Quickstart: **Micro inverter**

Technische specificaties

Voltage	230Vac
RF Frequency Z-Wave	868.42 MHz
Average wireless range	10 to 30m
Solar panel max load	300 W

AC power connector

Solar panel connectors

Basic functions

- Monitoring of single solar panels.
- Reporting of instant values such as energy, VDC, IDC and temperature.
- Reporting of cumulative energy value of the connected solar panel in kWh.
- Reporting of a possible error of the hardware.

How it works

Built-in hardware converts the solar panels DC signal to AC voltage. The information is monitored and can be requested by a Z-Wave Controller. It is a micro inverter so it can be connected to a single solar panel (up to 300 watt). And since it can monitor single solar panels the (possible) loss is kept to a minimum.

Mounting

1. Connect the solar panel output connectors to the solar panels input connectors on the micro inverter.
2. Connect a power cable to the AC power connector on the micro inverter.
3. Connect the other side of the power cable to the mains power.

Add to a Z-Wave network[1]

Caution: Risk of fatal injury from electric current. Make sure you are qualified to install this product.
- Adding can be done 2 different ways:
  1. Startup the Micro Inverter by applying its power. The Add mode will go on for circa 30 minutes.
  2. If the Micro Inverter is already mounted (and therefore provided of power) press and hold the push button (inside the housing) for 2 seconds and release it to start the add mode.

Remove from a Z-Wave network

- Removing can be done 2 different ways:
  1. Press and hold the push button (inside the housing) for 2 seconds and release it to start the remove mode. [2]
  2. Start the remove mode (as described in point 1). During the remove mode press the button for 4 times within 1,5 seconds. [3]

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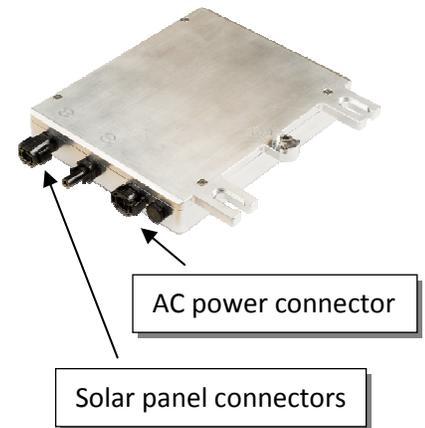
[1] A Z-Wave controller should be in add mode to complete the installation successfully.

[2] A Z-Wave controller should be in remove mode to complete the de-installation successfully.

[3] The product is forced removed. There is no need for a Z-Wave controller to complete de-installation successfully.

Technical Manual: **Micro Inverter**

Caution:
- **This device is using a radio signal that passes through walls, windows and doors. The range is strongly influenced by local conditions such as large metal objects, house wiring, concrete, furniture,**
- **Do not attempt to repair this product. If the product is damaged or if you are in doubt about the proper operation, take the product back to the place of purchase.**
- **Do not clean the product with any liquid.**

Voltage AC (Un)	230Vac
Voltage	176~276Vac
Frequency range	868.42 MHz (EU)
Wireless range Mesh-network	30 line of sight 100-300 meter (with a maximum of 4 hops)
Environmental Category	For outdoor use
Pollution degree	3
Ingress protection	IP66
Operating temperature	-35°C to +85°C
Operating humidity	4% to 100%
Maximum Altitude	2000 m
Maximum load solar panel	300 watt
Z-Wave Security	Yes

Product dimensions

Height: 22

Width: 17

Height: 3

LED indication mode

The micro inverter doesn't have an indication led.

Z-Wave Plus

Z+ Device type: Sub Energy Meter
Z+ Role type: REPORTING_SLEEPING_SLAVE

Generic type: GENERIC_TYPE_METER
Specific type: SPECIFIC_TYPE_SIMPLE_METER
Listening: FALSE, Z-Wave Lib: 6.51.06
Z-Wave Security: Yes

