

devolo

G3-PLC Modem 500k



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devolo AG

Charlottenburger Allee 67

52068 Aachen

Germany

www.devolo.com/smart

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Contents

1	About this manual	5
1.1	Intended use	5
1.1.1	CE conformity	6
1.2	devolo on the Internet	6
1.3	Disposal of old devices	6
2	Product overview	7
2.1	Functionality	7
2.1.1	What role does the modem play?	7
2.1.2	What is the structure of a G3-PLC network?	7
2.1.3	Connections, indicators and buttons	9
2.2	Example application – smart metering	11
3	Installation	12
3.1	Installation prerequisites	12
3.2	Safety instructions and installation	12
3.2.1	Electrical installation	13
3.3	Installation instructions	13
3.3.1	PAN coordinator installation	13
3.3.2	PAN client installation	14
3.3.3	Testing the network	15
4	Configuration	17
4.1	Configuration interface	17
4.1.1	Overview page	18
4.2	Network configuration	18
4.2.1	IPv4 address	18
4.2.2	Date and time	19
4.3	Modem configuration	19
4.3.1	Mode: PAN coordinator	20
4.3.2	Mode: PAN client	22
4.4	Device status	29
4.4.1	Current status	29
4.4.2	Topology	30
4.4.3	Licence information	32
4.5	Update firmware	32
4.6	Security	32
4.6.1	Key administration	32
4.6.2	Device security	33
4.6.3	Device access: Allowed interfaces and protocols	33
4.6.4	Network access whitelist	34
4.6.5	Save the network access whitelist	34
4.6.6	Restore the network access whitelist	35
4.7	Serial interface	36
4.7.1	Scenarios and configuration	37

1 About this manual

The G3-PLC Modem 500k from devolo is a cost-effective solution for IP-based data communication in the field of Access Powerline technology. It acts as a link between consumers and energy suppliers to transmit data at speeds up to 240 kbps (gross) over the low-voltage network.

Carefully read all instructions before initial use of the device and store the manual for later reference.

Having begun with the introduction to the "G3-PLC" topic and the functional description of the G3-PLC Modem 500k with corresponding networking example in **Chapter 2**, in **Chapter 3** you will learn how to set up the G3-PLC Modem 500k successfully while taking into account the safety instructions. For information on configuring the G3-PLC network and useful tips, please see **Chapter 4**.

You can find the technical data for the G3-PLC Modem 500k online at www.devolo.com/smart.

Icons

This section contains a brief description of the icons used in this manual.



Very important note. Failure to observe this note may result in damage.



Important note that should be observed.



The device may only be used indoors in dry conditions.



Additional information, background material and configuration tips for your device.

1.1 Intended use

Ensure that the G3-PLC Modem 500k is used according to its intended use in order to prevent damage to this or other devices:

The intended use of the G3-PLC Modem 500k is to connect devices in the installation area (e.g. smart meter gateway) with the low-voltage network in order to transmit consumption data. The G3-PLC Modem 500k may only be used indoors.



The device may only be used indoors in dry conditions.

The G3-PLC Modem 500k is intended for installation on the top-hat rail in an electrical cabinet or in an access restricted place, in the installation area of overvoltage category 4 or lower.



Please note that devices with type number MT 2638 are not compatible with devices with other type numbers for technical reasons. As such, they cannot be operated within a G3-PLC network.

1.1.1 CE conformity



The product conforms to the requirements from the directives

- 2014/35/EU



***The product is intended for operation in the EU, Switzerland and Norway.
This product is a Class A device.***

- RoHS 2011/65/EU
- ErP 2009/125/EC and the other relevant provisions of the Radio and Telecommunications Terminal Equipment Act (FTEG).

You can find the CE declaration for the product online at www.devolo.com/smart.

1.2 devolo on the Internet

For detailed information on our products, visit www.devolo.com/smart.

The download area provides you not only with product descriptions and documentation, but also updates for devolo software.

If you have any further ideas or suggestions related to our products, please don't hesitate to contact us at sg-support@devolo.com!

1.3 Disposal of old devices



The icon with a crossed-out recycle bin on the device means that this device is an electrical or electronic device that falls within the scope of application of the German Electrical and Electronic Equipment Act (or EU WEEE Directive). The legal codes and regulations for disposal apply.

2 Product overview

G3-PLC (in accordance with ITU-T G.9903) is a standard developed for Access Powerline Communication (Access PLC) for exchanging meter data between consumers and energy suppliers in a smart grid. Access PLC technology operates in the frequency range from 150 to 500 kHz.

2.1 Functionality

- Ethernet over G3-PLC functionality
- Transmission of any IPv4/IPv6 packages
- Gross data rate up to 240 kbps, corresponding to 65 kbps (net) for TCP/IP data transmission for instance
- Conforms to G3-PLC (ITU-T G.9903)
- Operating frequency: 150 kHz to 500 kHz
- OFDM modulation
- Dynamic routing mechanism supports mesh networking and the automatic selection of the optimum transmission path
- Automatic Repeat Request (ARQ) improves error detection and data reliability
- Dynamic connection adaptation to select the optimum data rate based on the channel conditions
- Operating temperature range: -25 °C to +55 °C
- Connection to 230 V
- Single or three-phase coupling with neutral conductor
- Authentication via EAP-PSK
- Encryption using AES-128
- Serial (RS232 or RS485) over G3-PLC functionality

2.1.1 What role does the modem play?

There are two different roles within a G3-PLC network (or PAN = **P**owerline **A**rea **N**etwork), the PAN coordinator and the PAN clients.

2.1.2 What is the structure of a G3-PLC network?

For setting up a G3-PLC network, you need at least one G3-PLC Modem 500k configured as a PAN coordinator. Normally this PAN coordinator is installed at the uplink. The modem is connected (to the Internet) with a broadband connection at that point.



In spite of this set-up, communication between PAN clients must be permitted (see Chapter 4.3.2 Mode: PAN client).

The factory defaults for the G3-PLC modem 500k have it configured as a PAN client. A typical set-up involves installing a PAN coordinator at a central location and installing PAN clients in the premetering or postmetering area of end consumers. The PAN coordinator and the PAN clients registered there form a G3-PLC network (PAN) (see Chapter **2.2 Example application – smart metering**).

You assign a separate PAN ID to each G3-PLC network (PAN) or PAN coordinator. This ID is issued once during configuration while performing setup.

You can assign terminal devices to a specific G3 PLC network (PAN) or specific PAN coordinator using the PAN ID or allow the PAN client to search for the best possible connection by itself (see also Chapter 4.3.2 **Mode: PAN client**).

Initial use of a G3-PLC network

There are two options for setting up a G3-PLC network:

- **First installing the PAN coordinator, then all the PAN clients**

For setting up a G3-PLC network, start by putting the PAN coordinator into operation first. All PAN clients that you subsequently install can then pair with the PAN coordinator directly.

- **First installing some PAN clients, then the PAN coordinator**

For setting up a G3-PLC network, start by putting some PAN clients into operation and then define a suitable location for the PAN coordinator. Communication between the devices in the G3-PLC network is not possible until the PAN coordinator is installed and online.



If a PAN client cannot join a G3-PLC network, it waits for a random amount of time before initiating a new connection request. The maximum wait time increases with each connection attempt, from 1 minute to 5 minutes, then to 15 minutes and finally 30 minutes. This prevents connection requests from occurring too frequently, helping to prevent a network overload after a power failure.



*You can find more tips and information in the Chapters titled **3.3 Installation instructions** and **4.3 Modem configuration**.*

2.1.3 Connections, indicators and buttons

The connections, indicators and buttons of the G3-PLC Modem 500k are described below:



Fig. 1: G3-PLC modem 500k

Ethernet connection

You can connect the G3-PLC Modem 500k to a smart meter gateway or another Ethernet device using an Ethernet cable.

RS232/RS485 port

You can find a list of the protocols and applications supported by this interface in the corresponding application notes:

- www.devolo.de/G3-PLC-AppNotes and www.devolo.com/G3-PLC-AppNotes.

Line connections

This is where you connect the conductors to the corresponding line connections:










Single-phase connection: the external conductor is connected to the **L1** terminal. The neutral conductor is connected to the **N** terminal.

Three-phase connection: one external conductor each is connected to the **L1**, **L2** and **L3** terminals. The neutral conductor is also connected to the **N** terminal.


The permitted **conductor cross-section** for the connection to the terminals is **1.5 mm² to 6 mm²**.

Indicator lights


The indicator lights (LEDs) show all of the statuses for the G3-PLC Modem 500k by illuminating and/or flashing in different ways. The status and LED behaviour of the device is summarised in the following table:

Status	 Power LED	 PLC link LED	 Indicator LED
Power: Off	Off	Off	Off
Self-test	Orange  Off	Orange  Off	Orange  Off
Start-up process	orange	Off	Off
Started (PAN client = no PAN/ PAN coordinator = conflict)	green	orange	Off
G3 operating mode	green	green	green
G3 modem error/G3 firmware update	green	orange	orange
Factory default	Orange  Off	Orange  Off	Orange  Off
Reset	Off	Off	Off

Reset button

 You can use a pointed object to press the reset button. It has two different functions:

- The device restarts if you press the **Reset** button for less than 15 seconds.
- To change the configuration of the G3-PLC Modem 500k back to the **factory default**, press the **Reset** button **for more than 15 seconds** (until all of the LEDs go out).

