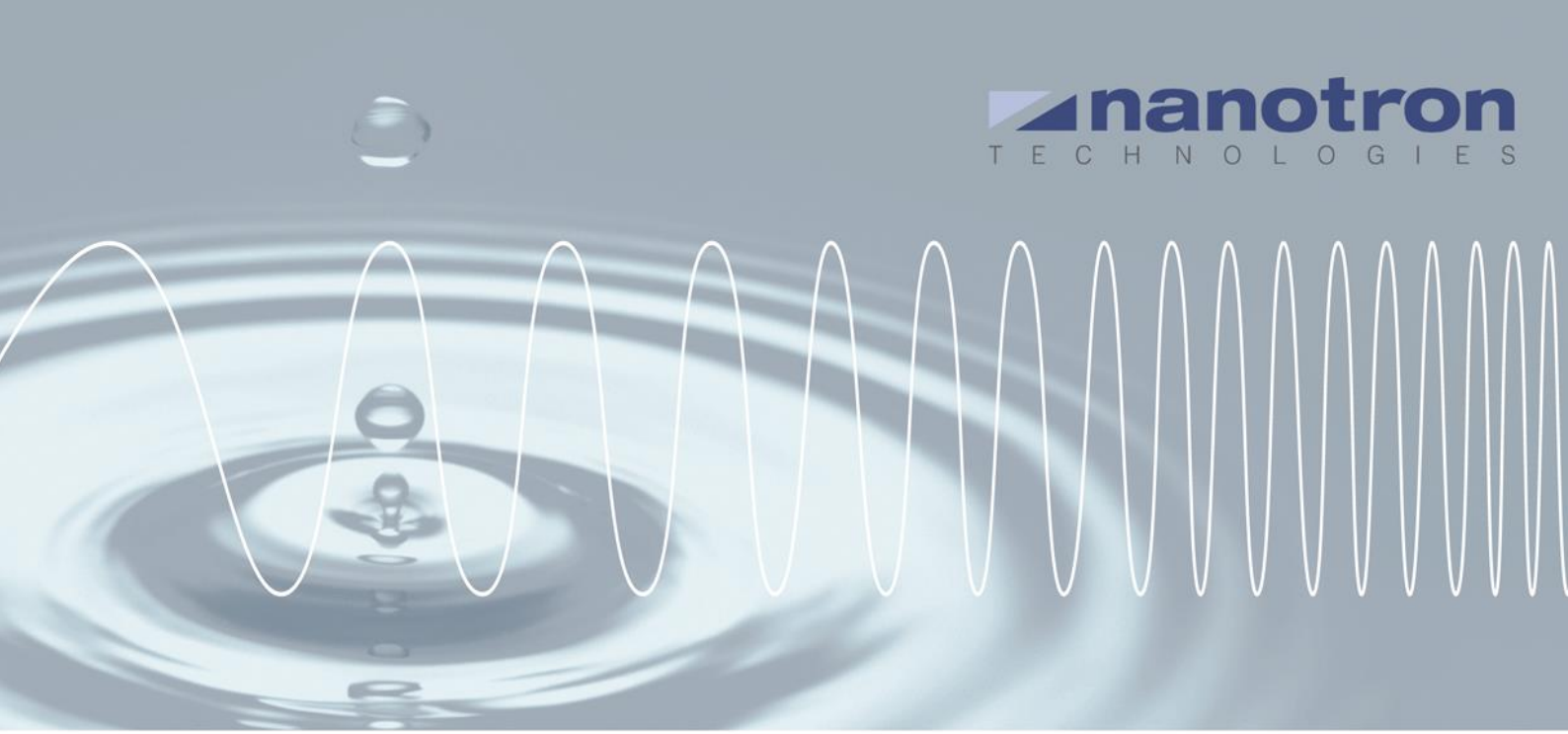

swarm PC Tool
User Guide

3.0

NA-15-0356-0008-3.0

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1. Introduction

swarm PC Tool is a PC software developed for users of nanotron's *swarm* products. The latest version 3.0 includes all API commands according to *swarm* API V2.1 and V3.0.

With this software tool users can configure the *swarm* nodes very conveniently. Ranging Monitor shows users how to initiate ranging between *swarm* nodes and record the ranging data. With Sensor Monitor the 3D acceleration changes of the *swarm* node which is connected to the host can be observed.

Note: The *swarm* PC Tool 3.0 is compatible with *swarm* API V2.1 and V3.0.

2. Hardware Requirement

To use *swarm* PC Tool a *swarm* device is required. There are two available options of *swarm* device: *swarm* bee LE Development Board (hereafter "Dev. Board" for short) and *swarm* bee LE Development Kit Plus Board (hereafter "DK+ Board" for short). At least two *swarm* devices are needed for the ranging application.

In the following, the Dev. Board and DK+ Board are described.

2.1. Description of Dev. Board

The Dev. Board (see Figure 2-1) mainly consists of a *swarm* bee LE module, a U.FL antenna and a header board. The header board has a U.FL connector X1, a connector X3 and two optional pads for further connectors (X2, X4), see Figure 2-2.

Figure 2-1 *swarm* bee LE Dev. Board, top view

Figure 2-2 shows the PCB placement of Dev. Board. The detailed function of connectors X1, X2, X3 and X4 is described in Table 2-1.

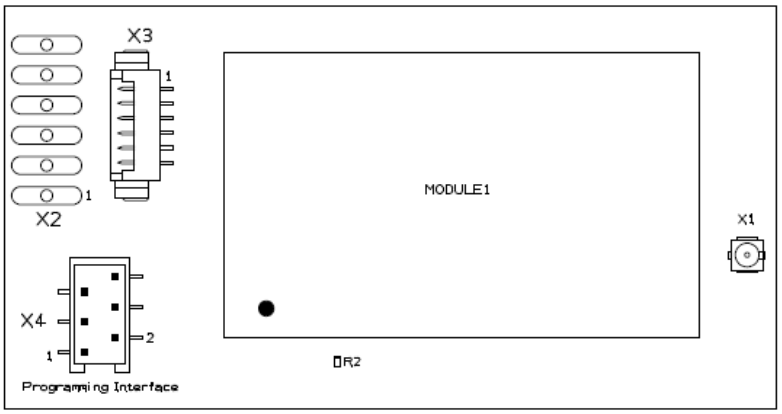

Figure 2-2 *swarm* bee LE Dev. Board, PCB placement

Table 2-1 Function of the connectors on Dev. Board

Bezeichnung	Name	Beschreibung
X1	RF_PORT	U.FL Connector
X2/1	MOD_EN	*swarm* bee Module Enable
X2/2	GND	Ground
X2/3	VIN	Input voltage + 3V … +5,5 V
X2/4	UART_RX	Incoming signal to *swarm* bee
X2/5	UART_TX	Outgoing signal from *swarm* bee
X2/6	GND	Ground
X3/1	GND	Ground
X3/2	UART_TX	Outgoing signal from *swarm* bee
X3/3	UART_RX	Incoming signal to *swarm* bee
X3/4	VIN	Input voltage + 3V … +5,5 V
X3/5	GND	Ground
X3/6	MOD_EN	*swarm* bee Module Enable
X4/1	+2V6	Digital output voltage of *swarm* bee
X4/2	N.C.	Reserved
X4/3	GND	Ground
X4/4	N.C.	Reserved
X4/5	/NRST	Reset
X4/6	N.C.	Open

2.2. Description of DK+ Board

The DK+ board is a tool for developing and testing products using *swarm* bee LE module, and for software debugging. Several test points and connectors are available, which help to measure certain parameters such as RF output power or power consumption.

