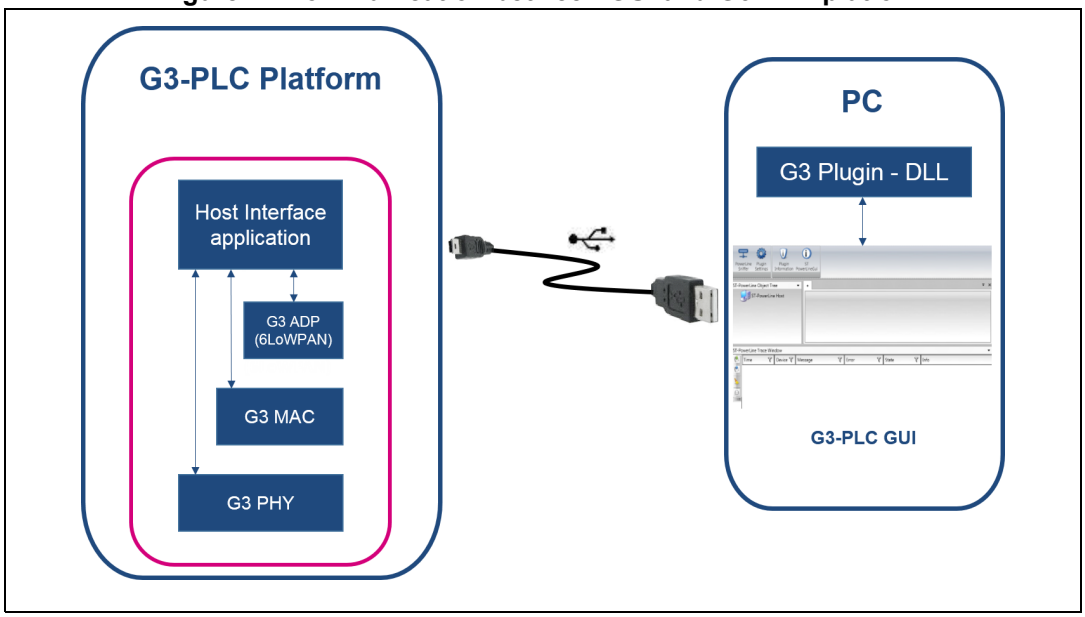
UM1811
User manual

G3-PLC graphical user interface (GUI)

Introduction

The G3 power line communication (G3-PLC) graphical user interface (GUI) is a tool implemented by STMicroelectronics™ that allows interfacing one or more ST platforms equipped with the G3-PLC protocol, hereafter called G3-PLC platforms. This tool is running on a Microsoft® Windows® PC that is connected to a supported G3-PLC® platform (see *Section 2 on page 6*) through to a serial link, converted to a USB connection. On the PC side, the communication with the G3-PLC platform is managed thanks to a node interface plugin written in C# accessible through a graphical front-end. On the G3-PLC platform, the communication is managed thanks to a host interface application that receives/sends the messages from/to the PC. Messages are translated into commands for the ST G3-PLC library. This document does not describe in details the plugin, the host interface application, nor the ST G3-PLC library. It describes the PC tool features, it details the options that it offers, it gives clear guidance on how to connect a G3-PLC platform to the tool and it provides examples in order to transmit data between two different G3-PLC platforms. To better understand some menu of the GUI, it is useful to understand how the ST G3-PLC protocol stack is implemented:

Figure 1. Communication between GUI and G3-PLC platform



On the G3-PLC platform, a Host Interface application forwards commands from the serial link to the right layer of the protocol stack (6LoWPAN, MAC, PHY) and it forwards responses from one layer of the protocol stack to the serial link. On the PC side, the node interface plugin forwards commands from the graphical front-end to the serial link and it forwards the responses from the serial link to the graphical front-end. The host interface application and node interface plugin communicate thanks to a serial link.

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1 Documentation conventions

List of abbreviations

The following abbreviations are used:

Table 1. List of abbreviations

Abbreviation	Description
6LoWPAN	IPv6 over low power wireless personal area networks
ADP	Adaptation layer
BER	Bit error rate
GUI	Graphical user interface
G3	G3-PLC powerline protocol
MAC	Medium access control layer
PC	Personal computer
PHY	Physical layer
PLC	Power line communication
UART	Universal asynchronous receiver transmitter
USB	Universal serial bus

2 GUI installation

2.1 System requirements

A personal computer (PC) including:

- Operating system Windows 7.
- Microsoft .NET© framework 4.0 or later installed.
- 20 Mbytes free on the local disk for the archive to be uncompressed.
- One or more USB ports.

2.2 G3-PLC GUI release

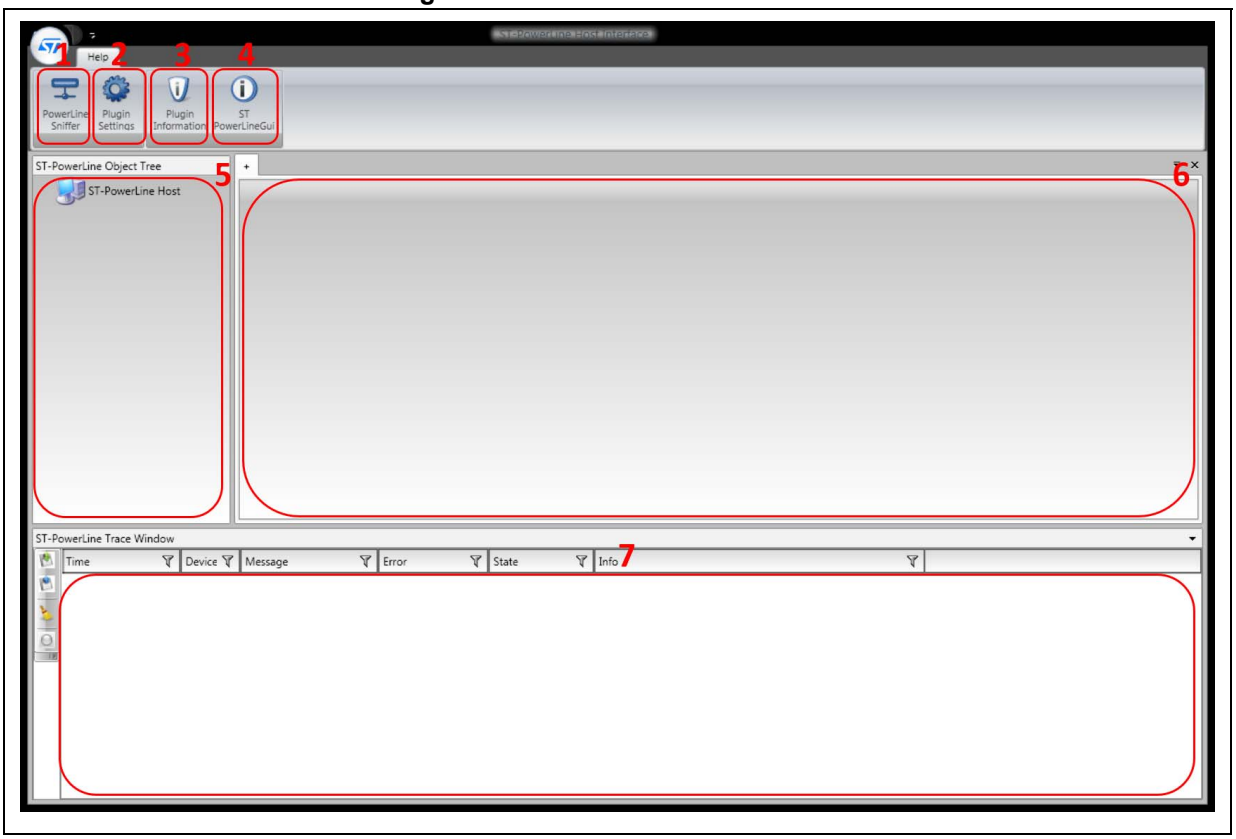
The GUI is released in a zip archive. To run the application, the archive needs to be uncompressed on the user local disk.

Once the archive is successfully uncompressed, the user needs to run the StPowerLineGui.exe file.

2.3 G3-PLC GUI main window overview

Once the StPowerLineGui.exe executable has been launched, the main window of the G3-PLC GUI appears on the screen after few seconds.

Figure 2. Main G3-PLC GUI window



The elements of the main window are:

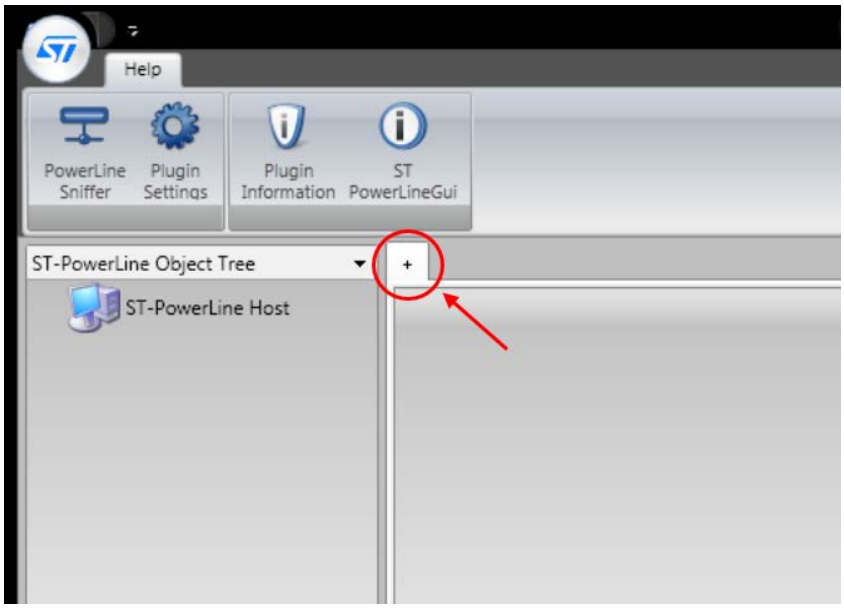
1. Power Line Sniffer button: it opens the Sniffer tool panel
2. Plugin Settings button: it opens the configuration panel
3. Plugin Information button: it shows the plugin information panel
4. ST Power Line GUI information button: it shows the G3-PLC GUI information panel
5. Node tree navigation panel: it is used to select a specific node and to choose the command type
6. Command panel: it is used to execute a specific command
7. Trace window: it traces the traffic from/to the G3-PLC GUI application and one node.

3 Getting started

3.1 Node connection

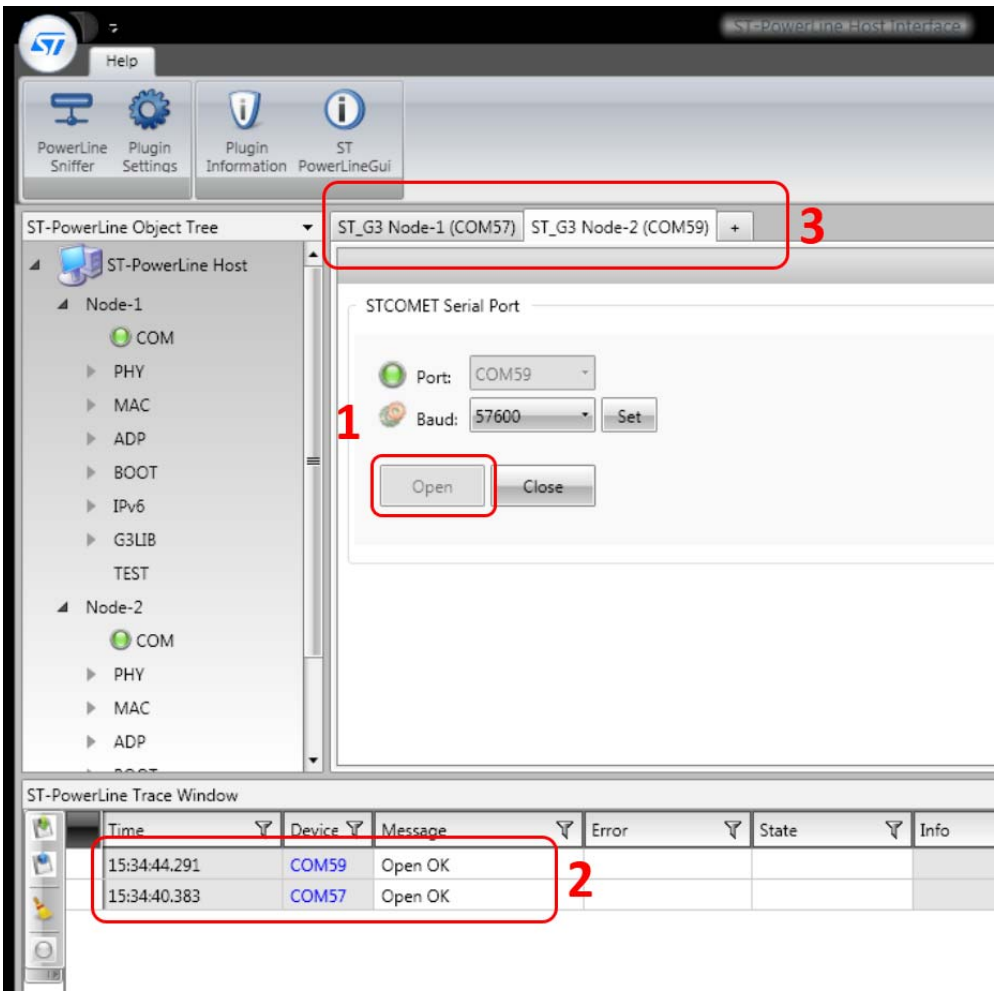
More than one G3-PLC platforms can be connected to the same instance of the G3-PLC GUI. Click on the small cross on the command panel to connect one G3-PLC platform (*Figure 3*). Alternatively, right-click on the ST PowerLine Host icon and click on “Add Node”.

Figure 3. Add a node



Once the “Add Node” cross has been selected, one new tab appears in the command panel. In the node tree panel, selecting the “COM” section gives access to the serial link configuration. Then the enhanced COM port that corresponds to the G3-PLC platform to be driven needs to be selected. Click the Open port button (*Figure 4*) to enable the communication between the G3-PLC GUI and the board.

Figure 4. Node connection



Once the Open button has been selected (1), the trace window (2) allows checking that the command has been correctly transmitted to the evaluation board. The G3-PLC GUI command panel has as much tab as G3-PLC platforms are connected. To identify the tab, the associated COM port is displayed in the panel title (3).

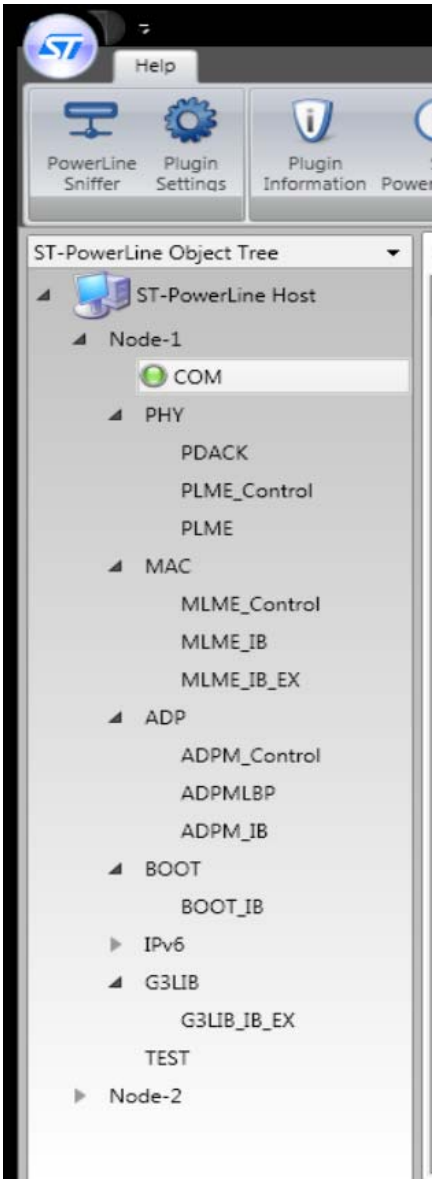
3.2 Node tree panel

The G3-PLC GUI offers access to the “Service Access Points” (SAP) of each layer specified by the G3-PLC standard plus some additional features such as a bootstrap application or the G3 library configuration.

Once a G3-PLC platform is connected, it can be explored thanks to the object tree panel. Each root menu can be collapsed or not to see its detailed content. The detailed content gives access to each specific SAP: PHY, MAC, ADP, BOOT and G3LIB.

Additional levels of the interface (such as IPv6) may be present. The related functions may be used in conjunction with specific firmware projects that may be obtained from your local support.

Figure 5. Node tree panel



All the services provided by one layer may be accessed from the main menu or from one of its sub menus. Below here there is a brief description of each main menu:

- PHY: the PHY menu offers an interface to use the PHY primitives of the G3-PLC protocol.
- MAC: the MAC menu offers an interface to use the MAC primitives of the G3-PLC protocol.
- ADP: the ADP menu offers an interface to use the 6LoWPAN primitives of the G3-PLC protocol.
- BOOT: the BOOT menu offers an interface to use the ST defined bootstrap application. This feature will not be described in this document. Please contact your ST local support for additional information.

- G3LIB: this menu offers an interface to be able to configure the G3-PLC library and access additional parameters that are not specified in the G3-PLC protocol.
- IPv6: the IPv6 menu offers the possibility to drive a specific firmware with the IPv6 on the top of G3. This feature will not be described in this document. Please contact your ST local support for additional information.
- TEST: the TEST menu offers an interface for test purposes.

Each menu provides one specific SAP layer of the G3-PLC stack. In order to access a given SAP layer, the G3-PLC implementation needs to be configured to work in a specific operational mode.

In order to do this, the G3LIB section exports the HI-MODE-SET command, which can set one of the following values:

- 0x00 - PHY_MODE: the PHY only working mode. The device may perform all the operations described by the G3-PLC standard for the PHY layer.
- 0x01 - MAC_MODE: the MAC working mode. The device may perform all the operations described by the G3-PLC standard for the MAC layer.
- 0x02 - ADP_MODE: the ADP/6LoWPAN working mode. The device may perform all the operations described by the G3-PLC standard for the adaptation layer.
- 0x03 - BOOT_MODE (default): the BOOT working mode. The device may perform all the operations described by the G3-PLC standard for the adaptation layer. In addition, the bootstrap application is activated. This is the default mode of operation.

Additional operational modes (such as IPv6) may be present. The related functions may be used in conjunction with specific firmware projects that may be obtained from your local support.

