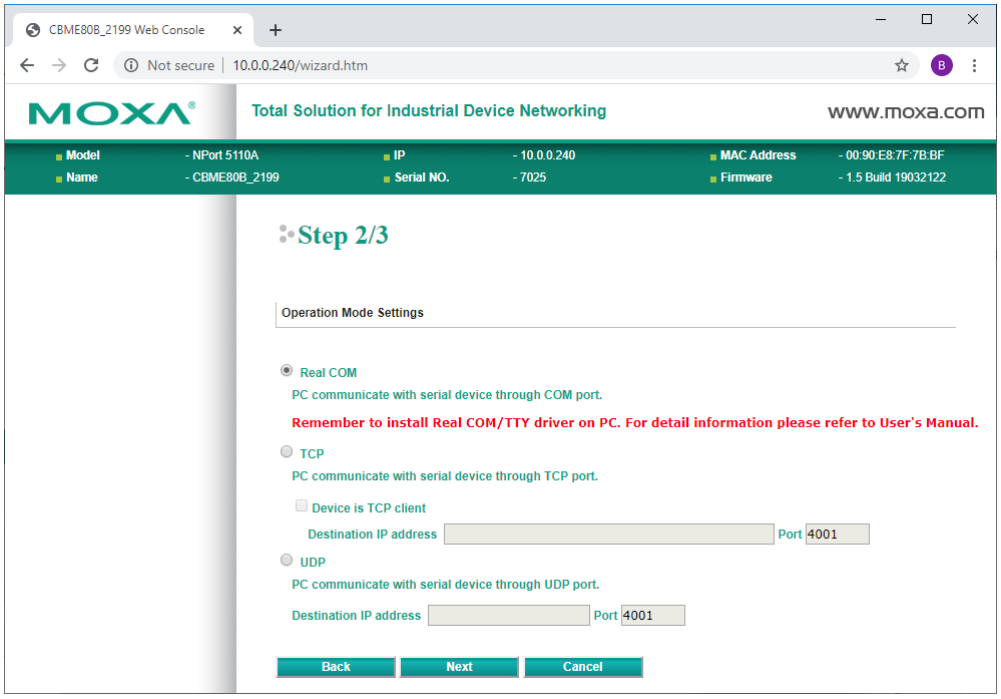
- Static
  Use a static IP address

When using DHCP addresses the IP address, Netmask and Gateway will be automatically filled in by the result of the DHCP server.

When using Static IP address all these fields needs to be filled in. Please ask your network administrator for suitable settings to use.

Note: The network settings will not be applied until the last step when the Ethernet service is restarted.

Press Next to go to the second step.



The second step is to configure the operation mode.

Real COM

This is the typical setup to use the Ethernet as a Device Server with virtual serial ports.

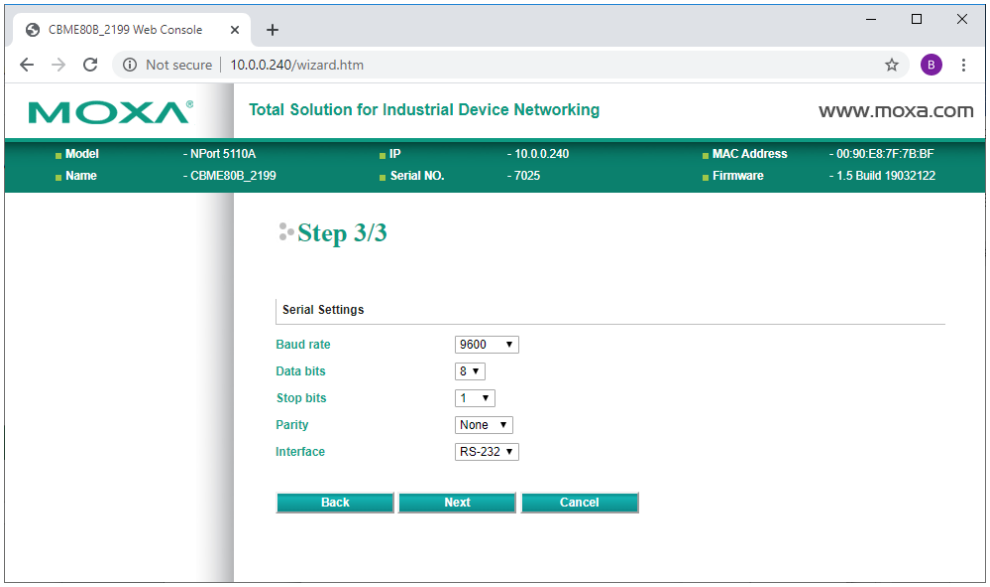
Note: In order to use this mode the suitable drivers needs to be installed on the server PC. Driver exists for Microsoft Windows, Linux and several other operating systems.

TCP or UDP

The Ethernet driver may use socket communication over TCP or UDP by connecting to specific IP address and port. Please specify the destination IP address and Port for the selected communication protocol (TCP or UDP).

Note: Make sure that any firewalls are configured accordingly to allow TCP or UDP traffic between the ceilometer server and the destination client.

Press Next to go to the third step.



The third step configures the serial settings.

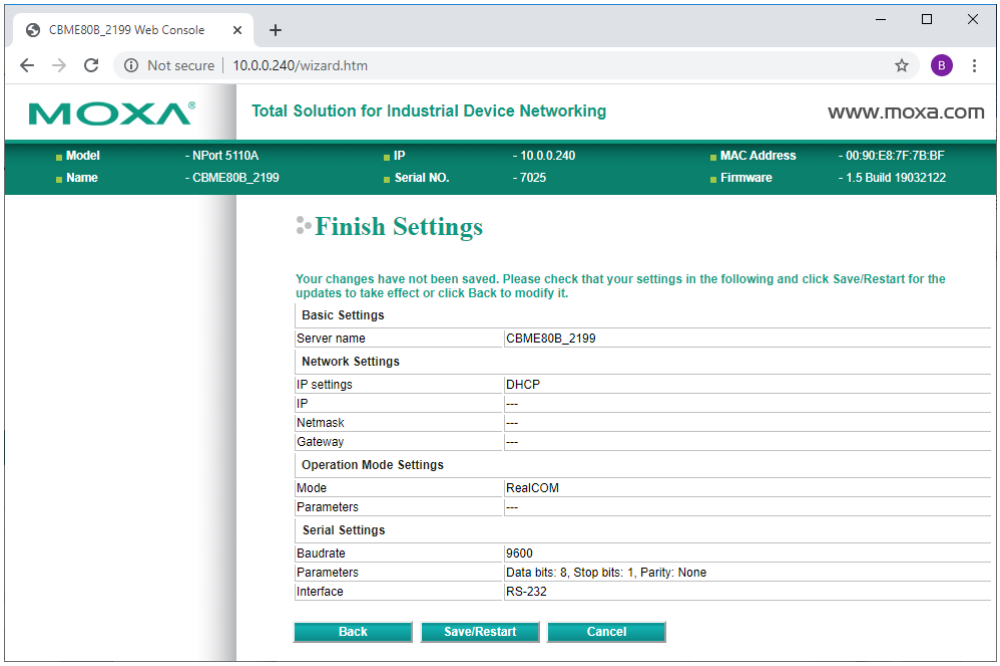
Note: The serial settings refer to the settings towards the ceilometer. If using Ethernet for Device Server, the server settings are used to configure the virtual communication ports serial settings.

The recommendation settings are:

```
Baud rate: 9600
Data bits: 8
Stop bits: 1
Parity: None
Interface: RS-232
```

Note: The settings here must match the serial settings of the selected interface for the ceilometer.

Press Next to go to the fourth and final step.



The final step shows a summary of all the settings for review.

Once everything has been verified to be correct, please press Save/restart to save the settings to the Ethernet adapter and restart the process to make all the changed settings active.

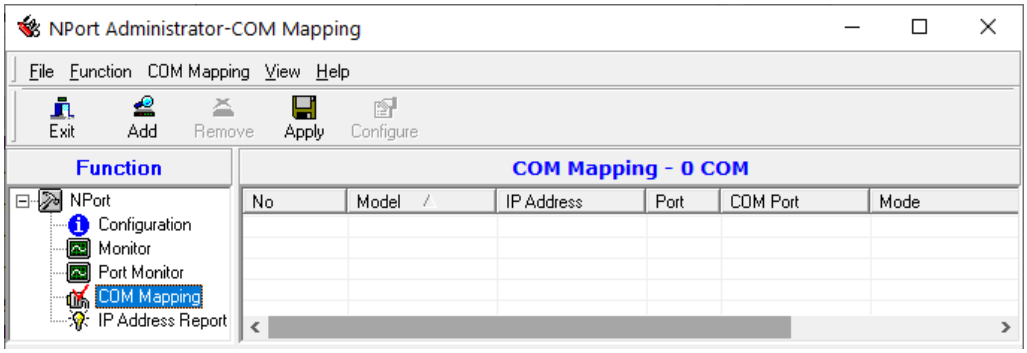
The standard configuration of the Ethernet service is now complete.

Note: Multiple configuration and setups are possible using the Ethernet adapter. Please see the Moxa NPort 5000 series User's Manual for detailed information on all available options.

5.3.2 Device Server (Windows)

To install the Device Server for Virtual serial ports to the Ethernet connection please install and run the NPort Administrator software.

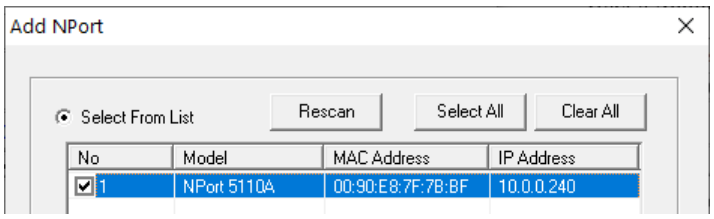
Note: Drivers for Device Server for Linux exists as well. For information about how to install Device Server for Linux, see the Moxa NPort 5000 series User's Manual.



Star the NPort Administrator and click on the COM Mapping function.

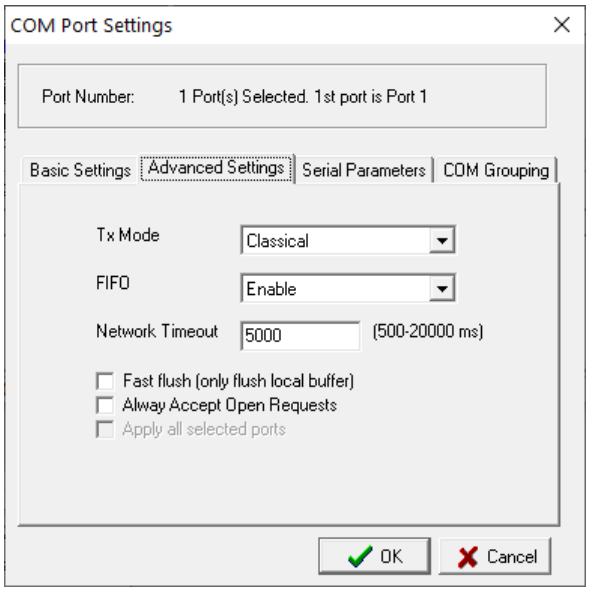
Click on Add and Scan for available devices.

Note: Make sure the ceilometer is powered on and connected to the network before proceeding with the setup process in order to find the adapter.



Select the device and click OK.

The Virtual Serial port is now created with default values. To configure the port, please select it and click on Configure to open the configuration screen.



Please configure the port according to desired settings.

Basic Settings

COM Number: Select communication port name (i.e. COM10)

Advanced Settings

Tx Mode: Use Classical

FIFO: Use Enabled

Network Timeout: Select suitable network timeout. The default 5000 ms is recommended to keep.

Fast Flush and Always Accept is recommended to keep un-checked.

Serial Parameters

Select the desired serial parameters

It is recommended but not mandatory to select similar settings as on the server site. The reason for selecting similar, at least for the baud rate, is to keep similar speed to not slow down and risk losing data, and not speed up to risk having delay periods between data and risk triggering of processing of messages.

COM Grouping

No COM Grouping

Select OK to close the COM Mapping configuration.

Note: Make sure to apply the settings by clicking the Apply button. Otherwise the settings are not stored and applied.

5.4 Connection of Maintenance Terminal to Service port (J6)

For connection of terminal to service port J6, the following has to be done.

1. Open up the four locks located at the corners of the hood.
2. Remove the hood upwards carefully.
3. Disconnect the heating elements (J8) for safety.
4. Connect maintenance cable to service port (J6) located at the left bottom corner of the master unit.

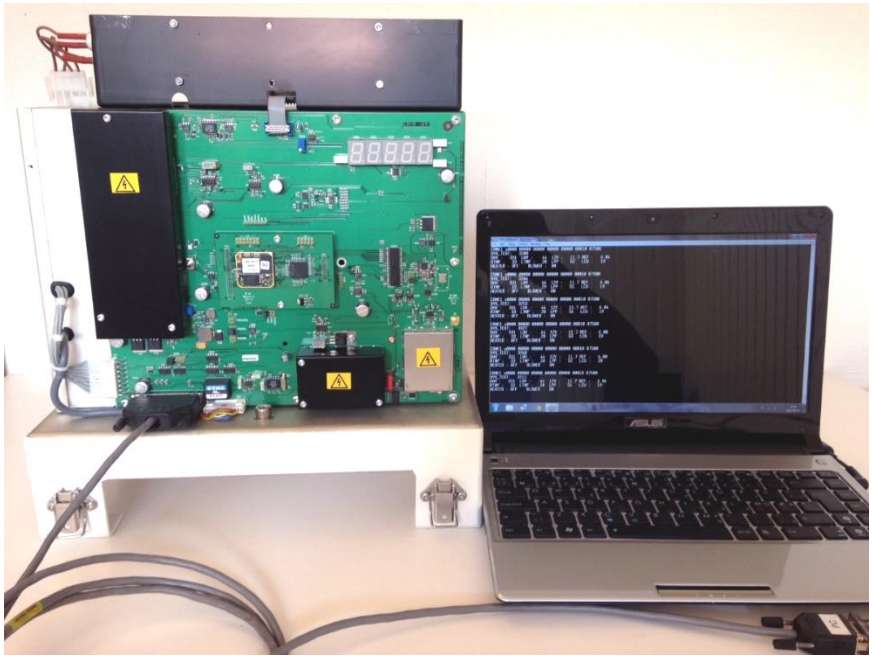


Figure 5-1 Connection of service cable

5.5 Wiring of service cable

The wiring of the service cable is as in *Figure 5-2*.

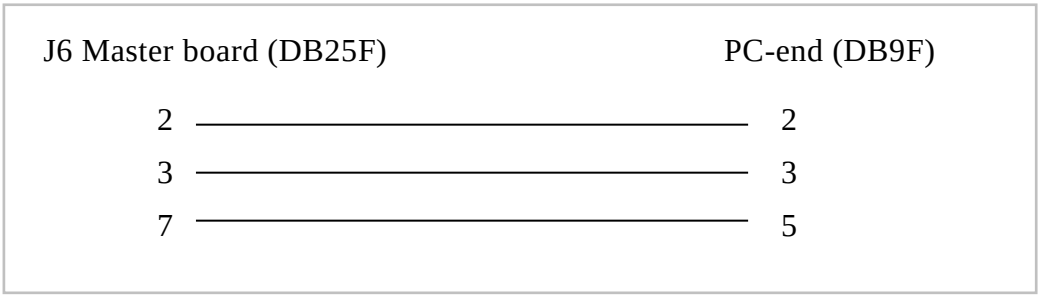


Figure 5-2 Wiring of service cable

5.6 User commands

5.6.1 General

All interaction with the ceilometer by the operator is made thru the service port by aid of a menu. By logging into the menu, all parameters can be viewed and changed, among other functions by the operator.

Any terminal or PC with a serial interface and terminal emulation program can be used for operation and maintenance of the CBME80B Ceilometer.

The following aid is needed:

- Service cable according to *section 5.4* part no BEAB 217 810.

To login to the menu, push ESC-key twice or type OPEN. The ceilometer will respond with the top level of the menu hierarchy. (See *section 5.6.2* for further information about the menus).

NOTE

When using modem port in a multi-drop RS-485 setup with multiple sensors listening for "OPEN" it is possible to address the ceilometers individually by typing "OPEN <ID>" and press enter. <ID> is the ceilometer identity configured in EE51.

Due to this restriction, any command entered outside the service menu will not be echoed back (since it may be multiple ceilometers in the same loop). Once inside the service menu all commands are echoed.

5.6.2 Service Menu Operation and Hierarchy

Connect the terminal to the service port (J6) on master unit (see *section 5.4).*

Factory default settings for service port are:

Baud rate:	2400
Data bits:	8
Stop bits:	1
Parity:	None

Start communication by pushing the ESC-key twice or type OPEN.

The ceilometer answers with its main menu

```
MAIN MENU (Main)
------------------------------------
1:MODEMPORT                  ASCII
2:SERVICEPORT              SERVICE
3:IND.:/SITE PARAMS
4:CLOUD AMOUNT
5:PARAMETERS
6:SPECIAL FUNCTIONS
Q:QUIT
------------------------------------
ENTER NUMBER (1-6) OR Q(UIT):
```

The main menu is divided into a number of different groups (6) that can be selected by typing the first digit. This causes the sub menu for this group to be presented.

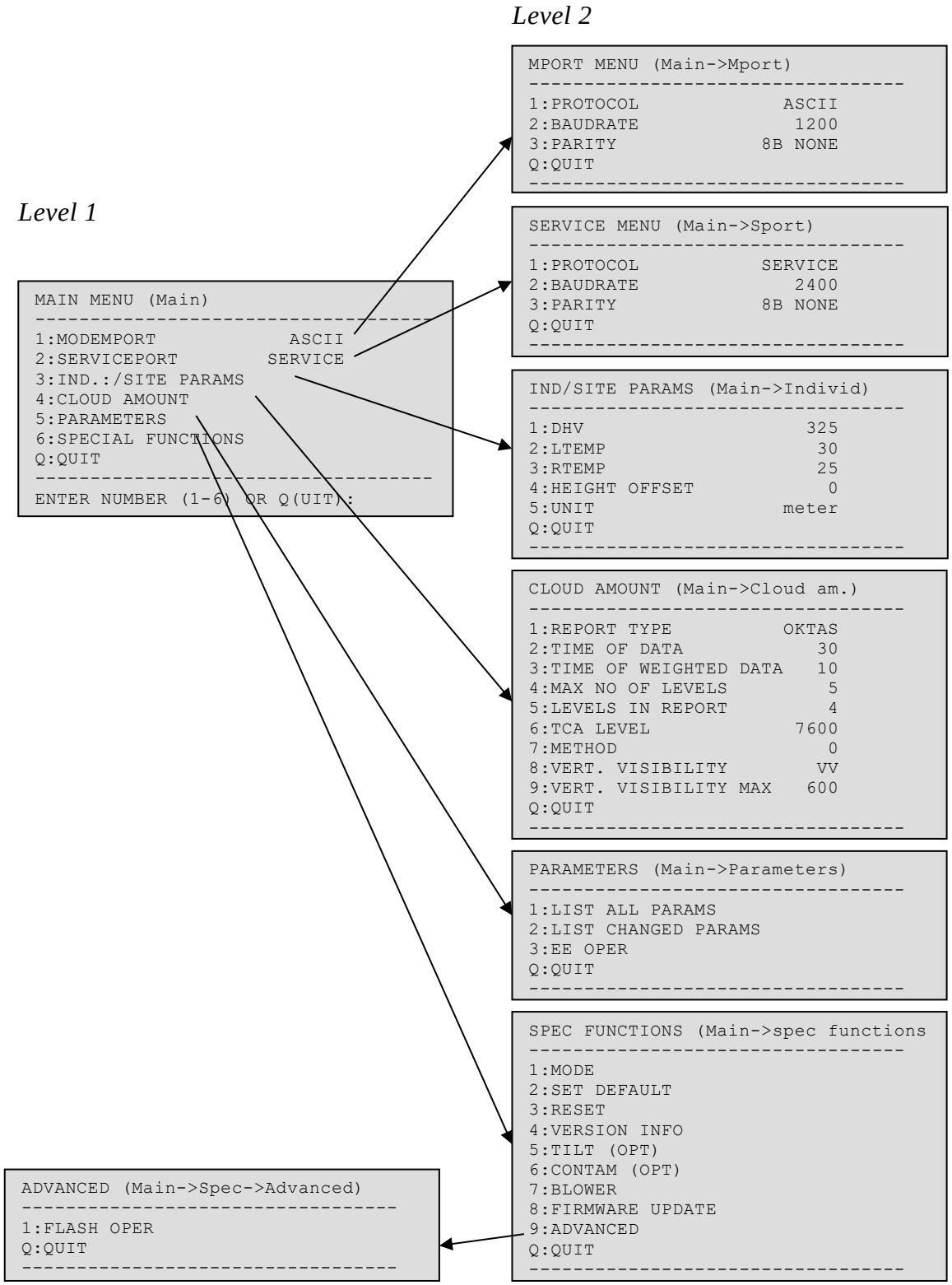
At any point in the menu hierarchy, there is always possibility to exit the menu by typing Q one or more times, depending of position in the menu hierarchy, until the top level of the menu is exited.

NOTE

If any settings have been changed, the menu must be exited otherwise the EEPROM (nonvolatile memory) checksum will not be updated.

Menu Hierarchy

The menu hierarchy is built up in three levels. Below the possible choices/alternatives in the two first levels in the hierarchy are presented.



5.6.2.1 Control of Reasonableness

All choices, which are done via the menu system (except those under `EE OPER`) are checked for validity and limits for the parameters/values, which shall be changed. If any choice or value is invalid at this check, an error message will be presented.

For information of limits see parameter list under *section 5.7.*

5.6.2.2 Change of parameter/value via menu

To show how an alternation shall be done, a number of examples are shown below. For all examples, a terminal needs to be connected to the service port.

Example 1: Change of message protocol on Modem Port.

Login to main menu by pushing the *ESC*-key twice or type `OPEN`.

Select MODEM PORT by typing `1`

```
MAIN MENU (Main)
--------------------------------
1:MODEMPORT            ASCII
2:SERVICEPORT        SERVICE
3:IND.:/SITE PARAMS
4:CLOUD AMOUNT
5:PARAMETERS
6:SPECIAL FUNCTIONS
Q:QUIT
--------------------------------
ENTER NUMBER (1-6) OR Q(UIT):
```

Select PROTOCOL by typing `1`

```
MPORT MENU (Main->Mport)
--------------------------------
1:PROTOCOL             ASCII
2:BAUDRATE              1200
3:PARITY             8B NONE
Q:QUIT
--------------------------------
ENTER NUMBER (1-3) OR Q(UIT):
```

Select wanted protocol by typing its no.

```
MODEM PROTOCOL (Main->Mport->Prot)
--------------------------------
0:NONE
1:INTEGER
2:ASEA
4:SERVICE
5:ASCII
6:OS21
9:EMULATE
Q:QUIT
--------------------------------
ENTER NUMBER (0-2,4-6,9) OR Q(UIT):
```

As an acknowledgment for selected protocol the following answer is presented:

```
ASEA PROTOCOL CHOSEN
ENTER NUMBER (0-2,4-6,9) OR Q(QUIT)
```

To end, step upwards through the menu by typing Q until the menu hierarchy is exited.

Example 2: Change the value for DHV.

Login to main menu by pushing the *ESC*-key twice or type `OPEN`.

Select `IND.:/SITE PARAMETERS` by typing `3`

```
MAIN MENU (Main)
--------------------------------
1:MODEMPORT               ASCII
2:SERVICEPORT             ASCII
3:IND.:/SITE PARAMS
4:CLOUD AMOUNT
5:PARAMETERS
6:SPECIAL FUNCTIONS
Q:QUIT
--------------------------------
ENTER NUMBER (1-6) OR Q(UIT):
```

Select `DHV` by typing `1`

```
IND/SITE PARAMS (Main->Individ)
--------------------------------
1:DHV                       325
2:LTEMP                      30
3:RTEMP                      25
4:HIGH OFFSET                 0
5:UNIT                    meter
Q:QUIT
--------------------------------
ENTER NUMBER (1-5) OR Q(UIT):
```

Now an invitation is presented to type the desired value on DHV.

Write the wanted value for `DHV` (in this example `200`) followed by `<CR>`.

```
TYPE DHV VALUE OR Q(UIT)
DHV=200

DHV=    200
DHV=
```

The ceilometer echoes back `DHV=200` and writes again the text `DHV=` and waits for input.

Type `Q`

End the conversation by stepping upwards through the menu by typing Q until the menu hierarchy is exited.

Example 3: List all changed parameters

Login to main menu by pushing the *ESC*-key twice or type `OPEN`.

Select `PARAMETERS` by typing `5`

```
MAIN MENU (Main)
--------------------------------
1:MODEMPORT                ASCII
2:SERVICEPORT            SERVICE
3:IND.:/SITE PARAMS
4:CLOUD AMOUNT
5:PARAMETERS
6:SPECIAL FUNCTIONS
Q:QUIT
--------------------------------
ENTER NUMBER (1-6) OR Q(UIT):
```

Select `LIST CHANGED PARAMS` by typing `2`

```
PARAMETERS (Main->Parameters)
------------------------------
1:LIST ALL PARAMS
2:LIST CHANGED PARAMS
3:EE OPER
------------------------------
ENTER NUMBER (1-3) OR Q(UIT):
```

A list of all the changed parameters are presented together with the default values.

Type `Q`

```
EE 00002=   350 (   300)
EE 00003=   150 (   130)
EE 00006=    27 (    30)
EE 00013=    11 (     0)
EE 00014=    44 (     0)
EE 00015=  9998 (     0)
EE 00090=     1 (     0)
```

End the conversation by stepping upwards through the menu by typing Q until the menu hierarchy is exited.

Examples of error messages:

```
ILLEGAL CHOICE!

ERROR: ILLEGAL CHARACTERS!

ERROR: NOT AN INTERVAL 1:ST VALUE>2:ND VALUE!

ERROR! VALUE OUT OF RANGE (MIN: 50, DEF: 300, MAX: 500)

VALUE OUT OF RANGE!
```

5.7 Parameter Settings

5.7.1 General

A number of parameters define the changeable capacity of the ceilometer. The parameters are stored in FRAM and can be changed within certain limits.

The program reads the stored parameters at start up and after every parameter change.

The parameters can easily be changed or be checked with the aid of a terminal connected to the service port on the master unit. When the terminal is connected, control and changing of parameters can be done with the aid of a menu (see *section 5.6.2).*

5.7.2 Parameters and Limits

The table below describes all default values and their limits. Observe that the values in the default column are the values that will be set when command

DEFAULT is issued and may not be the actual values for the specific unit; The actual valid values for the specific unit can be found in the delivery documents parameter list.

NOTE

Observe that some parameters are individually set at factory such as EE2, EE3, and EE6 in addition some customer specific settings may have been done (EE18, EE19, EE20, EE50, EE56 and EE58). Remember to note the initial value before changing any of these parameters.

EE#	Min	Def	Max	Function
1	20	60	100	*DHV at disturbance measurement,* **Not Used**
2	50	300	500	Detector high voltage (DHV) at 25ºC (brk-70)
3	50	130	250	Nominal Laser Current (LCU) (130 = 13.0 A)
4	35	40	50	Laser peak power (LPP) low limit alarm
5	35	50	60	Nominal laser peak power (LPP)
6	10	30	50	Nominal laser temperature
7	50	50	500	Laser current in service mode (50 = 5.0 A)
8	10	22	40	DHV temperature coefficient (22=2,2V/ºC)
9	10	30	50	Nominal receiver temperature, set point for heater on
10	200	230	255	Response of peltier element, max heating power
11	6	9	24	Number of samples (9=9000)
12	0	0	3	Measuring time *0 = 30sec* *1 = 60sec* *2 = 120sec* *3 = 15sec*
13	0	0	32000	Reset counter
14	0	--	32000	Week counter
15	0	--	9999	Serial number
16	0	0	2	Measuring mode *0 = Normal measurement* *1 = test mode (alignment)* *2 = test mode (sys-test)*
17	0	1	1	Signal filtering (9-pin filter) *0 = off* *1 = on*
18	0	1	1	Height unit in telegrams *0 = feet* *1 = meter*

EE#	Min	Def	Max	Function
19	0	1	1	Height unit on local display *0 = feet* *1 = meter*
20	-100	0	100	Height correction in meters relative runway
21	-50	10	50	Internal height calibration in meters
22	1000	7600	7600	Measuring range
23	10	300	1000	Threshold for cloud detection
24	10	350	500	Threshold slope (k-factor)
25	10	325	500	Slope threshold for cloud detection (dx)
26	1	100	500	Blower integrated backscatter threshold
27	100	160	500	Blower height evaluation in meters
28	10	150	1000	Signal threshold for vertical visibility
29	10	50	100	Start position for VV evaluation in meters
30	10	250	500	Stop position for VV evaluation in meters
31	10	200	500	Threshold for vertical visibility, integrated backscatter value
32	1	1	2	Limit for noise filter usage in VV routine
33	10	200	500	Maximum distance variation within layer.
34	0	0	1	Noise filter ON/OFF *0 = off* *1 = on*
35	0	1	1	Type or reporting of “Haze clouds”, *0 = VV* *1 = cloud base*
36	10	250	1000	Maximum showed cloud depth 500 = 500 meter
37	10	25	100	Limit [m] for converting low cloud to VV
38	1	15	50	Signal scale factor (10=1.0), compensate for different output power
39	10	30	100	Ratio (25=2.5) between rain backscatter and signal threshold
40	1	3	10	Slope step (slope index) 3=30 meter
41	750	3000	4000	Vert.max (maximum height for pre-evaluation of VV
42	50	120	200	Correction of vertical visibility (measured value minus correction)
43	100	600	1000	Threshold for cloud detection at 10 meter, (falling to normal threshold (EE23) at 300 m)

EE#	Min	Def	Max	Function
44	100	800	2000	Peak Threshold for cloud detection
45	200	450	1000	Window size in haze cloud searching routine in meters
46	100	600	5000	Threshold for haze clouds
47	200	200	4000	Start height for haze cloud search in meters
48	100	425	1000	Threshold offset for haze clouds
49	0	30	100	Cloud gap (distance between clouds at double cloud detection
50	0	2	39	Modem protocol *0 = Don't send* *1 = Integer (for test purpose)* *2 = ASEA* *3 = CT12K* *4 = Service* *5 = ASCII* *6 = OS21* *7 = CT25K Message 6* *8 = CT25K Message 1* *9 = CT25KAM Message 6-1* *30 = CL31 Msg 1 class 1 (msg1_10x770)* *31 = CL31 Msg 1 class 2 (msg1_20x385)* *32 = CL31 Msg 1 class 3 (msg1_5x1500)* *33 = CL31 Msg 1 class 4 (msg1_5x770)* *34 = CL31 Msg 1 class 5 (msg1_base)* *35 = CL31 Msg 2 class 1 (msg2_10x770)* *36 = CL31 Msg 2 class 2 (msg2_20x385)* *37 = CL31 Msg 2 class 3 (msg2_5x1500)* *38 = CL31 Msg 2 class 4 (msg2_5x770)* *39 = CL31 Msg 2 class 5 (msg2_base)* *40 = CL51 Msg 1 class 6 (51_msg1_10x1540)* *41 = CL51 Msg 1 class 8 (51_msg1_base)* *42 = CL51 Msg 2 class 6 (51_msg2_10x1540)* *43 = CL51 Msg 2 class 8 (51_msg2_base)*
51	0	1	15	ID (number in telegram) *10 = A, 11 = B, 12 = C, 13 = D, 14 = E, 15 = F*
52	0	2	2	Modem port data bits and parity *0=Odd, 1=Even, 2= None*
53	0	2	2	Service port data bits and parity *0=Odd, 1=Even, 2= None*
54	300	1200	38400	Baud rate data port Note: 1200 Baud max rate for FSK/V.23 9600 Baud max rate for RS-232 38400 Baud max rate for RS-485

EE#	Min	Def	Max	Function
55	300	2400	9600	Baud rate service port
56	0	4	39	Service protocol 1 minute after start up *0 = Don't send* *1 = Integer (for test purpose)* *2 = ASEA* *3 = CT12K* *4 = Service* *5 = ASCII* *6 = OS21* *7 = CT25K Message 6* *8 = CT25K Message 1* *9 = CT25KAM Message 6-1* *30 = CL31 Msg 1 class 1 (msg1_10x770)* *31 = CL31 Msg 1 class 2 (msg1_20x385)* *32 = CL31 Msg 1 class 3 (msg1_5x1500)* *33 = CL31 Msg 1 class 4 (msg1_5x770)* *34 = CL31 Msg 1 class 5 (msg1_base)* *35 = CL31 Msg 2 class 1 (msg2_10x770)* *36 = CL31 Msg 2 class 2 (msg2_20x385)* *37 = CL31 Msg 2 class 3 (msg2_5x1500)* *38 = CL31 Msg 2 class 4 (msg2_5x770)* *39 = CL31 Msg 2 class 5 (msg2_base)* *40 = CL51 Msg 1 class 6 (51_msg1_10x1540)* *41 = CL51 Msg 1 class 8 (51_msg1_base)* *42 = CL51 Msg 2 class 6 (51_msg2_10x1540)* *43 = CL51 Msg 2 class 8 (51_msg2_base)*
57	2	10	100	Scale factor for noise calculation. **Not used.**
58	0	1	2	Transmission mode Modem Port *0 = None* *1 = Periodic* *2 = Request (Polling)*
59	0	1	2	Transmission mode Service Port *0 = None* *1 = Periodic* *2 = Request (Polling)*
60	0	1	1	Blower connected *0 = Not connected* *1 = Connected*
61	0	9	16	Local display brightness 0 = Disabled 1-16 = Brightness (1=lowest, 16=highest)
62	0	6000	7600	Cloud height noise limit. Minimum height of the (detected) cloud to be considered for the noise algorithm. If enabled (EE34) all clouds above this level will be filtered.
63	0	1	1	Height interpolation (1=on, 0=off)

EE#	Min	Def	Max	Function
				Interpolate to 5m / 10ft output resolution
64	0	1	1	Type of data in backscatter output *0 = unfiltered data* *1 = filtered data (requires EE17 = 1)*
65	0	30	60	Menu timeout in minutes, service port *0 = disabled*
66	0	5	60	Menu timeout in minutes, modem port *0 = disabled*
67	0	0	1	Tilt sensor present. *0 = No* *1 = Yes*
68	0	1	1	Tilt Angle Correction *0 = No* *1 = Yes*
69	0	2	10	Modem port direction timeout/restore in minutes *0 = disabled*
70	0	0	1440	Timeout on telegram in 10 minutes (cause WD reset) *0 = disabled* *1= 10 minutes* *2= 20 minutes etc.*
71	0	30	60	Tilt average time, number of measurements *1 = instant values*
72	0	0	1	Laser power control mode *0 = Laser current (target in. EE3)* *1 = Output power (target in EE5)*
73	5	25	30	Maximum Laser Current (when in output power laser control mode, i.e. EE72=1)
74	100	1000	1500	Threshold for state 0 in cloud detection algorithm
75	0	1	1	Signal backscatter profile unit in ASEA telegram output. *0 = $sr^{-1}m^{-1}$ (note: values in resolution 10^{-7} $sr^{-1}m^{-1}$)* *1 = arbitrary unit* **Note:** When $sr^{-1}m^{-1}$ is selected, parameter EE76 is used for instrument scaling factor
76	1	51	10000	Signal backscatter profile scale factor $51 = 51*10^{-9} = 0.051*10^{-6}$)
77	100	180	250	Dynamic adjustment in VertVis routine
78	0	1	2	Blower control *0 = Manual OFF* *1 = Auto*

EE#	Min	Def	Max	Function
				2 = Manual ON
79	0	0	1	Indicates if the Blower Sense option is available. (Allows for blower current to be sensed and reporting blower failure.) *0 = Off* *1 = On*
80	10	1500	2000	Height limit for combine cloud algorithm (in meters)
81	10	500	1000	Lower threshold for combine cloud algorithm
82	10	150	500	Derivate threshold for combine cloud algorithm
83-89	1	1	1	Spare
90	0	0	1	Remote API active. (Allows for remote API to be used to control the ceilometer.) *0 = No (not active)* *1 = Yes (active)*
91	0	1	1	Remote API checksum usage (CRC16). Indicates if all commands must include checksum for verification. *0 = ignore/don't use checksum* *1 = check/calculate checksum*
92-99	1	1	1	Spare

Parameters for Cloud Amount algorithm, EE100 to 137

EE#	Min	Def	Max	Function
100	3	4	15	Max allowed status errors in cloud amount (number of minutes)
101	15	30	30	Time of data in cloud amount calculation (number of minutes)
102	2	10	15	Time of weighted data in cloud amount calculation (number of minutes)
103	1	2	3	Weight (Integer)
104	3	5	5	MaxNoOfLevels (number after unconditionally merging)
105	150	300	500	loLevel (meter)
106	20	30	60	loLevelLimit (meter)
107	10	12	30	DtHgtRatio (dimensionless kvot 15=0.15)
108	1000	3000	5000	hiLevel (meter)

EE#	Min	Def	Max	Function
109	300	450	600	hiLevelLimit (meter)
110	5	10	30	HystRatioLim (dim.less kvot 15=0,15)
111	30	30	60	mRoundLevel_1 (meter)
112	150	300	500	mRoundLevel_2 (meter)
113	500	1500	3000	mRoundLevel_3 (meter)
114	1500	3000	5000	mRoundLevel_4 (meter)
115	10	30	60	mRoundTo_1 (meter)
116	10	30	300	mRoundTo_2 (meter)
117	10	30	300	mRoundTo_3 (meter)
118	10	30	300	mRoundTo_4 (meter)
119	10	300	500	mRoundTo_5 (meter)
120	30	100	200	ftRoundLevel_1 (feet)
121	150	5000	15000	ftRoundLevel_2 (feet)
122	500	10000	25000	ftRoundLevel_3 (feet)
123	30	100	200	ftRoundTo_1 (feet)
124	10	100	300	ftRoundTo_2 (feet)
125	10	100	300	ftRoundTo_3 (feet)
126	10	1000	3000	ftRoundTo_4 (feet)
127	0	1	1	vertVisOn (flag 0=off, 1=on)
128	2	6	15	Minimum VertVis in vertVisWindow (in minutes)
129	4	8	15	ccaVertVisWindow (in minutes)
130	10	600	4000	vertVisMax in cloud amount algoritm
131	0	1	1	reportType (flag 0=acronyms, 1=octas)
132	3	4	4	No of levels in report
133	1	2	9	PriorityType (flag 1=first method, 2=second method)
134	0	0	25	Octas offset Value x100 *0 = no offset* *20 = offset 0.20*
135	1000	7600	12000	TCA-level
136	0	2	2	Combination method *0 = mean value, 1=Max-Min value* *2 = standard deviation*
137	0	0	1	Filter remove noise in cloud amount 0=off, 1=on
138-149	1	1	1	Not used (spare)

Parameters for contamination function (option)

EE #	Min	Def	Max	Function
150	0	0	1	Contamination function present *0 = N/A* *1 = Available*
151	0	0	1	Contamination warning enabled *0 = Off* *1 = On*
152	1	20	100	Contamination samples (number of samples i.e. 20 equals 10minutes with 30sec interval)
153	1	1000	10000	ContaminationMeasSamples, number of measuring samples for contamination led test
154	1000	3500	10000	LedBaseLevel System test (led test) reference level
155	1	20	100	LedBaseSamples Number of samples for system test (led test) reference. (i.e. 20 equals 10 min with 30s interval)
156	100	500	5000	ContaminationCleanbaseLevel Base level for clean windows
157	100	3000	10000	Threshold for contamination warning
158	0	1	1	ContaminationPrecipitationBlock Disable transmission warning during precipitation *0 = Block disabled, always report warnings* *1 = Block enabled (no warning if precipitation)*
159	0	30	500	PrecipitationStart in meters Start height in calculations for precipitation
160	0	200	1000	PrecipitationStop in meters Stop height n calculations for precipitation
161	0	100	5000	PrecipitationTreshold Threshold for the integrated value between EE159 and EE160
162	1	80	100	ContaminationPrecipitationSamples Number of samples to consider for precipitation block
163	1	1	100	ContaminationPrecipitationRequiredhits Number of hits within the samples required for block due to precipitation
164	0	1	1	ContaminationNoiseBlock Disable transmission warning during abnormal high noise *0 = Block disabled, always report warnings* *1 = Block enabled (no warning if high noise)*

EE #	Min	Def	Max	Function
165	0	100	1000	ContaminationNoiseTreshold Threshold for the noise block
166	1	10	100	ContaminationNoiseSamples Number of samples to consider for noise block
167	0	1	100	ContaminationNoiseRequiredHits Number of hits within the samples required for block due to noise
168	0	150	1000	ContaminationBreakdownLimit Limit for detecting breakdown (i.e. contam not working) (0 = disabled). Raw value.
169	10	50	10000	ContaminationReferenceTarget Reference target (i.e. target value) (0.01x, i.e. 50 = 5000)
170	10	50	10000	ContaminationReferenceLevel Calibrated reference level (0.01x, i.e. 50 = 5000) (factor = Level/Target)
171-179	1	1	1	Not used (spare)
180	-4500	0	4500	Tilt sensor calibration (Pitch bias (X)) in degrees *(0 = 0, 4500 = +45 degree)*
181	-4500	0	4500	Tilt sensor calibration (Roll bias (Y)) in degrees *(0 = 0, 4500 = +45 degree)*
182-199	1	1	1	Not used (spare)

Parameters for special operations

EE #	Min	Def	Max	Function
699	0	0	1	Debug data Enable debug printouts in service telegram *0 = Off* *1 = On*
700	-1	-1	100	Software update mode. Set to 0 to enable software update mode. After the value is set, do a reset to enter software update mode. See the user's guide for more information. The value will be reset to -1 after 100 seconds in update mode.
701	0	2	2	Software Update Channel Communication channel to use for software updates. *0 = No channel. Software updates disabled*

EE #	Min	Def	Max	Function
				1 = Data channel *2 = Service channel*
702	300	2400	19200	Software Update Baud Rate Baud rate for software updates. Supported baud rates: 300, 600, 1200, 2400, 4800, 9600, 14400, 19200
703	0	2	2	Software Update Parity Data bits and parity to use for software updates. *0 = Odd parity (7 data bits, 1 stop bit, odd parity)* *1 = Even parity (7 data bits, 1 stop bit, even parity)* *2 = None parity (8 data bits, 1 stop bit, none parity)*
704	5	120	480	Software Update Max Time Maximum time (in minutes) for software update mode to complete. After this time the ceilometer will automatically reset. (This is for fault management if reprogramming is unsuccessful, connection is lost, etc.)
705	0	1	1	Software Update Boot Output Output information on boot (and allows the rescue methods to be identified) *0 = Output disabled* *1 = Output enabled*
706	3	10	60	Software Update Boot Delay Bootup delay time when the bootloader starts and before the secondary firmware is loaded. During this boot delay it is possible to enter rescue mode.
800	0	0	170	Temporarily disable blower start. Set to 0xAA (170) while running to disable blower. Will be cleared (i.e. blower enabled) on reset. (Typical usage is in combination with UPS to reduce power consumption while on UPS)

Near zone function

The near zone function is stored in EE-prom, parameter 200 to 250. EE-200 equal to 10-meter bin, 201 equal to 20-meter bin etc. up to 250 equal to 500-meter bin.