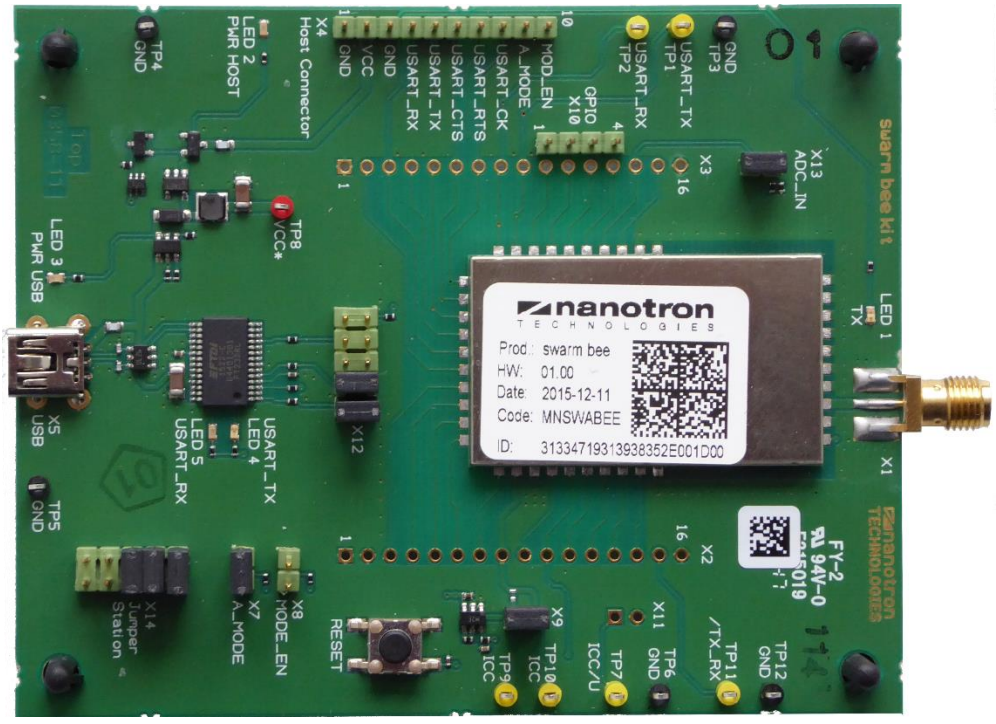

Figure 2-3 *swarm* bee LE DK+ Board

2.2.1. Connector Configuration

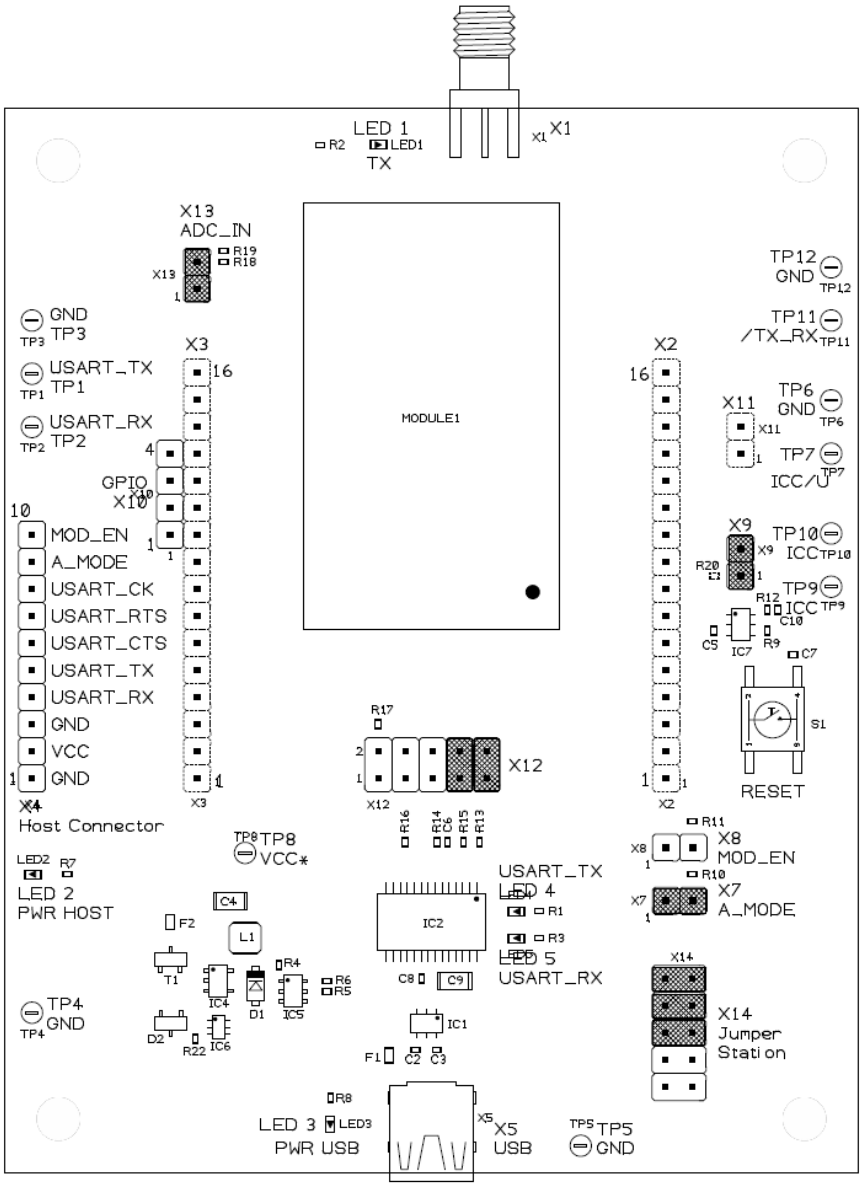

Figure 2-4 DK+ Board assembly and connector configuration, test point assignment

Table 2-2 DK+ Board connector configuration

Connector No.	Description	Type	Default State
X1	RF port	SMA type, 50 Ohm impedance	assembled
X2	*swarm* bee LE pins lead through	Pin connector, 16 pole	not assembled
X3	*swarm* bee LE pins lead through	Pin connector, 16 pole	not assembled
X4	Host connector	Pin connector, 10 pole	assembled, open
X5	USB	Mini-B	assembled
X7	Enables autonomous mode	Pin connector, 2 pole, jumper	assembled, closed
X8	Enables *swarm* bee LE module	Pin connector, 2 pole, jumper	assembled, open
X9	Measurement of power-down current profile	Pin connector, 2 pole, jumper	assembled, closed
X10	GPIO ports 0…3, *swarm* bee LE pins lead through	Pin connector, 4 pole	assembled, open

Connector No.	Description	Type	Default State
X11	Voltage output of current profile	Pin connector, 2 pole	not assembled
X12	USB to Serial	Pin connector, 2 x 5 pole	assembled, closed
X13	ADC input for measuring supply voltage	Pin connector, 2 pole, jumper	assembled, closed
X14	Jumper station	Pin connector, 2 x 5 pole	fitted with 2 spare jumper bridges

2.2.2. Test Points

On DK+ board several test points are available for measurement. The assignment is shown in Figure 2-4. The function is described in Table 2-3.

Table 2-3 Function description of test points

Testpoint No.	Description	Function	Remarks
TP1	USART_TX	Serial port TX	Connected to *swarm* bee LE module, X4 and X12
TP2	USART_RX	Serial port RX	Connected to *swarm* bee LE module, X4 and X12
TP3	GND	Circuitry ground	
TP4	GND	Circuitry ground	
TP5	GND	Circuitry ground	
TP6	GND	Circuitry ground	
TP7	ICC/U	Supply current converted to voltage	Supply current is converted to a voltage, relation is 1:10 (100 mA → 1V)
TP8	VCC*	Supply voltage	Supply voltage for *swarm* bee LE module
TP9	ICC	For measuring power-down current	Same function as X9, see Table 2-2
TP10	ICC	For measuring power-down current	Same function as X9, see Table 2-2
TP11	/TX_RX	Hardware TX indicator	TX = LOW, RX (2.8 V) = HIGH
TP12	GND	Circuitry ground	

3. Getting Started with *swarm* PC Tool

In this chapter some basic steps and API commands are introduced for using *swarm* PC Tool. The use of tools “Ranging Monitor” and “Sensor Monitor” is explained in chapter 4 and 5 respectively.

To get started, download the *swarm* tools set from the link provided by nanotron.

3.1. Connecting to *swarm* PC Tool

Connect a *swarm* device to the PC. Select the file `swarm-pc-tool.exe` from the downloaded file folder. Double click to open. A window pops up as shown below:

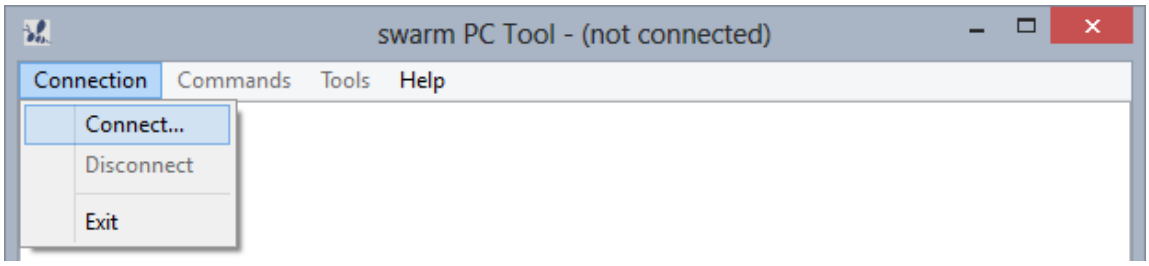

Figure 3-1 Start window, device not connected

Click `Connection->Connect`, another window appears for selecting USB Serial Port (COM port):

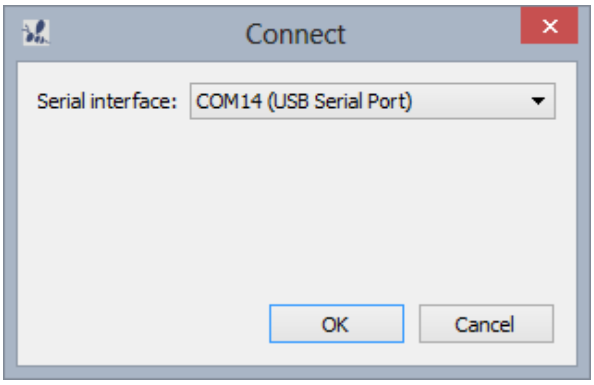

Figure 3-2 Select COM port

Select one proper serial port and click “OK”. The following window appears. Information about the *swarm* device connected to the PC is read out:

- Version of the *swarm* firmware: `03001F00`
- Node ID of the *swarm* device: `00005594493D`

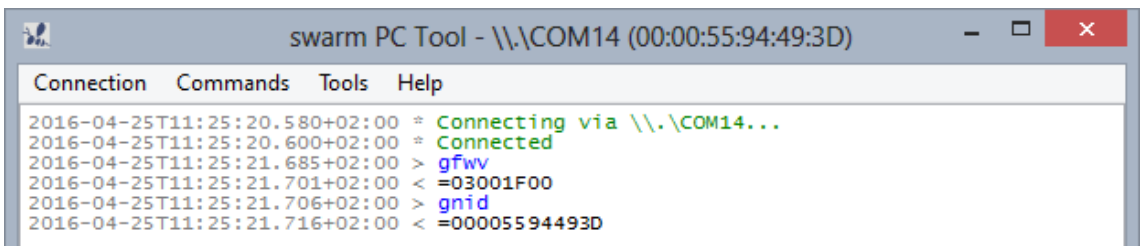

Figure 3-3 Device connected, showing node ID and FW version

By clicking "`Commands`" in the main menu bar, the API command groups can be seen:

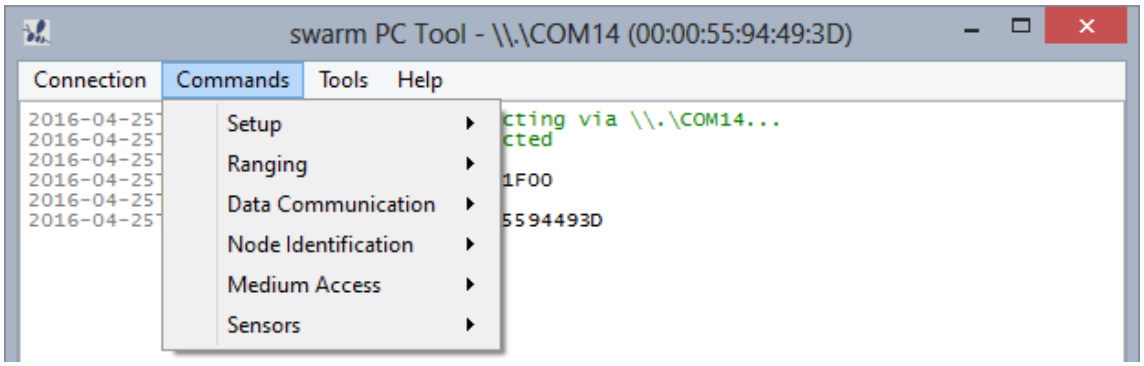

Figure 3-4 API command groups

Depending on the firmware version (*swarm* API V2.1 or V3.0) of the *swarm* device connected to *swarm* PC Tool, the corresponding commands are shown. For a detailed explanation of all API commands, please refer to [1] or [2]. In the following, the command differences between API V2.1 and V3.0 are explained. After that the commands "Save Settings", "Set Node ID", "Ranging Result Notification" are introduced.

3.2. Command Differences Between API V2.1 and V3.0

Most commands in API V2.1 and V3.0 are the same. The differences mainly exist in command groups Setup and Sensors.

3.2.1. Command Differences in "Setup"

As shown in Figure 3-5 there are four different commands in the command group Setup:

- Power Management: In API V2.1 only modes 0 and 1 are available, in API V3.0 mode 3 is added.
- Set PHY Syncword: In API V2.1 the range of values is 0…8, in API V3.0 it is 0…12.
- Set UART Speed: This command is only available in API V3.0.
- AIR Interface: Enables/disables backchannel air interface. This command is only available in API V3.0.

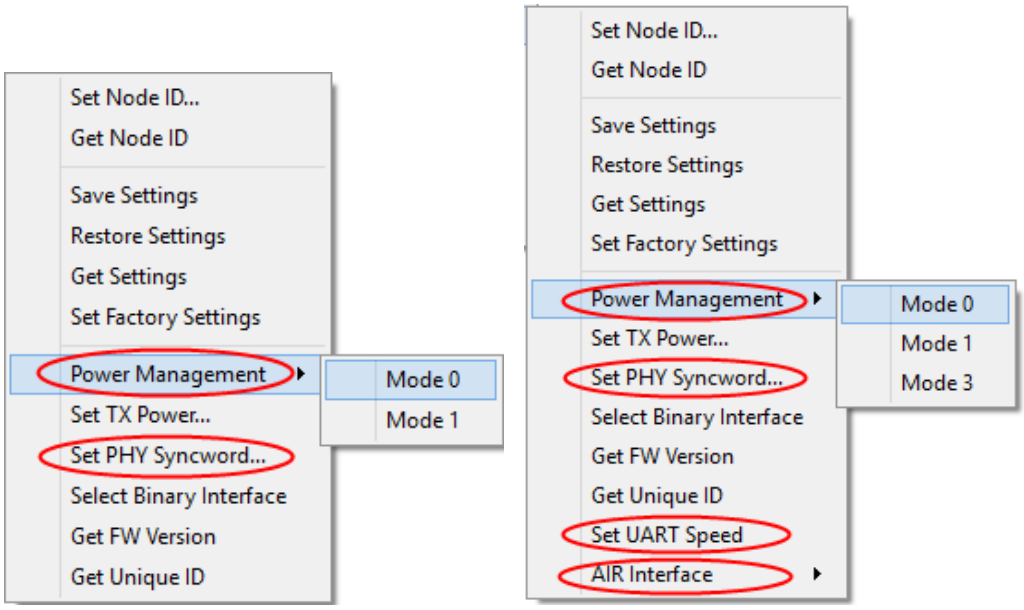

Figure 3-5 Command differences in Setup (left API V2.1, right API V3.0)

Note: Please refer to [1] and [2] for detailed information about these commands.

3.2.2. Command Differences in "Sensors"

There is one difference in the command group Sensors, which lies in GPIO settings. Compared to API V2.1, the GPIO pins in API V3.0 are completely refurbished. There is no mask any more, and each pin must be configured separately. For more information please refer to [1] and [2].

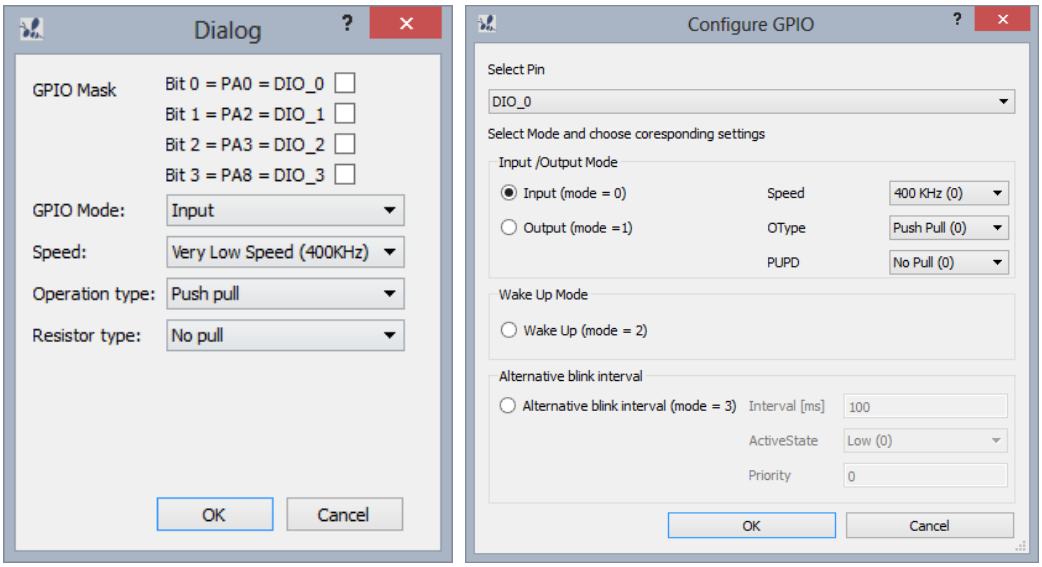

Figure 3-6 GPIO pin configuration options in API V2.1 (left) and API V3.0 (right)

3.3. Save Settings

Before disconnecting the device from the *swarm* PC Tool, remember to save settings. Otherwise, the changes will get lost. It suffices to save settings once after all parameters have been changed. Click `Commands->Setup->Save Settings` to save settings:

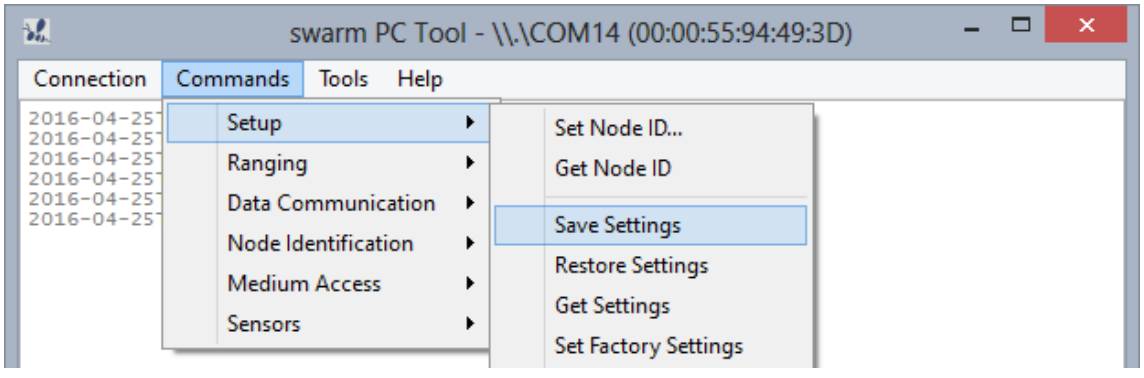

Figure 3-7 Command "Save Settings"

The return value "`=0`" shows that settings are saved successfully to EEPROM. Otherwise "`=1`" will be returned.