Supported command classes:

class: 0x5E COMMAND_CLASS_ZWAVEPLUS_INFO_V2 **(S)**,
class: 0x26 COMMAND_CLASS_VERSION_V2 **(S)**,
class: 0x72 COMMAND_CLASS_MANUFACTURER_SPECIFIC_V2 **(S)**,
class: 0x5A COMMAND_CLASS_DEVICE_RESET_LOCALLY **(S)**,
class: 0x85 COMMAND_CLASS_ASSOCIATION_V2 **(S)**,
class: 0x59 COMMAND_CLASS_ASSOCIATION_GRP_INFO **(S)**,
class: 0x70 COMMAND_CLASS_CONFIGURATION **(S)**,
class: 0x32 COMMAND_CLASS_METER_V4 **(S)**,
class: 0x60 COMMAND_CLASS_MULTI_CHANNEL_V4 **(S)**,
class: 0x60 COMMAND_CLASS_MULTI_CHANNEL_ASSOCIATION_V3 **(S)**,
class: 0x98 COMMAND_CLASS_SECURITY,
class: 0x56 COMMAND_CLASS_CRC_16_ENCAP,
class: 0x31 COMMAND_CLASS_SENSOR_MULTILEVEL_V6,
class: 0x71 COMMAND_CLASS_NOTIFICATION_V3,
class: 0x73 COMMAND_CLASS_POWERLEVEL,
class: 0x7A COMMAND_CLASS_FIRMWARE_UPDATE_MD_V2,
class: 0x84 COMMAND_CLASS_WAKE_UP_V2

Security:

This product is a <u>Security Enabled Z-Wave Plus Product</u>. The Z-Wave frames can be encapsulated with standard Z-Wave security encryption. This product can therefore be added to a Z-Wave controller that has support for security. It is recommended to use an Z-Wave controller that has security support in order to fully utilize the product. The frames of several command classes will have the security encryption when they are requested by that controller. The command classes that have support for the security encryption can be found in above list by the **(S)** mark.

Note: The product has the same functionality when added to a non-secure Z-Wave controller.

Routing slave
This Z-Wave product will be used as slave. Slave nodes are nodes in a Z-Wave network that receive commands and perform actions based on the command. A routing slave can route Z-Wave messages to other nodes in the network.

Reporting Sleeping Slave
The Z-Wave plus role type of this routing slave product is 'REPORTING SLEEPING SLAVE'.

That means that this device is not always reachable for the controller. In sleep mode the device is not active listening, the device will wake up according to the wakeup command class. Once the device sends a wake up notification it can communicate with a Z-Wave controller.

Add initiator
The add initiator is used when Primary and add Controllers add nodes into the network. When both the add initiator have been activated simultaneously the new nodewill be added to the network (if the node was not added previously)

Remove initiator
The remove initiator is used by Primary Controllers to remove nodes from the network. When the remove initiator and a slave initiator are activated simultaneously, it will result in the slave being removed from the network (and reset to NodeID zero). Even if the slave was not part of the network it will still be reset by this action.

Z-Wave compatibility
Because this is a Z-Wave device, it means it can co-operate with other Z-Wave devices of other manufacturers. It can co-exist in a Z-Wave network existing with product from other manufacturers.

Hops & retries
The Z-Wave range has a range of up to 40 meters in line of sight. This signal is not limited to the 40 meter range due to routing the Z-Wave message to other nodes in the network. This way the range of the Z-Wave network can be expanded to 160 meters indoors (limit of 4 hops).

COMMAND_CLASS_ZWAVEPLUS_INFO_V2

With the Z-Wave plus info get command you can request the Z-Wave plus information of the *Micro Inverter.* The information contains

- Role Type: Reporting Sleeping Slave
- Node Type: Z-Wave Plus Node
- Installer Icon: Sub Energy Meter (0x1000)
  This will be shown on a GUI as the following icon:

- User Icon: Sub Energy Meter (0x1000)
  This will be shown on a GUI as the following icon:

COMMAND_CLASS_MULTI_CHANNEL_V4

De *Micro Inverter* has 2 end points (channels). All channels are using the Meter V4 command class.
for more information see § COMMAND_CLASS_METER_V4

End point 1: Energy AC
End point 1 is used to report the instant energy (W) and the cumulative (kWh) values of the AC side. This side
is the value after it is inverted and is returned to the mains power.