 **Keep in mind that ALL settings that have already been made will be lost and the device may no longer connect with the network automatically!**

2.2 Example application – smart metering

The following figure shows a section of a smart grid. A portion of it uses Access PLC for data communication in smart metering. Multiple households are connected to the distribution station on a shared supply line and are connected together to form one communication cluster (G3-PLC network). Communication is transmitted using PLC from the households to the next distribution station (PAN coordinator) or to one or more separate and suitable transfer points over the low-voltage distribution network.

From there, media transfer takes place based on broadband uplink technology.

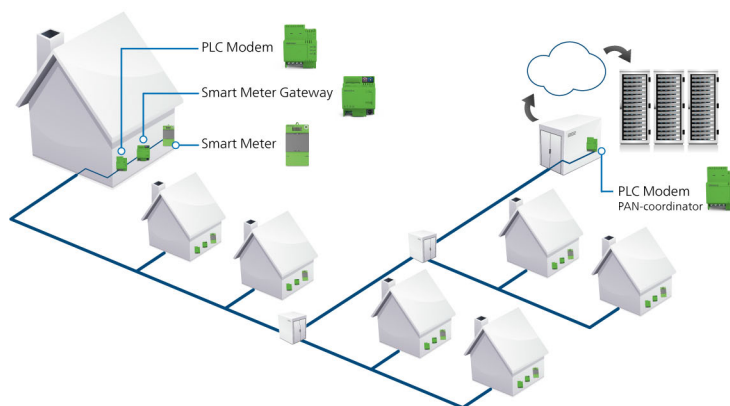


Fig. 2: Smart metering

3 Installation

In this chapter we describe the electrical installation of the G3-PLC Modem 500k on the top-hat rail in the power distribution box.

3.1 Installation prerequisites

You will need:

- A web browser for the installation of the G3-PLC network, at least for the installation of the PAN coordinator
- A IPv4 DHCP server or IPv6 link-local addresses are used for configuration

3.2 Safety instructions and installation

It is essential to have read and understood all safety and operating instructions before the device is used for the first time; these should then be kept safely for future reference.



The device may only be used indoors in dry conditions.

Installation may be performed by a qualified electrician only (in acc. with German Low Voltage Connection Ordinance (NAV), Part 2, §13).*

If possible, install the device when it is de-energised. Be aware of the relevant safety instructions, otherwise there is risk of electric shock or electric arcing (risk of burns).

When installing the device when it is energised, abide by the regulations for working with live voltage. This is only permitted for skilled persons with the corresponding qualifications (such as the German AuS-Pass)

Additional restrictions on installation authorisation may apply at the intended installation location (e.g. premetering area). This requires co-ordination with the associated power company.



Use short-circuit-proof lines in the premetering or postmetering area without separate fuse protection if the sizes have to be less than the prescribed nominal cross-sections for the existing fuse protection.

- The device is intended for installation on the top-hat rail in an electrical cabinet or in an access restricted place, in the installation area of overvoltage category 4 or lower.
- The device may be installed only at locations where adequate ventilation is guaranteed. Slots and openings on the housing are used for ventilation:
- **Slots and vents must remain uncovered.**
- **Do not place any objects** on the device.
- **Do not insert any objects** into the **openings** of the device.
- **Do not place the device** directly **next to open flame** (such as fire or candles).
- **Do not expose the device to sources of direct heat radiation** (such as a radiator or direct sunlight).

*For Germany:
NAV = Niederspannungs-Anschlussverordnung (Low-voltage Connection Ordinance) of 3 September 2010

The device must be operated exclusively on a public mains power supply as described on the rating plate.

3.2.1 Electrical installation

- 1 Install the G3-PLC Modem 500k properly on the top-hat rail.



Take into account the vertical installation alignment of the device, so that the mains power supply comes from below.

- 2 Now connect the conductors according to the line connections.



When connecting to the sockets, make sure the conductor cross-section is 1.5 mm² to 6 mm².

- **Single-phase connection:** the external conductor is connected to the **L1** terminal. The neutral conductor is connected to the **N** terminal.
- **Three-phase connection:** one external conductor each is connected to the **L1**, **L2** and **L3** terminals. The neutral conductor is also connected to the **N** terminal.



To optimise the data transmission, we recommend the three-phase connection.

3.3 Installation instructions

In this chapter, you will find helpful tips and information for setting up a G3-PLC network.

3.3.1 PAN coordinator installation

Position the PAN coordinator as close to the centre of the network as possible so that as many PAN clients as possible can connect to it directly. G3-PLC technology does feature a "repeating" function, but you should use it as little as possible if you want to achieve high bandwidth (see Chapter **Prefer direct PAN coordinator connection**).

When connecting an area with many PAN clients, it may make sense or even be necessary to place multiple PAN coordinators in their respective selected positions. There can be many reasons for this:

- Multiple PAN coordinators can provide redundancy. In case of a dropout or an inability to connect to the PAN coordinator, a PAN client can automatically connect to another PAN coordinator.
- Multiple PAN coordinators each cover their own regions to prevent repeating.



It is important that each PAN coordinator receive its own PAN ID. This ID is issued once for configuration during setup.

When setting up a G3-PLC network, start by setting up the PAN coordinator:

- Install any modem at the "PAN coordinator" location.
- Approximately 1 minute after it has been **switched on**, the **Power LED lights up in green**.
- The **PLC link LED** lights up in **orange** because the G3-PLC Modem 500k is configured as a "PAN client" by default.

- Now, configure the device as a "PAN coordinator" and assign it a unique PAN ID. Approximately 1 minute after confirming the configuration change by selecting **Save**, the **PLC link LED lights up in green**, signalling the **online** link status. This means that the PAN coordinator is now ready to pair with PAN clients. Initially, the network access whitelist is still empty.



Once you have assigned a static IP to the devices (either manually or through configuration of a DHCP server connected to the PAN coordinator), it is recommended that you also write down this address in the network plan.

3.3.2 PAN client installation

Each G3-PLC Modem 500k is configured as a PAN client by default and does not normally require any additional configuration.

After switching it on, the modem immediately searches for an available PAN coordinator.

Please note that if you establish a G3-PLC network by first setting up the PAN clients in order to determine the best possible location for the PAN coordinator later on, be aware that no communication is possible within the G3-PLC network until the PAN coordinator is installed and online.

Once the network is installed and online, the PAN client can immediately pair with the PAN coordinator.

Upon **successful pairing**, the **PLC link LED** lights up in **green**.



If the PLC link LED is still lit in orange after several minutes, then the PAN client could not connect to any PAN coordinator. This may be because the distance is too large or interference in the mains supply is preventing the connection or the automated PAN search is deactivated because the device is no longer set to the factory defaults.

Initial pairing on the network can take place using other PAN clients (as repeaters) at this point, provided that these clients are paired with the PAN coordinator.

As soon as the PAN client has successfully paired with the PAN coordinator, the installation of this device is complete.



Before you install the next PAN client, write down the MAC address of the modem and the installation location. The MAC address is listed on the label of the device housing.

3.3.3 Testing the network

If all PAN clients are successfully installed (**online** link status), then you can scan the network access whitelist at the PAN coordinator. All installed PAN clients should now be listed here.

Here, you can identify the devices using their individual MAC address. Upon pairing, the PAN coordinator automatically assigned an individual node ID to each PAN client. Only this node ID is output for further topology queries. Therefore, it may be wise to write down this node ID in a network plan.

G3-PLC technology has a "repeating" function. This allows PAN clients to use other modems as repeaters if they cannot connect to the PAN coordinator directly.

Additional important information

The following information is helpful in understanding the behaviour of the modems and helping you to optimise it:

- If the PAN coordinator is installed first and online, this has the advantage that PAN clients can pair with the PAN coordinator immediately.
- If the PAN clients are installed first, and the PAN coordinator is then installed afterwards, this has the advantage that the best possible location for all PAN clients can be specifically determined.
- If the PAN coordinator is not available when starting a PAN client, then the modem waits several seconds before a new attempt is initiated to pair with the PAN coordinator. This time interval between attempts is random, but tends to increase. If a PAN coordinator cannot be accessed for a long period of time, then the time interval can be many minutes.
- The online status of a PAN client is set to **online** immediately after successfully pairing with the PAN coordinator. When this occurs, the PAN client's PLC link LED turns green.
- If the connection is interrupted after PAN client pairing (due to interference in the mains supply, for example), then this is detected only if data can no longer be successfully transported via this connection. Only then does the client search for an alternative route and, if specified by the configuration, for an alternative PAN coordinator. In this scenario, the status of the PAN client is changed to offline and the PLC link LED lights up orange. The modem software offers a "Keepalive" function that maintains an online status even without a payload (see Chapter **Advanced settings – Mode: PAN client**).
- Usually, the modem can be tested and configured by connecting a computer to the modem via Ethernet. The computer frequently transmits broadcast packets via the Ethernet interface, depending on the settings and installed programs. If too many broadcast packets are fed into the network as a result (for example, ARP packets for devices outside of the G3-PLC network), then this can cause substantial interference in the G3-PLC network. To reduce the broadcast load of the G3-PLC net-

work, we recommend using an upstream router. This reduces the broadcast domain (see also Chapter 4.3.1 **Mode: PAN coordinator**).