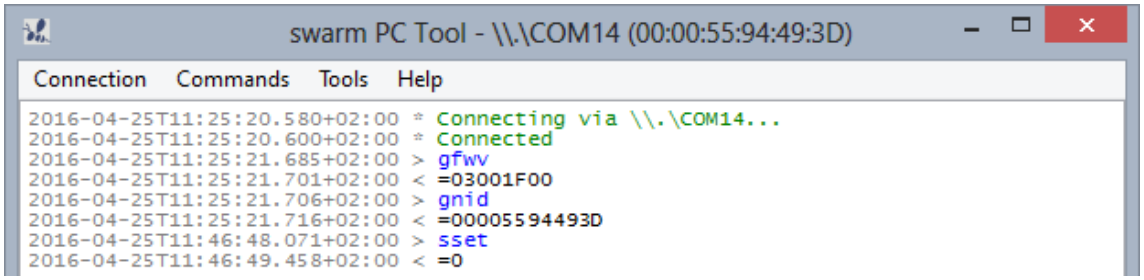

Figure 3-8 Settings successfully saved

3.4. Setting Node ID

During manufacturing each *swarm* device gets a unique node ID. This node ID may not be suitable for different reasons and can be modified according to application requirement. It is always possible to reset the node ID to its original value.

Note: Be aware to set unique IDs within a cluster. Otherwise, you will have address conflicts which may lead to unpredictable results.

The command to set node ID can be found in the menu bar, see figure below:

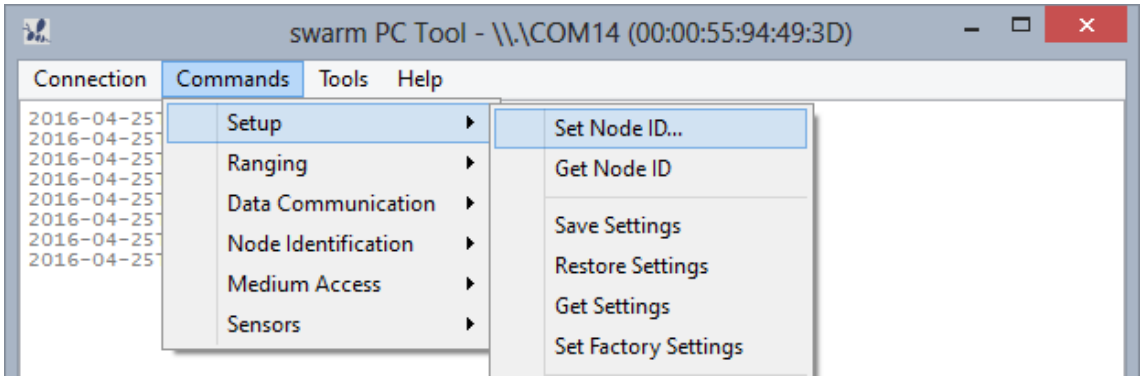

Figure 3-9 Command “Set Node ID”

By clicking `Commands->Setup->Set Node ID`, another window appears asking to enter a new node ID:

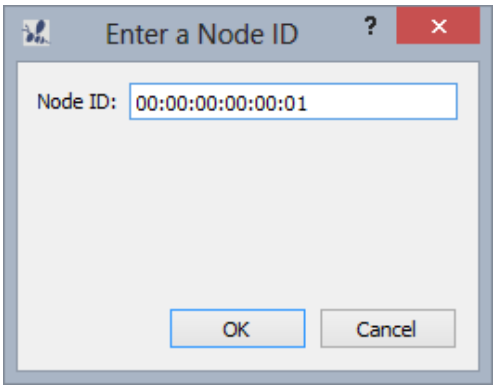

Figure 3-10 Enter Node ID

Enter “000000000001” as a new node ID, click `OK` and the new ID is returned. Figure 3-11 shows that the ID is changed successfully.

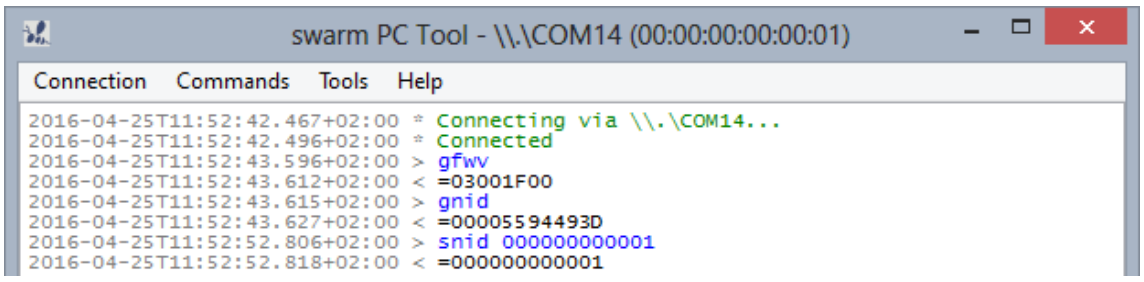

Figure 3-11 Node ID successfully changed

Note: Each node ID consists of 6 bytes. The available range is from 000000000001 to FFFFFFFFFFFE. The ID 000000000000 is used to reset the ID to factory default value, while the ID FFFFFFFFFFFF is used for broadcast messages.

3.5. Disabling Ranging Result Notification

When *swarm* nodes are switched on, they start to range to each other automatically. By default, the ranging result notification (RRN) is enabled, see Figure 3-12.

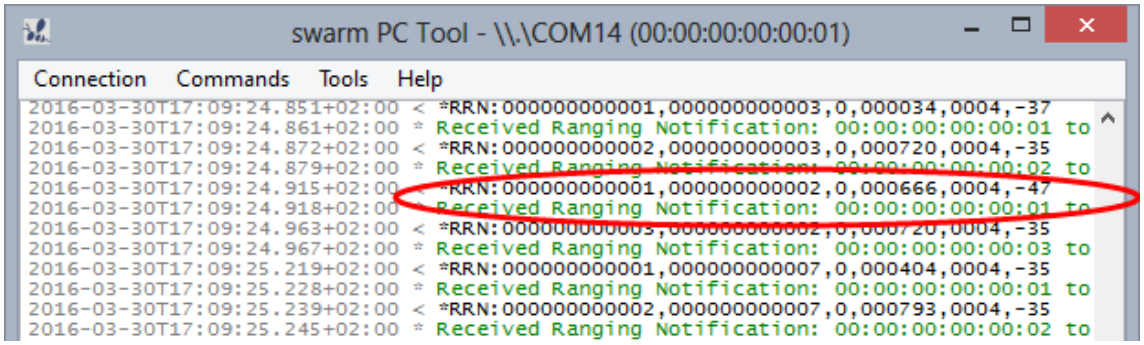

Figure 3-12 Ranging Result Notification (RRN) enabled by default

As an example an RRN is marked red and explained in Table 3-1:

```
*RRN: 000000000001,000000000002,0,000666,0004,-47
Received Ranging Notification: 00:00:00:00:00:01 to 00:00:00:00:00:02 0,000666,0004,-47
```

Table 3-1 Explanation of ranging result notification

Code	Meaning
000000000001	ID of *swarm* node which initiates the ranging
000000000002	ID of *swarm* node which receives the ranging request
0	Error code indicating that ranging was successful
000666	The distance between the two nodes is 666 cm.
0004	NCFG mask. Sets visible information in RRN. Here it is the RSSI value.
-47	The RSSI value is – 47 dBm.

Note: For a detailed explanation of ranging result notification (RRN), please refer to [1] or [2].

To avoid overcrowded results when using other commands or tools (Ranging Monitor, Sensor Monitor), it is recommended to disable the RRN at first by clicking `Commands->Ranging->Ranging Result Notification->Disable`, see Figure 3-13.

Note: RRN may be enabled again at any time if required.

