■ Diagnosis and service

■ Status messages

Status messages appear in the 3rd line of the display - see example below:

Local stop (ENAB STP LOC.):
"Local" or "Local with external stop" has been selected in parameter 003. The "Local/Hand" key on the frequency converter operating panel is activated and "Stop" on the keyboard is activated, too.

VLT ready, local (UNIT RDY LOC.):
"Local" or "Local with external stop" has been selected in parameter 003. The "Local/Hand" key on the frequency converter operating panel is activated and "Coasting stop" in parameter 404; there is 0 V on terminal 27.

Local operation OK (RUN OK LOCAL):
"Local" or "Local with external stop" has been selected in parameter 003. The "Local/Hand" key on the frequency converter operating panel is activated and the frequency converter is running at the set speed reference (parameter 004).

Local ramp operation (RAMP LOCAL):
"Local" or "Local with external stop" has been selected in parameter 003. The "Local/Hand" key on the frequency converter operating panel is activated and the output frequency is varying in accordance with the set ramping times.

Stop (ENAB STOP.):
Remote Control Mode ("Remote/Auto") is active and the frequency converter has been stopped via the keyboard or the control terminals.

VLT ready (UNIT READY.):
Remote Control Mode ("Remote/Auto") is active and "Coasting stop" has been selected in parameter 404; there is 0 V on terminal 27.

Operation OK (RUN OK.):
Remote Control Mode ("Remote/Auto") is active and the frequency converter is running at the speed reference.

Jogging (JOGGING.):
Remote Control Mode ("Remote/Auto") is active and "Jogging" has been selected in parameter 405; at the same time there is 24 V on terminal 29.

Ramping (RAMPING):
Remote Control Mode ("Remote/Auto") is active and the output frequency is varying with the set ramping times.

Freeze reference (FREEEZE.):
Remote Control Mode ("Remote/Auto") is active and freeze reference has been selected in parameter 400, 401 or 405; at the same time, the respective input (16, 17 or 29) is active.

Off 2 (OFF 2):
Bit 01 of the control word is "0".

Off 3 (OFF 3):
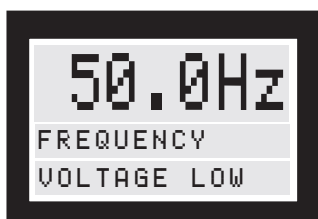Bit 02 of the control word is "0".

Start disabled (START INHIB.):
Bit 06 of the status word is "1".

Reference locked (HOLD.):
Bit 05 of the control word is "0".

■ Warnings

Warnings appear in line 3 of the display - see example below:

```
50.0Hz
FREQUENCY
VOLTAGE LOW
```

Voltage warning, low (VOLTAGE LOW):
The intermediate circuit voltage (DC) is below the warning limit of the control card, see table page 77. The inverter is still active.

Voltage warning, high (VOLTAGE HIGH):
The intermediate circuit voltage (DC) is above the warning limit of the control card, see table page 77. The inverter is still active.

Undervoltage (UNDER VOLTAGE):
The intermediate circuit voltage is below the undervoltage limit of the inverter, see table page 77. The inverter has stopped and a trip will occur when the delay time selected in parameter 311 has passed.

Overvoltage (OVER VOLTAGE):
The intermediate circuit voltage is above the overvoltage limit of the inverter, see table page 77. The inverter has stopped and a trip will occur when the delay time selected in parameter 311 has passed.

Current limit (CURRENT LIMIT):
The motor current is higher than the value stated in parameter 209.

Overcurrent (OVER CURRENT):
The peak current limit of the inverter (approx. 250% of the rated current) has been exceeded; after 7-11 secs. a trip will occur.

Reference fault (REF FAULT):
There is a fault on an analogue input signal (terminal 53 or 60), when a signal type with "live zero" has been chosen (4-20 mA, 1-5 V or 2-10 V). The warning is activated when the signal level is less than half the zero level (4 mA, 1 V or 2 V).

No motor (NO MOTOR):
The motor check function (par. 313) detects that a motor has not been connected to the frequency converter output.

Frequency warning, low (LO FREQ WARN):
The output frequency is lower than the value selected in parameter 210.

Frequency warning, high (HI FREQ WARN):
The output frequency is higher than the value selected in parameter 211.

Current warning, low (LO CURR WARN):
The output current is lower than the value selected in parameter 212.

Current warning, high (HI CURR WARN):
The output current is higher than the value selected in parameter 213.