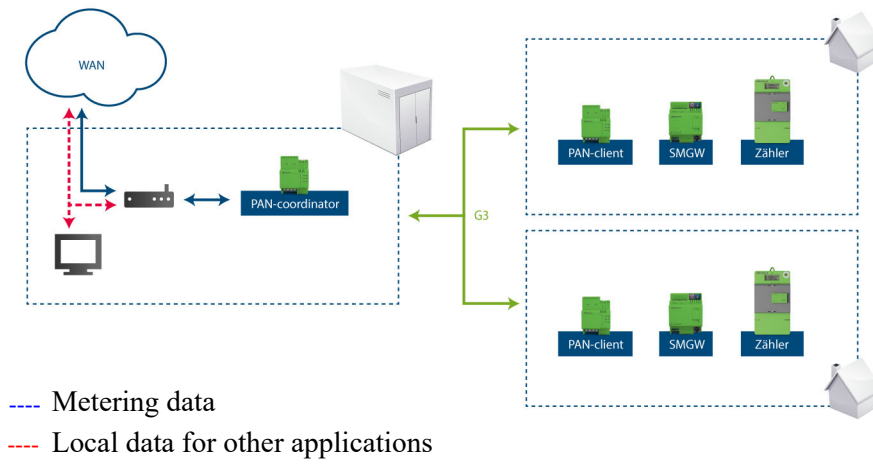


Fig. 3: G3-PLC network with upstream router

4 Configuration

The G3-PLC Modem 500k has a built-in configuration interface that can be called up using a standard web browser. All settings for operating the device can be modified here.

4.1 Configuration interface

IP address

You can reach the configuration interface for the G3-PLC Modem 500k using its current IP address. This can either be entered manually as a static address or obtained automatically from a DHCP server (see also Chapter **4.2 Network configuration**).

The G3-PLC Modem 500k can be addressed using IPv4 or IPv6:

- In the case of **IPv6**, the modem always has a fixed address which can be used to access it within the connected Ethernet or PLC network segment. This link-local address is derived from the Ethernet MAC address.
- In the case of **IPv4**, you can access the device's configuration interface using its manually configured IP address or using the IPv4 address the device obtains automatically from a DHCP server. The option **Use this to accept network settings automatically from a DHCP server** is enabled for the G3-PLC Modem 500k in the factory defaults.

The configuration has no effect on piping data via the modem. The full functionality for piping IPv4 and IPv6 packets is specified here.



Note the different MAC addresses for Ethernet and PLC. A DHCP server registers the G3-PLC Modem 500k using the Ethernet MAC address. The Ethernet MAC address is always one lower than the PLC MAC address. The PLC MAC addresses can be found on the label on the housing; below is an example:

PLC MAC address_30:D3:2D:0A:9A:AF

The Ethernet MAC address is then: **30:D3:2D:0A:9A:AE**

The IPv6 address (FE80 = Link Local) is then:
FE80::32D3:2DFF:FE0A:9AAE

Login password

The built-in configuration interface of the G3-PLC Modem 500k is assigned the factory default password **admin**. You should replace the default password by assigning an individual login password after installing the G3-PLC Modem 500k to prevent access by third parties (see also Chapter **4.6 Security**).

When calling up the configuration interface for the first time, enter **admin** into both the **user name** field and the **password** field.

Menu description

All menu functions are described both in the corresponding interface as well as in the associated chapter in the manual. The sequence of the description in the manual follows the structure of the menu.

Click **Save** to save the settings of the respective area of the configuration interface.

Click **Back** to leave the respective area of the configuration interface.

Language selection



Select the desired language in the language selection list.

4.1.1 Overview page

The five central areas of the configuration interface are shown on the main menu. Click the button of an area to move directly into it.

- The **Network configuration** area lets you change network and time control settings.
- The **Modem configuration** area lets you specify the mode of the device and the settings for data communication.
- The **Device status** area contains specific device data.
- The **Update firmware** area lets you update the firmware of your device.
- Define the access restrictions for your device or the G3-PLC network in the **Security** area.
- Configure piping of the serial interface over the G3-PLC network in the **Serial interface** area.

4.2 Network configuration

The **Network configuration** area lets you change network and time control settings.

4.2.1 IPv4 address

As a component of your network, the G3-PLC Modem 500k communicates using the IPv4 protocol. The IP address required for this can either be entered manually as a static address or obtained automatically from a DHCP server.

The option **Use this to accept network settings automatically from a DHCP server** is enabled in the factory defaults. If a DHCP server for the assignment of IP addresses is present in the network and the **Use network settings provided by a DHCP server** option is enabled, the G3-PLC Modem 500k receives an address automatically from this.

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[Main menu](#) > [Network configuration](#) >

IPv4 address

DHCP client

☒ Use network settings provided by a DHCP server

IP address

Here you can configure the local IP address for the device.

IP address:
 Netmask:
 Default gateway:
 Name server:



The IPv4 address is only necessary for configuring and managing the device.

If you assign a static IP address, make the corresponding entries under **IP address**, **Netmask**, **Default gateway** and **Name server** and click **Save** to confirm your entries.

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[Main menu](#) > [Network configuration](#) >

IPv4 address

DHCP client

☐ Use network settings provided by a DHCP server

IP address

Here you can configure the local IP address for the device.

IP address:
 Netmask:
 Default gateway:
 Name server:

4.2.2 Date and time

A time server is a server in the network whose task consists of providing the exact time.

Enable the option **Retrieve date and time automatically**, so that the G3-PLC Modem 500k can automatically synchronise the date and time. Select your **Time zone** and the **Time server**.



A DNS server must be entered when entering a time server name (manually or via DHCP). No DNS server needs to be present in the network if an IPv4 address is entered.

If you have enabled the option **Adjust to daylight savings time automatically**, the G3-PLC Modem 500k automatically adjust to daylight savings time. Confirm your entries with **Save**.

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[Main menu](#) > [Network configuration](#) >

Date and time

Time server

The device can retrieve the date and time automatically from a time server. An IP route to this time server is required for this purpose.

☐ Retrieve date and time automatically

Time zone:

Time server:

☒ Adjust to daylight saving time automatically

4.3 Modem configuration

The **Modem configuration** area lets you specify the mode of the device and the settings for data communication.

The device has two different modes: **PAN coordinator** and **PAN client**. Depending on the selection, the corresponding configuration options are displayed.

4.3.1 Mode: PAN coordinator

If the G3-PLC Modem 500k is to be configured as a PAN coordinator, select the **PAN coordinator** mode.

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[Main menu >](#)

Modem configuration

Mode: PAN-coordinator ▼

PAN ID: 27



Advanced configuration

Advanced configuration of the G3 modem

The **PAN ID** (value range 0 to 255) is the identifier of a G3-PLC network or a PAN coordinator that you assign once to each G3-PLC network or PAN coordinator specifically during configuration (during setup).

Advanced settings – PAN coordinator

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[Main menu > Modem configuration >](#)

Advanced configuration

☐ Send all Ethernet packets with high priority

☒ Packets destined for devices which are not on the network are discarded

Maximum allowed consecutive error events: 3

Packet discard time: 240 s

Ethernet over UDP

Port: 65535

Fragment size: 1200

☒ Filter Ethernet broadcasts except IPv4 ARP, DHCP and IPv6 Neighbor Solicitation and Advertisement.

TxQueueLen: 256 Packets

Shortest allowed time between retransmissions: 30 s

Send all Ethernet packets with high priority

If this option is enabled, all of this device's PLC data packets are sent with high priority.



We recommend not enabling this setting so that different prioritisations remain possible depending on the service.

Packets destined for devices which are not on the network are discarded

If this option is enabled, undeliverable Unicast data packets are discarded by the PLC network without transmission.

Receiver devices are not detected as being available in the network if the number of consecutive lost packets to that node meets or exceeds the value configured under **Maximum allowed consecutive error events**.

Example: 3 is configured. A failed delivery attempt is repeated twice without success. After that, no more data packets are sent to the receiver for the configured packet discard time. Once the configured packet discard time has elapsed, all data packets are allowed through to that node again.



Error events can cause network-wide disruptions and data transmission delays.

Ethernet over UDP

Ethernet data packets are transmitted over the G3-PLC network using UDP.

In the **Port** field, enter the port number of the UDP port used to handle the transmission of Ethernet data packets in the G3-PLC network. The same UDP port is used throughout the entire PAN.

Indicate the maximum size of the UDP data packet in the **Fragment size** field. Data packets that are the same size or smaller are transmitted without being affected. Larger data packets are split up into multiple UDP data packets.

