



RENEWABLE ENERGY SUB-CODE

for Distribution Network connected Variable
Renewable Energy Power Plants in Ghana

JANUARY 2015

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Measurement

W	Watt	Wp	Watt peak	Wh	Watt hour
kW	Kilowatt	kWp	Kilowatt peak	kWh	Kilowatt hour
MW	Megawatt	MWp	Megawatt peak	MWh	Megawatt hour
GW	Gigawatt	GWp	Gigawatt peak	GWh	Gigawatt hour

List of Acronyms

DN	Distribution Network
DU	Distribution Utility
ETU	Electricity Transmission Utility
IEC	International Electro-technical Committee
MV	Medium Voltage
NITS	National Interconnected Transmission System
POC	Point of Connection
TN/TS	Transmission Network/ Transmission System
VRPP	Variable Renewable Power Plant

PART A:

1 Introduction

The Republic of Ghana seeks to develop, manage and utilize renewable energy sources in an effective and environmentally suitable manner for the production and distribution of electricity in accordance with the Renewable Energy Act, 2011 (Act 832). This requires guidelines to facilitate the connection of variable renewable energy sources to a Distribution Network without affecting the secured operation of transmission or distribution networks in Ghana.

This Renewable Energy Sub-Code proposes minimum technical connection conditions for a Variable Renewable Power Plant (VRPP) or Embedded Generator to the Distribution Network. This Sub-Code is in line with National Electricity Distribution Code and international best practices and standards.

A VRPP applicant seeking connection to a Distribution Network with a nominal voltage greater than 1kV shall comply with this Sub-Code and all applicable articles of the National Electricity Distribution Code.

1.1 Scope

This Renewable Energy Sub-Code constitutes the basic technical performance requirements that a VRPP needs to comply with in order to connect its generating facility to a Distribution Network in Ghana and defines rules and standards that the network operators shall follow when connecting a VRPP to its Distribution Network.

- (1). Compliance with this Sub-Code is meant to ensure safe, reliable and secure operation of all VRPPs connected to Distribution Networks.
- (2). The basic technical performance requirements provided in this Sub-Code applies to all VRPPs connected to voltage levels greater than 1 kV and up to 36 kV (medium voltage network).
- (3). The Distribution Utility (DU) and a VRPP operator shall supply each other with the necessary data and information about their network or plant that is required for ensuring compliance with this Sub-Code and if required, the DU shall facilitate the arrangement for a VRPP operator to contact Electricity Transmission Utility (ETU) for additional information.

1.2 Status

This Sub-Code constitutes an Addendum to the National Electricity Distribution Code.

1.3 Terms and Definitions

Available generation capacity

It is the maximum actual generation capacity of the generator unit that could be generated stably and continuously in the determined period.

Capability Curve

A curve developed for generators showing the limits of reactive and active power that a generator can produce without overheating or becoming unstable.

Connection Agreement

It is an agreement between the DU and a Grid Participant that seeks connection of its facilities to the NITS and sets out the rights, obligations and liabilities of both parties.

Connection point

The point of physical linkage to or with the Distribution Network for the purpose of enabling the flow of electricity as the boundary between the Distribution Network and a facility or other equipment.

Continuous Operation

Network operating frequency or voltage range, outside normal range of operation, within which no generating unit is allowed to disconnect.

Distribution Network (DN)

In this Sub-Code in relation to a Distribution Utility, DN means a system of electric lines and associated equipment (at nominal voltage levels of 1 kV up to 36 kV), which that Distribution Utility is licensed to use to distribute electricity for supply under its distribution licence excluding public lighting assets.

Distribution Company

A person licensed under the Energy Commission Act, 1997 (ACT 541) to distribute and sell electricity without discrimination to consumers in an area or zone designated by the Board of the Energy Commission.

Distribution Utility (DU)

Electricity Distribution Company licensed by the Energy Commission that operates the distribution network to provide services in accordance with the Performance and Reliability Standards of the National Electricity Distribution Code.

Disturbance

An unplanned event that produces an abnormal system condition or any occurrence that adversely affects normal power flow in a system.

Echo

In relation to park control system, it is the signal that is sent from a VRPP to the communication system of the network operator.

Electricity Transmission Utility (ETU)

The entity mandated by the Energy Commission Act, 1997 (ACT 541) to operate the National Interconnected Transmission System (NITS) to provide services in accordance with the Performance and Reliability Standards of the National Electricity Grid Code.

Emergency

Any abnormal system condition that requires automatic or immediate manual action to prevent or limit loss of generation supply or transmission facilities that could adversely affect the reliability of the electric system.

Frequency control

The retention of the frequency on the power system within acceptable limits.

Frequency regulation

The automatic adjustment of active power output by a generation unit, initiated by fast acting frequency controller action in response to continuous minor fluctuations of frequency on the power system.

Flicker

A fast fluctuation in voltage leading to quick intermittent coming on, of an appliance and gives the impression of unstable visual sensation induced by a light stimulus with luminance or spectral distribution that fluctuates with light.

Generating unit

An equipment or plant for producing electrical energy from other forms of energy.

Generation facility

A facility comprising of generators for producing electric energy from other forms of energy expressed in watt-hours (Wh).