Motor overloaded (MOTOR TIME):
According to the electronic thermal motor protection, the motor is too hot. This warning only comes up if "warning" has been selected in parameter 315.

Inverter overloaded (INVERT TIME):
According to the electronic inverter protection, the frequency converter is close to tripping because of overload (too high current for too long a time). The counter for electronic inverter protection has readed98% (100% results in a trip).

24 V fault (NO 24 VOLT):
The 24 V voltage supply from the power unit to the control card is not present.

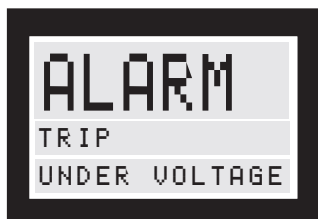**EEPROM fault** (EEPROM ERROR):
EEPROM fault. Data changes are not saved when the mains supply is cut out.

Lost motor (STALLING):

■ **Reset messages**

Reset messages appear in the 2nd line of the display and alarm messages appear in the 3rd line of the display - see the example below:

Automatic restart (RESTART):
When "automatic reset" has been selected as the reset function, the message indicates that VLT 3500 HVAC is trying to restart automatically after having tripped. The time delay before the restart depends on parameter 312.

Trip (TRIP):
VLT 3500 HVAC has tripped and manual reseting is required. Manual resetting can be carried out by means of the reset key on the keyboard, a digal input (terminal 16, 17 or 27) or bit 07 of the control word (RS 485).

Trip locked (TRIP LOCKED):
VLT 3500 HVAC has tripped and resetting is only possible if the mains supply is cut out. Having cut the mains supply back in, manual resetting is required.

■ **Alarm messages**

Undervoltage (UNDER VOLTAGE):
Error code 3
The intermediate circuit voltage is below the undervoltage limit of the inverter.

Overvoltage (OVER VOLTAGE):
Error code 2
The intermediate circuit voltage is above the overvoltage limit of the inverter.

Current limit (CURRENT LIMIT):
Error code 9
The motor current has exceeded the value of parameter 209 for a longer time than that permitted in parameter 310.

Overcurrent (OVER CURRENT):
Error code 4
The peak current limit of the inverter (approx. 250% of the rated current) has been exceeded for more than 7-11 secs. (Trip locked).

Ground fault (GROUND FAULT):
Error code 5
There is a discharge from the output phases to ground, either in the cable between the frequency converter and the motor, or from inside the motor. (Trip locked).

Overtemperature (OVER TEMP):
Error code 6
An excessive temperature has been measured internally in VLT 3500 HVAC. A cooling-down period is required before resetting is possible. (Trip locked).

Inverter overloaded (OVERLOAD):
Error code 7
The electronic thermal inverter protection reports that VLT 3500 HVAC has tripped because of overload (too high current for too long). The counter for electronic thermal inverter protection has reached 100%.

Motor overloaded (MOTOR TRIP):
Error codes 8 and 15
According to the electronic thermal motor protection, the motor is too hot. The alarm only comes up if "trip" has been selected in parameter 315. See also parameter 400.

Inverter fault (INVERT FAULT):
Error code 1
There is a fault in the power side of VLT 3500 HVAC. Please contact DANFOSS.

Voltage limits:

VLT 3500 range	3x200/230 V [VDC]	3x380/415 V [VDC]	3x440/500 V [VDC]	VLT 3575-3800 [VDC]
Undervoltage	210	400	460	470
Voltage warning, low	235	440	510	480
Voltage warning, high	370	665	800	790
Overvoltage	410	730	880	850

The voltage is the intermediate circuit voltage of the frequency converter. The corresponding mains voltage is the intermediate circuit voltage divided by √2.

4.4 Fault messages

■ Fault messages

- If an inactive key is pressed:
  KEY DISABLED
  This indicates that either factory setting has been selected (parmeter 001).
  Parameter 001 must be changed to set-up 1-4.
  Or the key in question has been blocked (parameters 006-009).
- If an attempt is made to change data that can only be changed when the frequency converter has stopped: **ONLY IN STOP.**
- If an attempt is made to change data with an open LOCK switch: **LOCK OPEN.**
- If an attempt is made to change data outside the permissible range: **LIMIT.**

■ Start-up test:
VLT 3500 HVAC carries out a self-test of the control card when the mains supply is cut in. The following message may appear:

The reason for this fault message is a fault on the control card or an option card, if used. Contact DANFOSS.

Warning:

Touching the electrical parts may be fatal - even after the equipment has been disconnected from mains.