Filter Ethernet broadcasts except IPv4, ARP, DHCP and IPv6 Neighbor Solicitation and Advertisement.

If this filter option is enabled, the IPv6 protocols router solicitation (type 133), router advertisement (type 134), neighbor solicitation (type 135) and neighbor advertisement (type 136) are transmitted in addition to the data packets of the listed transmission protocols. This function is used to reduce the load on the G3-PLC network.

Broadcast packets are data packets without a unique destination address. Broadcast packets that go to a G3-PLC Modem 500k over the Ethernet interface are sent to all G3-PLC network nodes with an Ethernet port. A maximum data rate of 24 kbps has been determined for broadcast transmissions.

Ethernet over UDP	Packet discard time: <input type="text" value="240"/> s
	Port: <input type="text" value="65535"/>
	Fragment size: <input type="text" value="1200"/>
<input checked="" type="checkbox"/> Filter Ethernet broadcasts except IPv4 ARP, DHCP and IPv6 Neighbor Solicitation and Advertisement.	
TxQueueLen: <input type="text" value="256"/> Packets	
Shortest allowed time between retransmissions: <input type="text" value="30"/> s	

TxQueueLen



The use of this parameter is suitable only for TCP.

Incoming data packets are stored temporarily in the input buffer. The buffer, however, also fills up quickly due to the high data transmission of the Ethernet interface (100 Mbps). In contrast, sending data packets over the Powerline connection is significantly slower (max. 65 kbps).

The use of repeaters can also reduce the available bandwidth.

In order to ensure an equal distribution of the available bandwidth to all services, specify the memory size in the **TxQueueLen** field (number of data packets). The permitted value range is between 1 and 1000 packets.



Setting the TxQueue value to 1 is useful if delays in transmission need to be reduced to a minimum.

This setting is important when using TCP protocols because a certain, predetermined number of data packets (window size, transmission or reception window size) can be

set at full Ethernet speed without having to wait for a positive acknowledgement of receipt (ACK) from the receiver. The sender is prompted to wait until an acknowledgement of receipt is obtained from the receiver before sending the next data packet only if what is known as the transmission or reception window size is utilised completely.

To prevent data loss and to make optimal use of the G3-PLC connection, the TxQueue should correspond to the complete transmission or reception window size. Otherwise, packets would need to be repeated and bandwidth would be wasted.

Shortest allowed time between retransmissions (e.g. when using TCP/IP)

The round trip delay in a G3-PLC network is significantly higher than in an Ethernet network and can vary widely depending on the degree of the interference and network load.

This function is used to filter out premature retransmission of (supposedly) lost data packets in order to optimise the utilisation of the G3-PLC network.

4.3.2 Mode: PAN client

If the G3-PLC Modem 500k is to be configured as a PAN client, select the **PAN client** mode.

devolo G3-PLC Modem 500k

[Main menu >](#)

Modem configuration

Mode:

PAN ID:



Advanced configuration

Advanced configuration of the G3 modem

Each G3-PLC network or each PAN coordinator has its own PAN ID. Under **Advanced settings**, enable the **Select PAN automatically** option to ensure the PAN client automatically selects the G3-PLC network or the PAN coordinator. The **PAN ID** field is greyed out in this case. This means your G3-PLC Modem 500k G3 is not assigned to a specific G3-PLC network or PAN coordinator. Instead, it selects the best possible connection, picking the most readily accessible PAN coordinator as a result.



If communication between PAN clients is to be possible, this must explicitly be allowed!

If you want to assign your G3-PLC Modem 500k to a specific G3-PLC network, disable the **Select PAN automatically** option under **Advanced settings** and enter the PAN ID of the corresponding G3-PLC network. In this case, your G3-PLC Modem 500k can communicate only using that selected G3-PLC network.

Advanced settings – Mode: PAN client

[Main menu](#) > [Modem configuration](#) >

Advanced configuration

☐ Send all Ethernet packets with high priority

☒ Packets destined for devices which are not on the network are discarded

Maximum allowed consecutive error events:

Packet discard time: s

Ethernet over UDP

Port:

Fragment size:

☒ Filter Ethernet broadcasts except IPv4 ARP, DHCP and IPv6 Neighbor Solicitation and Advertisement.

☐ Communication between PAN-clients

☒ Keep G3 connection alive

Interval: s

☒ Force PAN discovery after a period of time without data traffic from the PAN-coordinator

Interval: s

☒ Select PAN automatically

☒ Prefer previously used PAN.

LQI bonus:

☒ Prefer direct PAN-coordinator connection

TxQueueLen: Packets

Shortest allowed time between retransmissions: s

Send all Ethernet packets with high priority

If this option is enabled, all of this device's PLC data packets are sent with high priority.



We recommend not enabling this setting so that different prioritisations remain possible depending on the service.

Packets destined for devices which are not on the network are discarded

If this option is enabled, undeliverable Unicast data packets are discarded by the PLC network without transmission.

Receiver devices are not detected as being available in the network if the number of consecutive lost packets to that node meets or exceeds the value configured under **Maximum allowed consecutive error events**.

Example: 3 is configured. A failed delivery attempt is repeated twice without success. After that, no more data packets are sent to the receiver for the configured packet discard time. Once the configured packet discard time has elapsed, all data packets are allowed through to that node again.



Error events can cause network-wide disruptions and data transmission delays.

Ethernet over UDP

Ethernet data packets are transmitted over the G3-PLC network using UDP.

In the **Port** field, enter the port number of the UDP port used to handle the transmission of Ethernet data packets in the G3-PLC network. The same UDP port is used throughout the entire PAN.

Indicate the maximum size of the UDP data packet in the **Fragment size** field. Data packets that are the same size or smaller are transmitted without being affected. Larger data packets are split up into multiple UDP data packets.

Filter Ethernet broadcasts except IPv4, ARP, DHCP and IPv6 Neighbor Solicitation and Advertisement.

If this filter option is enabled, the IPv6 protocols router solicitation (type 133), router advertisement (type 134), neighbor solicitation (type 135) and neighbor advertisement (type 136) are transmitted in addition to the data packets of the listed transmission protocols. This function is used to reduce the load on the G3-PLC network.

- ☒ Filter Ethernet broadcasts except IPv4 ARP, DHCP and IPv6 Neighbor Solicitation and Advertisement.
 - ☐ Communication between PAN-clients
 - ☒ Keep G3 connection alive
 - ☒ Force PAN discovery after a period of time without data traffic from the PAN-coordinator
- Interval: s
Interval: s

Broadcast packets are data packets without a unique destination address. Broadcast packets that go to a G3-PLC Modem 500k over the Ethernet interface are sent to all G3-PLC network nodes with an Ethernet port. A maximum data rate of 24 kbps has been determined for broadcast transmissions.

Communication between PAN clients

If you enable the **Communication between PAN clients** option, you are allowing data communication between the PAN clients.

! *At low bandwidths, it is useful to disable this option to prevent unnecessary data traffic and network overloading.*

Keep G3-PLC connection alive – Force PAN discovery after a period of time without data traffic from the PAN coordinator

As soon as a PAN client has paired with a PAN coordinator, it receives the status **online** (see also Chapter 4.4.1 **Current status**).

! *The status of the modem is both shown under **4.4.1 Current status** in the drop-down list and indicated by the green Link LED.*

! *Continuous data traffic is required to ensure the status of a modem is always up to date. The modem only notices a disruption to or interruption in the network connection when trying to send a data packet. Not until this moment, the modem looks for an alternative route.*

In order to keep the online status up to date and avoid delays from pairing again, enable the options **Keep G3-PLC connection alive** and **Force PAN discovery after a period of time without data traffic from the PAN coordinator**. The modem then generates artificial data traffic (in the form of keepalive packets) at the interval you specify.



Incoming data traffic over Ethernet resets the timer to avoid generating unnecessary additional data traffic.

If the keepalive packet cannot be forwarded, an alternative route is sought automatically. If the search is unsuccessful, this leads to a communication error. If no PAN coordinator can be reached, the PAN client switches from the online status to the offline status, which is indicated by the orange link LED.

In addition, this is used to monitor whether data from the PAN coordinator is being received over Powerline. If no data traffic takes place over Powerline during the interval you specify, a new pairing with an available PAN coordinator is started. In doing so, the G3-PLC Modem 500k can either establish an alternative route to a known PAN coordinator or can pair with another available PAN coordinator.

In the second case, the device becomes a node in another G3-PLC network and usually receives a new IPv4 address because it now belongs to another G3-PLC network and it is assigned a new IP address from another DHCP server.

*Note that if the IP address has been entered into the network plan as described under 4.6.4 **Network access whitelist**, this is no longer valid.*



*When using multiple PANs or if the **Select PAN automatically** option is enabled, the PAN clients change the G3-PLC network. For this reason, you should regulate the IP address assignment using DHCP (no static IP addresses).*

Select PAN automatically

Each G3-PLC network and each PAN coordinator has its own PAN ID. This option must be enabled if you want the PAN client to select the G3-PLC network or PAN coordinator automatically. The **PAN ID** field under **4.3.2 Mode: PAN client** is greyed out in this case. This means your G3-PLC Modem 500k is not assigned to a specific G3-PLC network or PAN coordinator. Instead, it selects the best possible connection, picking the most readily accessible PAN coordinator as a result.

