Application Note - SolarEdge Three Phase Inverters, Power Control Options

Version History

- Version 6 (February 2019)
  - Removed display based configuration
  - Removed Appendix B
  - Align values notation
  - Removed power phase balancing
- Version 5 (December 2018)
  - Q Configuration Appendix update
- Version 4 (November 2018)
  - Added SetApp menus
  - Added Diesel Generator menu options
  - Active Power ramp-up firmware information
  - Phase balancing – supporting firmware information
- Version 3 (December 2017)
  - Added Active Power ramp-up option
  - Added new active power phase balancing feature
- Version 2 (November 2017)
  - Added Demand Response Enabling Device (DRED) connectivity option
  - Clarified correct cosphi(p) setting
  - Removed Active Power phase balance option
  - Removed country defaults list
  - New appendix with explanation of cosphi
- Version 1 (December 2012)

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Introduction
To improve grid stability, many electric utilities are introducing advanced grid limitations, requiring control of the active and reactive power of the inverter by various mechanisms.

SolarEdge inverters with CPU version 2.337 and later support these requirements (some features may require later versions; refer to the relevant feature for details). These inverters include default settings per country, based on the specific requirements in that country, as well as the ability to configure these settings (settings may have to be configured according to installation size or utility requirements).

This document details the available power control configuration options in the inverters, and explains how to adjust these settings if such changes are required, using SetApp.

Installation Note for Three Phase Inverters
If power control is enabled, the order of connection of grid lines to the inverter is important. A 120 degree phase difference between L1 and L2 and between L2 and L3 should be maintained (L1-L2-L3 and not, for example, L1-L3-L2

Power Control Hierarchy
Multiple control modes can be used to control inverter active and reactive power. This section details the mode hierarchy in case multiple modes are active.

Reactive Power Control
The following scenarios describe reactive power control conditions:

- If RRR is disabled, and “Reactive Pwr. Conf ➔ Mode” is not set to RRR, the RRR points will be ignored.
- If RRR is enabled, and “Reactive Pwr. Conf ➔ Mode” is set to RRR, the RRR points will control active power and reactive power.
- If RRR is enabled, and “Reactive Pwr. Conf ➔ Mode” is not set to RRR, the RRR points will control only active power, and reactive power will be controlled by the selected mode.
Active Power Control

The following modes can control the active output power of the inverter:

- RRCR
- Power Limit <\%>
- Current Limit <A>
- wakeup Gradient
- P(f)
- P(V)

If several control modes are active, the output power of the inverter will be the minimum power. For example, if an RRCR point is configured to “Pwr Reduce=60%” and “Active Power Conf. → Power Limit=70%”, the output power will be limited to 60% of Pnom.

Power Control Options

The inverter power control options are described in the following sections:

- Grid Control
- Energy Manager
- RRCR Configuration
- Reactive Power Configuration
- Active Power Configuration
- Wakeup Configuration
- Error! Reference source not found.

Advanced

- Load Defaults

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NOTE:
CosPhi Value notations:
- Setting positive CosPhi will lead to inductive / current lagging voltage / sinking behaviour.
- Setting negative CosPhi will lead to capacitive / current leading voltage / sourcing behaviour.

---

NOTE:
Q Value notations:
- Setting positive Q will lead to capacitive / current leading voltage / sourcing behaviour
- Setting negative Q will lead to inductive / current lagging voltage / sinking behaviour.

Grid Control

The Grid Control feature may be enabled or disabled by default, depending on the country setting. When disabled, the following menus do not appear:

- Reactive Pwr Conf.
- Active Pwr Conf.
- Wakeup Conf.
- Advanced

To show these menus, enable Grid Control.

To configure the Grid Control solution using SetApp, click here.
Energy Manager

SolarEdge offers the Smart Energy Management solution for increasing the self-consumption of a site. One method used for this purpose is limiting the export power: The inverter dynamically adjusts the PV power production in order to ensure that export power to the grid does not exceed a preconfigured limit. To enable this functionality, an energy meter that measures export or consumption must be installed at the site.

To configure the Smart Energy Management solution using SetApp, click here.

RRCR Configuration

SolarEdge inverters can connect to an external device, which can control active and reactive power according to commands sent by the grid operator (examples, RRCR – Radio Ripple Control Receiver, DRED – Demand Response Enabling Device).

