

USER GUIDE

CANopen Tunnel

ID PRG.1318
Revision 1.7
Date 30.06.2022

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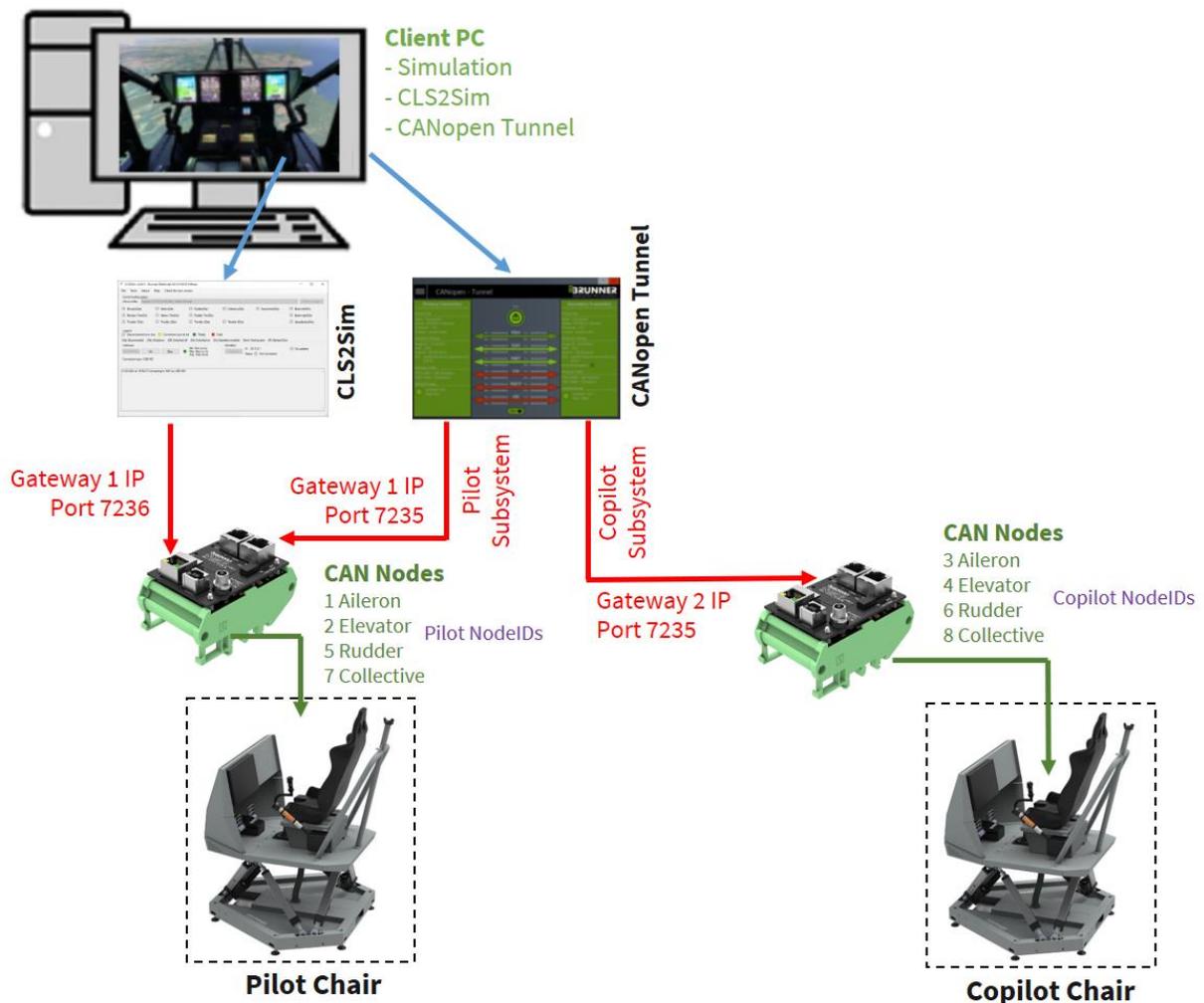
1. Overview

The *CANopen Tunnel* allows to connect two separate CAN buses over Ethernet. For that purpose, it has to interface to an Ethernet-to-CAN gateway on either side of the system.