Using VLT 3502-3562 HVAC: wait 4 minutes

Using VLT 3542-3562 (230 V) HVAC: wait 14 minutes

Using VLT 3575-3800 HVAC: wait 14 minutes

■ **Fault messages**

Inverter fault
The power section of VLT 3500 HVAC is defective.

Overvoltage
The voltage of the intermediate circuit (DC voltage) is too high. Possible reasons: mains voltage too high, transients on the mains voltage, or regenerative motor operation.

Note: When VLT 3500 HVAC stops via ramps, energy from the motor is returned to the frequency converter (regenerative operation), which charges the intermediate circuit.
• If the fault message is given when the speed is ramped down, the ramp-down time can be increased.

If the fault message arises in other situations, the problem is probably in the mains supply.

Undervoltage
The voltage of the intermediate circuit of the frequency converter (DC current) is too low. Possible reasons: Mains voltage too low or a fault on the charging circuit/rectifier of the frequency converter.
• Check whether the mains voltage is in order.

Overcurrent
The upper limit of the rectifier peak current is reached, possibly because of a short-circuiting of the frequency converter output.
• Check that there is no short-circuiting at the motor or in the motor cable.

Ground fault
A ground fault on VLT 3500 HVAC's output. Another possibility is that the motor cable is too long.
• Check under technical data to find out how long the cable must be. Check whether motor and motor cable have been grounded correctly.

Critical temperature
The temperature inside VLT 3500 HVAC is too high. Possible causes: Ambient temperature too high (max. 40/45°C), the heat sink ribs of the frequency converter have been covered, or the fan is out of order.
• Reduce the ambient temperature by increasing the amount of ventilation. Clear/clean the heat sinks. Replace the fan if faulty.

Overload
The electronic VLT 3500 HVAC protection is active. This means that the motor has consumed more than 110% of the rated current of the frequency converter for too long.
• Reduce the motor load. If this is not possible, the application may require a larger frequency converter.

Motor trip
The electronic motor protection is active. This means that the current consumed by the motor at low speed has been too high for too long.
• The motor has been loaded excessively at low speed. If the load cannot be changed, the motor has to be replaced by a bigger version, or extra cooling must be provided for the existing motor. Subsequently, the electronic motor protection can be de-activated in parameter 315.

NB!:
Electrostatic discharges
Important! Many electronic components are sensitive to static electricity. Even voltages so low that they cannot be felt, seen or heard, may impair components or damage them completely.

Discharge of static electricity can have the following unpleasant consequence: the service life of components is reduced.

Section 4

■ **Earth leakage current**

Earth leakage current is primarily caused by the capacitance between the conductor and the motor cable screen. When an RFI filter is used, this contributes additional leakage current, as the filter circuit is connected to earth through capacitors.

The size of the leakage current to the ground depends on the following factors:
- Length of motor cable
- Switching frequency
- RFI filter used or not
- Motor grounded on site or not
- Motor cable w/ or w/o screen

The leakage current is of importance regarding safety during handling/operation of the frequency converter if an earth connection has not been established.

NB!:
Never operate the frequency converter without an effective earth connection complying with local regulations for high leakage current (>3.5 mA). Never use HFI relays. That is not allowed because of the rectifier load.

If FI relays are used, they must be
- Suitable for protecting equipment with direct current in the discharge current (3-phase bridge rectifier)
- Suitable for power-up with pulsing, short discharge
- Suitable for a high discharge current

■ **Extreme running conditions**

Short circuit

VLT 3500 HVAC is protected against short circuit by means of current measurement in each of the three motor phases. A short circuit between two output phases will cause an overcurrent in the inverter. However, each transistor of the inverter will be turned off individually when the short circuit current exceeds the permitted value.

After 5-10 seconds the driver card turns off the inverter and the frequency converter will display a fault code.

Earth fault

In case of an earth fault in a motor phase, the inverter is turned off within 5-10 ms.

Switching on the output

Switching on the output between the motor and the frequency converter is fully permitted. It is not possible to damage VLT 3500 HVAC in any way by switching on the output. However, fault messages may appear.

Motor-generated overvoltage

The voltage in the intermediate circuit is increased when the motor acts as a generator. This occurs in two cases:
1. The load drives the motor (at constant output frequency from the frequency converter), i.e. the load generates energy.
2. During deceleration ("ramp-down") if the moment of inertia is high, the load is low and/or the ramp-down time is short.