Use the RRCR Conf. menu to enable this control and to configure up to 16 control states. Each control state is composed from the following three fields:

- **AC output power limit** – limits the inverter’s output power to a certain percentage of its rated power with the range of 0 to 100 (% of nominal active power).
- **CosPhi** – sets the ratio of active to reactive power. The Reactive Power Conf. Mode must be set to RRCR when using this control mode. The CosPhi range is from 0.8 leading to 0.8 lagging.
- **Enable/Disable** – enables or disables control according to the specific state.


To control active and reactive power with the RRCR function using SetApp, click here.

Reactive Power Configuration

Use the Reactive Power menu to select one of the reactive power control modes listed below, and to configure the various modes:

- **CosPhi** – sets a constant CosPhi, regardless of other parameters. Range: from 0.8 leading to 0.8 lagging.
- **CosPhi(P)** – sets a graph of CosPhi to active power (P). CosPhi(P) has a 6-point graph setup. P can be set to any value between 0 and 100 [% of nominal active power], and should increase from P(0) to P(5). CosPhi can be set to any value between “0.8 leading” and “0.8 lagging”. Each point includes the following fields: < % of nominal active power, CosPhi >.
- **Q** – sets constant reactive power (Q). Range: -100 to 100 (% of nominal reactive power).
- **Q(U)+Q(P)** – sets a graph of reactive power (Q) to grid voltage (U) and to active power (P); this mode can be used when Q(U) control is required, by setting Q(P) to zero, and vice versa. Q(U) and Q(P) have 6-point graph setups. Refer to Appendix A – Q Configuration on page 14 for additional configuration instructions.
  - U: 0 to 200 [% of nominal voltage].
  - P: 0 to 100 [% of nominal active power]
- **RRCR** – enables CosPhi control through the RRCR. RRCR must be enabled when using this control mode.
- **Unom** – The Reactive Power menu is also used to set Unom, a reference grid voltage, when required for installation testing. Range: 0 to 500 [V].

To control reactive power using SetApp, click here.
Active Power Configuration

Use the Active Power menu to control the inverter active power:

- **Power Limit** – limits the inverter maximum output power. The power limit can be set to any value between 0-100 [% of nominal active power].
- **Current Limit** – Current Limit: limits the inverter’s maximum output current (available from inverter CPU version 2.549). The current limit can be set to any value between 0 and the inverter’s max AC current [A].
- **Wakeup Grad** – Wakeup Gradient: enables gradual power production when it begins operation after a fault or an inverter reset. For gradual power production during normal operation, use the Ramp Rate option.
- **Grad Time** – Gradient Time: The wakeup time setting. This line is displayed only if the Wakeup Gradient is enabled. Can be set to any value between 1 and 9999 seconds.
- **P(f)** – Power Frequency: This is used when frequency-based power reduction is required. This defines a linear graph set by two points. The inverter de-rates power according to the defined graph, until the frequency reaches the trip value and the inverter disconnects (the trip point is preset per country therefore does not need to be defined as one of the two points).
- **P(V)** – Power Voltage: This is used when voltage-based power reduction is required. This defines a linear graph set by six points (available from inverter CPU version 3.1808). The inverter de-rates power according to the defined graph, until the voltage reaches the trip value and the inverter disconnects.
- **Ramp Rate** – enables gradual power production during normal operation (available from inverter CPU version 3.22xx). Can be set to any value between 0-100%/sec with 0.1% resolution. A ramp rate of 0 means that the production increase is immediate.

NOTE: The Ramp Rate feature is not supported in inverter CPU version 4.x.xxx.

To control active power using SetApp, click [here].

Wakeup Configuration

Use the Wakeup menu to set the minimum and maximum grid frequencies and grid voltages between which the inverter can begin power production. This menu does not set the inverter disconnection values, which are pre-set per country.

The ranges for Wakeup parameters are:

- Frequency: 0 to 100 [Hz]
- Voltage 0 to 500 [V]

To configure wakeup settings using SetApp, click [here].

Advanced

Use the Advanced menu to configure the following settings:

- **K-Factor**. For BDEW-MVGC certification in Germany. It is set to a default value of 2.
- **FRT-K**. The range for the FRT-K parameter is 0 to 16.

To configure advanced using SetApp, click [here].

Load Defaults

Use the Load Defaults menu to restore the default Power Control settings of the country to which the inverter is set, according to the settings detailed below. The following configurations are not reset when you select the Load Defaults option:

- Energy Manager
- Power Reduction Interface / RRCRConf.
Power Control Configuration using SetApp

Access SetApp from your mobile device and select Commissioning ➔ Power Control.