Generic device class: GENERIC_TYPE_METER
Specific device class: SPECIFIC_TYPE_SIMPLE_METER
Supported command class(es): COMMAND_CLASS_METER_V4

COMMAND_CLASS_METER_V4:
- Meter type: Electric Meter
- Supported scales:
    o AC kWh: scale 0x00.
    o AC energy: scale 0x02.

End point 2: Energy DC
Edn point 2 is used to report the voltage (V), the current (I) and the instant energy (W) values of the DC side.
This side contains the values directly from the solar panel before they are inverted.

Generic device class: GENERIC_TYPE_METER
Specific device class: SPECIFIC_TYPE_SIMPLE_METER
Supported command class(es): COMMAND_CLASS_METER_V4

COMMAND_CLASS_METER_V4:
- Meter type: Electric Meter
- Supported scales:
    o PAC: scale 0x02.
    o VDC: scale 0x04.
    o IDC: scale 0x05.

COMMAND_CLASS_ASSOCIATION_V2
COMMAND_CLASS_MULTI_CHANNEL_ASSOCIATION_V3
The Association Command Class and Multi Channel Association command class are used to associate other
devices with the *Micro Inverter*.
The *Micro Inverter* has 3 supported association groups.

Group 1: Lifeline
Maximum supported nodes per group: 1

The node associated in this group will receive the following messages unsolicited
- METER_REPORT
- SENSOR_MULTILEVEL_REPORT
- NOTIFICATION_REPORT
- DEVICE_RESET_LOCALLY_NOTIFICATION

All reports in this association group are reported without the MULTI_CHANNEL_ENCAPSULATION unless a destination end point is associated using the MULTI_CHANNEL_ASSOCIATION_SET command. In that case the source end point is 0.

Group 2: End point 1 reports
Maximum supported nodes per group: 1

The node associated in this group will receive the following messages unsolicited
- METER_REPORT

All reports in this association group are reported with the MULTI_CHANNEL_ENCAPSULATION with source end point 1. A destination end point can be associated using the MULTI_CHANNEL_ASSOCIATION_SET command.

Group 3: End point 2 reports
Maximum supported nodes per group: 1

The node associated in this group will receive the following messages unsolicited
- METER_REPORT

All reports in this association group are reported with the MULTI_CHANNEL_ENCAPSULATION with source end point 2. A destination end point can be associated using the MULTI_CHANNEL_ASSOCIATION_SET command.

COMMAND_CLASS_ASSOCIATION_GRP_INFO

The *Micro Inverter* has supports for 3 association groups.

Group 1

- Name:
    o 'Lifeline'
- Info:
    o Mode: 0
    o Profile:
        ▪ Main profile   : General (0x00)
        ▪ Sub profile   : Lifeline (0x01)
    o Event Code: 0

Group 2

- Name:

o 'Energy AC'
- Info:
  o Mode: 0
  o Profile:
    ▪ Main profile   : Meter (0x32)
    ▪ Sub profile   : Meter electric (0x01)
  Event Code: 0

Group 3

- Name:
  o 'Energy DC'
- Info:
  o Mode: 0
  o Profile:
    ▪ Main profile   : Meter (0x32)
    ▪ Sub profile   : Meter electric (0x01)
  Event Code: 0

NOTE: All other groups report list length 0.

class: 0x20 COMMAND_CLASS_BASIC
According to the device type specification it is not mandatory to map the basic command class.
Therefore the basic command class has an application specific functionality in a supported role.
It can be used to retrieve the status of the hardware. So in the case a Z-Wave controller that doesn't support the notification command class, it can still request if the product works as expected.

- Value 0x00: All hardware processes are running good. Product works as expected.
- Value 0xFF: Some of the hardware processes is not functioning. It may be possible that the product doesn't work as expected.

In case the BASIC_REPORT contains the value 0xFF. The NOTIFICATION command class can be used to retrieve the exact hardware error. See also § COMMAND_CLASS_NOTIFICATION_V3 for more information.

class: 0x86 COMMAND_CLASS_VERSION_V2

This command class is used to obtain information about the *Micro Inverter*. The Z-Wave library type, the Z-Wave protocol version and the application version will be reported.