EE	Min	Def	Max	Remark
200	1	480	2000	
201	1	320	2000	

EE	Min	Def	Max	Remark
202	1	255	2000	
203	1	218	2000	
204	1	177	2000	
205	1	127	2000	
206	1	79	2000	
207	1	43	2000	
208	1	27	2000	
209	1	19	2000	
210	1	15	2000	
211	1	13	2000	
212	1	13	2000	
213	1	13	2000	
214	1	13	2000	
215	1	14	2000	
216	1	15	2000	
217	1	17	2000	
218	1	20	2000	
219	1	23	2000	
220	1	27	2000	
221	1	32	2000	
222	1	37	2000	
223	1	43	2000	
224	1	49	2000	
225	1	55	2000	
226	1	61	2000	
227	1	67	2000	
228	1	74	2000	
229	1	81	2000	
230	1	88	2000	
231	1	95	2000	
232	1	103	2000	
233	1	111	2000	
234	1	119	2000	
235	1	128	2000	
236	1	137	2000	
237	1	146	2000	
238	1	155	2000	
239	1	165	2000	
240	1	175	2000	
241	1	185	2000	
242	1	195	2000	
243	1	205	2000	
244	1	215	2000	
245	1	225	2000	
246	1	235	2000	
247	1	246	2000	
248	1	256	2000	
249	1	267	2000	
250	1	278	2000	

Parameters for tilt function (option)

Note: This is for internal calibration of the tilt sensor and is done at factory prior to delivery. These are stored in flash memory (and not EE memory).

Only calibrated (and populated) if tilt option is available.

Flash #	Min	Def	Max	Function
001 - 009	--	0	--	Spare (Not used)
010	--	0	--	Temperature slope for Angle X (* 10)
011	--	0	--	Temperature slope for Angle Y (* 10)
012	--	0	--	Temperature slope for Angle Z (* 10)
013	--	0	--	Low point: Temperature (value in deg C)
014	--	0	--	Low point: dataX (raw measured value)
015	--	0	--	Low point: dataY (raw measured value)
016	--	0	--	Low point: dataZ (raw measured value)
017	--	0	--	Mid point: Temperature (value in deg C)
018	--	0	--	Mid point: dataX (raw measured value)
019	--	0	--	Mid point: dataY (raw measured value)
020	--	0	--	Mid point: dataZ (raw measured value)
021	--	0	--	High point: Temperature (value in deg C)
022	--	0	--	High point: dataX (raw measured value)
023	--	0	--	High point: dataY (raw measured value)
024	--	0	--	High point: dataZ (raw measured value)

5.7.3 Individual parameters

Due to the fact that certain components have unique operating specifications (such as laser diode and avalanche diode) and that the ceilometer is highly configurable for different baud rates, units, message no according to customer needs some of the EE parameters may be individually set.

This section describes the most likely individually parameters.

EE2 – Detector high voltage (DHV)

Every Avalanche diode is unique in the manor that amplification is dependent of the reversed voltage. The EE2 value set at delivery shall be remain during the whole lifetime. Small changes (maximum ± 10V) to reduce noise registrations are allowed. Note that the value corresponds to the unique avalanche diode mounted on the actual master unit.

EE3 – Laser current (LCU)

Every laser diode is unique and the laser current is set to a value corresponding to give nominal output power at delivery. After many years, the laser may be ageing, (give lower power). To compensate for ageing the laser

current may be increased. Note that the value is related to the unique laser diode and not the master unit.

EE6 – Laser temperature (Ltemp)

The temperature of the laser affects the wavelength of the laser. The value is kept at the set value all the time and must be above 28 degrees Celsius (typical 30 degrees Celsius) to prevent condensation on the laser diode.

NOTE

Observe that if the complete master unit (including laser diode and avalanche diode) is replaced also the optical band pass filter in the filter unit may need to be replaced to match the laser wavelength.

EE18 – Unit in telegrams

This parameter affects the unit of measured values (sent as meter or feet in outgoing telegrams). It can also be changed via the menu.

EE19 – Unit on local display

This parameter affects the presented value for cloud base and vertical visibility on the local display (meter or feet). A positive indication of chosen unit is indicated by the LED lights (backlighters) of the local display.

EE20 – Height correction relative reference point

This parameter affects how the actual measured cloud height values shall be corrected for topographical height difference between ceilometer location and a reference point (runway).

Formula is: Reported values = Measured values + Height correction

EE50 – Message no on Modem port

This parameter affects the choice of telegram number for the Modem port. Normally this parameter is changed by aid of the menu hierarchy (Main menu -→ Modem port-→ Protocol).

EE56 – Message no on Service port one minute after start up

This parameter holds the telegram number to be sent on the Service port one minute after start up.

NOTE

Observe that changing the telegram number using the menus does not affect this parameter. The selection made throughout the menus will only be valid until the next power off/on or reset. To make permanent change of telegram number, the parameter must be changed via the EE menu

Normally this parameter shall always be set to 4, service telegram sent all the time on Service port.

EE54 – Baud rate on Modem port

This parameter holds the baud rate chosen via the menu system for the Modem port.

NOTE

Observe that Baud rate can be a maximum of 1200 bps if the Modem port is strapped for V23 interface (modem signal) or a maximum 2400 bps if strapped for RS232 connection.

EE55 – Baud rate on Service port

This parameter holds the value of the baud rate for the service port chosen via the menu system

5.7.3.1 Set Default

It is possible to restore all parameter changes by issuing a `SET DEFAULT` command.

i. Go into the service menu

ii. Select menu alternative 6. SPECIAL FUNCTIONS

iii. Select operation 2. SET DEFAULT

iv. Confirm the operation by answering y (yes)

This will reset all parameter to its default value (as listed in the parameter table). However, a number of parameters will be kept with their current value since they are typical calibration values or runtime values that should not be reset.

The following parameters will **not** be affected when issuing a `SET DEFAULT` command:

Parameter	*Explanation*
EE2	Detector high voltage (DHV) at 25 degree Celsius (op-10)
EE3	Nominal Laser current (LCU)
EE6	Nominal laser temperature

EE14	Week counter
EE15	Serial number
EE67	Tilt Sensor Present (option)
EE72	LPP Control Mode
EE150	Contamination Sensor Available (option)
EE151	Contamination Warning Enabled (option)
EE154	Contamination reference (option)
EE156	Contamination clean window reference (option)
EE170	Contamination output level (option)
EE180	Tilt Pitch Angle Bias (option)
EE181	Tilt Roll Angle Bias (option)

5.8 Message Formats

5.8.1 General

The ceilometer CBME80B has in its standard software the possibility to send multiple different types of data messages.

The following standard messages are provided:

Data message No. 0, 1, 2, 3, 5, 6 and 7.

Status message is No 4.

In addition, full support for CL31 and CL51 message formats are available as Data message No. 30 – 43.

Each port can individually be set to transmit a specified message automatically. Selection of message No is made by changing parameter 50 (modem port) and parameter 56 (service port) or via menu.

The following message formats exist:

0 Don’t send (no output)

1 Integer format (for test purpose)

2 Graphic format (modified ASEA format)

3 CT12K format (emulates VAISALA ceilometer CT12K)

4 Service format
5 ASCII format
6 OS21 format
7 CT25K No. 6 format (emulates VAISALA CT25K message no. 6)
8 CT25K No. 1 format (emulates VAISALA CT25K message no. 1)
30 CL31 Message 1 subclass 1 (emulates CL31 msg1_10x770)
31 CL31 Message 1 subclass 2 (emulates CL31 msg1_20x385)
32 CL31 Message 1 subclass 3 (emulates CL31 msg1_5x1500)
33 CL31 Message 1 subclass 4 (emulates CL31 msg1_5x770)
34 CL31 Message 1 subclass 5 (emulates CL31 msg1_base)
35 CL31 Message 2 subclass 1 (emulates CL31 msg2_10x770)
36 CL31 Message 2 subclass 2 (emulates CL31 msg2_20x385)
37 CL31 Message 2 subclass 3 (emulates CL31 msg2_5x1500)
38 CL31 Message 2 subclass 4 (emulates CL31 msg2_5x770)
39 CL31 Message 2 subclass 5 (emulates CL51 msg2_base)
40 CL51 Message 1 subclass 6 (emulates CL51 msg1_10x1540)
41 CL51 Message 1 subclass 8 (emulates CL51 msg1_base)
42 CL51 Message 2 subclass 5 (emulates CL51 msg2_10x1540)
43 CL51 Message 2 subclass 5 (emulates CL51 msg2_base)

NOTE

Service port will always send service message (No 4) regardless of selected message during approximately 2 minutes after startup of the ceilometer.

All characters are 7-bit US ASCII.

Start-of-Header, Start-of-Text, End-of-Text, Carriage Return and Line Feed are non-printing characters in most practical terminal use.

5.8.2 Message Format 0 (Don’t’ send)

This is not a message format but gives the possibility to disable the transmission of data.

5.8.3 Message Format 1 (Integer)

Message format 1 contains raw data and is used for test by the manufacture.

5.8.4 Message Format 2 (Graphic Format)

When the signal profile from the cloud measuring should be presented, the graphic format is selected. The telegram includes information of identity, status, cloud bases, penetration depths, cloud amount and signal profile.

FORMAT STRUCTURE

Data block 1 and 2 follow the selected unit (meter or feet) in the ceilometer.

In the signal profile block the unit is always meter independent of selected unit.

Normally meter shall be selected for this format.

MESSAGE FORMAT

<STX><CR><LF> **DATABLOCK 1**<CR><LF>**DATABLOCK 2**<CR><LF><ETX><LRC>
<STX><CR><LF>**SIGNAL PROFILE BLOCK**<ETX><LRC>

Symbol	*Explanation*
STX	Start of text (ASCII 02 Hex)
ETX	End of text (ASCII 03 Hex)
CR	Carriage Return (ASCII 0D Hex)
LF	Line Feed (ASCII 0A Hex)
LRC	Checksum character

LRC (Longitudinal Redundancy Checksum) calculation

The start character <STX> is not included in the calculation of the checksum.

All characters in the text after <STX> including <ETX> are summed exclusive-OR to get the LRC character.

DEFINITION OF THE DATABLOCK'S

Datablock 1

IIIII<sp>SSSS<sp>HHHHH$_1$<sp>TTTTT$_1$<sp>HHHHH$_2$<sp>TTTTT$_2$<sp>
HHHHH$_3$<sp>TTTTT$_3$<sp>VVVVV<sp>RRRRR

Symbol	*Explanation*
IIIII	Identity (normally <sp>CBM1)
SSSS	Status word (hexadecimal coded)
HHHHH	Cloud bases (cloud base one, two and three) ///// if no detection
TTTTT	Penetration depth (penetration depth one, two and three) ///// if no detection
VVVVV	Vertical visibility, ///// if no detection
RRRRR	Measuring range

Datablock 2

OOO_1:LLLLL$_1$<sp>OOO_2:LLLLL$_2$<sp>OOO_3:LLLLL$_3$<sp>OOO_4:LLLLL$_4$<sp>TTT_c

Symbol	*Explanation*
OOO	Cloud amounts in code: CLR, FEW, SCT, BKN, OVC or in octas depending on selection by parameter X/8 (where X can be 0, 1,2,3,4,5,6,7,8 or 9) For no detection, CLR or 0/8 is presented. For vertical visibility 9/8 or " VV" is presented. If the value is invalid, /// is presented
LLLLL	Height of cloud layer 1, 2, 3 and 4 For no detection or if the value is invalid, ///// is presented
TTT_c	Total cloud amount in acronyms or in octas For no detection, CLR or 0/8 is presented. If the value is invalid, /// is presented.
:	Colon separation

Note: During startup (normally first 30 minutes after power on) or if too many measurements during the period are invalid (i.e. has an alarm set); the cloud amount can't be correctly calculated and the values will be presented as invalid.

See chapter 6.4 for more information about cloud amount calculations.

Signal profile block (18 rows)

DDD<SP>DDD<SP>DDD<SP> … 20 entries per line … <CR><LF>

Resolution in the signal profile block:

Resolution (m)	*Row number*	*Meas. range (m)*	*Meas. range ack. (m)*
10	1 – 8	10 – 1600	1600
30	9 – 18	1630 - 7600	7600

DDD = Signal value (000 to FFF) in Hex code

```
DDD<SP> … … … <CR><LF>  < 200 m>  20 data blocks (DDD<SP>) per row
DDD<SP> … … … <CR><LF>  < 400 m>
DDD<SP> … … … <CR><LF>  < 600 m>
DDD<SP> … … … <CR><LF>  < 800 m>
DDD<SP> … … … <CR><LF>  <1000 m>
DDD<SP> … … … <CR><LF>  <1200 m>
DDD<SP> … … … <CR><LF>  <1400 m>
DDD<SP> … … … <CR><LF>  <1600 m>
DDD<SP> … … … <CR><LF>  <2200 m>
DDD<SP> … … … <CR><LF>  <2800 m>

...                  <+600 m for each row>

DDD<SP> … … … <CR><LF>  <7000 m>
DDD<SP> … … … <CR><LF>  <7600 m>
```

5.8.4.1 Examples of telegrams

Example 1

One cloud base detected and two layers calculated, total cloud amount 8/8 and unit meter.

Cloud amount information expressed in octas.

```
 CBM1 0000 01070 00180 ///// ///// ///// ///// ///// 07600
1/8:00140 8/8:00690 0/8:///// 0/8:///// 8/8
□^
000 000 039 091 041 07D 036 01E 00B 029 072 06E 068 058 064 04C 052 044 03D 02D
022 01D 00E 004 006 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000
000 000 000 000 000 000 000 000 000 000 000 000 000 000 001 000 000 000 000 000

<13 more rows, total 18 rows>

000 000 000 000 000 07E 000 000 025 000 000 000 000 042 000 000 000 000 000 000
000 000 000 028 000 000 000 000 000 000 000 000 0D9 0DD 000 03B 000 000 000 000
□T
```

Example 2

One cloud base detected and two layers calculated, total cloud amount 8/8 and unit meter.

Cloud amount information expressed in acronyms (codes).

```
 CBM1 0000 01070 00180 ///// ///// ///// ///// ///// 07600
FEW:00140 OVC:00690 CLR:///// CLR:///// OVC
□^
<(Signal profile as in example 1)>
```

5.8.5 Message Format 3 (CT12K)

For adapting the ceilometer CBME80B to system programmed for VAISALA CT12K ceilometer the CT12K telegram No 5 is implemented in CBME80B. This telegram includes information of status, cloud bases, penetration depths and cloud amount.

MESSAGE FORMAT

<STX><CR><LF> **DATABLOCK** <ETX><CR><LF>

Where <STX> = ASCII 02 HEX
<ETX> = ASCII 03 HEX
<CR> = ASCII 0D HEX
<LF> = ASCII 0A HEX

DEFINITION OF DATABLOCK

First row

NSB<sp>$H_1H_1H_1H_1H_1$<sp>$T_1T_1T_1T_1T_1$<sp>$H_2H_2H_2H_2H_2$<sp>$T_2T_2T_2T_2T_2$ <sp>$S_1S_2S_3S_4S_5S_6S_7S_8S_9S_{10}$<cr><lf>

Second row

<sp>OO_1<sp>LLL_1<sp>OO_2<sp>LLL_2<sp>OO_3<sp>LLL_3<sp>OO_4 <sp>LLL_4<cr><lf>

Explanation of First row:

N = 0 No significant backscatter (clear air)

N = 1 One cloud base detected

N = 2 Two cloud bases detected

N = 3 Sky is fully obscured but no cloud base can be detected from echo signal received (e.g. vertical visibility)

N = 4 Sky is partly obscured and no cloud or vertical visibility detected

S = 0 No alarm status bits S1….S4 (normal status)

S = 1 At least one alarm status bit S1….S4 is on

B = Space (20 HEX) or Bell (07 HEX) if S =1

N = 0 or 4: $H_1=H_2=T_1=T_2$ = /////

N = 1	$H_1H_1H_1H_1H_1$	=	The lowest detected cloud height in 5 digits.
	$T_1T_1T_1T_1T_1$	=	Penetration depth of first cloud base, Leading zeroes not suppressed, ///// if not defined
N = 2	$H_1H_1H_1H_1H_1$	=	The lowest detected cloud height in 5 digits.
	$T_1T_1T_1T_1T_1$	=	Penetration depth of first cloud base,
	$H_2H_2H_2H_2H_2$	=	Second cloud base,
	$T_2T_2T_2T_2T_2$	=	Penetration depth of second cloud base, Leading zeroes not suppressed, ///// if not defined
N = 3	$H_1H_1H_1H_1H_1$	=	Calculated vertical visibility
	$T_1T_1T_1T_1T_1$	=	Signal range i.e. height of highest detected backscatter

Status indicators

S_1 = Hardware alarm (i.e. CBME status bit D8 or D14)

S_2 = Supply voltage alarm (i.e. CBME status bit D5)

S_3 = Laser power low (i.e. CBME status bit D0)

S_4 = Temperature alarm (i.e. CBME status bits D2 or/and D3)

S_5 = Solar shutter ON (i.e. CBME status bit D9)

S_6 = Blower ON

S_7 = Heater ON

S_8 = 0: Unit is feet
1: Unit is meter

S_9 = Saving mode Not used by CBME 80, always zero

S_{10} = Polling mode Not used by CBME 80 always zero

Explanation of second row

OO_1 = Layer 1 amount (0….8) or 9 if vertical visibility reported

-1 if less than ”30 minutes” (parameter) of data available

-2 if data not available because of hardware failure

LLL_1 = Layer 1 height or vertical visibility in 10^{th} of meters or 100's of feet depending of unit (S_8)

OO_2 = Layer 2 amount (0….8)
LLL_2 = Layer 2 height in 10^{th} of meters or 100's of feet depending of unit

OO_3 = Layer 3 amount (0….8)
LLL_3 = Layer 3 height in 10^{th} of meters or 100's of feet depending of unit

OO_4 = Layer 4 amount (0….8)
LLL_4 = Layer 4 Height in 10^{th} of meters or 100's of feet depending of unit

All positions OO_2 to OO_4 and LLL_1 to LLL_4 are set to zero if OO_1 is -1 or -2

Leading zeros are suppressed (sent as space (20HEX))

5.8.5.1 Examples of telegrams

Example 1:
No cloud or vertical visibility detected, unit is meter cloud amount is 1 octa at 30 meter.

```
00  ///// ///// ///// ///// 0000000100
  1   3  0   0  0   0  0   0
```

Example 2:
No cloud or vertical visibility detected, unit is meter, to few samples for determination of cloud amount.

```
00  ///// ///// ///// ///// 0000000100
 -1   0  0   0  0   0  0   0
```

Example 3:
Hardware error indicated.

```
01///// ///// ///// ///// 1000000100
 -2   0  0   0  0   0  0   0
```

Example 4:
Vertical visibility detected, unit is meters and blower is on.

```
30  00030 00150 ///// ///// 0000010100
  9   3  0   0  0   0  0   0
```

5.8.6 Message Format 4 (Service)

This format is intended for maintenance purposes. It contains information about all supervised and controlled variables, as well as status, cloud bases, penetration depths, vertical visibility, measuring range and other various information.

Example of telegram:

```
CBME1 s0000 00220 00090 00000 00000 00000 07500

CEILOMETER
S/N  :  9998   VER  :A1.08A   BUILD :  1760
WEEKS:    12   RESET:     5

SYSTEM TEST    VAL  :  3589   POS   :    61
LTMP :  35.3   LHV  :  43.2   LCU   :  17.0   LPP    :    50
RTMP :  29.8   DHV  : 363.3   NOISE :     9   OFFSET :   159
REF  :  6.00   12V  :  13.7   HEAT  :   OFF   BLOWER :    ON

OPTIONS
TILT :    ON   COMP : 0.978   PITCH :   0.2   ROLL   :  12.9
CONT :   N/A
```

NOTE

This format is always sent on the service port during the first 2 minutes after power up after two minutes the format is switched to the format selected in parameter 56 (default message no4.)

The service format is a maintenance format and as such it is subject to change between subsequent releases.

If the Debug data printout is active (EE699=1) additional data will be included in the service telegram in a separate `DEBUG` block.

5.8.7 Message Format 5 (ASCII)

This format is intended for use when host computers, data loggers, digital displays, and PC presentation shall be used without signal profile.

The message includes information of identity, software version, status, blower, serial number, measuring range, cloud bases, penetration depths and cloud amount.

MESSAGE FORMAT

<STX> **DATABLOCK** <CR><LF><ETX>LRC

Symbol	*Explanation*
STX	Start of text (ASCII 02 Hex)
ETX	End of text (ASCII 03 Hex)
CR	Carriage Return (ASCII 0D Hex)
LF	Line Feed (ASCII 0A Hex)
LRC	Checksum character

LRC (Longitudinal Redundancy Checksum) calculation

The first character <STX> is not included in the LRC-sum. The following characters inclusive the termination character <ETX> is included in the LRC-calculation. The LRC-sum is calculated as exclusive-OR sum.

DEFINITION OF DATABLOCK

First row

IIIII<SP>AAAAAAAAA<SP>NNNNNNN<SP>F<SP>SSSS<SP>RRRRR<CR><LF>

Symbol	*Explanation*
IIIII	Identity (normally <sp>CBM1)
AAAAAAAAA	Software version (Ver:A1.08)
NNNNNNN	Serial number (SN: 123)
F	Blower (1=on, 0=off)
SSSS	Status word (hexadecimal coded)
RRRRR	Measuring range

Second row

$HHHHH_1$<sp>$TTTT_1$<sp>$HHHHH_2$<sp>$TTTT_2$<sp>$HHHHH_3$<sp>$TTTT_3$ <sp>VVVVV<sp>
O_1<SP>$LLLLL_1$<sp>O_2<SP>$LLLLL_2$<sp>O_3<SP>$LLLLL_3$<sp>O_4<SP>$LLLLL_4$<sp>T_c<SP>//

Symbol	*Explanation*
HHHHH	Cloud bases (cloud base one, two and three) in meter or feet, 00000 if no detection
TTTT	Penetration depth (penetration depth one, two and three) in meter or feet, 0000 if no detection

VVVVV	Vertical visibility in meter or feet, 00000 if no detection
O	Cloud amounts in octas (0,1,2,3,4,5,6,7,8 or 9) If the value is missing, / is presented
LLLLL	Height of layer 1, 2, 3 and 4 in meter or feet If the value is missing, ///// is presented
T_c	Total cloud amount in octas If the value is missing, / is presented
//	For future use (spare)

NOTE

The penetration depth has only four positions, which means that the depth cannot be greater than 9999 meter or feet (limited by the unit parameter).

Examples of telegrams

Example 1

In this example there are no hits on either cloud base or VV. The cloud amount information has not attained the time criteria and because of that contains “slash”.

```
CBM1 VER:A1.08 SN:1264 0 0000 07600
00000 0000 00000 0000 00000 0000 00000 / ///// / ///// / ///// /
///// / //
```

Example 2

In this example the blower is ON, VV is 30 meter and cloud amount 8/8 on 30 meter (layer 1), layer 2, 3 & 4 empty and total cloud amount 8/8

```
CBM1 VER:A1.08 SN:1264 1 0000 07600
00000 0000 00000 0000 00000 0000 00030 8    30 0     0 0
    0 0     0 8 //
```

5.8.8 Message Format 6 (OS21)

This format is intended for use in the OS21 system or in similar implementations. This message includes information of status, measuring range, cloud bases, penetration depths and vertical visibility.

MESSAGE FORMAT

<STX> **DATABLOCK** <LF><CR><ETX>LRC

Symbol	*Explanation*
STX	Start of text (ASCII 02 Hex)
ETX	End of text (ASCII 03 Hex)
CR	Carriage Return (ASCII 0D Hex)
LF	Line Feed (ASCII 0A Hex)
LRC	Checksum character

DEFINITION OF DATABLOCK

IIIII_SSSSS_HHHHH_PPPPP_HHHHH_PPPPP_HHHHH_PPPPP_VVVVV_RRRRR

Symbol	*Explanation*
IIIII	Identity (The identity of the ceilometer default CBME1)
SSSSS	Status word (hexadecimal coded)
HHHHH	Cloud base height (base one, two and tree) in meter or feet
PPPPP	Penetration depth (depth one, two and tree) in meter or feet
VVVVV	Vertical visibility in meter or feet
RRRRR	Measuring range in meter or feet
_	Space

LRC (Longitudinal Redundancy Checksum) calculation

The first character <STX> is not included in the LRC-sum. The following characters inclusive the termination character <ETX> is included in the LRC-calculation. The LRC-sum is calculated as exclusive-OR sum.

5.8.9 Message Format 7 (CT25K Message No. 6)

For adapting the ceilometer to system programmed for VAISALA CT25K ceilometer the CT25K message no. 6 is supported. This telegram includes information of status, cloud bases, penetration depths and cloud amount.

Note: Message format CT25K Message No. 6 is identical to CT25KAM Message No. 6-0.

MESSAGE FORMAT

First row (11 chars)

<SOH>IIUVVMM<STX><CR><LF>

Second row (31 chars)

NS<SP>$H_1H_1H_1H_1H_1$<SP>$H_2H_2H_2H_2H_2$<SP>$H_3H_3H_3H_3H_3$
<SP>$S_1S_2S_3S_4S_5S_6S_7S_8$<CR><LF>

Third row (30 chars)

<SP>OO_1<SP>LLL_1<SP>OO_2<SP>LLL_2<SP>OO_3<SP>LLL_3<SP>OO_4
<SP>LLL_4<CR><LF>

Forth row (3 chars)

<ETX><CR><LF>

Explanation of First row

Symbol	***Explanation***
<SOH>	Start of Heading (ASCII 01 Hex)
II	Ceilometer identification string, always CT
U	Unit identification number 0..F (set in EE51)
VV	Software level id 00..99
MM	Message number; this message always = 60
<STX>	Start of Text (ASCII 02 Hex)
<CR>	Carriage Return (ASCII 13 Hex)
<LF>	Line Feed (ASCII 10 Hex)

Explanation of Second row

Symbol	***Explanation***
N	Detection status as follows: 0 No significant backscatter 1 One cloud base detected 2 Two cloud bases detected 3 Three cloud bases detected 4 Sky is fully obscured but no cloud base can be detected (e.g. vertical visibility) 5 Sky is party obscured and no cloud or vertical visibility detected (n/a)
S	Warnings and Alarm information as follows: 0 Self-check OK 1 W At least one Warning active, no Alarms 2 A At least one Alarm active
<SP>	Space

Symbol	*Explanation*
$H_1H_1H_1H_1H_1$	Lowest cloud base height (if N = 1, 2, 3) Vertical visibility (if N = 4) ///// (if N= 0, 5)
$H_2H_2H_2H_2H_2$	Second lowest cloud base height (if N = 2, 3) ///// (if N = 0, 1, 4, 5)
$H_3H_3H_3H_3H_3$	Third lowest cloud base height (if N = 3) ///// (if N = 0, 1, 2, 4, 5)
$S_1S_2S_3S_4$	Status. Alarm (A), Warning (W), or internal status (S)
$S_5S_6S_7S_8$	Information. Each character is a hexadecimal representation of four bits (i.e. 0-F). As each character represents the sum of four individual bits, the total number of bits is 32 (b00-b31).

Third row (30 chars)

<SP>OO_1<SP>LLL_1<SP>OO_2<SP>LLL_2<SP>OO_3<SP>LLL_3<SP>OO_4<SP>LLL_4<CR><LF>

Explanation of Third row

Symbol	*Explanation*
OO_1	Detection status: 0 – 8 Cloud amount of the first layer in oktas 9 Vertical visibility 99 Not enough data (after start-up) The number is right aligned and padded with space
OO_{2-4}	Cloud amount of the layer (second, third or fourth). 0 if no cloud layer has been detected The number is right aligned and padded with space
LLL_{1-4}	Height of the layer (first, second, third, or fourth). Reporting resolution is 100 ft or 10 m depending on feet or meter selection (i.e. 170 equals 17000 ft or 1700 m). If the corresponding cloud amount is zero, /// is presented.

Explanation of Forth row

Symbol	*Explanation*
<ETX>	End of Text (ASCII 03 Hex)

Example:

Two cloud bases detected (570 m, 2340 m).

Cloud amount of first layer is 3/8 and is located at 550 m. Cloud amount of second layer is 5/8 and is located at 2200 m.

The status code `00000180` means that bit 7 and bit 8 is set. This means that the polling mode is active (bit 7) and the unit is meters (bit8).

```
CT12060
20 00570 02340 ///// 00000180
  3 055  5 220  0 ///  0 ///
```

5.8.10 Message Format 8 (CT25K Message No. 1)

For adapting the ceilometer to system programmed for VAISALA CT25K ceilometer the CT25K message no. 1 is supported. This telegram includes information of status, cloud bases, penetration depths.

MESSAGE FORMAT

First row (11 chars)

`<SOH>IIUVVMM<STX><CR><LF>`

Second row (31 chars)

`NS<SP>`$H_1H_1H_1H_1H_1$`<SP>`$H_2H_2H_2H_2H_2$`<SP>`$H_3H_3H_3H_3H_3$
`<SP>`$S_1S_2S_3S_4S_5S_6S_7S_8$`<CR><LF>`

Third row (3 chars)

`<ETX><CR><LF>`

This message format is the same as CT25K message no. 6 except that the cloud amount is not present in this telegram (e.g. the third row is removed). See chapter 5.8.9 for an explanation of the telegram format.

Example:

Two cloud bases detected (570 m, 2340 m).

The status code `00000180` means that bit 7 and bit 8 is set. This means that the polling mode is active (bit 7) and the unit is meters (bit8).

```
CT12010
20 00570 02340 ///// 00000180
```

5.8.11 Message Format 9 (CT25KAM Message No. 6-1)

For adapting the ceilometer to system programmed for VAISALA CT25KAM ceilometer the CT25KAM message no. 6-1 is supported. This telegram includes information of status, cloud bases, penetration depths and cloud amount.

MESSAGE FORMAT

First row (11 chars)

<SOH>IIUVVMM<STX><CR><LF>

Second row (31 chars)

NS<SP>$H_1H_1H_1H_1H_1$<SP>$H_2H_2H_2H_2H_2$<SP>$H_3H_3H_3H_3H_3$
<SP>$S_1S_2S_3S_4S_5S_6S_7S_8$<CR><LF>

Third row (37 chars)

<SP>OO_1<SP>LLL_1<SP>OO_2<SP>LLL_2<SP>OO_3<SP>LLL_3<SP>OO_4
<SP>LLL_4<SP>OO_5<SP>LLL_5<CR><LF>

Forth row (3 chars)

<ETX><CR><LF>

This message format is the same as CT25K message no. 6 except that the cloud amount is extended from 4 layers to 5 layers (e.g. the third row is changed from 30 chars to 37 chars). See chapter 5.8.9 for an explanation of the telegram format.

Example:

Two cloud bases detected (570 m, 2340 m).

Cloud amount of first layer is 3/8 and is located at 550 m. Cloud amount of second layer is 5/8 and is located at 2200 m.

The status code 00000180 means that bit 7 and bit 8 is set. This means that the polling mode is active (bit 7) and the unit is meters (bit8).

```
CT12061
20 00570 02340 ///// 00000180
  1 055  3 220  0 ///  0 ///  0 ///
```

5.8.11.1 CT25K Status word

The standard status messages as well as information elements has been translated in accordance to the CT25K status message.

Note: Not all information is available. In those cases, the specific event will never be triggered and 0 will always be sent.

Pos	*Bit*	*S*	*Explanation (CT25K)*	*Explanation (CBME80B)*	*Bit*
S_1	b31	A	Transmitter shut-off (Laser temperature high).	Laser temperature high (LTemp)	d2
	b30	A	Laser failure	Faulty laser current (LCU)	d1
	b29	A	Receiver or coaxial cable failure.	Faulty receiver high voltage (DHV)	d7

Pos	Bit	S	Explanation (CT25K)	Explanation (CBME80B)	Bit
	b28	A	Engine, voltage or memory failure.	Faulty reference voltage, Faulty laser high voltage, EE-prom checksum error	d4, d6, d10
S_2	b27	A	Spare	Spare	
	b26	A	Spare	Spare	
	b25	A	Spare	Spare	
	b24	A	Spare	Spare	
S_3	b23	W	Window contaminated	Contamination warning	d12
	b22	W	Battery low	*(Not supported)*	
	b21	W	Laser power low	Low laser power (LPP)	d0
	b20	W	Heater or humidity sensor failure	*(Not supported)*	
S_4	b19	W	Internal temperature high or low	Abnormal operating temperature (Rtemp)	d3
	b18	W	Voltage high or low	Abnormal supply voltage	d5
	b17	W	Relative humidity high > 85% (option)	*(Not supported)*	
	b16	W	Receiver optical cross-talk compensation poor	Abnormal receiver sensitivity (sys-test)	d8
S_5	b15	W	Blower failure	Blower failure (option)	d11
	b14	W	Spare	Spare	
	b13	W	Spare	Spare	
	b12	W	Spare	Sun shutter active **Note**: Also cause b16 and b21 to be active	d9
S_6	b11	S	Blower is ON	Blower is ON	S
	b10	S	Blower heater is ON	*(Not supported)*	
	b09	S	Internal heater is ON	Heater is ON	S
	b08	S	Units are METERS (if ON) else FEET	Unit (0 = Feet, 1 = Meters)	S
S_7	b07	S	Polling mode is ON	Transmission mode (1 = Polling, 0 = Other)	S
	b06	S	Working from battery	*(Not supported)*	
	b05	S	Always 0	Always 0	
	b04	S	Always 0	Always 0	

Pos	Bit	S	Explanation (CT25K)	Explanation (CBME80B)	Bit
S_8	b03	W	Tilt angle is > 45 degrees	Tilt angle warning (opt)	d13
	b02	W	High radiance warning	*(Not supported)*	
	b01	S	Manual blower control	Manual Blower Control	S
	b00	S	Spare	Spare	

5.8.12 Message Format 30-43 (CL31/CL51 Message No. 1 and No. 2)

For adapting the ceilometer to system programmed for VAISALA CL31/CL51 ceilometer the CL31/CL51 telegram No. 1 and No. 2 are supported. This includes all of the separate subclasses for a total of 10 different message formats.

Message No. 1 includes information of status, cloud bases, penetration depths, vertical visibility and backscatter profile.

Message No. 2 includes all the information in telegram no. 1 and is extended to also include cloud amount information.

There are also short versions of both the telegrams without the backscatter information. This is suitable for low bandwidth or low storage systems. In the short versions line 3 and 4 from message 1 and line 4 and 5 from message 2 is omitted creating very short and compact messages.

Id	Msg No and Subclass	Message Name	Resolution (m)	Length (bytes)
30	CL31 11	msg1_10x770	10	3956
31	CL31 12	msg1_20x385	20	2031
32	CL31 13	msg1_5x1500	5 [1]	7606
33	CL31 14	msg1_5x770	5 [1]	3956
34	CL31 15	msg1_base	-	55
35	CL31 21	msg2_10x770	10	3993
36	CL31 22	msg2_20x385	20	2068
37	CL31 23	msg2_5x1500	5 [1]	7643
38	CL31 24	msg2_5x770	5 [1]	3993
39	CL31 25	msg2_base	-	92
40	CL51 16	51_msg1_10x1540	10	7806
41	CL51 18	51_msg1_base	-	55
42	CL51 26	51_msg2_10x1540	10	7848
43	CL51 28	51_msg2_base	-	97

[1] The ceilometer has an internal measuring resolution of 10 m, the actual outputted data is 10 m (and duplicated for compatibility with the message format).

MESSAGE FORMAT

CL31/CL51 data message no. 1

First row (12 chars)

<SOH>IIUVVVM$_1$M$_2$<STX><CR><LF>

Second row (35 chars)

NS<SP>H$_1$H$_1$H$_1$H$_1$H$_1$<SP>H$_2$H$_2$H$_2$H$_2$H$_2$<SP>H$_3$H$_3$H$_3$H$_3$H$_3$
<SP>S$_1$S$_2$S$_3$S$_4$S$_5$S$_6$S$_7$S$_8$S$_9$S$_{10}$S$_{11}$S$_{12}$<CR><LF>

Third row (49 chars)

SSSSS<SP>RR<SP>LLLL<SP>EEE<SP>TTT<SP>WWW<SP>AA
<SP>BBBB<SP>P$_1$P$_2$P$_3$P$_4$P$_5$P$_6$P$_7$P$_8$P$_9$<SP>NNN<CR><LF>

Forth row (number of chars depends on res and length, i.e. 5x770+2=3852)

SSSSS$_1$SSSSS$_2$...(5x770 bytes)...SSSSS$_n$<CR><LF>

Fifth row (8 chars)

<ETX>CCCC<EOT><CR><LF>

CL31/CL51 data message no. 2

First row (12 chars)

<SOH>IIUVVVM$_1$M$_2$<STX><CR><LF>

Second row (35 chars)

NS<SP>H$_1$H$_1$H$_1$H$_1$H$_1$<SP>H$_2$H$_2$H$_2$H$_2$H$_2$<SP>H$_3$H$_3$H$_3$H$_3$H$_3$
<SP>S$_1$S$_2$S$_3$S$_4$S$_5$S$_6$S$_7$S$_8$S$_9$S$_{10}$S$_{11}$S$_{12}$<CR><LF>

Note: Please note the difference in the third row between CL31 and CL51. The Layers has 3 digits for CL31 and 4 digits for CL51.

