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1. Supplement to Manual Set

1.1. Introduction

The information in the enclosed manual set applies, with the addition of this supplementary information.

Refer to the download area at www.danfoss.com/solar for the newest manuals.

2. Grid Codes

2.1. Grid Codes

Select grid codes as follows:

Germany
New installations:

- "Germany_MV" = for installations on the medium-voltage grid (medium-voltage guideline).
- "Germany_LV1" = for installations up to and including 13.8 kVA connected to the low-voltage grid (AR-N 4105).
- "Germany_LV2" = for installations above 13.8 kVA connected to the low-voltage grid (AR-N 4105).
- "Germany_LV3" = for installations connected to the low-voltage grid (AR-N4105) with pre-configured Power factor = 1

Existing installations:

- "VDE_0126_1_1_A1" = Exchange units in installations where "Germany" is the selected grid code.

Italy

- "Italy" = for installations connected to the low-voltage grid without a transformer.
- "Italy-plant" = for installations connected to the low-voltage grid or medium-voltage grid with a transformer.
- "Italy 6 kW" = for installations up to 6 kW connected to the low-voltage grid without an external disconnection device (SPI).

Denmark
New installations:

- "Denmark_LV1" = for installations up to and including 11 kVA connected to the low-voltage grid (TF 3.2.1 / AR-N 4105).
- "Denmark_LV2" = for installations above 11 kVA connected to the low-voltage grid (TF 3.2.1 / AR-N 4105).
- "Denmark_LV3" = for installations connected to the low-voltage grid (AR-N 4105) with preconfigured Power factor = 1
- "EN 50438-DK" = for installations with TLX / TLX Pro (TF 3.2.1 / EN 50438-DK)

Existing installations:

- "EN 50438-DK" = Exchange units in installations (before 01.01.2012) where "Denmark" is the selected grid code or for TLX / TLX Pro (TF 3.2.1 / EN 50438-DK).

2.2. Reactive Power

Standard reactive power settings are configured with the grid code. Changes to a standard grid code will generate the grid code 'custom'.

PF(P)
The inverter will generate a variable level of reactive power depending on the output power. The relationship between reactive power and active power is entered as a setpoint curve. The setpoint curve can consist of up to 9 points with the reactive power in the range from: 0.8 under-excited to 0.8 over-excited.

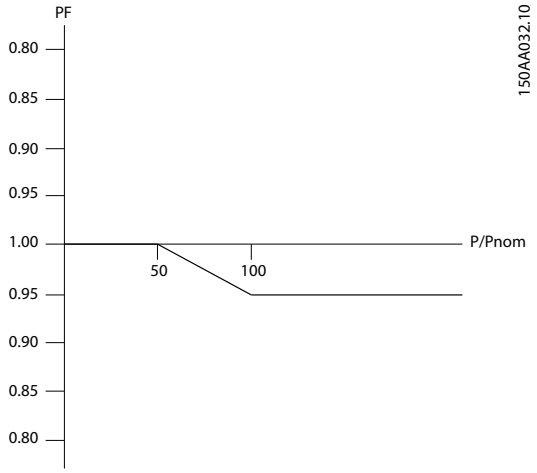

Illustration 2.1: Example of Default Setpoint Curve for Germany LV: Installations less than or equal to 13.8 kVA

For some grid codes, the setpoint curve behaviour is only activated over a certain grid voltage level.

Italy
To ensure that sufficient current is always available to supply the required reactive power, the inverter must allocate spare capacity. In these cases, the inverter active power output is limited to: [name plate rating] x [cos(φ) required]
Example: 6 kVA x 0.9 = 5.4 kW (see AC power rating table)

To override this value, set reactive power settings via the web interface, at
Plant level: [Setup → Grid Management]

To remove this allocation of spare capacity, disable reactive power.

3. Functionality Supporting EEG2012 (Germany)

3.1. Introduction

For installation in Germany, for inverters of any rating, follow this instruction carefully.

This inverter complies with the requirements of Erneuerbare-Energien-Gesetz (EEG2012). The EEG2012 redefines how PV installations are designed in terms of output power and grid connection:

- The requirement for remote-controlled power reduction (known as Power Level Adjustment) is extended from installations exceeding 100 kW capacity only, to apply to all installations.
- Alternatively for installations of capacity up to and including 30kWp, a 70% rule can be applied.