Because this product supports version 2 it reports the additional information: hardware version and number of firmware targets.

class: 0x72 COMMAND_CLASS_MANUFACTURER_SPECIFIC_V2
This will report information about the manufacturer. This product will contain the manufacturer ID of *BeNext.*

Manufacturer ID of *BeNext* is 0x008A, the ID of this product is 54.

Because the version 2 is supported this command class can also be used to request the serial number of the device with the DEVICE_SPECIFIC_GET command.

COMMAND_CLASS_DEVICE_RESET_LOCALLY
When the product is removed manually (zie § manual exlcusion) the DEVICE_RESET_LOCALLY_NOTIFICATION command is sent to node associated in the lifeline association group.

class: 0x70 COMMAND_CLASS_CONFIGURATION

Configure parameters:

0. Niet gebruikt

1. Set to default

Description:	Set all config values to default values (factory settings).
	Read more in chapter Configuration Reset.
Size:	1 byte*
Param1:	All values (0x00 – 0xFF) except for 0x55 can be used to default all the configuration params.
Param2,3,4:	Not used

2. Request frequency

Description:	Set the request frequency (in time) that the data is synchronized with the micro inverter hardware.
Size:	1 byte*
Default	0x05 (500 milliseconds)
Param1:	The value * 100 ms with a range from 100 to 25.500 ms.
	(Both values 0 as 1 are interpreted as 100 ms)

3. Z-Wave send timeout

Description:	Set the Z-Wave send timeout that a certain value can't be reported. This doesn't mean that there is no Z-Wave transmission at all. It means that that particular value (e.g. temperature) is not reported (unsolicited) for the configured value time.
Size:	1 byte*
Default	0x18 (60 seconds)
Param1:	Value = 0: disable all unsolicited reporting.
	Value > 0: timeout (s) = ((Value * 5) * cfg param 2) / 10
	(Example: ((24 * 5) * 5) / 10 = 60 seconds)

4. Not used **

5. Not used **

6. Enable unsolicited CRC

Description:	Configure if any unsolicited message are sent using the CRC command encapsulation.
Size:	1 byte*
Default	0x02 (unsolicited CRC enabled)
Param1:	Value 0x02: Enable unsolicited CRC.
	Value 0x00, 0x01, 0x03-0xFF: Disable unsolicited CRC.

7. Not used **

…

70. Not used **

71. t/m 78: Unsolicited Report conditions

Description:	The requirements that a value is reported unsolicited.
	If both watt and % requirement differ from previous sent value, a new unsolicited value is sent.
	(Note that the time configured in parameter 3 also should have passed before the value is sent).

Size:		4 bytes* (per parameter)
Default:		See below in overview
Value:		BYTE 0 (LSB): Percentage (%)
		BYTE 1 – BYTE 3: Absolute value (watt)
		(If *absolute value* AND *percentage* are TRUE the value is reported unsolicited)

Parameter	Unsolicited Z-Wave Report	Default
71	VDC (METER_REPORT, end point 2)	0x0003E814 > 1000 (mV)|20%
72	IDC (METER_REPORT, end point 2)	0x0003E814 > 1000 (mA)|20%
73	PDC (METER_REPORT, end point 2)	0x98968014 > 10.000.000 (uW)|20%
74	Energy AC (METER_REPORT, end point 1)	0x98968014 > 10.000.000 (uW)|20%
75	Temperature (SENSOR_MULTILEVEL_REPORT)	0x00000100 > 0,1 (C)|0%
76	kWh AC (METER_REPORT, end point 1)	0x00000A00 > 100 mWh|0%
77	NOT USED	0x00000100
78	Error (NOTIFICATION_REPORT)	0x00000100 > 1 state changed.

* If a size is other then given size the frame is ignored totally so configuration values are **not** changed.
** All 'not used' values can be changed and requested but don't have any effect on the functionality of the product.

class: 0x32 COMMAND_CLASS_METER_V4
NOTE: This chapter describes de METER v4 command class but some frames that the *Micro Inverter* transmits are encapsulated with the MULTI_CHANNEL command class. The Z-Wave controller that receives those commands should unpack those frames first.
- End point 1:
  - o kWh generated: Meter V4 scale 0x00
  - o W generated: Meter V4 scale 0x02
- End point 2:
  - o PDC: Scale 0x02
  - o VDC: Scale 0x04
  - o IDC: Scale 0x05

The Meter Command class is used to monitor de values from the *Micro Inverter*.
The information is retrieved automatically. A report of the consumption can be request with the METER_GET command.