Third row CL31 (37 chars)

<SP>OO$_1$<SP>LLL$_1$<SP>OO$_2$<SP>LLL$_2$<SP>OO$_3$<SP>LLL$_3$<SP>OO$_4$
<SP>LLL$_4$<SP>OO$_5$<SP>LLL$_5$<CR><LF>

Third row CL51 (42 chars)

<SP>OO$_1$<SP>LLLL$_1$<SP>OO$_2$<SP>LLLL$_2$<SP>OO$_3$<SP>LLLL$_3$<SP>OO$_4$
<SP>LLLL$_4$<SP>OO$_5$<SP>LLLL$_5$<CR><LF>

Forth row (49 chars)

SSSSS<SP>RR<SP>LLLL<SP>EEE<SP>TTT<SP>WWW<SP>AA
<SP>BBBB<SP>P$_1$P$_2$P$_3$P$_4$P$_5$P$_6$P$_7$P$_8$P$_9$<SP>NNN<CR><LF>

Fifth row (number of chars depends on res and length, i.e. 5x770+2=3852)

$SSSSS_1SSSSS_2$...(5x770 bytes)...$SSSSS_n$<CR><LF>

Sixth row (8 chars)

<ETX>CCCC<EOT><CR><LF>

Explanation of First row

Symbol	***Explanation***
<SOH>	Start of Heading (ASCII 01 Hex)
II	Ceilometer identification string, always CL
U	Unit identification number 0..F (set in EE51)
VV	Software level id 100..999
M_1M_2	Message number, message without sky condition = 1, message with sky condition 2.
M_2	Message subclass number: 1 = Backscatter 10 m res x 770 samples. Range: 7700 m 2 = Backscatter 20 m res x 385 samples. Range: 7700 m 3 = Backscatter 5 m res x 1500 samples. Range: 7500 m 4 = Backscatter 5 m res x 770 samples. Range: 3850 m 5 = No backscatter profile
<STX>	Start of Text (ASCII 02 Hex)
<CR>	Carriage Return (ASCII 13 Hex)
<LF>	Line Feed (ASCII 10 Hex)

Explanation of Second row

Symbol	***Explanation***
N	Detection status as follows: 0 No significant backscatter 1 One cloud base detected 2 Two cloud bases detected 3 Three cloud bases detected 4 Sky is fully obscured, but no cloud base can be detected (e.g. vertical visibility) 5 Sky is party obscured, and no cloud or vertical visibility detected (n/a)

Symbol	Explanation
	/
S	Warnings and Alarm information as follows: 0 Self-check OK W At least one Warning active, no Alarms A At least one Alarm active
<SP>	Space
$H_1H_1H_1H_1H_1$	Lowest cloud base height (if N = 1, 2, 3) Vertical visibility (if N = 4) ///// (if N= 0, 5)
$H_2H_2H_2H_2H_2$	Second lowest cloud base height (if N = 2, 3) ///// (if N = 0, 1, 4, 5)
$H_3H_3H_3H_3H_3$	Third lowest cloud base height (if N = 3) ///// (if N = 0, 1, 2, 4, 5)
$S_1S_2S_3S_4$ $S_5S_6S_7S_8$ $S_9S_{10}S_{11}S_{12}$	Status. Alarm (A), Warning (W), or internal status (S) Information. Each character is a hexadecimal representation of four bits (i.e. 0-F). As each of the 12 characters represents the sum of four individual bits, the total number of bits is 48 (b00-b47). See chapter 5.8.12.2 for details about the status code.

Explanation of additional Third row if message no. 2

Symbol	Explanation
OO_1	Detection status: 0 – 8 Cloud amount of the first layer in oktas 9 Vertical visibility 99 Not enough data (after start-up) The number is right aligned and padded with space
OO_{2-5}	Cloud amount of the layer (second, third, fourth or fifth). 0 if no cloud layer has been detected The number is right aligned and padded with space
LLL_{1-5}	Height of the layer (first, second, third, fourth or fifth). Reporting resolution is 100 ft or 10 m depending on feet or meter selection (i.e. 170 equals 17000 ft or 1700 m).

	If the corresponding cloud amount is zero, /// is presented.

Explanation of Third row (Forth row if message no. 2)

Symbol	*Explanation*
SSSSS	Scale parameter. 100 (%) is normal
RR	Resolution of backscatter profile in meters.
LLLL	Number of samples.
	The number is right aligned and padded with 0, i.e. 0770
EEE	Laser diode output power (% of nominal factory calibration)
	100 (%) is standard. Possible values: 000 – 999
TTT	Laser diode temperature in Celsius (-50 - +99). Note: Sign is always present (also for positive temperatures)
WWW	Window transmission estimate in percent: 000 – 100 (%) Note: Requires contamination option. Otherwise always 100.
AA	Tilt angle in degrees from vertical (0 – 90)
	Absolute value. No signs.
	Note: Requires tilt option. Otherwise always 00.
BBBB	Background light (0 – 2500)
$P_1P_2P_3P_4$	Measurement parameters
$P_5P_6P_7P_8$	P1 Pulse **L**ong/**S**hort (always long)
P_9	P2-5 Pulse quantity (in thousand), i.e. 0020 = 0020x1024
	P6 Gain **H**igh/**L**ow (always high)
	P7 Bandwidth **N**arrow/**W**ide (always narrow)
	P8-9 Sampling frequency **15**/**30** MHz
NN	Sum of detected and normalized backscatter.
	Possible values: 0 – 999.

Explanation of Forth row (Fifth row if message no. 2)

Symbol	*Explanation*
$SSSSS_1$	Attenuated backscatter profile with sensitivity normalized
…	units (10^{-7} $sr^{-1}m^{-1}$) unless otherwise scaled with Scale
$SSSSS_n$	parameter. Each sample is coded with 20-bit character set.
	The length is 5 times the length of the profile (n) + 2.
	Note: The data is not corrected for any tilt angle.

Explanation of Fifth row (Sixth row if message no. 2)

<ETX>CCCC<EOT><CR><LF>

Symbol	*Explanation*
<ETX>	End of Text (ASCII 03 Hex)
CCCC	Checksum, see chapter 5.8.12.1 for information on calculation 4-digit hex value. Hex values in lower letters.
<EOT>	End of Transmission (ASCII 04 Hex)
<CR>	Carriage Return (ASCII 13 Hex)
<LF>	Line Feed (ASCII 10 Hex)

5.8.12.1 CL31/CL51 Checksum

The calculation of the checksum starts after the Start-of-Heading character and ends after the End-of-Text character, that is, the first character included is C and the last one included is End-of-Text.

The checksum is a variant of the CRC-16 called Genibus.

This uses the CCITT CRC-16 polynomial $X^{16} + X^{12} + X^5 + 1 = 0x1021$.

```
unsigned short crc16(const unsigned char *data, int offset, int
len)
{
   short crc;
   short xmask;
   int i, j;
   crc = 0xffff;

   for (i = offset; i < (offset+len); ++i)
   {
      crc ^= data[i] << 8;
      for (j = 0; j < 8; ++j)
      {
         xmask = (crc & 0x8000) ? 0x1021 : 0;
         crc <<= 1;
         crc ^= xmask;
      }
   }
   return crc ^ 0xffff;
}
```

5.8.12.2 CL31/CL51 Status word

The standard status messages as well as information elements has been translated in accordance to the CL31 status message.

Note: Not all information is available. In those cases, the specific event will never be triggered and 0 will always be sent.

c	*Bit*	*S*	*Explanation (CL31)*	*Explanation (CBME80B)*	*Bit*
S_1	b47	A	Transmitter shut-off (Laser temperature high).	Laser temperature high (LTemp)	d2
	b46	A	Transmitter failure	Faulty laser current (LCU)	d1
	b45	A	Receiver failure.	Faulty receiver high voltage (DHV)	d7
	b44	A	Voltage failure	Faulty laser high voltage	d6
S_2	b43	A	Alignment failure	*(Not supported)*	
	b42	A	Memory error	EE-prom checksum error	d10
	b41	A	Light path obstruction	*(Not supported)*	
	b40	A	Receiver saturation	Noise high level	S
S_3	b39	A	Spare	Spare	
	b38	A	Spare	Spare	
	b37	A	Spare	Spare	
	b36	A	Spare	Spare	
S_4	b35	A	Spare	Spare	
	b34	A	Spare	Spare	
	b33	A	Coaxial cable failure	*(Not supported)*	
	b32	A	Ceilometer engine board failure	Faulty reference voltage	d4
S_5	b31	W	Window contaminated	Contamination warning	d12
	b30	W	Battery voltage low	*(Not supported)*	
	b29	W	Transmitter expires	Low laser power (LPP)	d0
	b28	W	High humidity	*(Not supported)*	
S_6	b27	W	Spare	Spare	
	b26	W	Blower failure	Blower failure	d11
	b25	W	Spare	Spare	
	b24	W	Humidity sensor failure	*(Not supported)*	
S_7	b23	W	Heater fault	Abnormal operating temperature (Rtemp)	d3

c	*Bit*	*S*	*Explanation (CL31)*	*Explanation (CBME80B)*	*Bit*
	b22	W	High background radiance	Sun-shutter active	d9
	b21	W	Ceilometer engine board failure	*(Not supported)*	
	b20	W	Battery failure	*(Not supported)*	
S_8	b19	W	Laser monitor failure	Power sensor board failure	S
	b18	W	Receiver warning	Abnormal receiver sensitivity (sys-test)	d8
	b17	W	Tilt angle > 45 degrees warning	Tilt angle warning (opt)	d13
	b16	W	Spare	Spare	
S_9	b15	S	Blower is ON	Blower is ON	S
	b14	S	Blower heater is ON	*(Not supported)*	
	b13	S	Internal heater is ON	Heater is ON	S
	b12	S	Working from battery	*(Not supported)*	
S_{10}	b11	S	Standby mode is on	*(Not supported)*	
	b10	S	Self-test in progress		
	b09	S	Manual data acquisition settings are effective	*(Not supported)*	
	b08	S	Spare	Spare	
S_{11}	b07	S	Units are METERS (if ON) else FEET	Unit (0 = Feet, 1 = Meters)	S
	b06	S	Manual blower control	Manual blower control	S
	b05		Polling mode is ON	Transmission mode (1 = Polling, 0 = Other)	S
	b04	S	Spare	Spare	
S_{12}	b03	S	Spare	Spare	
	b02	S	Spare	Spare	
	b01	S	Spare	Spare	
	b00	S	Spare	Spare	

5.9 Status Word Interpreting

5.9.1 General

Each supervised parameter in the CBME80B has an assigned status bit.

The corresponding status bit(s) is set active (high) if an error is detected.

An overall alarm bit is set automatically if error indicated by certain individual status bits causing operational error of the ceilometer.

If the overall alarm bit is indicating operational error, measured cloud related values should not be trusted. During the error situation values in the outgoing messages may be either slashes (////) or zeros (0) depending of message number. Detailed information of the error is reported in corresponding bits.

If only individual status bit(s) are active it means a warning, measured values can be trusted.

5.9.2 Status Word in Messages

The status word is a four-character word hexadecimal code.

The rightmost bit is d0 and leftmost bit is d15

For example:
4400 means that bit d14 and d10 is active indicating an overall alarm (d14) and EE-prom checksum error (d10), measured values is slashed (////) and not to be trusted.

0020 means abnormal supply voltage (d5) this is a warning message and measured values can be trusted.

NOTE

Observe that some telegram numbers (CT12K, CT25K, CL31/CL51) have different layout of the status word to be compatible with older systems/sensors from other manufactures, please refer to respectively message format.

5.9.3 Status Word on local Display (option)

Only status errors causing the overall alarm bit (D14) to be set will be indicated on the local display except for sun shutter active. The warning errors will not be presented since trusted measured values have higher priority than non-critical warnings.

The error code is present as a four digit hexadecimal value proceeded by an “E” instead of measured value.

Example:

E4400 (E for error and 4400 means status bit D14 and D10)

5.9.4 Status bits definition

d0 Low laser power (LPP)
d1 Faulty laser current (LCU)
d2 Faulty laser temperature (Ltemp)
d3 Abnormal operating temperature (Rtemp)
d4 Faulty reference voltage (+6V ref)
d5 Abnormal supply voltage (+12V)
d6 Faulty laser high voltage (LHV)
d7 Faulty receiver high voltage (DHV)
d8 Abnormal receiver sensitivity (sys-test)
d9 Solar shutter on (SH)
d10 EE-prom checksum error
d11 Blower warning (option)
d12 Contamination warning (option)
d13 Tilt angle warning (option)
d14 Over all alarm bit (error in operation)
d15 Not used (spare)

5.9.5 Alarm limits for the status bits

The following limits cause respective status bit to go active.

Bit d0 If measured laser power is lower than parameter EE5
Bit d1 If measured laser current differ more than +/- 3A from parameter EE3
Bit d2 If measured laser temperature differ more than +/- 5 degree Celsius from EE6
Bit d3 If measured receiver temperature is below 0 or higher than +65
Bit d4 If measured reference voltage differ more than +/-0,2V from 6.00V
Bit d5 If supply voltage (+12V) is below 10.0V or higher than 17.5V
Bit d6 If laser high voltage is below +12V or higher than +90V
Bit d7 If receiver high voltage differ more than +/-20V from the parameter EE2 (corrected for temperature)
Bit d8 If measured sys-test is below 1000 units or higher than 20000 units
Bit d9 If solar shutter is on (also cause d0 and d8 to be active)
Bit d10 EE-prom checksum error detected
Bit d11 Blower warning (option)
Bit d12 Contamination warning (option)
Bit d13 Tilt angle warning (option)

Bit d14 If any or combinations of bit d1, d2, d4, d6, d7 or d10 is active

Bit d15 not used

5.10 Polling mode

The modem port can be set to transmit a message when polled by a predefined polling string. The identification of the ceilometer must be included in the polling string.

The ceilometer identification string (ID) is set using EE parameter 51 (EE51). The default identification string is 1 (one).

By default, the modem port operates in periodic mode, i.e. periodically transmits messages at a predefined interval. To enable polling mode set the EE parameter 58 (transmission mode modem port), to 2. To return to periodic transmission of the messages EE58 should be set to 1.

For the service port the polling mode is controlled by EE parameter EE59.

5.10.1 Polling command

The polling request is issued with the following polling string:

<ENQ>CB<ID><MsgFmt><CR><LF>

Symbol	*Explanation*
ENQ	Enquiry (Ctrl+E) (ASCII 05 Hex)
ID	Ceilometer identifier (specified in EE51)
MsgFmt	Telegram format to return. 1 Integer format (for test purpose) 2 Graphic format (modified ASEA format) 3 CT12K format (emulates VAISALA CT12K) 4 Service format 5 ASCII format 6 OS21 7 CT25K No. 6 format (emulates VAISALA CT25K message no. 6) 8 CT25K No. 1 format (emulates VAISALA CT25K message no. 1) 30-43 CL31/CL51 message 1 and 2 (emulates VAISALA CL31/CL51 message no 1 and 2)
CR	Carriage Return (ASCII 0D Hex)
LF	Line Feed (ASCII 0A Hex)

Note: For compatibility reasons, it is also possible to use the CT25K polling string, see chapter 5.10.2.

5.10.2 CT25K Compatibility

For CT25K compatibility it is possible to poll the CT25K telegram format by the following polling string:

<ENQ>CT<ID><MsgFmt><CR><LF>

Symbol	*Explanation*
ENQ	Enquiry (Ctrl+E) (ASCII 05 Hex)
ID	Ceilometer identifier (specified in EE51)
MsgFmt	Telegram format to return. **Note**: Only telegram format 1 (CT25K Data Message No. 1) and 6 (CT25K Data Message No. 6) are supported

CR	Carriage Return (ASCII 0D Hex)
LF	Line Feed (ASCII 0A Hex)

Note: To adhere to the CT25K polling requirements, the transmission mode must be set to polling for the channel to use for polling.

Example
To use polling mode, issue the following commands:

Configuration (one time)

EE58=2 (enable polling mode for modem port)
EE51=1 (set identifier for this ceilometer)

Request telegram (repeat at will)

<ENQ>CT16<CR><LF>

The ceilometer will answer with the CT25K telegram containing the latest measurement data available.

Note: The data will be updated in the same interval as specified in the measuring time configuration (EE12).

If additional polling requests are done in-between, the same data will be used in the output.

5.11 Set and get EE parameters

It is possible to set and get the value of EE parameters directly without going into the menu hierarchy. These commands are useful for programmatically reading of changing the values.

These commands can be issued on the Modem Port using RS-232 and RS-485, or the service port using RS-232.

They may also be issued using the Ethernet interface using either of the ports.

Explanation of the symbols:

Symbol	*Explanation*
ENQ	Enquiry (Ctrl+E) (ASCII 05 Hex)
ID	Ceilometer identifier (specified in EE51). Use a Space as ID if all ceilometers should answer.

EEnum	EE parameter number identifier
EEval	EE parameter value
CR	Carriage Return (ASCII 0D Hex)
LF	Line Feed (ASCII 0A Hex)

The following commands are available:

5.11.1 Get EE parameter

To request a parameter value, enter the following command:

<ENQ>CB<ID>EER:<EEnum><CR><LF>

The answer will be given in the following format:

EE<EEnum>=<EEval><CR><LF>

The requested parameter's value is displayed in the <EEval> position.

Example
Send a request to display the currently configured telegram format for the Modem Port for the ceilometer with ID 3 (EE51=3)

<ENQ>CB3EER:50<CR><LF>

If there is a ceilometer with ID 3 (EE51=3) connected the following answer will be given:

EE50=2<CR><LF>

This answer tells us that the ceilometer is configured to use the ASEA telegram (number 2) on the Modem Port.

5.11.2 Set EE parameter

To set a parameter value, issue the following command:

<ENQ>CB<ID>EER:<EEnum><CR><LF>

No answer will be given. If you would like confirmation that the value has been stored correctly, make a subsequent call to the get method.

Example

Send a request to set the telegram format for the Modem Port for the ceilometer with ID 3 (EE51=3) to ASEA (number 2):

```
<ENQ>CB3EEW:50=2<CR><LF>
```

If there is a ceilometer with ID 3 (EE51=3) connected its Telegram format for the modem port (EE50) will be set to the ASEA telegram (number 2). To validate that the command has been entered correctly, please issue a get EE parameter command and compare the value of the output.

5.11.3 Retrieve the current status code for the ceilometer

To request the current status code for the ceilometer, enter the following command:

```
<ENQ>CB<ID>SSC<CR><LF>
```

The answer will be given in the following format:

```
SSC=<StatusCode><CR><LF>
```

The current status code of the ceilometer (as a standard hex coded status code) will be displayed in the `<StatusCode>` position.

Example
Send a request to get the status code for any ceilometer on the line (e.g. only use this when using RS-232 or only one ceilometer on a RS-485 line):

```
<ENQ>CB SSC<CR><LF>
```

5.12 Tilt (option)

The ceilometer may be optionally equipped with a tilt function. Using the tilt function, it is possible to use the ceilometer in a tilted direction. There is a built-in tilt angle sensor that measures the tilt angle, i.e. the deviation from the vertical axis.

The ceilometer is typically mounted in either vertical (i.e. 0 degrees), or tilted (i.e. approximately 12 degrees). This is done using the tilt extension for the stand when mounting the ceilometer.

The tilt function consists of the following:

- Tilt extension for stand
  The tilt stand extension is placed on top of the stand and will mount the ceilometer in a 12-degree angle.

- Extended blower air rubber tube
  A longer version of the blower air rubber tube, to connect the blower output to the air pipe in the extended tilted position.

- Tilt sensor
  The tilt sensor in the ceilometer will automatically detect the current tilt angle (deviation from vertical axis) and automatically compensate the reported values (i.e. cloud bases, penetration depth, vertical visibility, cloud amount layers, etc.).

The tilt sensor and its function are configured via the service menu via the Special functions → Tilt (Opt) hierarchy.

If the ceilometer is equipped with the tilt functionality, it will by default be enabled and set to compensate the measured values.

The status of the tilt sensor can be seen in the service telegram.

NOTE

Calibration of the tilt sensor is done at factory and is not required to be repeated.

5.13 Contamination (option)

5.13.1 General

The ceilometer may be optionally equipped with a contamination function. Using the contamination function, the ceilometer will issue a warning whenever the windows are contaminated and require cleaning.

The contamination function consists of the following:

- Contamination detection sensor
  The contamination sensor is located on the power sensor board (contamination sensor diode, system test diode, power sensor diode, and sun light detector are all parts of this board).

The contamination detection sensor and its function are configured via the service menu via the Special functions → Contam (Opt) hierarchy.

If the ceilometer is equipped with the contamination functionality, it will by default be enabled and all calibration of the option will already be pre-configured.

The status of the contamination sensor can be seen in the service telegram and the actual change value. The contamination warning is available in all telegrams in the status word.

No contamination measurements are performed when the sun shutters are active. This means the contamination measurement state and values are kept during the time the sun shutters are active.

When the contamination warning is raised the windows should be cleaned. See chapter 7.2 for details about cleaning the windows.

5.13.2 Calibration

If the contamination system starts issuing contamination warnings frequently and shortly after window cleaning, this may indicate that either the window is in a bad shape and needs to be replaced, or that the window contamination measurement has drifted.

When this happens, please carefully inspect the windows to determine the quality of them. If the windows are worn out, they need to be replaced.

If the windows are good, the contamination system needs to be re-calibrated.

Perform the following steps for calibration:

1. Carefully clean the windows and make sure they are clean

2. Go into the contamination calibration menu option: Special functions → Contam (opt) → Contam Calibration → Calibrate clean ref
   Note: Make sure to wait at least 10 minutes after cleaning the windows before the calibration clean ref command is issued.

The calibration is completed automatically.

NOTE

If the windows are worn out, they should be replaced.

Calibration of the contamination sensor is done at factory and is not normally required to be repeated unless windows are replaced.

5.14 Remote API

It is possible to access several functions of the ceilometer using the Remote API. The remote API makes it possible to execute the commands programmatically without having to go through the service menu hierarchy.

These commands can be issued on the Modem Port using RS-232 and RS-485, or the service port using RS-232.

They may also be issued using the Ethernet interface using either of the ports.

In order to use the Remote API it needs to be activated by setting the RemoteAPIAccess parameter (EE90) to active (1):

EE90=1

The following commands are available:

- RESET
  Reset the ceilometer
- VERSION
  Get the version information for the different subparts of the system
- LIST-ALL
  List all parameters
- LIST-DIFF
  List changed parameters
- GET
  Get any number of parameters as specified in the argument
- SET
  Set any number of parameters as specified in the argument
- TELEGRAM
  Poll a telegram. Telegram number in the argument.

5.14.1 API Syntax

The API requests and responses are sent in ASCII using the default settings for each communication interface.

Request

<ENQ>CB<ID>CCA|<VER>|<OP>|<DATA>|<CHKSUM><ENTER>

Explanation of the symbols:

Symbol	*Explanation*
<ENQ>	Enquiry (Ctrl+E) (ASCII 05 Hex)
CB	Fixed identifier for enquires to the Ceilometer
<ID>	Ceilometer identifier (specified in EE51). Use a Space as ID if all ceilometers should answer. **Note:** If the identifier is included only ceilometers with the same configured identifier will answer.
CCA	Fixed string for Cloud Control API
<VER>	Version of the CCA API. At this time always 1
<OP>	Command to execute.

	List of available commands: `RESET, VERSION, LIST-ALL, LIST-DIFF, GET, SET, TELEGRAM`
`<DATA>`	Additional data to the command. See respective command for details about data for each separate command.
`<CHKSUM>`	Checksum of command to validate command. This requirement may be enabled or disable. Leave blank or any value when disabled. CRC-16/Genibus. See chapter 5.8.12.1 for information on how to perform the calculation. The checksum is calculated after (exclusive) or <ENQ> character and up to and including (inclusive) the last pipe (|) divider before the `<CHKSUM>`.

`<ENTER>`
or
`<CR><LF>`
	Newline characters (<CR><LF>
	Carriage Return (ASCII 0D Hex)
	Line Feed (ASCII 0A Hex)

Response

`CCA|<VER>|R-<OP>|<ID>|<STATUS>|<DATA>|<CHKSUM><ENTER>`

Explanation of the symbols:

Symbol	*Explanation*
`CCA`	Fixed string for Cloud Control API
`<VER>`	Version of the CCA API. At this time always 1
`R-<OP>`	Response of command. Will be the requesting command prefixed with "R-" as in Response. **Note:** <OP> may also be `ERR` if a general error or unknown command is sent.
`<ID>`	Ceilometer identifier (specified in EE51).

`<STATUS>`	Status of the operation. The possible status values are the following:
	`200 Status OK`
	`500 Error Generic`
	`510 Error Syntax`
	`520 Error Command`
	`530 Error Data`

	540 Error Checksum 550 Error Version Basically, 2xx is Status OK, and 5xx is Error
<DATA>	Response from the actual command. See respective command for details about the response data for each separate command.
<CHKSUM>	Checksum of command to validate command response. See chapter 5.8.12.1 for information on how to perform the calculation to verify the answer. The checksum is calculated after (exclusive) or <ENQ> character and up to and including (inclusive) the last pipe (|) divider before the <CHKSUM>.
<ENTER> or <CR><LF>	Newline characters (<CR><LF> Carriage Return (ASCII 0D Hex) Line Feed (ASCII 0A Hex)

5.14.2 API Commands

For all the API commands an example command is used to illustrate how it is sent. In each of these examples we use the wildcard (i.e. space) identifier to address any ceilometer on the same line.

We also assume checksum verification is on and include the checksum.

5.14.2.1 Reset

The RESET command will reset (restart) the ceilometer.

Note: Please be careful to execute this command as it will restart the ceilometer and the restart procedure takes typically a few minutes until the ceilometer is up and running again.

Example

Request:
<ENQ>CB CCA|1|RESET||a6a1<ENTER>

Response:
CCA|1|R-RESET|1|200|Restarting ceilometer S/N 9998|
dbb9<ENTER>

Will cause the ceilometer to reset.

5.14.2.2 List-All

The `LIST-ALL` command will list all parameters that is used in the ceilometer along with the current value of the parameter.

Example

Request:
`<ENQ>CB CCA|1|LIST-ALL||1398<ENTER>`

Response:
`CCA|1|R-LIST-ALL|1|200|1=60,2=350,3=150,4=40 […]`

Will list all parameters used in the ceilometer along with the values.

The response data will be in the format `<EEnum>=<EEval>` in a comma-separated string.

5.14.2.3 List-Diff

The `LIST-DIFF` command will list all parameters that has a changed value compared to the default value in the current firmware used in the ceilometer.

Example

Request:
`<ENQ>CB CCA|1|LIST-DIFF||11df<ENTER>`

Response:
`CCA|1|R-LIST-DIFF|1|200|2=350(300),3=150(130) […]`

Will list all changed parameters used in the ceilometer along with the actual values and the default value.

The response data will be in the format `<EEnum>=<EEval>(<EEdefVal>` in a comma-separated string.

5.14.2.4 Get

The `GET` command will list all parameters supplied in the argument along with the current value of the parameter.

Example

Request:
`<ENQ>CB CCA|1|GET|1,2,3,100|95f2<ENTER>`

Response:
`CCA|1|R-GET|1|200|1=60,2=350,3=150,100=4|e370<ENTER>`

Will list the requested parameters along with their values.

The response data will be in the format <EEnum>=<EEval> in a comma-separated string.

5.14.2.5 Set

The SET command will modify the value of all parameters supplied in the argument.

Example

Request:
<ENQ>CB CCA|1|SET|300=0,301=1,302=2|838c<ENTER>

Response:
CCA|1|R-SET|1|200|300=0,301=1,302=2|b6b4<ENTER>

Will set the parameters to the supplied values.

The response data will list the updated parameters and the new values. The response data will be in the format <EEnum>=<EEval> in a comma-separated string.

5.14.2.6 Telegram

The TELEGRAM command will output the requested telegram format with the results from the last active measurement.

Example

Request:
<ENQ>CB CCA|1|TELEGRAM|5|ceec<ENTER>

Response:
CCA|1|R-TELEGRAM|1|200| CBM1 VER:A1.08 SN:9998 1 0000 07600
00000 0000 00000 0000 00000 0000 00035 9 30 0
0 0 0 0 0 9 //P|c93a

The response data will include the full telegram message for the requested telegram format prefixed and suffixed with the standard API response data.

5.15 Software update

It is possible to update the software in the ceilometer using only one of the communication ports and standard terminal software.

NOTE

Please be careful and perform every step in this guide when performing the update process, otherwise you may risk losing individual configuration and calibration for the ceilometer.

5.15.1 General

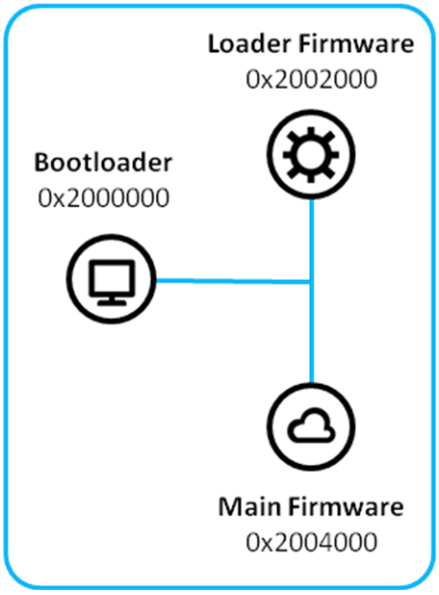
New software versions are released periodically. Usually it is not necessary to upgrade to newer software versions if the ceilometer have normal operation, but some software versions may include enhanced functionality or more accurate settings and/or algorithms. As a customer, you will be informed when new relevant software updates are available.

The ceilometer software is divided into three parts:

- **Boot loader**
  Contains the boot loader that will load either the loader (re-programming) firmware or the standard (main) firmware.
  Also contains recovery procedure if main firmware is broken

- **Loader Firmware**
  Contains the loader (re-programming) firmware.
  Allows for re-programming of all firmware.

- **Main Firmware**
  Standard ceilometer software.
  Used during normal operation of the ceilometer



The purpose of the boot loader is to either load the main firmware (standard ceilometer software) for normal operation, or to set the software in a software update mode and load the loader firmware (re-programming) allowing the ceilometer firmware to be updated.

5.15.2 Environment

Upgrading the software of the ceilometer can be done directly in field using the current setup for either the data port or service port if both the Rx and Tx signals are connected.

It is however recommended to be indoors to not be distracted by environment and be able to operate in a calm and structured way.

5.15.3 Preparations

Make sure to install a terminal emulator program on the Terminal PC to be used for the upgrade process.

Connection to the ceilometer can be done using either the data port or the service port. The update can be done either using the RS-232, RS-485 or Ethernet interface.

NOTE

Updating the firmware via the FSK/V.23 interface is not supported.

Any decent terminal emulator software may be used if it supports sending files in binary mode. Throughout this manual reference will be made towards the free and open-source alternative Tera Term. The program is available to download for free from http://ttssh2.sourceforge.jp/ and have been tested with version 4.104. Other software and versions should be supported as well.

5.15.4 Configuration

Using the menu choice Firmware update under special function the EE parameters used to control the behavior of the re-programming application can be configured.

Parameters EE700 – EE706 is used for the configuration.

Note: Before proceeding with the update, please validate the current setting of these parameters prior to performing the update.

Parameter	*Min*	*Default*	*Max*	*Description*
EE700	-1	-1	100	Software Update Mode Set to 0 to enable software update mode. After the value is set, do a reset to enter software update mode. The value will be reset to -1 after exiting the software update mode or timeout.
EE701	0	2	2	Software Update Channel Communication channel to use for software updates.

Parameter	Min	Default	Max	Description
				0 = Software updates disabled 1 = Data channel 2 = Service channel
EE702	300	2400	19200	Software Update Baud Rate Baud rate for software updates. Supported baud rates: 300, 600, 1200, 2400, 4800, 9600, 14400, 19200 **Note:** The current software is about 500 KB in size and takes 30 minutes on 2400 baud.
EE703	0	2	2	Software Update Parity Data bits and parity to use for software updates. 0 = Odd parity (7 data bits, 1 stop bit, odd parity) 1 = Even parity (7 data bits, 1 stop bit, even parity) 2 = None parity (8 data bits, 1 stop bit, none parity)
EE704	5	120	480	Software Update Max Time Maximum time (in minutes) for software update mode to complete. After this time the ceilometer will automatically reset. (This is for fault management if reprogramming is unsuccessful, connection is lost, etc.).
EE705	0	1	1	Software Update Boot Output Output information on boot (and allows the rescue methods to be identified) 0 = Output disabled 1 = Output enabled
EE706	3	10	60	Software Update Boot Delay Bootup delay time when the bootloader starts and before the secondary firmware is loaded.

Parameter	Min	Default	Max	Description
				During this boot delay it is possible to enter rescue mode.

5.15.5 Update procedure

It's recommended to perform the software update at the site or at workshop thru service port (factory default) if anything goes wrong, but it's possible to make the update remote via modem port.

General update procedure is as below. Please follow the procedure carefully.

1. Prepare for update
2. Write down all individual and configuration parameters for this specific ceilometer
3. Update the main firmware of the ceilometer
4. Issue a DEFAULT command to ensure all new and updated parameter values are loaded
5. Re-enter the previously noted individual and configuration parameters in step 2

The update is normally complete at this stage. You may optionally also update the loader (re-programming) firmware and/or the boot loader firmware.

6. Update the loader (re-programming) firmware (optional)
7. Update the boot loader firmware (optional)

5.15.5.1 Preparations

1. Transfer the Software update file to the Terminal to use for the upgrade process.

   The Software update package should contain the following:

   a) Software file(s):
      i) CBME80B_SW_<version>.ldr (Main firmware)
      ii) CBME_SW_BOOTLOADER_<version>.ldr (Boot loader) (opt)
      iii)CBME_SW_REPROGRAM_<version>.ldr (Loader firmware) (opt)

   b) Software revision document including checksum of the software file(s): CBME Software revision history.pdf

2. Connect to the ceilometer using a terminal emulator (e.g. TeraTerm). Depending on the specific installation you are now connected to either the

data or service port. Setup the terminal emulator with the settings for the selected port.

3. Verify the software update parameters.
   Go into the service menu and verify the software update parameters available in the 6. Special Functions → 9. Firmware update submenu.

   Make sure they have the correct values for the update procedure. If the update procedure is started with the wrong configuration (i.e. incorrect channel etc.), you may not be able to connect to the ceilometer until the update procedure times out (normally in 120 minutes).

5.15.5.2 Write down individual parameters

4. Write down individual parameters

   Go into the service menu and write down the individual parameter values for this ceilometer and configurable values that may have been changed by customer.

   The easiest way to do this is to list all changed parameters using the 5. Parameters → 2. List changed params command in the service menu. This will list all changed parameters.

5.15.5.3 Update firmware

5. Enable update software mode

   To enter the program software update mode you select 6. Special Functions → 9. Firmware update → 9. Perform update. This will restart the ceilometer in firmware update mode.

   Note: Do not turn off the computer or ceilometer during the software update. If the software update is unsuccessful, it may not be possible to specify the software update mode using the EE parameter. If this happens, it is possible to enter the software update mode by sending the star sign (*) during the ceilometer boot-up process. Please see *section 5.15.6.1* for details about the emergency update process.

6. Change the terminal software baud rate

   If the baud rate selected for the software update mode is different than the one used normally, please modify the terminal software to use the configured baud rate and parity for software updates.

7. Ready for update

Once the boot loader is set into software update mode, the boot loader will continuously send out number signs (#) to indicate it is running in software update mode.

Press any key (i.e. space) to indicate that you are ready to start the software update.

The software will answer with the following:

```
You are now connected to the reprogramming application
Do you want to proceed [y/n]
```

If you answer n (no) the ceilometer will automatically reset and boot into the standard firmware and normal operation of the ceilometer will resume.

Answer y (yes) to proceed with the update.

Note: If you are not seeing the repeated number signs the program is not in update software mode. Please restart from step 5.

8. Send the updated software file

   The software is now ready to accept the updated software file (LDR-file).

```
=======================================================
You are now connected to the reprogramming application
=======================================================
Send the LDR-file
```

   Select the upload file operation from the terminal emulator software (in Tera Term it is File -> Send File…") and select the LDR-file to be loaded.

   Note: Make sure to send the file in binary mode. In TeraTerm check the Binary option in the send file dialog.

   The update software routine reads the data until an end of file is received.

   Updating the main firmware will take about 7 minutes using 9600 baud, and about 30 minutes using 2400 baud.

   Once the software has been sent to the software update application it will present information about the received program file to assist in verifying everything has been received correctly. The following is presented:

```
Received file with length = <FILESIZE>
Size in flash : <FLASHSIZE>
Stream checksum : <CHECKSUM>
LDR file received.
Do you want to erase flash sectors and reprogram the
application? [y/n]
```

9. Verify the received file

Before continuing to update the program, please compare the reported values for <FILESIZE>, <FLASHSIZE> and <CHECKSUM> with the values provided as part of the program update notification.

If they do not match, please abort the update process by answering n (no). The ceilometer will automatically perform a reset and boot into the standard firmware and resume normal operation.

10. Program the flash

    If all sizes and checksum match, press y (yes) to start the process of programming the flash with the loaded updated software program.

    The programming process will first erase the current program, and then program the new one. Once the process has completed, the size and checksum of the new software will be reported.

    ```
    Erasing sector 1
    Programmed streamsize : <PROGRAM_FLASHSIZE>
    Programmed checksum : <PROGRAM_CHECKSUM>
    ```

    Note: The update process takes a couple of seconds. Do **not** power off the ceilometer during this process, doing so may require you to use the emergency update procedure, see *section 5.15.6*.

11. Verify the program in flash

    Compare the reported values for <PROGRAM_FLASHSIZE> and <PROGRAM_CHECKSUM> with the values provided as part of the program update notification (and the values reported in step 9 above).

    Note: If the checksums do not match, you need to redo the process.

12. Reset the ceilometer

    The new software has now been successfully installed. The ceilometer will automatically perform a reset and boot into the new standard firmware and resume normal operation.

5.15.5.4 Update parameter values

13. Update parameters

    The new software most likely has new and/or updated parameter values.

    The easiest way to verify what has changed is to once again list all changed parameters, see step 4.

    This list can be compared to the previous list obtained in step 4. For all additional parameters listed, please look at the firmware release notes to know the meaning of them and normally set them to their default value.

i. Go into the service menu

ii. Select menu alternative 5. PARAMETERS -> 3. EE OPER

iii. For each value listed, re-enter the values using the format

`<EEnum>=<value><ENTER>`

Example: `18=0<ENTER>`

Repeat for all parameter values noted in step 4.

iv. Exit the menu hierarchy by pressing Q until the menu is closed

It is also possible to issue a DEFAULT command to reset all configured values to the new default values as available in the updated software version. This will change all values except for factory calibrated values.

After this is done the same routine should be done to list all the changed parameters and compare to the previous ones. If anyone is missing from earlier, please verify the correct value of this parameter and re-enter if required.

v. Go into the service menu

vi. Select menu alternative 6. SPECIAL FUNCTIONS

vii. Select operation 2. SET DEFAULT

viii. Confirm the operation by answering y (yes)

14. Reset the ceilometer

Reset the ceilometer by selecting the menu alternative: Reset (6->3)

i. Go into the service menu

ii. Select menu alternative 6. SPECIAL FUNCTIONS

iii. Select operation 3. RESET to reset the ceilometer

15. Software update complete

The program software update is now complete, and you may verify that it is working correctly prior to restoring it for operation.

5.15.5.5 Update the re-programming or boot loader firmware

In seldom cases the loader (re-programming) firmware or the boot loader firmware may be updated.

Note: Only update these firmware if you are experienced. If the power is lost during the 1-2 second write of the actual firmware (or if a different firmware is loaded) the CPU module needs to be sent to service (or programmed using a hardware programmer).

The procedure is similar to the normal firmware update, but less complicated.

Before either of the loader (re-programming) or boot loader firmware is updated, make sure to perform the same preparations as for the normal firmware update (See chapter 5.15.5.1 step 1 – 3 for details)

1. Enable update software mode

   To enter the program software update mode you select 6. Special Functions → 9. Firmware update → 9. Perform update. This will restart the ceilometer in firmware update mode.