☒ Select PAN automatically

☒ Prefer previously used PAN.

LQI bonus:

☒ Prefer direct PAN-coordinator connection

TxQueueLen: Packets

Shortest allowed time between retransmissions: s

To ensure the pairing is permitted by the PAN coordinator, either the PAN client's PSK (Pre-Shared Key) must already be entered in the PAN coordinator's network access whitelist or the **Limit network access to G3 modems of the network access whitelist** option must be disabled. The respective PSK is always listed in the network access whitelist. The PSK is individually or automatically generated. Additional information about PSK can be found in Chapter **4.6.1 Key administration**.

If you want to assign your G3-PLC Modem 500k to a specific G3-PLC network, disable the **Select PAN automatically** option and enter the PAN ID of the corresponding G3-PLC network in the **PAN ID** field under **4.3.2 Mode: PAN client**. In this case, your G3-PLC Modem 500k can communicate only using that selected G3-PLC network.

Prefer previously used PAN

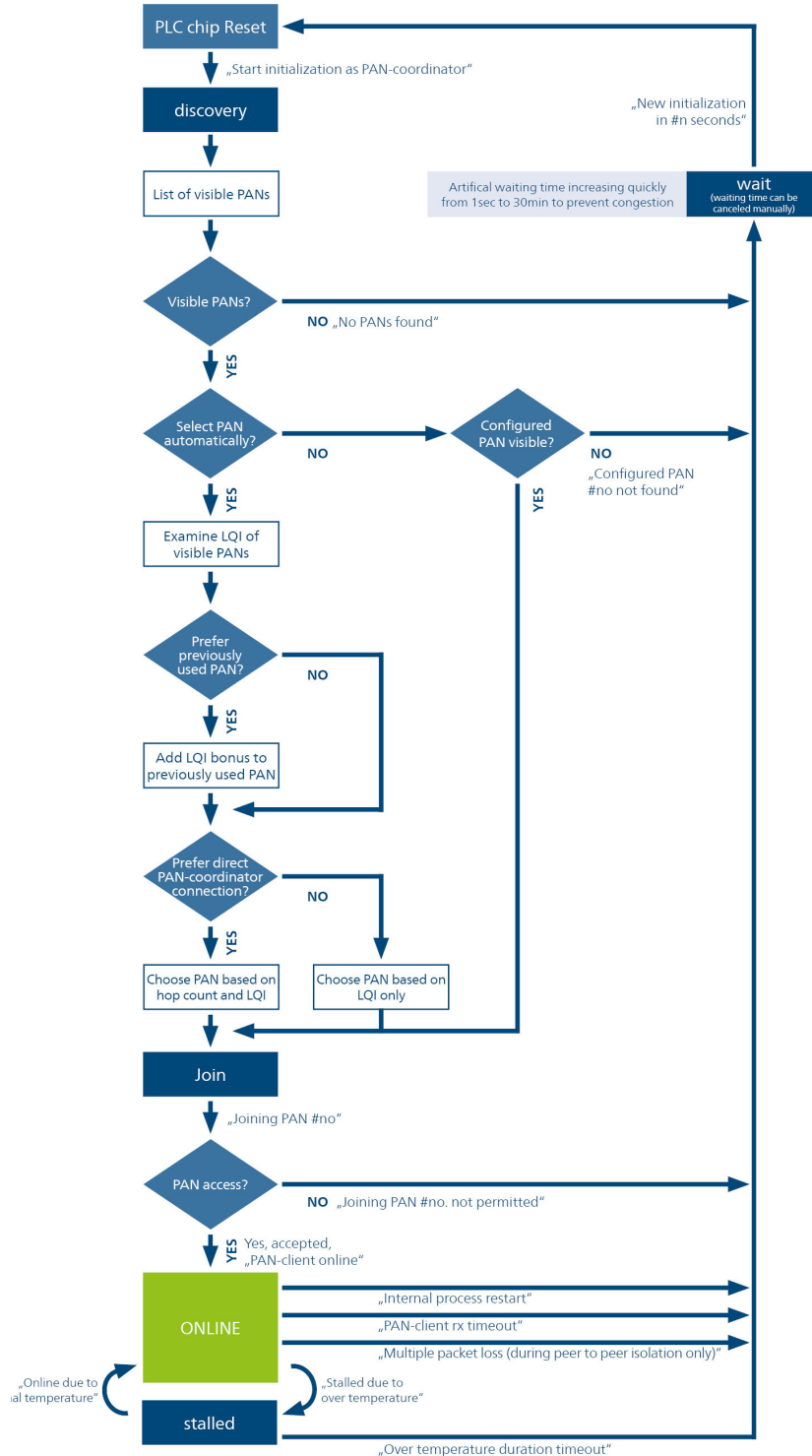
This function only has an effect if the **Select PAN automatically** option is enabled. You can use this option to prevent a PAN client from switching between two accessible G3-PLC networks. If the PAN client can access more than one PAN coordinator, the LQI (Line Quality Indicator, a metric for connection quality) decides to which G3-PLC network the PAN client is to connect. If the PAN client has already successfully connected to a G3-PLC network, this G3-PLC network receives a configurable bonus. The permitted value range is between 0 and 255.

Fig. 4:
PAN coordinator connection

Prefer direct PAN coordinator connection

If you enable this option, repeating connections are selected only if a direct connection cannot be made from the PAN client to the PAN coordinator (regardless of the connection quality). The PAN coordinator that is easiest to access is selected.

PAN membership of PAN-clients



Modems that cannot directly communicate with each other due to a large distance use other modems as relay stations ("repeaters"). Each modem has this "repeating" function, which can only be changed to a limited extent by the user.

In case of connection problems between two modems, it may be helpful to install an additional modem in between the existing ones. The modem is used as a repeater automatically.



Please note that the bandwidth decreases significantly through the use of repeating, but repeating may be necessary for there to be a connection between two modems in the first place.

TxQueueLen



The use of this parameter is suitable only for TCP.

Incoming data are stored temporarily in the input buffer. The buffer, however, also fills up quickly due to the high data transmission of the Ethernet interface (100 Mbps). In contrast, sending data over the Powerline connection is significantly slower (max. 65 kbps).

The use of repeaters can also reduce the available bandwidth.

In order to ensure an equal distribution of the available bandwidth to all services, specify the memory size in the **TxQueueLen** field (number of data packets).

TxQueueLen: Packets

Shortest allowed time between retransmissions: s

This setting is important when using TCP protocols because a certain, predetermined number of data packets (window size, transmission or reception window size) can be set at full Ethernet speed without having to wait for a positive acknowledgement of receipt (ACK) from the receiver. The sender is prompted to wait until an acknowledgement of receipt is obtained from the receiver before sending the next data packet only if what is known as the transmission or reception window size is utilised completely.

To prevent data loss and to make optimal use of the G3-PLC connection, the TxQueue should correspond to the complete transmission or reception window size. Otherwise, packets would need to be repeated and bandwidth would be wasted. The permitted value range is between 1 and 1000 packets.



Setting the TxQueue value to 1 is useful if delays in transmission are to be reduced to a minimum.

Shortest allowed time between retransmissions (e.g. when using TCP/IP)

The round trip delay in a G3-PLC network is significantly higher than in an Ethernet network and can vary widely depending on the degree of the interference and network load.

This function is used to filter out premature retransmission of (supposedly) lost data packets in order to optimise the utilisation of the G3-PLC network.

4.4 Device status

The **Device status** area contains specific device data.

4.4.1 Current status

In addition to static information such as the ID and firmware version of the G3-PLC Modem 500k, you can find an assortment of device information in the drop-down list.

devolo G3-PLC Modem 500k

[Main menu](#) > [Device status](#) >

Current status

Device code: E DVL01 0000 0000 (Rev.: 0004)

Firmware version: 1.2.11 (2016-09-05)

G3 firmware version: AM58-14.1.12 Universal-R2

OnlineStatus ▼

online

Internal event meter

Restart: 8

Process start: 0

Reboot

Status messages:

```
23.9.2016, 08:37:22 Start initialization as PAN-coordinator  
23.9.2016, 08:37:56 PAN-Coordinator online  
23.9.2016, 15:35:40 Start initialization as PAN-coordinator  
23.9.2016, 15:36:11 PAN-Coordinator online
```

Refresh

Stop waiting

OnlineStatus

As soon as a PAN client has paired with a PAN coordinator, it receives the **online** status. The link LED lights up green.

Continuous data traffic is required to ensure the status of a modem is always up to date. The modem first notices a disruption to or interruption in the network connection when

trying to send a data packet. At this point, the modem first looks for an alternative route.