End point 0 and End point 1

NOTE 1: The messages from end point 0 are <u>not</u> encapsulated unless the end point destination is set. The messages from end point 1 are always encapsulated.
Meter Type = 0x01 = Electrical Meter.

The supported scales:

Description	Scale	Scale (in frame)	Unit
Total	0x00	0x00	kWh
Current	0x02	0x10	W

The supported rate types:

Secription	Type	Type (in frame)
Export / Generated	0x02	0x40

For example, if you want to request the <u>generated energy</u>. The following frame should be sent to the *Micro Inverter.*

COMMAND_CLASS_METER   : 0x32
METER_GET   : 0x01
RATE TYPE | SCALE   : 0x50 (rate type import, scale 2)

NOTE 3: If the requesting device send uses METER_GET V1 frame the used kWh energy value is reported.
NOTE 4: A non-supported scale is ignored by the application.

End point 2

Meter Type = 0x01 = Electrical Meter.
The supported scales:

Description	Scale	Scale (in frame)	Unit
Instant	0x02	0x00 (byte 1) 0x10 (byte 2)	W
Voltage	0x04	0x80 (byte 1) 0x00 (byte 2)	V
Current	0x05	0x80 (byte 1) 0x04 (byte 2)	A

The supported rate types:

Secription	Type	Type (in frame)
Export / Generated	0x02	0x40

For example, if you want to request the <u>generated energy</u>. The following frame should be sent to the *Micro Inverter.*

COMMAND_CLASS_METER   : 0x32
METER_GET   : 0x01
RATE TYPE | SCALE   : 0x50 (rate type import, scale 2)

NOTE 3: If the requesting device send uses METER_GET V1 frame the used kWh energy value is reported.
NOTE 4: A non-supported scale is ignored by the application.

class: 0x31 COMMAND_CLASS_SENSOR_MULTILEVEL_V5
The Sensor Multilevel command class is used to retrieve a sensor report from the *Micro Inverter*.
The reported values is the measured temperature inside the housing

Because this is version 6, it is necessary to add the sensor type to the SENSOR_MULTILEVEL_GET frame.

Supported sensor types:
- Temperature

Note that all other types are ignored by the application.

class: 0x31 COMMAND_CLASS_NOTIFICATION_V5

The Micro Inverter is designed in the Push mode. This means that the notification values are normally sent unsolicited. This can be disabled using the NOTIFICATION_SET command. The current status is reported in the NOTIFICATION_REPORT command displayed in the 'notification status' byte.

The Micro Inverter has support for only 1 notification type.
- Notification type: System (0x09)
- Notification event: System hardware failure with manufacturer specific code (0x03)
- Event parameters:

0x00	**No error**
0x01	**Grid not within specification**
0x02	**Unable to deliver power**
0x03	**Internal DC-bus too high**
0x04	**Internal Temperature too high**
0x05	**Internal Temperature too low**
0x06	**PV voltage too low**
0x07	**Internal voltage too low**

COMMAND_CLASS_FIRMWARE_UPDATE_MD_V2

The *Micro Inverter* supports OTA (Over-The-Air) update.
This means that is possible to update the software over the air, in other words using Z-Wave frames.

COMMAND_CLASS_SECURITY

For safety reasons the *Micro Inverter* can encapsulate his Z-Wave messages with a security encryption.
Therefore it is not possible to read in and outgoing Z-Wave data with a RF monitoring tool.