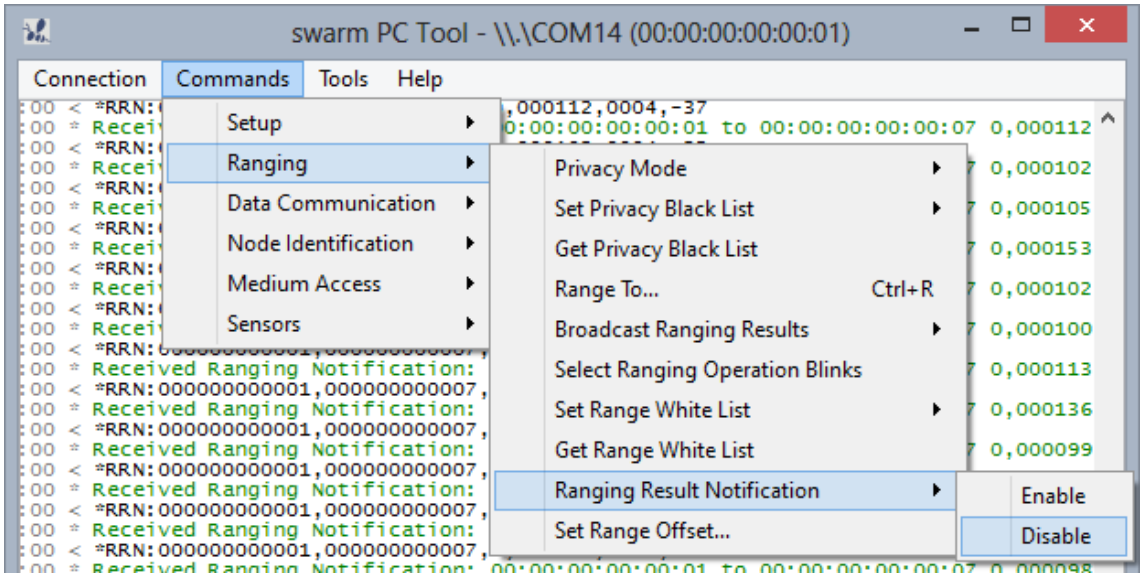

Figure 3-13 Command "Disable RRN"

The return value "`=0`" indicates that the RRN is disabled successfully. Otherwise "`=1`" will be returned. The RRN message doesn't appear again after RRN is disabled, see Figure 3-14.

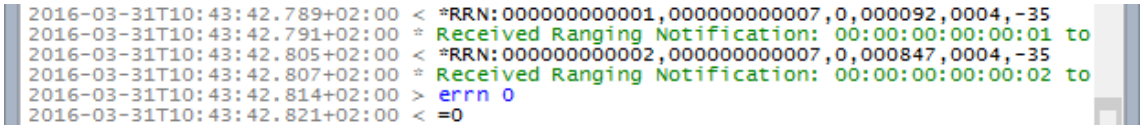

Figure 3-14 RRN successfully disabled

3.6. Disconnecting from *swarm* PC Tool

To disconnect a device from *swarm* PC Tool, click `Disconnect` as shown in Figure 3-15. Remember to save settings before disconnection as explained in 3.3

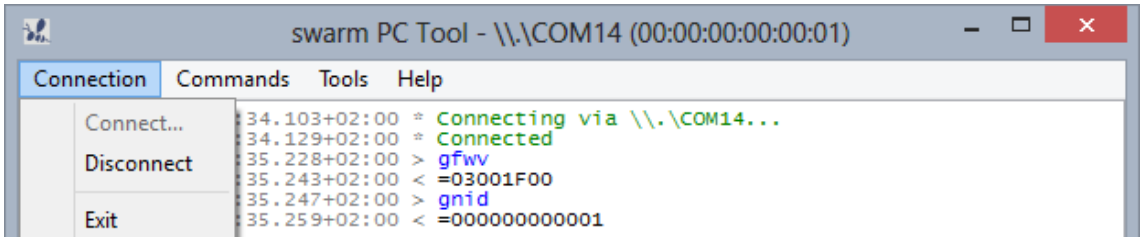

Figure 3-15 Disconnect a device

The device is now disconnected:

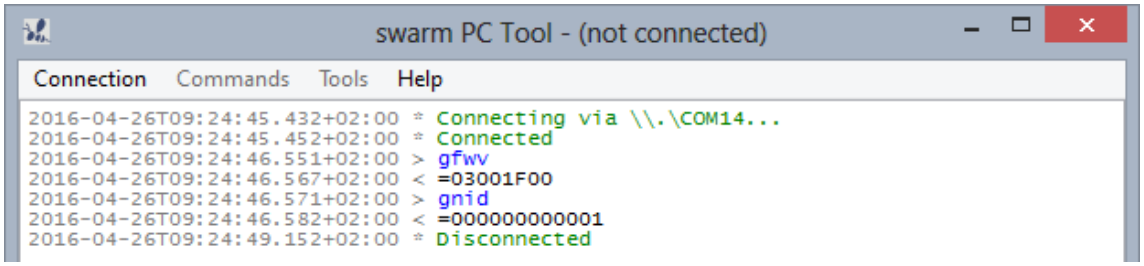

Figure 3-16 Device disconnected

4. Ranging Monitor

Ranging Monitor is an integrated tool which shows the basic ranging functionality of *swarm* nodes. It also provides the possibility to record the ranging results for further analysis.

4.1. Start & Stop Ranging

To start ranging of *swarm* nodes using Ranging Monitor, click `Tools->Ranging Monitor`:

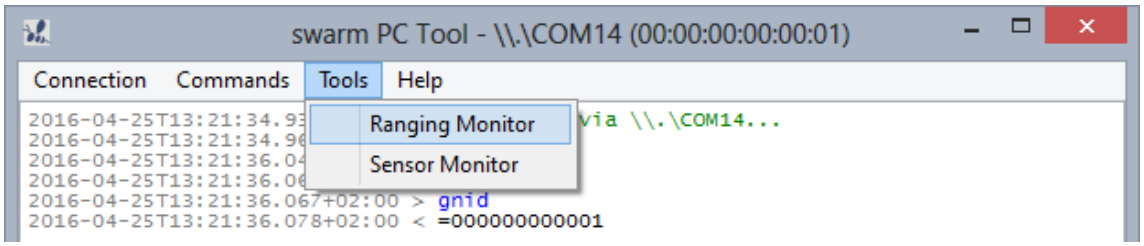

Figure 4-1 Ranging Monitor menu

The following window pops up after that. The parameter “Ranging interval” can be changed. In the following example 1000 ms is chosen, see Figure 4-2. The node ID of the *swarm* node which initiates ranging is 000000000001, see Figure 4-1.

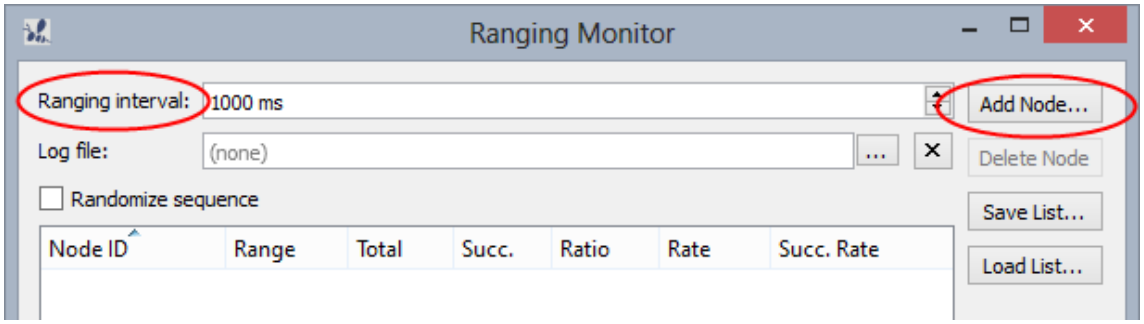

Figure 4-2 Ranging Monitor window

To start ranging, the node ID of remote *swarm* nodes must be provided. Click `Add Node` (see Figure 4-2), another window appears asking to enter a node ID. Click `OK` after entering the node ID.