The control unit attempts to correct the ramp if possible.
The inverter turns off to protect the transistors and the intermediate circuit capacitors when a certain voltage level is reached.

Mains drop-out

During a mains drop-out, VLT 3500 HVAC continues until the intermediate circuit voltage drops below the minimum stop level, which is typically 15% below VLT 3500 HVAC's lowest rated supply voltage.

The time before the inverter stops depends on the mains voltage before the drop-out and on the motor load. Ride-through and/or flying start can be programmed.

Static overload

When VLT 3500 HVAC is overloaded (the current limit I_{LIM} is reached), the controls will reduce the output frequency in an attempt to reduce the load. If the reduction of the output frequency does not reduce the load, a trip is activated when the output frequency has fallen below 0.5 Hz.

Operation in the current limit can be limited in time (0-60 s) by adjusting parameter 310.

■ du/dt and peak voltage on motor

When a transistor in the inverter is activated, the voltage applied to the motor will rise by the du/dt ratio determined by
- the motor cable (type, cross-section, length, screened/unscreened)
- inductors

The self-inductance will cause an overshoot U_{PEAK} for the motor voltage before it stabilizes at a level determined by the voltage in the intermediate circuit. Both the du/dt ratio and the peak voltage U_{PEAK} influence the lifetime of the motor. Too high values will primarily affect motors without phase coil insulation. If the motor cable is short (a few metres), the du/dt ratio will be quite high, but the peak voltage quite low. If the motor cable is long (100 m), du/dt will decrease and U_{PEAK} will increase.
To ensure a long service life of the motor, VLT 3500 HVAC features as standard built-in motor coils which ensure a low value for the du/dt ratio, even with very short motor cables.

If very small motors are used without phase coil insulation, it is recommended to mount a clamp filter or an LC filter after the frequency converter.
Clamp filter, ordering no. 175H5147 (fits all units in VLT type 3502-3562).
Typical values for the du/dt ratio and the peak voltage U_{PEAK} measured on the terminals of the frequency converter between two phases (30 m screened motor cable).

VLT type 3502 - 3562:
- **du/dt** ~ 200 - 300 V/µs
- U_{PEAK}~ 800 - 1100 V

VLT type 3575 - 3800:
- **du/dt** ~ 2000 - 2100 V/µs
- U_{PEAK}~ 900 - 950 V measured with a 20 m unscreened cable

• Derating for ambient temperature

The ambient temperature ($T_{AMB,MAX}$) is the maximum temperature allowed. The average ($T_{AMB,AVG}$) measured over 24 hours must be at least 5°C lower in accordance with VDE 160 5.2.1.1.
If VLT 3500 HVAC is operated at temperatures above 40 °C, a derating of the continuous output current is necessary.

• Derating for air pressure
Below 1000 m altitude no derating is necessary.

Above 1000 m the ambient temperature (T_{AMB}) or max. output current ($I_{VLT,MAX}$) must be derated :
1) Derating of output current versus altitude at T_{AMB} = max. 40°C
2) Derating of max. t_{AMB} versus altitude at 100% output current.

• Derating for running at low speed

When a centrifugal pump or a fan is controlled by a VLT 3500 HVAC frequency converter, it is not necessary to reduce the output current at low speed because of the load type characteristic of the centrifugal pumps/fans.

• Derating for installing long motor cables or cables with larger cross-section

VLT 3502-3800 HVAC has been tested using 300 m unscreened cable and 150 m screened cable (for 3502-3505 this only applies to f_{SWITCH} ≤ 4.5 kHz. For f_{SWITCH} > 4.5 kHz, max. is 40 m).

VLT 3500 HVAC has been designed to work using a motor cable with a rated cross-section. If a cable with a larger cross-section is to be used, it is recommended to reduce the output current by 5% for every step the cross-section is increased.
(Increased cable cross-section leads to increased capacitance to earth, and thus an increased earth leakage current).

• Derating for high switching frequency

This only applies to VLT 3502-62, since the max. switching frequency is 4.5 kHz in VLT 3575-3800. Higher switching frequencies (par. 224) lead to greater losses and greater heat formation in the transistors and motor coils of the frequency converter. Consequently, the frequency converter automatically derates the maximum permitted constant output current $I_{VLT,N}$ whenever the switching frequency exceeds 4.5 kHz. The reduction is carried out as a linear reduction down to 60% at 14 kHz .
If the ASFM function (Adjustable Switching Frequency Modulation) is applied (parameter 225) it is not necessary to derate, since the variable torque characteristic provides automatic derating.

Section 4