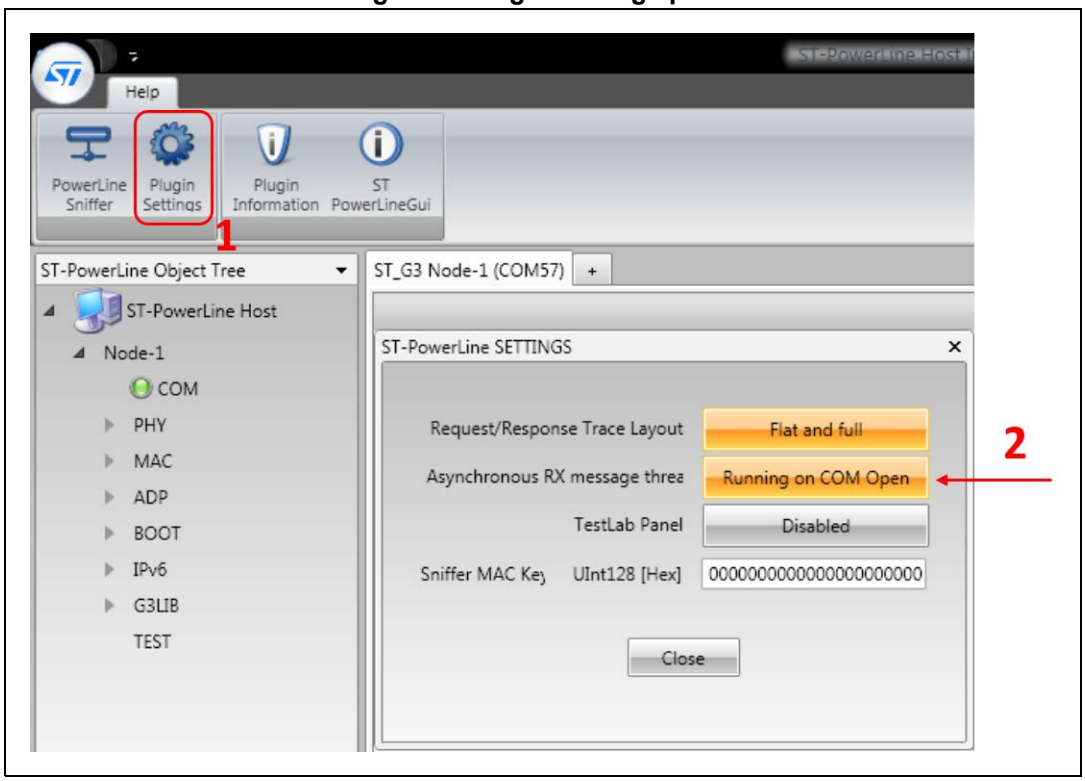
3.3 GUI and Plugin Settings

Under the Plugin Settings button (1) represented in *Figure 5*, some advanced G3-PLC GUI features may be enabled or disabled.

- Request/Response Trace Layout: it changes the layout of the trace panel
- Asynchronous Rx message thread: see *Section 3.4 on page 12*
- TESTLAB panel: enables the test panel as described in *Section 8 on page 38*
- Sniffer MAC Key: the 128-bit key used by the MAC layer to cipher data. Configuring the key is necessary to decipher the MAC frames captured by the Sniffer.

Additional information (i.e.: the version numbers) related to the G3-PLC GUI may be checked under the Plugin Information and ST PowerLine GUI buttons.

Figure 6. Plugin Settings panel



3.4 Automatic confirm and indication events parsing

The G3-PLC GUI has an automatic management of the “Confirm” and “Indication” events communicated by the G3-PLC platform. As a consequence the user does not need to periodically poll the status of the G3-PLC platform.

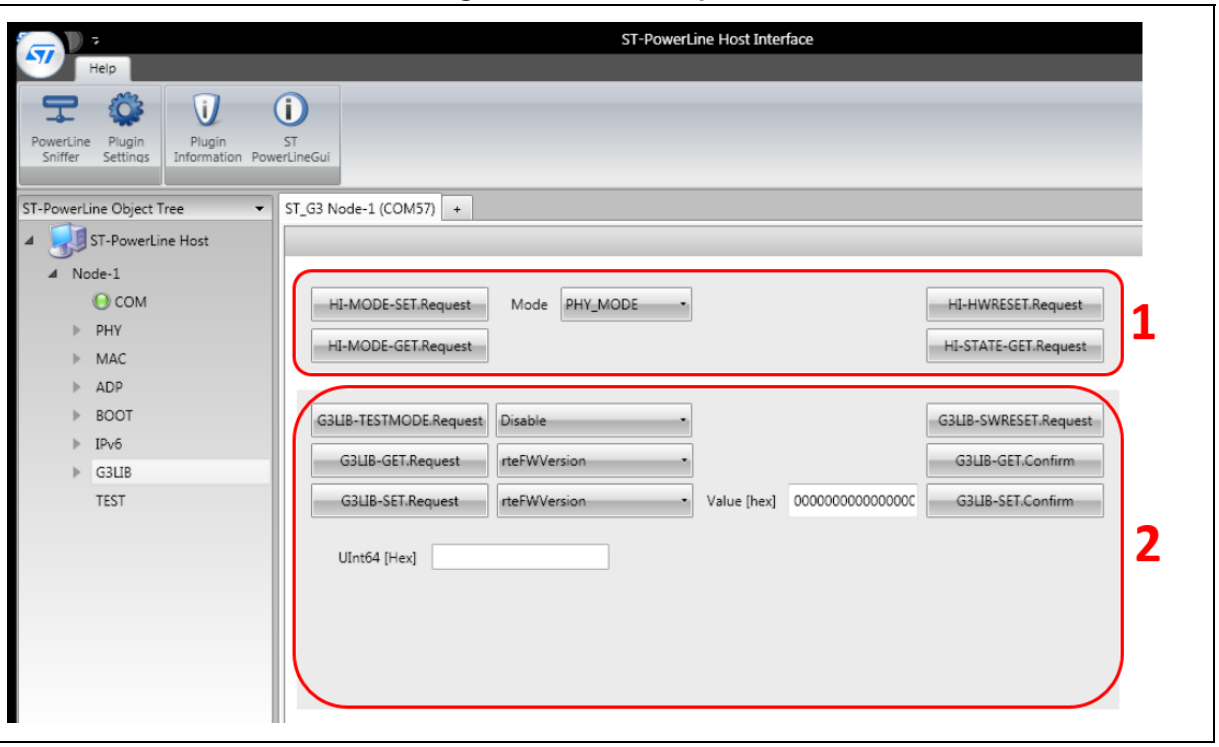
It is possible to disable this functionality for test purposes. Under the Plugin Setting (1) the Asynchronous Rx message thread button (2) enables or disables that feature.

4 G3LIB menu

4.1 G3LIB root menu

The G3LIB root menu allows to configure the G3-PLC library implementation and to get access to features not specified by the G3 protocol.

Figure 7. G3LIB root panel



The G3LIB main menu contains two areas. The first one (1) comprises the commands useful to configure the host interface application:

- HI-MODE-SET.Request: this command sets the G3-PLC platform working mode.
- HI-MODE-GET.Request: this command gets the operational mode of the host interface application.
- HI-STATE-GET.Request: this command performs a basic action to test the connection with the board.
- HI-HWRESET.Request: this command performs a system reset of the device.

The second area includes (2) all the commands related to the G3 library configuration. The following commands are available:

- G3LIB-TESTMODE.Request: this command enables or disables a specific test mode used for G3-PLC library verification, which normally is not useful for the user.
- G3LIB-GET.Request: this command is used to get the value of one attribute of the G3-PLC ST library.
- G3LIB-SET.Request: this command is used to set the value of one attribute of the G3-PLC ST library.

Below this SET command, a list of options or a text box allows providing the value with which the selected attribute is set.

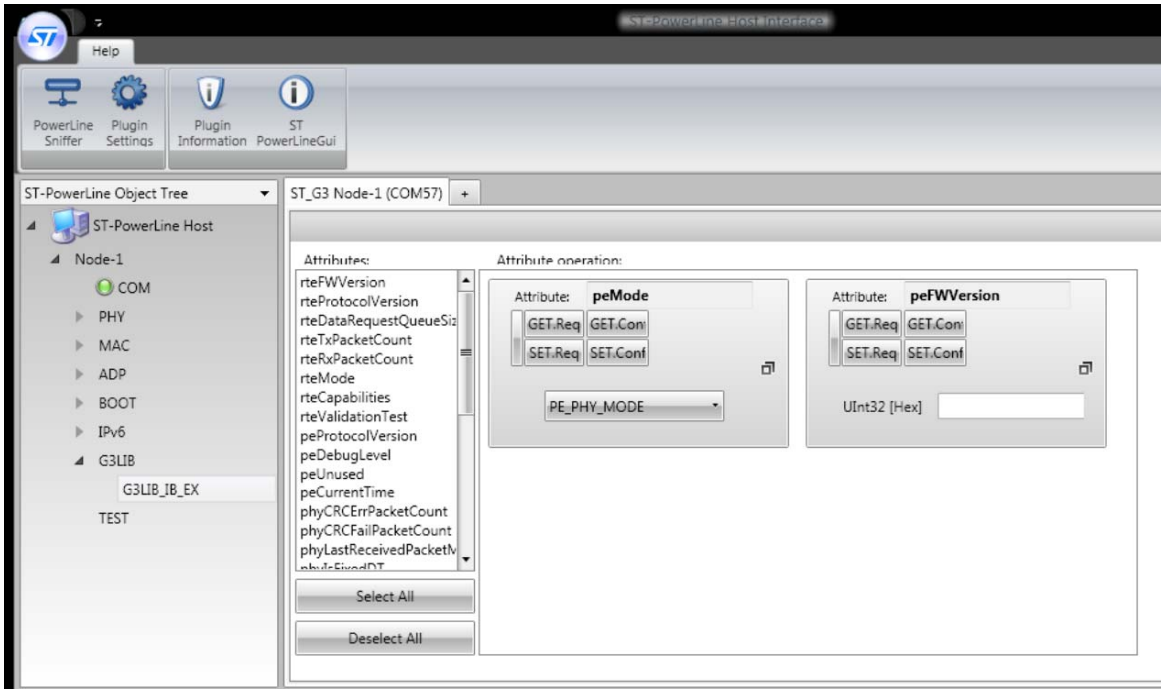
- G3LIB-SWRESET.Request: this command performs a software reset of the G3-PLC protocol stack (RTE and non-RTE part.).
- G3LIB-GET/SET.confirm: these commands are used to get asynchronous confirm message from the application to the connected device. Note that the “Confirm” message is sent automatically by the application as described in *Section 3.4 on page 12*.

4.2 G3LIB IB EX menu

IB-EX stands for the information base explorer. This menu offers the user the ability to read/modify any attribute of the library information base.

It is made of a white board in which the user can drag and drop the desired attribute from the list on the left side.

Figure 8. G3LIB information base explorer



More than one attribute may be added in the white board. A generic set/get method is then available to write/read the attribute.

4.3 G3LIB information base attributes description

From the G3LIB menu, a set of attributes may be read and written. These attributes are not specified by the G3-PLC protocol. Here is a brief description of all those attributes:

Table 2. G3LIB real-time engine information base attributes

	Real-time engine attributes
RTEFWVERSION	The real-time engine firmware version
RTEPROTOVERSION	The real-time engine protocol version
RTEDRQUEUESIZE	The number of TX packets that could be handled by the real-time engine
RTETXPACKETCOUNT	The statistical counter of transmitted packet by the real-time engine
RTERXPACKETCOUNT	The statistical counter of correct received packet by the real-time engine
RTEMODE	The real-time engine working mode (0 rt-MAC, 1 PHY-only)
RTECAPABILITIES	Internal use
RTEVALIDATIONTEST	Internal use

Table 3. G3LIB protocol engine information base attributes

	Protocol engine attributes
PEFWVERSION	The protocol engine firmware version
PEPROTOVERSION	The protocol engine protocol version
PEDEBUGLEVEL	Debug mode settings
PEMODE	The G3-PLC library working mode (0 PHY, 1 MAC,2 ADP, 3 BOOT)
PEUNUSED	Unused
PECURRENTTIME	Current time in the G3-PLC library

Table 4. PHY layer information base attributes

	PHYSICAL layer attributes
PHYCRCERRPKTCOUNT	The statistical counter of the packet received by PHY with error detected by CRC5
PHYCRCFAILPKTCOUNT	The statistical counter of the packet received by PHY with a correct CRC5 but with error on the fields range
PHYLASTRCVPKTMODE	Last received mode
PHYISFIXEDDT	The DT field has a fixed value specified by the PHYDTValue attribute (0 - DT has not the fixed value, 1 - DT has a fixed value)
PHYDTVALUE	The value of the DT field in PHY FCH of the next frames
PHYISFIXEDPDC	PDC has a fixed value specified by the PHYPDCValue attribute (0 - PDC has not the fixed value, 1 - PDC has a fixed value)
PHYPDCVALUE	The value of the PDC field in PHY FCH of the next frames
PHYRSFAILPKTCOUNT	The statistical counter of the packet received by PHY with errors that can't be corrected by the Reed-Solomon decoder

Table 4. PHY layer information base attributes (continued)

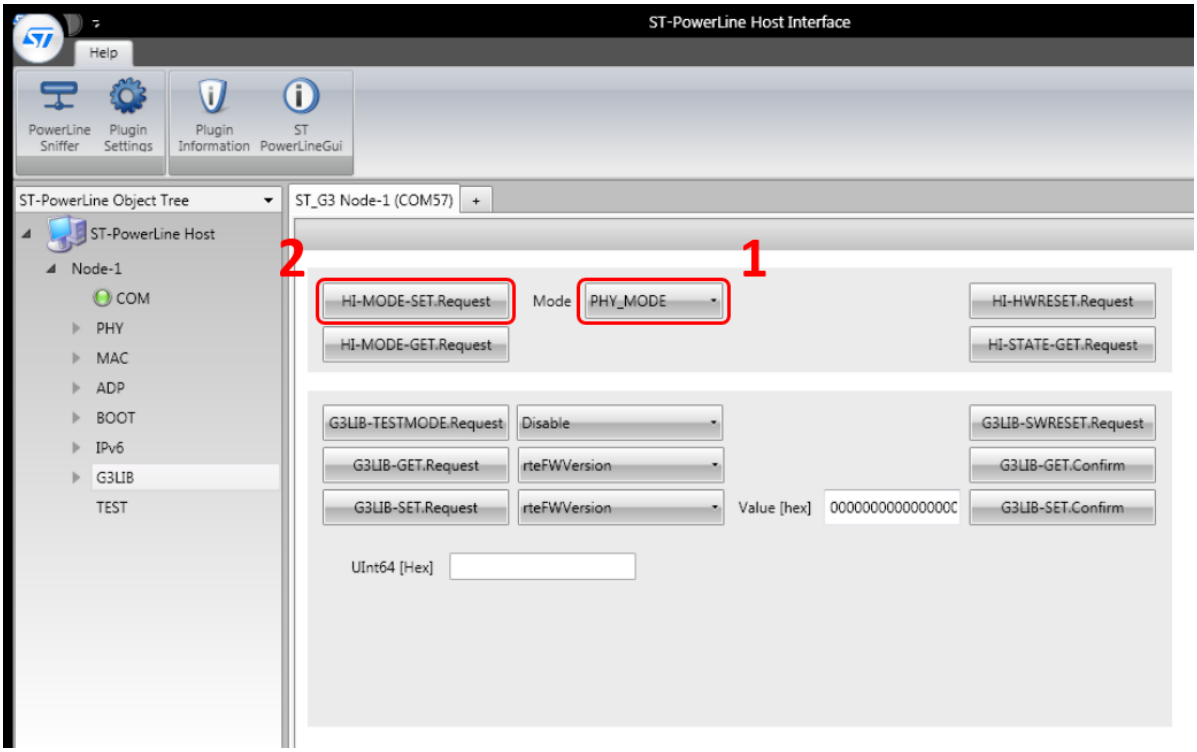
	PHYSICAL layer attributes
PHYLASTRCVPKTRSSTATUS	Status returned by the Reed-Solomon decoder on the last received packet (0 - no errors, 1 - corrected errors, 2 or 3 - errors detected but not corrected)
PHYLASTRCVPKTDT	DT value of the last RX PHY packet
PHYLASTRCVPKTPDC	PDC value of the last RX PHY packet
PHYLASTRCVPKTTM	TM value of the last RX PHY packet
PHYFREECHANNELTIME	Timestamp at which the channel becomes free
PHYPREDRIVERGAIN	Correspondence between the attribute value and predriver gain
PHYLASTRXVALIDFCH	FCH of the last valid RX PHY packet
PHYLASTTXFCH	FCH of the last TX PHY packet
PHYAGCRESETTIMEOUT	The number of SYNCP preamble symbols without any preamble detection after which the AGC is reset
PHYCENELECLEGACYMODE	0 (elementary interleaving, interleaver parameters are not swapped), 1 (full block interleaving, interleaver parameters are swapped)
PHYRSFILTERDISABLED	Disabled the RS filter: 0 filter active, 1 filter not active
PHYTHRPCS_S	The carrier sense threshold on one SYNCP
PHYTHRPCS_S2	The carrier sense threshold on two SYNCP
PHYPCSWINDOW	The number of SYNCP symbols to wait for the preamble detection after PCS
PHYZCDELAYCOMPENSATION	The delay in µs between the zero crossing of powerline AC and the zero crossing at the ZC_IN pin. The compensation is applied for phase detection purposes such as PDC field.

5 PHY menu

To be able to execute PHY layer commands, the G3-PLC platform working mode needs to be configured to the PHY mode.

To do this, simply go to the G3LIB panel as shown in *Figure 9*. Choose the PHY_MODE from the available modes (1) and press the HI-MODE-SET.Request button (2).

Figure 9. Configure the host interface in PHY mode



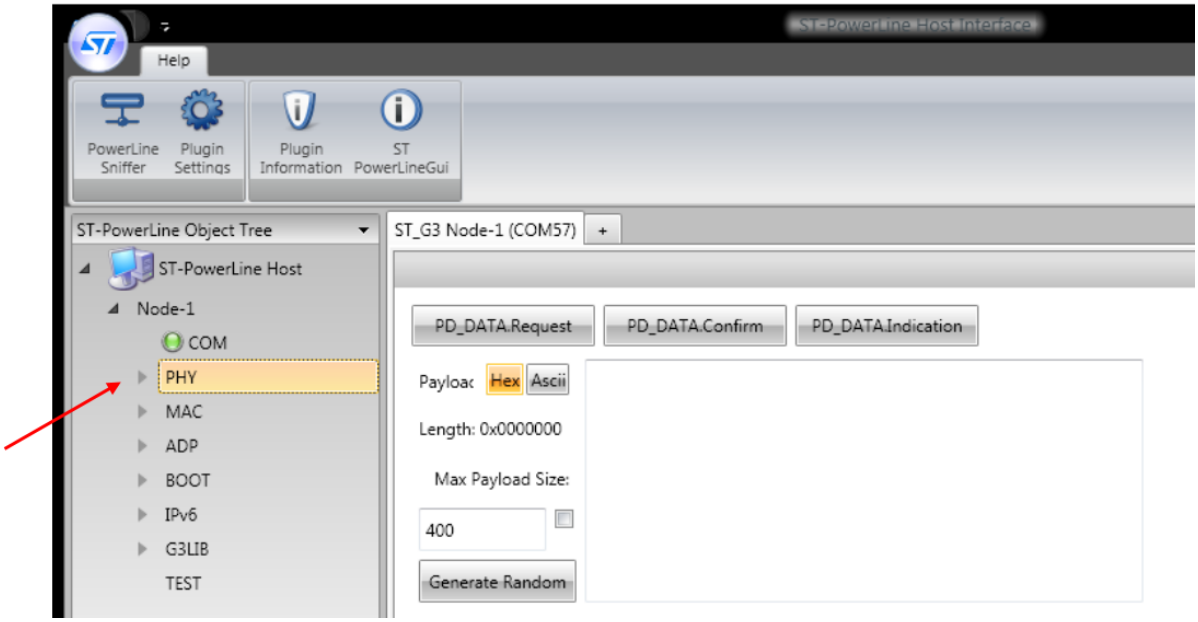
Once the PHY mode is selected, the following menu panels may be accessed:

- PHY root menu: it allows to send data in the physical layer mode
- PDACK: physical data service for acknowledgment message sending
- PLME control: physical layer management entity control panel, used for the line status request and RX/TX configuration
- PLME: physical layer management entity panel, used to set the transmission parameter details (modulation, ToneMap, ToneMask, etc.).

5.1 PHY root menu

The root menu offers the possibility to enter a payload and send the frame in physical layer mode, as represented *Figure 10*.