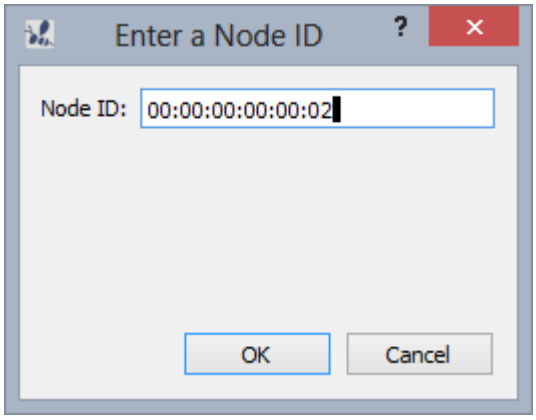

Figure 4-3 Add node by entering Node ID

In the following example two remote *swarm* nodes are added with node IDs 000000000002 and 000000000003. Click `Start` to start ranging:

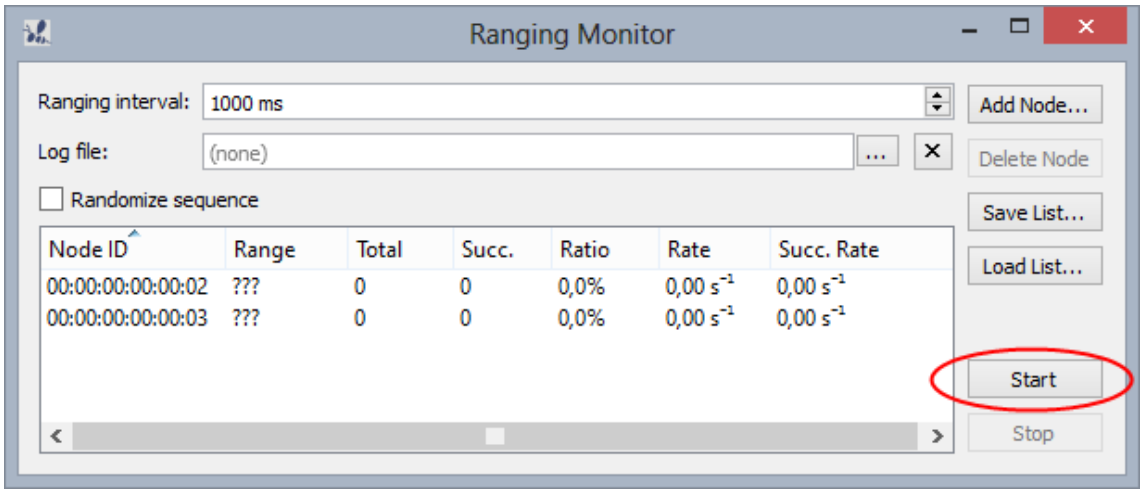

Figure 4-4 Remote *swarm* nodes added

After ranging has started, each ranging update can be seen in Ranging Monitor window (see Figure 4-5) and the whole ranging results are shown in the *swarm* PC Tool main window (Figure 4-6).

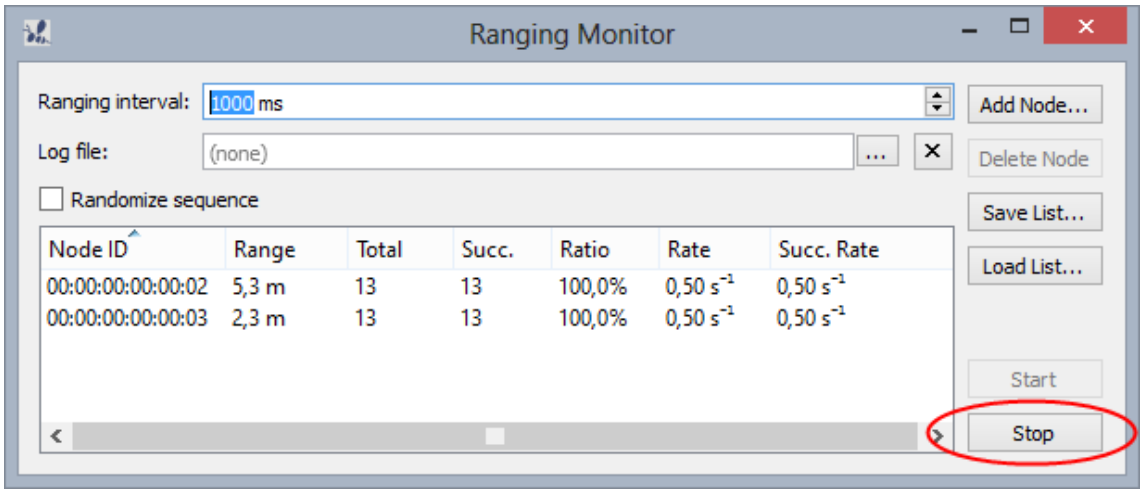

Figure 4-5 Ranging updates in Ranging Monitor

It can be seen that *swarm* node 1 ranges to *swarm* node 2 and to *swarm* node 3 alternately. Take one ranging result from Figure 4-6 for example:

```
rato 0 000000000002
=0, 000487, -37
```

The first line indicates the ranging request to *swarm* node 2 by *swarm* node 1. The second line shows the ranging result. “0” means that the ranging was successful. “000487” means that the distance between *swarm* node 1 and *swarm* node 2 is 487 cm. “-37” indicates the RSSI value in dBm. For a detailed explanation of ranging results, please refer to [1] or [2].

Note: To ensure successful ranging the settings “data mode, syncword, FEC on/off” must be the same for all participating *swarm* nodes. The settings can be read out by clicking `Commands`→`Setup`→`Get Settings`.

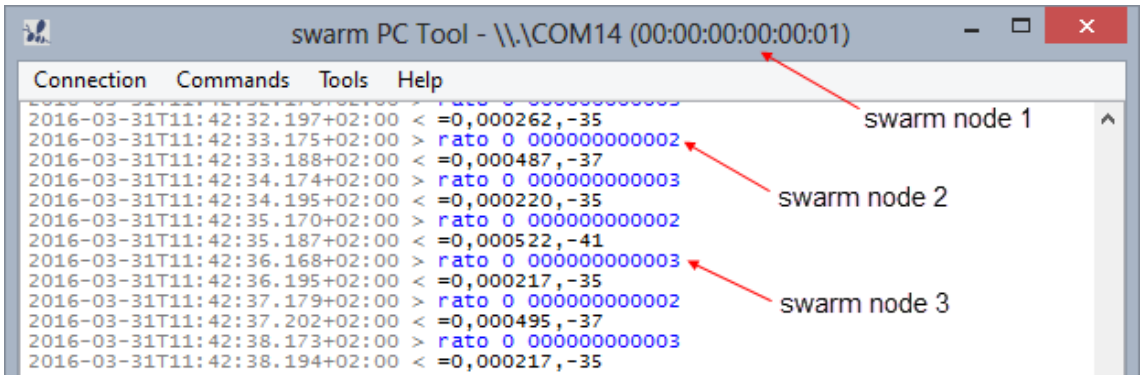

Figure 4-6 Ranging results in the main window

To stop the ranging, just click the `Stop` button as shown in Figure 4-5.

To delete a node, just select it and click on `Delete Node`, then the node is deleted. In this way, all the listed nodes can be deleted one after another.

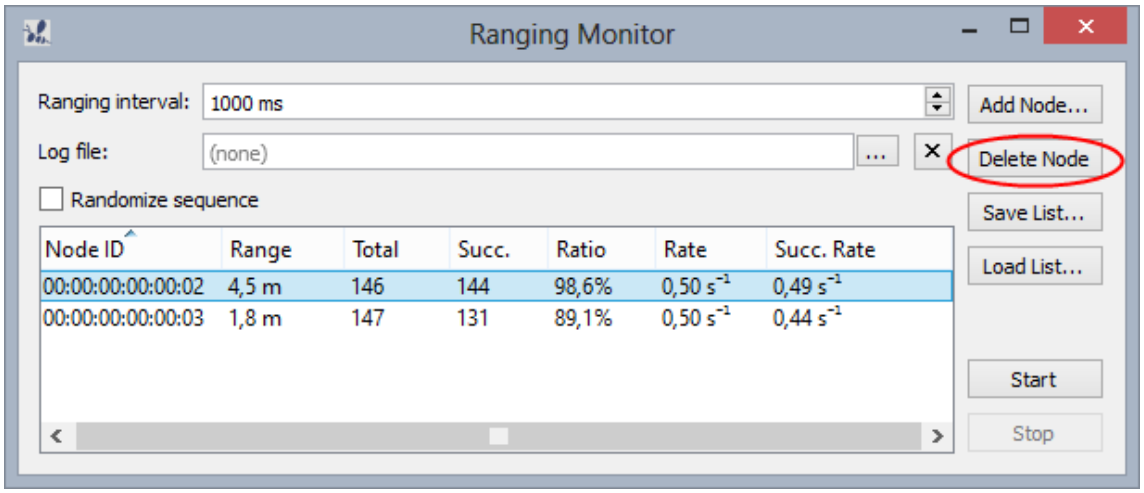

Figure 4-7 Delete Node

4.2. Recording Ranging Results

To record ranging results, an existing log file can be chosen or a new log file can be created by clicking `Choose log file`, see Figure 4-8:

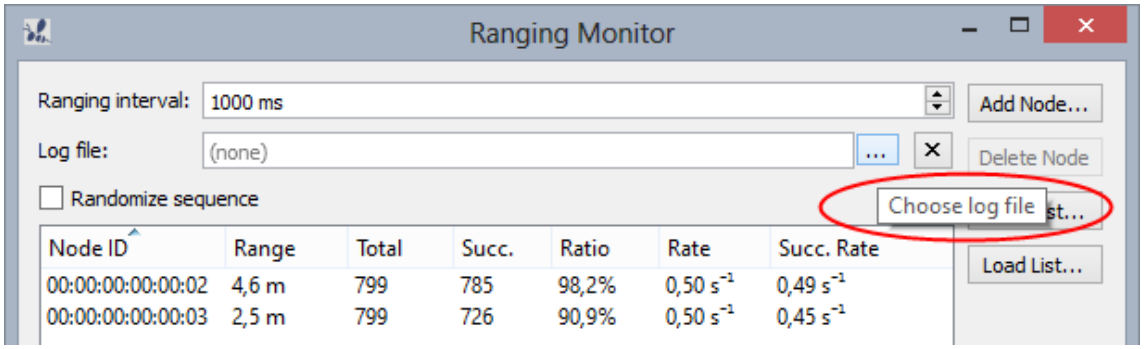

Figure 4-8 “Choose log file” button

Another window appears for selecting existing log files. In case that none is available, a new log file can be created and saved, e.g. under the file name “ranging result”, see Figure 4-9.

