

Application Note: Medium Voltage Transformer Selection

AP-XC-048-EN
Revision B

DANGER

RISK OF FIRE, ELECTRIC SHOCK, EXPLOSION, AND ARC FLASH

This Application Note is in addition to, and incorporates by reference, the relevant product manuals for each product in the Schneider Electric Conext™ Core XC and XC-NA Series Grid-Tied Photovoltaic Inverters. Before reviewing this Application Note you must read the relevant product manuals. Unless specified, information on safety, specifications, installation, and operation is as shown in the primary documentation received with the product. Ensure you are familiar with that information before proceeding.

Failure to follow these instructions will result in death or serious injury.

Overview

The Conext Core XC Series (PV and ESS versions) and Conext Core XC-NA Series (PV and ESS versions) inverters must be used with a custom, high-efficiency, line-frequency isolation transformer between the inverter AC output and the grid. This transformer is not provided and must be supplied as a separate component.

Medium voltage (MV) isolation transformers that are connected to Conext Core XC and XC-NA Series inverters must meet the technical requirements described in this document.

NOTICE

EQUIPMENT DAMAGE

- You must select a transformer appropriate for the overall system design. Medium voltage (MV) isolation transformers that are connected to Conext Core XC and XC-NA Series must meet the technical requirements described in this document.
- If an overvoltage protection is required (for example, a Schneider Electric Cardew-type limiter) for sizing information refer to this document and the *Conext Core XC Series Planning and Installation Manual (part number; 990-4613)* or *Conext Core XC-NA Series Planning and Installation Manual (part number; 990-5144)*. For simplicity, do not connect the overvoltage protection device to the neutral; connect it between any one line (L1~ L1, L2~ L2, or L3 / ~ L3) and ground. Multiple overvoltage protection devices may be used, but are restricted to one overvoltage protection device per line.
- Do not connect any point on the inverter-side winding of the isolation transformer to ground.

Failure to follow these instructions will result in damage to equipment.

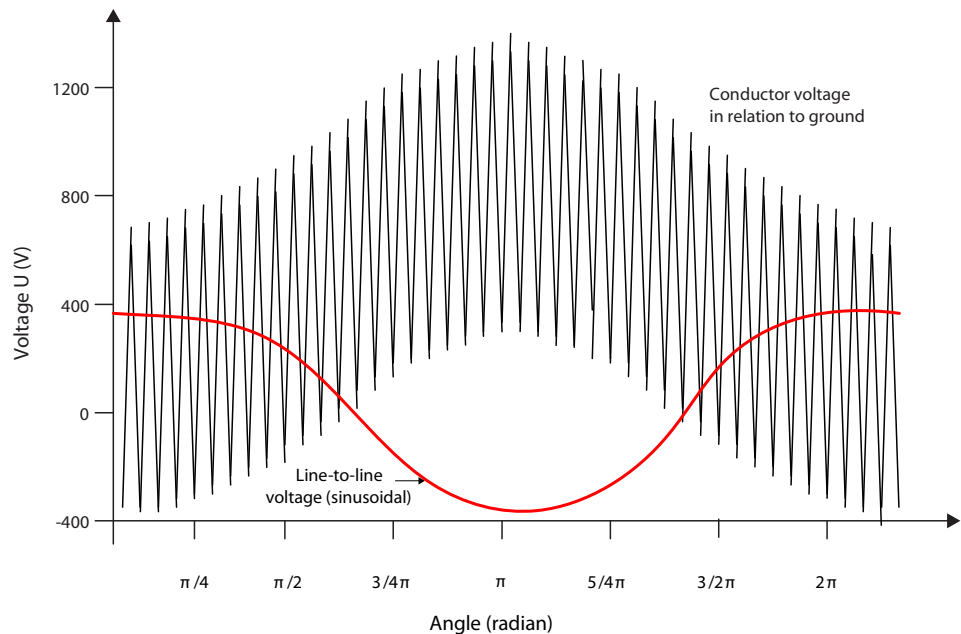
General Requirements

- A shield winding is recommended as a dU/dt filter between the low voltage and high voltage windings.
- LV-MV impedance Z (%) for the transformer must meet the requirements shown in Table 1, "Parameter limits" on page 4.
- The temperature rating and behavior of the MV transformer needs to be coordinated with the inverter temperature behavior and the site conditions.
- The configuration of the MV transformer should take into account the local grid frequency and should meet local and regional standards.
- The low voltage (inverter-side) windings of the MV transformer can only be configured as a Delta or floating Wye. If the MV side of the system is grounded Wye, use of a floating Wye on the inverter side may not be allowed by the local utility. Make sure you understand your system configuration and the utility's rules before installation.

NOTICE

INVERTER DAMAGE

Do not connect any point on the inverter-side winding of the MV transformer to ground.
Failure to follow this instruction will result in equipment damage.