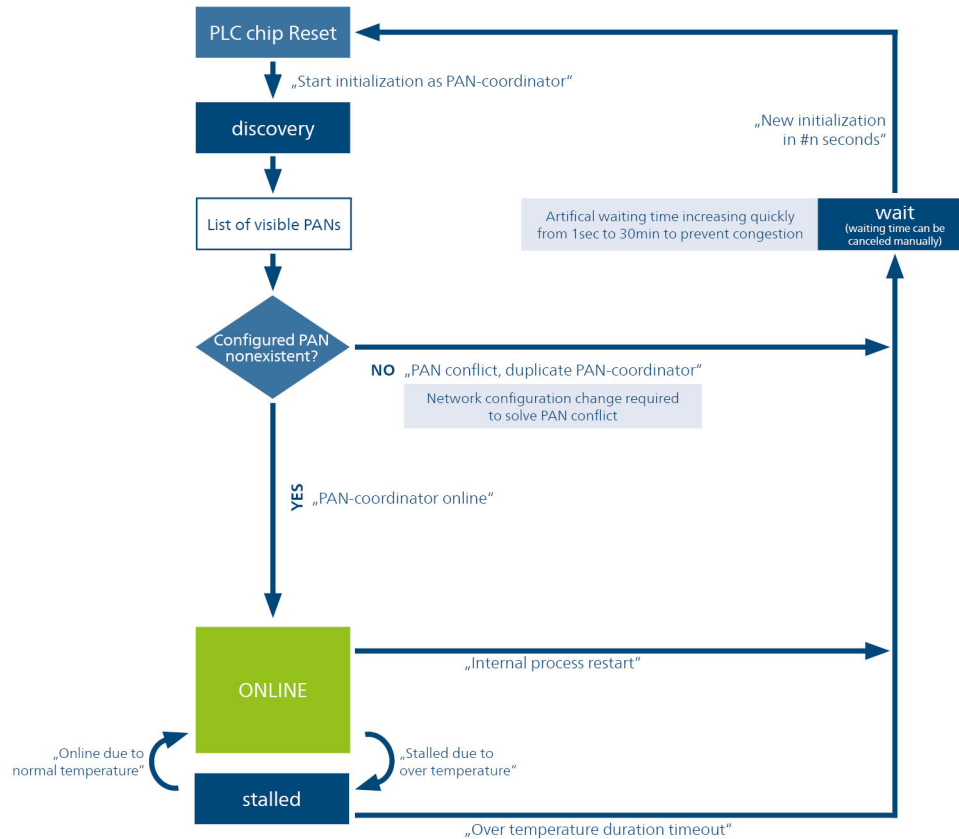


Fig. 5: PAN coordinator status

Internal event meters

These event counters are used to monitor the system. Events such as resetting or re-starting the modem after a software update or a power failure are recorded in the **Restart** or **Process start** counter.

4.4.2 Topology

You can view the connected modems in the topology overview.

devolo G3-PLC Modem 500k

[Main menu](#) > [Device status](#) >

Topology

Sort the table by clicking on the header column. You can select and update single devices.
Own Node ID: 0

	Node ID	MAC address	State	Time stamp	Join count	LQI/Cost	Path
<input type="checkbox"/>	1	30:D3:2D:0A:99:F3	Online	1970-01-01 23:18:53	0	6	0,1
<input type="checkbox"/>	2	30:D3:2D:0A:9A:4D	Online	1970-01-01 23:20:54	0		no topology data
<input type="checkbox"/>	3	30:D3:2D:0A:99:73	Online	1970-01-01 23:24:08	0		no topology data
<input type="checkbox"/>	4	30:D3:2D:0A:99:55	Added	1970-01-01 07:59:32	0		no topology data
<input type="checkbox"/>	5	??:??:??:??:??:??	Added	1970-01-01 07:59:30	0		no topology data

Each device is assigned an individual **node ID** of up to 4 digits when it pairs with the PAN coordinator. The node ID of the PAN coordinator itself is always 0. The node ID is specified so that devices can be identified.

The current status of the device is displayed in the **State** column. The **Online** status means that the device is ready for communication.

The **Timestamp** specifies the time of the most recent PLC network activity for the removed device.

The number of connections to this G3-PLC network is displayed in the **Join count** column.

A measure of the connection quality is specified under **LQI/Costs**. Here there is a distinction between the device hardware used:

Modems with a type number of "MT 2638" specify the connection quality as LQI (line quality indicator). The higher this value is, the better the connection. For example:

LQI	SNR/dB	Modulation
0xff/255	53,75	D8PSK
0x80/128	22	D8PSK
0x50/80	10	D8PSK
0x41/65	6,35	DQPSK
0x33/51	2,75	DBPSK
0x23/35	-1,25	ROBO mode
0x00/0	-10	ROBO mode

Modems with a type number of "MT 2746" or higher specify the connection quality in terms of costs. The lower this value is, the better the connection. Here the costs are also displayed between the repeater stages, just like with the path information.

! You can find the algorithm for calculating the LQI in ITU-T G.9903, Annex B 'Routing cost'.

Example: The logical topology is specified in the **Path** column. In the depicted topology overview, devices with a node ID of 1 through 5 are connected directly to the PAN coordinator (= node ID 0). The modem with a node ID of 6 uses the modem with a node ID of 5 as a repeater.

Node ID	MAC address	State	Time stamp	Join count	LQI/Cost	Path
<input type="checkbox"/> 1	30:D3:2D:0A:99:F3	Online	1996-11-22 08:12:11	1	6	0,1
<input type="checkbox"/> 2	30:D3:2D:0A:9A:4D	Online	1996-11-22 06:16:53	1	5	0,2
<input type="checkbox"/> 3	30:D3:2D:0A:99:73	Online	1996-11-22 08:12:47	1	5	0,3
<input type="checkbox"/> 4	30:D3:2D:0A:99:55	Online	1996-11-22 08:12:14	1	5	0,4
<input type="checkbox"/> 5	30:D3:2D:0A:9A:55	Online	1996-11-22 08:11:10	1	5	0,5
<input type="checkbox"/> 6	30:D3:2D:0A:9A:59	Online	1996-11-22 08:12:43	1	5,5	0,5,6

The costs between modems 0 and 1 are 6. Between modems 2 and 3, the costs are 5.

The topology information is not determined until the menu is opened or the **Refresh** button is pressed. You can open specific topology information by selecting individual modems and then confirming the selections by pressing the **Refresh** button.

Press the **Invert selection** button to deselect the selected devices and vice versa. This simplifies operation in many cases.

4.4.3 Licence information

You can display the licence information for the device software under this menu item.

4.5 Update firmware

If necessary, devolo offers new versions on the Internet as a file download, for example to modify existing functions.

devolo G3-PLC Modem 500k

[Main menu](#) >

Update Firmware

Current firmware version: 1.2.11 (2016-09-05)

Please select the firmware file to be loaded onto the device.

File name: Keine ausgewählt

- ❶ To bring the firmware up to the latest version, first go to the devolo website, www.devolo.com/smart, and download the appropriate file for the G3-PLC Modem 500k onto your computer.
- ❷ Then in the configuration dialogue, go to the **Update firmware** area. Click **Select file** and select the downloaded file.
- ❸ Then start the update procedure with the **Update firmware** button. After a successful update, the G3-PLC Modem 500k restarts automatically.

4.6 Security

Here you can configure the access options for the G3-PLC Modem 500k and the entire G3-PLC network.

4.6.1 Key administration

PSK (pre-shared key) is the customised registration key for each individual device.

devolo G3-PLC Modem 500k



[Main menu](#) > [Security](#) >

Key administration

Change PSK

The PSK should be used for login to a G3 PAN. To this it must be registered to the network access whitelist of the PAN-coordinator. Please enter the PSK as a 32-digit hexadecimal number.

Hexadecimal numbers can contain the numbers 0-9 and the letters A-F.

Present PSK:

New PSK:

Repeat PSK:

Generate PSK

You can generate a PSK and encode it by a 32-digit hexadecimal number. This AutoPSK key forms a PAN and must be the same in every device of the PAN. An automatically generated key results in a lower security level as if using the individual PSK stored in the device.

☒ Compute used PSK automatically.

Key:

Changing the PSK

If the **Generate PSK** option is disabled, the PSK configured for the device at the factory is used for encryption.

The PSK of the PAN client has to be entered into the network access whitelist of the PAN coordinator before the PAN client can connect to a G3-PLC network. Otherwise, it is entered automatically upon pairing (see Chapter 4.6.4 **Network access whitelist**)

Generate PSK

The network access whitelist must be open during initial pairing using the automatically generated PSK (**Compute used PSK automatically**) (see Chapter 4.6.4 **Network access whitelist**).

4.6.2 Device security

You can specify a login password for access to the configuration interface.

devolo G3-PLC Modem 500k



[Main menu](#) > [Security](#) >

Device security

Access password

Enter a password to restrict access to your device configuration. The password may not be longer than 24 characters. The password must be longer than 5 characters. The letters A-Z, a-z, the numbers 0-9, the space and the following special characters are allowed:
!"#\$%&'()*+,-./:;<=>?@[\\]^_`{|}~

The username for configuration access is "admin".

