4-noks s.r.l.

WIRELESS FAMILY DEVICES
ZB-CONNECTION
End Device ZED-3IAC
(product code: ZED-3IAC-M)

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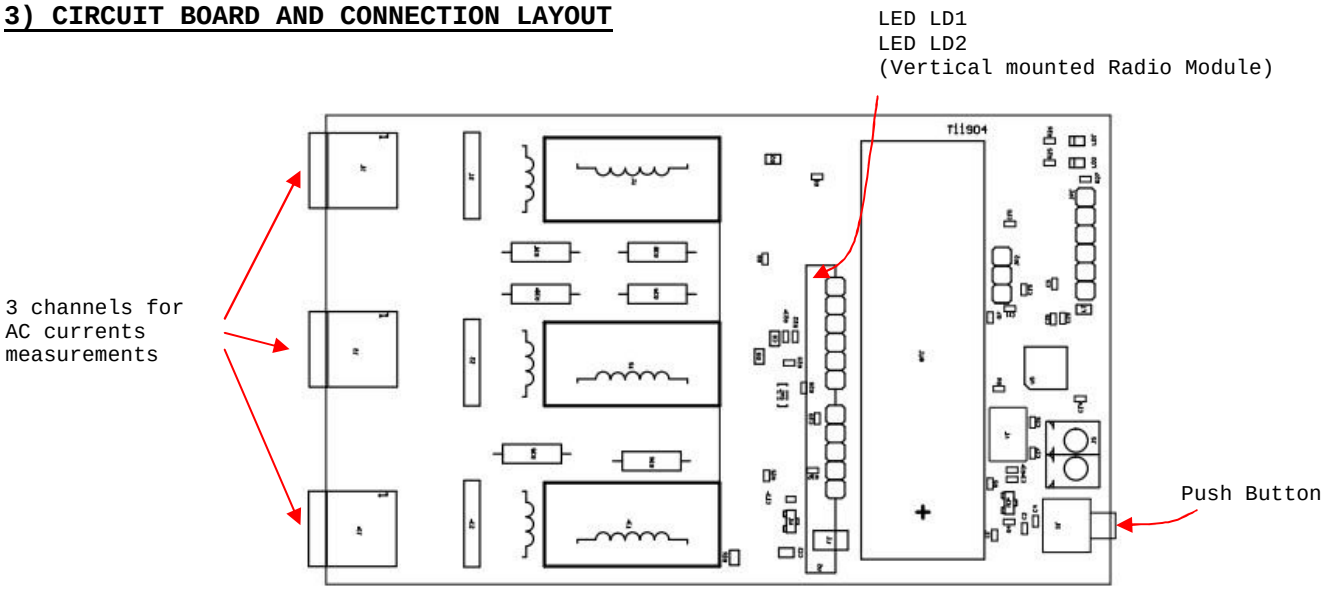
1) GENERAL DEVICE CHARACTERISTICS

ZED-3IAC (ZED-3IAC-M) belongs to ZB-Connection devices family.
It can perform alternate current measurements on 3 channels and send these values at regular intervals to a Gateway of the 4-noks family products.
It generates alarms when adjustable thresholds are exceeded;
Modbus address is set via special radio message.
The device must be supplied with a 3.6V battery.
Its role in the network is End-Device.

2) DEVICE ELECTRICAL CHARACTERISTICS

SUPPLY:	3,6V Battery
WIRELESS CHARACTERISTICS:	2405 MHz ÷ 2480 MHz DSSS Modulation Nominal transmission Power 0 dBm IEEE 802.15.4 compliant Stack EmberZNet3.5.x Stack version 0 Proprietary profile ID Proprietary encryption key
AC CURRENT MEASUREMENT:	Measurement range: 0 ÷ 5A rms Measurement resolution: 1mA Measurement accuracy: ±2%
OPERATING CONDITIONS	-20 + 55 °C +10÷30°C for nominal battery duration
BATTERY DURATION:	> 3 years (+10°C÷30°C when transmission time > 3 minutes)
CONNECTION:	None
DEGREE OF PROTECTION:	IP 55