Grid Participant

A Wholesale Supplier or a VRPP facility owner or Bulk Customer with facilities that are connected to the DN.

Harmonics

A sinusoidal wave having a frequency that is an integral multiple of a fundamental frequency.

Interconnected system

It is a system consisting of two or more individual electric systems that normally operate in synchronism and that have connecting tie-lines.

Individual Harmonic Distortion

IHD is the ratio between RMS value of the individual harmonic content and the RMS value of the fundamental voltage expressed in percentage.

$$IHD = \sqrt{\frac{V_i^2}{V_1^2}} * 100 \%$$

V_i = Voltage component of harmonic order i ;

V_1 = Voltage component of fundamental frequency (50 HZ).

Island

A portion of a power system or several power systems that is electrically separated from the inter-connection due to the disconnection of distribution network equipment.

National Interconnected Transmission System

Incorporates all equipment which form part of the national interconnected transmission system irrespective of ownership or whether it is dedicated to the service of an entity.

Nominal Voltage

The voltage by which the system is designated and to which certain operating characteristics are related, and the voltage at which the system operates and is normally about 5 to 10 percent below the maximum system voltage for which system components are designed.

Operating reserve

The additional megawatt output required from a generation unit or demand reduction which must be realizable in real time operation to contain and correct any potential power system frequency deviation to an acceptable level.

Point of Connection (POC)

Point on a public power supply system where the installation under consideration is, or can be connected.

Note: A supply system is considered as being public in relation to its use, and not its ownership.

Ramp rate

The rate of change at which the power output of a generator can be increased or decreased (in MW/min)

Single contingency

Includes the singular that involves,

- (a). ...sudden, unexpected failure or outage of any single component of a power system, like generating unit, transmission line, transformer, etc.; or
- (b). ...removal from service of an element of the power system like generating unit, transmission line, transformer etc. as part of the operation of a remedial action scheme, the occurrence of which shall not affect the normal operation of the NITS.

Synchronize

The process of connecting two previously separated alternating current apparatuses after matching frequency, voltage and phase angles like paralleling a generator to the electric system.

System Protection Dependability

A measure of the ability of protection to initiate successful tripping of circuit-breakers which are associated with a faulty item of apparatus. It is calculated by using the formula:

$$D_p = 1 - F_i/A$$

Where: A = Total number of faults

F_i = Number of system faults where there was a failure to trip a circuit breaker.

Total Harmonic Distortion

THD shall be defined as the ratio of the RMS voltage of the harmonic content to the RMS value of the fundamental voltage, expressed in percent.

$$THD = \sqrt{\frac{\sum V_i^2}{V_1^2}} * 100 \%$$

THD = Total Harmonic Distortion of voltage;

V_i = Voltage component of harmonic order i;

V₁ = Voltage component of fundamental frequency (50 HZ).

Transmission System/Transmission Network

An interconnected group of electric transmission lines and associated equipment for moving or transferring electric energy in bulk between points of supply and points at which it is transformed for delivery over the distribution system lines to consumers, or to other electric systems.

Unrestricted Operation Range

Normal network frequency or voltage operating range during which no generating unit is allowed to disconnect and where there is no technical restriction with regard to the delivery of active power or reactive power.

Variable Renewable Power Plant

Renewable power plants with continuously varying power output following the availability of primary energy without any storage (Wind and PV farms).

Voltage regulatory system

A centralized control system at a VRPP that measures voltage compared to a set point voltage and controls reactive power devices.

VRPP owner

The owner of a generation facility or an independent power producer seeking to interconnect their facility with DN.

VRPP operator

Operator of a VRPP seeking connection to or already connected to the DN.

Wholesale Supplier

A person licensed under the Energy Commission Act, 1997 (Act 541) to install and operate a facility to procure or produce electricity for sale to a bulk customer or to a distribution company for distribution and sale to consumers.

PART B:**2 Technical Connection Conditions****2.1 General**

In the implementation of this Sub-Code, the following general rules shall apply:

- (1). The interconnection of a VRPP with the DN shall not deteriorate system security.
- (2). A VRPP shall meet the requirements of this guideline at the POC unless otherwise specified in this document or by the DU.
- (3). The design, installation, commissioning, maintenance and operation of the generation facility shall be conducted in a manner that ensures safety and security of a VRPP, DN and NITS.
- (4). A VRPP owner or operator shall maintain and operate power plants in accordance with the instructions of the ETU/DU to supply electricity through DN to consumers.
- (5). A VRPP or any other generator or consumer connected to the DN shall be responsible for protecting its equipment in such a manner that faults or other disturbances in the NITS or DN do not cause damage to their equipment.
- (6). DU shall not assume any responsibility for the protection of a VRPP's plant or any other generator or consumer or equipment or any other portion of the VRPP's electrical equipment. A Grid Participant shall be responsible for protecting its equipment in such a manner that faults or other disturbances in the NITS or DN do not cause damage to the Grid Participant's equipment.
- (7). A VRPP shall at all times comply with applicable requirements and conditions of connection for generating units and in accordance with any Connection Agreement with the DU.
- (8). A VRPP owner/operator shall permit and arrange participation in the inspection, testing or commissioning of facilities and equipment to be connected to the DN.