3.2. Configuration of Power Level Adjustment

Power level adjustment (PLA) is an existing feature in the inverter which is now used for smaller installations. For further information about PLA, refer to the Reference Manual and the Web Server User Manual.

3.3. Configuration of 70% Rule

The EEG2012 states that the power at the point of common coupling (PCC) must be limited to transfer of max. 70% of installed nominal PV module power [kWp]. This limit is referred to as "70% of installed PV power". Thus it is possible to take self-consumed power into account. It is important that the self-consumption can be guaranteed. This means that the real value of self-consumption must under no circumstances fall below the value used in the calculation.

Limit the power at PCC to 70% of the installed nominal PV module power [kWp]

Note: ✍
When an incorrect value of "70% of installed PV power" is entered, serious consequences can result. In the event that the 70% limit is exceeded, the DNO can demand disconnection of the installation from grid.

3.3.1. Example of Calculation

This is an example of how to calculate "Absolute value", used in the section *How to Configure a Limit for the Output Power*.
Data:

- 12 kWp installed power
- Inverter rating 10 kW
- 1 kW guaranteed self-consumption

Calculation of ”70% of installed PV power”:

- Absolute value
  = (Installed peak PV power x 0.7)[kW] + Self-consumption [kW]
  = (12 kWp x 0.7 kW/kWp) + 1 kW
  = 8.75 kW+1 kW
  = 9.75 kW
  = 9750 W
- The entry for "Absolute value" is 9750.

3.3.2. How to Configure a Limit for the Output Power (Inverter Level)

Note: ✍
Access at security level 1 or higher is required, in order to configure PLA and output power limits.

Configuration via display interface:

1. In the inverter display, go to [Setup → Grid management → Output power]
2. Follow the steps in the section *Configuration via Display Interface (Inverter Level)*.
3. To replicate to the other inverters in the network, go to [Setup → Service → Replicate].

Configuration via the web server or service interface (TLX Pro and TLX Pro+ only):

1. Go to [Inverter → Setup → Grid management → Output power]
2. Follow the steps in the section *Configuration via the Web Server or Service Interface (Inverter Level)*.
3. To replicate to the other inverters in the network, go to [Inverter → Setup → Service → Replicate]

3.3.3. Configuration via Display Interface (Inverter Level)

There are four methods to limit the output power of the inverter:

1. Limit output power by external input (default setting).
2. Absolute value [W].
3. Percentage based on total installed PV power *(peak PV power connected to the inverter).
4. Percentage based on nominal AC output power **(kW – nominal AC output power of the inverter).

To set an absolute value:

1. In the inverter display, go to [Setup → Grid management → Output power → Lim type].
2. Choose "Absolute value".
3. Choose "Output power limit" and enter the applicable output limit of the inverter (for example 7000 W).
4. Click "Save".

The inverter output power will now be limited to an absolute value. For example: 7 kW.

To set a percentage based on total installed PV power:

1. In the inverter display, go to [Setup → Grid management → Output power → Lim type].
2. Choose "Pct based on PV" .
3. Choose "Output power limit" and enter the applicable output limit of the inverter (for example 70%).
4. Click "Save".

The inverter output power will now be limited to a percentage value of the total installed PV power.
For example: When the installed power is 18 kWp, and the output power of the inverter is limited to 70%, then output power = 18x0.7 = 12.6 kW.

To set a percentage based on nominal AC output power:

1. In the inverter display, go to [Setup → Grid management → Output power → Lim type].
2. Choose "Pct based on ACP" in the Lim. Type menu.
3. Choose "Output power limit" and enter the applicable output limit of the inverter (for example 70%).
4. Click "Save".

The inverter output power will now be limited to a percentage of the nominal AC output power.

For example:
For a 12.5 kW inverter when the output power is limited to 70%, then output power = 12.5x0.7 = 8.75 kW.

3.3.4. Configuration via Web Server or Service Interface (Inverter Level)

There are four methods to limit the output power of the inverter:

1. Limit output power by external input (default setting).
2. Absolute value [W].
3. Percentage based on total installed PV power (peak PV power connected to the inverter).
4. Percentage based on nominal AC output power (kW – nominal AC output power of the inverter).

To set an absolute value:

1. Go to [Inverter → Setup → Grid management → Output power].
2. Click on "Absolute value".
3. Type the applicable output limit of the inverter (for example 7000 W).
4. Click "Save".