### Commissioning

- Country and Language
- Pairing
- Communication
- Power Control
- Device Manager
- Maintenance
- Information
- Site Configuration
- Status

### Power Control

- Grid Control
- Energy Manager
- Power Reduction Interface (RRCR)
- Reactive Power
- Active Power
- Wakeup Configuration
- Advanced
- Load Defaults

The sections below describe how to configure each of these menu options.

Please notice that the actual menus in the SetApp may differ from the drawings below.

**Grid Control**

The Grid Control menu options appear in the figure below.

1. To enable/disable Grid control:
   - From the Power Control Menu, select Grid Control and select Enable or Disable.
Energy Manager


RRCR Configuration

The RRCR menu options appear in the figure below.

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To enable/disable RRCR control:
1. Make sure the inverter is connected to a power reduction device.
2. From the Power Control Menu, select Power Reduction Interface (RRCR) ➔ Power Reduction Interface (RRCR) ➔ Select Enable or Disable

To enable/disable any of the 16 states and set its values:
1. From the Power Control Menu, select Power Reduction Interface (RRCR) ➔ Set Values. Select one of the 16 states to edit.
2. In the PRI (RRCR) Setting screen, set the following values as required:
   - Select Enable or Disable.
   - In the Power Output (Pout) field, enter the output power as a percentage of rated power.
Reactive Power Configuration

The Reactive Power menu options are depicted in the figure below.

1. From the Power Control menu, select Reactive Power  ➔ Mode.
2. Select a mode from the Reactive Power Mode menu.

To set the values of a reactive power control-mode:
1. From the Power Control menu, select Reactive Power.
2. Scroll the Reactive Power menu, and select the mode you wish to configure.
3. Enter the mode's settings.
Active Power Configuration

The Active Power menu options are depicted in the figure below.

→ To change the power or current limit:
  1. From the Power Control menu, select Active Power ➔ Mode
  2. Choose Power Limit or Current Limit and enter the required setting.

→ To set gradual power production:
  1. From the Power Control menu, select Active Power ➔ Wakeup Gradient ➔ Enable
  2. Select Gradient Time and enter the gradient time in seconds.

→ To set P(f) and change the P or f values:
  1. From the Power Control menu, select Active Power ➔ P(f)
  2. In the P(f) menu, enter Frequency (Hz) and P (% of nominal active power) values for P0 and P1.

→ To set P(V) and change the P or V values:
  1. From the Power Control menu, select Active Power ➔ P(V)
  2. In the P(V) menu, enter Voltage (V) and P (% of nominal active power) values for points P0 to P5.
Wakeup Configuration

The Wakeup menu options are depicted in the figure below.

1. From the Power Control menu, select **Wakeup Configuration**
2. In the Wakeup Configuration screen, set the values for the following parameters:
   - Minimum wakeup frequency [Hz]
   - Maximum wakeup frequency [Hz]
   - Minimum wakeup voltage – Vgrid [Vac]
   - Maximum wakeup voltage – Vgrid [Vac]

Diesel Generator Configuration

Advanced

The Advanced function menu options are depicted in the figure below.
To set FRT-K:

1. From the Power Control menu, select Advanced
2. In the Advanced Power Control screen Set FRT and select Enable or Disable
3. If FRT was enabled, select FRT-K Factor, and input the required value.

Load Defaults

The Load Defaults function is depicted in the figure below.

To restore country default power control settings:

1. From the Power Control menu, select Load Defaults.
2. When prompted to confirm, select Yes.
Power Control Status

Power control status information appears in the Status screen shown in the figure below.