2.2 Frequency Range of Operation

- (1). A VRPP shall be capable of staying connected within the frequency ranges and times specified in Table 1.

Table 1: Frequency Ranges of Operation (Must remain connected conditions)

Frequency (Hz)	Operation
$47.5 \leq F < 48.75$	90 Minutes
$48.75 \leq F < 51.25$	Unlimited (Continuous Range)
$51.25 < F \leq 51.5$	90 Minutes
$51.5 < F \leq 52$	15 Minutes

- (2). In case of frequencies outside the frequency and time ranges specified in A VRPP shall be capable of staying connected within the frequency ranges and times specified in Table 1.

(3). Table 1, a VRPP shall be allowed to disconnect from the DN.

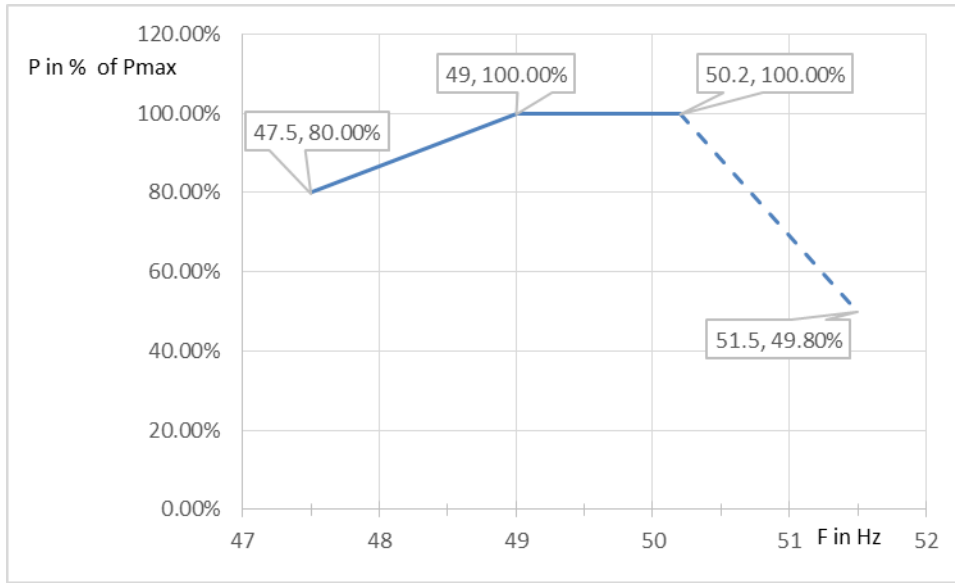


Figure 1: Maximum Active Power Capability in Function of Frequency

(4). There shall be no technical restriction with regard to the delivery of active power or reactive power within the frequency range of 49 Hz to 51 Hz and a VRPP shall be permitted unrestricted operation within this frequency range.

(5). The minimum active power output that a VRPP shall be capable of delivering is depicted in Figure 1.

Note 1: The frequency dependent power limits according to Figure 1 relate to the technical capability under the condition that sufficient primary energy is available (e.g. wind speed, solar irradiation). Additional limits due to limited primary energy may apply but these limits are not frequency dependent.

Note 2: The dashed line displayed for frequencies >50.2Hz results from the high frequency response according to section 2.8.1.

2.3 Voltage Range of Operation

- (1). For a VRPP, no disconnection of any unit within a power park is permitted as long as voltage at POC remains within +/-10% of nominal voltage or within IEC-voltage limits for continuous operation, whatever is the more narrow voltage range (Continues Voltage Range).
- (2). For voltages at the POC between +/-5% of nominal voltage, no restrictions with regard to the provision of active or reactive power are permitted (Unrestricted Voltage Range).

2.4 Power Quality

- (1). A VRPP shall ensure that the power it injects into the DN is within the limits prescribed in this sub-section.
- (2). A VRPP operator shall continuously monitor the power quality in accordance with Part C of this Sub-Code and submit periodic report
- (3). All power quality parameters shall be monitored at POC and shall comply with limits presented in this section.

Note: For the purpose of this Article, power quality parameters refer to voltage, flicker and harmonics.

2.4.1 Rapid Voltage Changes

- (1). During regular switching operations within a VRPP such as switching operation on a wind turbine within a wind farm or switching of a shunt reactor or capacitor, the resulting voltage change at the POC shall not deviate by more than 2 % of the Nominal Voltage.
- (2). The maximum permitted voltage change at any point in the network shall be limited to 5 % of Nominal Voltage in respect of changes resulting from;
 - a. switching of several units within a VRPP,
 - b. connection of a complete VRPP, or
 - c. disconnection of a complete VRPP.

2.4.2 Flicker

- (1). A DU shall apportion flicker emission limits to each VRPP based on flicker planning levels according to IEC61000-3-7, existing background flicker levels, possible future installations and the total size of a VRPP to be connected. The methodology for apportioning VRPP-specific flicker limits shall be in-line with IEC61000-3-7.
- (2). In the absence of any project-specific flicker limits apportioned by the DU, flicker caused by any VRPP shall not exceed the flicker limits as shown in Table 2 at POC.

Table 2: Flicker limits to be applied in the absence of apportioned limits

Planning level	Emission Limit (MV)
P _{st}	0.4
P _{tt}	0.4

2.4.3 Voltage Unbalance

- (1). A VRPP's contribution to negative sequence voltage shall not exceed 1 % at the POC.