2. Change the terminal software baud rate

   If the baud rate selected for the software update mode is different than the one used normally, please modify the terminal software to use the configured baud rate and parity for software updates.

3. Ready for update

   Once the boot loader is set into software update mode, the firmware will continuously send out number signs (#) to indicate it is running in software update mode.

   Press any key (i.e. space) to indicate that you are ready to start the software update.

   The software will answer with the following:

   ```
   You are now connected to the reprogramming application
   Do you want to proceed [y/n]
   ```

   If you answer n (no) the ceilometer will automatically reset and boot into the standard firmware and normal operation of the ceilometer will resume.

   Answering y (yes) will continue with standard firmware updates.

   To update any of the special firmware (boot loader or re-programming) answer

   $ To update the loader (re-programming) firmware

   ! To update the boot loader

   These two options are “hidden” alternatives to only allow experienced personal to perform these actions.

4. Send the updated software file

The software is now ready to accept the updated software file (LDR-file).

```
Your are about to reprogram the boot application !!!!
BE SURE NOT TO LOOSE POWER TO THE UNIT !!!

Send the LDR-file
```

Select the upload file operation from the terminal emulator software (in Tera Term it is File -> Send File…") and select the LDR-file to be loaded.

Note: Make sure to send the file in binary mode. In TeraTerm check the Binary option in the send file dialog.

The update software routine reads the data until an end of file is received.

Once the software has been sent to the software update application it will present information about the received program file to assist in verifying everything has been received correctly. The following is presented:

```
Received file with length = <FILESIZE>
Size in flash : <FLASHSIZE>
Stream checksum : <CHECKSUM>
LDR file received.
Do you want to erase flash sectors and reprogram the
application? [y/n]
```

5. Verify the received file

   Before continuing to update the program, please compare the reported values for `<FILESIZE>`, `<FLASHSIZE>` and `<CHECKSUM>` with the values provided as part of the program update notification.

   If they do not match, please abort the update process by answering n (no). The ceilometer will automatically perform a reset and boot into the standard firmware and resume normal operation.

6. Program the flash

   If all sizes and checksum match, press y (yes) to start the process of programming the flash with the loaded updated firmware.

   The programming process will first erase the current program, and then program the new one. Once the process has completed, the size and checksum of the new software will be reported.

   ```
   Erasing sector 1
   Programmed streamsize : <PROGRAM_FLASHSIZE>
   Programmed checksum : <PROGRAM_CHECKSUM>
   ```

   Note: The update process takes a couple of seconds. Do **not** power off the ceilometer during this process, doing so may require you to send the CPU module for service or use a hardware programmer to perform the update.

7. Reset the ceilometer

   The new software has now been successfully installed. The ceilometer will automatically perform a reset.

   Note: Due to the possibility to break the system while updating the boot loader and/or the re-programming application this should only be done after direct instruction from the manufacturer.

5.15.6 Troubleshooting

Please refer to this section if anything goes wrong during the update process.

5.15.6.1 Emergency recovery mode

If there was a problem during the write process of the new software, there is an emergency recovery mode that can be used to update the ceilometer with new software.

To get into the emergency recovery mode software update, perform the following steps:

1. Make sure step 1-2 in the update software procedure has been completed.

2. Connect to the port using the baud rate and parity as previously configured (default: service port, 2400 baud, 8 data bits, no parity)

3. Press the reset button on the ceilometer.

4. You will now see three dots appearing on the screen with 1 second apart. Make sure to press the star sign (*) during this process.

   Note: You only have 2 seconds to press this key. If you miss, please just repeat step 3 until you succeed.

5. You can now continue from step 12 in the update software procedure to update the software.

5.15.6.2 Garbage characters in terminal emulator

Make sure you are using the correct baud rate (and communication settings).

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6. FUNCTIONAL DESCRIPTION

6.1 Technical description

6.1.1 General

The function of the ceilometer is described here with reference to the block diagram (drawing 217 004F).

The microprocessor is Blackfin BF-537. The memory consists of SDRAM and Flash on the CPU unit, and FRAM on the master unit. The parameters in the FRAM can be changed via the service port (J6).

The transmitter is a pulsed laser diode with fiber connection. The laser peak power is about 50 Watts output, pulse length about 100 ns, the pulse frequency about 1000 Hz, the wave length about 905 nm.

The receiver uses a fiber connected avalanche diode as a light detector. The signals from the light detector are amplified in a broadband amplifier and converted to digital values in a very fast flash analog-to-digital converter (ADC1). The digital value is stored in a FPGA, from which the values can be read by the microprocessor.

There are two communication ports from the microprocessor, one used for data output and one for the service port. There is interface for converting data output to V23/FSK and RS232- or RS485-signals and RS232-signal for the service port.

The measuring interval is normally set to 30 seconds (other alternatives selectable).

Every measuring sequence consists of several sub functions.

- Measuring and evaluation of echo signal profile from cloud/atmosphere.
- Control of the laser output power and temperature.
- Control of temperature and gain of the receiver amplifier.
- Supervision of the receiver calibration and the FADC function.
- Supervision of the reference voltage and power supply.
- Transmission of data to communication lines.

6.1.2 Measuring sequence

Measuring of cloud base takes place in two steps. First the echo signal profile from the ground and up to the limit of the range is measured. Then the signal profile is evaluated with regard to occurrence of cloud, the cloud height, the light penetration in the cloud and vertical visibility.

When the laser pulse passes small water drops in fog, cloud etc. in the atmosphere some parts of the energy is reflected straight backward and collected by the receiver optic lens, which via a mirror focuses the light into an optical filter. A narrow band filter damps light frequencies outside the pass band and increases the signal/noise ratio. After the filter, the light is guided by an optical fiber to the avalanche diode. The signal output from the receiver is proportional to the reflection from the laser pulse.

When conditions for measuring are fulfilled, the microprocessor starts the laser output by generating laser trig pulse LTRG. A new pulse is sent as soon as the measured value of the laser pulse echo value is read. This pulsing is going on until the total numbers of pulses are sent (default 8000 pulses).

At the transmitter mirror the laser pulse is reflected 90º and then passes through the transmitter optic lens, which concentrates the light to a beam. When the microprocessor starts the laser sequence, the AD-converter continuously converts the analog echo-signal from the receiver for every pulse. The conversion rate is 15 MHz, which corresponds to one sample per 10 m up to the max range. Each converted value is stored in FPGA. The total time for the conversion sequence up to maximum range is about 10 seconds.

When the echo-signal for each pulse is converted and stored the FPGA it sends a signal to the microprocessor, which then read the data from the FPGA.

The first converted value corresponds to the height of 0 m, the second value 10 m, the third 20 m and so on up to the limit of the range.

Because of light divergence the received signal level decreases with the cloud height. Echo signals from high clouds will be significantly lower than the receiver noise caused by sun radiation, which via scattering in the water droplets reaches the receiver. Because of that the echo signal must be amplified in relation to the noise, which is done by summing of measured values. The filtering increases the signal/noise ratio with the square root of the number of values of the same interval that are summed.

Normally 18000 values (2*9000) are summed up at the highest range.

The result of a total measuring sequence is a digitized echo signal profile, which is processed by the microprocessor with regard to the occurrence of signal pictures caused by clouds. The result of the process is sent as a telegram in a number of eligible formats (chosen by parameters in FRAM) via the FSK modem, RS232-, or RS485-interface to external displays and/or superior systems.

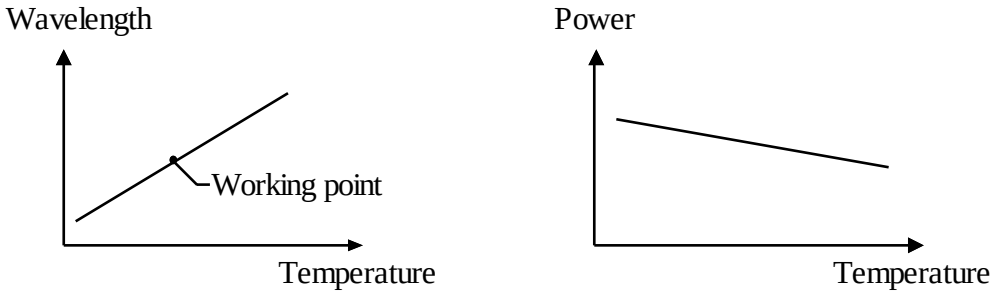
6.1.3 Transmitter

The transmitter consists of a CVN laser diode and a pulse circuit that generates current pulses through the laser diode. The peak power of the laser pulses depends on the current pulse and the temperature of the laser diode.

The temperature also affects the wavelength of the light.

The current pulses have a half value width of about 100 ns. To get the nominal output power the current peak value should typically be between 10 and 15 A depending on the laser diode data.

The wavelength is increased by higher temperature and the power is decreased by higher temperature and operating time.



The microprocessor starts the charging of the pulse circuit with relative low current.

The laser high voltage (LHV) for the pulse circuit is generated by a DC/DC-converter. The peak value of the laser current pulse (LCU) and output power (LPP) is measured by the microprocessor with the aid of peak detector circuits, which is connected to input channels of an ADC-converter.

With the aid of the measured current pulse the processor regulates the laser high voltage to get the laser current set by a parameter in FRAM.

The pulse frequency of the transmitter is about 1000 Hz.

The wavelength of the emitted light pulse and the center wavelength of the optical band pass filter in the receiver are adapted to each other. As earlier mentioned the wavelength is affected by temperature that must be stable. Because of that the laser diode is mounted on a "Peltier element" which temperature can be regulated with the aid of a bi-directional current through the element.

The temperature of the laser diode (LTMP) is measured by the processor by the aid of a temperature sensor connected to one of the channels of the ADC2. Via the temperature control circuit the processor controls the value and direction of the current through the "Peltier element" so the laser diode gets the set point temperature (parameter in FRAM) independent of the ambient temperature. When the temperature of the laser diode is out of preset limits trigging is blocked. At the connection of the equipment to mains there will be a time delay depending on the ambient temperature before the laser diode has the right temperature and the measuring starts.

6.1.4 Receiver

The avalanche photo diode of the receiver converts the laser light echo signals to an electric current, which is amplified by the avalanche effect in the diode.

The current gain depends on the reverse voltage (DHV) across the diode. The reverse voltage is generated by a DC/DC-converter and the processor sets the level via the gain control circuit.

The current gain as a function of the reverse voltage is different for different diodes so the voltage has to be individually set. The current gain depends on temperature and because of that the processor measures the receiver temperature RTMP via ADC2 and regulates DHV so that gain will be stable independent of the ambient temperature.

6.1.5 Internal Monitoring and Supervision

The processor continuously monitors and controls the following voltages and signals:

- Laser high voltage (LHV)
- Laser temperature (LTMP)
- Laser peak power (LPP)
- Laser current (LCU)
- Detector high voltage (DHV)
- Receiver temperature (RTMP)
- Receiver sensitivity (sys_test)
- +6V reference voltage (REF)
- +12V un-stabilized voltage supply
- Window contamination (option)
- Tilt (option)
- Blower (option)

By the aid of an IR diode located on the power sensor above the receiver lens the receiver function is checked. The processor connects the laser trig pulse (LTRG) from the transmitter to a driver for the IR diode. The driver generates a test pulse LDST that is delayed a time corresponding to a time delay of an echo from a cloud at a height of about 550 m. The pulse generates a light pulse in the IR diode with a level corresponding to an echo signal from a cloud at this height. The test echo signal is detected as a normal cloud base echo and the processor checks that the height and signal level measured are within preset limits. If any value exceeds preset limits, alarm is generated as error code in the status word in the output telegram.

6.1.6 Data transmission

The processor transmits telegram with measured data via the communication ports. The signal is connected to a modem circuit and an RS232-, and RS485-interface and then connected to a signal connector at the bottom of the unit. Several data format for data output can be selected by parameter set in FRAM. The other communication port is via an RS232-interface connected to the signal connector and to the service port on the master unit. The service port can be used for test, setting of parameters adjustment and repair of the equipment. The port can even be used as a data port.

By the aid of a terminal connected to the service port all parameters stored in the FRAM can be changed. Different telegram format, baud rates etc. can be selected with parameter setting in the FRAM.

6.2 Local Display (option)

The Local display is used for local presentation and is an integrated part of the master unit, it consists of five digits, three 3 back lighters and one LED for power on indication of the ceilometer.

The measured value (lowest cloud base or vertical visibility) is present by the five digits. In addition, one of the back lighters indicate if the presented value are cloud base or vertical visibility (LED 6), the two other back lighters gives a positive indication of the selected unit (meter or feet) for the measuring result (parameter).

If no cloud base or vertical visibility is detected (no hit) “99999” is presented.

If solar shutter (option) is active it’s indicated by the text “SH” on the display.

If an alarm situation exists in the ceilometer the local display shows the error code the error code is always preceded by an “E” in the leftmost digit. For example if the local display shows E4004 it means Alarm and the error code is 4004.

At power up all segments and LED lights (back lighters) are lit up for about 10 seconds (segment test).

As soon as the ceilometer is powered up the single LED always will be lit up (permanently connected to +5V in the hardware).

NOTE

The digits, LED back lighters and the LED for power (+5V) are possible to switch off by a jumper on the master unit.

6.3 Program Description

6.3.1 Hardware environment

The functions of the ceilometer are controlled by a microprocessor, Blackfin BF-537. The program is stored in a Flash RAM, passing data are stored in SDRAM and parameters are stored in a FRAM-chip.

Signal values are transferred through a FPGA from the flash ADC (ADC1) to the microprocessor. The process values are measured by an A/D-converter (ADC2) and the microprocessor controls the ceilometer by the aid of a DA-converters and digital outputs. There are two serial ports for external communication. One port for data output the other for communication with a service terminal.

6.3.2 Program Development Environment

The program languages used are:

C/C++ (Blackfin) and VHDL (FPGA)

6.3.3 Program structure

The program system is of modular design and the program functions are to a high extent controlled by parameters in FRAM. The program function is supervised by a watchdog that restarts the program if the watchdog is not updated within a certain time interval.

6.3.4 Software Modes

- Normal mode
- Systest mode
- Alignment mode

6.3.5 Program module description

Laser power regulation

Method of power regulation is selected in parameter EE72 (Laser power control mode). Normally the power regulation is Output power mode.

Output power mode

If the measured laser peak power (LPP) value differs from the set point value more than permitted, the laser voltage is regulated until the power set point value is obtained with a tolerance of 1W. If the laser current value reaches the maximum permitted value the control phase is interrupted, and a max laser current warning is set in the status word.

If the laser peak power value is below the minimum threshold (typical -10%), a low laser power warning is set in the status word.

Laser current mode (and in alignment mode)

If the laser current differs from the set point value more than permitted, the laser current is regulated until the set point value is obtained with a tolerance of 1A. If the current value is larger than maximum permitted laser current value the control phase is interrupted, and system alarm is set in the status word.

Temperature regulation

The temperature regulation is an integral part of the measuring cycle. If the laser temperature differs more than 5°C, the measuring cycle is interrupted and only the temperature is regulated. If it is not possible to obtain set point temperature the corresponding alarm bit and the system alarm bit are set in the status word.

Measuring of operation variables and status word

In every measuring cycle the operation variables are compared with the alarm limits. If these limits are exceeded the program sets the corresponding bits in the status word transmitted in each output telegram.

Bit	*Status*	*Exceeding limits*
D0	Low Laser peak power (LPP)	If lower than set in EE4
D1	Laser current (LCU)	LCU = X (X set in EE3)
D2	Laser temperature (LTMP)	X ± 5°C (X set in EE6)
D3	Receiver temperature (RTEMP)	0°C < RTMP < 65°C
D4	6V Reference voltage (REF)	6.00V ± 0.2V
D5	12V un-stabilized voltage supply	10.0V < U < 17.5V
D6	Laser high voltage (LHV)	12V < X < 90V
D7	Detector high voltage (DHV)	X ± 20V (X set in EE2) compensated with receiver temperature
D8	System test	1000 < X < 20000
D9	Solar shutter	0=OFF, 1=ON
D10	EE-prom checksum error detected	
D11	Blower warning (opt)	If no blower current consumption and blower is attached (EE60)

D12	Contamination warning (opt)	If higher than set in EE157
D13	Tilt angle warning (opt)	X > 45°
D14	System error	0=No error, 1=error
D15	Not used (spare)	

System error (D14) is set at alarm for one or more of D1, D2, D4, D6, D7 or D10.

The status word is presented as hex code in 4 positions in the data output telegram and on local display (option) when system error is set.

D9 will be shown as “SH” on the local display when solar shutter is active.

6.4 Sky Condition Algorithm

6.4.1 General

The description of the cloud cover algorithm in this section shall be read in conjunction with *Figure 6-1* to fully understand the principals.

It is presumed that automatic generated reports from automatic weather stations contain cloud amount. The calculation algorithm can then be placed either in the acquisition system or in the ceilometer if it has sufficient capability. The latter method has the advantage of decentralized data processing, and provides independency and less calculation in the acquisition system.

For ceilometer CBME80B the cloud amount calculation module is in its program.

The algorithm follows the ICAO and WMO recommendations.

6.4.1.1 Presumptions and assumptions

The algorithm is built on the following assumptions:

- Homogeneous sky e.g. the area above the ceilometer is representative for the whole sky.
- The measured result from one-time interval is assumed to be representative for the dynamic occurrence.
- Higher cloud layers supposed to cover the sky above lower cloud layer.
- Round off will be done after a complete analysis.

Locally height values are as integers in meters and cloud amounts are as decimal digits. The results will therefore not have any influence on earlier done round off, which has not taken place.

A complete calculation and output of new data take place after each measuring cycle (30 seconds).

6.4.2 Data collection

Input data to the algorithm are the lowest measured cloud base or alternatively vertical visibility together with status from each measurement. These values are stored in a buffer. The buffer size corresponds to selected integration time (parameter).

The latest time frame (normally for 10 minutes) can be weighted if preferred which means that changes will influence the value rapidly (time for weight and weight coefficient are parameters).

Two minor rearrangements/calculations are done in conjunction with the collection according to the following:

Rearrangement 1

The raw data buffer is tested for hit and a “hit data base” is built up containing number of hits per height increment. In this database vertical visibility sets equal to cloud base.

Rearrangement 2

The raw data from the last 10 minutes in the raw data buffer is tested for vertical visibility.

If at least eight of the last 10 minutes contains vertical visibility, a mean value of the vertical visibility is calculated (time and requirement are parameters).

Conclusion

The lowest cloud base value (if more than one hit is detected) or, alternative the value of vertical visibility and status for the measuring are stored in a buffer that contains the value for the last 30 minutes (parameter).

Double (parameter) weight of the measured value from the last 10 minutes (parameter) in the buffer is done.

Check of value (parameter) in buffer with status = OK is done (validity digit).

Measure value with vertical visibility higher than 1500m (parameter) is modified to cloud base (status will be changed for actual value).

The buffer will be checked for hits (measure value).

Mean value for vertical visibility is calculated for selected time period (parameter).

Name	*Min*	*Def*	*Max*	*Function*
noOfData	15	30	30	Integration time (number of minutes)
noOfWeightData	2	10	15	Weight (number of minutes)
weight	1	2	3	Weight coefficient
maxNoOfStatusErrors	3	4	15	Max allowed number of status errors in buffer
vertVisMax	10	1500	4000	VV-value above this height
vertVisWindow	4	8	15	Number of minutes included in VV-calc.
maxNoOfVertVis	2	6	15	Minimum number of minutes of VV in vertVisWindow

6.4.3 Clustering

Clusters of measured value are made by combining cloud layers until the max number set by a selectable parameter is reached.

a) Establish the number of different values of heights. If there are 5 or less go to *section 6.4.4* (combining clusters) otherwise continue.

b) The values shall be ordered from the lowest to the highest height.

c) Calculate the least square distance between all adjacent layers according to the following:

$$D = \sqrt{\frac{[N(J) \times N(K)] \times [H(J) - H(K)]^2}{N(J) + N(K)}}$$

D = least square distance

H = height for the lower layer J

N(J) = number of hits in that layer

H(K) = height for the higher layer K

N(K) = number of weighted hits in the higher layer

d) Combine the two layers (heights) which have the smallest least square distance. If more than one pair of adjacent layers (heights) has the same least square distance, combine the pair with the lowest height.

Combine the layers using the formula:

$$\text{Height: } H(J) = \frac{(N(j) * H(j)) + (N(k) * H(k))}{N(j) + N(k)}$$

Number of hits: N(j)=N(j) + N(k)

H(J) is the weighted height for the combined layer.

N(J) is the number of hits in the combined layer.

The combined layer H(J), N(J) shall replace the H(j), N(j) and H(k), N(k).

e) A new check is done if there are more than 5 layers (clusters). If so the routine from point b) is repeated until only 5 layers (or clusters) are left. When only 5 intervals (or clusters) remains, this routine is exited.

Conclusion

The purpose with the routine combine clusters is to reduce the number of cloud layer heights at a complex cloud situation by combining adjacent layers.

In cases when layers have been combined, a new layer (cloud base) is created with a weighted center depending of the ingoing combined layers. The number of hits in the combined new layer is the sum of all hits from the combined interval.

Parameters

There is only one parameter for this routine.

Name	*Min*	*Def*	*Max*	*Function*
maxNoOfLevels	3	5	5	Max number of clusters to be used

Results

Up to maximum 5 cloud layers (clusters) containing cloud heights with the number of hits.

6.4.4 Combining clusters

The function for combining clusters aims to conditionally combine adjacent cloud layers. The combining take place in the same way as the NWS algorithm for combining clusters. However, the conditions for the combining to take place are selectable.

The user has the possibility to choose between three different conditions for combining:

a) The distance between two different layers.

b) The distance between max and min values for two different layers

c) The standard deviation between two different layers

After possible clusters have been made, a check is done if some clusters conditionally can be combined. The check is the same; not taking into consideration selected method however the input values are different according to the following rules:

Rule 1 (The distance between two different layers)

The distance between the heights of measured layers is calculated as the distance between the heights in the upper layer minus the height in the lower layer. To get a quote to be compared with a limit value (parameter) the calculated distance is divided with the mean height of the two involved layers. For calculation of the height mean value see clustering in *section 6.4.3*.

Rule 2 (The distance between max & min for the two layers)

The distance between the heights of measured layers is calculated as the distance between the lowest heights in the upper layer minus the highest height in the lower layer. To get a quote to be compared with a limit value (parameter) the calculated distance is divided with the mean height of the two involved layers. For calculation of the height mean value see clustering in *section 6.4.3*.

Rule 3 (The distance between the standard deviation for the two layers)

Instead of using max and min as in rule 2 the standard deviation is calculated from the values of heights in lower and upper layers. With the aid of the standard deviation the mean height of the lower layer and the mean height of the upper layer are calculated.

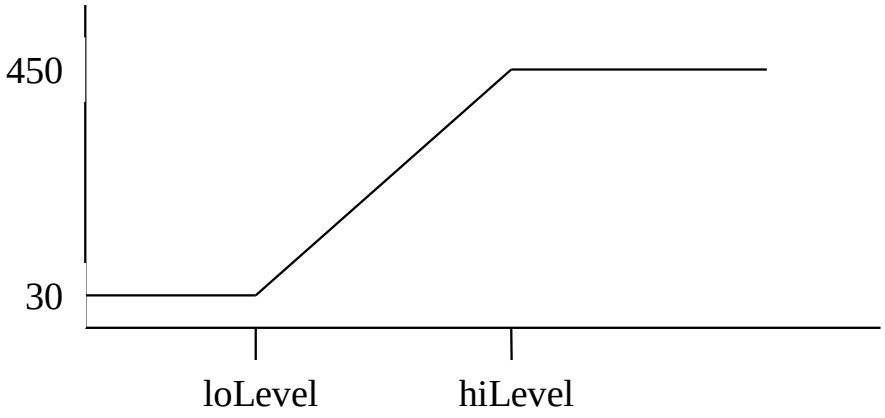
The distance between the heights of measured layers is calculated as the distance between the calculated standard deviation values of height for the upper layer minus the calculated standard deviation value of height for the lower layer. To get a quote to be compared with a limit value (parameter) the calculated distance is divided with the mean height of the two involved layers. For calculation of the height mean value see clustering in *section 6.4.3*.

Combining conditions (valid for all rules)

If the common mean height is under loLevel (parameter, default 300m) the layers then will be combined if the distance between them is smaller than loLevelLimit (parameter, default 30 m).

If the common height of the layers is over hiLevel (parameter, default 3000m) then the layers is combined if the distance between them is smaller than hiLevelLimit (parameter, default 450m).

If the common mean height of the layers is between loLevel and hiLevel and if the above-mentioned quote is smaller than the limit value dstHgtRatio (parameter) then the layers are combined.



Parameters

Name	*Min*	*Def*	*Max*	*Function*
loLevel	150	300	500	Fix lower limit in meter
loLevelLimit	20	30	60	Max distance between layers for combining
hiLevel	1000	3000	5000	Fix upper limit
hiLevelLimit	300	450	600	Max distance for combining
dstHgtRatio	0.1	0.12	0.30	Quote requirement for combining
method	0	2	2	Choice of method for combining

6.4.5 Selection of vertical visibility or cloud base

Input data to this function are the calculated layers (where all hits have been treated as cloud bases apart from if it has been VV or not) together with value for vertical visibility if the requirements for vertical visibility have been fulfilled at the collection.

The function gives the user the possibility to select if vertical visibility (if fulfilled requirement) or if all measured values shall be treated as cloud base

The selection takes place with the aid of a parameter.

Parameter

Name	*Min*	*Def*	*Max*	*Function*
vertVisOn	0	1	1	Vertical visibility on/off (0=off, 1=on)

Result

If vertical visibility is selected “ON” the output is a vertical visibility value (if the requirement for VV is fulfilled) or the height value of the current layer.

If vertical visibility is selected “OFF” the output is the heights of the current layer (all possible vertical visibility hits have been treated as cloud bases), which means that vertical visibility cannot appear in cloud amount.

6.4.6 Hysteresis control

The control of the hysteresis is made as a dragging filter of the mean value. If a height of cloud layer after all combining lies “sufficiently near” a corresponding height value of a layer in the preceding measuring the new height value will be filtered according to the following:

New height value = (old height value + new height value)/2

“Sufficiently near” is calculated with the following procedure:

- Differences in height are calculated as distances between height values of new and preceding layers.
- Differences are calculated down upward, the new “lowest layer” is compared with the preceding “lowest layer”, the new “next lowest layer” is compared with the preceding “next lowest layer” etc.
- The quote between height differences and heights of new layers are calculated and are compared with a limit value (a selectable parameter).
- When a quote is smaller than the limit value the filter is used according the above.
- In other case the new height is used both as current value for height and as old value for height. Meaning: If a new value comes outside the limit the filter restarts.
- The sensitivity is still there for sufficient level on transient noise
- Noise with small amplitude (small cloud height fluctuation) is filtered.
- Small but enduring changes cause effect after some time.

The hysteresis has influence only on the height value. The cloud amount is not affected at all.

Parameter

Name	*Min*	*Def*	*Max*	*Function*
hystRatioLimit	0.05	0.10	0.3	Quote (no dim.)

6.4.7 Calculation of cloud amount and total cloud amount

The cloud amount for respective layer is calculated by this routine.

The number of hits, which are in a layer, is divided with the number of possible hits (considering weighting) to determine the number of octas.

The cloud amount is stored from down upwards.

The cloud amounts of lower layers are added to all higher laying layers.

The values for respective layer are round off to octas.

Layer above the layer that reaches 8/8 is left without consideration and is aborted.

The total cloud amount (regardless of layer heights) is calculated up to a parameter-controlled height (default 7600 meter).

Selection between ICAO-code and octas

Octas are decided according to the following hit conditions in the current buffer.

0/8 0.0000 –- 0.0625

1/8 0.0625 –- 0.1875

2/8 0.1875 –- 0.3123

3/8 0.3123 –- 0.4375

4/8 0.4375 –- 0.5625

5/8 0.5625 –- 0.6875

6/8 0.6875 –- 0.8125

7/8 0.8125 –- 0.9375

8/8 0.9375 –- 1.000

9/8 Requirement for VV fulfilled (only reported if VV function in algorithm is switched on, otherwise VV will be treated as cloud bases in algorithm)

Total cloud amount is calculated as a number of hits during selected time period divided by the number possible hits (including weighting). This leads

to a total cloud amount that can be higher than those in the highest reported layer depending of rules for priority according to *section 6.4.9*.

Parameters

Name	*Min*	*Def*	*Max*	*Function*
reportType	0	1	1	Choice ICAO code and Octas
TCAlevel	1000	7600	7600	Max height for total cloud amount

6.4.8 Rounding of values

Up to now all calculations of the heights of cloud layers and vertical visibility (if appearance) have been done on not-rounded values. This routine has in view to round off the final calculated heights to valid norms for meter or feet depending on selected unit.

There are two sets of parameters for meter respective feet.

In every set of parameters for different units the user is free to select a number of steps and to which nearest number the value shall be rounded to in respective height interval.

Parameters

Name	*Min*	*Def*	*Max*	*Function*
mRoundLevel_1	30	30	60	
mRoundLevel_2	150	300	500	
mRoundLevel_3	500	1500	3000	
mRoundLvel_4	1500	3000	5000	
mRoundTo_1	10	30	60	
mRoundTo_2	10	10	300	
mRoundTo_3	10	30	300	
mRoundTo_4	10	60	300	
mRoundTo_5	10	300	500	
ftRoundLevel_1	30	100	200	
ftRoundLevel_2	150	5000	15000	

ftRoundLevel_3	500	10000	25000
ftRoundTo_1	30	100	200
ftRoundTo_2	10	100	300
ftRoundTo_3	10	200	300
ftRoundTo_4	10	1000	3000

6.4.9 Reporting layers and their priority

The user has the possibility to choose if a maximum of three or four cloud layers should be presented in the output telegram. Total cloud amount is always reported.

Because only a maximum three or four cloud layers can be reported in the output telegram (the ceilometer can determine five layers), this leads to some rules for priority that must be used.

General

Layers are reported in increasing height order down upwards.

Maximum four layers with cloud amount can be reported.

The layers are given a priority according to selected rule for priority (parameter).

Rule 1

Lowest cloud layer with at least 1/8

Next higher cloud layer which covers 3/8 or more

Next higher cloud layer which covers 5/8 or more

Next higher cloud layer which covers 7/8 or more

Rule 2 to 9

For future use

Parameters

Name	*Min*	*Def*	*Max*	*Function*
priorityType	1	2	9	Selection of rule for priority
levelsInReport	3	4	4	Number of cloud layers in output report

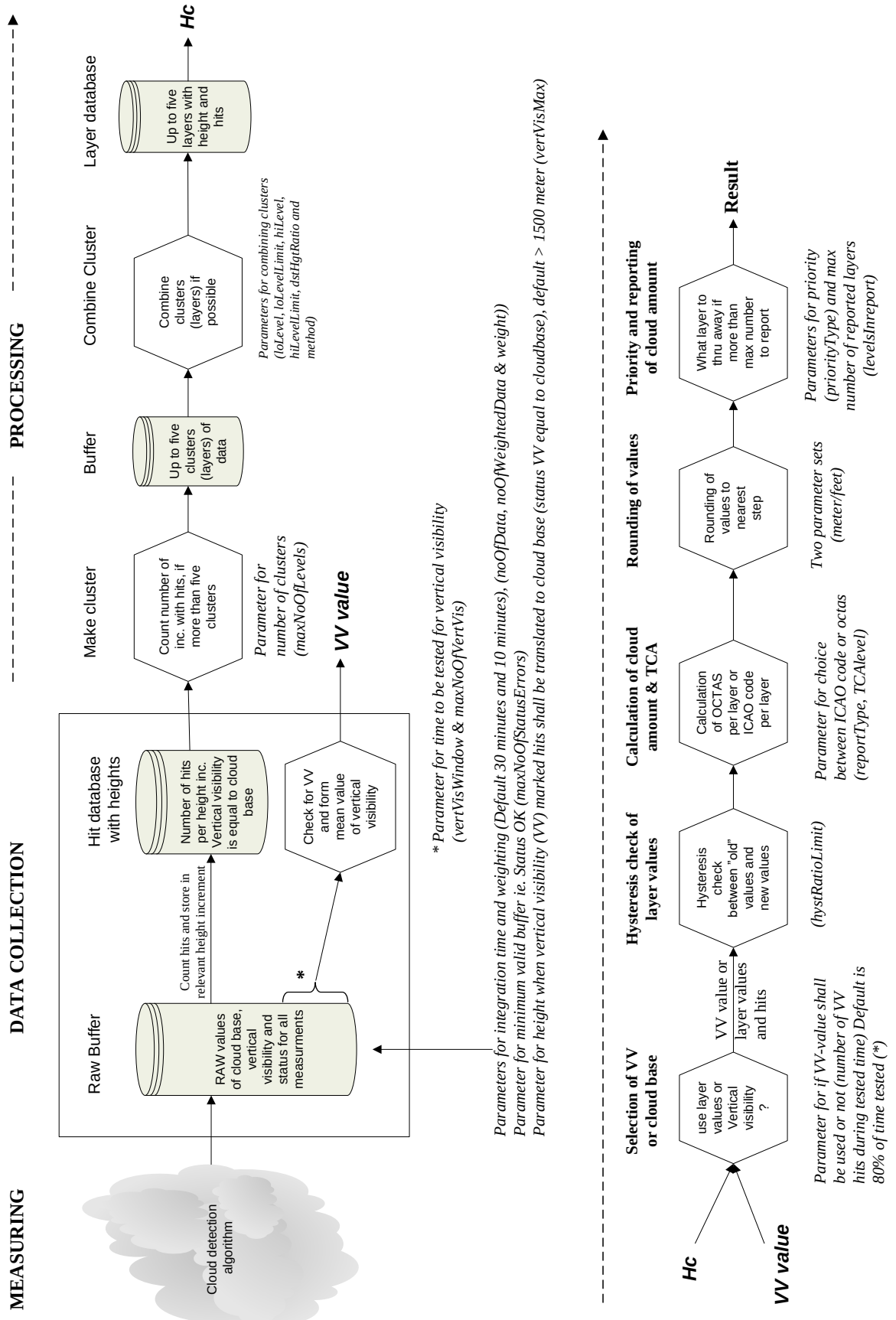


Figure 6-1 Cloud coverage algorithm

7. PERIODIC MAINTENANCE

Periodic maintenance is normally limited to window cleaning and replacement of blower filter. In addition, Warnings and Alarms should be checked regularly if not monitored by host systems and/or other presentation units.

7.1 Alarms and warnings

The data message should be checked for alarms and warnings at regular intervals if status word is not taken care of by host systems and/or other presentation units.

Connect a terminal or PC (see *section 5.4*) to the service port (J6) on the master unit and check that status word is 0000 (no errors or warnings).

In case there is an active alarm or warning, more information is given in *section 5.9* how to interpret the status word.

Repair and service must be done according to instructions in Chapters 8 and 9.

7.2 Window Cleaning

The windows should always be clean at regular interval from any dirt or particles during operation.

To clean the windows first flush it with water to remove coarse grains. Clean the window with a soft lint-free cloth moistened with a mild detergent. Be careful not to scratch the window surfaces.

NOTE

Do not clean the windows with dry rag, it can scratch the windows and the ceilometer might have reduced sensitivity.

7.3 Blower Function (option)

The function of the blower unit can be checked by holding a solid reflector approximately one meter above the windows; the blower should start after approximately 1-2 minutes.

NOTE

The blower does not stop directly after removal of the reflector to avoid going on and off if showers of precipitation is the case.

In addition, the blower may be tested by using the manual blower control.

Go into the Service menu and select Special Functions -> Blower Control. Here Blower Manual On and Blower Manual Off may be selected to manually force the blower to start or stop.

Verify the Blower function and make sure to restore the setting to Auto when the testing has been completed.

7.4 Replacement of Blower Filter (option)

If a Blower unit is attached to the system inspection of the blower filter should be done time-to-time depending on the ambient environment. Replacement of filter normally has to be done once a year.

The following procedure should be followed for filter replacement.

1. Loosen cable connector attached to ceilometer.
2. Remove the four nuts holding the air dust plate at the bottom of the blower unit.
3. Remove air dust plate.
4. Remove the old filter (visible after removing the air dust plate).
5. Refitting of a new filter is done in the opposite way

Also se assembly drawing 250 101F if further details are needed

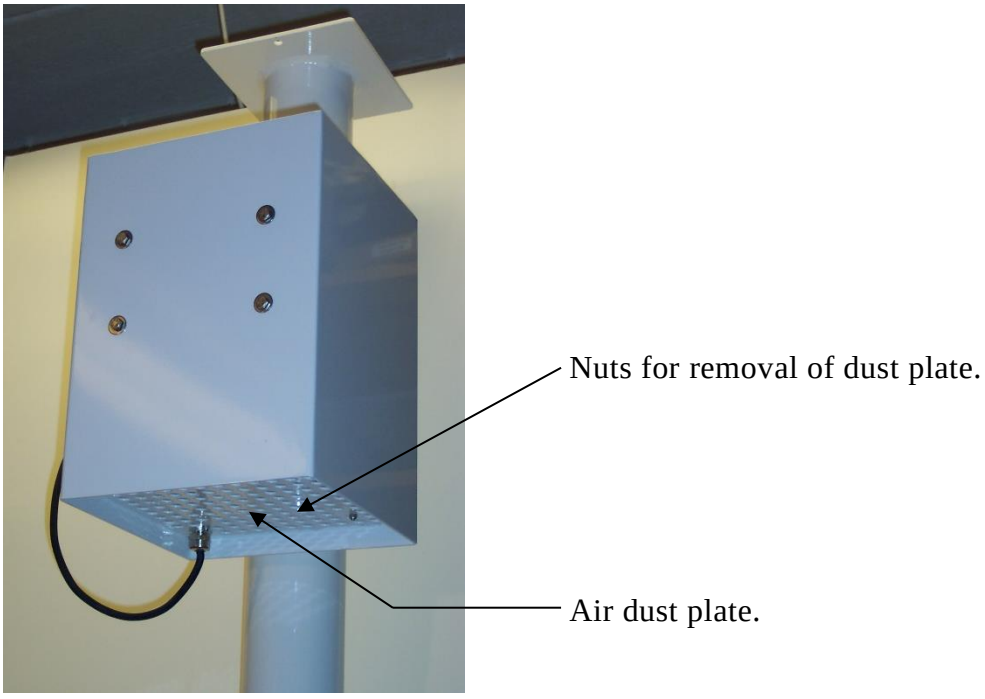


Figure 7-1 Blower Unit, air filter replacement

7.5 Storage

If stored unpacked for extended time, the windows should be covered to avoid dust building up on the windows.

8. TROUBLESHOOTING

8.1 General

The instructions for troubleshooting and repair in this manual are written to advise the service engineer to identify and replace malfunctioning sub units. Repair of units is intended to be done by the manufacturer or at a depot location with extended skills specific for the ceilometer.

The ceilometer is monitored by an integrated system of supervision that senses errors in the electronic circuits that may affects the function of the ceilometer.

If an error does not affect the communication, the error code is sent in the telegram. In most cases the error code gives an unambiguous guidance to find the faulty unit.

WARNING!

If the fiber connectors behind the cover plate of the optics are loosened during operation, or if nominal output power is increased by command via service port, the laser safety class 1M might change to class 3B (not eye safe) therefore a warning label is attached to the cover plate for the access to the laser fiber end.

The laser voltage is about 65V and the avalanche diode voltage can be up to 550V. The components with this high voltage on the master unit are fitted with shield boxes. Be extra careful when these shields are removed.

In the power unit there are mains voltage on several points. Use Caution when the covers of these units are removed for troubleshooting.

8.2 Equipment for Troubleshooting

Normally only a digital voltmeter and a PC (with any terminal software) connected to service port are needed for finding error down to LRU level in field service.

For more sophisticated troubleshooting and testing at depot level also a temperature probe and an oscilloscope (50 MHz) may be needed for finding error.

TABLE 8–1 takes up the instruments, besides standard tools, that are required at troubleshooting, repair and adjustment of the ceilometer at depot level.