The inverter output power will now be limited to an absolute value. For example: 7 kW.

To set a percentage based on total installed PV power:

1. Go to [Inverter → Setup → Grid management → Output power].
2. Click on "Percentage based on total installed PV power".

3. Type the applicable output limit of the inverter (for example 70%).
4. Click "Save".

For example:
When the installed power is 18 kWp, and the output power of the inverter is limited to 70%, then output power = 18 x 0.7 = 12.6 kW.

To set a percentage based on nominal AC output power:

1. Go to [Inverter → Setup → Grid management → Output power].
2. Click on "Percentage based on nominal AC output power".
3. Type the applicable output limit of the inverter (for example 70%).
4. Click "Save".

The inverter output power will now be limited to a percentage of the nominal AC output power.

For example:
For a 12.5 kW inverter when the output power is limited to 70%, then output power = 12.5 x 0.7 = 8.75 kW.

3.4. Verification

To verify that the change in configuration has been implemented, access at security level 0 or higher is required.

3.4.1. Display Interface (Inverter Level)

To view the output power limit of the inverter

- Go to [Status → Grid management → Output power limit]
- The value of the limit is displayed as an absolute value or percentage, depending on the chosen setting.

3.4.2. Web Server or Service Interface (Plant Level)

To view the power level adjustment setting of the plant

- Go to [Plant → View → Overview].
- The value for power level adjustment of the plant is displayed as a percentage.

3.4.3. Web Server or Service Interface (Inverter Level)

To view the overall output power limit of the inverter

- Go to [Inverter → View → Overview].
- The value for power level adjustment of the inverter is displayed as a percentage.

To view the output power limit of the inverter

- Go to [Inverter → Status → Grid management → Output power limit]
- The value of the power limit is displayed as an absolute value or percentage, depending on the chosen settings.

4. TLX Series 6k

4.1. Functionality Overview

4.1.1. TLX Series 6k

Unless otherwise specified, manual data and instructions for the Danfoss TLX+ 10k and TLX Pro+ 10k inverters apply equally to the Danfoss TLX+ 6k and TLX Pro+ 6k inverters.

Variant	**User interface**		**Ancillary services**		
	Local	Web Server	Power Level Adjustment, Primary Frequency Control	Ride Through	Fault Ride Through Reactive Power
TLX+ 6k	✓		✓	✓	✓
TLX Pro+ 6k	✓	✓	✓	✓	✓

Table 4.1: Functionality Overview

4.1.2. Derating

See also the TLX Reference Manual, Chapter 3.

	TLX Series 6k
PV current, per input	12 A (+ 2%)
Grid current, per phase	9 A (+ 2%)
Grid power, total	6000 W (+ 3%)
To avoid unintentional derating due to measurement inaccuracy, the values in brackets are added to the limits.	

Table 4.2: Derating Limits

4.1.3. Excessive Grid Power

See also the TLX Reference Manual, Chapter 3.

The factory settings include a preset PV power capacity per input, which is 6 kW per PV input. To avoid exceeding the maximum PV power allowed, the inverter will reduce the value evenly; hence:

Variant	**No. of PV Inputs**	**Power Limit per PV input**
TLX+ 6k TLX Pro+ 6k	2	6.0 kW

Table 4.3: DC Power Limits

4.1.4. Efficiency

See also the TLX Reference Manual, Chapter 3.

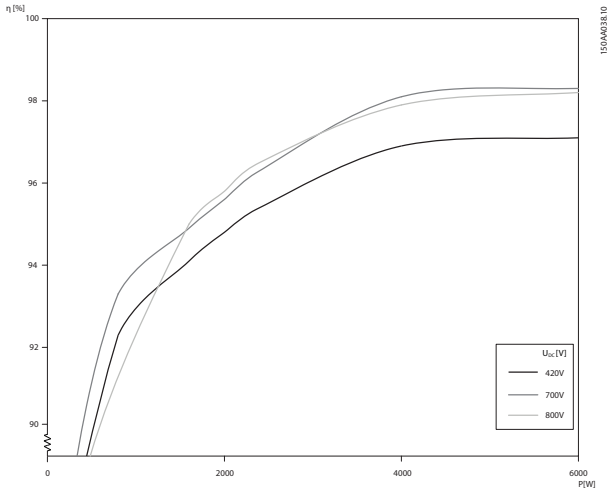

Illustration 4.1: Danfoss TLX+ 6k and Danfoss TLX Pro+ 6k: Efficiency [%] versus AC Power [kW]