Note: Voltage unbalance is measured in terms of negative sequence voltage in per cent of nominal voltage.

2.4.4 Harmonics

- (1). A DU shall apportion individual harmonic voltage distortion limits to each VRPP based on planning level for individual harmonic distortions (HD) and total harmonic distortion (THD) according to Article 19.70 of the Distribution Code, existing background harmonics, possible future installations and the total size of a VRPP to be connected, according to methodology described in IEC 61000-3.
- (2). In the absence of any apportioned limits, individual harmonic voltage distortion limits for odd harmonics shall not exceed 2 % and for even harmonics 1 %. Total harmonic voltage distortion shall not exceed 3 % at the POC.
- (3). In addition to (2), generators shall not exceed harmonic current distortion limits specified in Table 3 at the POC.

Table 3: Current distortion limits for DN connected VRPPs

Current Harmonic Distortion limits						
I_{sc}/I_L	Maximum Harmonic Current Distortion in Percent (%) of I_L					
	Individual Harmonic Order "h" (Odd Harmonics)					
	<11	$11 \leq h < 17$	$17 \leq h < 23$	$23 \leq h < 35$	$35 \leq h$	TDD
<20*	4.0	2.0	1.5	0.6	0.3	5.0
20<50	7.0	3.5	2.5	1.0	0.5	8.0
50<100	10.0	4.5	4.0	1.5	0.7	12.0
100<1000	12.0	5.5	5.0	2.0	1.0	15.0
>1000	15.0	7.0	6.0	2.5	1.4	20.0

* All power generation equipment are limited to these values of current distortion, regardless of actual I_{sc}/I_L .

1. Even harmonics are limited to 25% of the odd harmonic limits above.
2. Current distortions that result in a dc offset, e.g. half-wave converters, are not allowed.
3. I_{sc} = maximum short-circuit current at POC.
4. I_L = maximum demand load current (fundamental frequency component of generation current) at POC.
5. TDD (Total Demand Distortion) = harmonic current distortion in % of maximum demand load (or generation) current (15 or 30 min demand).

2.5 Reactive Power Capability

- (1). A VRPP shall operate within a power factor range of 0.95 leading to 0.95 lagging, measured at the POC.
- (2). For voltages between 0.9 and 1.0p.u., a VRPP shall provide maximum reactive power support to the system or for voltages between 1.0 and 1.1p.u., a VRPP shall provide full bucking at the POC.
- (3). A VRPP shall be capable of varying power factor continuously in the entire range of 0.95 under-excited to 0.95 over-excited during operation with maximum active power output and voltage within the Unrestricted Range of Operation
- (4). A VRPP shall be capable of varying reactive power at the POC within their reactive power capability range as defined by Figure 3 when operating within the Unrestricted Voltage Range and at an active power output level between 5% and 100% of Rated Power.
- (5). If voltage is outside the Unrestricted Voltage Range but within the Continuous Voltage Range the reactive power capability limits of a VRPP according to Figure 3 can be adjusted to the voltage dependent limits according to Figure 2.

Note: P_n in MW corresponds to the rated installed capacity of the VRPP minus the sum of the installed capacity of all units being temporarily out of service.

- (6). In the case of operation with active power below 5% of P_n , there is no reactive power capability requirement but in this range, reactive power must be within the tolerance range of +/-5% of P_n .