1.1 CLS2Sim Pilot/Copilot Setup

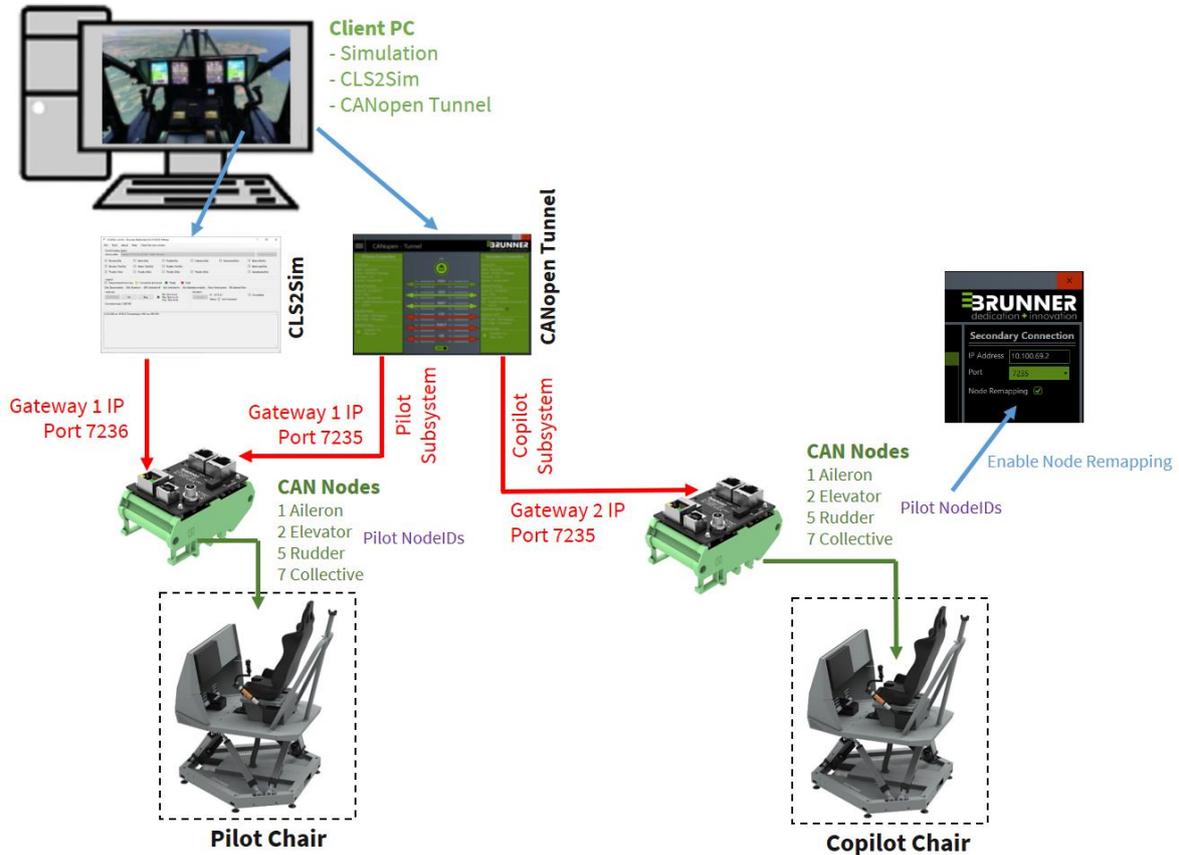
A major use case is to connect *CLS2Sim* to *Brunner CLS* devices in a Pilot/Copilot setup:

- CAN bus 1 connects the Pilot subsystem and can be accessed over Gateway 1
- CAN bus 2 connects the Copilot subsystem and can be accessed over Gateway 2
- *CANopen Tunnel* connects to Gateway 1 over the primary connection, and to Gateway 2 over the secondary connection
- *CLS2Sim* (CAN master) connects to Gateway 1 and allows to interface all CAN devices to the Simulation
- In the default configuration *CANopen Tunnel* uses TCP port 7235, while *CLS2Sim* uses port 7236