Figure 10. PHY root panel



On this panel, three main actions can be done:

- PD_DATA.Request: command to send data at the PHY level
- PD_DATA.Confirm: forces generation of a confirmation message (if automatic event is disabled)
- PD_DATA.Indication: forces generation of an indication message (if automatic event is disabled)

Data shall be specified in the hexadecimal or ASCII format, selecting the proper button. Note that, in case of the Hex format, if the payload is entered manually, the payload length must be even (each character corresponds to 4 bits, allowed characters are “0 - 9" and “A - F”).

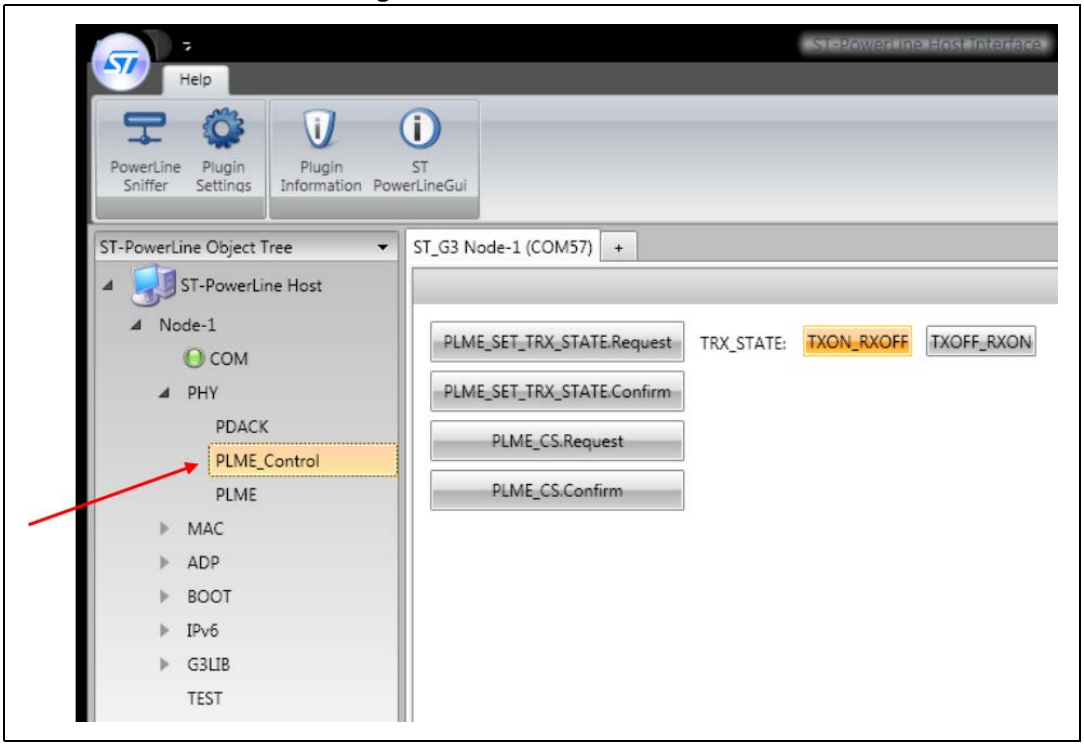
A random payload may be generated clicking the “Generate Random” button. In this case, if the Max Payload Size option is checked, the random payload has a fixed length as specified in the text box, otherwise a random length is generated and used (length is always less or equal to the specified maximum).

When the PD_DATA.Request command is executed, messages are logged into the trace window.

5.2 PLME control menu

The physical sublayer management entity control menu offers 2 options: set the RX and TX chain status and get the status of the line (carrier sense).

Figure 11. PLME control menu



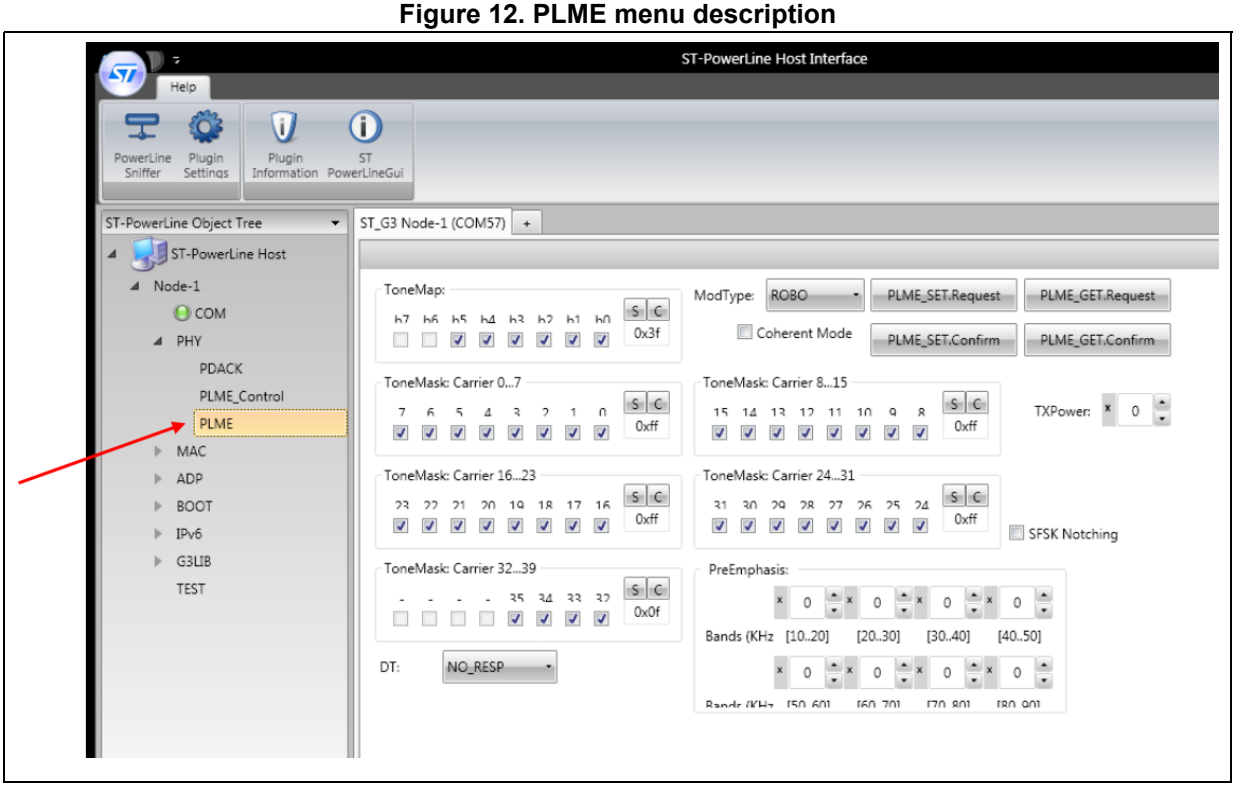
Concerning the PLME_SET_TRX_STATE.Request command, two options may be selected:

- TXON_RXOFF: used to configure the device in transmission
- TXOFF_RXON: used to configure the device in reception.

5.3 PLME menu

The physical sublayer management entity menu allows setting the transmission parameters, as shown in *Figure 12*.

Figure 12. PLME menu description



From this panel, the following commands are available:

- PLME_SET.Request: to set PHY layer transmission parameters
- PLME_GET.Request: to get parameters related to the latest received packet
- PLME_SET.Confirm: forces generation of a confirm message (if automatic event is disabled)
- PLME_GET.Confirm : forces generation of a confirm message (if automatic event is disabled).

The following transmission options are available in the panel:

- ToneMap: bitmap containing the list of the active sub bands (bit set to 1) or inactive (bit set to zero). Active means that data are transmitted in that sub-band, inactive means that dummy data are transmitted. The 6 less significant bits are only considered.
- ToneMask: bitmap containing the list of the active carriers (bit set to 1) or inactive (bit set to zero). Active means that the carrier has energy (transport data or dummy bit), inactive means that the carrier has no energy.
- DT: delimiter type
  - NO_RESP: start of the frame with no response expected
  - RESP_EXP: start of the frame with response expected
  - ACK: positive acknowledgment
  - NACK: negative acknowledgment

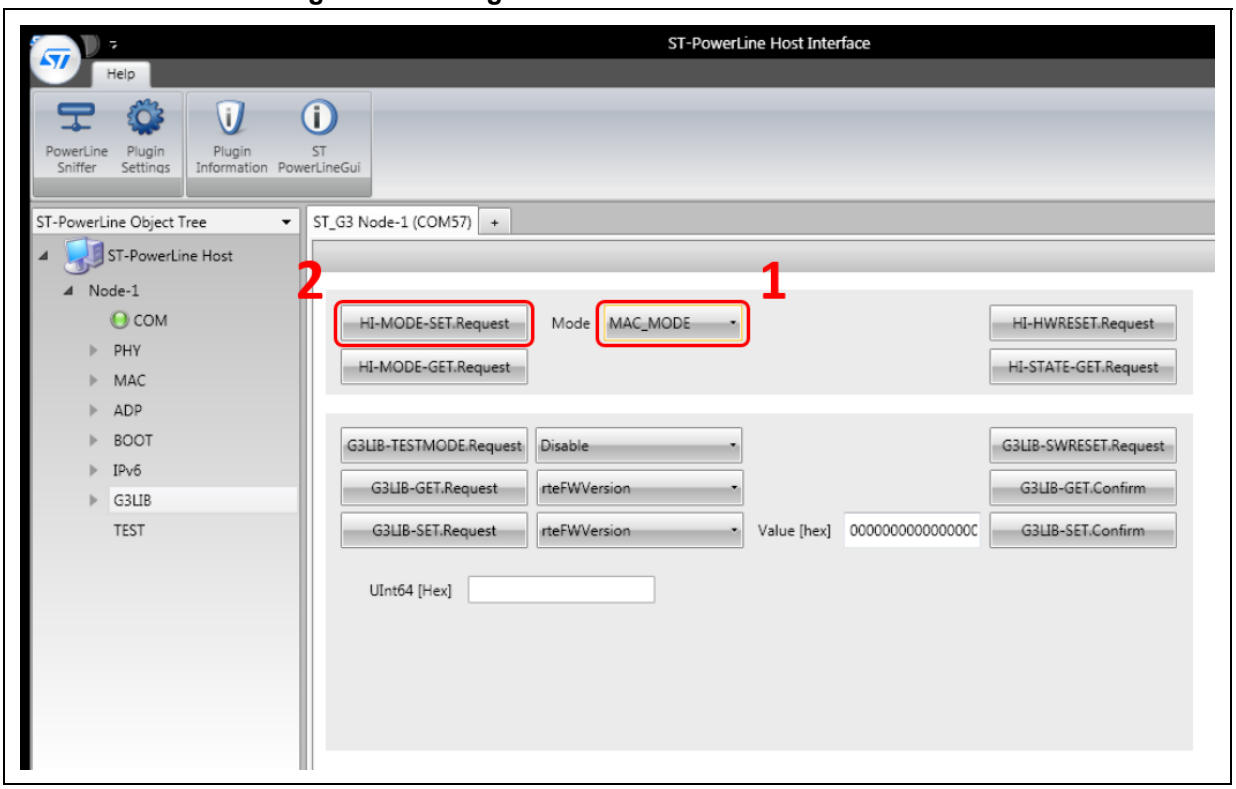
- ModType: the TX modulation type (0: ROBO, 1: DBPSK, 2: DQPSK, 3: D8PSK)
- TX Power: the transmission power (0x20 max. power - 0x00 min. power)
- SFSK Notching: activates the frequency notching coexistence mechanism. Frequency notching allows a G3 device to coexist with the existing narrow band FSK/PSK systems operating over the same frequency band. This checkbox acts on the ToneMask field.
- PreEmphasis: specifies transmission gain for each sub-band represented by the tone map (optional feature currently not supported in ST G3-PLC implementation).
- Coherent Mode: enables or disables the coherent modulations.

6 MAC menu

To be able to execute MAC commands, the G3-PLC platform working mode needs to be configured to the MAC mode.

To do this, simply go to the G3LIB panel as shown in *Figure 13*. Choose the MAC_MODE from the available modes (1) and press the HI-MODE-SET.Request button (2).

Figure 13. Configure the host interface in MAC mode



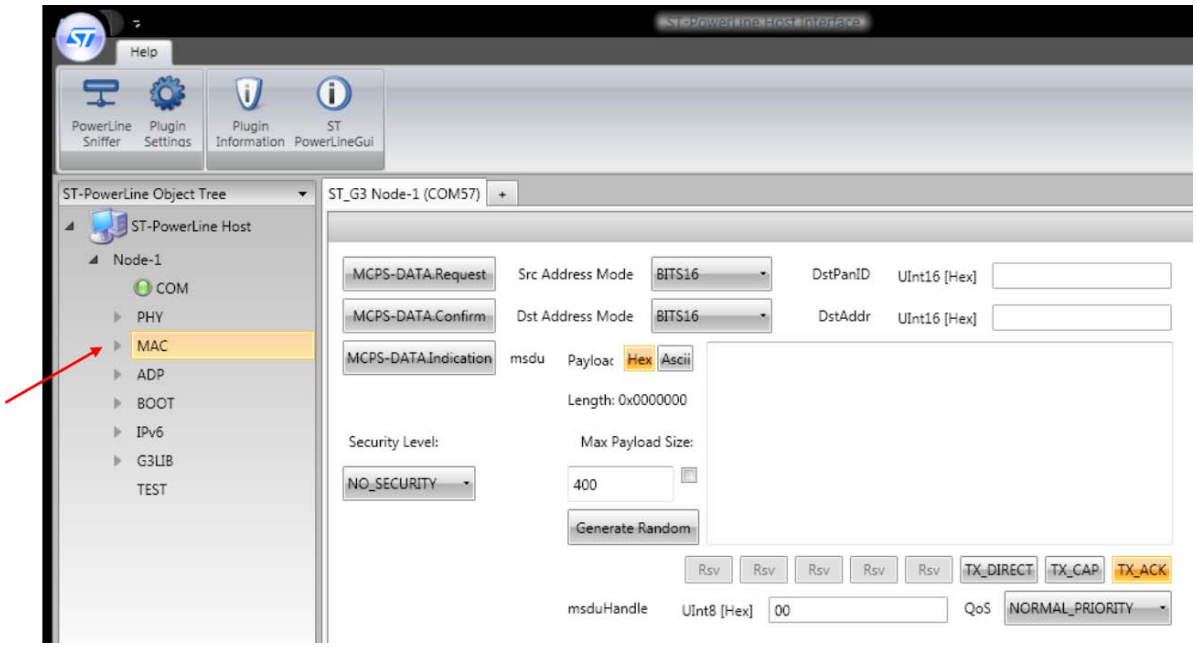
Once the MAC mode is selected, the user can access one of the following menu:

- MAC root menu: a command panel that will allow to send data at the MAC level
- MLME control: a MAC sublayer management entity control panel
- MLME IB: a MAC sublayer management entity information base panel
- MLME IB EX: a MAC sublayer management entity information base explorer panel.

6.1 MAC root menu

The root menu offers the possibility to enter a payload and send it at the MAC layer.

Figure 14. MAC root panel



On this panel, the following command may be executed:

- MCPS-DATA.Request: command used to send data across the MAC layer
- MCPS-DATA.Confirm: forces generation of a confirmation message (if automatic event is disabled)
- MCPS-DATA.Indication: forces generation of an indication message (if automatic event is disabled)

The following options are available in the panel:

- Security Level: the security level to be used (No Security, ENC-MIC-32 CCM*)
- Src Address Mode: the source address mode (BITS16: short address, BITS64: extended address)
- Dst Address Mode: the destination address mode (BITS16: short, BITS64: extended address)
- DstPANId: the ID of the powerline area network
- DstAddr: the destination address
- Msdu Payload type: select the hexadecimal or ASCII input mode for the MSDU
- Msdu Payload content: a free text window to enter the data to be sent
- Max Paylaod Size: a check box to configure the maximum size for the random MSDU option
- Generate Random: an option to generate a random MSDU
- TX options: transmission options for the MSDU (TX_ACK, TX_CAP, TX_DIRECT)

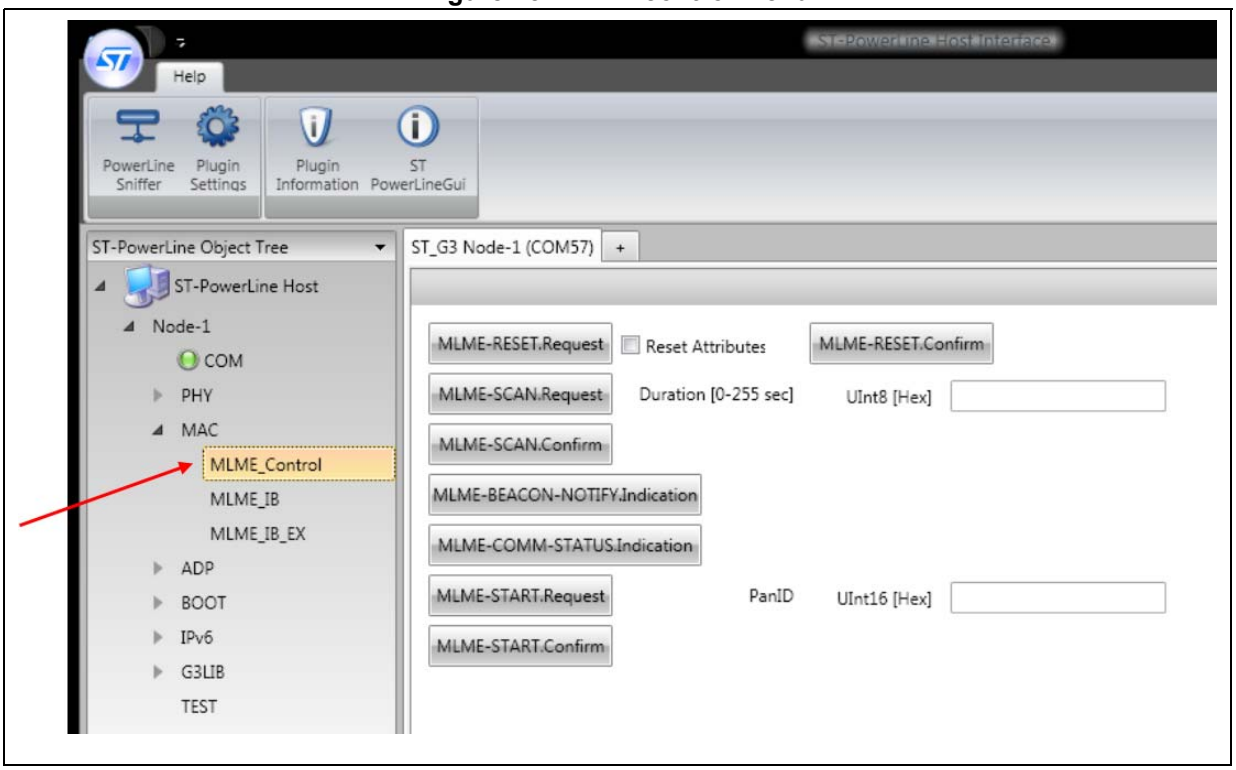
- msduHandle: the handle associated with the MSDU to be transmitted
- QoS: quality of service for the MSDU (normal priority, high priority, contention free)

Once the MCPS-DATA.Request command is executed, messages will be logged into the trace window.

6.2 MLME control menu

The MAC sublayer management entity control menu offers the management layer commands of the G3-PLC MAC layer, as shown in *Figure 15*.