<table>
<thead>
<tr>
<th>Status</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Inverter</td>
<td>Power 7.60 kW</td>
<td>Voltage 240 Vac</td>
</tr>
<tr>
<td></td>
<td>Frequency 60.9 Hz</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>P_OK:</strong> 30 of 30 Optimizers Connected</td>
<td><strong>S_OK</strong> Server Connected (LAN)</td>
</tr>
<tr>
<td>Status Production</td>
<td>Switch</td>
<td>ON</td>
</tr>
<tr>
<td>Cos Phi</td>
<td>Limit</td>
<td>Country USA2</td>
</tr>
<tr>
<td>1.00</td>
<td>No Limit</td>
<td></td>
</tr>
<tr>
<td>Voltage</td>
<td>Temp.</td>
<td>Fan</td>
</tr>
<tr>
<td>380 Vdc</td>
<td>156 F</td>
<td>OK</td>
</tr>
<tr>
<td>Communication</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LAN Connected</td>
<td>RS485-1 SE Slave NC</td>
</tr>
<tr>
<td></td>
<td>Cellular NA</td>
<td>Wi-Fi NC</td>
</tr>
<tr>
<td></td>
<td>RS485-2 Modbus 2 of 2</td>
<td>ZigBee NC</td>
</tr>
<tr>
<td>Inverter Energy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Today</td>
<td>This Month</td>
<td>This Year</td>
</tr>
<tr>
<td>45 kWh</td>
<td>1.14 MWh</td>
<td>13.68 MWh</td>
</tr>
<tr>
<td>Total:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>41.03 MWh</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The following power control fields appear in the Status screen:

- **Cos Phi**: The ratio between active to reactive power
- **Limit**: The inverter maximum output power set by the smart energy manager
- **Inverter Energy**: The power produced by the inverter during the current day, month, year, and overall.
Identifying the Inverter’s CPU Version

This section describes how to identify the inverter CPU version.

→ To obtain the CPU version information using SetApp.

<table>
<thead>
<tr>
<th>Commissioning</th>
<th>Information</th>
</tr>
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<tbody>
<tr>
<td>Country and Language</td>
<td>CPU Version</td>
</tr>
<tr>
<td>Pairing</td>
<td>4.0000.0000</td>
</tr>
<tr>
<td>Communication</td>
<td>DSP Version</td>
</tr>
<tr>
<td>Power Control</td>
<td>1.0210.1966</td>
</tr>
<tr>
<td>Device Manager</td>
<td>DSP2 Version</td>
</tr>
<tr>
<td>Maintenance</td>
<td>2.0652.0410</td>
</tr>
<tr>
<td>Information</td>
<td>Serial Number</td>
</tr>
<tr>
<td>Site Configuration</td>
<td>7F12B6A09-33</td>
</tr>
<tr>
<td>Status</td>
<td>Hardware IDs</td>
</tr>
<tr>
<td></td>
<td>Error Log</td>
</tr>
<tr>
<td></td>
<td>Warning Log</td>
</tr>
</tbody>
</table>
Appendix A – Q Configuration

If the utility requires Q(U) control of the inverter, it will typically provide a linear graph including Umin, Umax, Q(Umin) and Q(Umax) values.

**NOTE:**

Q controls are also valid for single phase inverters manufactured after week 44 2014. To check an inverter manufacturing week, check its serial number: the 3rd and 4th characters indicate the production week; 5th-6th characters indicate the year. For example, an inverter with serial number SJ511A-07F004FE5-B3 was manufactured in week 51 2014.

To translate this graph into values to be configured in the inverter, follow the definitions and instructions below. Bold-face Q and U are the values that should be set in the inverter:

- **Qmax** = 1.0 * Smax – for the following inverter DSP1 versions, for all countries except Austria:
  - Single Phase Inverters with HD-Wave Technology: version 1.0.658 and above
  - Single Phase (non HD-Wave) Inverters should be upgraded to version 1.210.14xx or above
  - Three Phase Inverters with synergy technology: version 1.13.11xx and above

- **Qmax** = 0.6 * Smax – for the following inverter DSP1 versions:
  - Single Phase Inverters with HD-Wave Technology: versions lower than 1.0.658
  - Three Phase Inverters with synergy technology: versions lower than 1.13.11xx

**NOTE:**

\[ Q_{\text{max}} = \sin \phi \times S_{\text{max}} = \sin(\cos^{-1} \frac{5}{6}) \times S_{\text{max}} \]

Optimally, CosPhi is set to a min/max value of -0.8/0.8 and therefore, \( \sin(\cos^{-1} 0.8) = 0.6 \)

**NOTE:**

After upgrading the DSP1 version in an inverter, you must re-select the country. This ensures that the Q value is correctly configured, with \( S_{\text{max}} = 100\% \) (\( S_{\text{max}} = 43.5\% \) in Austria).

Set the 6 points that create the linear Q(U) graph (see the table below) to the following values:

- Q values are in terms of Q/Qmax.
- U value are in terms of U/Unom.