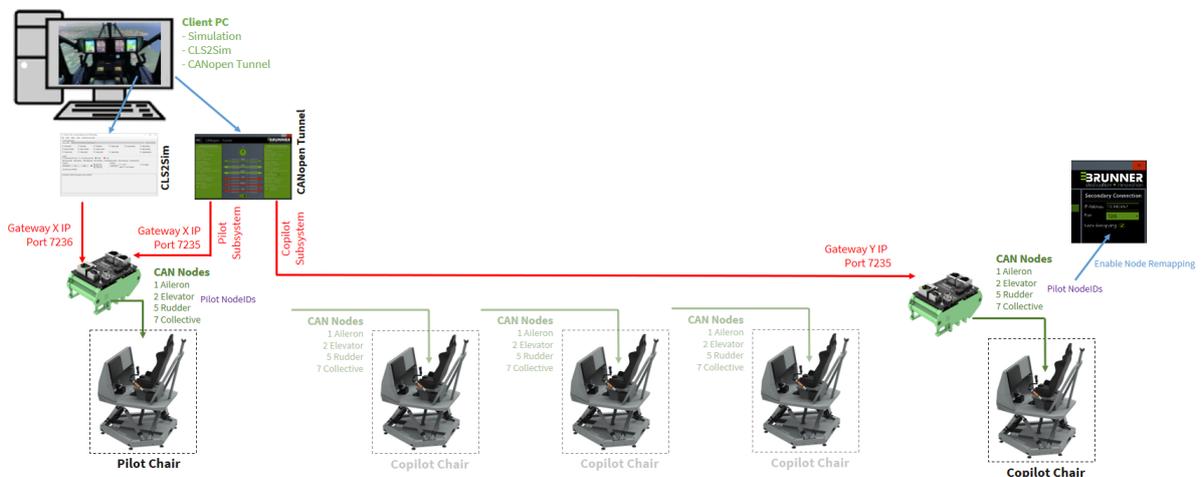


1.2 CLS2Sim Pilot/Copilot Setup with Node Remapping

This setup is very similar to the previous one, except that the Copilot subsystem contains CANopen devices with Pilot NodeIDs. In this configuration the “Node Remapping” feature has to be enabled on the secondary connection, which allows Pilot NodeIDs to be remapped as Copilot NodeIDs.



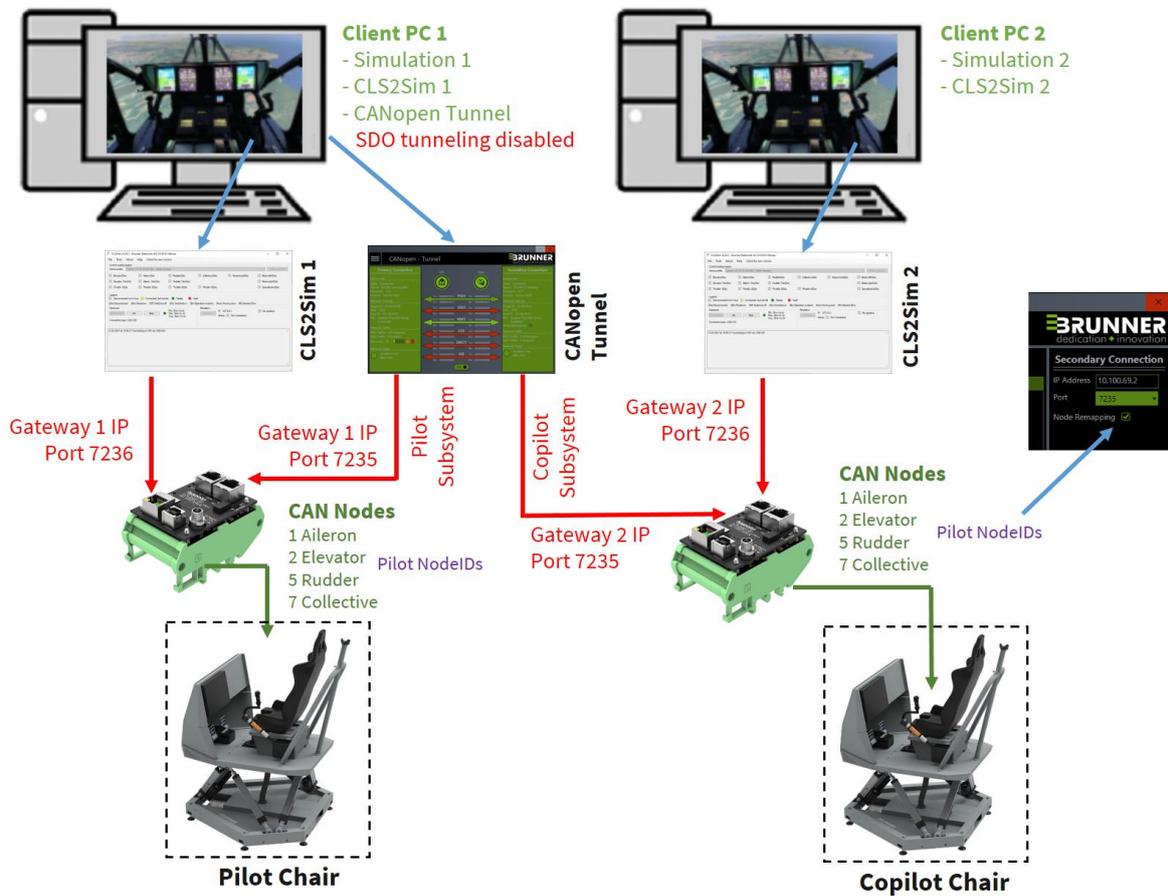
The main advantage of this setup is that each CAN subsystem can be selected as Pilot or Copilot, with minimal configuration effort, making it very flexible. A subsystem can be exchanged for another at any time.