	TLX Series 6k		
TPPV/ UPV	**420 V**	**700 V**	**800 V**
5%	88.2%	89.6%	87.5%
10%	91.8%	92.8%	91.4%
20%	93.6%	94.4%	94.5%
30%	94.9%	95.8%	96.0%
50%	96.4%	97.6%	97.4%
100%	96.7%	97.8%	97.9%
EU	95.4%	96.5%	96.3%

Table 4.4: Efficiencies, Danfoss TLX+ 6k and Danfoss TLX Pro+ 6k

4.1.5. Cable Requirements

See also the TLX Reference Manual, Chapter 5.

Cable Requirement	TLX Series 6k
Maximum inverter current	9 A
Recommended fuse type gL/gG	13 A

Table 4.5: Mains Circuit Specifications

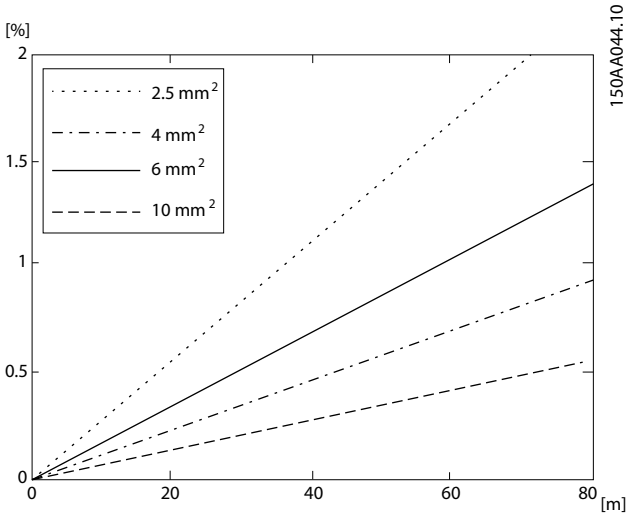

Illustration 4.2: TLX Pro+ 6k Cable Losses [%] versus Cable Length [m]

4.1.6. Grid Impedance

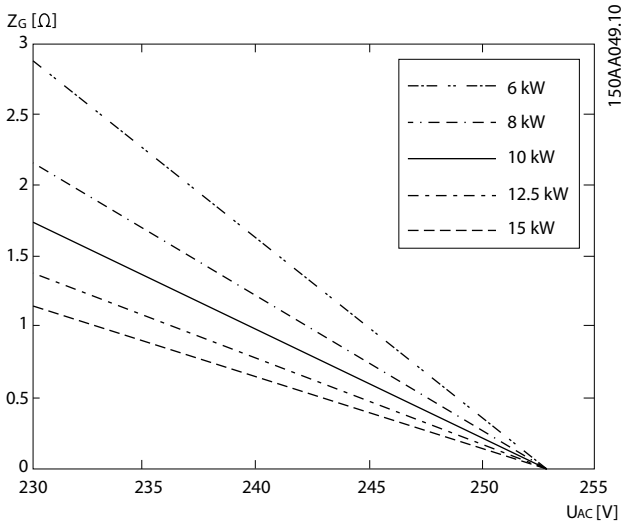

Illustration 4.3: Grid Impedance: Maximum Permissible Grid Impedance [Ohm] versus No-load Grid Voltage [V]

4.1.7. Nominal Operating Area

See also the TLX Reference Manual, Chapter 5.

The nominal/maximum input specification per PV input and total are given in the table below:

Parameter	TLX Series 6k
Number of inputs	2
Nominal / maximum PV power per input	6000 W
Maximum input voltage, open circuit	1000 V
Maximum input current	12 A
Nominal / maximum PV power, total	6200 W