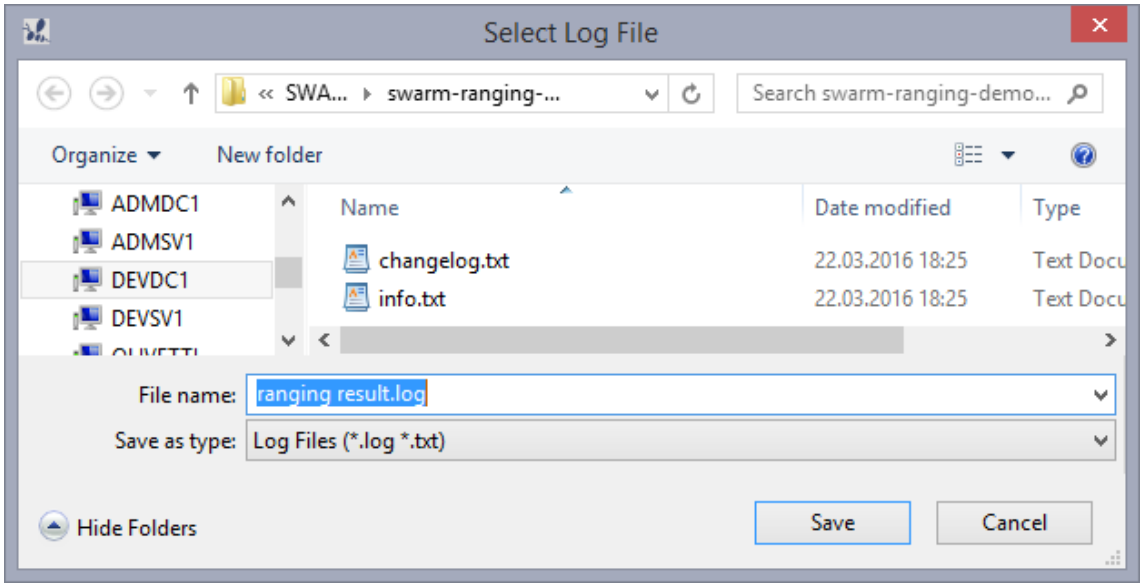

Figure 4-9 Select Log File window

Click `Save`, and the logging of ranging data starts. After a while the logging can be stopped by clcking `Stop logging` as shown in Figure 4-10.

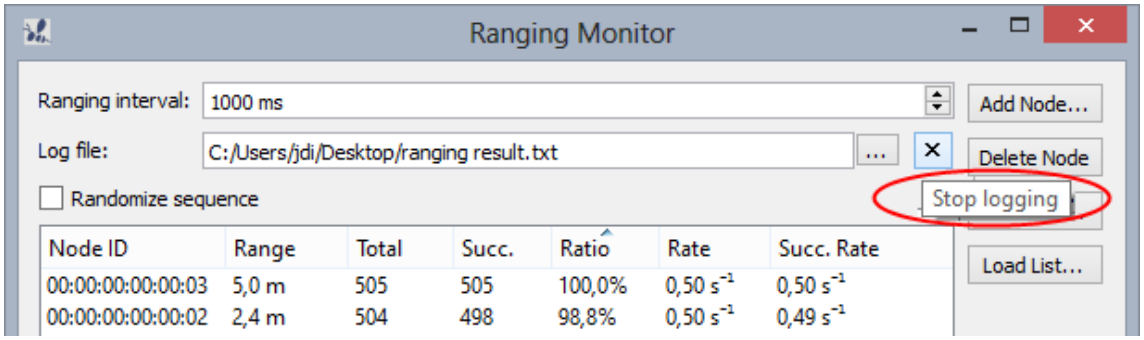

Figure 4-10 "Stop logging" button

Open the log file and the recorded ranging data can be seen as in Figure 4-11. Each ranging result contains following information: timestamp, node ID, error code, raw data, filtered data and RSSI value.

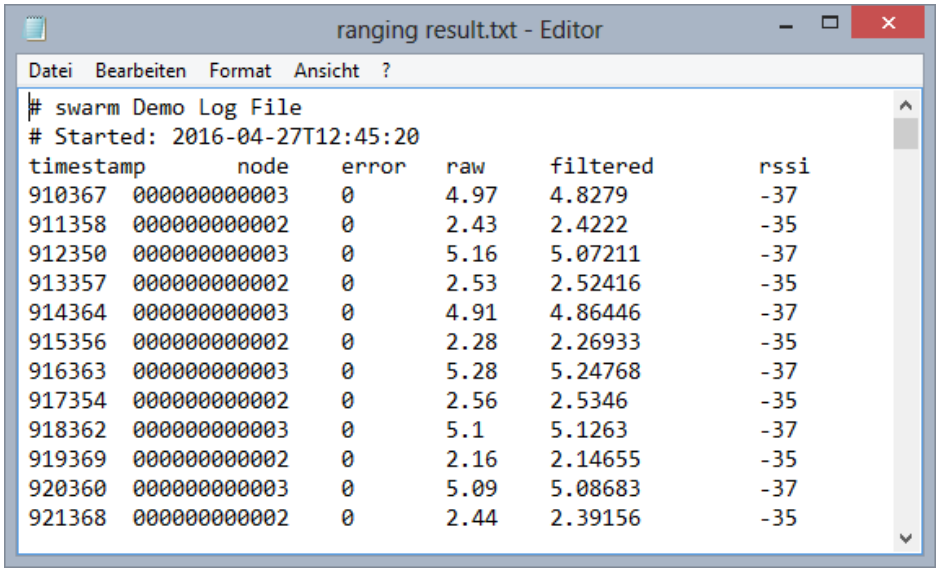

Figure 4-11 Ranging result log file

Recorded ranging results of a certain period can be analyzed and averaged with different tools (e.g. Excel, R etc.). This approximate average result can be compared with the real measurement to see how accurate the distance between two *swarm* nodes is measured using the ranging method.

4.3. Save List & Load List

In Ranging Monitor there are two commands related to node ID list: `Save List` and `Load List`. With `Save List`, a `.txt` file can be generated with the list of all the added nodes for ranging. Once this node ID list is saved, it can be used for the next ranging operation. Click `Load List` and the list will be imported. In this case, it is not any more necessary to add nodes manually.

If one *swarm* node should range to more than two or three other nodes, it is recommended to generate a list of the node IDs prior to any ranging operation. Just open a `.txt` file and enter the 6-byte node IDs. Figure 4-12 shows an example how a node ID list looks like:

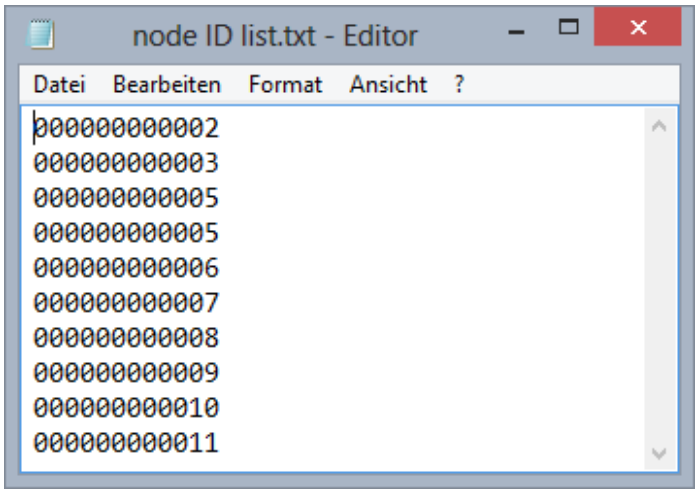

Figure 4-12 Node ID list generated manually

By clicking on `Load List`, this list can be imported and ranging can be started, see Figure 4-13. In this case, entering the node ID one by one is not any more necessary.