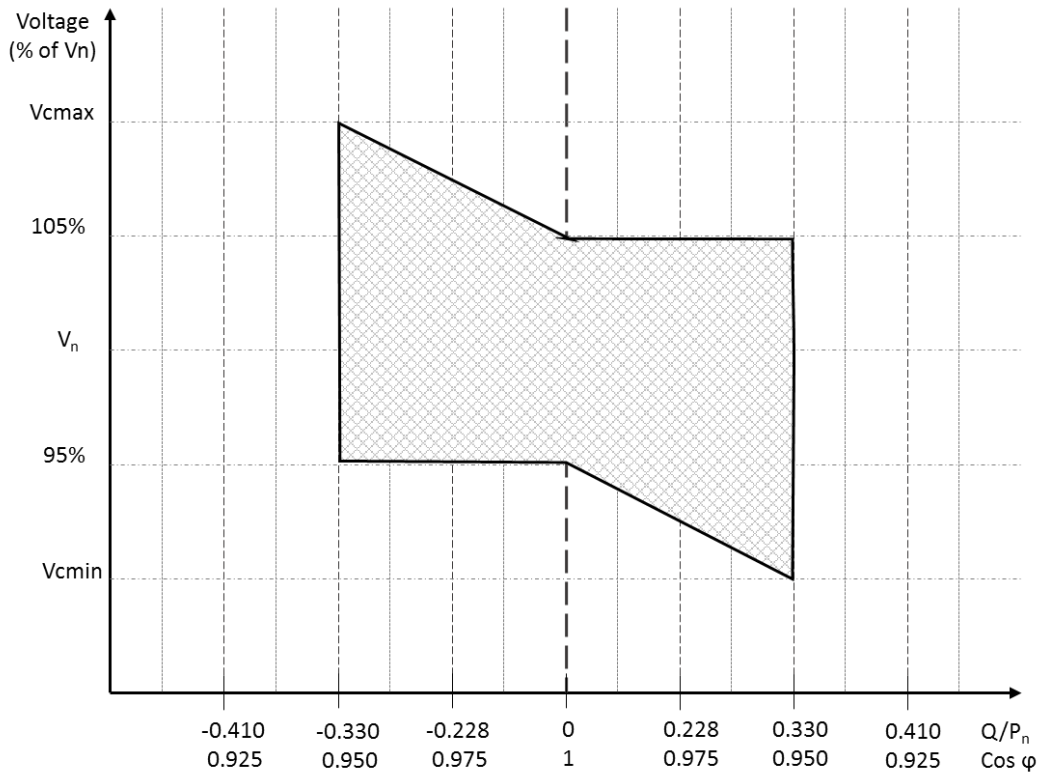


Figure 2: Reactive power requirements for DN connected VRPPs (corresponding to voltage)

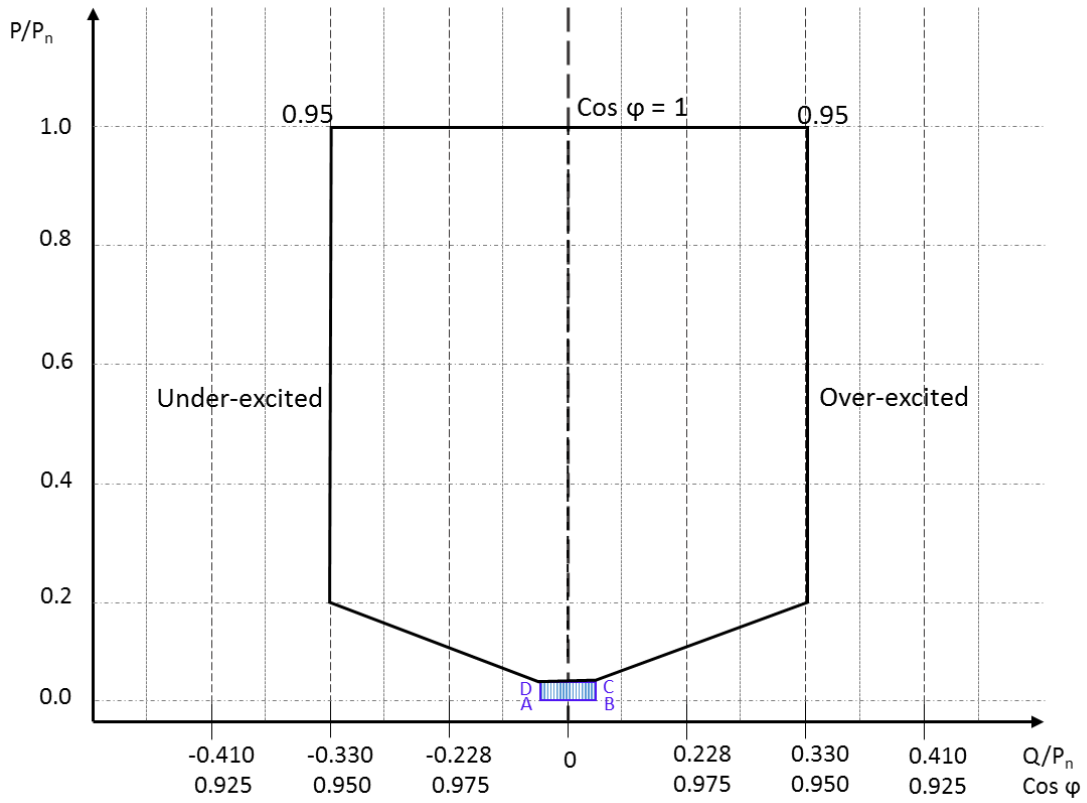


Figure 3: Reactive power requirements for DN connected VRPPs at full and partial active power output conditions

2.6 Reactive Power Control Requirements

2.6.1 General

- (1). A VRPP shall be equipped with control functions to control reactive power at the POC following instructions from the DU using set-points and gradients and the parameter settings shall be agreed between the DU and a VRPP operator shall be as documented in the relevant System Operational Manual.
- (2). A VRPP shall support each of the following control functions:
 - a. Q control (details in 2.6.2)
 - b. Power Factor Control
- (3). The choice of control mode and the definition of target values shall be within the responsibility of the DU and it must be possible for the DU to change control mode and target values at any time during the lifetime of a VRPP.

2.6.2 Reactive Power Control (Q Control)

- (1). A VRPP shall be capable of controlling reactive power at the POC either to a constant reactive power target (Q-target) or an active power dependent reactive power target (Q(P)).
- (2). The DU shall define the actual settings of the Q/ Q(P) control characteristic (shape of Q(P)-characteristic, target values).
- (3). If the control target is changed by DU, such change shall be completed not later than 2 minutes after the receipt of the new target value.
- (4). The maximum permitted deviation of actual reactive power from the Q-target shall not be greater than 2% of rated power, that is 0.02 p.u., 2 minutes after change of Q-target during steady system conditions.