Table 4.6: PV Operating Conditions

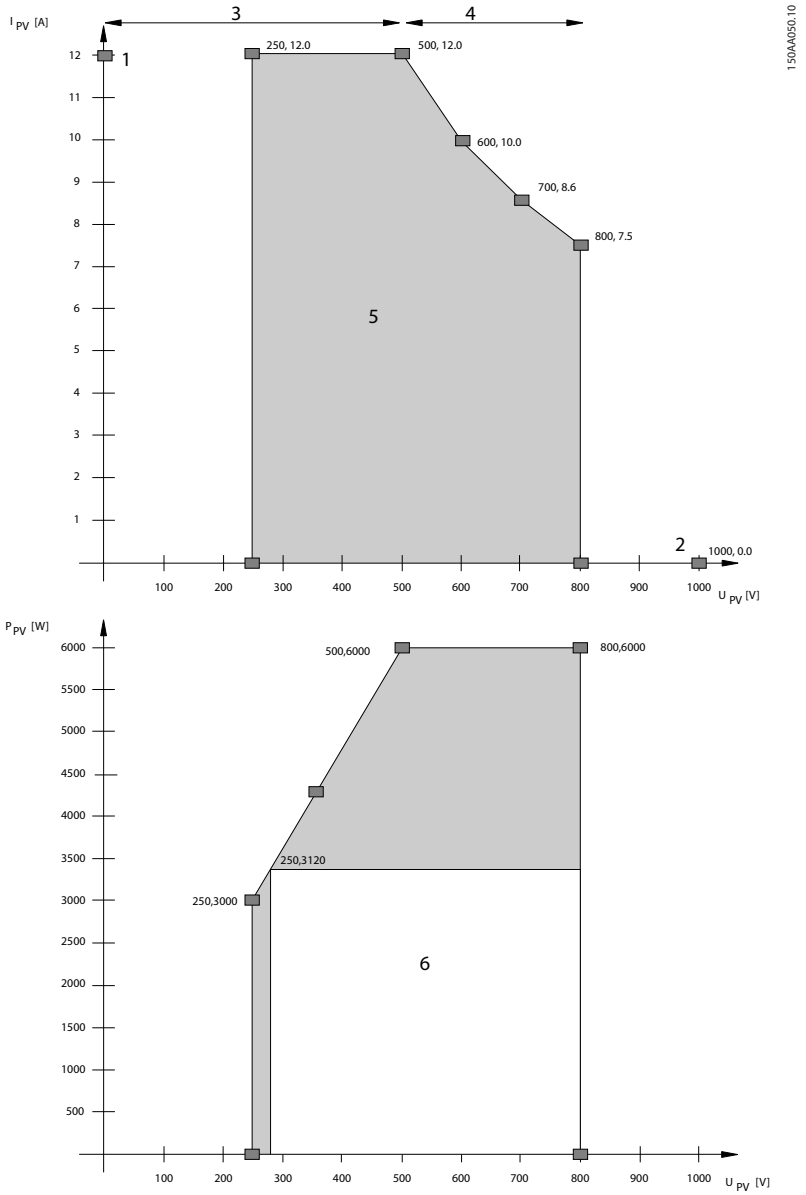

Illustration 4.4: MPP Area, TLX+ 6k and TLX Pro+ 6k

Legend	
1	Maximum short-circuit current
2	Maximum open-circuit voltage
3	Constant current
4	Constant power
5	MPP area
6	MPP area nominal power

4.1.8. Recommendations and Goals when Dimensioning - Optimising PV Power

See also the TLX Reference Manual, Chapter 5.

The ratio between installed PV power at STC (P_{STC}) and nominal inverter power (P_{NOM}), the so-called PV-to-grid ratio K_{PV-AC}, is used to evaluate the sizing of the inverter. To reach a maximum Performance Ratio with a cost-efficient solution, the following upper limits should not be exceeded.

System Type	Max K_{PV-AC}	Corresponding power for TLX Series 6k
Tracker systems	1.05	6.3 kWp
Fixed systems with optimal conditions: Close to ideal orientation (between SW and SE) and inclination (greater than 10°)	1.12	6.7 kWp
Fixed systems with semi-optimal conditions: Orientation or inclination exceeds the above mentioned limits.	1.18	7.1 kWp

Table 4.7: Optimisation of PV Configuration

4.1.9. Technical Specifications

See also the TLX Reference Manual, Chapter 12.