3) CIRCUIT BOARD AND CONNECTION LAYOUT



4) DEVICE ADDRESSING

The default value for address is fixed to 127.
Until device is not associated with a valid address (between 16 and 126) its operation is disabled.
The address assignment procedure is the following:

1) Operating on the gateway at the address 127 setup value 6521 on HoldingRegister[0] (command password);
2) Operating on the gateway at the address 127 setup the new address value on HoldingRegister[2] (User Parameter);
3) Operating on the gateway at the address 127 setup value 1 on CoilStatus[0] (command password trig);
4) Push the onboard Button of the ZED-3IAC device to let it perform quickly the address change, without waiting for it to wake up from sleep.

Attention: Be careful when assigning addresses. Two devices with the same address would put their data into the same container in the Gateway and this would generate ambiguity which would be difficult to identify in subsequent network operations.

5) ASSOCIATING THE DEVICE TO A COMPATIBLE NETWORK

The process to follow when join ZED-3IAC node to a network is the same as for all ZB-Connection end-devices.
The association process is activated by pressing the push button.
The association process is enabling only if the device is not already part of a network, i.e. if it is a new device or if it has been voluntarily disassociated.

5.1) Press the push button, led LD1 turns on and node starts the scanning process of all 16 radio channels in order to find an "open" compatible network (i.e. a ZB-Connection process). The scan process takes about 20 seconds; if the device detects an available network, all 2 leds flash quickly and afterward they turn off (network opening is performed by suitably stimulating the Gateway, for more information refer to the Gateway document);

5.2) otherwise, if the scan process ends without having found any available network, the device goes in a power-safe mode waiting for new push-button stimulating.

6) DISASSOCIATING THE DEVICE FROM THE NETWORK

Disassociating the device involves losing the network parameters and consequently leaving the network of which it had been a part.
Moreover device loads to the default value all of its operating parameters (HoldingRegister).

Disassociation can be commanded in two ways:

1) Receipt of the appropriate command password.
2) Holding the pushbutton on the card down for at least 6 seconds. Disassociation using the push-button is only possible within 20 seconds from when the device is switched on.

7) DEVICE LED/PUSH BUTTON INTERFACE

ZED-3IAC has two leds through which it shows information about its operating state.
The device has also a push button which is used to activate the joining process, to activate disassociation and to stimulate the device in order to send data to the Gateway.

Behaviour of leds at the start-up:
At the reset of ZED-3IAC both leds light for 2 seconds, then all leds flash fast for another half seconds.
At the end of flashing device starts the normal functioning.

How leds work when ZED-3IAC is NOT joined with a network:
All leds off

How leds work when ZED-3IAC is joined with a network:
Usually all leds off.
Led LD1 briefly switches on at acquisition of the probes and at transmission of a message towards the gateway. It also briefly switches on at receiving of an answer from the gateway.

Behaviour of leds during joining process
Led LD1 switches on for whole joining process.
Fast blinking of all leds at the successful association with a network.

Radio Link Quality Analysis
The device has a functional mode that permits to know the radio link quality, counting the number of blink of led LD2.
This functional mode is activate by pressing the button (only if node is joined to a network).
This functional mode continues for 60 seconds.
When this mode is active node ignores normal transmit time and transmits a message each 5 seconds.
When this mode is active, after the successful communication process node analyzes the signal strength (Rssi) associated to the message received from Gateway.
Based on this value node performs one, two or three flashes of LED LD3.

3 flashes of LD2 --> Rssi of received message >= -65dB (optimal level)
2 flashes of LD2 --> Rssi of received message >= -85dB (medium level)
1 flash of LD2 --> Rssi of received message < -85dB (low level)

8) DEFAULT PARAMETERS

Device has seven operating parameters, which are saved in its non-volatile memory, and at the moment of initializing are loaded as default settings.
The default parameters are loaded even after device disassociation.

