



REQUIREMENTS

for Distributed Generation
Interconnection

KE Net Metering Facilitation Centre:
Address: Second Floor, Block - K, Gate No 6,
Elandar Complex, Elandar Road, Karachi
Timing: 9:00 to 5:00 (weekdays)



Definitions and Acronyms

The following terms and definitions have been used in this document.

Acronym	Definitions
ANSI	American National Standard Institute
DG	Distributed Generation
DR	Distributed Resource
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EPS	Electric Power System
IEEE	Institute of Electrical and Electronics Engineers Inc.
ISE	Interconnection System Equipment
KE	K-Electric
NEPRA	National Electric Power Regulatory Authority
PCC	Point of Common Coupling
THD	Total Harmonic Distribution
UL	Underwriters' Laboratory

1. General

This document specifies requirements for Distributed Generation connected to K-Electric distribution network.

2. Scope

The document is intended to cover the inverter standards for interconnection of distributed PV generators having a capacity between 1 kW and 1 MW connected to a low voltage (400 V) and medium voltage (11 kV) distribution networks only. The document specifies the requirements for grid connected inverters and is in accordance with NEPRA Net Metering Regulations.

3. Grid Interconnection Standard: Electrical Parameters

The Distributed Generator (DG) shall operate and inject power when the network is within the parameters mentioned hereafter. The DG system shall disconnect itself from the utility network when the electrical parameter of the network falls out of the specified range.

3.1 Range of Operation: Voltage

The under voltage and over voltage levels and the corresponding trip times shall be in accordance with IEEE 1547 & IEC 61727. The interconnection system paralleling-device shall be capable of withstanding 220% of the interconnection system rated voltage. The tripping times for over and under voltages are as follows:

Voltage	Maximum Trip Time (Seconds)
$V < 50\%$	0.1
$50\% \leq V < 85\%$	2.0
$85\% \leq V < 110\%$	Continuous Operation
$110\% \leq V < 135\%$	2.0
$135\% \leq V$	0.05

3.2 Range of Operation: Power Factor

The DG system shall have power factor greater than 0.9 when the output is greater than 50% of the System rating. The Power Factor requirements set for respective consumer type by the utility company will remain applicable and larger DG (such as industrial connections) may be required to install additional systems for power factor correction.

3.3 Range of Operation: Frequency

The under frequency and over frequency levels exhibited should be as per IEEE 1547 & IEC 61727 standard as mentioned below:

Frequency Range (Hz)	Maximum Trip Time (Seconds)
$f_{nominal} < 47.5$	0.1
$47.5 \leq f_{nominal} \leq 51.5$	Continuous Operation
$51.5 < f_{nominal}$	0.1

3.4 Harmonics

The inverter must meet the harmonic current injections in accordance with IEEE 1547. The total harmonic distortion should be less than 5% at 100% rated power of the inverter.

3.5 DC Current Injection

DC Current Injection should not be greater than 0.5% of full rated output current at the DG connection.

3.6 Islanding Protection

For an unintentional island, in which the DR energises a portion of the area EPS through the PCC, the DR interconnection system shall detect the island and cease to energise the Area EPS within two seconds of the formation of an island.

3.7 Disconnection and Reconnection to the network

In case of utility line outage, fault or out of range site, the inverter should remain disconnected and provide islanding protection. Disconnection should occur within 2 seconds of the occurrence of the islanding condition and the system at a single point of common coupling (PCC) > 250 kVA should have provision for a monitoring device.

The DR interconnection system shall include an adjustable delay (or a fixed delay of five minutes) that may delay reconnection for up to five minutes after the Area EPS steady-state voltage and frequency are restored to the ranges identified above.

3.8 Acceptable Standards

Inverters meeting one of the following standards shall be acceptable for use for net metering. The following standards are stringent in terms of electrical characteristics and therefore, by definition, provide additional safety for the distribution networks.

- 1) **IEEE 1547:** IEEE standard 1547 is for interconnecting distributed resources with electric power systems. This standard ensures the lack of uniform national interconnection standards and tests for interconnection operation and certification, as well as the lack of uniform national building, electrical, and safety codes, are understood. Its development demonstrate a model for ongoing success in establishing additional interconnection agreements, rules, and standards, on a national, regional, and state level. This standard has the potential to be used in federal legislation in rule making for utilities and in formulating technical requirements for interconnection agreements for distributed generators powering the electric grid.
- 2) **UL1741:** The Underwriters' Laboratory UL Standard 1741 is for inverters, converters, controllers and interconnection system equipment for use with distributed energy resources. These requirements cover inverters, converters, charge controllers and interconnection system equipment (ISE) intended for use in stand-alone (non-grid-connected) or utility-interactive (grid-connected) power systems. Utility-interactive inverters, converters and ISE are intended to be operated in parallel with an electric power system (EPS) to supply power to common loads.

4. **Safety and EMC Standard**

Inverters and panels should be earthed. For systems greater than 10 kW, the inverter must comply with additional certifications and meet additional electromagnetic compatibility and safety standards, such as UL 1741 and IEEE 1547. The influence of EMI shall not result in a change in state or improper operation of the interconnection system.