Figure 15. MLME control menu



On the MLME_control panel, the following commands are available:

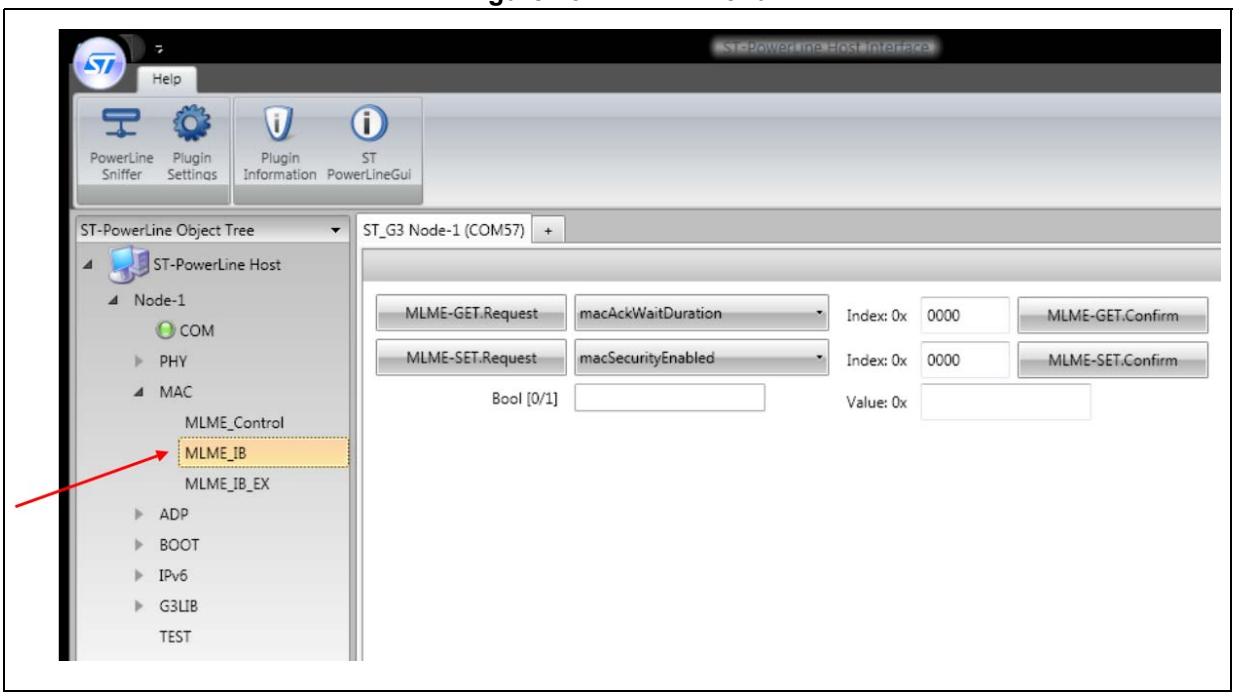
- MLME-RESET.Request: resets the MAC layer
- MLME-RESET.Confirm: forces generation of a confirm message (if automatic event is disabled)
- MLME-SCAN.Request: performs an active scan on the channel for the duration entered by the user in the free text area
- MLME-SCAN.Confirm: forces generation of a confirm message (if automatic event is disabled)
- MLME-BEACON-Notify.Indication: forces generation of an indication message (if automatic event is disabled)
- MLME-COMM-STATUS.Indication: forces generation of an indication message (if automatic event is disabled).

- MLME-START.Request: starts a new powerline area network in case of the G3-PLC platform acts as coordinator. The PANId needs to be specified in the corresponding text box area.
- MLME-START.Confirm: forces generation of a confirm message (if automatic event is disabled).

6.3 MLME IB menu

The MAC layer management entity menu offers the possibility to read and write the information base parameters of the G3-PLC MAC layer, as represented in *Figure 16*.

Figure 16. MAC IB menu



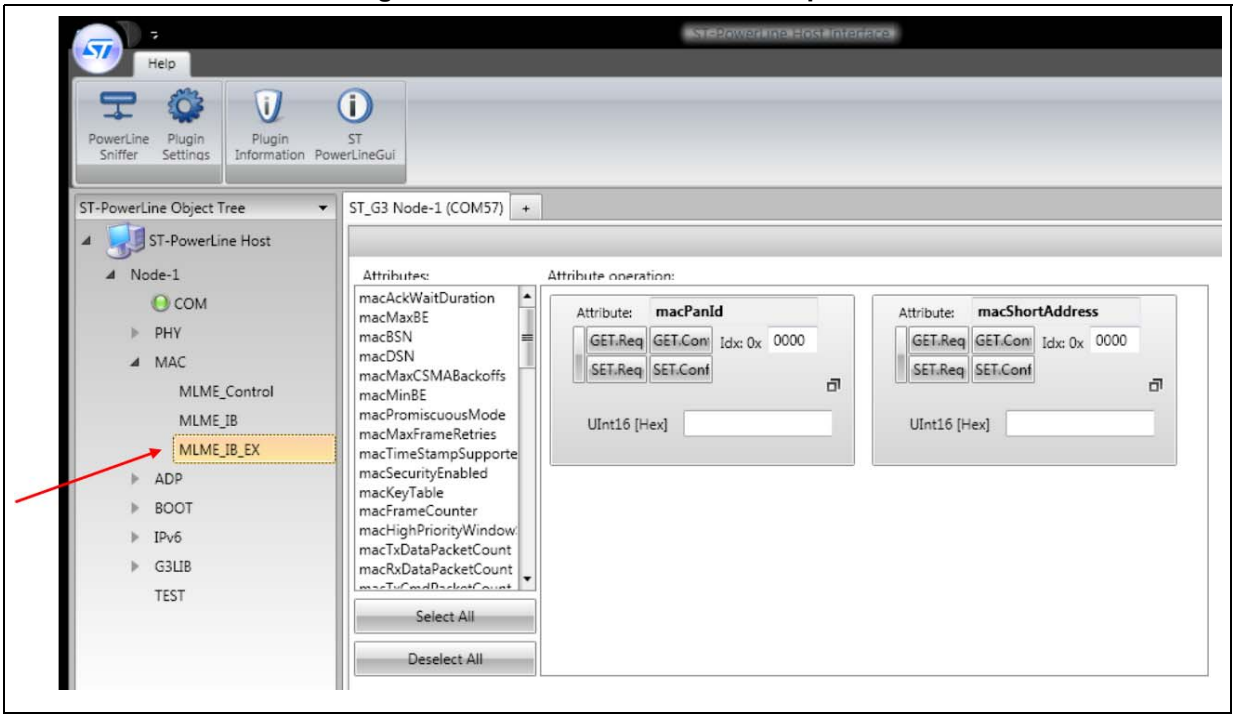
From this menu, the following commands are available:

- MLME-GET.Request: command to read one MAC entity parameter
- MLME-SET.Request: command to write one MAC entity parameter
- MLME-GET.Confirm: forces generation of a MLME-GET.Confirm message (if automatic event is disabled)
- MLME-SET.Confirm: forces generation of a MLME-SET.Confirm message (if automatic event is disabled).

6.4 MLME IB EX menu

Figure 17 shows the explorer menu of the information base for the MAC entity.

Figure 17. MAC information base explorer



This menu offers the same set of commands as the MLME IB ones. The main difference is the white board where the user may drag and drop any of the elements from the list.

6.5 MAC information base attributes description

Here is a brief description for all the attributes of the MAC information base.

Table 5. MAC IEEE 802.15.4 information base attributes

	Standard IEEE 802.15.4 attributes
macAckWaitDuration	Duration of acknowledgment in microseconds
macMaxBE	Maximum value of the backoff exponent. It should always be greater than macMinBE
macBSN	The beacon frame sequence number
macDSN	The data frame sequence number
macMaxCSMABackoffs	The maximum number of backoff attempts
macMinBE	Minimum value of the backoff exponent
macPANId	Personal area network identifier
macPromiscuousMode	Promiscuous mode enable
macShortAddress	Device short address
macMaxFrameRetries	The maximum number of retransmission
macTimeStampSupport	MAC frame time stamp support enable
macSecurityEnabled	Security enabled
macKeyTable	This attribute holds GMK keys required for MAC layer ciphering
macFrameCounter	The outgoing frame counter for this device

Table 6. MAC G.9903 information base attributes

	Standard G.9903 attributes
macHighPriorityWindowSize	The high priority contention window size in number of slots.
macTxDataPacketCount	The statistical counter of successfully transmitted unicast MSDUs
macRxDataPacketCount	The statistical counter of successfully received unicast MSDUs
macTxCmdPacketCount	The statistical counter of successfully transmitted command packets
macRxCmdPacketCount	The statistical counter of successfully received command packets
macCSMAFailCount	Counts the number of times the CSMA back-offs reaches macMaxCSMABackoffs
macCSMAnoACKCount	Counts the number of times an ACK is not received while transmitting a unicast data frame
macRxDataBroadcastCount	The statistical counter of successfully received broadcast frames
macTxDataBroadcastCount	The statistical counter of the number of broadcast frames sent
macBadCRCCount	The statistical counter of the number of frames received with bad CRC
macNeighborTable	The neighbor table for this device
macFreqNotching	S-FSK 63 and 74 kHz frequency notching

Table 6. MAC G.9903 information base attributes (continued)

	Standard G.9903 attributes
macCSMAFairnessLimit	The channel access fairness limit. Specifies how many failed back-off attempts, back-off exponent is set to minBE
macTMRTTL	Maximum time to live of tone map parameters entry in the neighbor table in seconds
macNeighbourTableEntryTTL	Maximum time to live for an entry in the neighbor table in seconds
macRCCoord	Route cost to coordinator to be used in the beacon payload as RC_COORD
macToneMask	Defines the tone mask to use during symbol formation.
macBeaconRandomizationWindowLengh	Duration time in seconds for the beacon randomization.
macA	This parameter controls the adaptive CW linear decrease
macK	Rate adaptation factor for the channel access fairness limit
macMinCWAttempts	The number of consecutive attempts while using minimum CW
macCENELECLegacyMode	This read only attribute indicates the capability of the node
macFCCLegacyMode	This read only attribute indicates the capability of the device

Table 7. MAC ST implementation defined information base attributes

	ST implementation defined attributes
aExtendedAddress	EUI-64 address to be used
SNRdBLOW	The low threshold for the SNR
SNRdBHIGH	The high threshold for the SNR
macCoordinatorType	MAC coordinator type definition: 0 device, 1 coordinator
macTrxStateNotCorrect	The counter of discarded frames due to an invalid state of the real-time engine
macPsduToLong	The counter of discarded frames due to a too long PDU
macInvalidFrameType	The counter of discarded frames due to an invalid frame type field detected
macInvalidFrameVersion	The counter of discarded frames due to an invalid frame version field detected
macInvalidDAM	The counter of discarded frames due to an invalid destination address mode detected
macInvalidSAM	The counter of discarded frames due to an invalid source address mode detected
macInvalidPANId	The counter of discarded frames due to an invalid PANId detected
macInvalidShortAddr	The counter of discarded frames due to an invalid short address detected
macInvalidExtAddr	The counter of discarded frames due to an invalid extended address detected
macInvalidBeacon	The counter of discarded frames due to an invalid beacon detected

Table 7. MAC ST implementation defined information base attributes (continued)

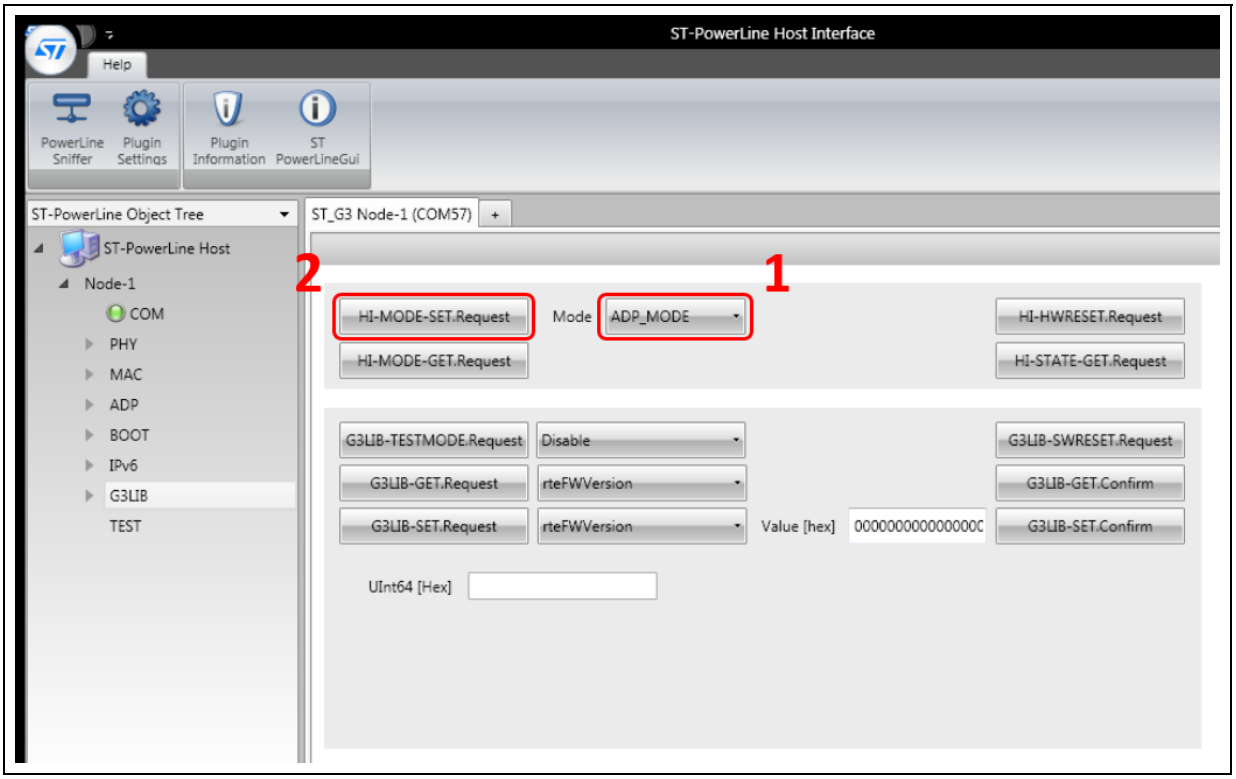
	ST implementation defined attributes
macInvalidDataCmd	The counter of discarded frames due to an invalid command detected
macInternalStateNotCorrect	The counter of discarded frames due to an invalid state of MAC when receiving a PD-DATA.indication
macFrameDiscarded	The counter of discarded frames for other reasons not represented by other errors
macAckTrxStateNotCorrect	The counter of discarded ACK frames for the PHY state not correct (PHY In TX)
macAckNotCorrect	The counter of discarded ACK frames for wrong FCH received
macAckIntStateNotCorrect	The counter of discarded ACK frames for an invalid state of the MAC
macAckCrcNotExpected	The counter of discarded ACK frames for invalid CRC expected
macAckDiscarded	The counter of total discarded ACK frames
macCSMASeed	Initial seed of the CSMA/CA procedure
macInvalidFramePending	The counter of discarded frames due to an invalid frame pending field detected
macInvalidPIC	The counter of discarded frames due to an invalid PIC field detected
SNRdBROBO	The tone map algorithm threshold for the robust mode
SNRdBDBPSK	The tone map algorithm threshold for DBPSK modulation
SNRdBDQPSK	The tone map algorithm threshold for DQPSK modulation
SNRdBD8PSK	The tone map algorithm threshold for D8PSK modulation
macRXBeaconReceivedFromLastScan	The number of received beacons from the start of the last scan
macModulationControl	The field mask to control the modulation used by the MAC layer where: Bit [0 … 3]: defines the modulation to be used for the data dtransmission (0: ROBO, 1: DBPSK or BPSK, 2: DQPSK or QPSK, 3: D8PSK or 8PSK, F use neighbor table) Bit [4 ... 7]: defines the modulation scheme to be asked in the tone map response (0: ROBO, 1: DBPSK or BPSK, 2: DQPSK or QPSK, 3: D8PSK or 8PSK, F use the internal algorithm) Bit 8: if 1 forces the differential data transmission Bit 9: if 1 forces the differential modulation in the tone map response
macOptionalFeatures	The field mask to control the optional features provided by the MAC layer where: Bit 0: if 1 it enables the TMR bit in the tone map response Bit 1: if 1 it enables the encryption of the tone map response

7 ADP menu

To be able to execute ADP commands, the G3-PLC platform working mode needs to be configured to the ADP mode.

To do this, simply go to the G3LIB panel as shown in *Figure 18*. Choose the ADP_MODE from the available modes (1) and press the HI-MODE-SET.Request button (2).

Figure 18. Configure the host interface in ADP mode



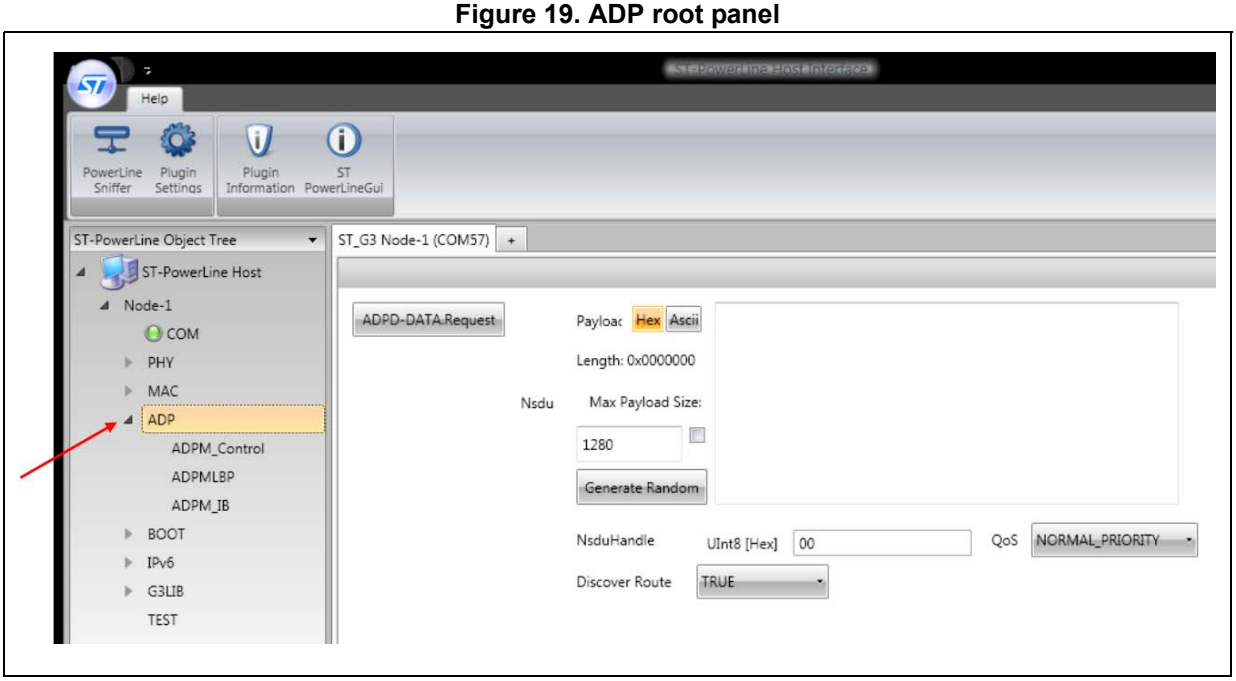
Once the ADP mode is selected, the following menus are accessible:

- ADP root menu: command panel to send data at the ADP level
- ADPM control: command panel to control the ADP layer
- ADPM LBP: adaptation sublayer management for 6LoWPAN bootstrapping protocol
- ADPM IB: adaptation sublayer management information base.

7.1 ADP root menu

The root menu offers the possibility to enter a payload and send it at the ADP layer, as shown in *Figure 19*.

Figure 19. ADP root panel



The ADP root panel is composed of one single command:

- ADPD-DATA.Request: requests IPv6 DATA transmission

Confirm and indication messages are automatically generated as explained in *Section 3.4 on page 12*.