Qty	*Instrument/tool*	*Remark*
1	Oscilloscope	Bandwidth 50 MHz
1	Digital voltmeter	Resolution > 4½ digits
1	Temperature probe	
1	Terminal (PC)	
1	Power cable	
1	Signal cable	
2	Coaxial cable 50 ohm	Length = 1 m

TABLE 8–1

8.3 Troubleshooting Procedure

8.3.1 Status indication

Start trouble shooting with the aid of the information in the status word from the ceilometer.

If no normal communication with the ceilometer check LED on master unit.

A. **No light –** Check supply voltages according to point D. If these voltages are OK change the master unit.

B. **Constant light –** Connect a terminal to the service port and wait for 1 minute to find out if any data is sent by the ceilometer. Try to communicate with the ceilometer (e.g. open the menu). If this is not possible go to D. and check if any of the supply voltages is missing or faulty. If the supply voltages are OK but the communication with the ceilometer via the service port fails, change the master unit.

C. **Blink** – The program is not running. Change the master unit.

D. Check the supply voltages at the master unit. If all voltages are OK but the communication with the ceilometer via the service port fails, change the master unit. If any supply voltage is incorrect, go to point E.

E. Check the power unit for blown fuses and output voltages. If any error, change the power unit. If no error, go to point A.

8.3.2 Possible error indicated by Status word

Start trouble shooting with the aid of the information in the status word from the ceilometer.

For communication with the ceilometer thru the service port, see *section 5.6.*

Status word is in ASCII format; four digits (hex) except for message no 3

At status alarms check according to the following procedure:

Alarm	*Definition*	*Possible error*
D0=1	Low laser power (LPP)	Laser diode error, change master unit
D1=1	Faulty laser current (LCU)	Check fuse F1 at master unit, if OK change master unit
D2=1	Faulty laser temperature (LTMP)	Check fuse F3 at master unit, if OK change master unit
D3=1	Abnormal operating temperature (RTMP)	Check fuse F5, F6 and relay for heater in power unit
D4=1	Faulty reference voltage (+6V reference)	Check 5V reference input to amplifier (A301 pin 3) and +6V on TP6V
D5=1	Abnormal supply voltage	Check incoming mains voltage level.
D6=1	Faulty laser high voltage (LHV)	Check fuse F1 at master unit, if OK change master unit
D7=1	Faulty receiver high voltage (DHV)	Check fuse F2 at master unit, if OK change master unit
D8=1	Abnormal receiver sensitivity (system test)	Check that EE2 has correct value, Try to adjust level on power sensor (R3), if not possible replace the power sensor
D9=1	Solar shutter on (option)	Warning that sun shutters are active, If active at night or no sun, try to adjust level, replace power sensor
D10=1	EE-prom check sum error	Check all parameters, reset the program and check if error has disappeared.
D11=1	Blower warning (option)	Check blower fuse

Alarm	*Definition*	*Possible error*
D12=1	Contamination warning (option)	Clean the windows
D13=1	Tilt angle warning (option)	Check the mounting position of ceilometer. Check the tilt calibration. Replace the CPU adapter board (containing the tilt sensor).
D14=1	System error	Indicated if any or combinations of d1, d2, d4, d6, d7 or d10 is active

NOTE

Malfunction is very likely if the optical system has been displaced e.g. if the ceilometer has been exposed to high shock etc. In this case the ceilometer must be sent for service at a skilled maintenance workshop.

Check the fibers inside if burnt by sun.

8.3.3 Error presentation on the local display (option)

The local display presents an "E" followed by 4-digit error code if an error exists (CPU must be running). The error code is hex coded.
The following may be present on the local display:

E4004 Bit 14 (system error) and D2 (LTMP fault) active, Error situation

SH Solar shutter active

99999 Normal measurement, no clouds or VV detected (overrange)

8.3.4 Blower Problems

a) **If blower runs at no precipitation**

In areas with high humidity, the backscatter can be sufficient high for false start of the blower unit. Parameter EE26 (blower threshold) can then be necessary to increase this value in steps with 20 to 40 units.

b) **If there is not a normal start at test**

Check in service telegram that the blower is indicated ON. If not, try lowering the blower threshold parameter (EE26) in steps of 20 to 40 units and see if it starts indicating blower ON.

Loosen the connector J12 and check the voltage at the chassis connector. If there is no voltage present, check fuses F5 and F6 in the power unit.

If the voltage is OK on the connector and the blower doesn't start, the blower unit is faulty and shall be replaced.

c) **Start test of the blower**

Make a short distance simulation for precipitation by placing a reflector (paper sheet or equivalent) about 1 meter above the windows. The blower should start within 1 to 2 minutes if ceilometer is measuring.

8.4 Adjustment instructions

Power unit has no adjustment possibilities.

Master unit and power sensor has possibilities for adjustments.

Instrument needed:

- DVM with temperature probe
- PC-terminal and service cable
- Oscilloscope

8.4.1 +6V Reference voltage

The +6.00V reference voltage is used for measurement and control of the laser temperature (LTMP) and receiver temperature (RTMP)

Value should be +6.00 ±0.10V, measured at TP6V. Reference is not adjustable.

8.4.2 Adjustment of receiver temperature (RTMP)

Adjust the temperature RTMP with the potentiometer R162 until the value of RTMP in service telegram (message no 4) corresponds to the value measured by a temperature probe attached to the temperature sensor A13 (located at the backside of the master unit).

8.4.3 Adjustment of laser temperature (LTMP)

a) Wait until laser temperature is stable.

b) Note the set point value (EE6).

c) Measure with a temperature probe laser diode temperature on the diode holder (near temperature sensor A10).

d) Adjust with potentiometer R155 the diode temperature until it corresponds to the set point value EE6. (Note! The time constant is about 1-2 minutes.)

e) Check that the variable LTMP in service telegram on the PC-terminal corresponds to the measured temperature within ±1 degree Celsius.

8.4.4 Adjustment of laser high voltage (LHV)

a) Connect a PC-terminal to the service port according to chapter 6.3.

b) Wait for stable temperature in the ceilometer.

c) Measure the voltage on diode V16 anode.

d) Perform reset and adjust with potentiometer R154 the voltage to 25V (±2V) within 30 seconds.

Note! If adjustment not ready within 10 seconds perform reset again.

e) Check that the value of the variable LHV in the service telegram on the PC-terminal does not differ more than ±5V from the measured value.

8.4.5 Adjustment of detector high voltage (DHV)

a) Wait for stable temperature in the ceilometer (at least 30 minutes).

b) Check the set point value for the receiver voltage in parameter EE2. The set point value is the operating voltage for the avalanche diode at 25°C.

c) Measure the voltage on diode V31 anode.

d) Adjust the voltage with the potentiometer R159 until the voltage corresponds to the set point value in parameter EE2 compensated for the measured receiver temperature RTMP *(see note*).

e) Check that the DHV value in the service telegram (message no 4) does not differ more than ±10V from the measured value.

NOTE!

The measured voltage changes with 2.2V/°C (parameter) in comparison with the value in EE2 when the temperature RTMP differs from 25°C.

DHV = EE2 + 2.2V*(RTMP-25)

8.4.6 Adjustment of laser current (LCU)

a) Read the laser current (LCU) value for the laser diode in the test report.

b) Adjust the measured power value (LPP) with potentiometer R2 on the power sensor unit. (Lowering the LPP value will increase the LCU value and vice versa.)

c) Compare the presented LCU value in service telegram with the value from the test report.

Note: The LPP value will automatically adjust to 50 units, and change the LCU value in the process. When comparing the LCU values, the LPP value should be fixed at 50 units.

8.4.7 Adjustment of system test

a) Wait for stable temperature in the ceilometer (at least 30 minutes).

b) Use service telegram (message no 4).

c) Adjust the system test with the potentiometer R3 on the power sensor unit. Set the level to 3500 ± 1000 units (presented as “sys test”)

8.4.8 Adjustment of measured laser power (LPP)

a) Change the laser power regulation mode to Laser current (EE72=0)

b) Change the laser current value (EE3) to the laser current value (LCU) value for the laser diode in the test report.

c) Adjust the measured power value (LPP) to 50 ±3 (displayed as LPP) with potentiometer R2 on the power sensor unit when service laser current is set to correct value.

d) Change back the laser power regulation mode to the standard value (e.g. EE72=1)

8.4.9 Adjustment of sun shutter (option) sensitivity

Measure the voltage at circuit A1:2 on the power senor.

Value shall be 8,0V ±0,25V. Adjust with R6.

NOTE!

The sun intensity receiver shall not be exposed to ambient light, e.g. sunlight or lamps during this adjustment.

8.4.10 Adjustment of contamination detection (option) clean reference

Perform the following steps for calibration:

1. Carefully clean the windows and make sure they are clean

2. Go into the contamination calibration menu option: Special functions → Contam (opt) → Contam Calibration → Calibrate clean ref
   Note: Make sure to wait at least 10 minutes after cleaning the windows before the calibration clean ref command is issued.

The calibration is completed automatically.

NOTE

If the windows are worn out, they should be replaced.

Calibration of the contamination sensor is done at factory and is not normally required to be repeated unless windows are replaced.

8.4.11 Adjustment of contamination detection (option) power level

Perform the following steps for calibration:

1. Carefully clean the windows and make sure they are clean

2. Place the power reference calibration sheet on top of the windows.

3. Go into the contamination calibration menu option: Special functions → Contam (opt) → Contam Calibration → Calibrate level
   Note: Make sure to wait at least 10 minutes after placing the calibration sheet on top of the windows before the calibrate level command is issued.

The calibration is completed automatically.

NOTE

If the windows are worn out, they should be replaced.

Calibration of the contamination sensor's power level is done at factory and is not normally required to be repeated unless the contamination power sensor board is replaced.

9. REPLACEMENT OF SUBUNITS

9.1 General

The ceilometer consists of five subunits replaceable by costumer with minimum training without any special tools.

Tools needed for replacements are standard tools and Torx screwdrivers.

After change of the master unit a standard PC with any terminal software is needed to monitor the service telegram during adjustments.

9.2 Power Unit

This power unit has EMI-protection built in. Removal and refitting of the unit should be done according to the following steps:

1. Check that mains power is off (connector disconnected).
2. Remove the protective cover of the unit (2 screws on each side).
3. Disconnect the following connectors:
   - J1 and J37 (at the master unit)
   - J8 (to the heater element)
   - J14, J17, J20 and J21 (to the input connectors)
   - Loosen the protective earth from the hexagonal nuts.
4. Unscrew the 4 screws that hold the unit and remove the unit.
5. Refitting of a new unit is done in the opposite way

9.3 DC Power Unit (option)

This power unit has EMI-protection built in. Removal and refitting of the unit should be done according to the following steps:

1. Check that mains and DC power is off (connector disconnected).
2. Remove the protective cover of the unit (2 screws on each side).
3. Disconnect the following connectors:
   - J1 and J37 (at the master unit)
   - J8 (to the heater element)
   - J17 and J20 (to the input connectors)

- Disconnect the wires from the connectors at the fuse holders F4, F5 and F6 (3 wires)
- Loosen the protective earth from the hexagonal nuts.

4. Unscrew the 4 screws that hold the unit and remove the unit.

5. Refitting of a new unit is done in the opposite way

9.4 Power Sensor

Removal and refitting of the unit should be done according to the following steps:

1. Check that mains power is off (connector disconnected).

2. Unscrew the 4 screws that hold the unit and take care of the four distance elements under the PC-board.

3. Release the band cable between the power sensor and the master unit.

4. Refitting of a new unit is done in the opposite way.

5. Adjust the new unit according to 8.4.7 and 8.4.9 (and also 8.4.9 if solar shutter option is installed).

9.5 Master Unit

The optical fibers of the laser diode and the receiver are sensitive to mechanical stress (e.g. strong bending). For that reason, these fibers should be handled with special care. The end faces of the fibers, the receiver diode and the mirrors should be protected against dust and dirt. Don’t touch fiber ends and mirrors.

Removal of the master unit should to be done according to the following:

1. Check that the mains power is off (connector disconnected).

2. Remove the following connections to the master unit:
   - to power supply (connector J1 and J37)
   - to power sensor (connector J3)
3. Remove the shield plate for the mirror units from the case and the shield cover for the laser diode on the master unit.

4. Unscrew the laser diode fiber connector from the transmitter mirror unit. Unscrew the receiver fiber connector from the avalanche diode on the rear of the master unit.

5. Remove all screws (11) which hold the Master unit to the case. Carefully remove carefully the master unit from the case, at the same time guiding the laser diode fiber through the hole in the case.

6. Refitting of a new unit is done in the opposite way.

NOTE

The transmitter and the receiver fiber connectors must be finger tight only. **Do not use tools**. Check that the wavelength of the optical band pass filter (at the filter unit) is 1,5nm ±0,5nm higher than the laser diode wavelength in the new master unit. If not the filter has to be replaced to match the laser wavelength, se section 9.8.

7. After installing of a new unit, check that the laser current and the avalanche diode voltage are correctly adjusted. The laser current is calculated on the basis of diode data in the test report of the diode. The avalanche diode voltage is set by a parameter according to the test report. Laser current is set in parameter EE 3 and avalanche diode voltage is set in parameter EE 2.

   Check and adjust if necessary the laser power measurement LPP and check system test level with the aid of a PC-terminal connected to the service port.

9.6 CPU Unit

Removal and refitting of the unit should be done according to the following steps:

1. Check that mains power is off (connector disconnected).

2. Unscrew the 2 screws that hold the unit.

3. Gently remove the CPU unit.

   Note: The CPU unit is connected to the master unit via two connectors with multiple pins. Make sure it is lifted straight up.

4. Refitting of a new unit is done in the opposite way.

All ceilometer parameters are stored in the FRAM on the master unit and will be remain the same after replacing the CPU unit. However, the ceilometer software resides on the CPU unit.

9.7 Blower Unit (option)

The blower unit CBFL40 is attached to the stand with 4 bolts. The air outlet from the blower is connected with the air pipe on the ceilometer with a rubber pipe and two clamps.

Replacement is made in the following way:

1. Disconnect mains to the blower from ceilometer by loosen connector J12.
2. Unscrew/loosen the air pipe at the blower unit end.
3. Remove the tree bolts.
4. Refitting of a new unit is done in the opposite way.

9.8 Optical Band pass filter

Replacement is made in the following way:

1. Remove the cover plate to be able to access the mirror units.
2. Loosen the stop screw nearest the fiber at mirror unit for receiver.
3. Gently pull out the fiber holder from the filter housing.
4. Now the filter is accessible, remove the filter by tilting the ceilometer.
5. Mount the new filter; observe that the filter comes in to correct place in the bottom of the filter holder.
6. Gently push the fiber holder back into the filter housing, tight to the filter.
7. Tighten the stop screw.
8. Remount the cover plate.

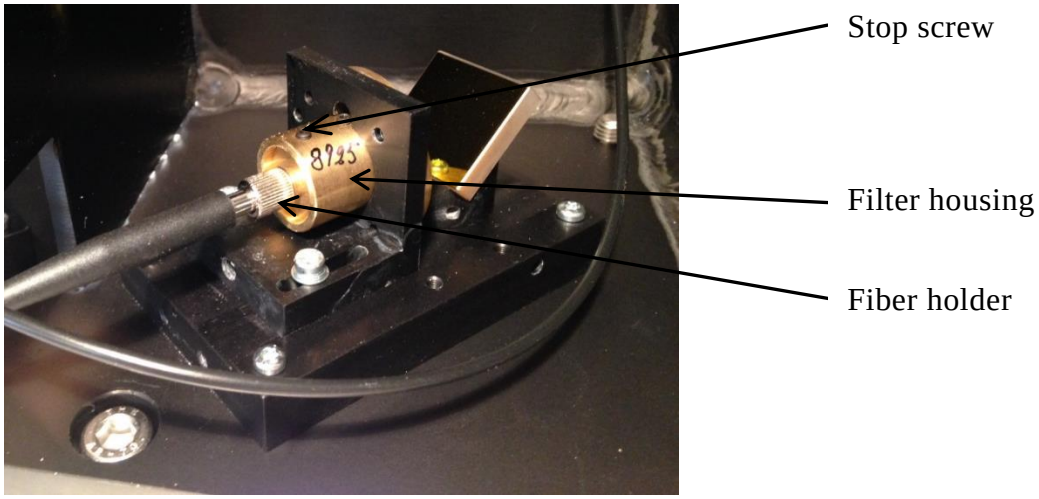


Figure 9-1 Mirror unit receiver

10. DRAWINGS

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Filter module	217 011 F
Hood	217 043 F
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Laser diode holder	217 191 F
Master unit	217 291 F
Power unit	217 925 F
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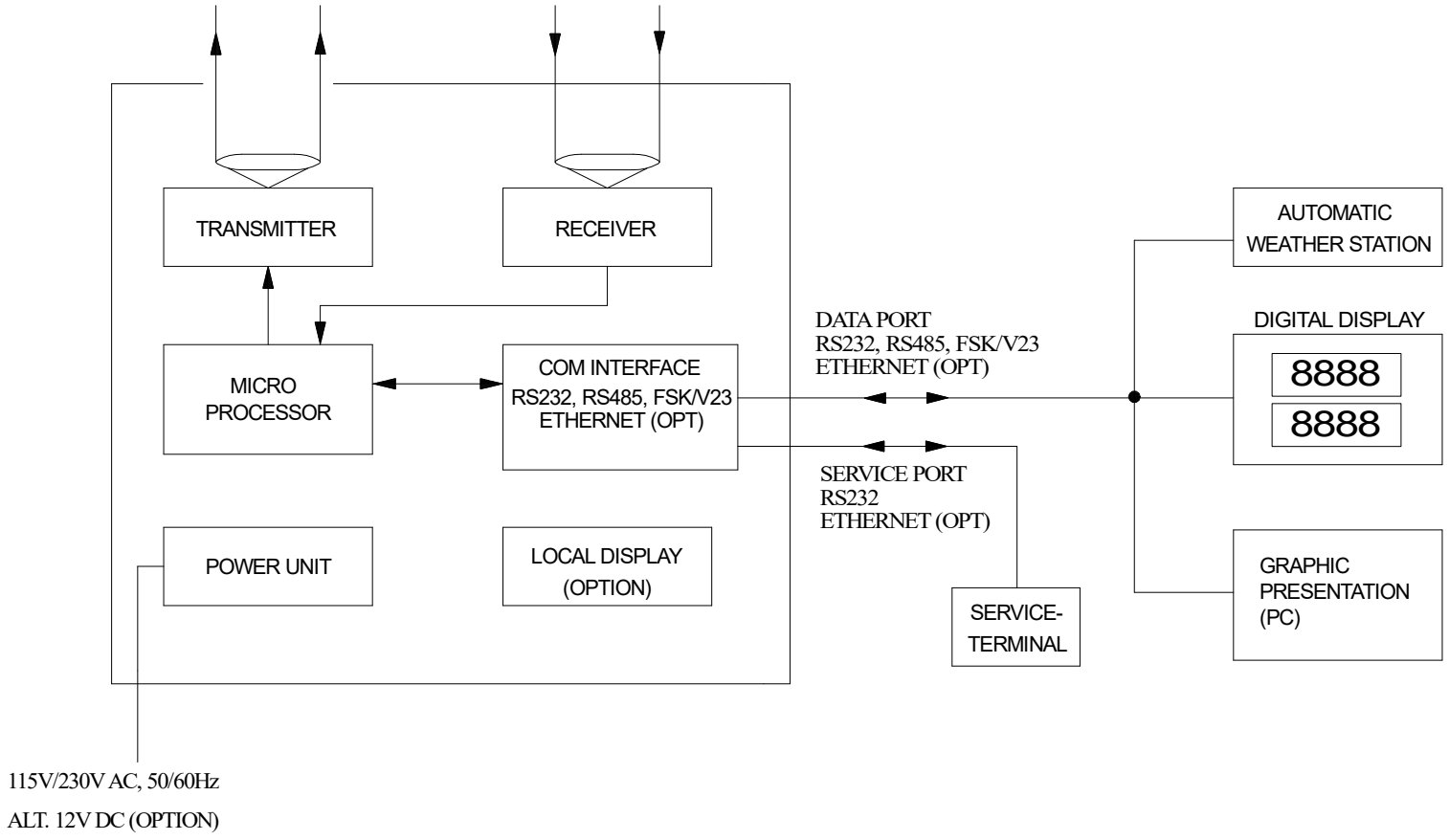
AC/DC-converter, component layout	217 621 F
DC/DC-converter, component layout	217 651 F
Master unit, component layout	218 101 B
Blower system (option)	250 006 F
Blower unit (option)	250 101 F



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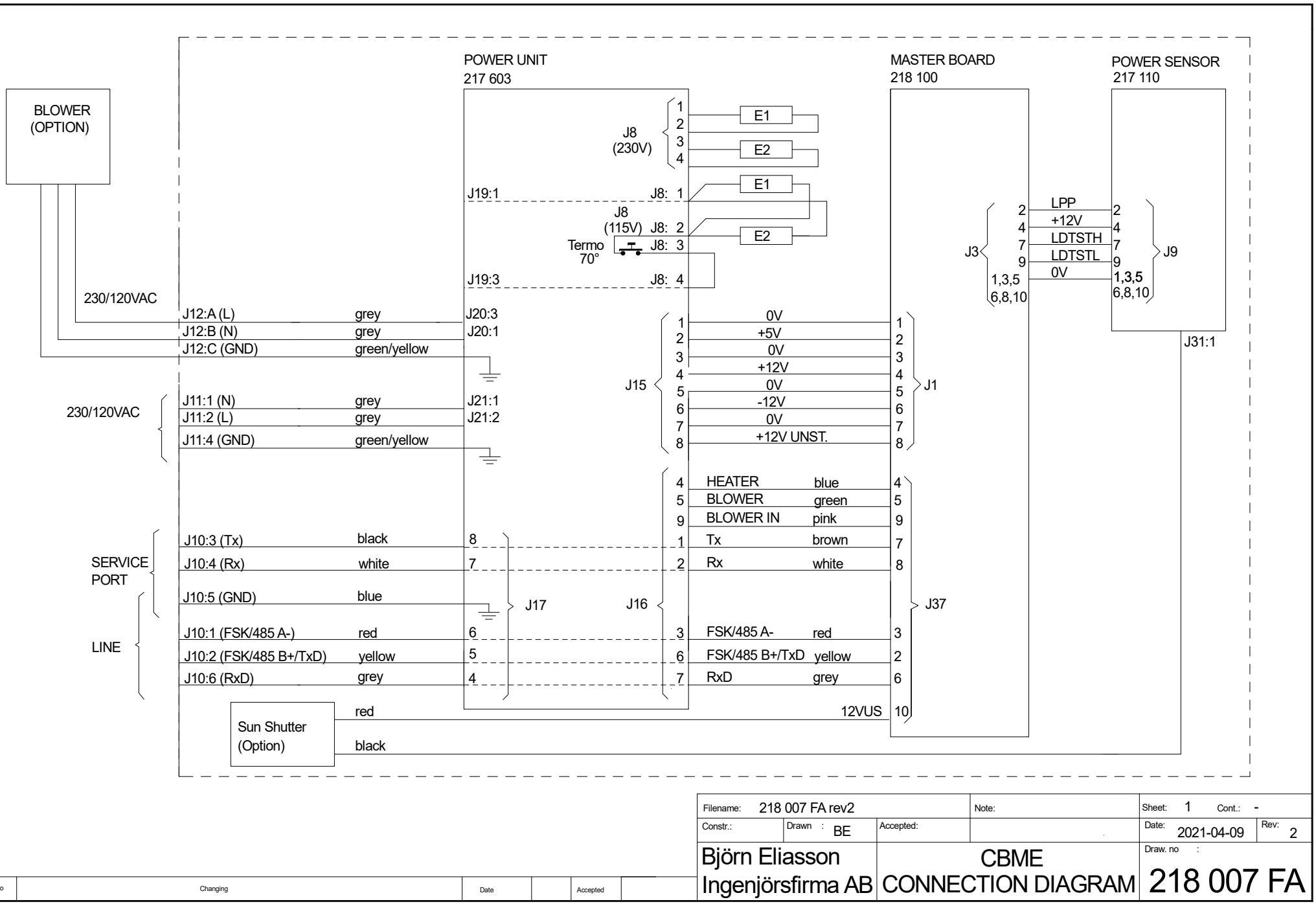

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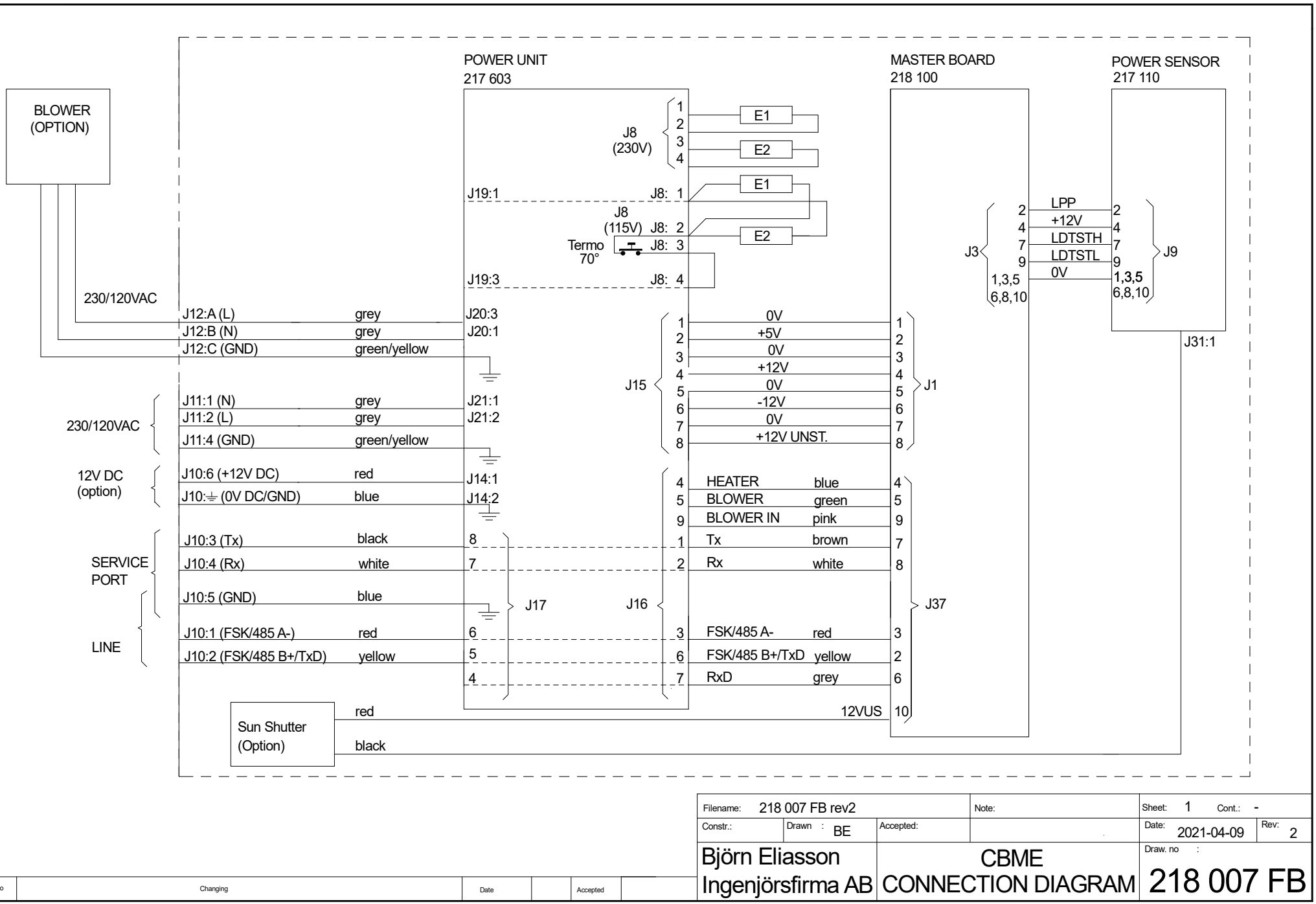

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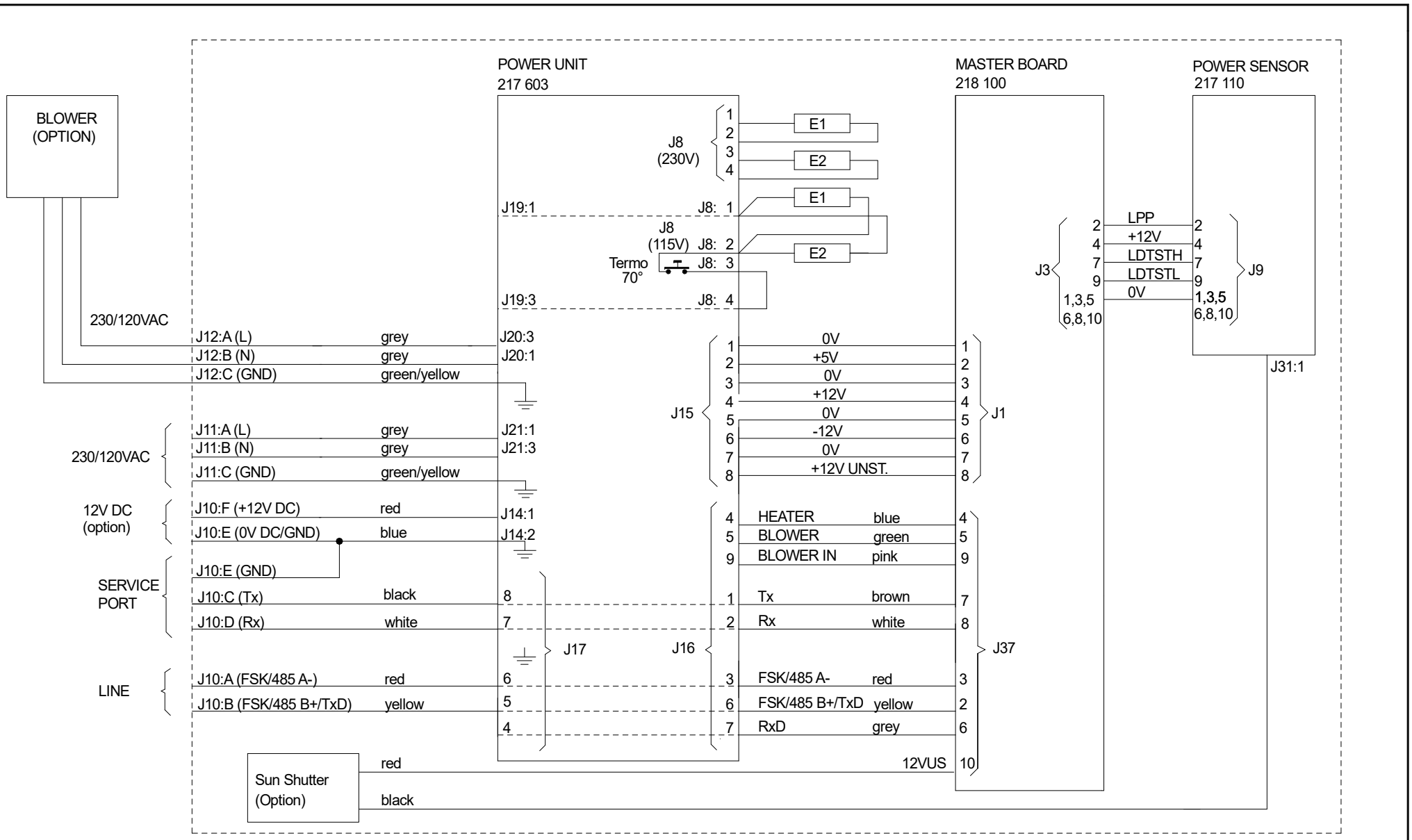

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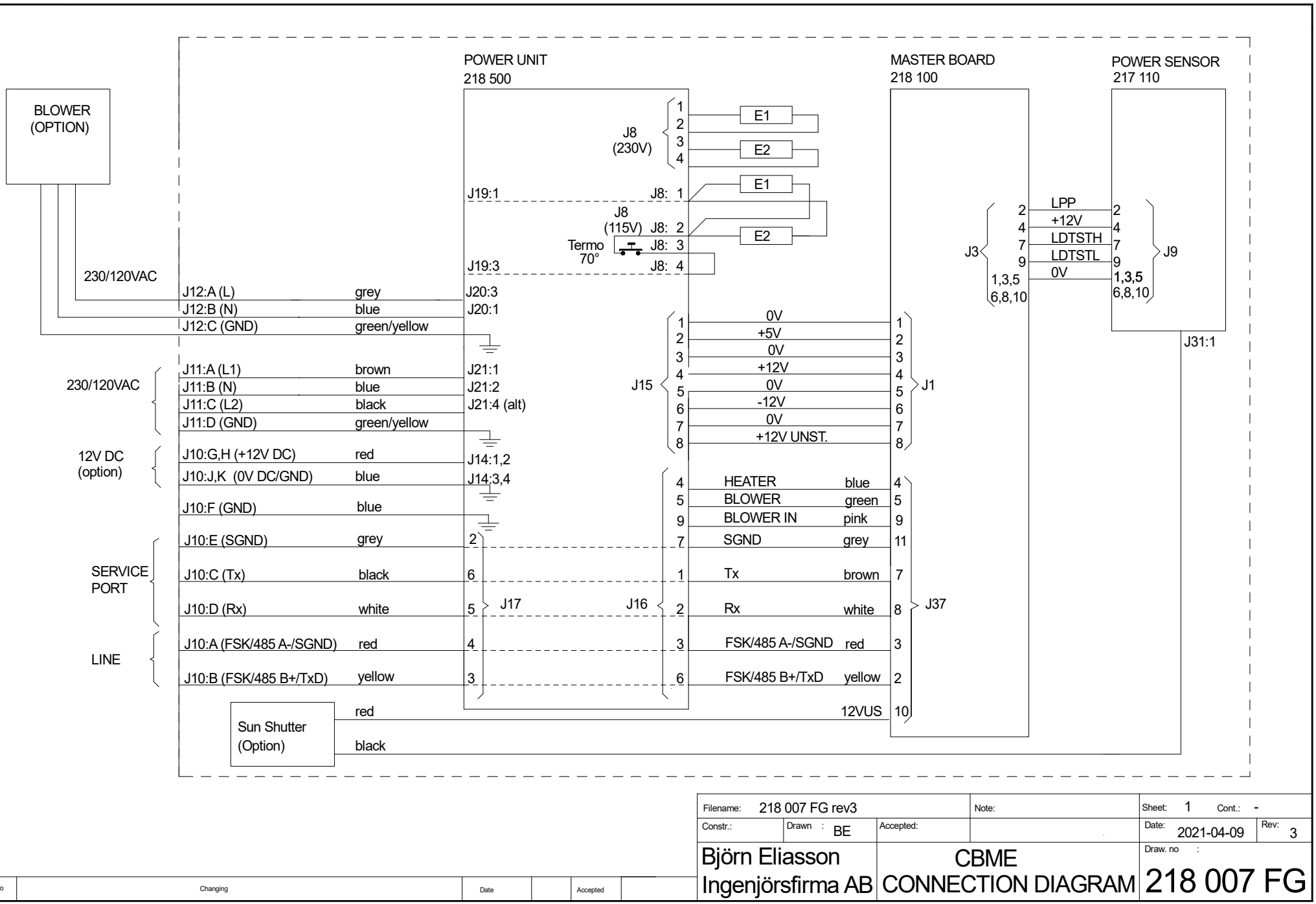

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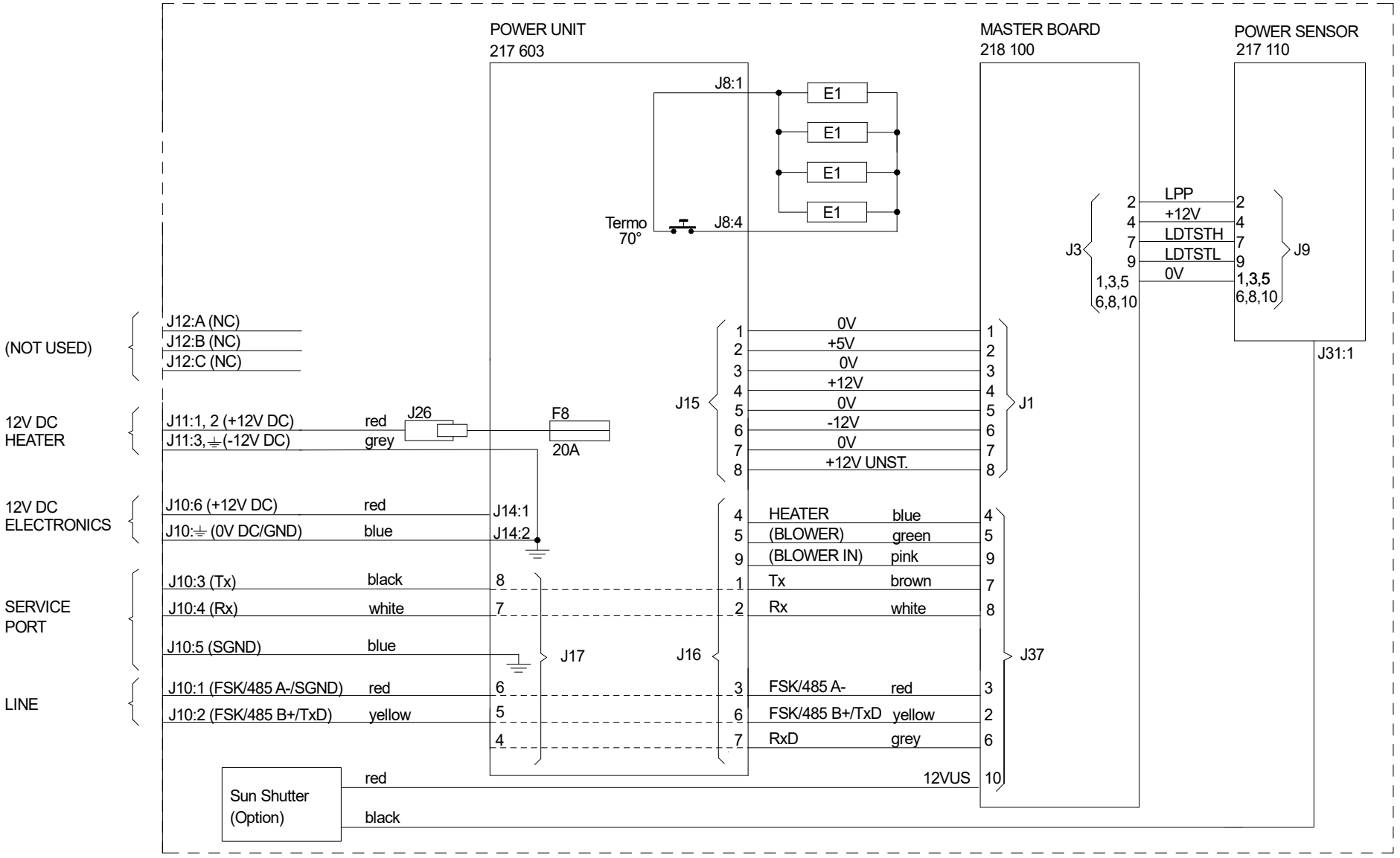