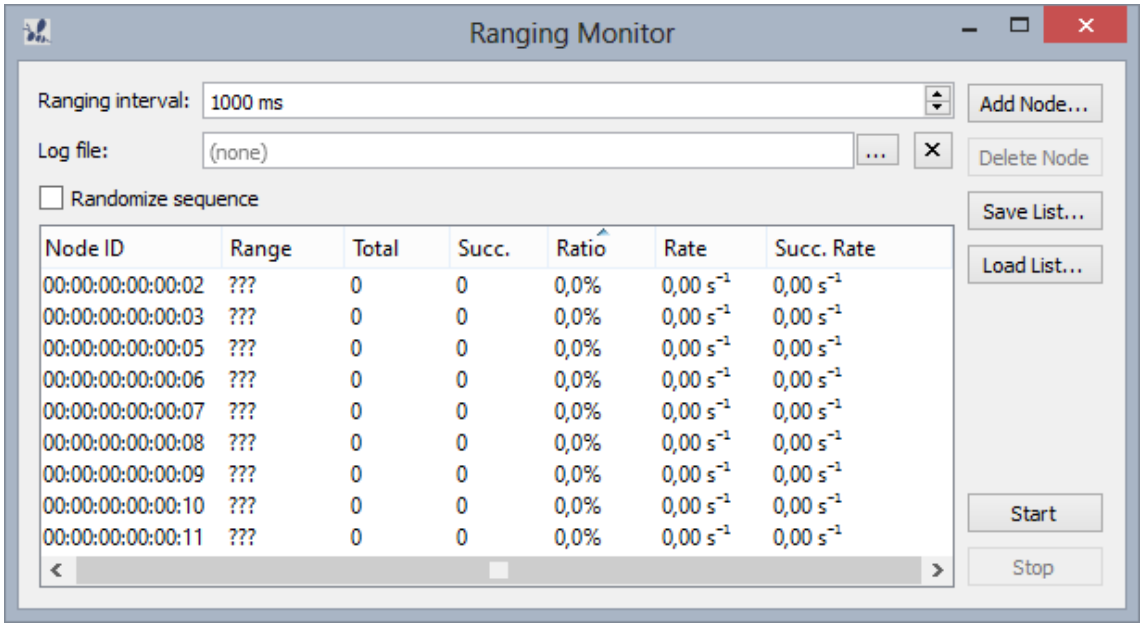

Figure 4-13 Loaded node ID list

5. Sensor Monitor

In each *swarm* device a MEMS sensor is integrated, which detects 3D acceleration data. Sensor Monitor is a tool that reads out the sensor data of the *swarm* node connected to host automatically and shows them graphically.

To start Sensor Monitor, click `Tools->Sensor Monitor`:

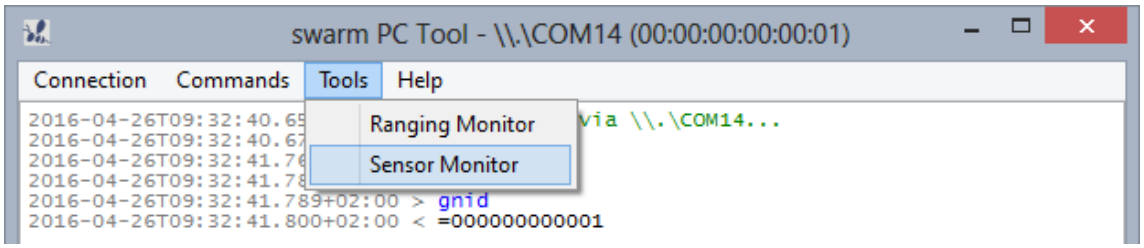

Figure 5-1 Sensor Monitor menu

The 3D accelerations of the *swarm* device are returned after starting Sensor Monitor:

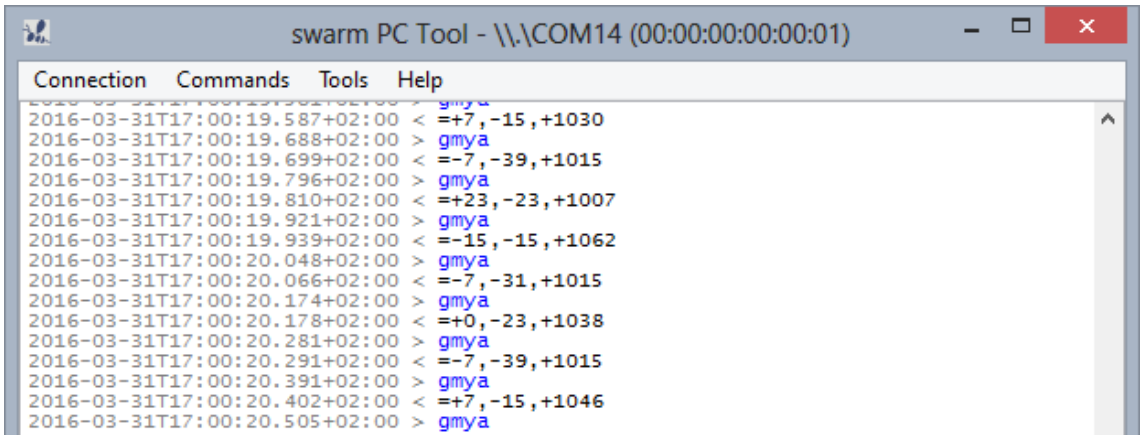

Figure 5-2 3D acceleration data of *swarm* node

At the same time, another window pops up showing the data flow of the acceleration values in x-, y-, z-axis. Figure 5-3 shows stable sensor data when the *swarm* device remains still, whereas Figure 5-4 observes great acceleration changes when the *swarm* device is vibrating tremendously.

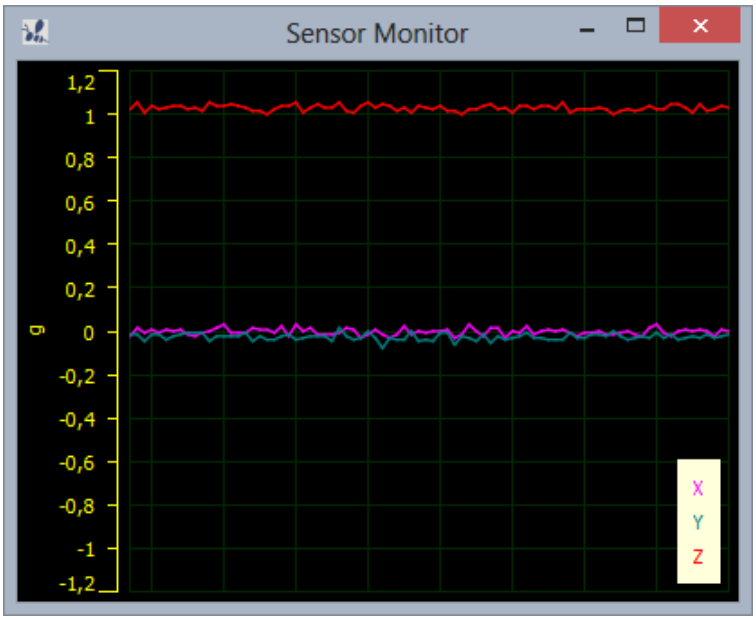

Figure 5-3 Sensor movement chart, static

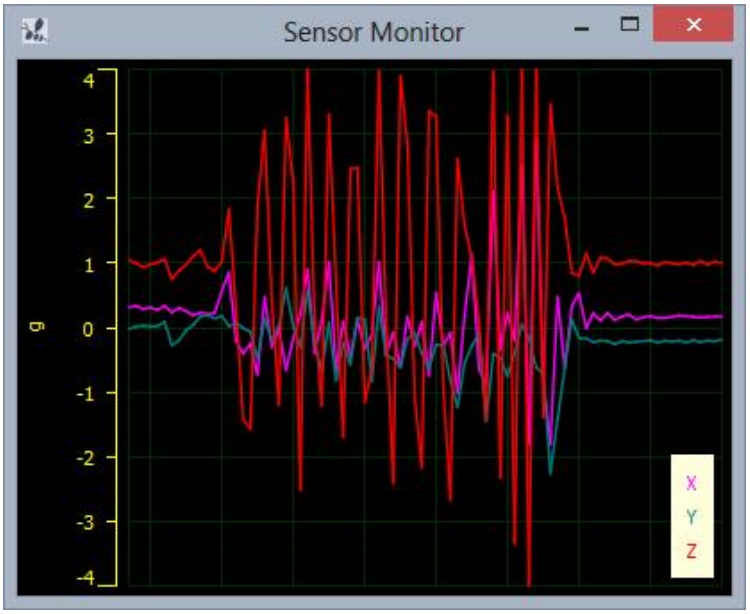

Figure 5-4 Sensor movement chart, dynamic

For a comprehensive explanation of sensor commands, please refer to [1] or [2].

For a practical guide to the use of MEMS sensor, please refer to [3].

6. References

[1] *swarm* API V2.1 Description, Doc ID NA-13-0267-0003-2.1, April 2015, nanotron Technologies GmbH.
[2] *swarm* API V3.0 User Guide, Doc ID NA-13-0267-0003-3.0, March 2016, nanotron Technologies GmbH
[3] AN0505 Using 3D Acceleration and Temperature Sensor Data from *swarm* bee LE V1.1, Doc ID April 2015, nanotron Technologies GmbH

7. Further *swarm* Tools

Another *swarm* tool – sniffer – is helpful to monitor data traffic between *swarm* nodes. It is part of *swarm* kit products or can be purchased separately. Contact nanotron team for more details if you are interested in it.

Document History

Date	Author	Version	Description
2015-05-15	JDI	1.0	Initial version. Corresponds to *swarm* PC Tool V2.1.
2016-04-30	JDI	3.0	Corresponds to *swarm* PC Tool V3.0. Text and pictures changed accordingly.

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Further Information

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