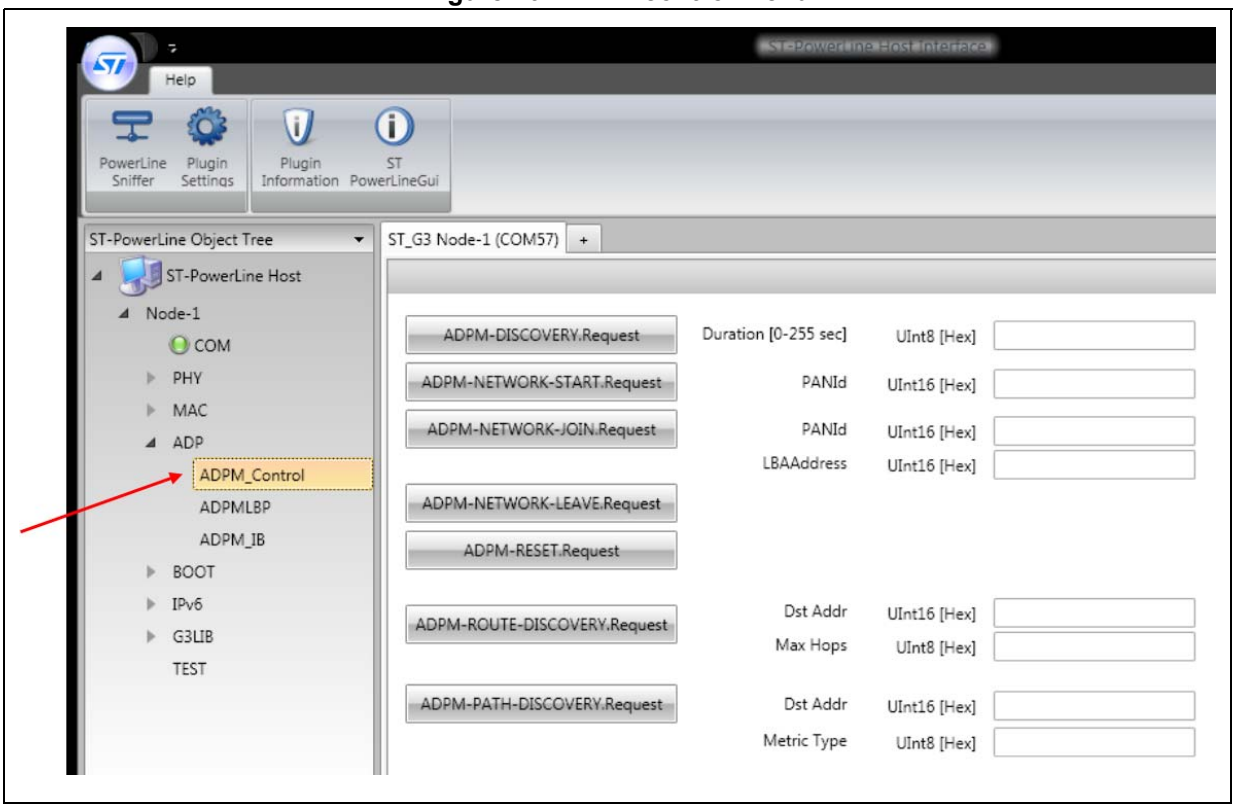
The following options are available in the panel:

- Payload type: selects the hexadecimal or ASCII input mode for the NSDU
- Payload content: free text window to enter the NSDU to be sent (note that the data has to be a valid IPv6 packet)
- Max Payload Size: check box to configure the maximum size for the random option
- Generate Random: option to generate a random NSDU
- NsduHandle: the handle associated with the NSDU to be transmitted
- QoS : quality of the service for the NSDU (normal priority, high priority, contention free)
- Discover Route option: if TRUE, a route discovery procedure will be performed prior sending the ADP frame, as long as a route to the destination is not available in the routing table. If FALSE, no route discovery is performed.

7.2 ADPM control menu

The ADP layer management entity control menu offers the management layer commands of the G3-PLC ADP layer, as shown in *Figure 20*.

Figure 20. ADPM control menu



This menu allows the user to execute the following commands:

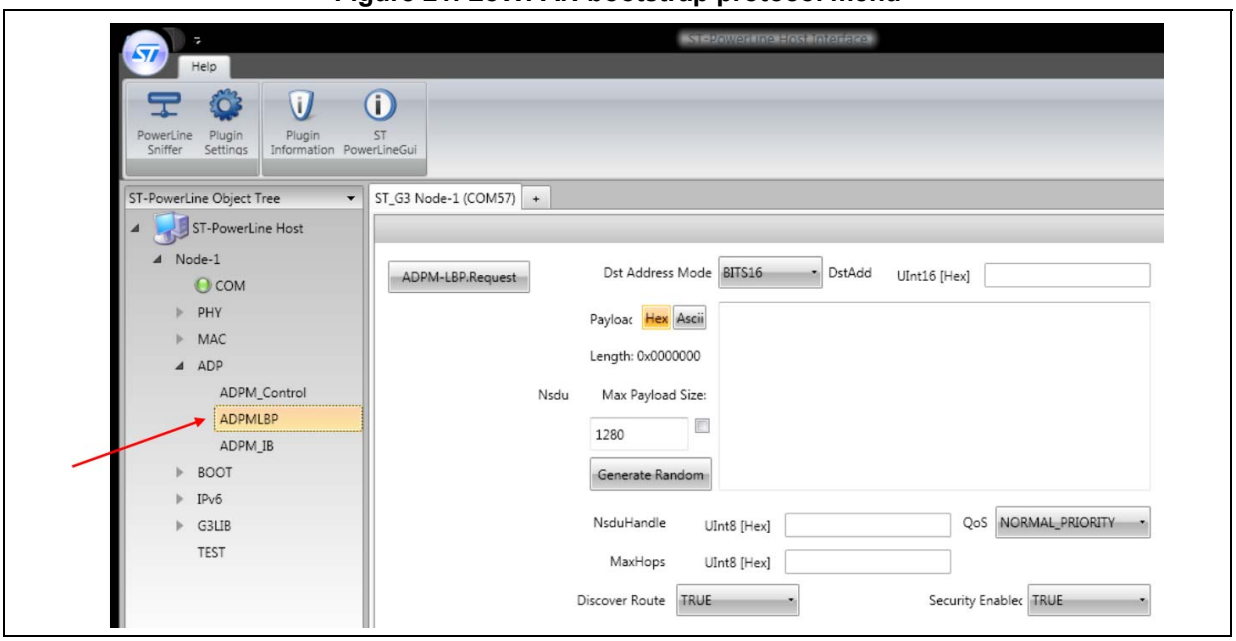
- ADPM-DISCOVER.Request: performs a discovery procedure for the duration entered by the user in the free text area.
- ADPM-NETWORK-START.Request: starts a new powerline area network on the server side with the specified PANId.
- ADPM-NETWORK-JOIN.Request: this primitive allows the next upper layer to join a network identified by PANId through a low bootstrap agent (short address).
- ADPM-NETWORK-LEAVE.Request: this primitive allows the next upper layer to leave an existing network.
- ADPM-RESET.Request: it resets the ADP layer.
- ADPM-ROUTE-DISCOVERY.Request: requests the discovery of the route towards a destination. The user needs to enter the destination address to look for and the maximum allowed number of hops.
- ADPD-PATH-DISCOVERY.Request: requests the discovery of the path towards a destination. The user needs to enter the destination address to look for and the metric type for the link cost evaluation.

7.3 ADPM LBP menu

The root menu offers the possibility to enter a payload and send it using the LoWPAN bootstrap protocol (LBP), as shown in *Figure 21*.

These primitives are accessible only to PAN coordinator devices.

Figure 21. LoWPAN bootstrap protocol menu



From this panel, the following command may be executed:

- ADPM-LBP.Request: this primitive allows the upper layer of a PAN coordinator device to send an LBP message.

The following options are available in the panel:

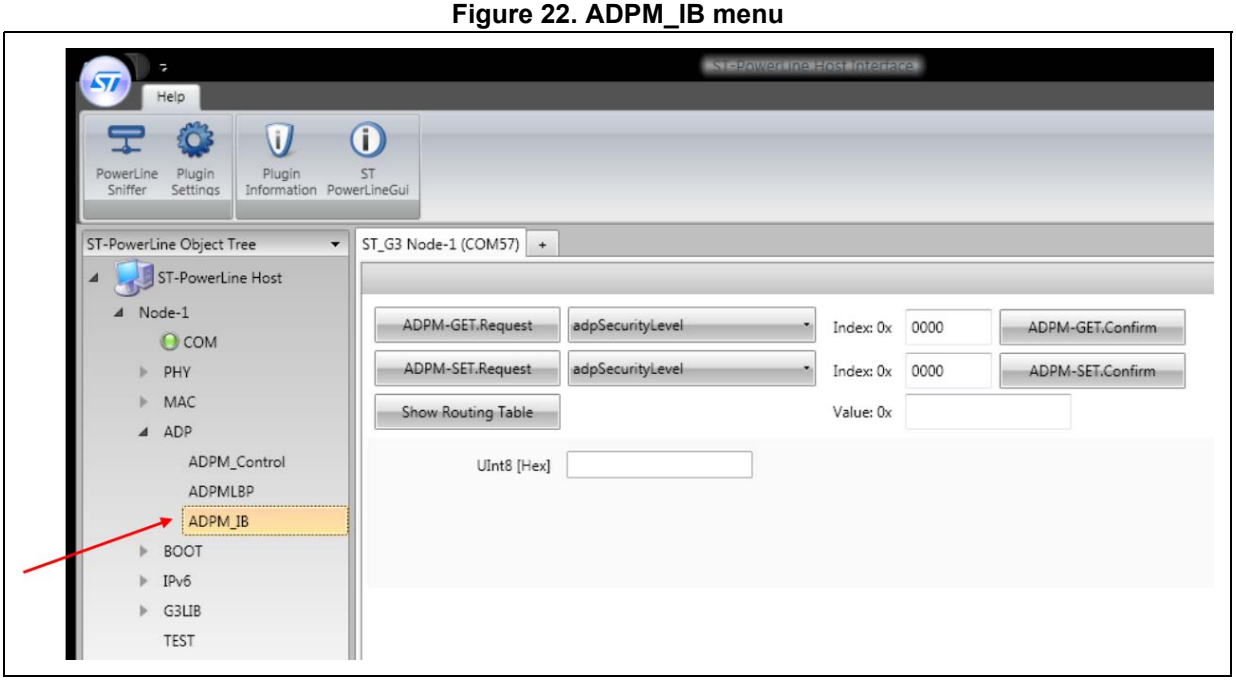
- Dst Address Mode: the destination address mode (BITS16: short, BITS64: extended address)
- DstAddr: the destination address
- Payload type: select the hexadecimal or ASCII input mode for the NSDU
- Payload content: a free text window to enter the NSDU to be sent (note that the data has to be a valid LBP message)
- Max Payload Size: a check box to configure the maximum size for the random option
- Generate Random: an option to generate a random NSDU
- NsduHandle: the handle associated with the NSDU to be transmitted
- MaxHops: the maximum number of hops before that the LBP message is going to be discarded
- QoS: quality of the service for the NSDU (normal priority, high priority, contention free)
- Discover Route option: if TRUE, a route discovery procedure will be performed prior sending the ADP frame, as long as a route to the destination is not available in the routing table. If FALSE, no route discovery is performed.

Confirm and indication messages are automatically generated as explained in *Section 3.4 on page 12*.

7.4 ADPM IB menu

The ADP layer management entity menu offers the possibility to get and set the information base parameters of the G3-PLC ADP layer.

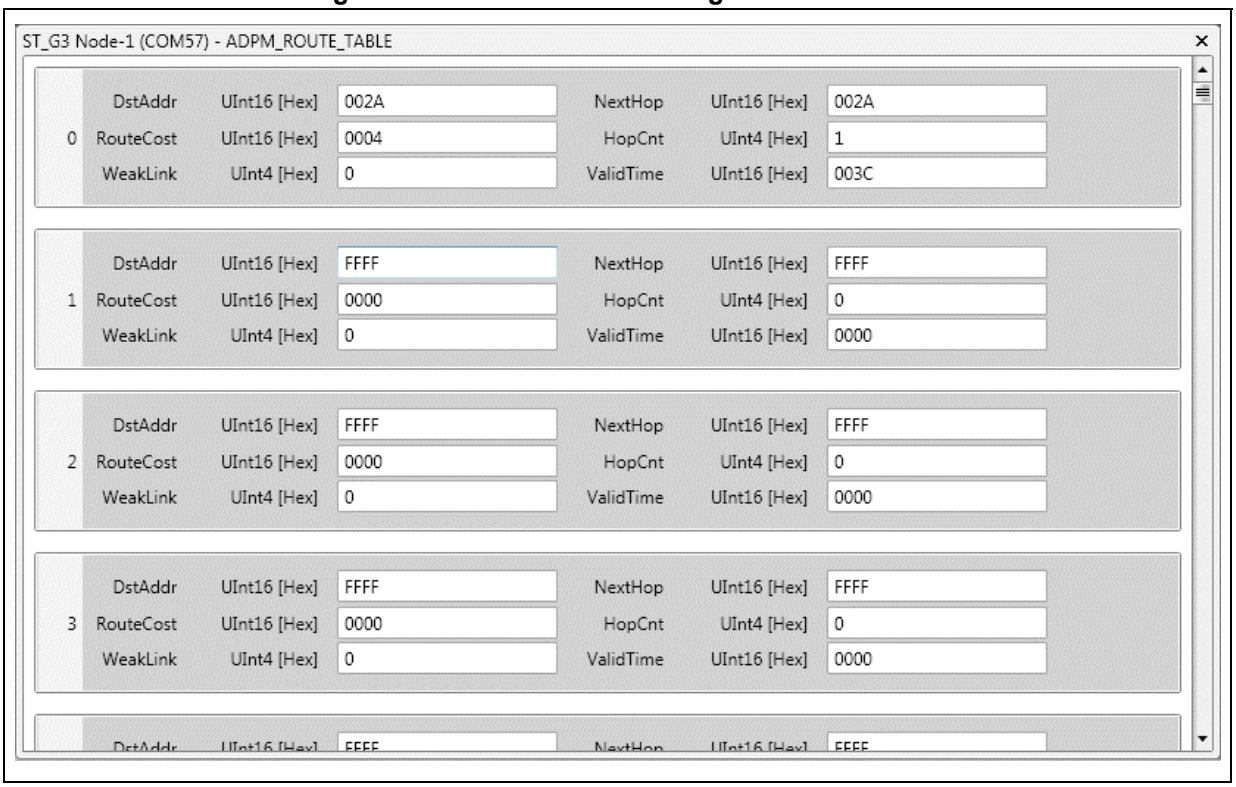
Figure 22. ADPM_IB menu



Using this panel, the following commands can be executed:

- ADPM-GET.Request: reads one attribute of the ADP information base. The attribute to read can be selected from a list.
- ADPM-SET.Request: writes the value of one attribute of the ADP information base. The attribute to set can be selected from a list and its value entered in a text area.
- ADPM-GET.Confirm: forces generation of a confirmation message (if automatic event is disabled).
- ADPM-SET.Confirm: forces generation of a confirmation message (if automatic event is disabled).
- Show Routing Table: it activates a pop-up window that shows the adpRoutingTable of the device (*Figure 23*).

Figure 23. Effect of show routing table command



7.5 ADP information base attributes description

Here is a brief description for all the attributes of the ADP information base.

Table 8. ADP G.9903 information base attributes52

	Standard G.9903 ADP information base attributes
adpSecurityLevel	The minimum security level to be used for incoming and outgoing adaptation frames
adpPrefixTable	Contains the list of prefixes defined on this PAN. Note that it is assumed that the link local IPv6 address exists independently and is not affected by the prefixes defined in the prefix table
adpBroadcastLogTableEntryTTL	Maximum time to live of a adpBroadcastLogTable entry (in seconds)
adpMetricType	A metric type to be used for routing purposes
adpNumDiscoveryAttempts	The number of discovery attempts
adpDiscoveryAttemptsWaitTime	Allows programming the maximum wait time between invocation of two consecutive network discovery primitives (in seconds)
adpContextInformationTable	Contains the context information associated to each CID extension field
adpCoordShortAddress	Defines the short address of the coordinator
adpRLCEnabled	Enables the sending of RLCREQ frame by the device
adpAddRevLinkCost	It represents an additional cost to take into account a possible asymmetry in the link

Table 8. ADP G.9903 information base attributes52 (continued)

	Standard G.9903 ADP information base attributes
adpBroadcastLogTable	Contains the broadcast log table
adpRoutingTable	Contains the routing table
adpUnicastRREQGenEnable	If TRUE, the RREQ shall be generated with its "unicast RREQ" flag set to '1' If FALSE, the RREQ shall be generated with its "unicast RREQ" flag set to '0'
adpGroupTable	Contains the group addresses to which the device belongs
adpMaxHops	Defines the maximum number of hops to be used by the routing algorithm
adpDeviceType	Defines the type of the device connected to the modem: 0: PAN device 1: PAN coordinator 2: not defined
adpNetTraversalTime	Maximum time that a packet is expected to take to reach any node from any node in seconds
adpRoutingTableEntryTTL	Maximum time to live of a routing table entry (in seconds)
adpKr	A weight factor for the robust mode to calculate the link cost
adpKm	A weight factor for modulation to calculate the link cost
adpKc	A weight factor for the number of active tones to calculate the link cost
adpKq	A weight factor for LQI to calculate the route cost
adpKh	A weight factor for hop to calculate the link cost
adpRREQRetries	The number of RREQ retransmission in case of RREP reception timeout
adpRREQRERRWait	Time in seconds to wait between two consecutive RREQ or RRER generations
adpWeakLQIValue	The weak link value defines the LQI value below which a link to a neighbor is considered as a weak link. A value of 52 represents an SNR of 3 dB.
adpKrt	A weight factor for the number of active routes in the routing table to calculate the link cost
adpSoftVersion	The software version
adpSnifferMode	The Sniffer mode activation/deactivation
adpBlacklistTable	Contains the list of the blacklisted neighbors
adpBlacklistTableEntryTTL	Maximum time to live of a blacklisted neighbor entry (in minutes)
adpMaxJoinWaitTime	Network join timeout in seconds for LBD
adpPathDiscoveryTime	Timeout for path discovery in seconds
adpActiveKeyIndex	Index of the active GMK to be used for data transmission
adpDisableDefaultRouting	If TRUE, the default routing (LOADng) is disabled. If FALSE, the default routing (LOADng) is enabled

Table 9. ADP ST implementation defined information base attributes

	ST implementation defined attributes
adpDatagramTag	It defines the DatagramTag for the fragmentation dispatch. Increased by one for each fragmented transmission.
adpBroadcastSeqNumber	It defines the SequenceNumber for the broadcast dispatch. Increased by one for each broadcast transmission.
adpEnableHeaderCompression	If set to 1, it enables the IPv6 header compression (default), if set to 0, it disables the IPv6 header compression.
adpRREQFfwdMaxTime	The maximum time in ms that can take a RREQ to be forwarded (512 ms by default).
adpEAPPSKKey	It contains the EAP-PSK used for bootstrap procedure.
adpEAPPSKIdP	It contains the IdP (device NAI) attribute used for bootstrap.
adpEAPPSKIdPLen	It contains the length of the IdP array used for bootstrap.
adpRREPWaitTime	The time to wait before RREP generation (in order to collect other RREQs).
adpLOADngSeqNum	The sequence number used by the LOADng routing algorithm.