The Conext Core XC and XC-NA Series inverter bridge switching frequency is 3.2 kHz. This graph is provided for informational purposes only. This should not be interpreted as typical operation. The voltage numbers on the y-axis are for reference only.

Figure 1 Pulsed inverter operation

Medium Voltage Winding Requirements

- The medium voltage (utility-side) windings of the MV transformer may be configured as a Delta or Wye and must match the voltage at the utility interconnection point.

If the medium voltage windings of the transformer are a Wye, the resulting neutral connection of this Wye combination may be connected to the neutral connection at the utility interconnection point. Connection of this utility-side neutral does not affect the operation of the Conext Core XC and XC-NA Series.

- The medium voltage windings should have a voltage level that matches the medium-voltage grid in the region.
- A tap changer should be installed on the medium voltage side to align the output voltage with the voltage level of the medium voltage grid.

Low Voltage Winding Requirements

- The voltage in relation to ground has a complex waveform comprised of AC, DC and pulsed DC components. The maximum rms (root mean square) value of the voltages in relation to ground is 580 V. The maximum peak pulsed line voltage in relation to ground is 1300 V.
- The low voltage (inverter-side) windings of the MV transformer can only be configured as a Delta or floating Wye. If the MV side of the system is grounded Wye, use of a floating Wye on the inverter side may not be allowed by the local utility. Make sure you understand your system configuration and the utility's rules before installation.

NOTICE

INVERTER DAMAGE

Do not connect any point on the inverter-side winding of the MV transformer to ground.

Failure to follow this instruction will result in equipment damage.

- One galvanically isolated low voltage three-phase winding combination must be available for each inverter.
- Each low voltage winding must match the rated AC voltage of the inverter.
- Each low voltage winding must be capable of handling non-sinusoidal voltages with a voltage gradient (dU/dt) of up to $500 \frac{V}{\mu s}$ of ground.
- The neutral point (if present) must not be connected or grounded.
- Transformers with multiple low voltage windings must meet the requirements for LV to LV short circuit impedances as shown in Table 1, "Parameter limits" on page 4.

Interwinding Impedances

Figure 2 and Figure 3 show the test setup for testing the short circuit impedance of LV1.

Table 1 states the parameter limits for low voltage and medium voltage short circuit impedance.

Table 1 Parameter limits

| Parameter | Minimum | Maximum | Nominal |
|-------------------------------|---------|---------|---------|
| Z_{1MV} Z_{2MV} Z_{3MV} | 4.5% | 6.5% | 6% |
| Z_{1LV} Z_{2LV} Z_{3LV} | 7% | N/A | 10% |

Short Circuit Impedance of LV1

NOTE: The normalization for Z_{1MV} and Z_{1LV} is with respect to the rated levels of the Conext Core XC Series (PV and ESS versions) and Conext Core XC-NA Series (PV and ESS versions) inverter:

$$I_n = 1040 \text{ A}$$

$$U_n = \begin{cases} 300 \text{ V (XC540 or XC540-NA)} \\ 350 \text{ V (XC630 or XC630-NA)} \\ 380 \text{ V (XC680 or XC680-NA)} \end{cases}$$

Figure 2 shows the measurement setup for the short circuit impedance Z_{1MV} .

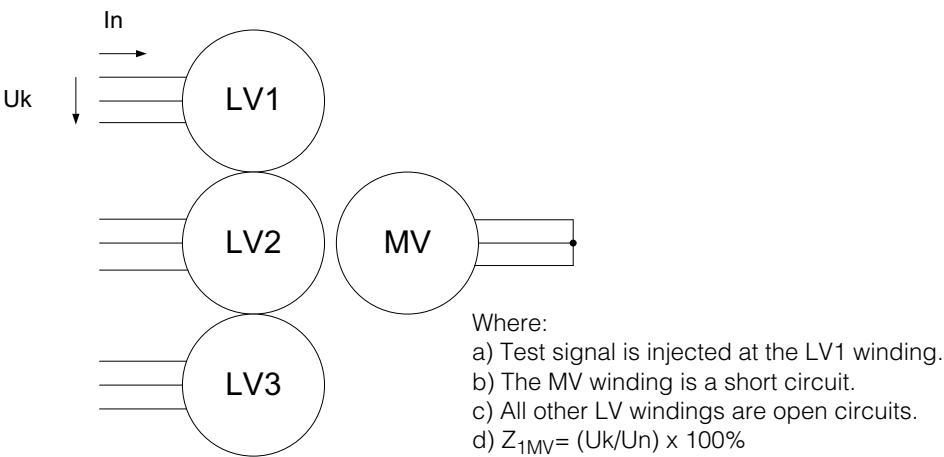


Figure 2 Setup to determine impedance Z_{1MV}

Figure 3 shows the measurement setup for the short circuit impedance Z_{1LV} .