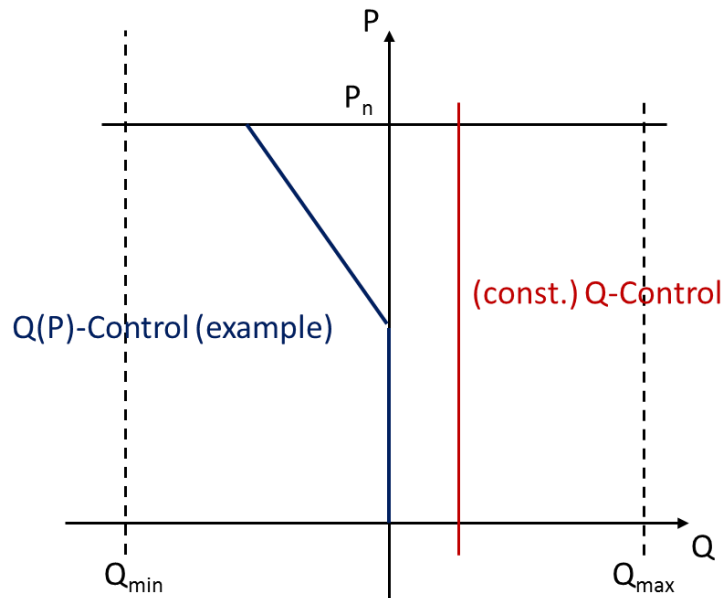


Figure 4: Reactive power control function of DN connected VRPP (const Q-control and Q(P)-control)

2.6.3 Power Factor Control (Cos ϕ -Control)

- (1). A VRPP shall be capable of controlling power factor at the POC either to a constant power factor target (cos ϕ -target) or an active power dependent power factor target (cos ϕ (P)).
- (2). The DU shall define the actual settings of the cos ϕ /cos ϕ (P) control characteristic (shape of cos ϕ (P)-characteristic, cos ϕ -target).
- (3). If the control target is changed by DU, such change shall be completed not later than 2 minutes after the receipt of the new target value.
- (4). The maximum permitted deviation of actual power factor from the cos ϕ -target shall be no greater than $\Delta \text{cos}\phi = 0.005$, 2 minutes after change of cos ϕ -target during steady system conditions.

2.7 Active Power Control

- (1). For system security reasons it may be necessary for the ETU or DU to curtail a VRPP's active power output.
- (2). A VRPP shall be capable of operating at a reduced power level if active power has been curtailed by ETU or DU, for network or system security reasons;
- (3). The accuracy of the control performed and of the set-point shall not deviate more than ± 1 % of the rated power.
- (4). The type of communication between a DU and a VRPP operator must be agreed between the parties and specified as part of the bilateral connection agreement.
- (5). The relationship between the ETU and a VRPP shall be specified as part of the bilateral connection agreement between the DU and a VRPP.

2.8 Frequency Response

2.8.1 High Frequency Response for VRPPs

- (1). During high frequency operating conditions in NITS and DN, each DN connected VRPP shall be required to operate at reduced active power output in order to stabilize grid frequency.
- (2). When the frequency on the NITS and DN exceeds 50.2 Hz, each VRPP shall be required to reduce active power as a function of change in frequency as illustrated in Figure 5.
- (3). High frequency response must operate with a minimum gradient of 100% of rated power per minute as provided by the primary frequency control time scales.

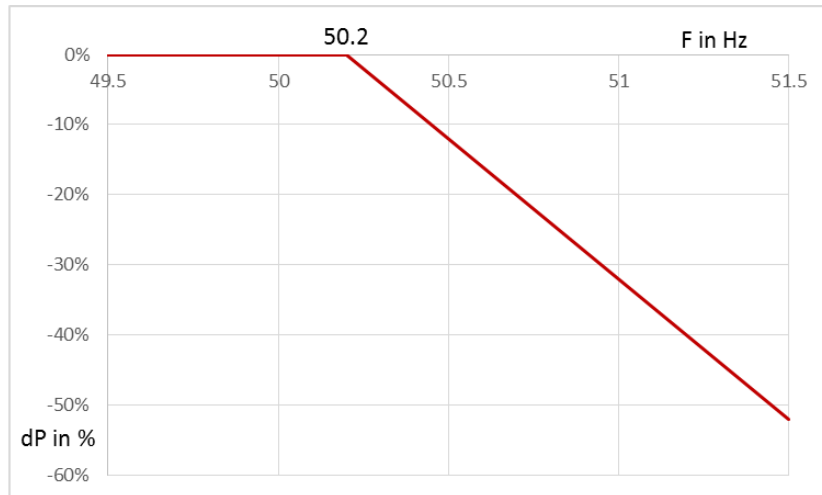


Figure 5: Mandatory high frequency response for all DN connected VRPPs

Note: 'dP' in the figure represents percentage of active power by which the output has to be decreased in case of increasing system frequency.

2.8.2 Primary and Secondary Frequency Control

- (1). Unless otherwise required by the ETU/DU, a VRPP shall be exempted from primary or secondary frequency control capabilities except from high frequency response according to section 2.8.1.