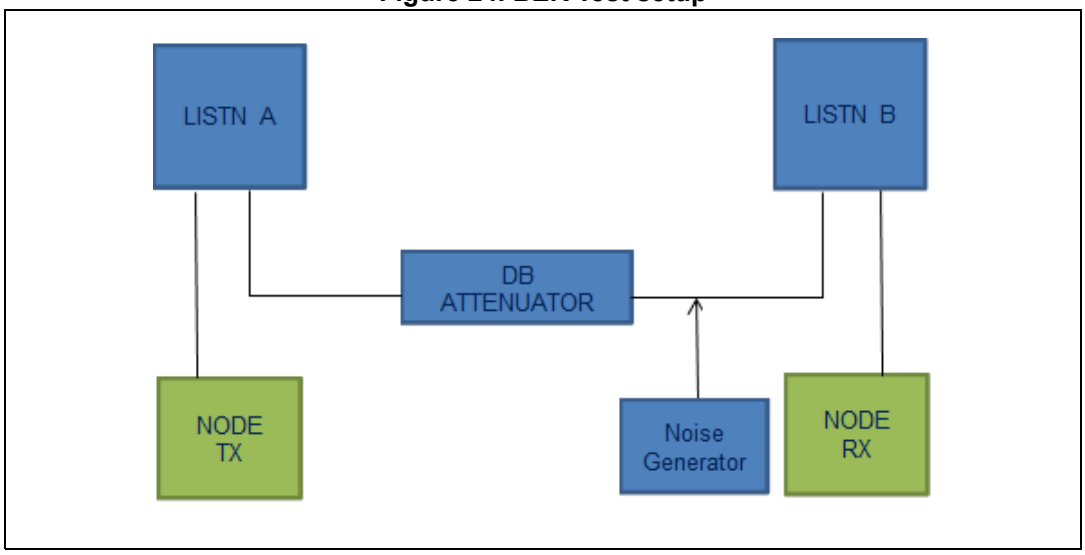
8 BER Test panel

The “Bit Error Rate” (BER) Test panel may be used to automate the evaluation of the bit error rate.

8.1 Typical setup

The following diagram shows the typical environment to perform the BER Test.

Figure 24. BER Test setup



The BER may be checked in different conditions. Increasing or decreasing the level of transmission attenuation and the level of injected noise results in a different BER value at the receiver side. The nature of the interfering noise (AWGN, colored, single carrier, etc.) may also impact the BER performance.

8.2 Test description

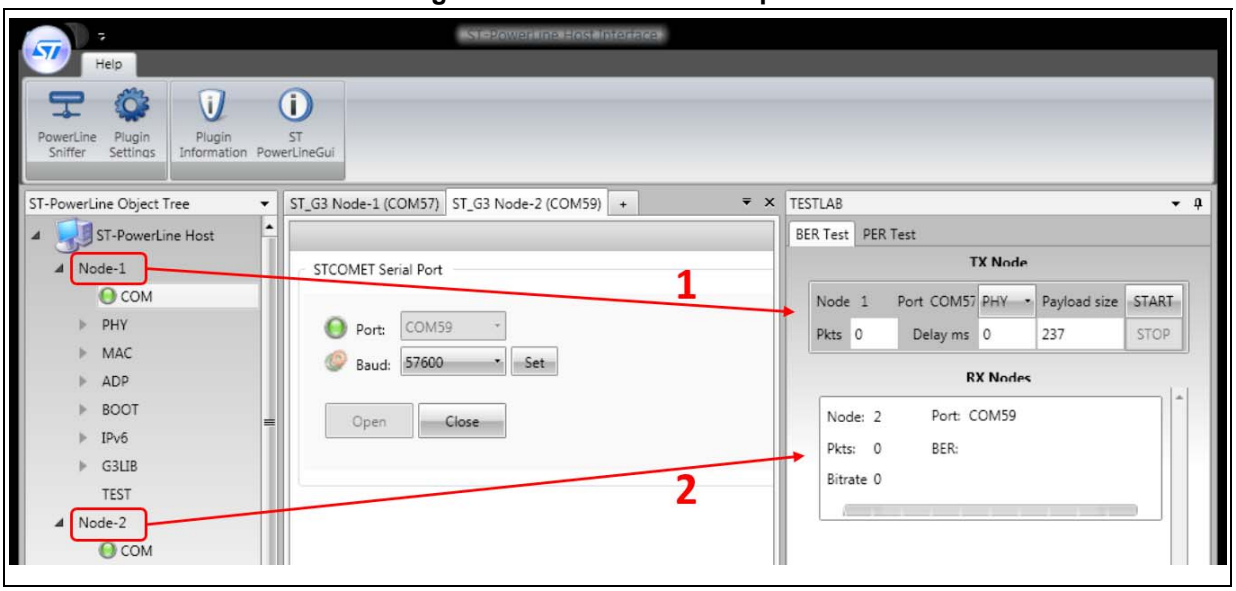
To be able to perform the BER Test, two G3-PLC platforms need be connected to the G3-PLC GUI. Both boards need to be configured in the PHY operational mode as described in *Section 5 on page 17*. The user needs to configure one G3-PLC platform in the TX mode and the other one in the RX mode.

The user can then follow the steps described in *Section 10.3 on page 43* in order to correctly configure the nodes.

Once the nodes configuration is done, the user can open the Test panel, as explained in *Figure 25*:

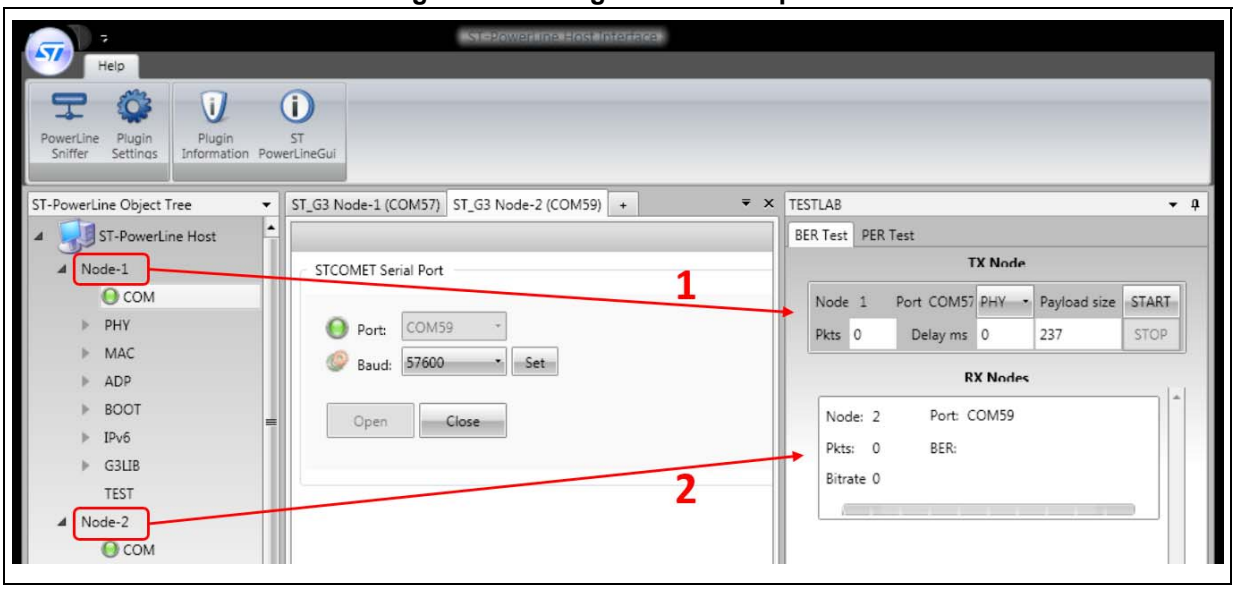
- Click on the Plugin Settings icon in the menu bar (1)
- Enable the TESTLAB panel (2)
- The TESTLAB panel will appear at the right side of the tool.

Figure 25. Enable BER Test panel



Once the Test panel is enabled, the RX and TX Nodes need to be slided into their area, as show in *Figure 26*. To do that, click on the TX Node in the object tree panel and slide it in the right area (1). Do the same for the RX Node (2).

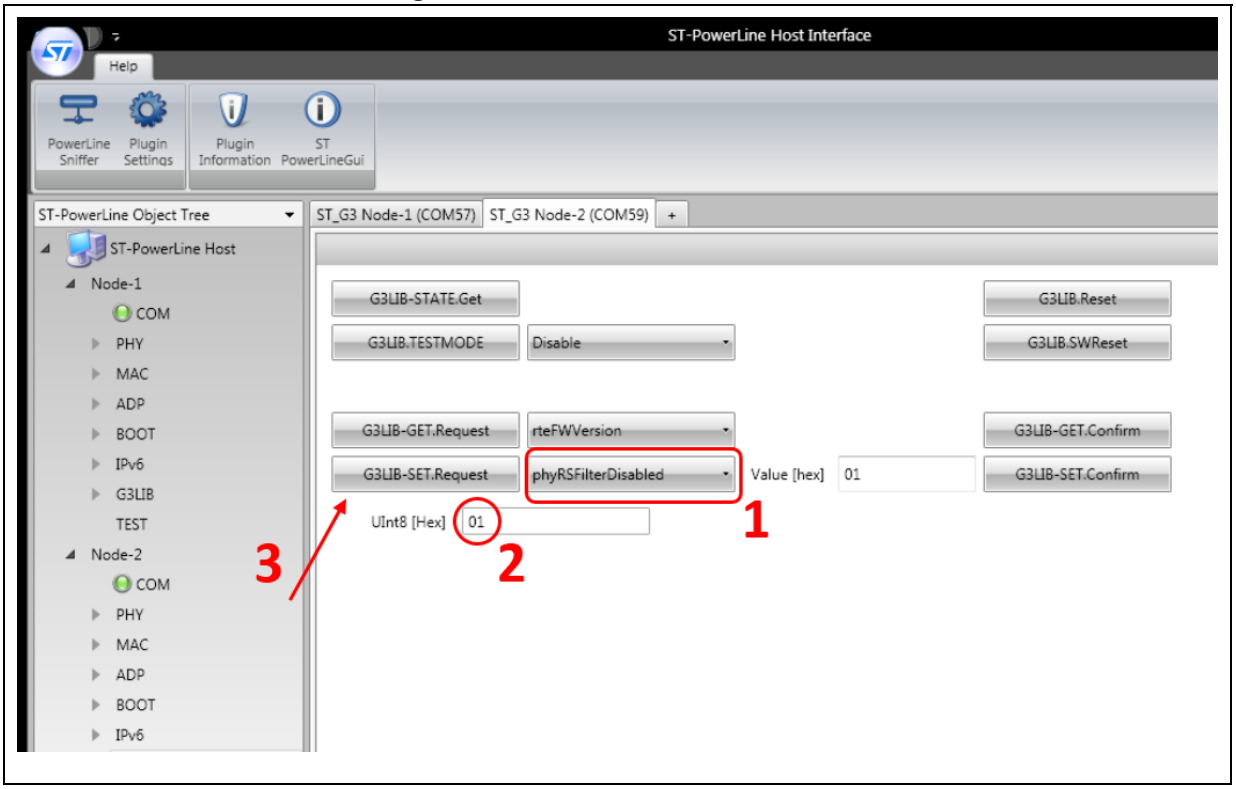
Figure 26. Configure BER Test panel



One last step is needed in the configuration process for the BER: the deactivation of the Reed-Solomon filter for the RX Node, as shown in *Figure 27*.

To deactivate it, select the G3LIB menu of the RX Node. Select the phyRSFilterDisabled in the list of attributes (1). Set 01 in the “Value” text field (2) and hit the G3LIB-SET.Request button (3). The Reed-Solomon block is now deactivated.

Figure 27. Deactivate Reed-Solomon



In the BER Test panel, the following parameters may be configured:

- Pkts: the number of packets to be sent (if 0, the test will end when the STOP button is pressed)
- Delay ms: delay in milliseconds between 2 packets
- Payload size: the size of each packet (up to 239 bytes, but based on the transmission parameters, this could be smaller. 128 bytes is an adequate size).

Once the configuration is done, the user may click the START button to start the BER session.

The BER Test session ends when the TX Node has transmitted as many packet as configured or when the user presses the STOP button. During the session, the bit error rate is computed and displayed in the RX Node area of the TESTLAB panel.

The TX settings may be modified, in the PHY / PLME menu, to test different conditions (modulation, output level, etc.) as well as the whole setup to perform different tests.

9 Sniffer panel

9.1 Introduction

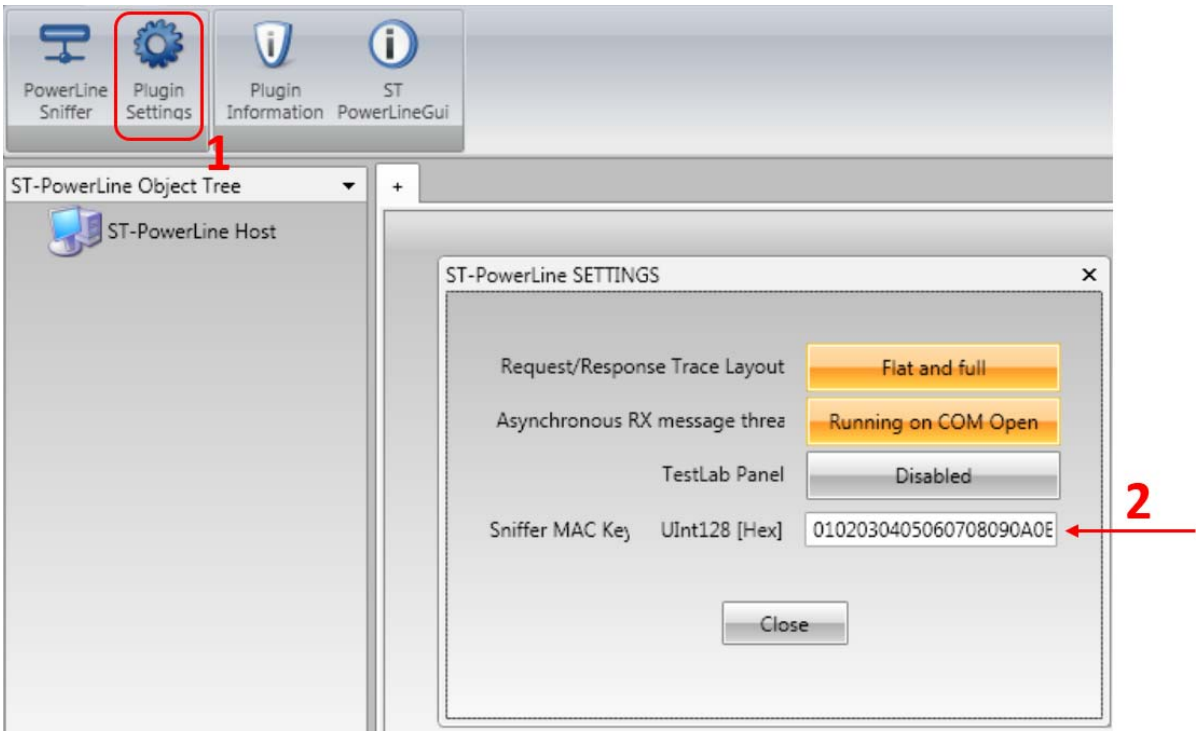
The Sniffer utility allows sniffing the physical link; using this tool all the PHY messages that can be detected by the G3-PLC platform are displayed in the Sniffer tab. While the Sniffer tool is running the G3-PLC platform cannot perform any other operation.

If a captured PHY message is encapsulating a MAC frame, the Sniffer tool can also show the content of such MAC frame. In case the MAC frame is ciphered the Sniffer tool also offers the capability to decipher on-the-fly the content of the MAC frame.

In order to perform the deciphering the G3-PLC GUI interface needs to be configured with the GMK used to cipher the MAC frames, as shown in *Figure 28*. First the Plugin Settings button has to be pressed (1), then the GMK can be inserted within the pop-up window (2).

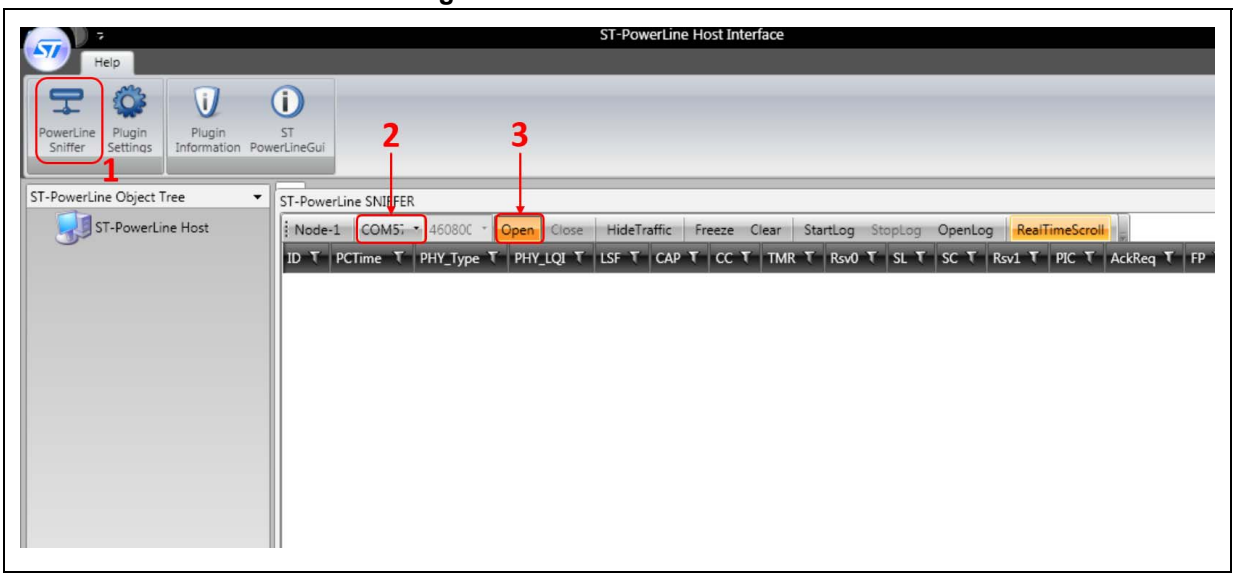
The GMK is typically a secret in a G3-PLC network, so it is not always possible to use the on-the-fly deciphering feature in a real scenario. Moreover ST cannot be responsible for key stealing when the user decides to reveal this secret in order to use this tool.

Figure 28. Set GMK for the Sniffer tool



In order to activate the Sniffer tool the PowerLine Sniffer button (1) has to be pressed, as represented in *Figure 29*; then the enhanced COM port has to be selected (2) and by clicking the Open button (3) the Sniffer tool is activated.

Figure 29. Sniffer tool activation



9.2 Data logs

Each captured PHY packet is displayed in a single row, whereas the columns show the various header fields (LSF, CAP, CC, etc.).

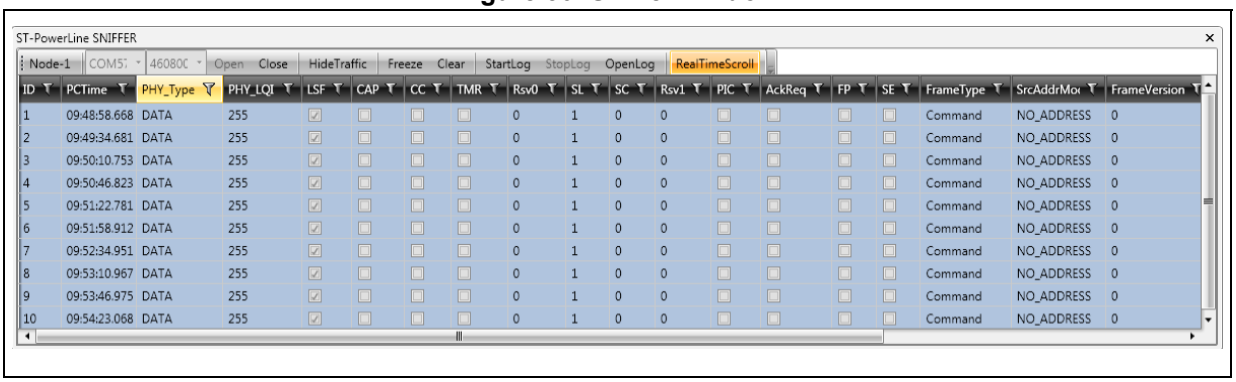
The PHY packets (data, acknowledgments) are displayed in white color.