Parameter	DEFAULT	unit
Transmission time	60	[sec]
The Gain parameter involved in current measurement (#1)	1	
The Gain parameter involved in current measurement (#2)	1	
The Gain parameter involved in current measurement (#3)	1	
The Offset parameter involved in current measurement (#1)	0	[mA]
The Offset parameter involved in current measurement (#2)	0	[mA]
The Offset parameter involved in current measurement (#3)	0	[mA]
Threshold of Low Current alarm (#1)	0	[mA]
Threshold of Low Current alarm (#2)	0	[mA]
Threshold of Low Current alarm (#3)	0	[mA]
Threshold of High Current alarm (#1)	4000	[mA]
Threshold of High Current alarm (#2)	4000	[mA]
Threshold of High Current alarm (#3)	4000	[mA]

9) DESCRIPTION OF THE ACQUISITION PROCESS

The device provides to the acquisition of all the values before transmitting its state to the Gateway.
Device’s sampling interval is equal to the Transmission time.

10) DESCRIPTION OF THE ALARM MANAGEMENT PROCESS

The device compares the AC currents measured in reference to the parameters that set the alarm limits.
The alarm warning's activation is not delayed; should the values acquired prove to be over or under the limit the relevant fault flag is activated.

```
If AC current[i] >  Limit High AC current[i] --> flag alarm: High Curr.[i] = 1
If AC current[i] <= Limit High AC current[i] --> flag alarm: High Curr.[i] = 0
If AC current[i] <  Limit Low AC current[i]  --> flag alarm: Low Curr.[i] = 1
If AC current[i] >= Limit Low AC current[i]  --> flag alarm: Low Curr.[i] = 0
```

11) DEVICE DATA MAPPING

Like almost all ZB-Connection devices, ZED-ICC shows its data through an agent.
The agent of a particular device resides locally in the Gateway, and is made up by data sent via radio and by data generated by the Gateway itself.
The Gateway allows access in read and write mode to the agents relating to the devices belong to the network and the Gateway data through a serial interface and Modbus protocol.
Given the nature of the Modbus protocol, the data is split into four memory areas:

InputRegister (16-bit variables in read only mode)
InputStatus (1-bit variables in read only mode)
HoldingRegister (16-bit generally non-volatile variables)
CoilStatus (1-bit variables)

The Gateway is compatible with the most common modbus commands such as single and sequential reading of all memory spaces and single and sequential writing of all holding registers and coil statuses.

ZED-THL device has the following data:

```
(15+5) InputRegister
   80  InputStatus
(9+1)  HoldingRegister
   16  CoilStatus
```

11.1) ZED-3IAC INPUT REGISTERS

InputRegister[0]	Device Type (=36)
InputRegister[1]	Firmware Version (Major/Minor)
InputRegister[2]	Transmission Counter
InputRegister[3]	Signal Level of the last message received by the device (2)
InputRegister[4]	Battery Level (in mils of volts)
InputRegister[5]	Battery Level (in mils of volts) while the probe sensor is active
InputRegister[6]	AC current measured in channel #1[mA]
InputRegister[7]	Current Gain involved in measurements (channel #1)
InputRegister[8]	Current Offset involved in measurements (channel #1)
InputRegister[9]	AC current measured in channel #2[mA]
InputRegister[10]	Current Gain involved in measurements (channel #1)
InputRegister[11]	Current Offset involved in measurements (channel #1)
InputRegister[12]	AC current measured in channel #3 [mA]
InputRegister[13]	Current Gain involved in measurements (channel #3)

InputRegister[14]	Current Offset involved in measurements (channel #3)
InputRegister[15]	*Seconds passed since receiving last messages* (1)
InputRegister[16]	*Counter of messages received from Gateway* (1)
InputRegister[17]	*Gateway message receiving instant time (100 * hours + minutes)* (1)
InputRegister[18]	*Signal Level of the last message received from Gateway* (1) (2)
InputRegister[19]	*Device network address* (1)
InputRegister[20]	Copy of InputStatus[0..15]
InputRegister[21]	Copy of InputStatus[16..31] (flag of pending writes of holdingRegister) (1)
InputRegister[22]	Copy of InputStatus[32..47] (not used) (1)
InputRegister[23]	Copy of InputStatus[48..63] (flag of pending writes of CoilStatus) (1)
InputRegister[24]	Copy of InputStatus[64..79] (general pending flag and presence flag) (1)

(1) These data are not sent from the device but generated by the Gateway
(2) The signal level gives information on the energy values relative to the last hop that the wireless message has completed. The value is expressed in dB+100 and its value ranges from 70 (maximum value) to 8 (very low value).