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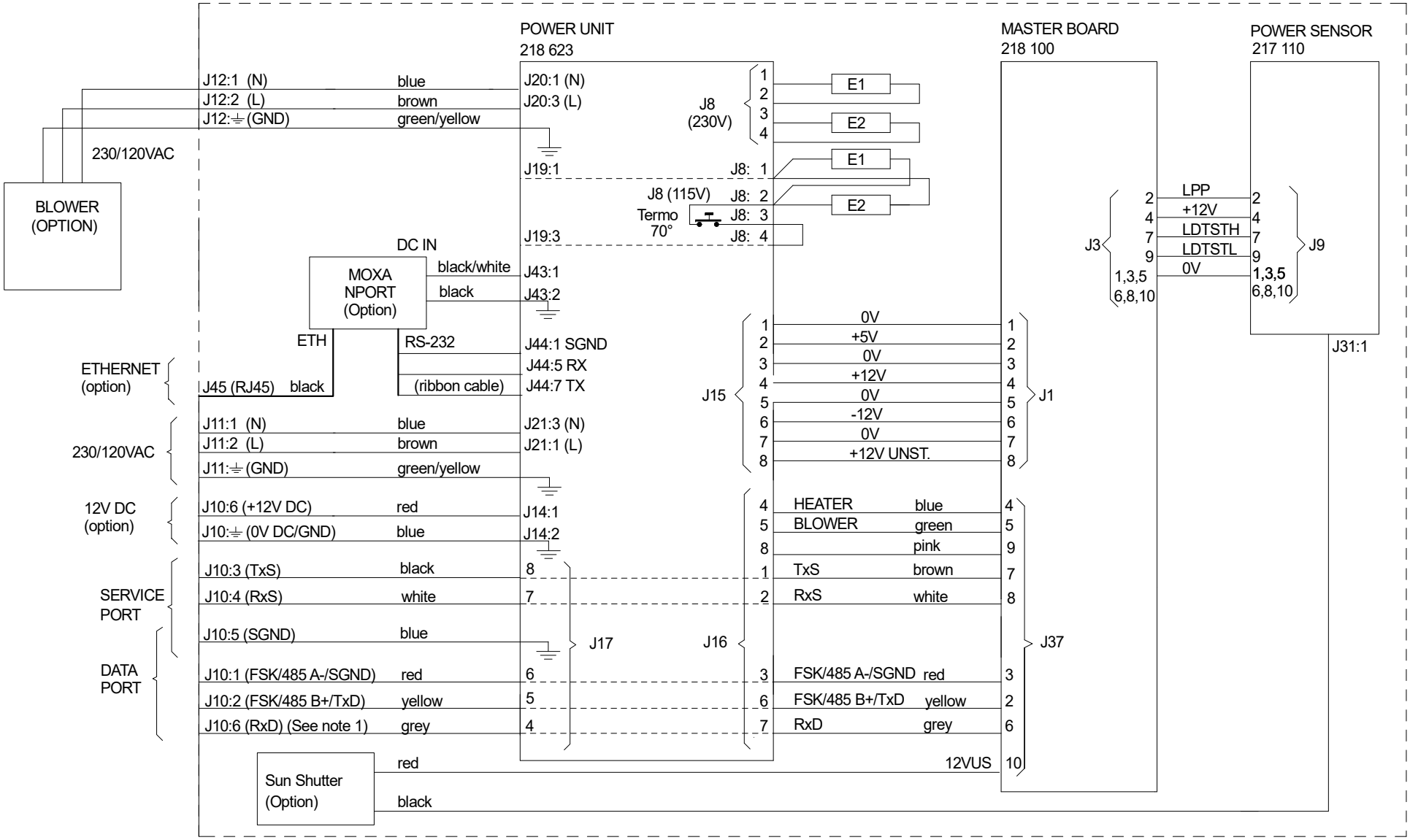

Note 1: J10:6 (RxD) only available when 12V DC option is not present

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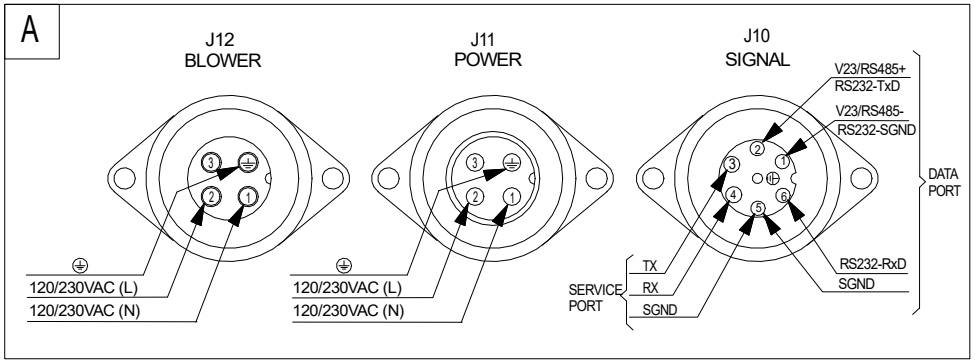

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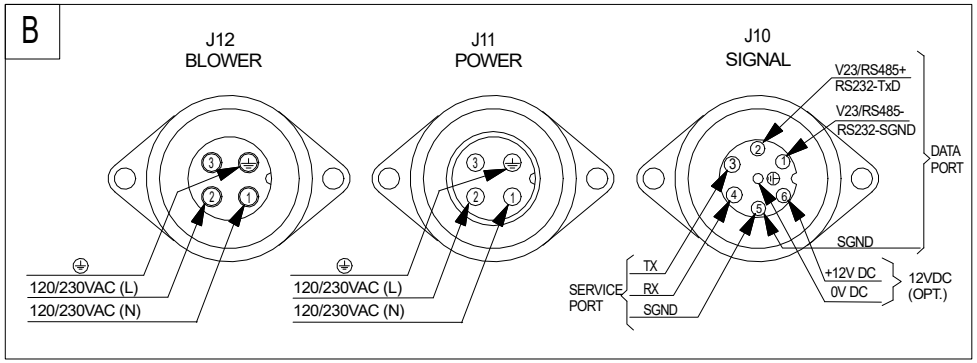

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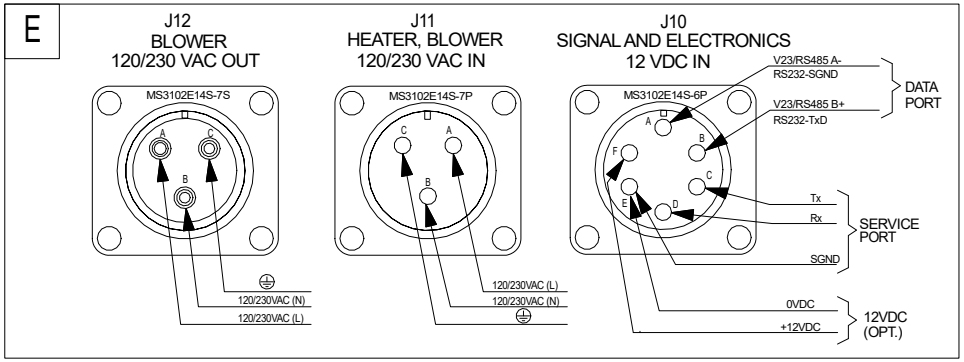

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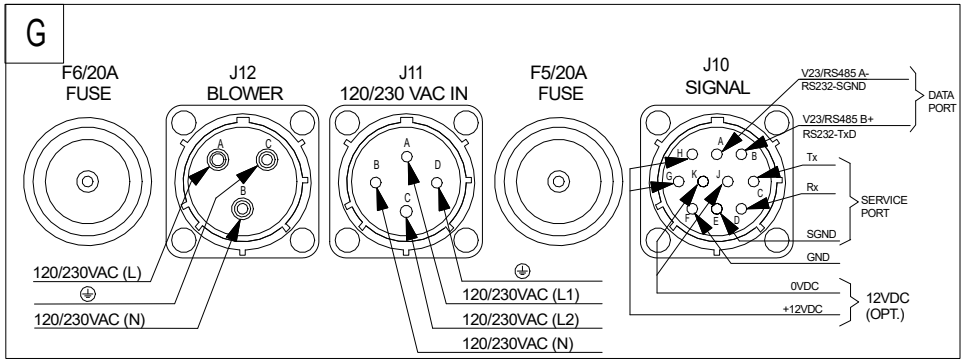

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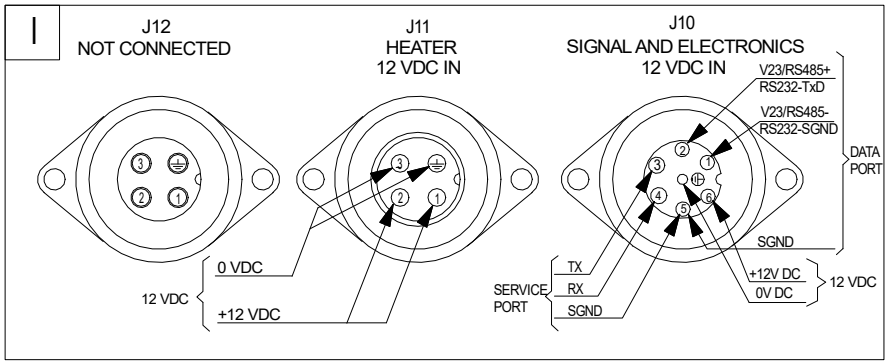

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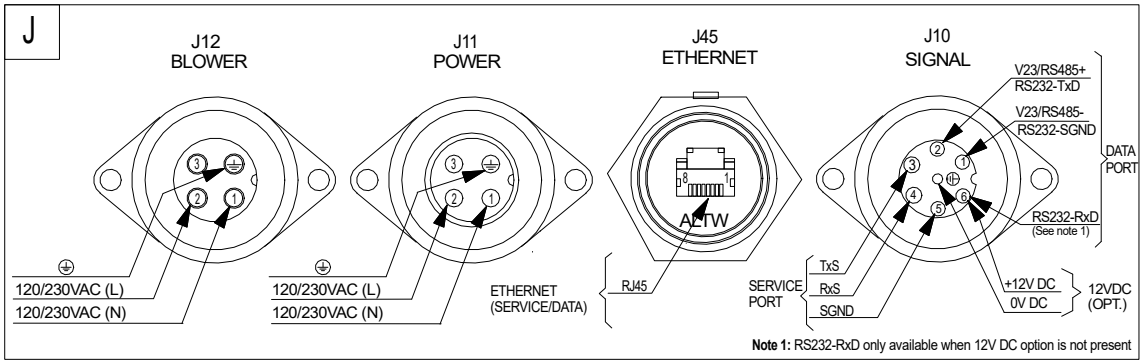

Note 1: RS232-RxD only available when 12V DC option is not present

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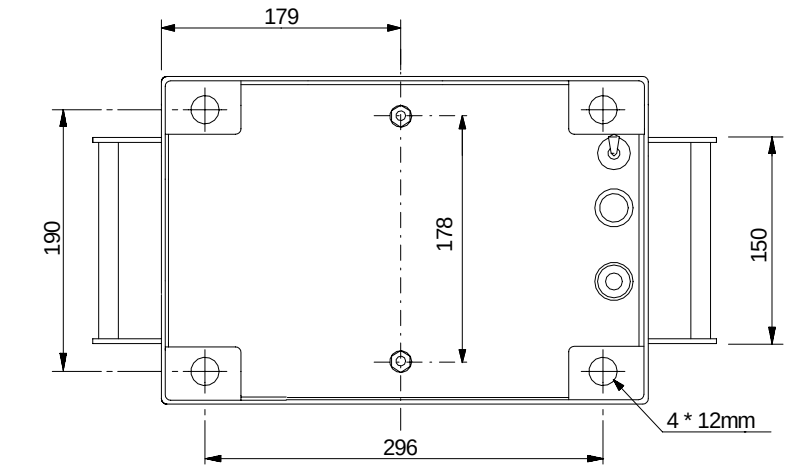

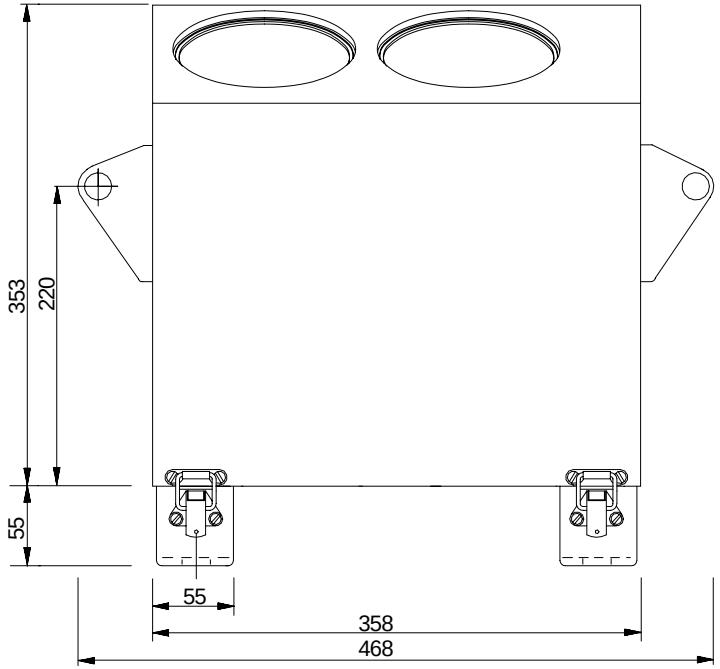

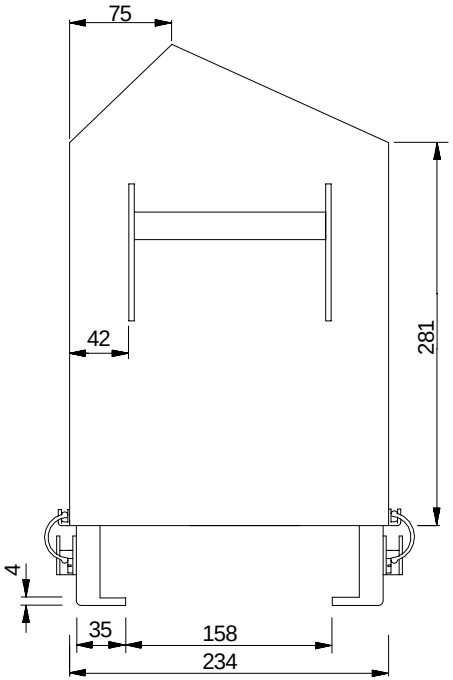

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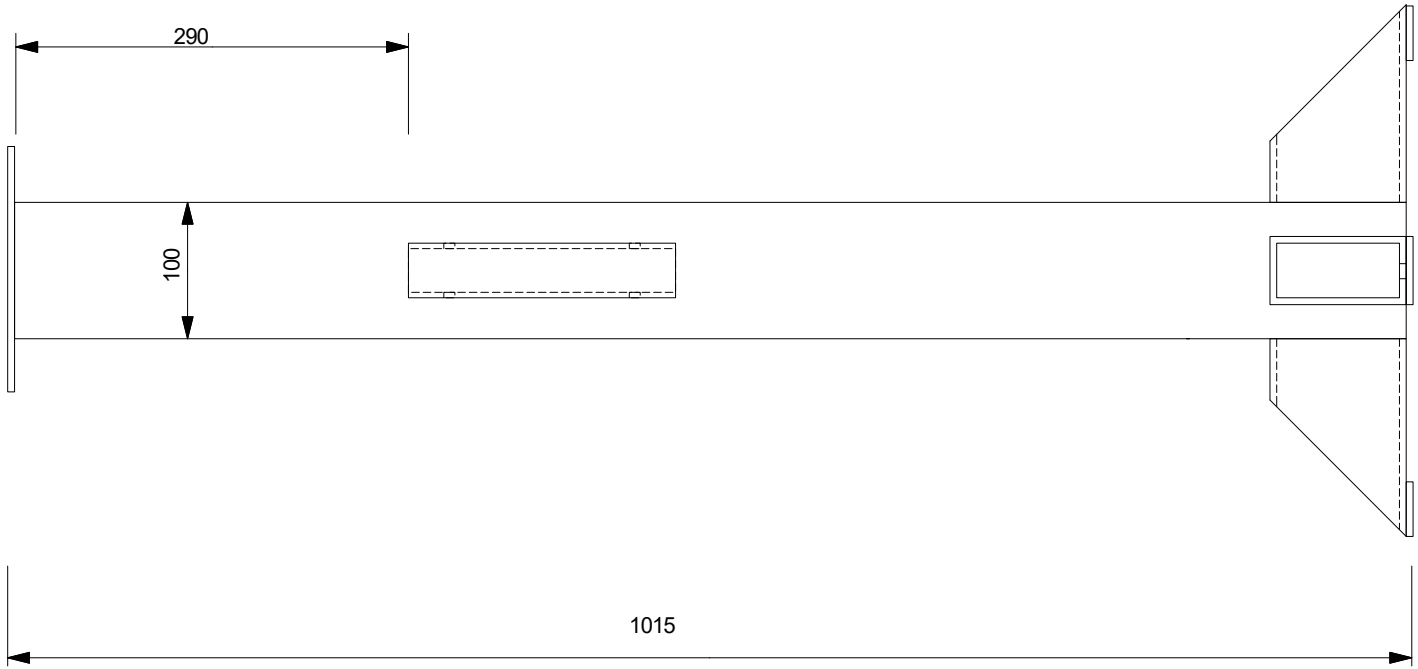
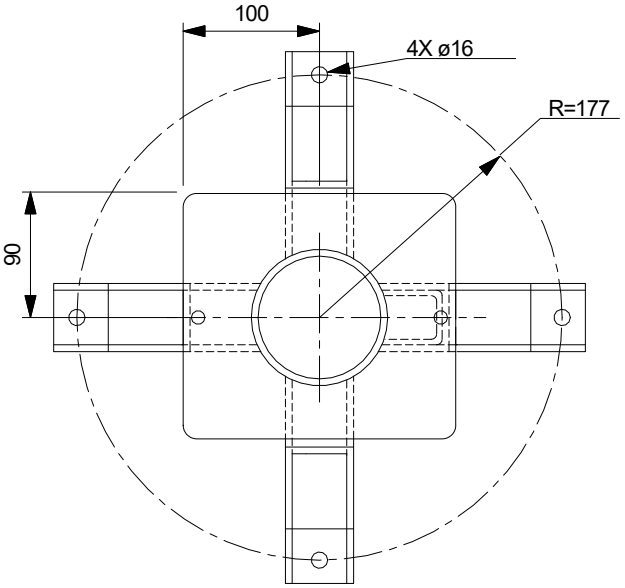
Mod. No	Changing	Date		Accepted	





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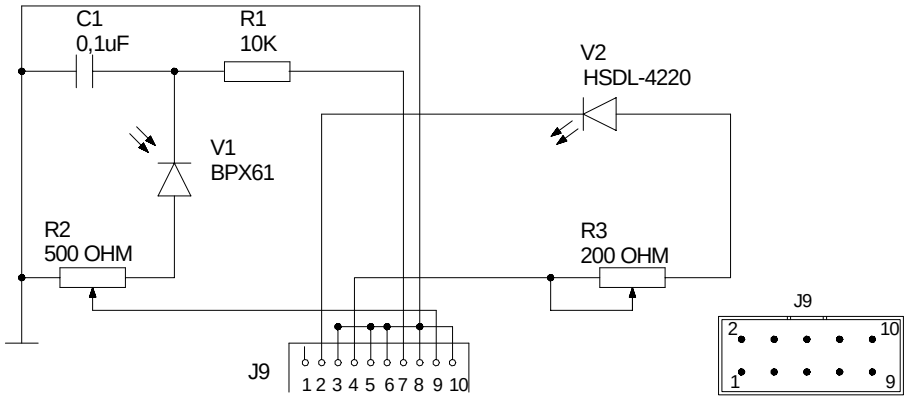
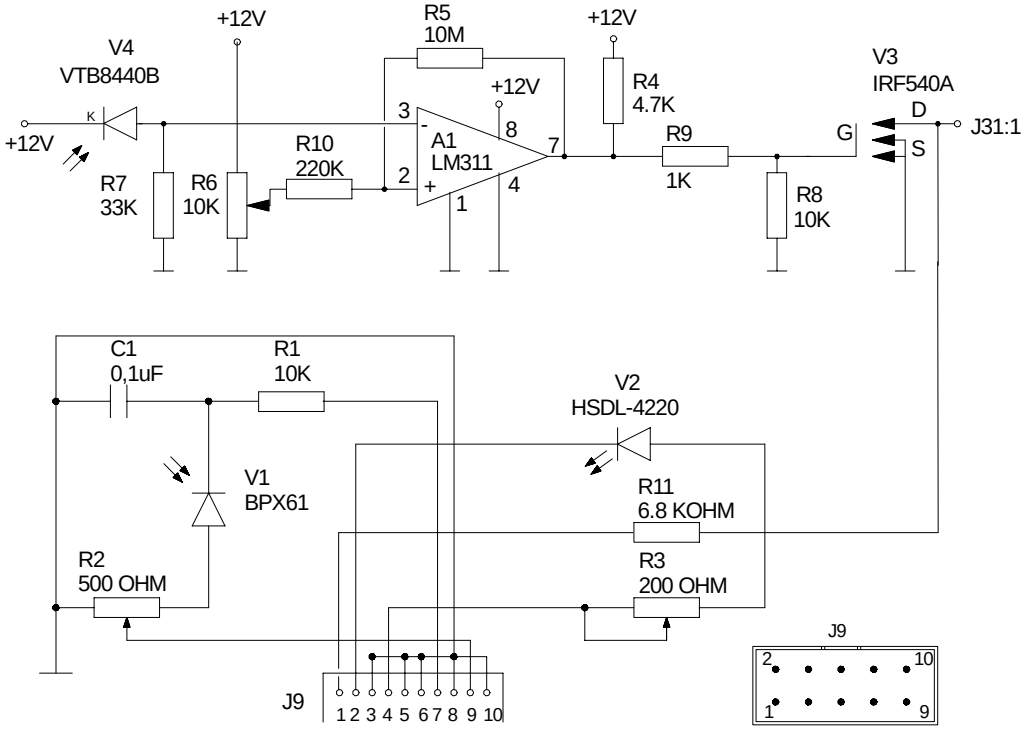
POWER SENSOR



POWER SENSOR WITH SUN SHUTTER



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1	Resistor R7 changed to 33K (was 1M)	2005-06-20		BE

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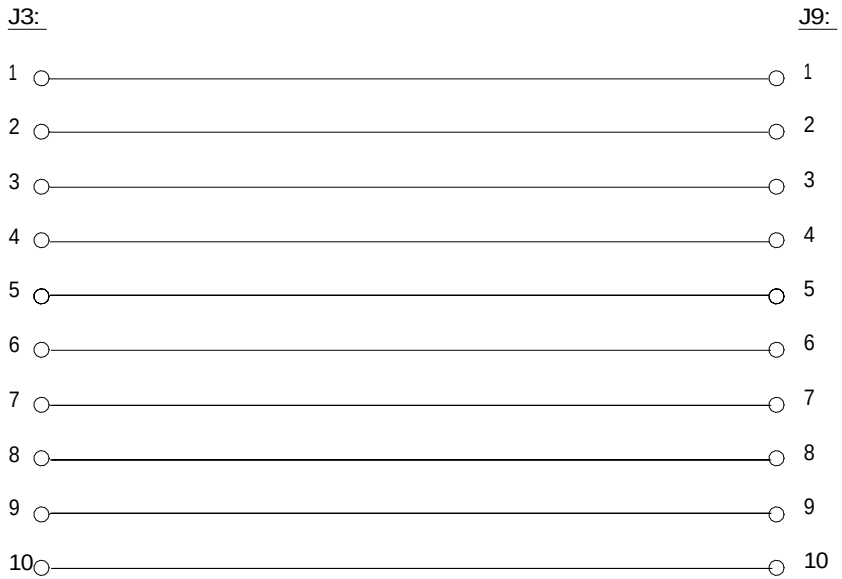

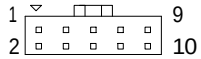

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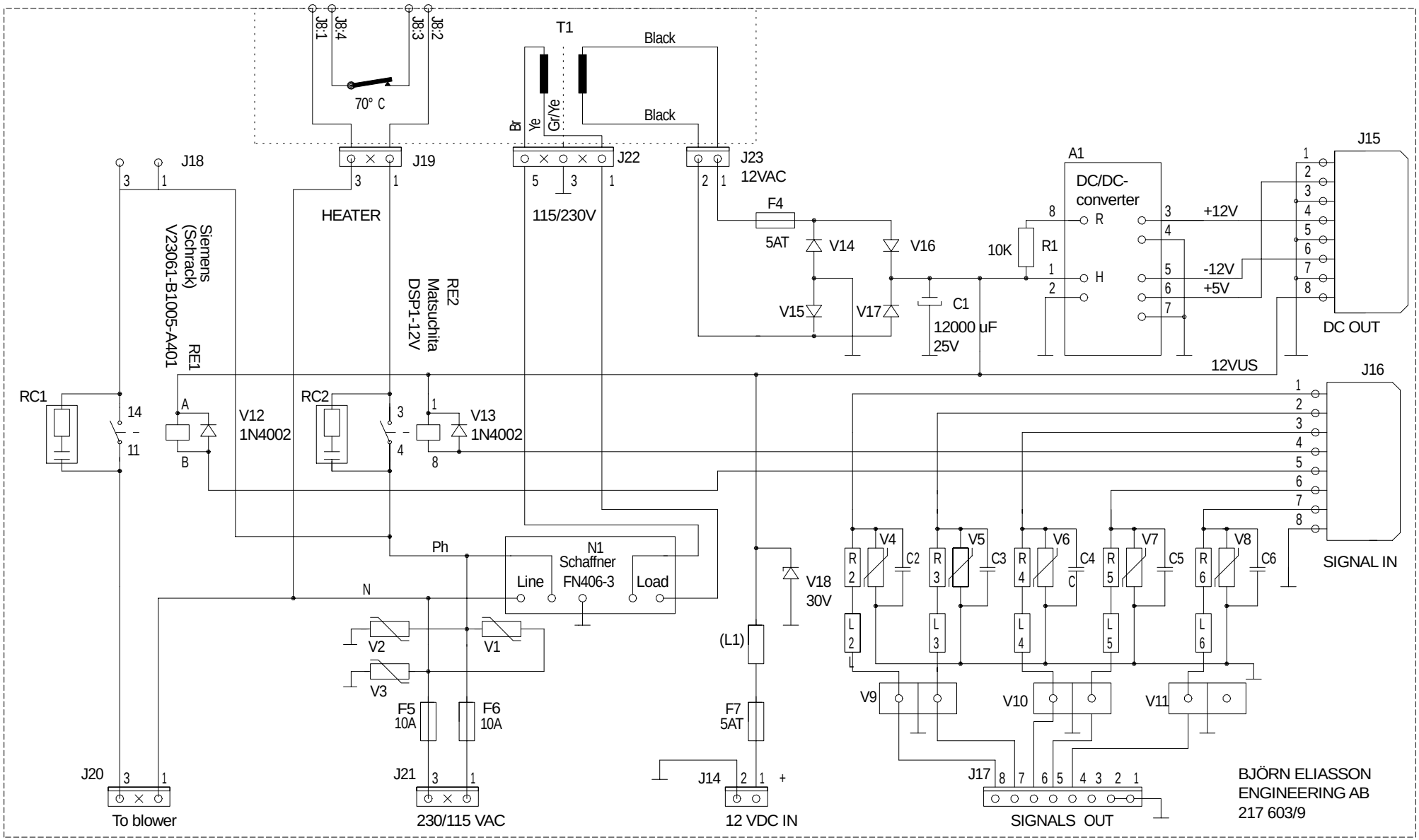

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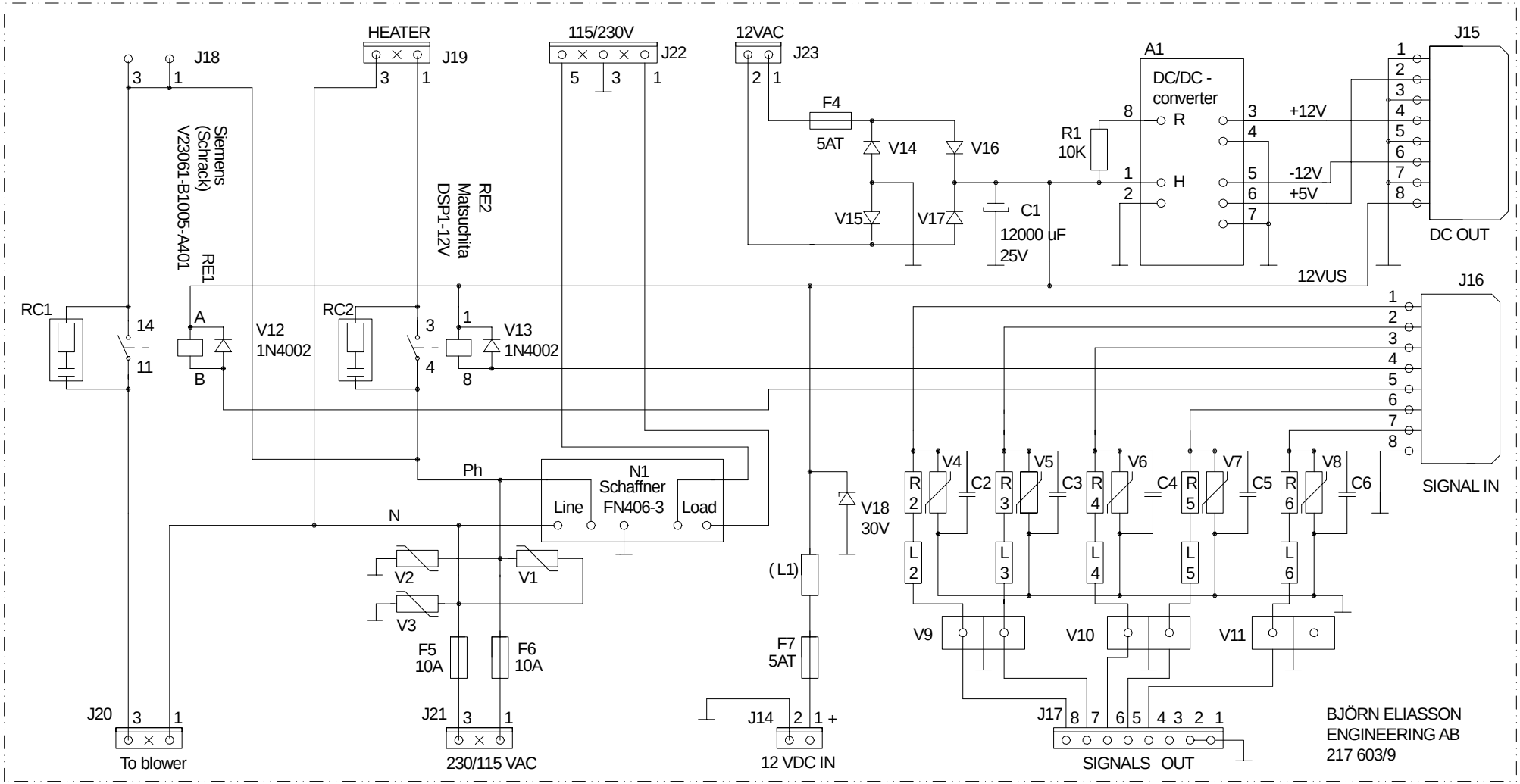
Mod. No	Changing	Date		Accepted	



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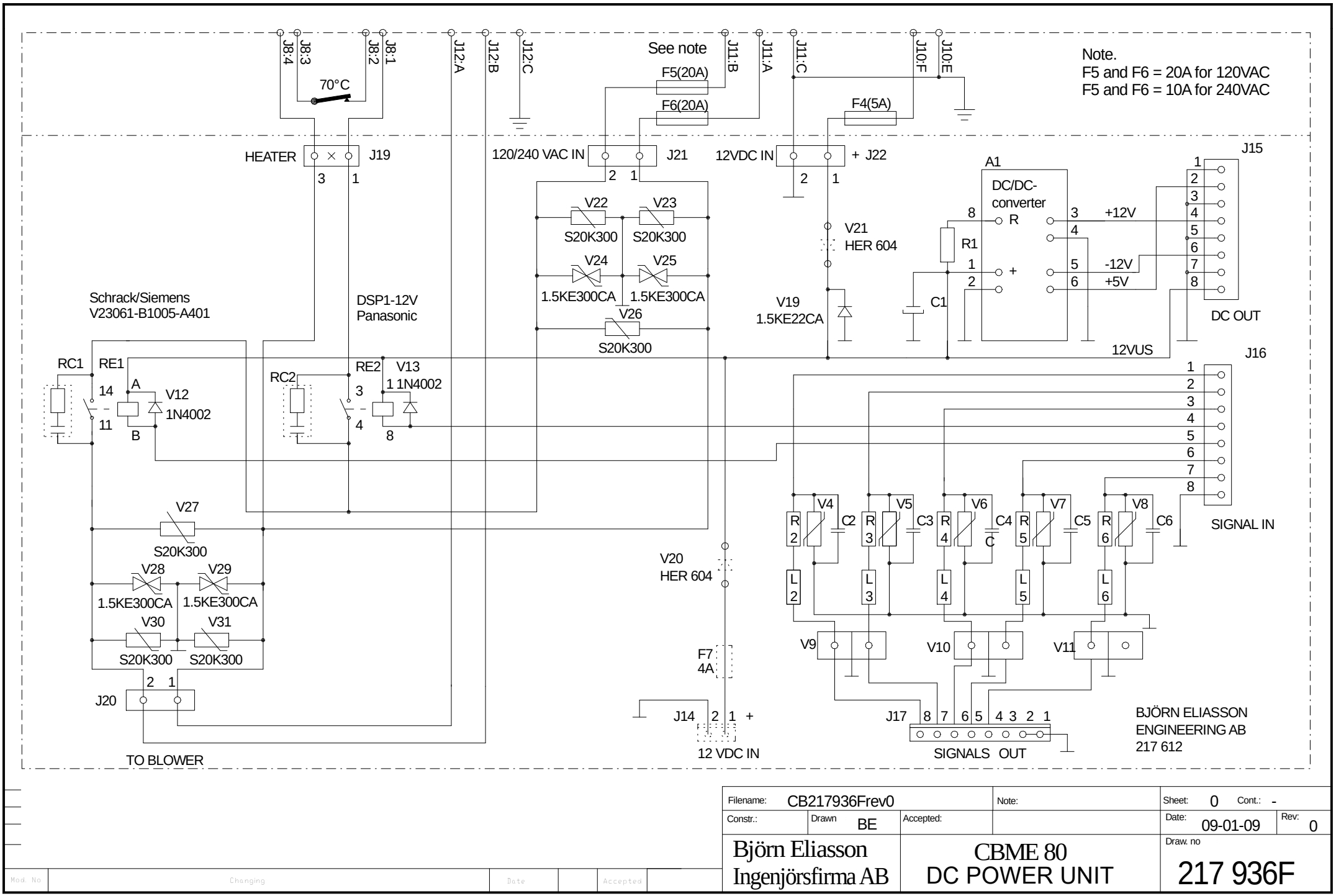

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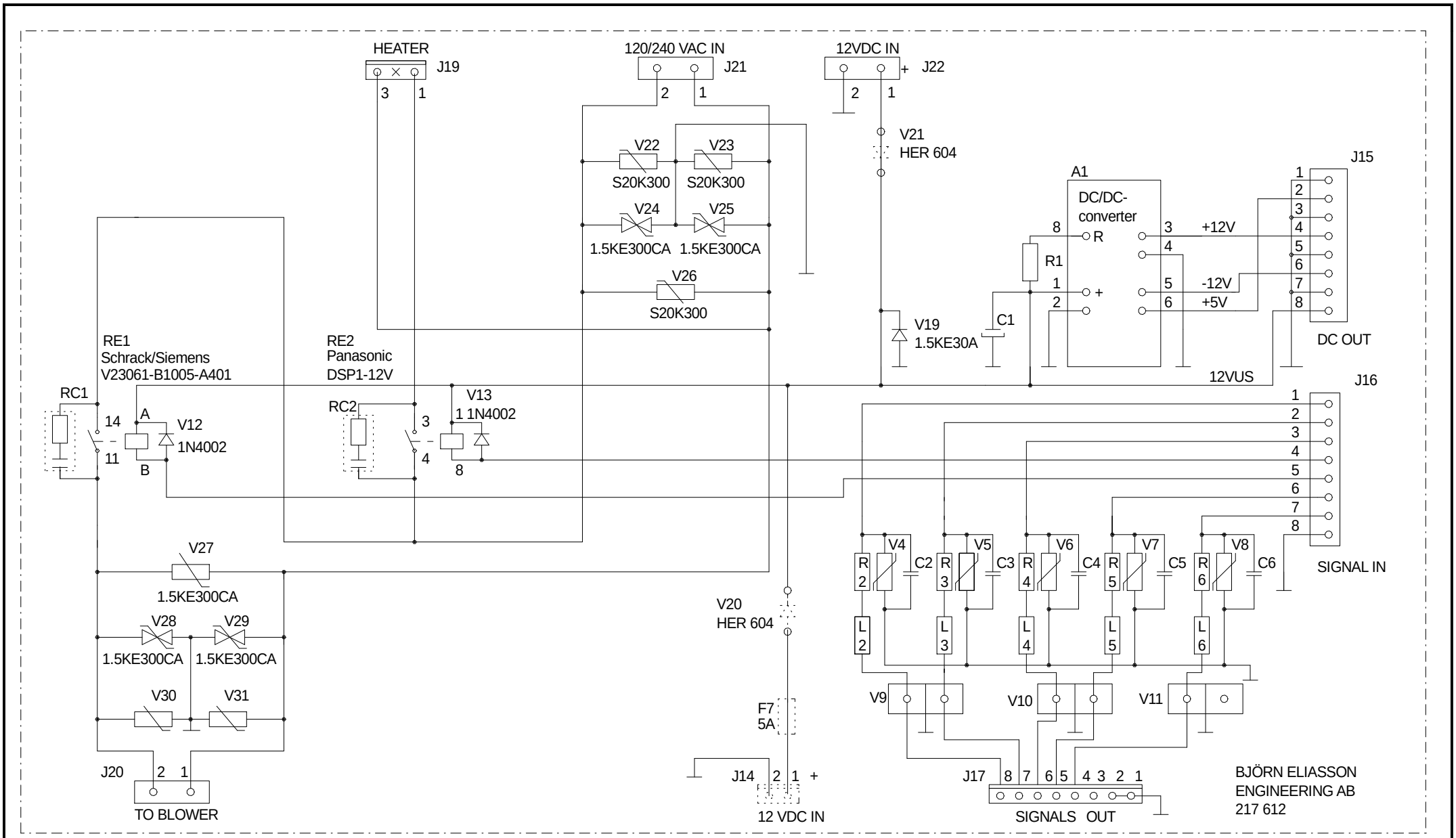
Mod. No.	Changing	Date		Accepted



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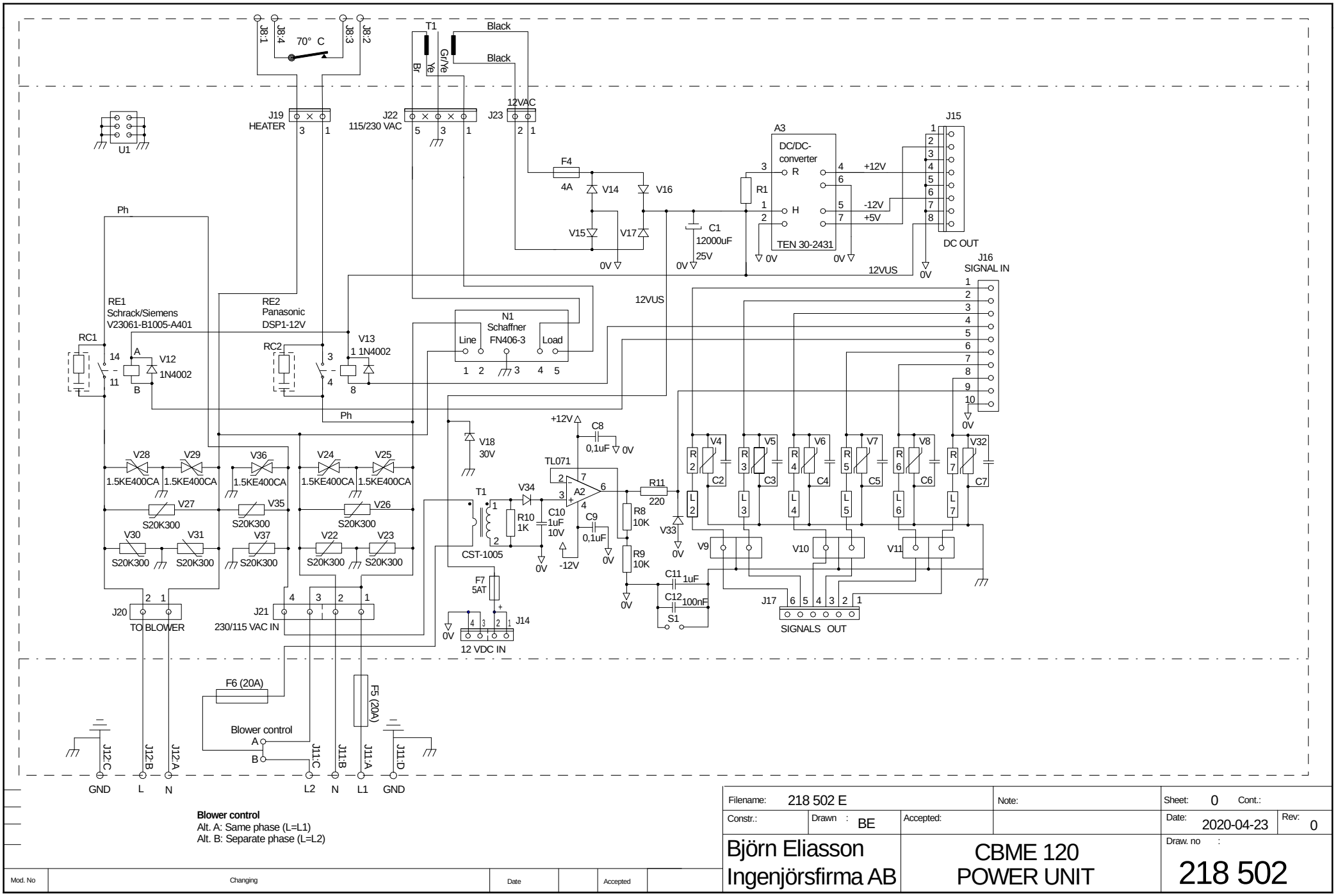
Mod. No.	Changing	Date		Accepted