Present password:

New password: 0 Characters

Repeat password: 0 Characters



The built-in configuration interface of the G3-PLC Modem 500k is assigned the factory default password admin as a means of providing some security. You should replace the default password by assigning an individual login password after installing the G3-PLC Modem 500k to prevent access by third parties.

- ❶ To do so, first enter (if present) the current password and then enter the desired new password twice. Now the configuration interface is protected against unauthorised access with your individual password!
- ❷ Enter **admin** in the **User name** field and your individual password in the **Password** field when signing in. The **admin** user name remains unchanged.

4.6.3 Device access: Allowed interfaces and protocols

Here you can specify the protocols used on specific ports to access the modem.

devolo G3-PLC Modem 500k



[Main menu](#) > [Security](#) >

Device access: Allowed interfaces and protocols

Define the protocols and interfaces that are to be allowed to access the device.

	HTTP	SSH
ETH	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
G3	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

HTTP

You can use HTTP (**H**yper **t**ext **T**ransfer **P**rotocol) in a web browser to access the modem.

SSH

The SSH protocol enables console-based access to the device.

4.6.4 Network access whitelist

Under the device's factory defaults, all of the PAN clients connected in a G3-PLC network appear in the network access whitelist automatically. The index is generated by the PAN coordinator automatically when pairing a new device. The PLC MAC address is permanently associated with the device.

devolo G3-PLC Modem 500k

[Main menu](#) > [Security](#) >

Network access whitelist

Use the selection box to delete the devices from the network

Node ID	MAC address	PSK
<input type="checkbox"/> 1	30:D3:2D:0A:99:F3	User assigned
<input type="checkbox"/> 2	30:D3:2D:0A:9A:4D	User assigned
<input type="checkbox"/> 3	30:D3:2D:0A:99:73	User assigned
<input type="checkbox"/> 4	30:D3:2D:0A:99:55	User assigned
<input type="checkbox"/> 7	30:D3:2D:0A:99:83	User assigned
<input type="checkbox"/> 8	30:D3:2D:0A:99:67	User assigned
<input type="checkbox"/> 9	30:D3:2D:0A:9A:67	User assigned
<input type="checkbox"/> 10	30:D3:2D:0A:99:69	User assigned

You can **refresh** the list and **remove** PAN clients from the list. Using the **Invert selection** button, you can deselect the selected devices and vice versa. This simplifies operation in many cases.



This function is only available in "PAN coordinator" mode.

4.6.5 Save the network access whitelist

You can save the network access whitelist by clicking **Save file**.

devolo G3-PLC Modem 500k

[Main menu](#) > [Security](#) >

Save network access whitelist

You can store the network access whitelist of the device in a file on your computer to edit it or restore it later when required.



This function is only available in "PAN coordinator" mode.

4.6.6 Restore the network access whitelist

To restore a saved network access whitelist, select the network access whitelist file with **Select file** and then confirm your selection with **Restore file**.

devolo G3-PLC Modem 500k

[Main menu](#) > [Security](#) >

Restore network access whitelist

Select a saved network access whitelist file to restore a configuration on the device.

Network access whitelist file: Keine ausgewählt



This function is only available in "PAN coordinator" mode.

4.7 Serial interface

Here you can configure the serial interface and piping of required data to a remote G3-PLC modem or another TCP communication partner over a TCP connection.

The G3-PLC Modem 500k parameters must match the settings of the connected device. You can only ever establish a point-to-point connection (TCP) between the G3-PLC modem and a TCP communication partner. This may be a G3-PLC modem or another type of remote device.

Serial interface

Here you can configure the serial interface and the pipe through the G3 network.

☐ Enable pipe

Parameters of the serial interface:

Standard: RS-485 ▾
 Speed: 9600 ▾
 Data bits: 8 ▾
 Parity: None ▾
 Stop bits: 1 ▾

IP is used for the serial pipe:

Role: Automatic ▾

IP address of the TCP server:

Port: 9940

☐ Communicate with multiple devices via IP like a serial bus

Port that the devices can connect to: 9941

Processing of in-band configuration parameters: No ▾

☐ Automatic restoring of configured serial parameters

Time without data traffic until restoration in ms: 50

These parameters control the latency:

Maximum buffer size: 100 bytes

Timeout to send partly filled buffer: 50 ms

Activate the **Enable pipe** option to enable piping of the data being transmitted and specify the **parameters of the serial interface**.

IP is used for the serial pipe

If the G3-PLC Modem 500k assumes the "client" role, the IP address of the server modem must be specified. The port number of both devices (server and client) must be identical.

Communicate with multiple devices via IP like a serial bus

Enter the number of the port to which the devices are to connect.

Select whether or not you would like **processing of in-band configuration parameters**.

These parameters control the latency:

The data received via the serial interface are sent using IP packets. The maximum packet size can be configured. As soon as the configured data quantity has been cached in the device, a data packet of that size is sent. If packets of the specified size cannot be filled, the system waits the specified **timeout** and then the data are sent using a smaller IP packet.

4.7.1 Scenarios and configuration

❶ Extending a serial connection

If two devices are connected over RS232 or a master is connected with many slaves over RS485, this connection can be extended by adding two G3-PLC modems connected over PLC:

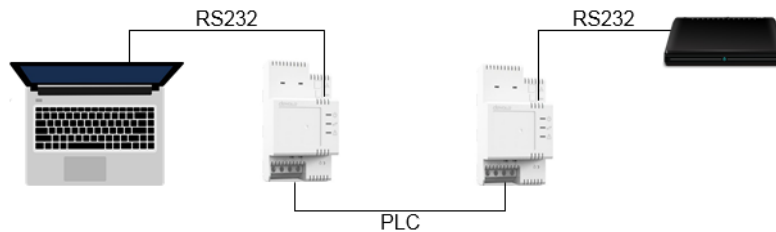


Fig. 6

In the case of an RS485 connection, additional devices may be connected to the master:

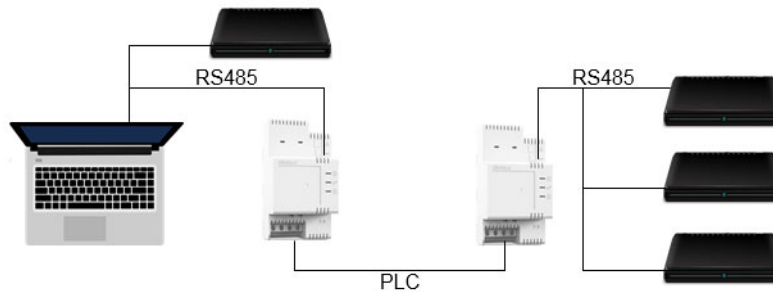


Fig. 7

In such cases, the enquiries from the master and the responses from the local slaves are transmitted to the remote devices over PLC, as they cannot be differentiated from one another. As a result, both the local and the remote slaves always see all the data, as is the case with a purely local connection.

Both G3-PLC modems can be configured with identical parameters. The serial parameters are set to the parameters used previously for the direct connection. If one of the devices is a PAN coordinator, the roles can be selected automatically for piping over IP. Then, this device becomes the IP server and the other becomes the IP client device. The port must be identical. The buffer size and timeout values have to be selected based on the requirements of the protocol.

If there are two PAN clients, one device must assume the role of the server and the other, the role of the client. In this case, the IP address of the server must be configured in the client. This is possible only if a third device is available to operate as a coordinator and the PAN clients are able to communicate with each other directly.

❷ Serial connection over IP

In this scenario, there is a master that must have a LAN connection but does not require a serial interface. Only communication with the slaves is transmitted over the serial interface(s).

The master must also have software that can send the data on a TCP/IP connection or over UDP so that they can be sent to the slaves as needed. This does not require a special protocol. Each byte received by the G3-PLC modem over IP is sent with the configured parameters over the serial interface and each character received by the modem

is sent as a byte inside a packet over IP. These bytes are simply combined into packets using the "Maximum buffer size" and "Timeout" parameters, so no individual bytes are sent in one packet.

Since a G3-PLC modem is required for transmission from Ethernet to PLC, the following set-up is used for two separate, simultaneous serial connections:

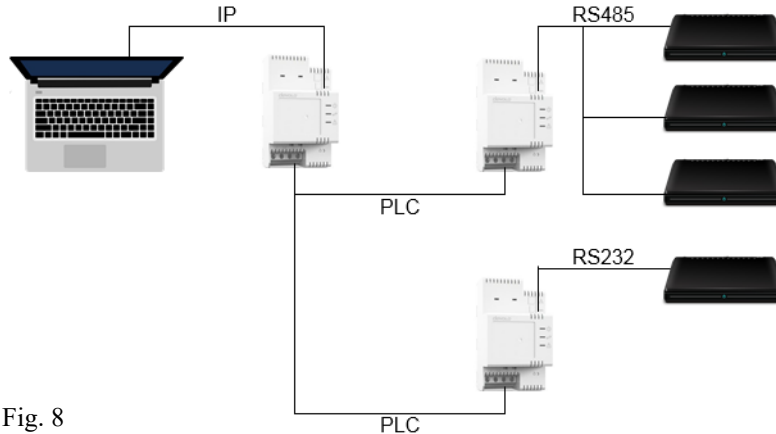


Fig. 8

For logical reasons, the local G3-PLC modem is configured as a PAN coordinator, while the other G3-PLC modems operate as PAN clients in the same PAN. The PAN coordinator operates without piping the serial interface. It is used only as a transition from Ethernet to G3-PLC.