If the PHY payload is encapsulating a MAC frame the row is displayed in light blue color. The MAC header fields are then displayed on the same row (MAC source address, MAC destination address, etc.).

Figure 29 shows an example of the Sniffer tool usage, used to capture some MAC command frames (beacon request).

In order to save the captured traffic also on a text file, the button StartLog may be pressed.

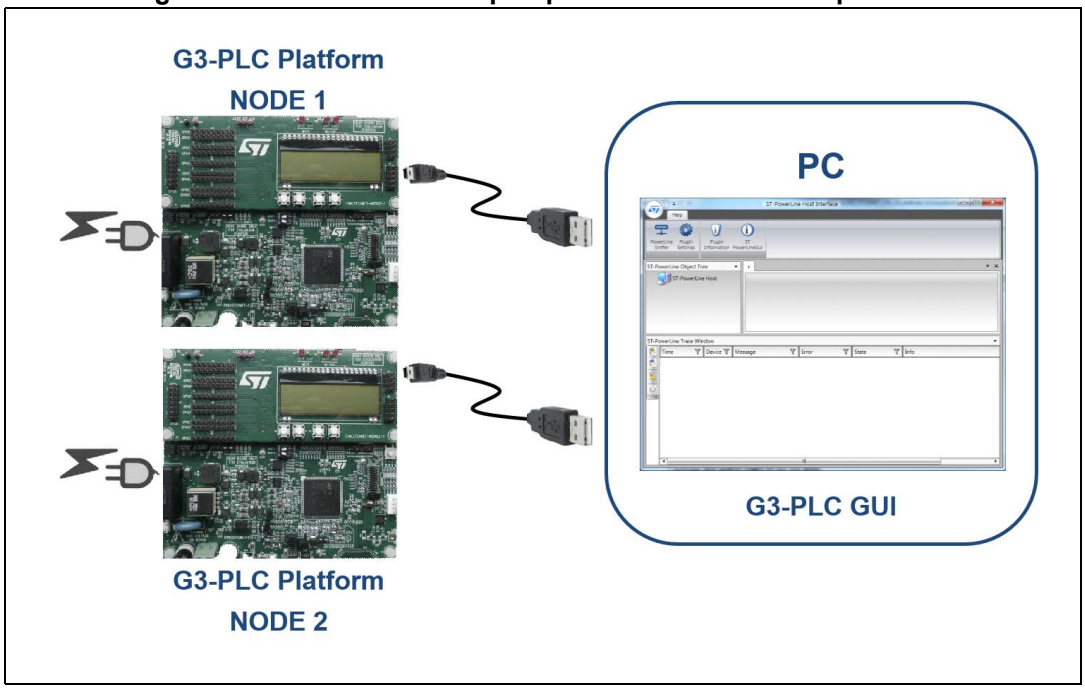
Figure 30. Sniffer window



10 Basic G3 operations

10.1 Environment setup

Figure 31. Environment setup to perform the basic G3 operations



10.2 Connect Node 1 and 2 on the G3-PLC GUI

The first action to perform with the G3-PLC GUI is to add two nodes. Click on the small cross on the top of the empty panel twice to open two tabs, as described in *Section 3.1 on page 8*.

For the following examples, the Node 1 enhanced Com port is mapped on the COM57 of the personal computer and the Node 2 enhanced Com port is mapped on the COM59.

10.3 PHY layer data exchange

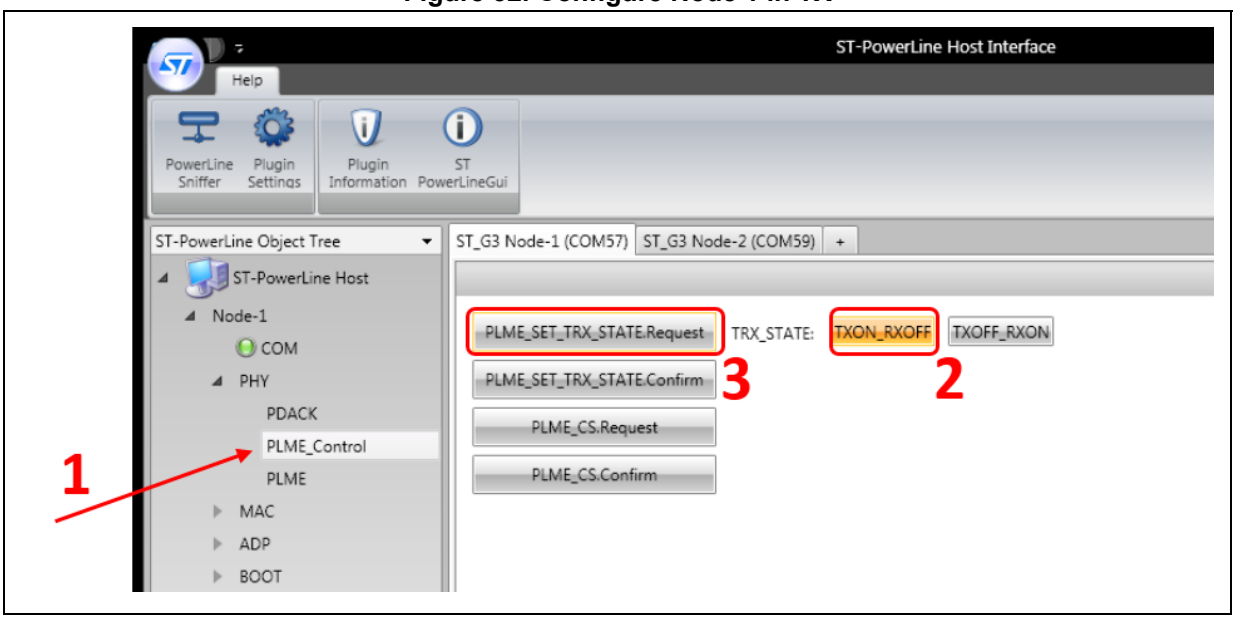
To be able to execute a PHY command, the Node 1 and 2 working modes need to be set to the PHY mode, as explained in *Section 5 on page 17*.

Now the direction of the data flow needs to be defined. Because it is a point-to-point communication, there must be one node acting as a sender and one acting as a receiver.

The Node 1 may be configured as the sender, and the Node 2 as the receiver.

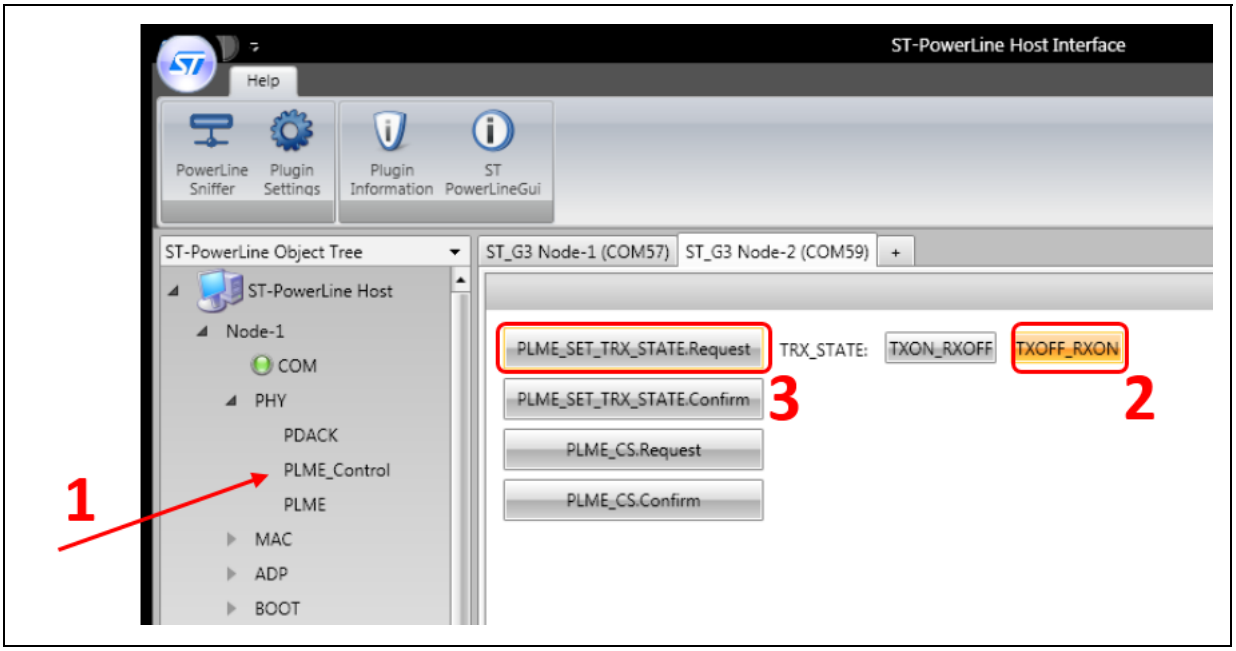
For the Node 1, as shown in *Figure 31*, go into the PHY menu / PLME_Control panel (1) to configure the state of the node. Check the TXON_RXOFF (2) parameter and click on the PLME_SET_TRX_STATE.Request button (3).

Figure 32. Configure Node 1 in TX



For the Node 2, as shown in *Figure 32*, go into the PHY menu / PLME_Control panel (1) to configure the state of the node. Check the TXOFF_RXON (2) parameter and click on the PLME_SET_TRX_STATE.Request button (3).

Figure 33. Configure Node 2 in RX

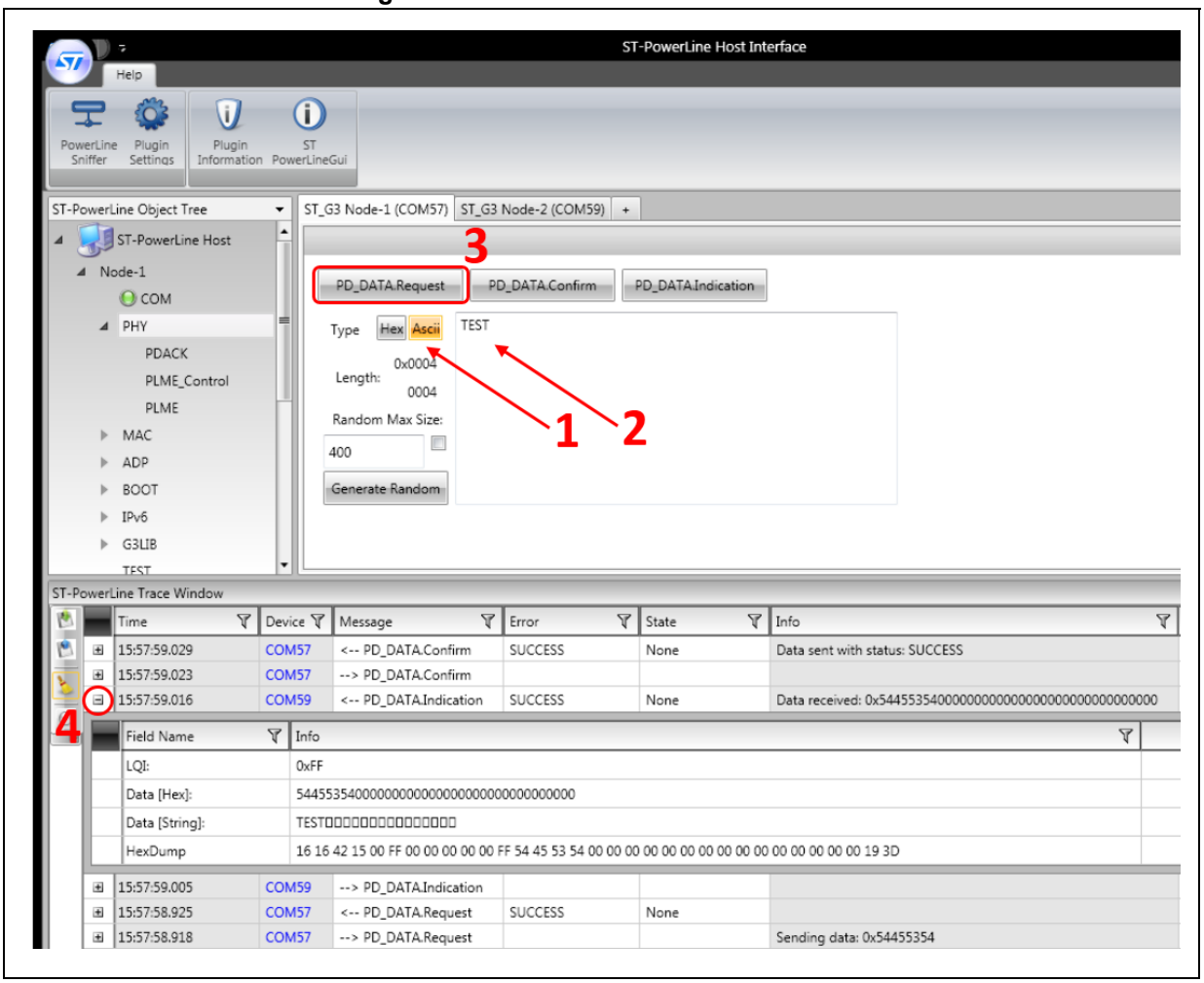


Now that the boards are plugged in the mains and the setup has been completed, data can be sent at the PHY level, as represented in *Figure 33*. To do this, go to the PHY root menu of the Node 1. Select the payload type to be ASCII (1), write the “TEST” string in the free text area (2) and click on the PD_DATA.Request button (3).

In the trace window, it is possible to check that the Node 2 has received the data message by checking that the PD_DATA.Indication message returned the SUCCESS status.

Any message in the trace window may be hovered over to see more details. The message content may also be expanded in the trace window by clicking on the small cross on the left side of the message (4).

Figure 34. Send PHY data from TX to RX



In the details of the PD_DATA.Indication message, the “Link Quality Indicator” and the content of the payload received (either in hexadecimal or string format) can be found.

Note that the PHY layer could generate padding if the amount of data inserted doesn't reach an acceptable length for the PHY block. This results in additional byte shown in the data field of the PD-DATA.Indication message. Also note that there's a limit on the amount of data that can be successfully sent, which is based on the modulation chosen. With the modulation that allows the biggest amount of data to be sent, that limit is 239 bytes.

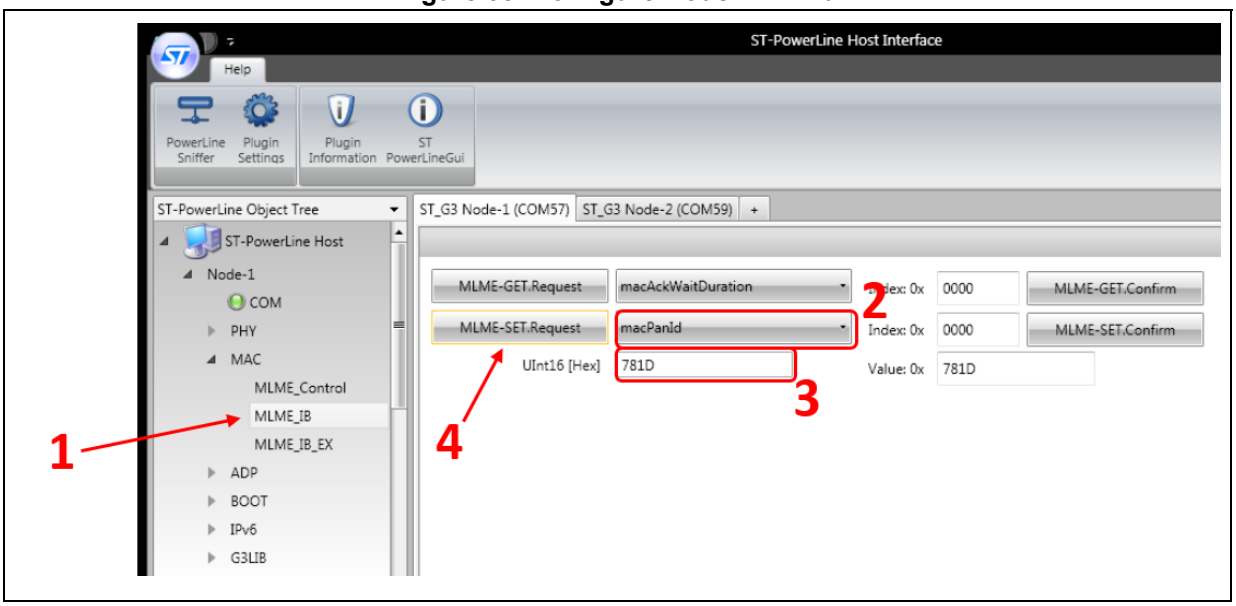
10.4 MAC layer data exchange

To be able to execute a MAC command, the Node 1 and 2 working modes need to be set to the MAC mode, as explained in *Section 6 on page 22*.

Then, to be able to send data from one node to the other one, at least the powerline area network ID and the short address must be configured for each device.

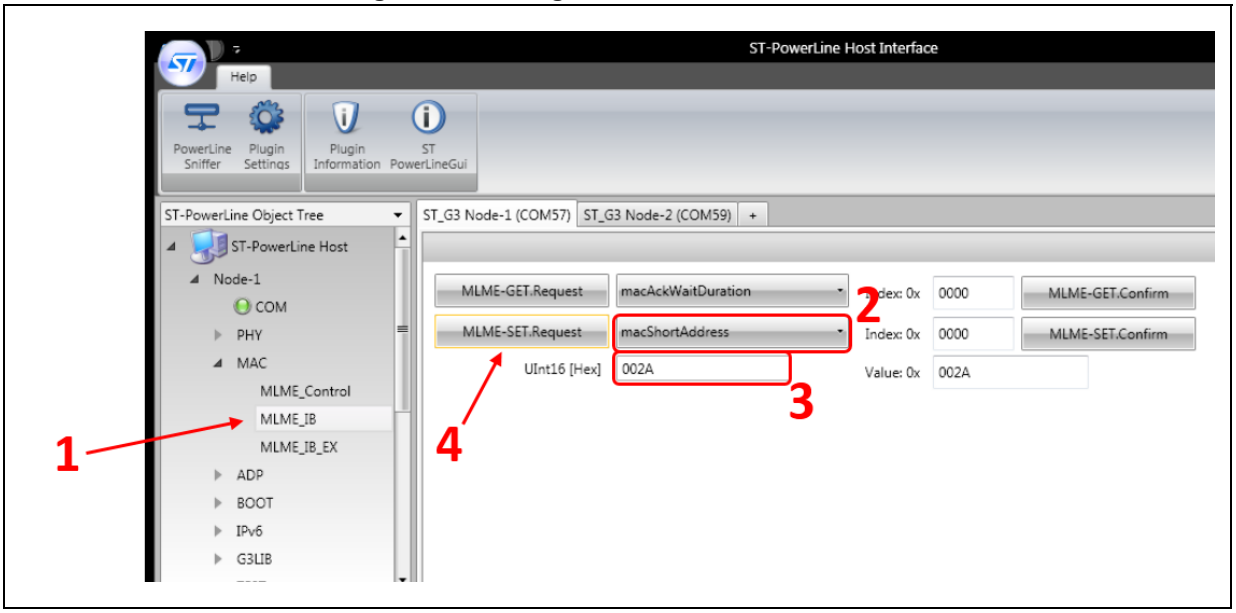
To configure the PANId, as shown in *Figure 34*, go into the MAC / MLME_IB (1) menu of the Node 1, select first the macPANId in the list on the right side of the MLME-SET.Request command (2). One text box area will appear just below. Enter the PANId of the node (3) and click on the MLME-SET.Request button (4).