If the messages are requested without the security encryption they are also reported without it the encryption. Therefore this product can still be used with a non-security Z-Wave controller.
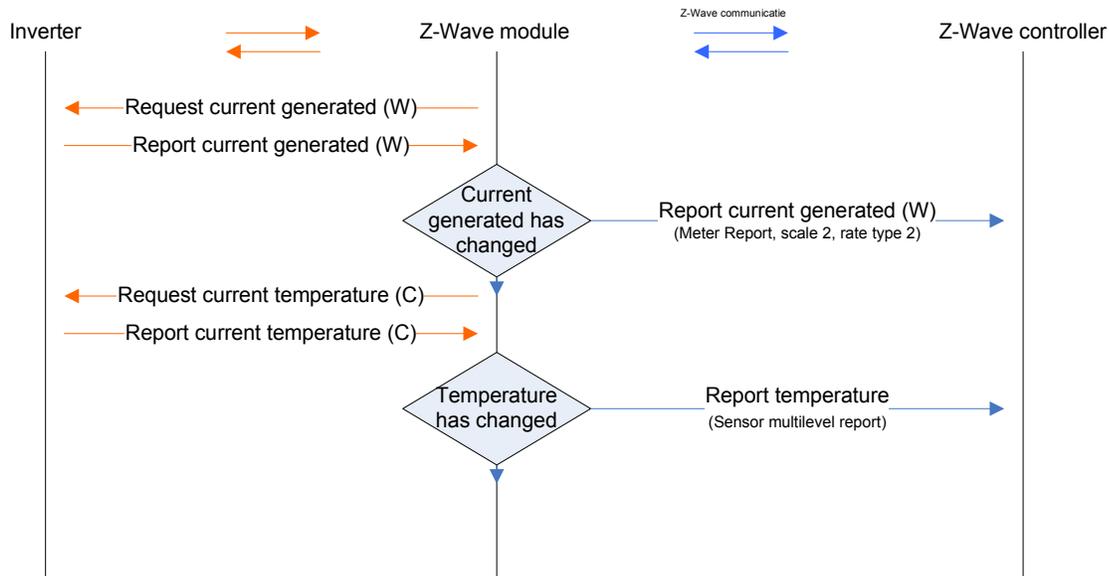
COMMAND_CLASS_CRC_16_ENCAP

A Z-Wave frame can be requested from the Micro Inverter using the CRC encapsulation.
Unsolicited frames can be configured to contain the CRC encapsulation. This can be done using configuration parameter 6.

Unsolicited reports

This product has a feature that it can send reports unsolicited. This happens when a change in values occurs.

NOTE 1: In above example only current generated energy and temperature are displayed. But auto reporting is done for every possible value.

NOTE 2: The frequency that the value is requested from the inverter can be adjusted with configuration parameter 2.

NOTE 3: De requirements that the values are auto reported can be changed with configuration parameters 71 until 78.

COMMAND_CLASS_WAKE_UP_V2
This product has the role type Reporting Sleeping Slave and therefore can use the wake up notification.

The WAKE_UP_INTERVAL_SET command is used to configure the periodical WAKE_UP_NOTIFICATION.
When the pushbutton is pressed for 4 seconds it is possible to trigger a WAKE_UP_NOTIFICATION on user interaction.

The following applies:
- Minimum value: 3 seconds.
- Maximum value: 86400 seconds (24 hours).
- Default: 3600 seconds (1 hour).
- Disable: 0 seconds (wake up notification can only be sent on user action).

BE⌂NEXT

Configuration Reset

The *Micro Inverter* supports a configuration resets function. Configuration reset means:
- All configuration values are defaulted.

This function can be activated by sending a configuration set frame:

CONFIGURATION_SET
Parameter: 0x01
Size: 0x01 (can't be different from 1)
Value: All values (0x00 – 0xFF) except for 0x55.

When the value of configuration value is requested 2 possible values can be returned.

CONFIGURATION_REPORT
Parameter: 0x01
Value 0x55:   Device doesn't have all his factory settings anymore.
                 Even when a configuration parameter is changed back to the default value
Value 0xAA: Devices still has all his factory settings.

Back to factory settings

This product has an option to set back to it's factory settings. This can be done manually without the interference of a Z-Wave controller. The following things will apply:
- Product is removed from its Z-Wave network
- All associations are cleared
- All configurations are set back to default settings

To reset the device follow the steps:
1. Press and hold the push button for 2 seconds and then release to start the remove routine
2. Now to reset the device, press and release the push button 4 times within 1.5 seconds during the remove routine.
3. When 'back to factory settings' is done successfully, A DEVICE_RESET_LOCALLY_NOTIFICATION is sent to the controller associated in the lifeline association group.