	Nomenclature [1]	Parameter	TLX Series 6k
AC	$P_{ac,r}$	Max./Nom. power AC	6000 W
		Reactive power range	0-3.6 kVA
	$V_{ac,r}$	Rated output voltage	3 x 230 V
	$V_{ac,\,min}$ - $V_{ac,\,max}$	AC voltage range (P-N)	3 x 230 V ± 20%
		Nominal current AC	3 x 9 A
	I_{acmax}	Max. current AC	3 x 9 A
		AC current distortion (THD%)	< 4%
	$cosphi_{ac,r}$	Power factor at 100% load	> 0.99
		Controlled power factor range	0.8 over-excited 0.8 under-excited
		"Connecting" power loss	10 W
		Night-time power loss (off grid)	< 5 W
	f_r	Grid frequency	50 Hz
	f_{min} - f_{max}	Grid frequency range	50 ± 5 Hz
DC		Nominal power DC	6200 W
		Max. recommended PV power at STC [2]	7100 Wp
	$V_{dc,r}$	Nominal voltage DC	700 V
	V_{mppmin} - V_{mppmax}	MPP voltage - nominal power [3]	260-800 V
		MPP efficiency	99.9%
	V_{dcmax}	Max. DC voltage	1000 V
	$V_{dcstart}$	Turn on voltage DC	250 V
	V_{dcmin}	Turn off voltage DC	250 V
	I_{dcmax}	Max. current DC	2 x 12 A
		Max. short circuit current DC at STC	2 x 12 A
		Min. on grid power	20 W
Efficiency		Max. efficiency	97.8%
		Euro efficiency, V at $_{dc,r}$	96.5%

Table 4.8: Technical Specifications

1) According to EN 50524:2009.
2) For fixed systems with semi-optimal conditions.
3) At identical input voltages. At non-identical input voltages, $Vmpp_{min}$ can be as low as 250 V depending on total input power.

5. Parallel PV String Configuration

5.1. Parallel PV String Configuration

For parallel PV string configuration, always use the internal parallel jumper, together with an external parallel coupling.

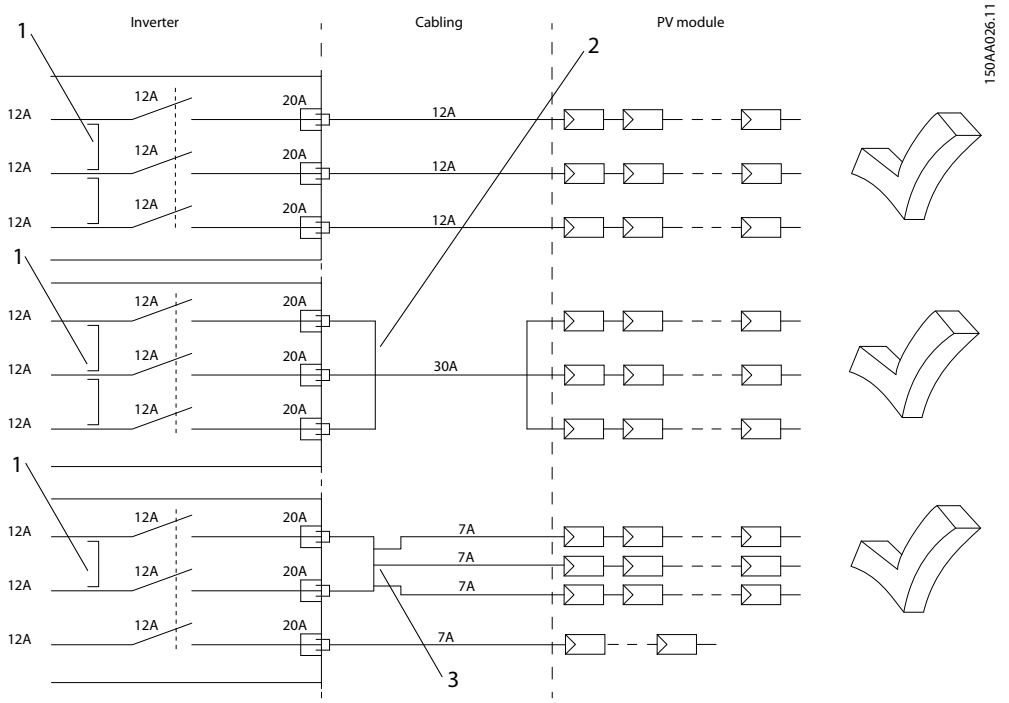

Illustration 5.1: Correct Parallel Connection

Legend	
1	Parallel jumper
2	Parallel connection, 3 inputs
3	Parallel connection, 2 inputs