Figure 35. Configure Node 1 PANId



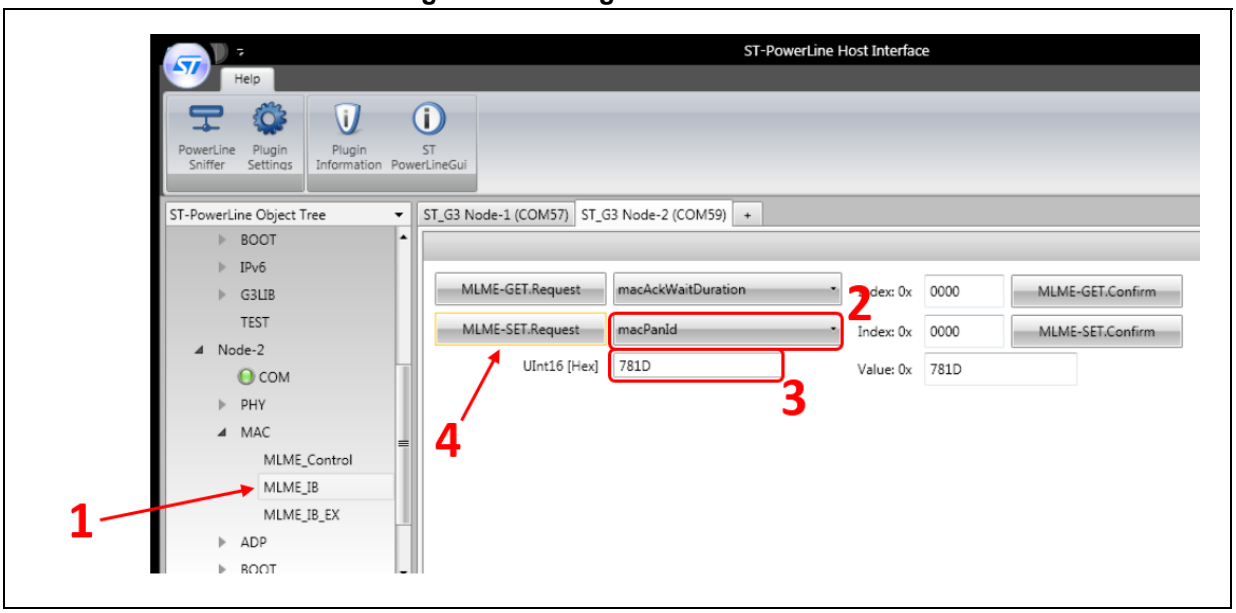
As shown in *Figure 35*, the same can be done for the macShortAddress parameter. Select first the attribute macShortAddress in the list of attributes (2) and enter its value in the text box area (3).

Figure 36. Configure Node 1 short address



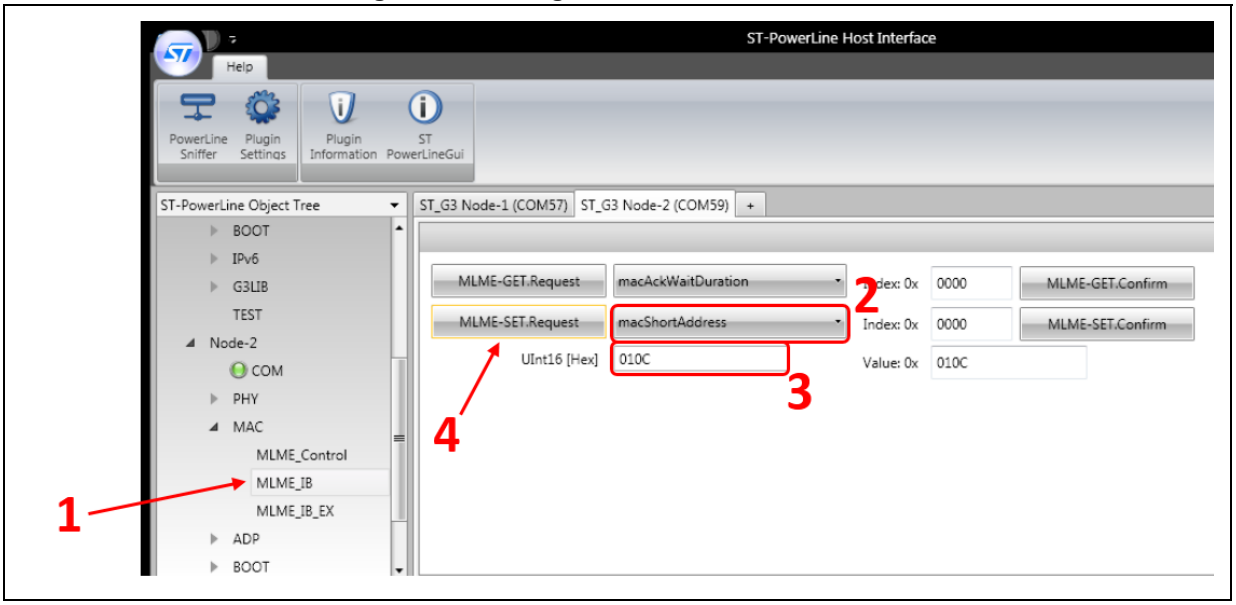
The same commands needs to be executed for the Node 2. The PANId may have the same value as for the Node 1, as represented in *Figure 36* (the same PANId means that the two nodes belong to the same network).

Figure 37. Configure Node 2 PANId



Then, the short address needs to be configured: it must be different from the one of the Node 1, as represented in *Figure 37*.

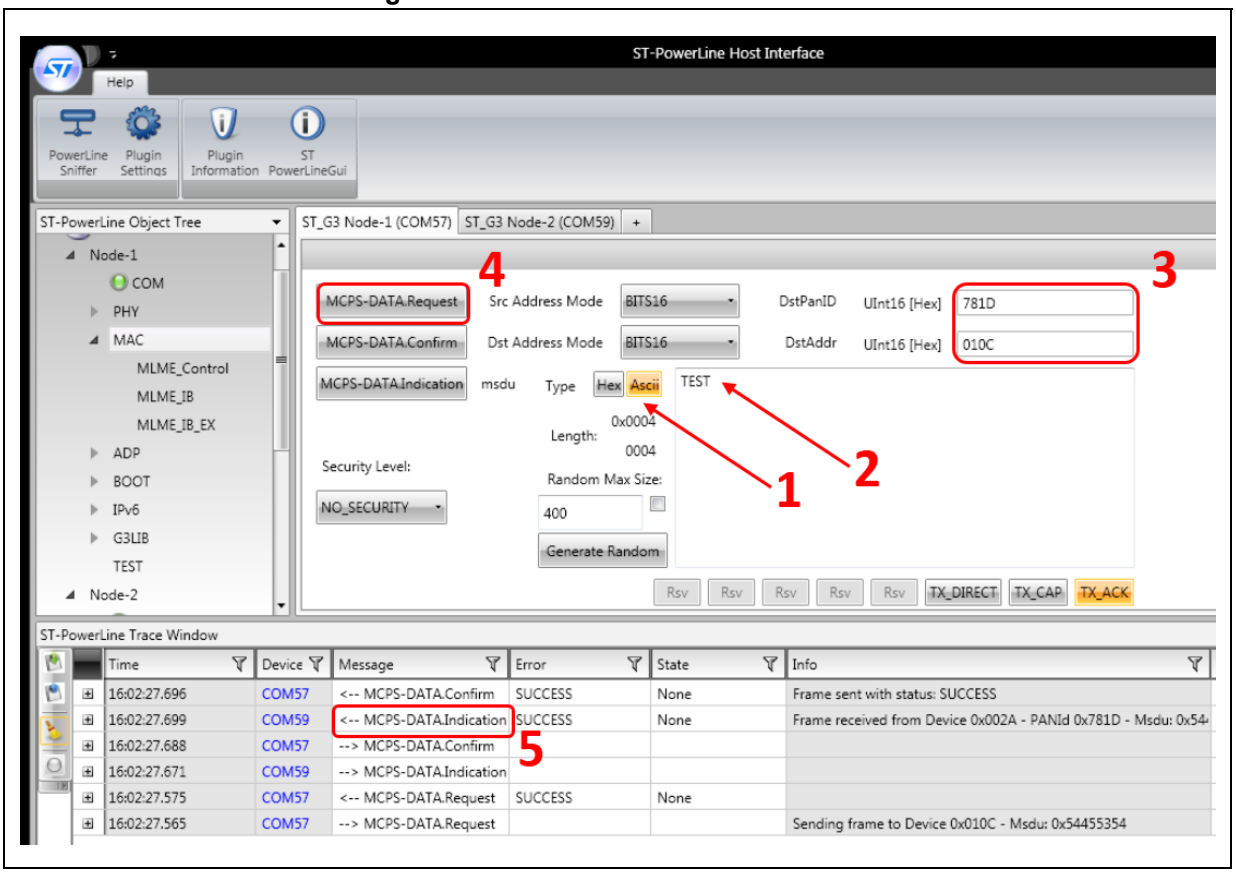
Figure 38. Configure Node 2 short address



Now that the Node 1 and Node 2 are properly configured, data can be exchanged from one node to the other one.

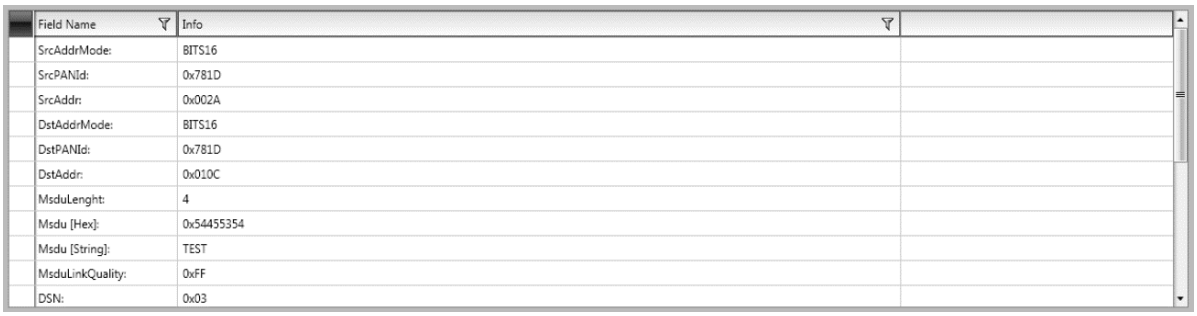
To do this, go in the MAC root menu, as show in *Figure 38*. First, enter the DstPANId of the destination node (781D), then the dstAddr of the destination node (010C) (1). Then, select the payload type to be ASCII (2) and enter your payload in the big text area (3).

Figure 39. Send MAC data from TX to RX



To check that the transmission was successful, look for the MCPS-DATA.Indication message in the trace window with the SUCCESS status. When hovering over this message its detailed content appears in a new window, as represented in *Figure 39*.

Figure 40. MCPS-DATA.Indication message details



Field Name	Info
SrcAddrMode:	BITS16
SrcPANId:	0x781D
SrcAddr:	0x002A
DstAddrMode:	BITS16
DstPANId:	0x781D
DstAddr:	0x010C
MsduLenght:	4
Msdu [Hex]:	0x54455354
Msdu [String]:	TEST
MsduLinkQuality:	0xFF
DSN:	0x03

10.5 ADP layer data exchange

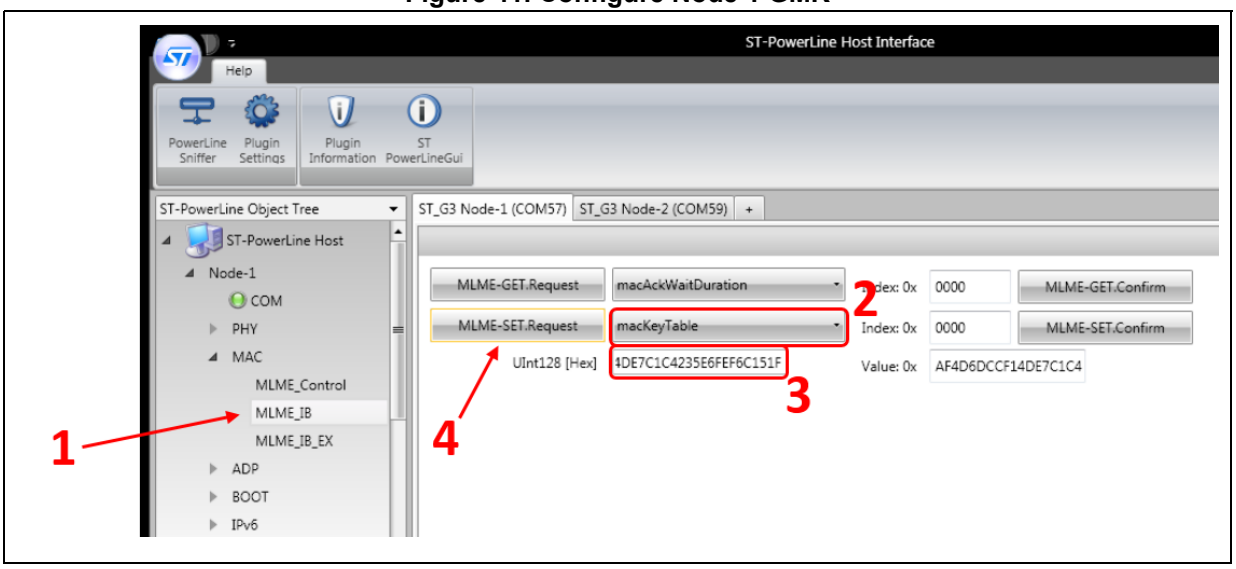
To be able to execute an ADP command, the Node 1 and 2 working modes need to be set to the ADP mode, as explained in *Figure 18 on page 30*.

To be able to send data at the ADP level, the macPANId and macShortAddress attributes need to be configured for both nodes as in the MAC layer scenario (*Section 10.4 on page 45*).

The 6LoWPAN layer uses data encryption by default; so the MAC layer of the two nodes needs to be configured with the same security keys.

In this scenario, the following key is used: [AF4D6DCCF14DE7C1C4235E6FEF6C151F], as show in *Figure 40*. To configure it, go into the MAC / MLME_IB menu (1). In the list of attributes for the set command, select the attribute macKeyTable (2). Then, enter the security key in the Text area (3), leave the Index set to 0 and click on the MLME-SET.Request button (4).

Figure 41. Configure Node 1 GMK



The same sequence needs to be repeated for the Node 2.

Once the security key has been configured for both nodes, data can be sent at the ADP layer. The ADPD-DATA.Request command is available in the ADP root panel. No destination PANId/macShortAddress needs to be entered at the ADP level, as the message is an IPv6 packet that already contains the source and destination addresses. The IPv6 packet must be correctly formatted to perform the data exchange.

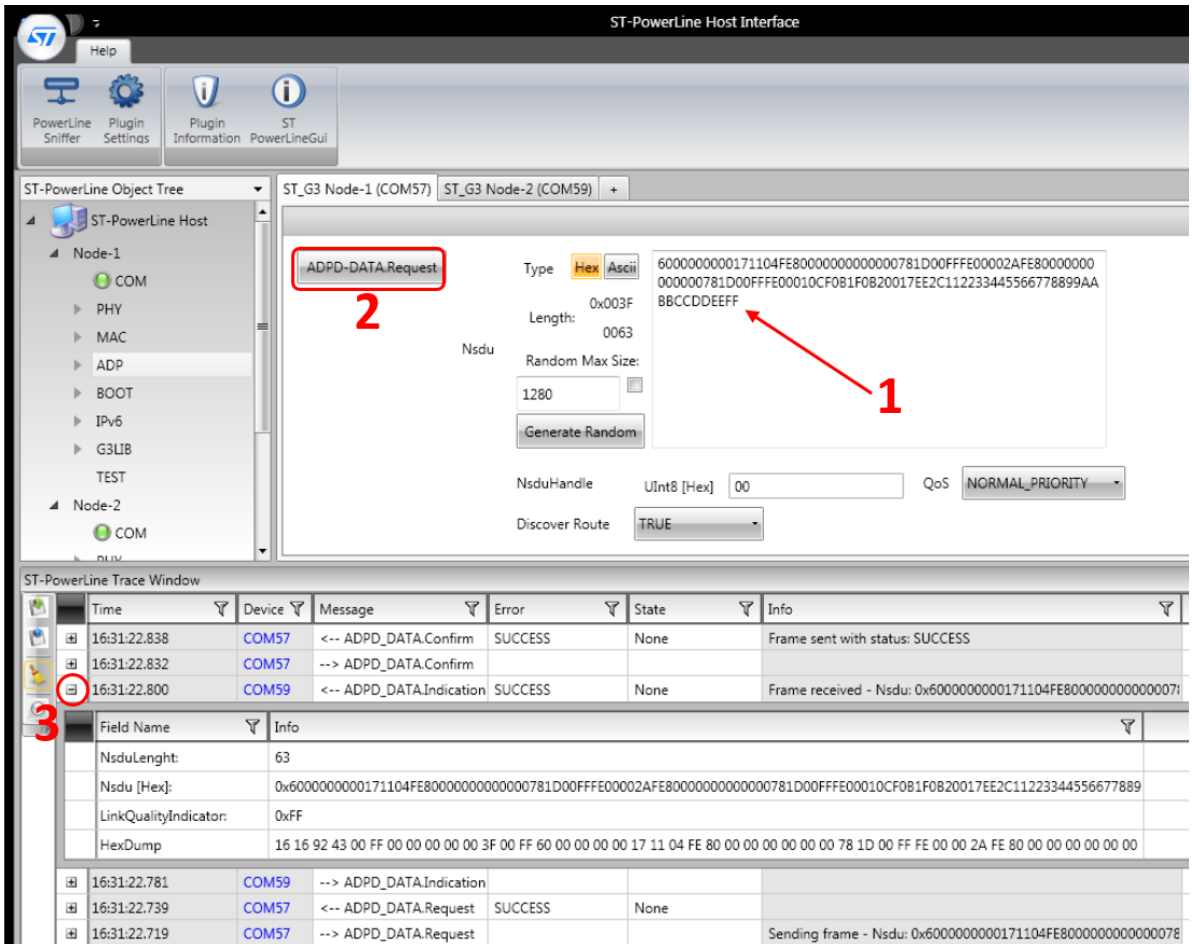
As a reference, the following is a working configuration for this test scenario, shown in *Figure 41*:

- Node 1
  - Short address: 002A
  - PANId: 781D
  - Key entry : AF4D6DCCF14DE7C1C4235E6FEF6C151F

- Node 2
  - Short address: 010C
  - PANId: 781D
  - MAC Key entry : AF4D6DCCF14DE7C1C4235E6FEF6C151F
- NSDU
  - 60000000000171104FE80000000000000781D00FFFE00002AFE8000000000000078 1D00FFFE00010CF0B1F0B20017EE2C11223344556677889 9AABBCCDDEEFF

Once the Nsdu is correctly set (1) and the ADPD-DATA.Request command has been executed (2), the ADPD-DATA-Indication message will be displayed in the trace window with the SUCCESS status (3). When hovering over this message, more details on its content are displayed.

Figure 42. Send ADP data from TX to RX



11 Revision history

Table 10. Document revision history

Date	Revision	Changes
07-Oct-2014	1	Initial release.