Both remote G3-PLC modems have enabled piping with suitable interface parameters and buffer size as well as timeout settings. The role configured in the IP network is usually "Server", where any (even the same) ports can be selected.

This enables the master to establish TCP connections there or send UDP packets there by knowing the IP addresses of the two remote G3-PLC modems. This allows the master to communicate with all connected serial devices.

The two G3-PLC modems can also be configured as clients, which requires that they have the IP address of the master and two different ports of the master configured. In this case, each of them establishes a TCP connection to the master, which can then differentiate between the devices based on the port in use.

③ Virtual serial bus

In the scenario above, a master connected over a LAN can already communicate with multiple interfaces from multiple G3-PLC modems simultaneously and the master can treat them as a serial bus if programmed accordingly.

If the master has an RS485 port, however, only the connection to a G3-PLC modem and its RS485 port is possible with normal piping. The G3-PLC modem connected to the master and configured as a server can open an additional port where clients can connect if they meet two requirements: they all receive data from the master and their data are sent to all other clients and to the master.

The local G3-PLC modem assumes the role of the server and the option **Communicate with multiple devices via IP like a serial bus** is activated and a port is specified. All

remote G3-PLC modems that are intended to use this bus are configured as clients on the port for the serial bus.

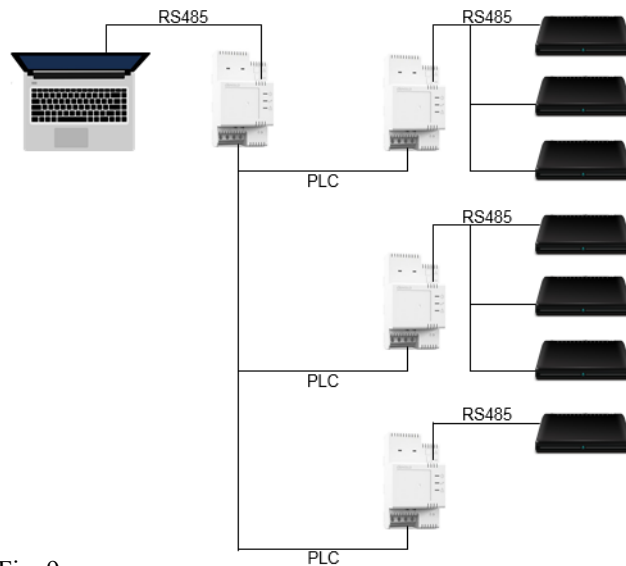


Fig. 9

④ Combination of ② and ③

Scenario ② allows a master to operate independently with multiple, remote serial interfaces. Nevertheless, a special program would have to be developed to combine these remote interfaces to create a virtual serial bus. Scenario ③, in turn, offers a virtual serial bus only if the master also has a serial interface.

It is also possible, however, to activate a virtual serial bus directly over IP. In this case, the G3-PLC modems are configured as described in Chapter ③. There is no master connected to the RS485 port of the local G3-PLC modem. There is either nothing or there are additional slaves of the virtual serial bus. The master connected over a LAN communicates with the local G3-PLC modem (as is the case with the remote G3-PLC modems under ②). This means that it establishes a TCP connection to the server's port or sends UDP packets there. Then the data are sent to the local serial port and to all

clients. Data received by the local serial port or clients are sent to the master but are not distributed to other clients.

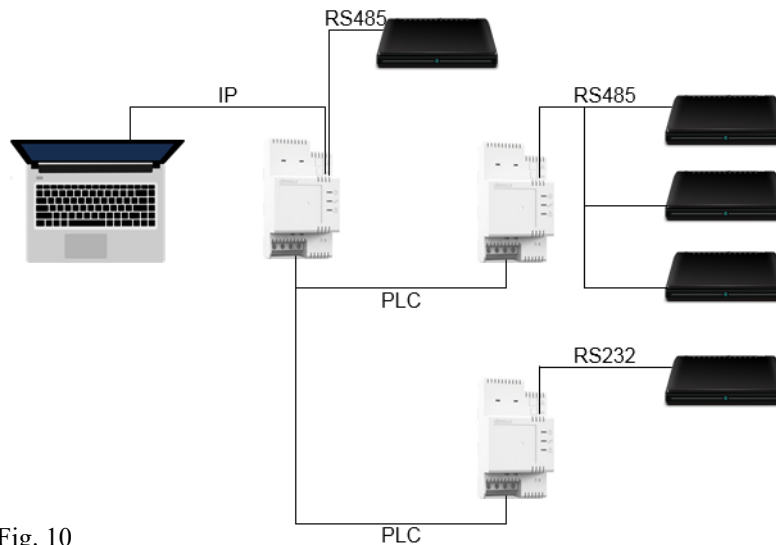


Fig. 10

Dynamic modification of the serial parameters

Optionally, it is possible to use special patterns in the data stream to change the parameters of the serial interface, filtering out the patterns in the process.

Currently, only the following pattern is detected:

#S#<baud rate>@<data bits><parity><stop bits>#E#

Examples:

#S#9600@7E1#E#, #S#19200@8N1#E# etc.

If a suitable pattern is detected in the data stream, it is not output on the serial interface. Instead, the parameters are switched. However, it is always transmitted over IP so that the remote G3-PLC modems are also reconfigured.

When configuring settings, users can either choose to retain a dynamic configuration until a new dynamic configuration is created or indicate that the preset configuration is to be used again automatically after a set period. In this case, you can select a time from 10-10,000 ms. The timer restarts with every character sent over IP or the serial interface. If no data are received during this time, the configuration is reset again.

Changes to the interface parameters are not persistent. This means that the configuration displayed in the interface does not change. The parameters configured in the interface are used again after a restart. Each change to the parameters during configuration requires restarting serial communication and, in turn, resetting the serial interface.

Using TCP or UDP

If two G3-PLC modems connect their serial interfaces virtually over PLC (one device configured as the server, the other as the client), TCP is always used. UDP can be used only with a device that is directly connected to a G3-PLC modem over a LAN or PLC. Then the G3-PLC modem has to be configured as a server and waits for both UDP packets and incoming TCP connections on the configured port. If UDP packets are re-

ceived, the data are sent on the serial interface and received responses are sent back as UDP packets to the device that provided the most recently received UDP packet.



If data are received on the serial interface before a TCP connection has been established or a UDP packet received, the data are discarded.

Prerequisites

Serial over IP can be used if the transfer protocol places minimal requirements on the latency (perhaps several seconds) and the average data rate is less than the data rate of approximately 50 kbps that can be achieved over G3-PLC. The feasible data rate drops when transmitting many small packets.

If only cables are used, a continuous bidirectional transmission with a maximum 19,200 bps or a unidirectional transmission with a maximum 38,400 bps and a latency of less than 1 second are possible. Higher data rates require corresponding breaks in the data stream. For a "request/response" protocol, breaks are created solely by the latency added through G3-PLC.

Example: Packets of 100 bytes are sent at 115,200 bps and the device waits for a response of similar size. Taking various delays into account, a response would be received after approximately 150-200 ms. The delay may be even longer for the first packet.

Using cables connected through multiple devices increase the latency and decreases the data rate. Considering three serial connections over PLC with six devices compared to exclusive use, less than one third of the effective data rate would be available per connection and the latency would be more than three times higher. This is due to potential retransmission caused by data collisions.

Index

Symbols

"Keepalive" function 15

A

Access PLC 7

Access Powerline 7

Application notes 9

B

Broadcast 15, 21

C

CE conformity 6

Conductor cross-section 10

Configuration interface 17

Costs 31

D

Default password 17, 33

DHCP server 18

E

Ethernet connection 9

Ethernet over UDP 21, 23

F

Filter Ethernet broadcasts 21, 24

Firmware update 32

G

G3-PLC network (PAN network, Powerline Area Network) 7

I

Indicator lights (LEDs) 10

Installation alignment 13

IP address 17, 18

IPv4 17

IPv6 17

L

License information 32

Line connections 10

LQI 31

M

MAC address 14, 17

N

Network access whitelist 34

Network plan 15

Neutral conductor 10, 13

Node ID 15, 30

O

OnlineStatus 15

P

PAN = Powerline Area Network 7

PAN client 7, 13, 22

PAN coordinator 7, 13, 20

PAN ID 7, 20

PSK (pre-shared key) 32

Q

Qualified electrician 12

R

Repeater 28

Repeating 13, 15

Reset button 10

RS232/RS485 port 9

S

Safety instructions 12

Serial interface 36

Single-phase connection 10, 13

Smart Grid 7

T

TCP connection 36

Terminals 10, 13

Three-phase connection 10, 13

Time server 19