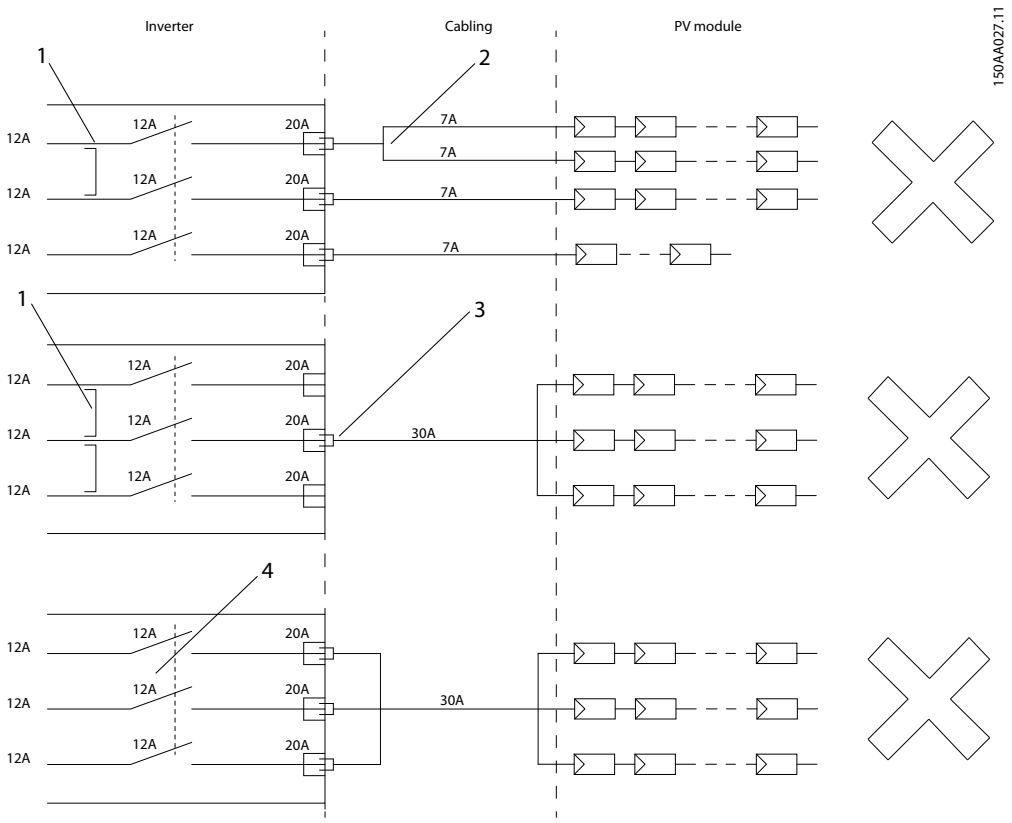

Illustration 5.2: Incorrect Parallel Connection

Legend	
1	Parallel jumper
2	Parallel connection, 1 input. Current in first input is exceeded, thus overloading cable and PV load switch.
3	Parallel connection missing. All PV power feeds into one input, thus risking overload of PV connector, cable and PV load switch.
4	Parallel jumper missing, thus risking overload of PV connector, cable and PV load switch in the event of inverter failure.

6. Miscellaneous

6.1. CLX Portal

6.1.1. How to Register the TLX Pro+ Inverter on the CLX Portal

For instructions on how to register the TLX Pro+ inverter on the CLX Portal, go to:
www.danfoss.com/solar → [Products → CLX Portal → How to register].

6.2. UTE Requirements in France

For installation in France, apply warning label to front of inverter.

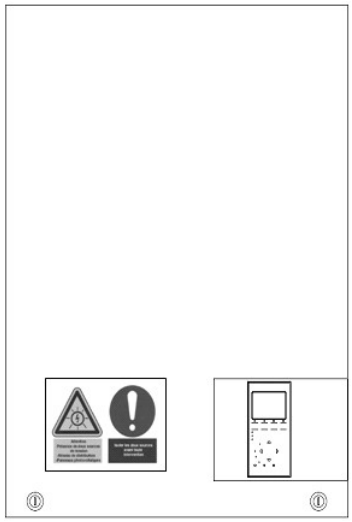

Illustration 6.1: Position of Warning Label

6.3. Residual-current Device (RCD)

The design of TLX leads to a DC leakage current exceeding 6 mA during single fault conditions.