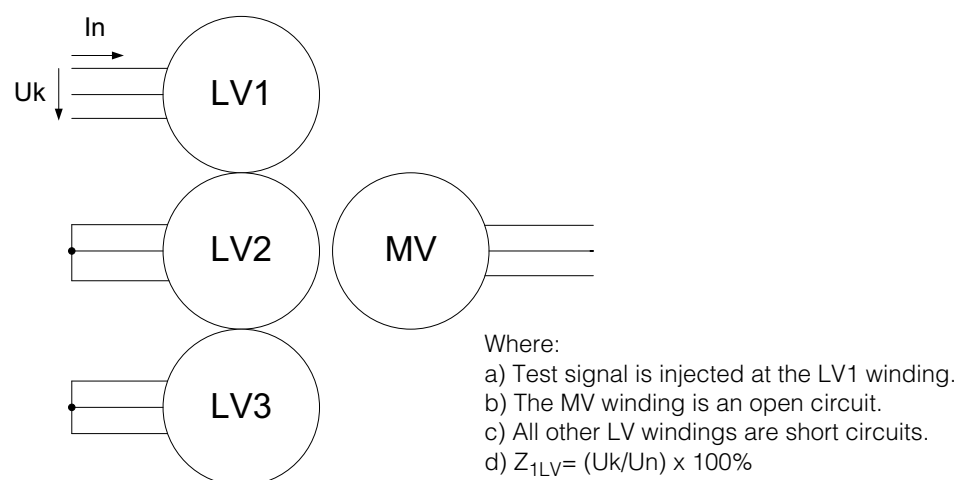


Figure 3 Setup to determine impedance Z_{1LV}

Short Circuit Impedance of LV2, LV3 for Multiple LV Windings

To measure the short circuit impedance of LV2, LV3 etc. repeat the setup in Figure 2 to determine Z_{2MV} and Z_{3MV} and the setup in Figure 3 to determine Z_{2LV} and Z_{3LV} .

Medium Voltage Transformer Selection Checklist

Complete the following checklist of important points when selecting your MV transformer.

Table 2 Medium voltage transformer selection checklist

| Parameter Description | Requirement from Inverter | Comments | Meets requirement Yes/No |
|---------------------------|---|--|--------------------------|
| No. of Phases | 3 | | |
| Freq Hz | Local grid frequency | The configuration of the MV transformer should take into account the local grid frequency and should meet local and regional standards. | |
| HV (Voltage Level) | Match the medium-voltage grid in the region | The medium voltage windings should have a voltage level that matches the medium-voltage grid in the region. | |
| LV (Voltage Level) | Rated inverter AC voltage | Each low voltage winding must match the Nominal AC voltage rating of the inverter. | |
| HV Configuration | Wye or Delta | The medium voltage (utility-side) windings of the MV transformer may be configured Wye or Delta and must match the voltage at the utility interconnection point. If the medium voltage windings of the transformer are configured Wye, the resulting neutral connection of this Wye combination may be connected to the neutral connection at the utility interconnection point. Connection of this utility-side neutral does not affect the operation of the Conex Core XC and XC-NA Series. | |
| LV Configuration (each) | Delta or floating Wye | The low voltage (inverter-side) windings of the MV transformer can only be configured as a Delta or floating Wye. If the MV side of the system is grounded Wye, use of a floating Wye on the inverter side may not be allowed by the local utility. Make sure you understand your system configuration and the utility's rules before installation. | |
| MV Tap | Required. 1 to 7 steps (4 is nominal) | A tap changer should be installed on the medium voltage side to align the output voltage with the voltage level of the medium voltage grid. | |
| HV - LV Impedance | 4.5% - 6.5% | Must meet the requirements in Table 1, "Parameter limits" on page 4. | |
| LV - LV Impedance | >7% | Must meet the requirements in Table 1, "Parameter limits" on page 4. | |
| LV non-sinusoidal voltage | 500 V/ μ s of ground | Each low voltage winding must be capable of handling non-sinusoidal voltages with a voltage gradient (dU/dt) of up to 500 V/ μ s of ground. | |
| LV neutral point | Not connected | The neutral point (if present) must not be connected or grounded. | |
| LV to GND | 580 V RMS, 1300 V pk | The voltage in relation to ground has a complex waveform comprised of AC, DC and pulsed DC components. The maximum rms (root mean square) value of the voltages in relation to ground is 580 V. The maximum peak pulsed line voltage in relation to ground is 1300 V. | |

Table 2 Medium voltage transformer selection checklist

| Parameter Description | Requirement from Inverter | Comments | Meets requirement Yes/No |
|-------------------------------|--|---|--------------------------|
| LV to MV Electrostatic Shield | Recommended | A shield winding is recommended as a dU/dt filter between the low voltage and high voltage windings. | |
| LV to LV Electrostatic Shield | Recommended | | |
| Temperature rating | Coordinated with inverter temperature behavior and site conditions | The temperature rating and behavior of the MV transformer needs to be coordinated with the inverter temperature behavior and the site conditions. | |
| Galvanic isolation | One per inverter | One galvanically isolated low voltage three-phase winding combination must be available for each inverter. | |

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