2.9 Behaviour during Abnormal Voltage Conditions

2.9.1 Low Voltage Ride Through (LVRT) / High Voltage Ride Through (HVRT) Capability for VRPPs

- (1). A VRPP shall be designed to operate for up to one minute within a voltage range of +/-15% of nominal voltage.
- (2). A VRPP shall be designed to have LVRT and HVRT capability as illustrated in Figure 6.
- (3). For all voltages at the POC, which are between the HVRT (red) and the LVRT (blue) lines according to Figure 6, no disconnection of a VRPP or of individual units within a VRPP shall be permitted.
- (4). The voltage at POC is defined to be the lowest of the three line-line or line-earth voltages.
- (5). If the voltage reverts to the Continuous Voltage Range (between V_{cmin} and V_{cmax}) during a fault sequence resulting from reclosing, subsequent voltage drops or voltage spikes shall be regarded as new LVRT or HVRT condition.

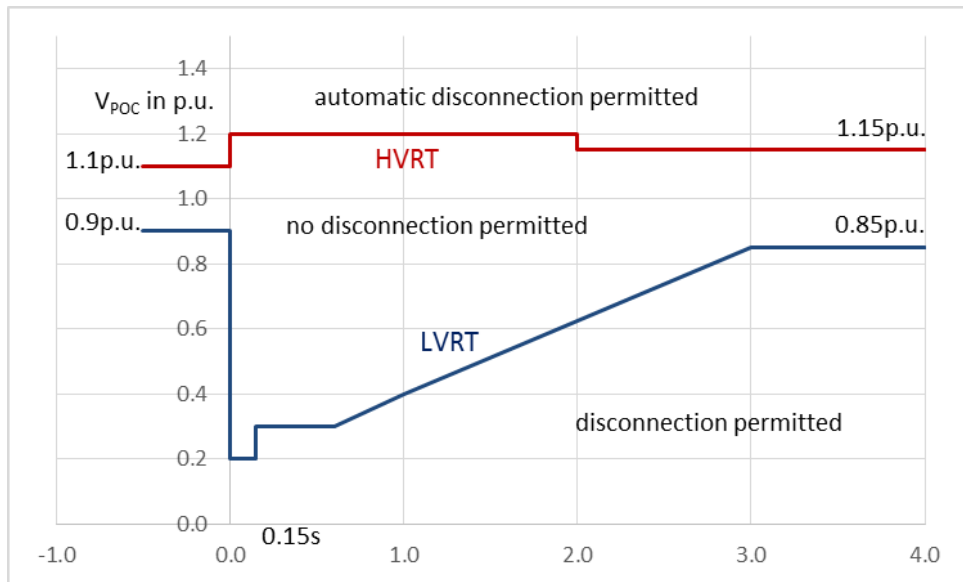


Figure 6: LVRT and HVRT capability for DN connected VRPPs

2.9.2 Reactive Current Support During LVRT/HVRT Situations

During a LVRT or HVRT situation, any VRPP having a direct connection to the secondary side of a substation shall support the DN voltage by injecting (or absorbing) reactive current as follows:

- (1). All units within a VRPP shall support the voltage by injecting or absorbing additional reactive current ΔI_Q at the generator terminals proportional to the change of the unit's terminal voltage ΔV_t , as depicted in Figure 7.
- (2). The factor of proportionality between additional reactive current and voltage deviation is named K ($\Delta I_Q = K \Delta V_t$ and the factor K must be set within the range of $0 \leq K \leq 10$).
- (3). The absolute value I of current in each of the three phases of the unit's terminals may be limited to rated current (1 p.u.).

Notes:

1. Voltages and currents in this section are defined to be positive sequence components of fundamental frequency value of voltages and currents respectively. This applies to pre-fault and post-fault voltages and currents.
2. The additional reactive current ΔI_Q shall be injected in addition to the pre-fault voltage.
3. The positive sign of ΔI_Q in Figure 7 is voltage supporting injection of reactive power.
4. The voltage deviation ΔV_t is defined by the difference between the pre-fault and the post-fault voltage.
5. The pre-fault current and pre-fault voltage are defined by the 1-minute average of current and voltage respectively.

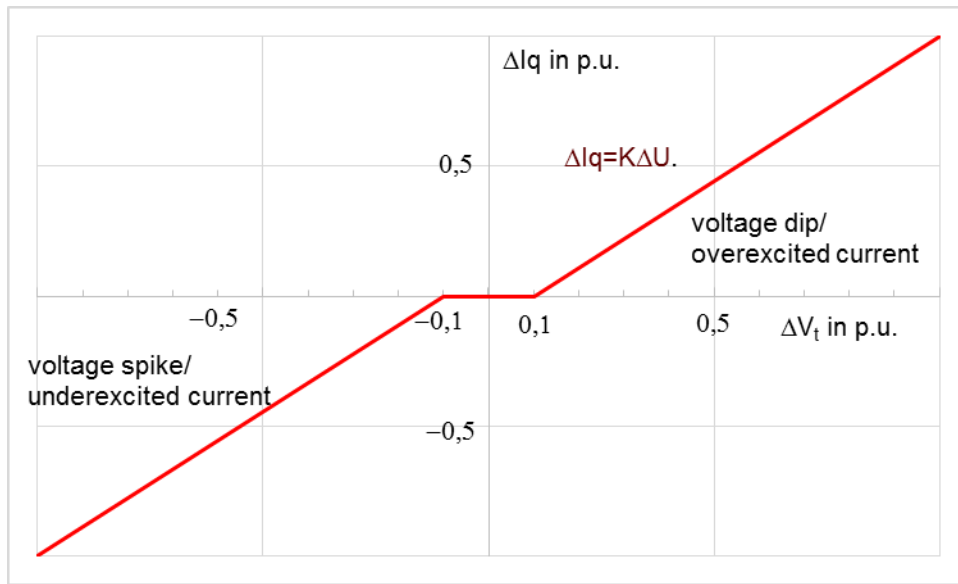


Figure 7: Reactive current support ΔI_Q during LVRT and HVRT situations at the unit's terminals