<table>
<thead>
<tr>
<th>Point</th>
<th>U</th>
<th>Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>P0</td>
<td>Umin</td>
<td>Q(Umin)</td>
</tr>
<tr>
<td>P1</td>
<td>Umin</td>
<td>Q(Umin)</td>
</tr>
<tr>
<td>P2</td>
<td>Umin</td>
<td>Q(Umin)</td>
</tr>
<tr>
<td>P3</td>
<td>Umax</td>
<td>Q(Umax)</td>
</tr>
<tr>
<td>P4</td>
<td>Umax</td>
<td>Q(Umax)</td>
</tr>
<tr>
<td>P5</td>
<td>Umax</td>
<td>Q(Umax)</td>
</tr>
</tbody>
</table>

**NOTE:**

The inverter requires the entry of six points. If fewer than 6 points are provided by the utility, use the same Q (Y axis) value for different points in the graph.
If you have technical queries concerning our products, please contact us:

<table>
<thead>
<tr>
<th>Region</th>
<th>Phone Number</th>
<th>Email Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia (+61)</td>
<td>1800 465 567</td>
<td><a href="mailto:support@solaredge.net.au">support@solaredge.net.au</a></td>
</tr>
<tr>
<td>APAC (Asia Pacific) (+972)</td>
<td>073 2403118</td>
<td><a href="mailto:support-asia@solaredge.com">support-asia@solaredge.com</a></td>
</tr>
<tr>
<td>Belgium (+32)</td>
<td>0800-76633</td>
<td><a href="mailto:support@solaredge.be">support@solaredge.be</a></td>
</tr>
<tr>
<td>Netherlands (+31)</td>
<td>0800-7105</td>
<td><a href="mailto:support@solaredge.nl">support@solaredge.nl</a></td>
</tr>
<tr>
<td>China (+86)</td>
<td>21 6212 5536</td>
<td><a href="mailto:support_china@solaredge.com">support_china@solaredge.com</a></td>
</tr>
<tr>
<td>France (+33)</td>
<td>0800 917 410</td>
<td><a href="mailto:support@solaredge.fr">support@solaredge.fr</a></td>
</tr>
<tr>
<td>DACH and Rest of Europe (+49)</td>
<td>089 454 59730</td>
<td><a href="mailto:support@solaredge.de">support@solaredge.de</a></td>
</tr>
<tr>
<td>Italy (+39)</td>
<td>0422 053700</td>
<td><a href="mailto:support@solaredge.it">support@solaredge.it</a></td>
</tr>
<tr>
<td>Japan (+81)</td>
<td>03 6262 1223</td>
<td><a href="mailto:support@solaredge.jp">support@solaredge.jp</a></td>
</tr>
<tr>
<td>New Zealand (+64)</td>
<td>0800 144 875</td>
<td><a href="mailto:support@solaredge.net.au">support@solaredge.net.au</a></td>
</tr>
<tr>
<td>United Kingdom (+44)</td>
<td>0800 028 1183</td>
<td><a href="mailto:support-uk@solaredge.com">support-uk@solaredge.com</a></td>
</tr>
<tr>
<td>US &amp; Canada (+1)</td>
<td>510 498 3200</td>
<td><a href="mailto:ussupport@solaredge.com">ussupport@solaredge.com</a></td>
</tr>
<tr>
<td>Greece (+49)</td>
<td>89 454 59730</td>
<td></td>
</tr>
<tr>
<td>Israel (+972)</td>
<td>073 240 3122</td>
<td></td>
</tr>
<tr>
<td>Middle East &amp; Africa (+972)</td>
<td>073 2403118</td>
<td><a href="mailto:support@solaredge.com">support@solaredge.com</a></td>
</tr>
<tr>
<td>South Africa (+27)</td>
<td>0800 982 659</td>
<td></td>
</tr>
<tr>
<td>Turkey (+90)</td>
<td>216 706 1929</td>
<td></td>
</tr>
<tr>
<td>Worldwide (+972)</td>
<td>073 240 3118</td>
<td></td>
</tr>
</tbody>
</table>

Before contact, make sure to have the following information at hand:

- Inverter and power optimizer model numbers
- Serial number of the product in question
- The error indicated on the inverter screen or on the SolarEdge monitoring portal, if there is such an indication.
- System configuration information, including the type and number of modules connected and the number and length of strings.
- The communication method to the SolarEdge monitoring portal, if the site is connected
- Inverter software version as appears in the ID status screen.