Consult local guidelines to choose the correct RCD type, dependent on:

- grid type
- whether the RCD is used to ensure automatic disconnection
- whether the RCD is used to provide additional safety

Note: ✍
For low-voltage grids in Denmark, an RCD Type B is required according to the local guidelines.

6.4. Fans

The TLX Series inverters are designed with two fans.

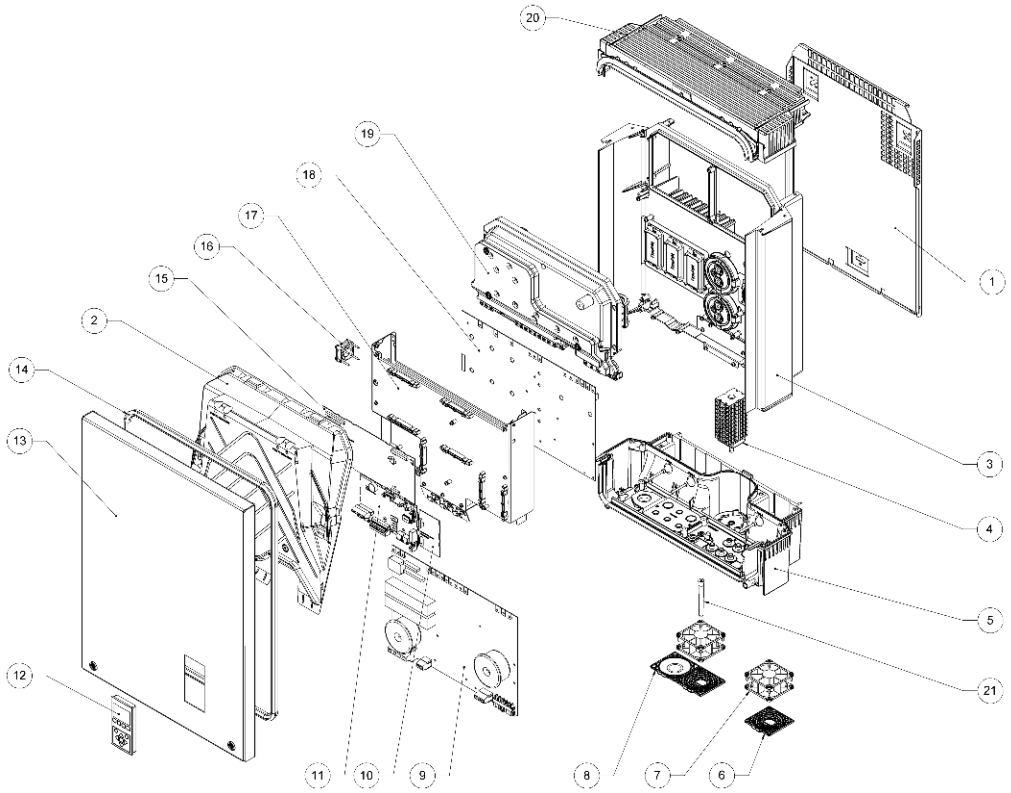

Illustration 6.2: Mechanical Overview of the Inverter

Item number	Part Name
1	Wall Plate
2	Condensing Cover
3	Die Cast Aluminium-Heatsink
4	PV load switch
5	Base plate
6	Fan grill, 80 mm x 80 mm
7	Fan, 80 mm x 80 mm x 38 mm
8	Cover for 80 mm x 80 mm fan hole
9	Aux. board
10	GSM modem (optional)
11	Communication board
12	Display
13	Front cover
14	Gasket for front cover
15	Control board
16	Fan, 40 mm x 40 mm x 15 mm
17	Mounting plate for PCB
18	Power board
19	Coil box
20	Top plate
21	GSM antenna (optional)

Table 6.1: Inverter Components

6.5. AC Power Rating

See also the TLX Reference Manual, Chapter 12.

		TLX Series				
Parameter	at cos(φ)	6k	8k	10k	12.5k	15k
S_max	-	6180 VA	8240 VA	10300 VA	12875 VA	15450 VA
S_nom	-	6000 VA	8000 VA	10000 VA	12500 VA	15000 VA
P_nom	1	6000 W	8000 W	10000 W	12500 W	15000 W
P_nom	0.95	5748 W	7664 W	9580 W	11975 W	14370 W
P_nom	0.90	5400 W	7200 W	9000 W	11250 W	13500 W

Table 6.2: AC Power Rating