Blower control
Alt. A: Same phase (L=L1)
Alt. B: Separate phase (L=L2)

Mod. No	Changing	Date		Accepted

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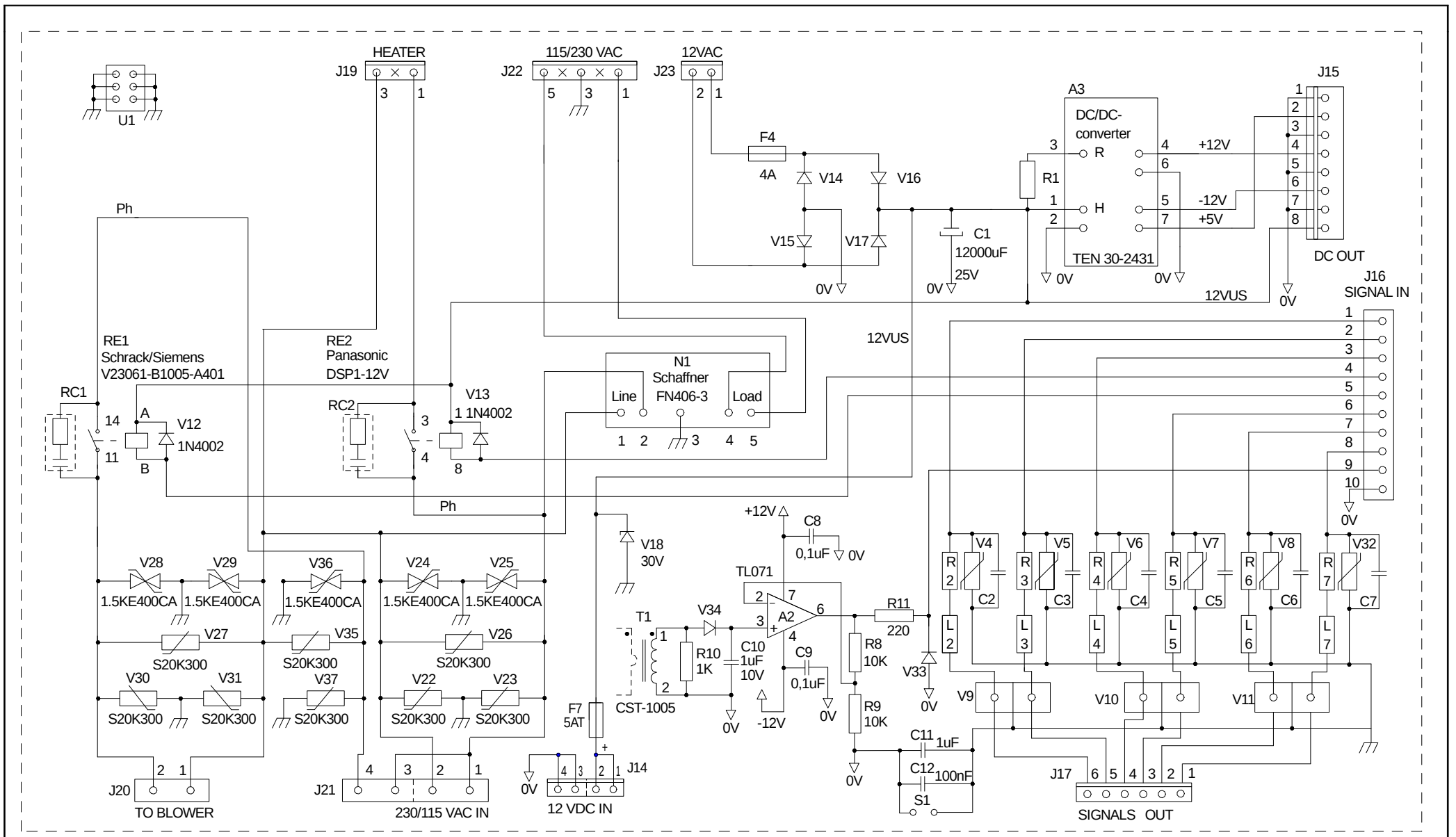

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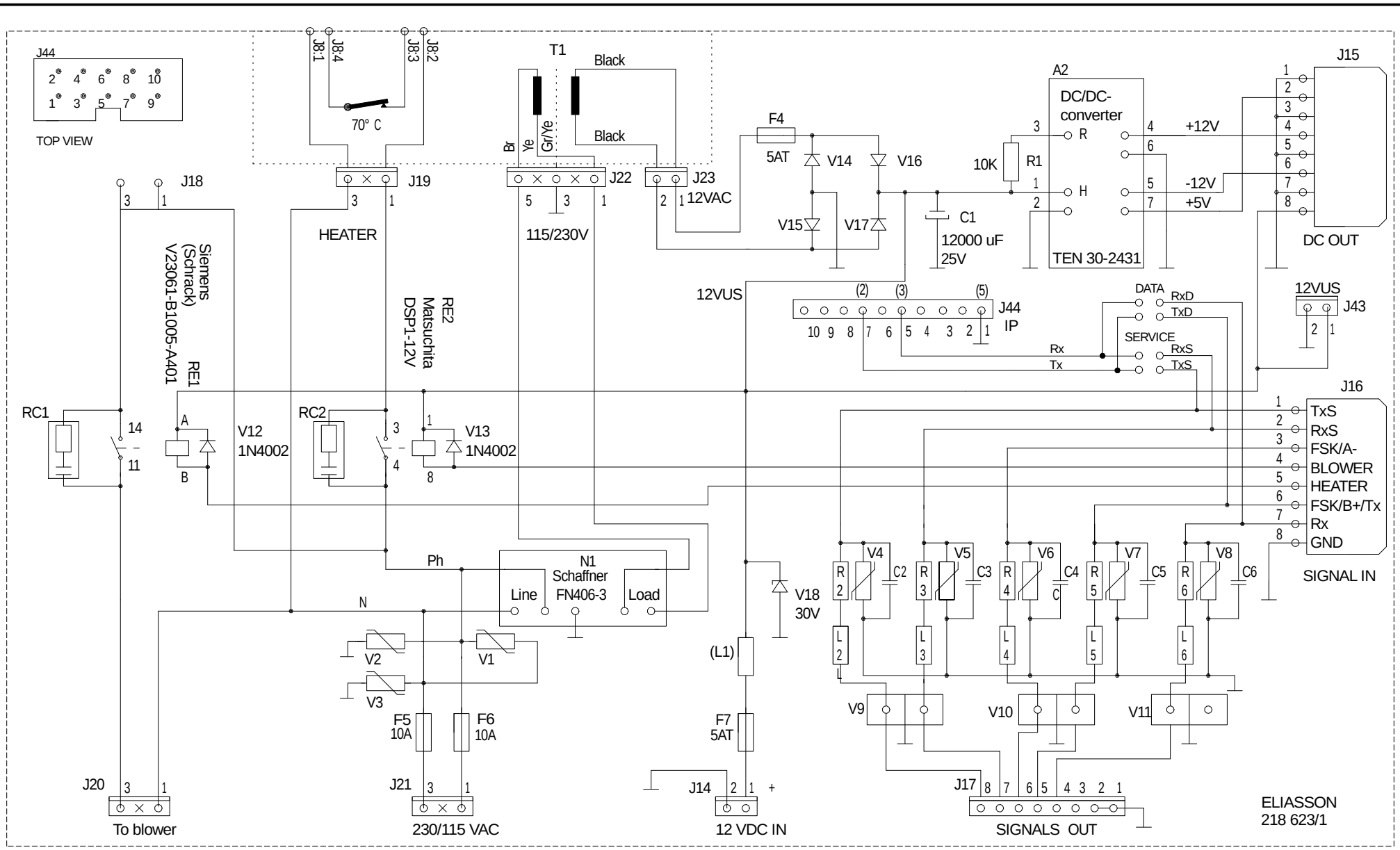

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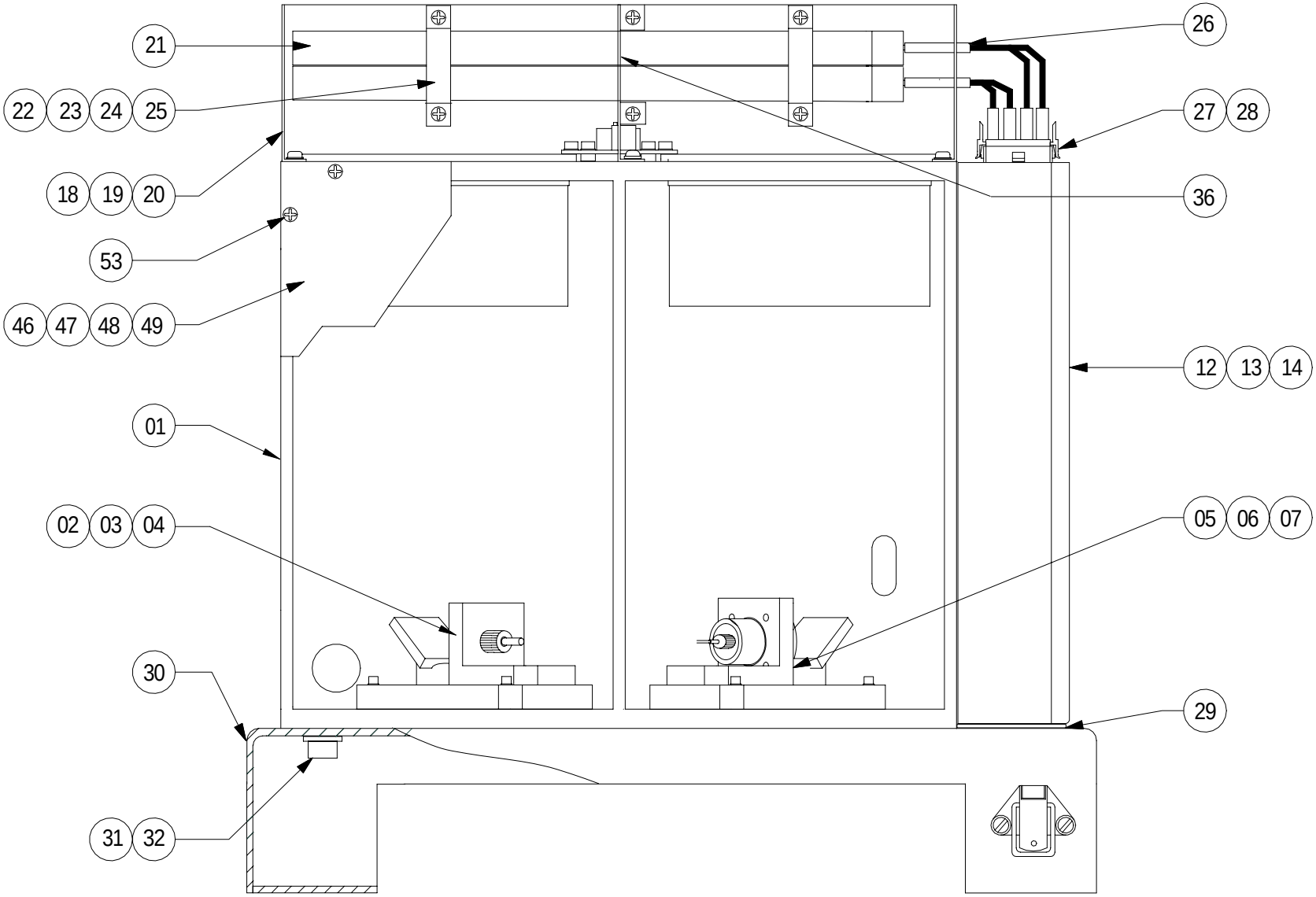

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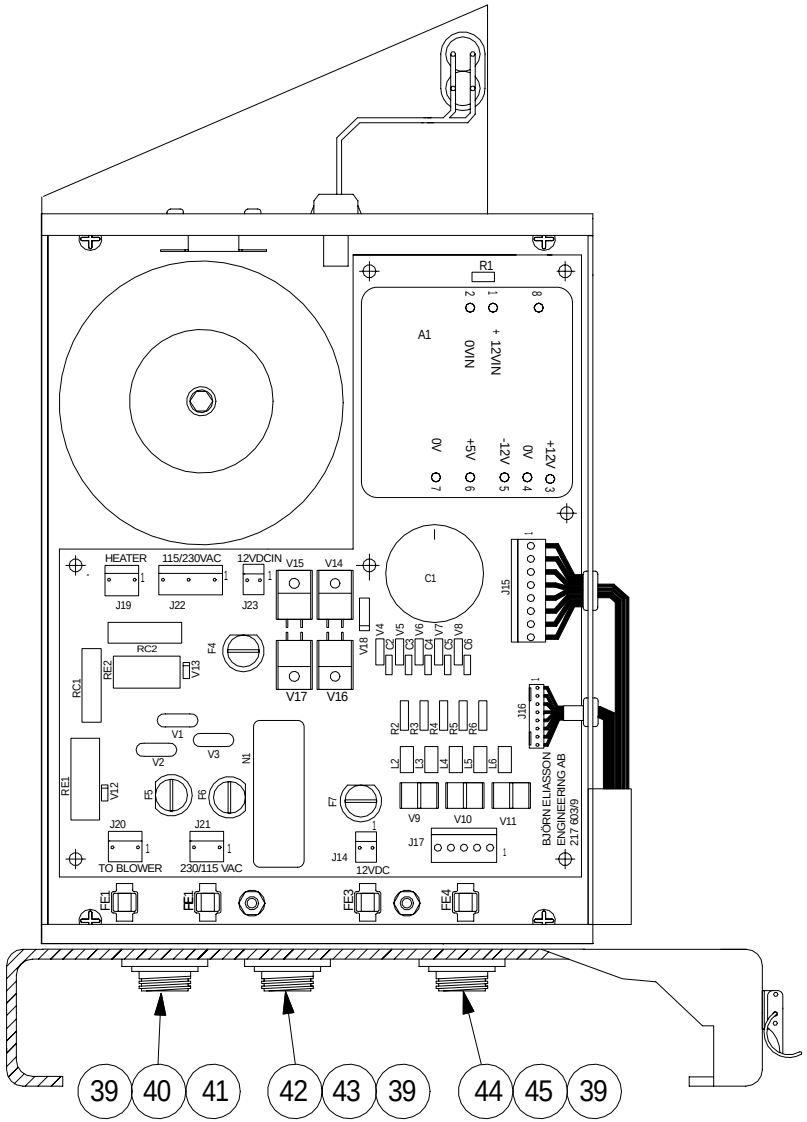
Mod. No	Changing	Date		Accepted	



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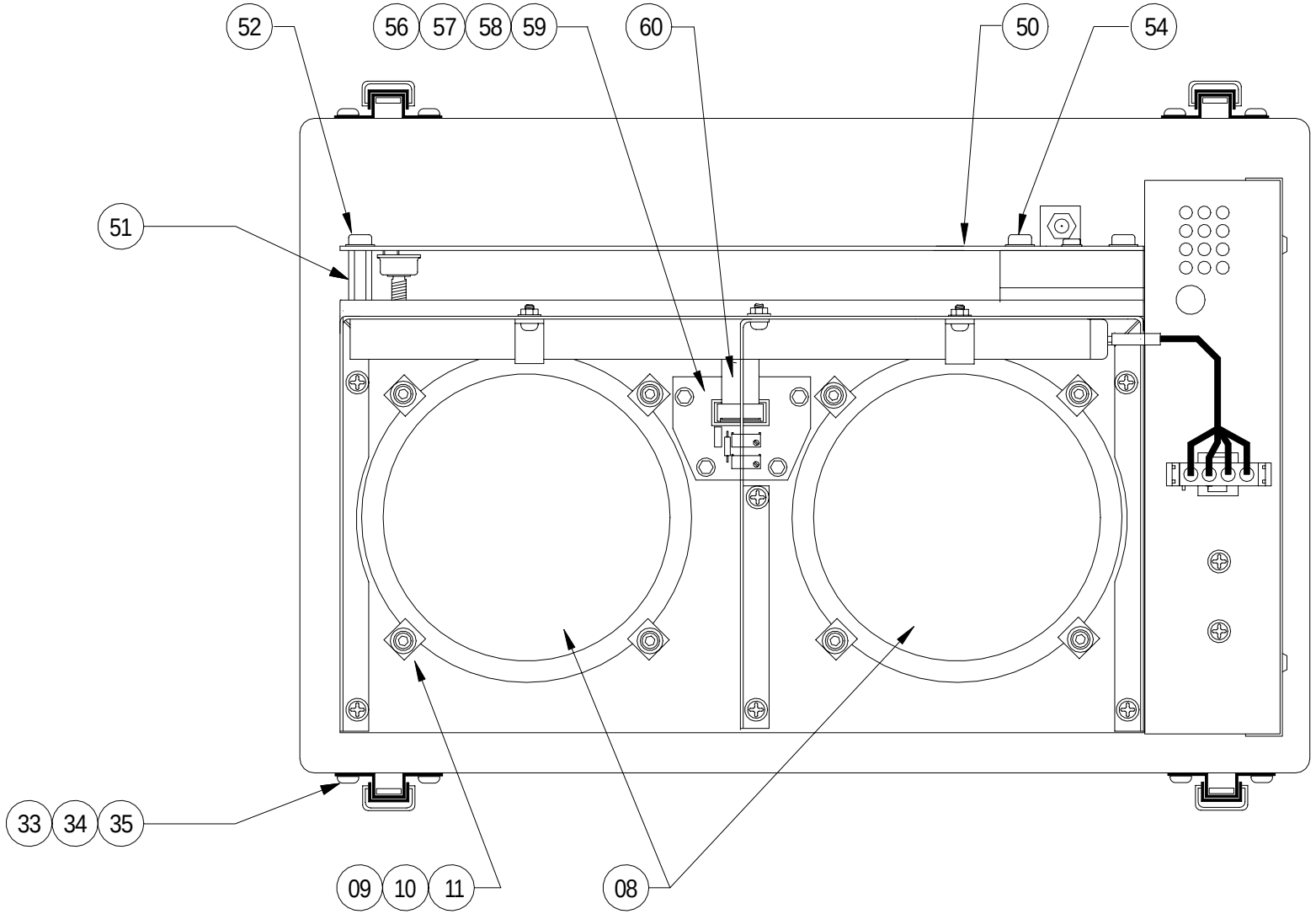
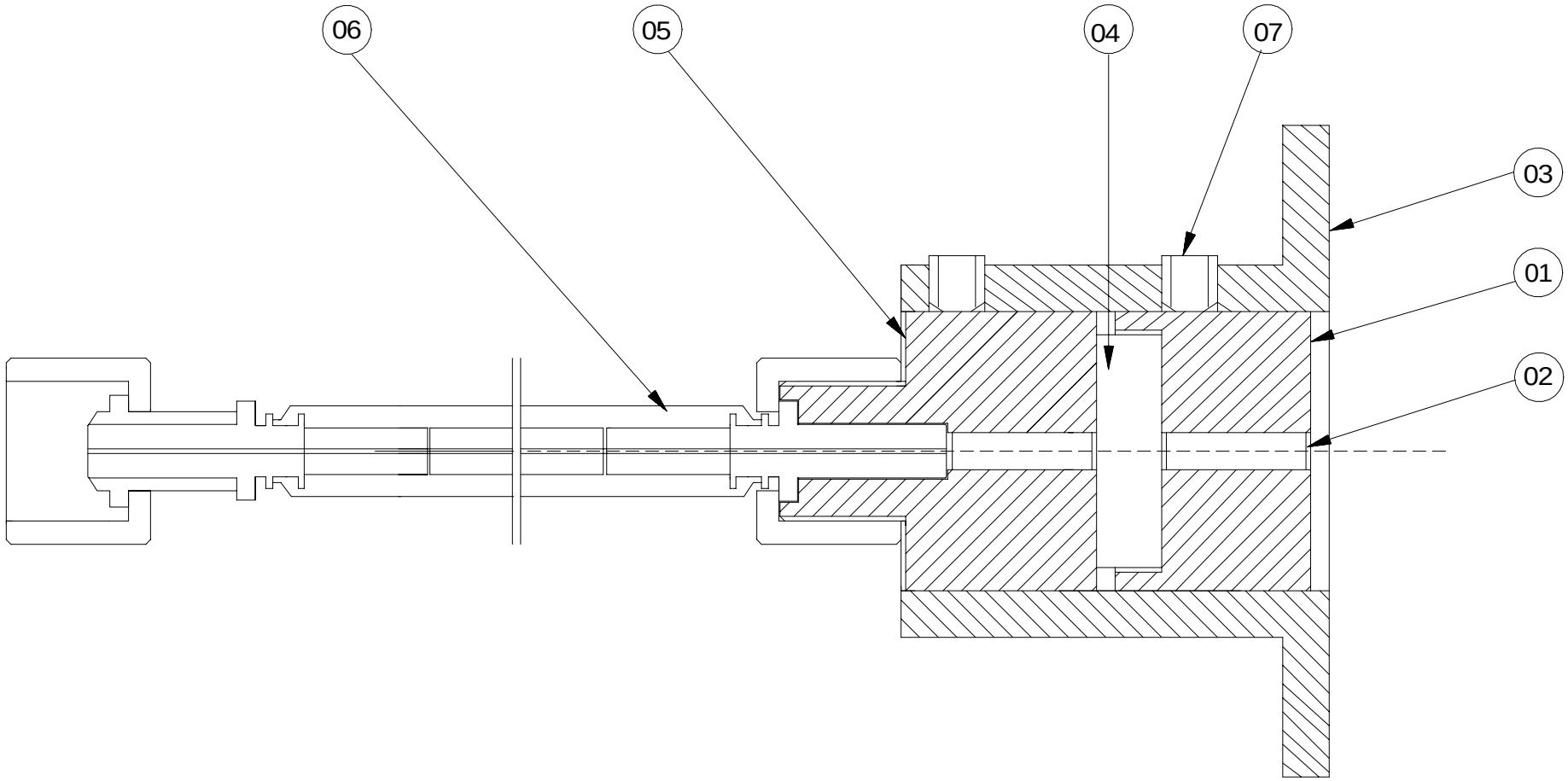
Björn Eliasson Ingenjörsfirma AB		CBME 80 CEILOMETER		Draw. no 217 006F	

Mod. No	Changing	Date		Accepted



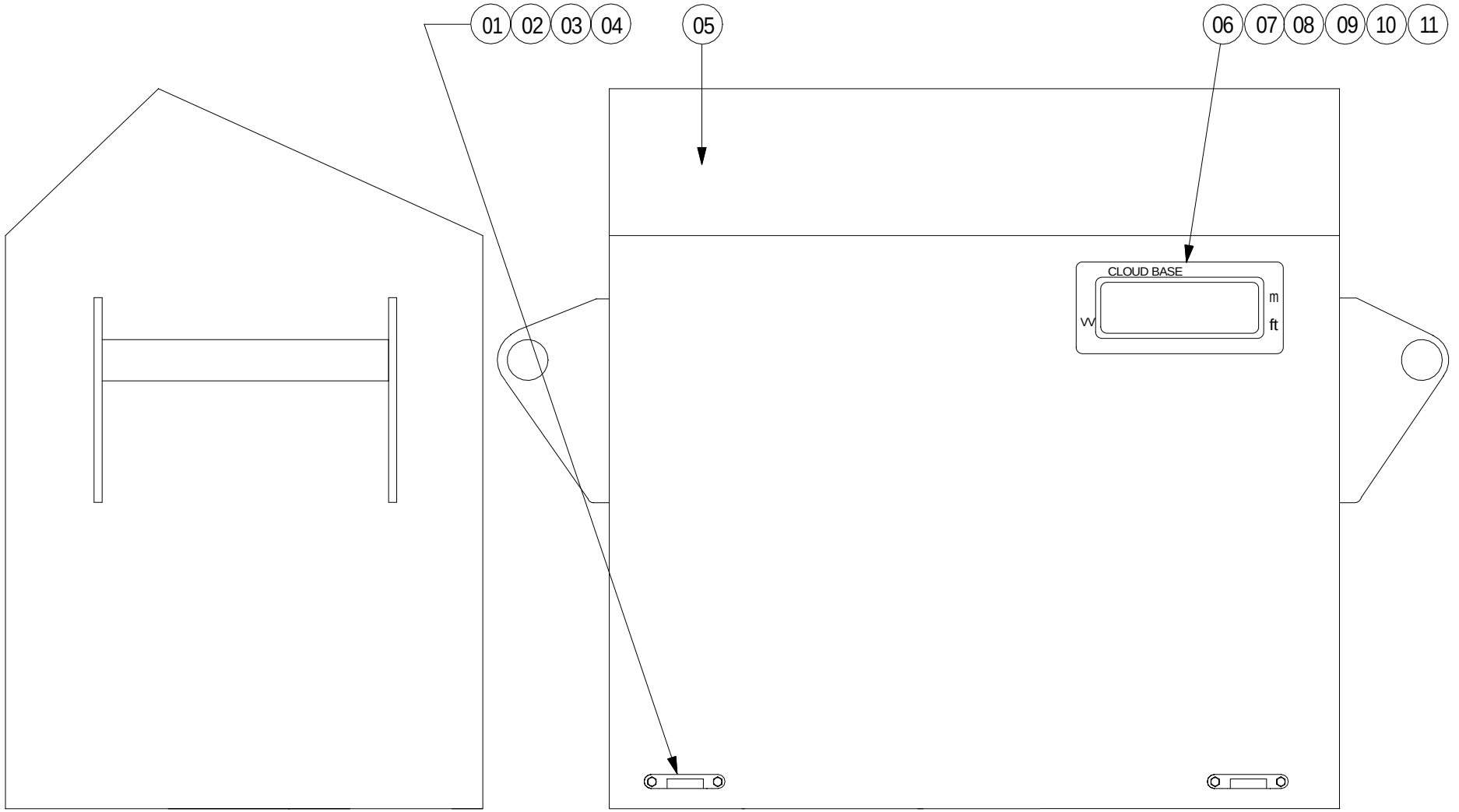
Mod. No	Changing	Date		Accepted	

Filename: CB217006F_3 rev 0			Note:	Sheet: 3	Cont.: -
Constr.:	Drawn BE	Accepted:		Date: 05-03-22	Rev: 0
Björn Eliasson Ingenjörsfirma AB		CBME 80 CEILOMETER		Draw. no 217 006F	



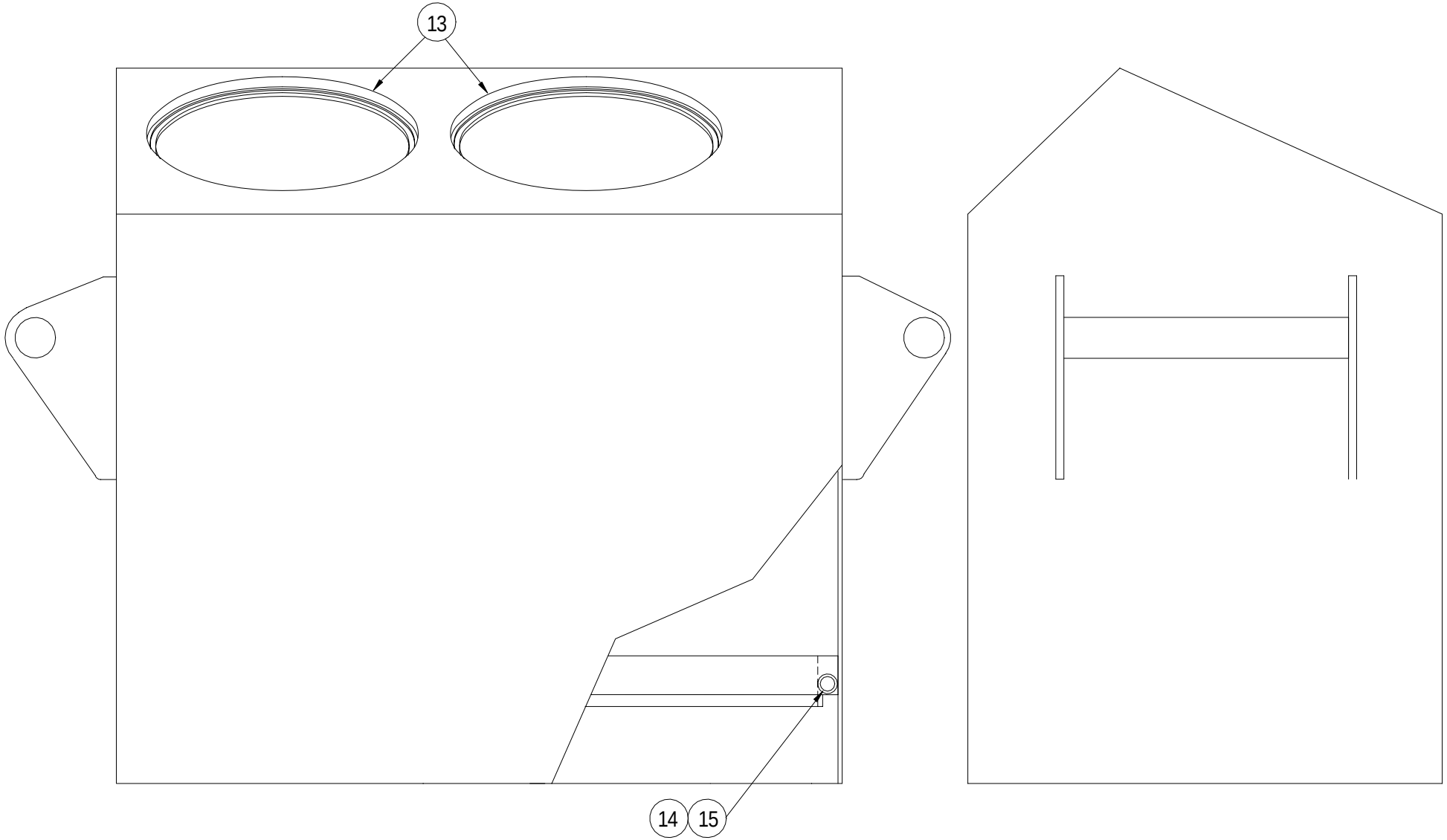
Mod. No	Changing	Date		Accepted	

Filename: CB217011F rev0			Note:	Sheet: 1	Cont.: -
Constr.:	Drawn BE	Accepted:		Date: 05-03-22	Rev: 0
Björn Eliasson Ingenjörsfirma AB		CBME 80 FILTER UNIT		Draw. no 217 011F	



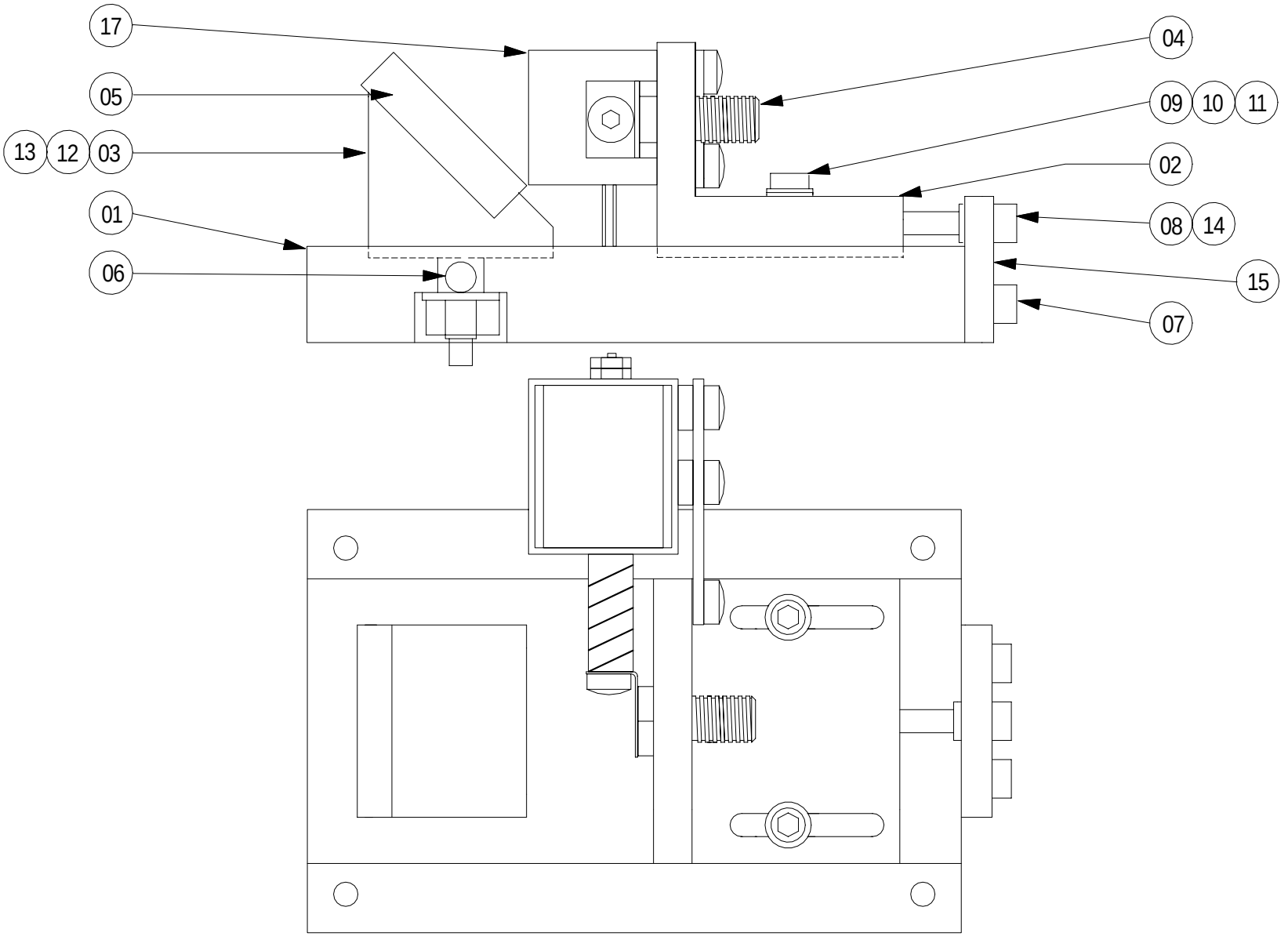
Filename: CB217043F_1 rev0			Note:	Sheet: 1	Cont.: 2
Constr.:	Drawn BE	Accepted:		Date: 05-03-22	Rev: 0
Björn Eliasson Ingenjörsfirma AB		CBME 80 HOOD, VIEW 1,2		Draw. no 217 043F	

Mod. No	Changing	Date		Accepted	



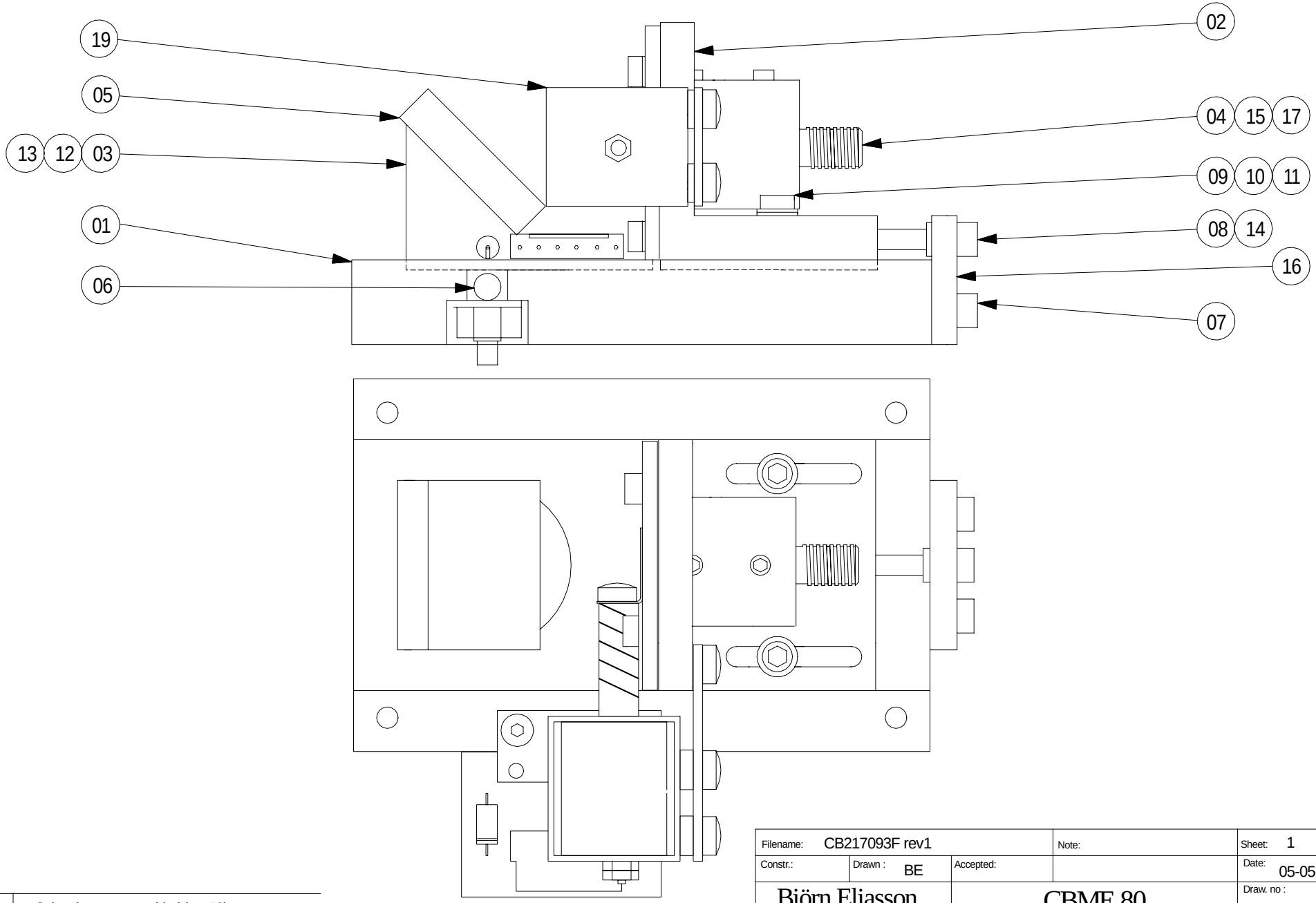
Mod. No	Changing	Date		Accepted	

Filename: CB217043F_2 rev0			Note:	Sheet: 2	Cont.: -
Constr.:	Drawn BE	Accepted:		Date: 05-03-22	Rev: 0
Björn Eliasson Ingenjörsfirma AB	CBME 80 HOOD, VIEW 3,4			Draw. no 217 043F	