- (4). During dynamic performance, after 60ms the additional current must have settled, meaning that it shall remain within a tolerance band of $\pm 20\%$ around the value according to Figure 7.
- (5). During a LVRT situation, a VRPP having a connection on a distribution feeder shall control active and reactive power according to a "zero current" strategy, meaning that both, active and reactive current shall be reduced to zero.
- (6). During a HVRT situation, a VRPP having a connection on a distribution feeder shall maintain normal active and reactive power control modes.

2.9.3 Active and Reactive Power Behaviour During Voltage Recovery

- (1). After voltage at POC has returned into the range of $\pm 15\%$ of nominal voltage, a VRPP shall restore its active power output to at least 90% of its pre-fault value within 1 second.
- (2). During voltage recovery, a VRPP shall not absorb more reactive power than prior to the LVRT situation.

2.10 Automatic Resynchronisation

- (1). Automatic synchronization device and automatic close equipment shall be installed by VRPP owner to connect to the DN automatically, with a delay of 5 minutes, if the following system conditions are fulfilled:
 - a. Voltage at the POC is within the Steady State Range of +/-10% of nominal voltage, as specified in the National Electricity Grid Code
 - b. Frequency is within the range of $49.8 \text{ Hz} \leq F \leq 50.2 \text{ Hz}$.
- (2). During automatic connection and synchronisation, a VRPP shall ensure compliance with “rapid voltage change” requirements according to section 2.4.1.

2.11 Protection and Fault Levels

- (1). A VRPP operator shall design, implement, coordinate and maintain its protection system to ensure the desired speed, sensitivity and selectivity in clearing faults on VRPP’s side of the connection point (POC).
- (2). Protection functions required for protecting the NITS or DN from getting out of normal operating ranges shall be specified by the DU in consultation with the ETU, including trip-settings and response times.
- (3). A VRPP shall be equipped with effective detection of islanded operation in all system configurations and shall have the capability to shut down generation of power in such condition within 2 seconds.
- (4). Operation in island with part of the DN shall not be permitted unless specifically agreed with the ETU and DU.
- (5). The coordination among protections at connection point shall be agreed between ETU, DU, and a VRPP operator.
- (6). The circuit breaker used for connection switching in the DN connected generators shall be equipped with a disconnection system to ensure safe operation during re-connection and re-synchronization to the DN.
- (7). The DU may request that the set values for protection functions be changed following commissioning if it is deemed to be of importance to the operation of the NITS and DN except that, such a change shall not result in a VRPP being exposed to negative impacts from the DN lying outside of the design requirements.
- (8). The DU shall inform a VRPP operator of the highest and lowest short-circuit current that shall be expected at the POC as well as any other information about the DN as may be necessary to define the VRPP’s protection functions.
- (9). Where a VRPP’s protection equipment is required to communicate with the DU’s protection equipment it must meet the communications interface requirements specified by the DU and this Sub-Code.

2.12 Communication and Control

- (1). A VRPP shall be equipped to receive target values for control purposes from the ETU such as voltage/reactive power control according to section 2.6, active power curtailment according to 2.7 and other control functions as it may be applicable.
- (2). All further requirements with regard to the exchange of information shall be agreed on between a VRPP operator and DU within the bilateral connection agreement.

PART C:

3 Testing, Inspection and Compliance Monitoring

- (1). A VRPP operator shall demonstrate compliance to all applicable requirements specified in this Sub-Code and any other applicable code or standard approved by DU in consultation with ETU, as applicable, before being allowed to connect to the DS and operate commercially.
- (2). A VRPP operator shall review and confirm to the DU, compliance by the VRPP with every requirement of this Sub-Code and shall do so according to article 19.65 of the National Electricity Distribution Code.
- (3). A VRPP operator shall conduct tests or studies to demonstrate that the VRPP complies with each of the requirements of this Sub-Code and submit such test reports to the DU.
- (4). A VRPP operator shall continuously monitor its compliance in all material respects with all the connection conditions of this Sub-Code.
- (5). The DU may issue an instruction requiring a VRPP operator to carry out a test to demonstrate that the VRPP complies with this Sub-Code's requirements and a VRPP operator shall not refuse such an instruction.
- (6). A VRPP operator shall keep records relating to the compliance of the VRPP with each section of this Sub-Code, or any other code applicable to that VRPP, setting out such information that the DU reasonably requires for assessing power system performance, including the actual VRPP performance during abnormal or continuous operating conditions.
- (7). Records generated under Part C of this Sub-Code shall be kept for a minimum of 5 years unless otherwise specified in this Sub-Code commencing from the date the information was generated.