11.2) ZED-3IAC HOLDING REGISTERS

HoldingRegister[0]	Command password
HoldingRegister[1]	Transmission time (expressed in seconds)
HoldingRegister[2]	Parameter used in conjunction with the Command password
HoldingRegister[3]	Low Current alarm threshold of channel #1 [mA]
HoldingRegister[4]	High Current alarm threshold of channel #1 [mA]
HoldingRegister[5]	Low Current alarm threshold of channel #2 [mA]
HoldingRegister[6]	High Current alarm threshold of channel #2 [mA]
HoldingRegister[7]	Low Current alarm threshold of channel #3 [mA]
HoldingRegister[8]	High Current alarm threshold of channel #3 [mA]
HoldingRegister[9]	*Copy of CoilStatus[0..15]*

11.3) ZED-3IAC COIL STATUSES

CoilStatus[0]	Command password activation
CoilStatus[1]	Not used
...	...
CoilStatus[15]	Not used

11.4) ZED-3IAC INPUT STATUSES

InputStatus[0]	Low current alarm (channel #1)
InputStatus[1]	High current alarm (channel #1)
InputStatus[2]	Low current alarm (channel #2)
InputStatus[3]	High current alarm (channel #2)
InputStatus[4]	Low current alarm (channel #3)
InputStatus[5]	High current alarm (channel #3)
InputStatus[6]	Not used
...	...
InputStatus[16]	HoldingRegister[0] write pending (1)
InputStatus[17]	HoldingRegister[1] write pending (1)
InputStatus[18]	HoldingRegister[2] write pending (1)
InputStatus[19]	HoldingRegister[3] write pending (1)
InputStatus[20]	HoldingRegister[4] write pending (1)
InputStatus[21]	HoldingRegister[5] write pending (1)

InputStatus[22]	HoldingRegister[6] write pending (1)
InputStatus[23]	HoldingRegister[7] write pending (1)
InputStatus[24]	HoldingRegister[8] write pending (1)
InputStatus[25]	Not used
...	...
InputStatus[48]	CoilStatus[0..15] write pending (1)
InputStatus[49]	Not used
...	...
InputStatus[64]	device presence state (validity of agent's data) (2)
InputStatus[65]	General pending status (logic OR of all write pending) (1)
InputStatus[66]	Not used
...	...
InputStatus[79]	Not used

(1) These flags are managed by Gateway and are set at the moment of writing a holding register or a group of coil status; they are reset when the device receives the datum (this immediately succeeds its transmission).
(2) The device's presence flag is managed by Gateway; it is set when the data present are valid. The flag is reset if the Gateway does not receive messages from the device for a period greater than four times that of the automatic transmission time.

13) SPECIAL COMMANDS - COMMAND PASSWORD

With command passwords it is possible to send special commands to the device. The commands are executed when the CoilStatus[0] bit is set.

HoldingRegister[0] (HEX)	HoldingRegister[0] (DEC)	Action
0x1968	6504	Activate device Bootloader
0x1970	6512	Device reset
0x1973	6515	Device Disassociation
0x1979	6521	Assignment of the new address specified in HR2
0x01FE	510	New offset value specified in HR2 (channel #1)
0x01FF	511	New gain value specified in HR2 (channel #1)
0x0208	520	New offset value specified in HR2 (channel #2)
0x0209	521	New gain value specified in HR2 (channel #2)
0x0212	530	New offset value specified in HR2 (channel #3)
0x0213	531	New gain value specified in HR2 (channel #3)