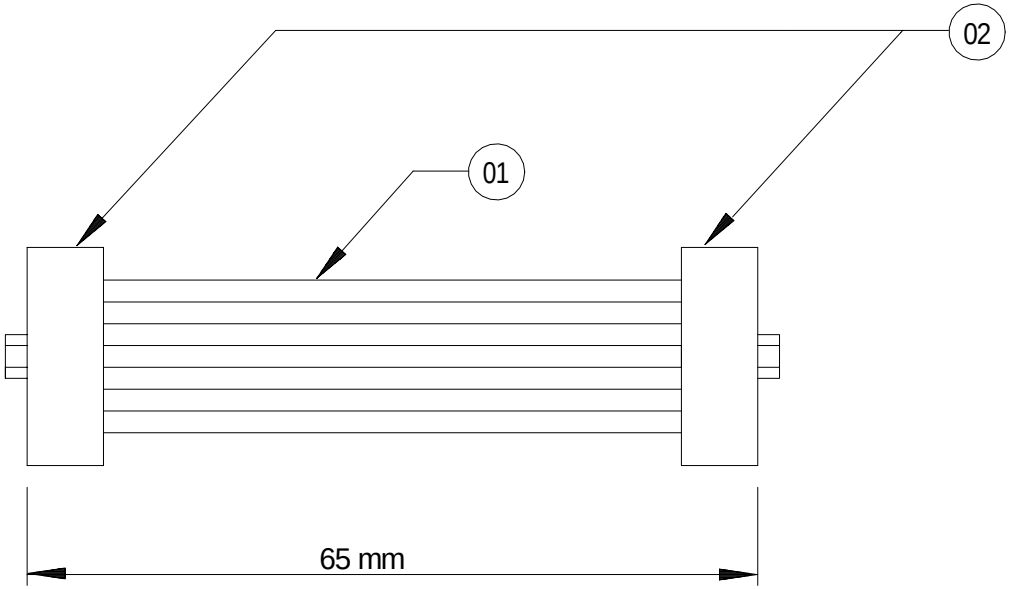
Mod. No	Changing	Date		Accepted
1	Solar shutter assy added (pos 17)	2005-05-21		BE

Filename: CB217091F rev1			Note:	Sheet: 1	Cont.: -
Constr.:	Drawn : BE	Accepted:		Date: 05-05-21	Rev: 1
Björn Eliasson Ingenjörsfirma AB	CBME 80 MIRROR UNIT TRANSMITTER			Draw. no : 217 091F	



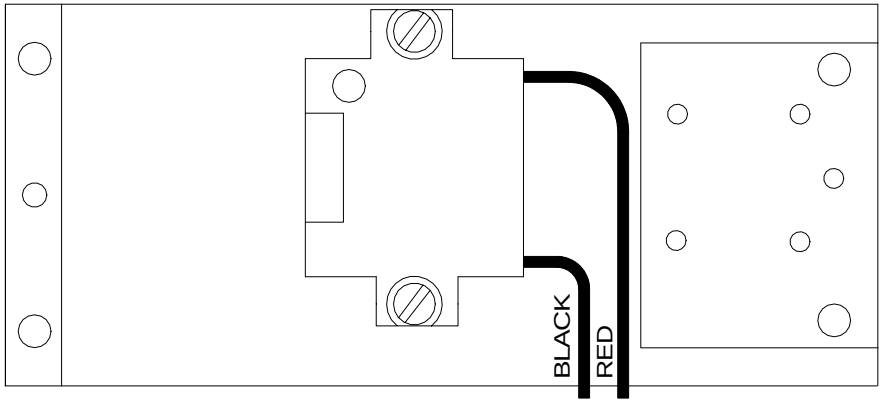
Mod. No	Change	Date		Accepted
1	Solar shutter assy added (pos19)			

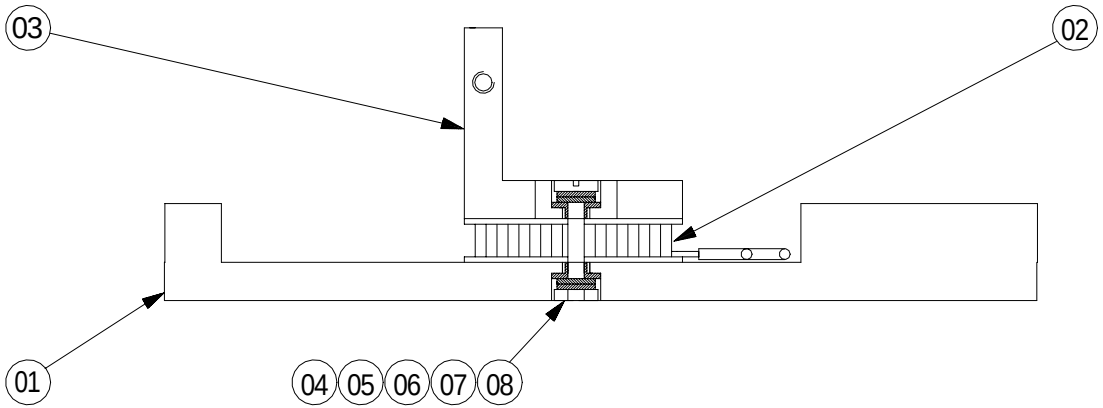
Filename: CB217093F rev1			Note:	Sheet: 1 Cont.: -
Constr.:	Drawn : BE	Accepted:		Date: 05-05-21 Rev: 1
Björn Eliasson Ingenjörsfirma AB	CBME 80 MIRROR UNIT RECEIVER			Draw. no : 217 093F



Mod. No	Changing	Date		Accepted	

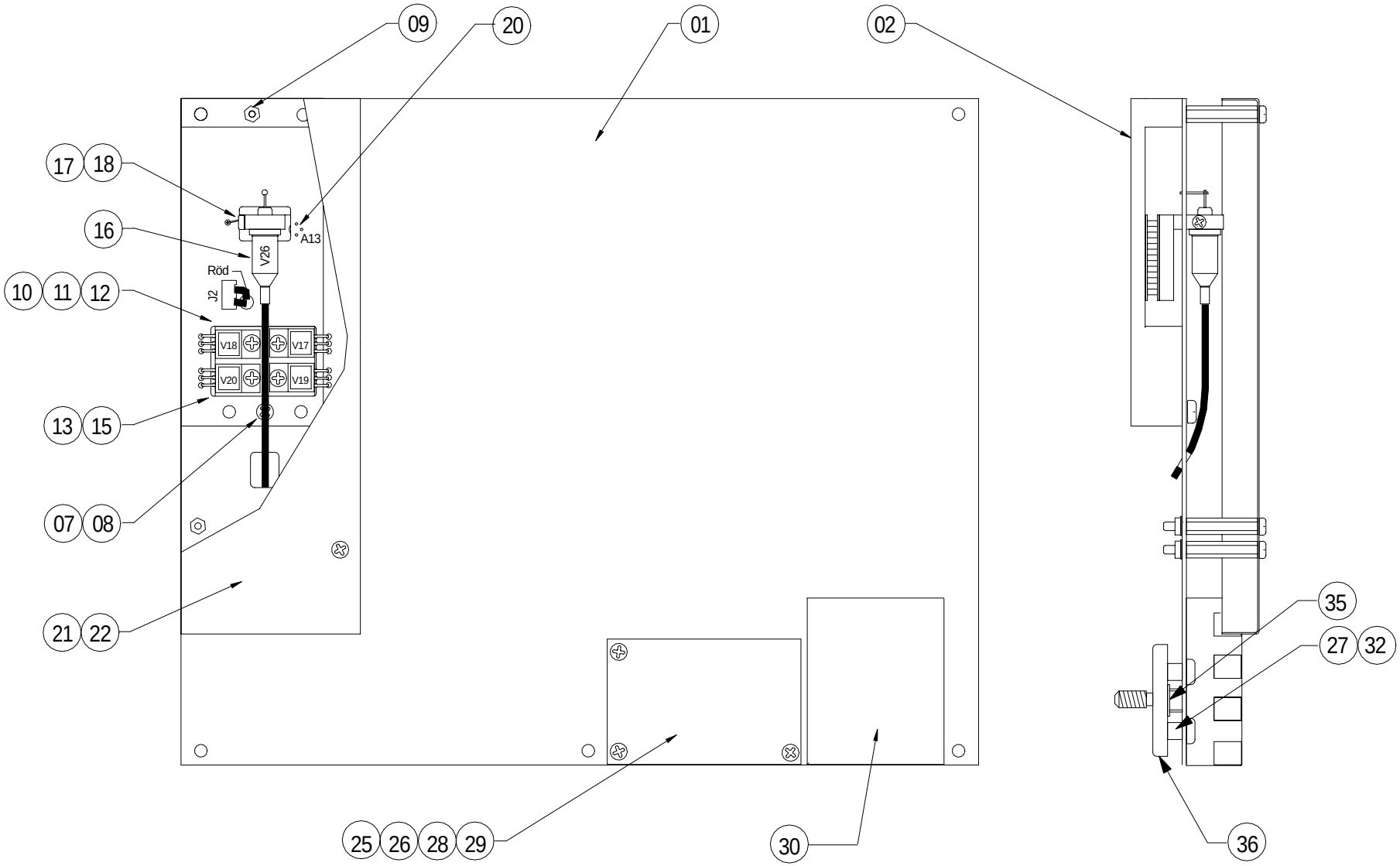
Filename: CB217115F rev0			Note:	Sheet: 1	Cont.: -
Constr.:	Drawn BE	Accepted:		Date: 05-03-22	Rev: 0
Björn Eliasson Ingenjörsfirma AB		CBME 80 RIBBON CABLE		Draw. no 217 115F	





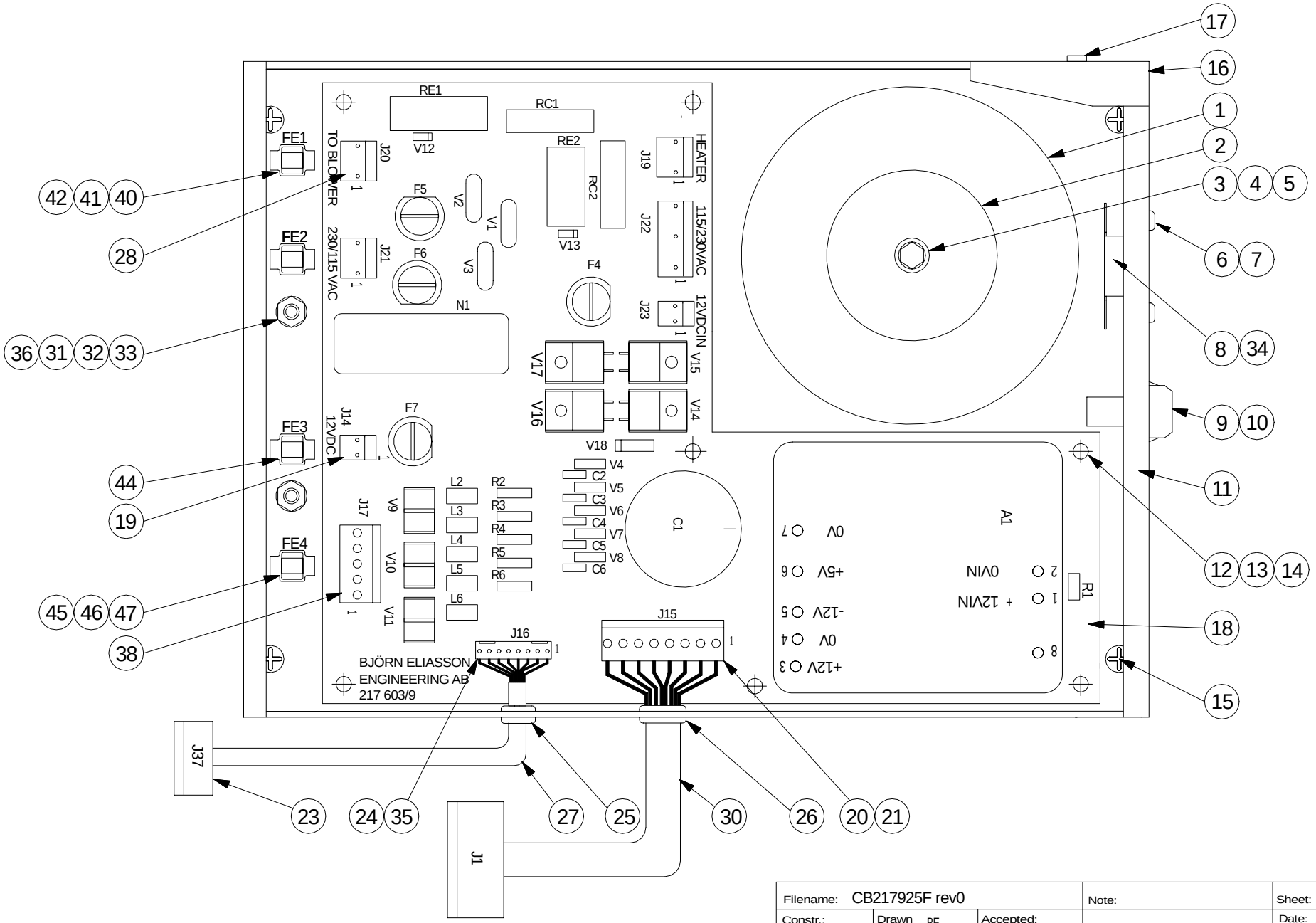
Mod. No	Changing	Date		Accepted	

Filename: CB217191F rev0			Note:	Sheet: 1 Cont.:
Constr.:	Drawn BE	Accepted:		Date: 05-03-22 Rev: 0
Björn Eliasson Ingenjörsfirma AB		CBME 80 LASER DIODE HOLDER		Draw. no 217 191F



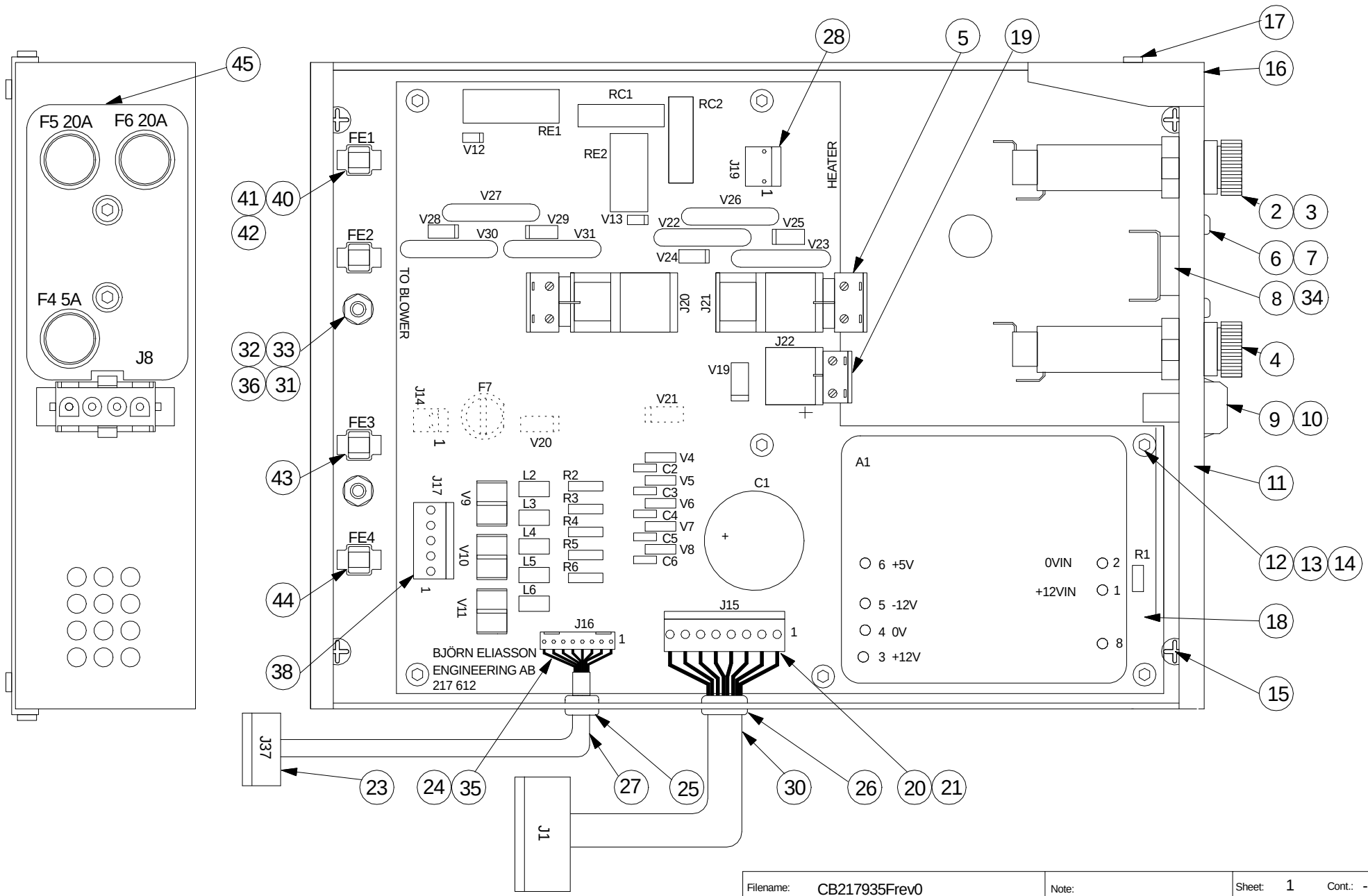
Filename: CB217291F rev0			Note:	Sheet: 1	Cont.: -
Constr.:	Drawn BE	Accepted:		Date: 05-03-22	Rev: 0
Björn Eliasson Ingenjörsfirma AB		CBME 80 MASTER UNIT		Draw. no 217 291F	

Mod. No	Changing	Date		Accepted	



Filename: CB217925F rev0			Note:	Sheet: 1	Cont.: -
Constr.:	Drawn BE	Accepted:		Date: 05-03-22	Rev: 0
Björn Eliasson Ingenjörsfirma AB		CBME 80 POWER UNIT		Draw. no 217 925F	

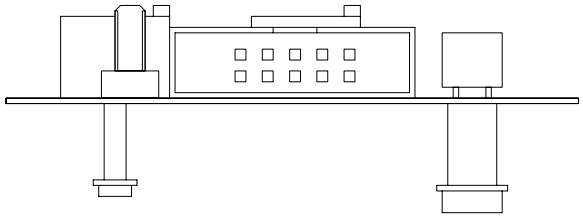
Mod. No	Changing	Date		Accepted	

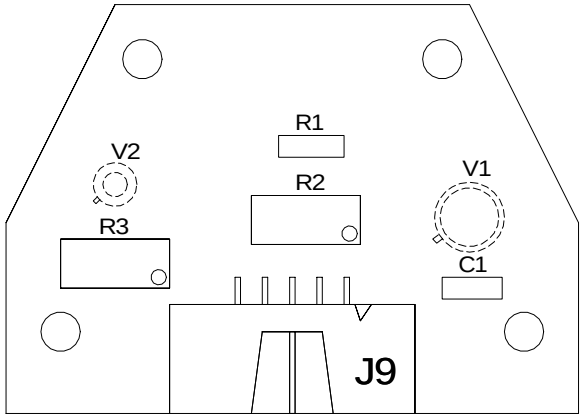


Filename: CB217935Frev0			Note:	Sheet: 1	Cont.: -
Constr.	Drawn: BE			Date: 09-01-10	Rev: 0
Björn Eliasson Ingenjörsfirma AB	CBME 80 DC POWER UNIT			Draw. no. 217 935F	

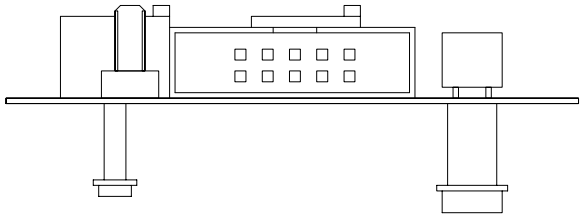
Mod. Nr	Ändring och/eller medd.-nr	Datum	Inf.	Godk.

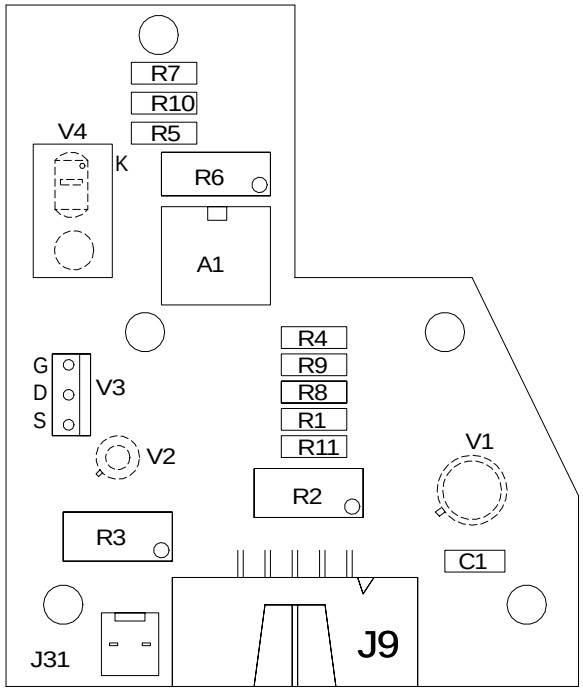
POWER SENSOR





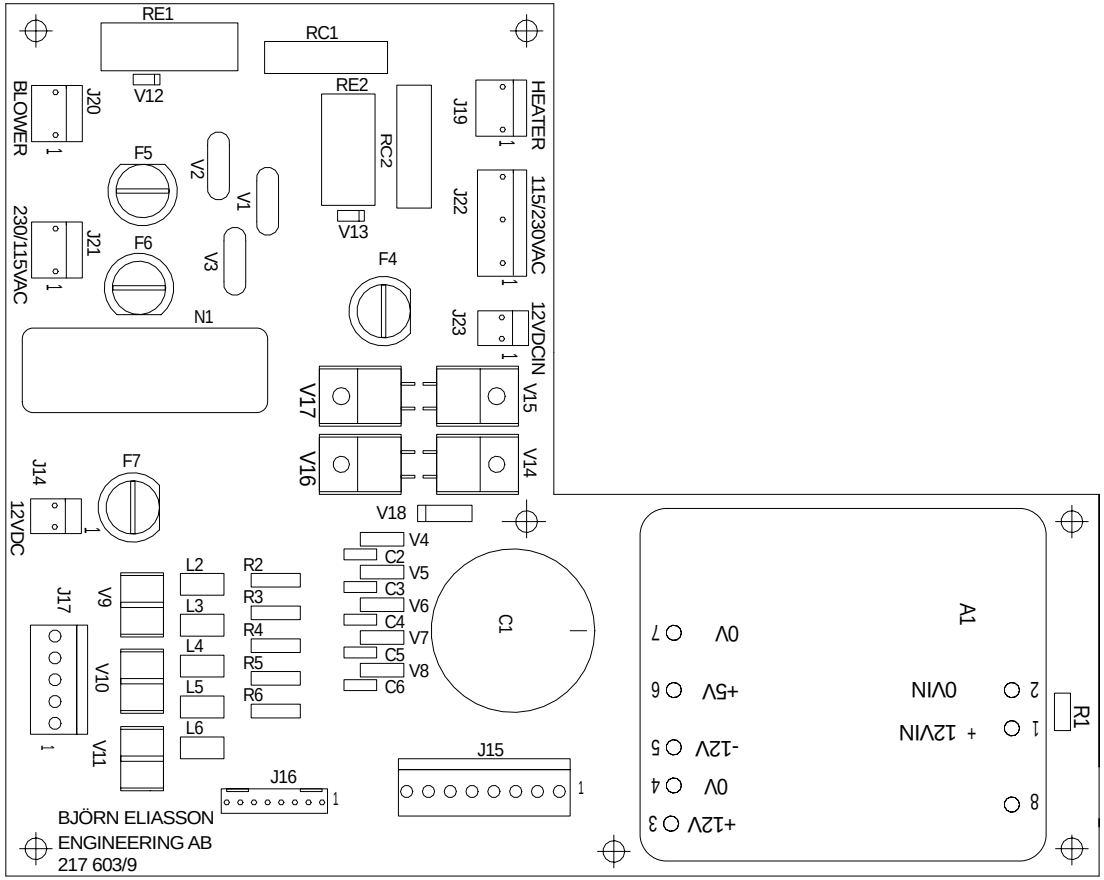
POWER SENSOR FOR SUN SHUTTER





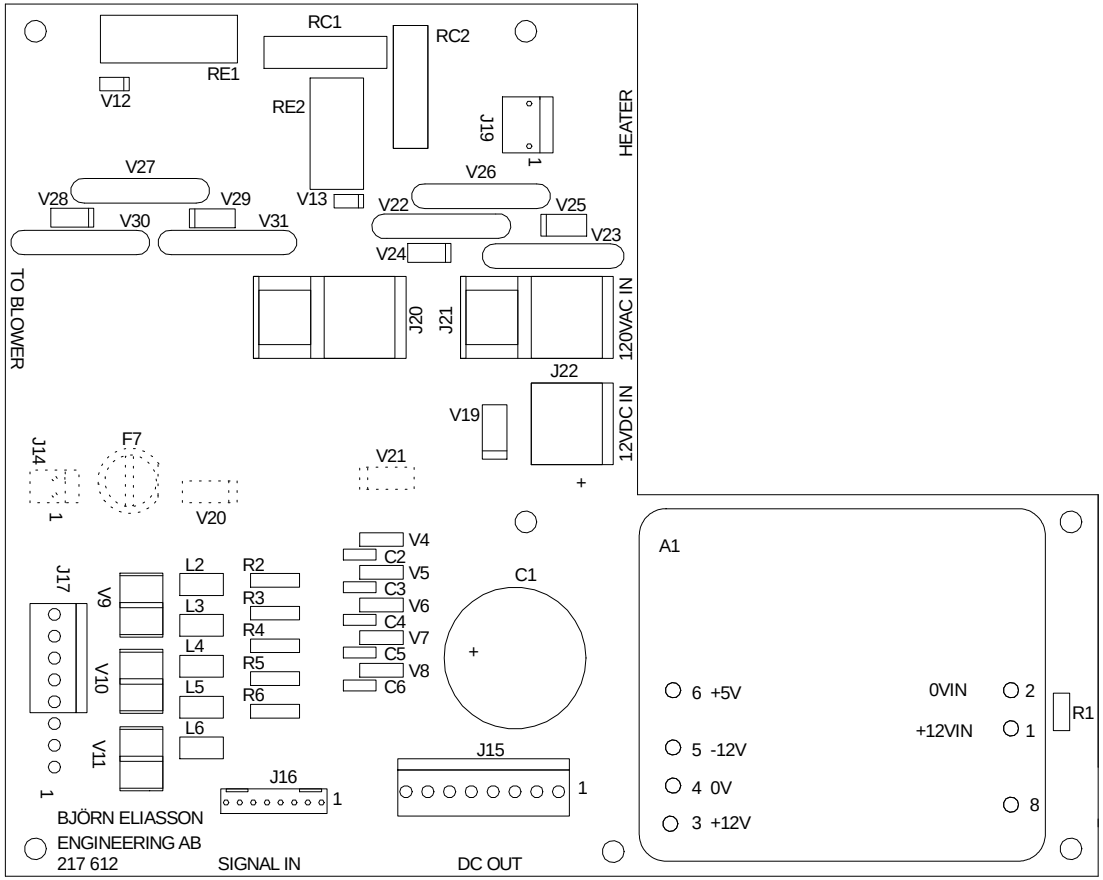
Filename: CB217111F rev0			Note:	Sheet: 1 Cont.: -
Constr.:	Drawn BE	Accepted:		Date: 05-03-22 Rev: 0
Björn Eliasson Ingenjörsfirma AB	CBME 80 POWER SENSOR			Draw. no 217 111F

Mod. No	Changing	Date		Accepted	



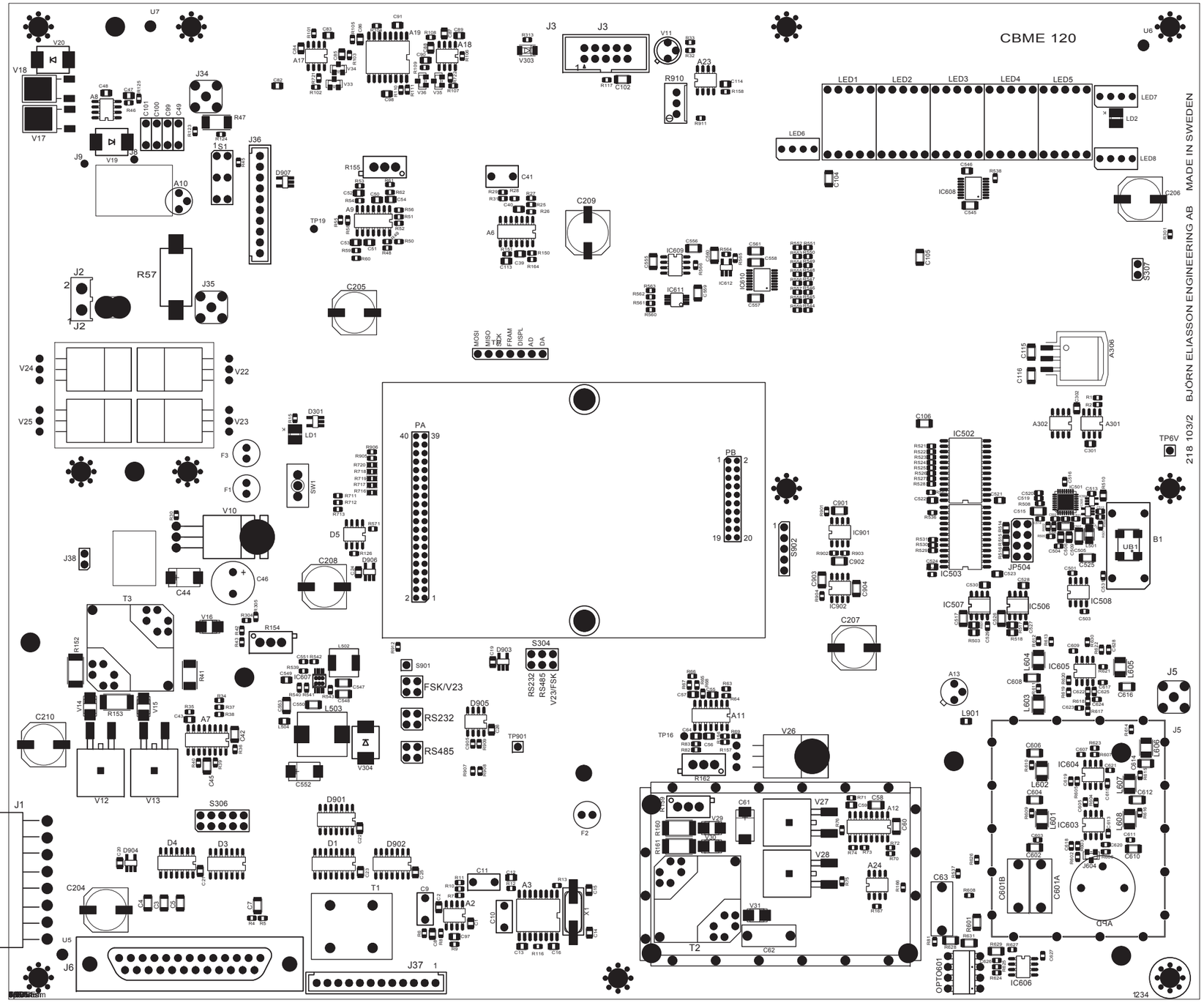
Filename: CB217621F rev0			Note:	Sheet: 1	Cont: -
Constr:	Drawn: BE	Accepted:	Scale	Date 05-03-22	Rev: 0
Björn Eliasson Ingenjörsfirma AB	CBME 80 AC-DC/CONV.			Draw. no 217 621F	

Mod. No	Changing	Date		Accepted	



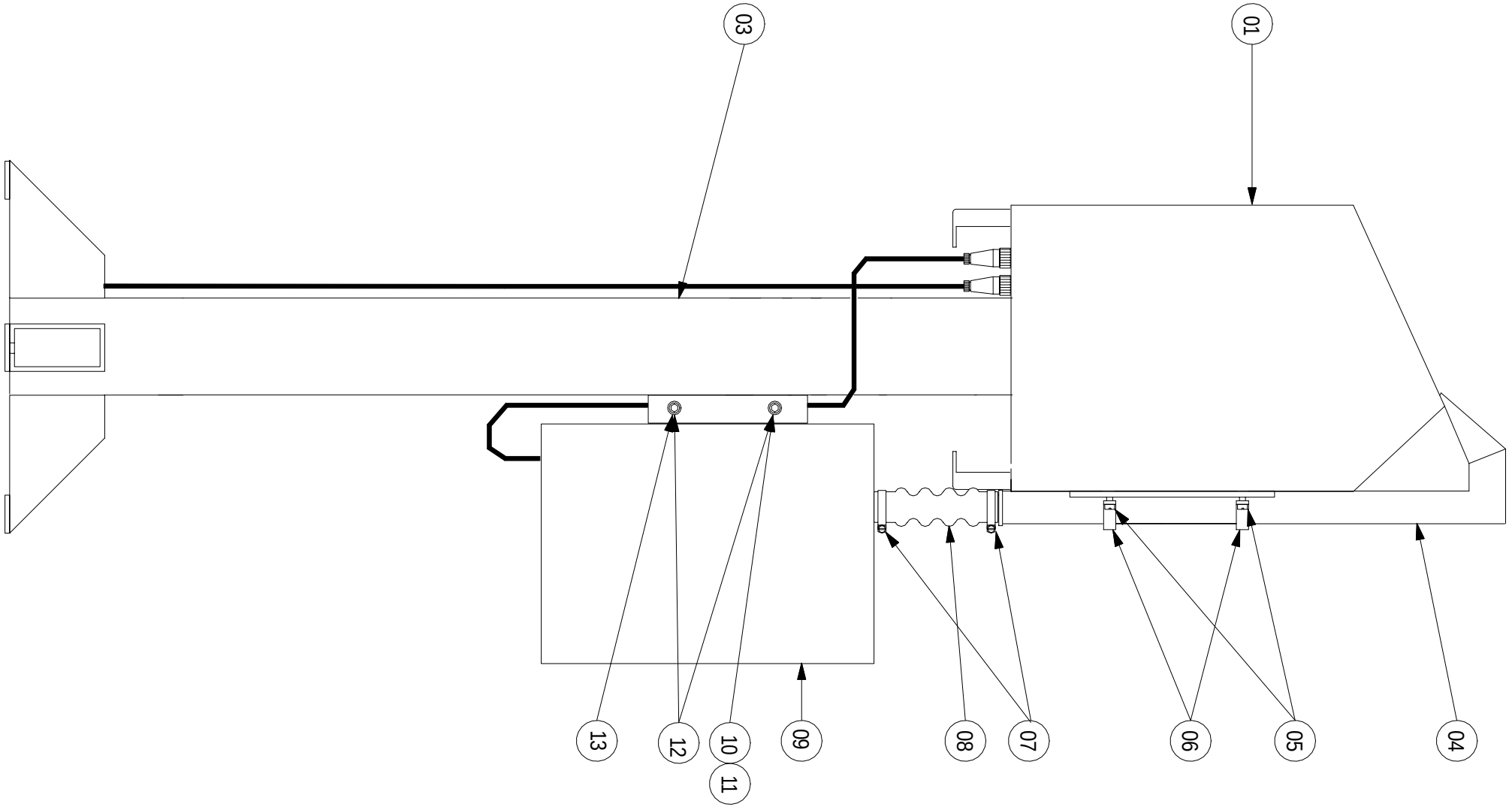
Filename: CB217651Frev0			Note:	Sheet: 1	Cont: -
Constr.	Drawn: BE	Approved:	Scale:	Date 09-01-09	Rev: 0
Björn Eliasson Ingenjörsfirma AB		CBME 80 DC/DC-CONVERTER		Draw.no.: 217 651F	

Mod. No	Changeing	Date		Accepted	



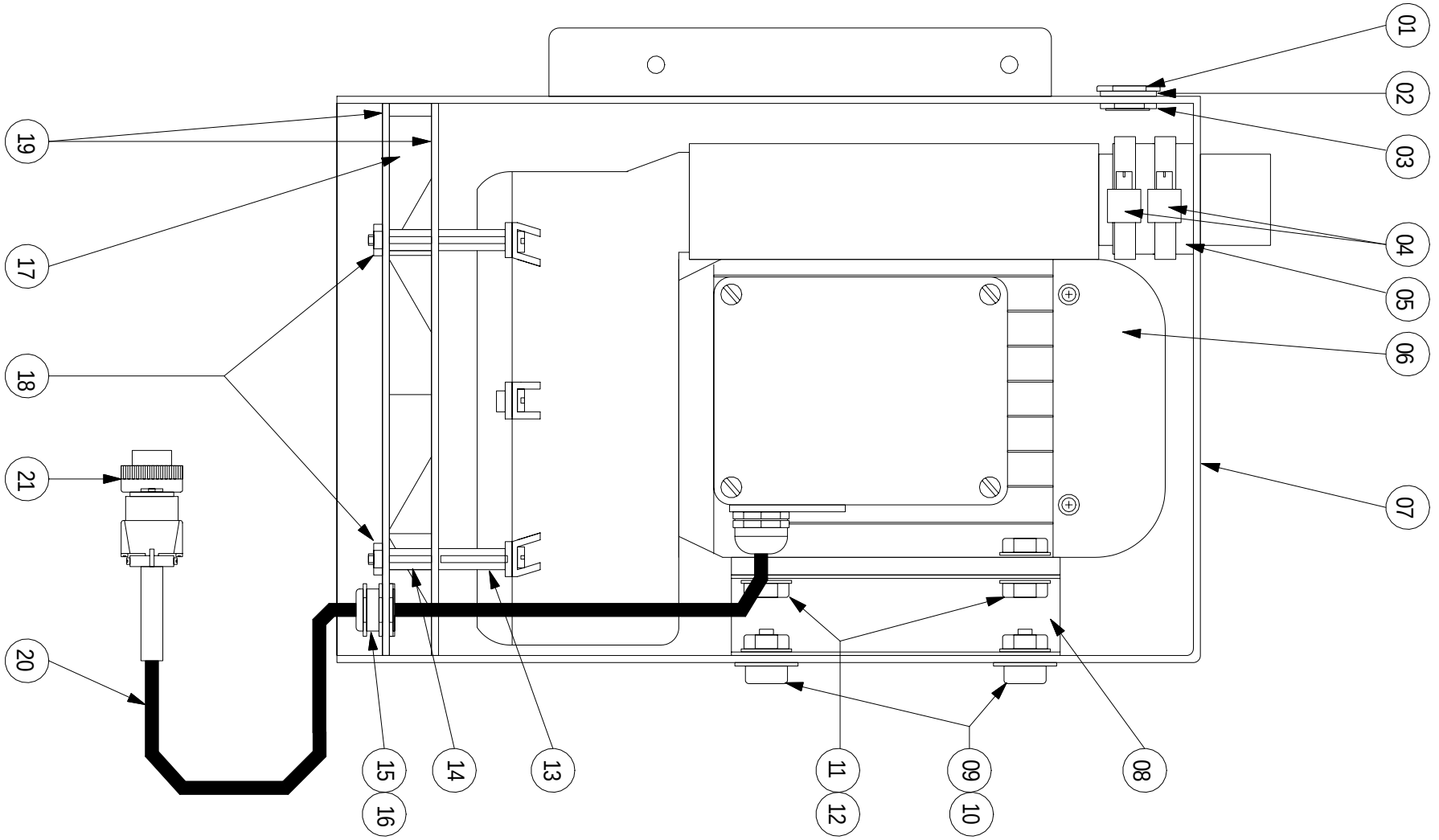
Mod. No	Changing	Date		Accepted	

Filename: 218 101 B			Note:	Sheet: 1	Cont.: -
Constr.:	Drawn *JE*	Accepted:		Date: 2012-10-11	Rev:
Björn Eliasson Ingenjörsfirma AB	CBME 80B/120 MASTER BOARD			Draw. no 218 101 B	



Filename:	CBB250006F rev0		Note:	Sheet: 1	Cont.: -
Constr.:	Drawn BE	Accepted:		Date: 05-03-22	Rev: 0
Björn Eliasson Ingenjörsfirma AB		CBME 80 BLOWER SYSTEM		Draw. no 250 006F	

Mod. No	Changing	Date		Accepted	



Filename: CBB250101F rev0			Note:	Sheet: 1	Cont.: -
Constr.:	Drawn BE	Accepted:		Date: 05-03-22	Rev: 0
Björn Eliasson Ingenjörsfirma AB		CBME 80 BLOWER UNIT		Draw. no 250 101F	

Mod. No	Changing	Date		Accepted	