1.3 Dual CLS2Sim Setup

The dual *CLS2Sim* setup features two separate client PCs, each running a simulation software:

- CAN bus 1 connects the Pilot subsystem and can be accessed over Gateway 1
- CAN bus 2 connects the Copilot subsystem and can be accessed over Gateway 2
- *CANopen Tunnel* connects to Gateway 1 over the primary connection, and to Gateway 2 over the secondary connection
- The *CANopen Tunnel* must disable SDO message tunneling, so that the two CAN masters cannot interfere with each other (see chapter 2.2)
- *CLS2Sim 1* (CAN master 1) connects to Gateway 1 and allows to interface the Pilot CAN devices to the Simulation 1
- *CLS2Sim 2* (CAN master 2) connects to Gateway 2 and allows to interface the Copilot CAN devices to the Simulation 2
- In the default configuration *CANopen Tunnel* uses TCP port 7235, while *CLS2Sim* uses port 7236



This setup works with and without “Node Remapping”. The same rules apply regarding CANopen NodeIDs.

2. Configuration

2.1 Connection Settings

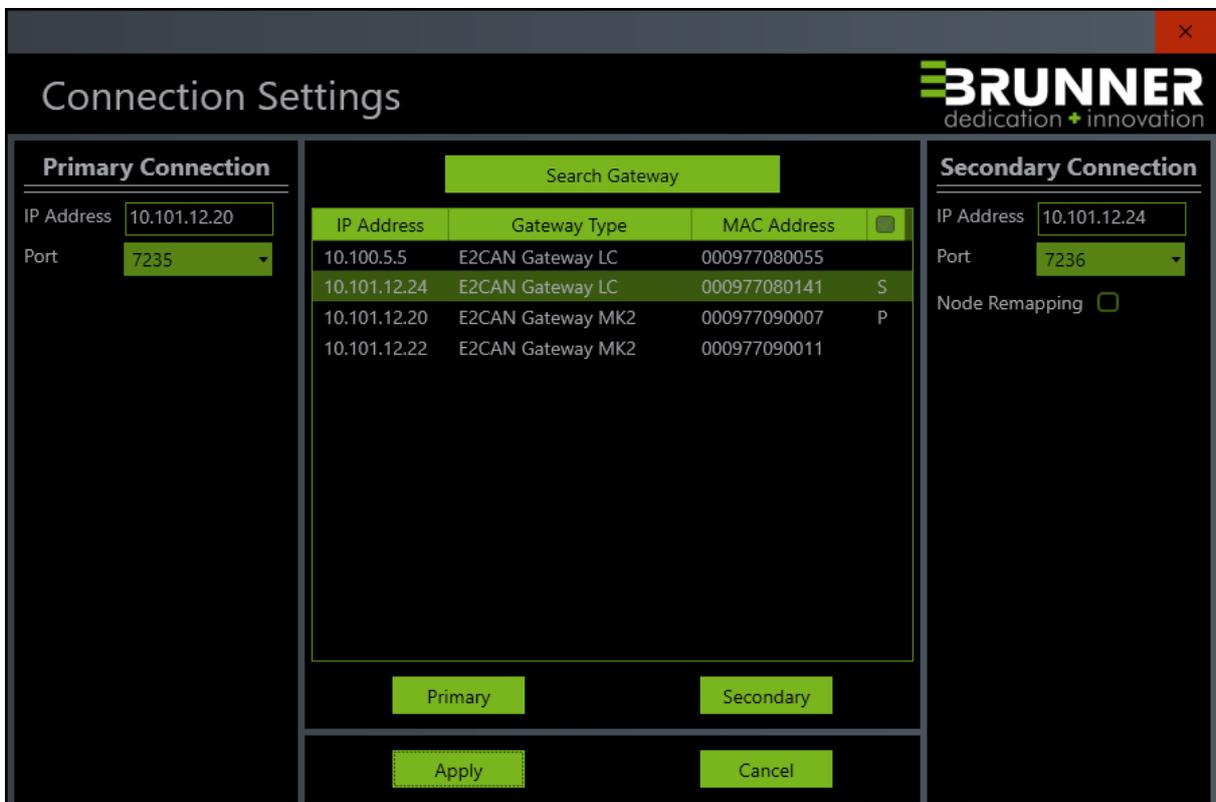
The Connection Settings can be accessed from the navigation bar in the upper left corner, or by pressing the ALT+S hotkey.



2.1.1 IP Address

Press “Search Gateway” to scan for all available *Brunner Elektronik* gateway devices. The results will be listed below.

Select a gateway from the list and press “Primary” to assign the selected gateway as primary connection. Similarly, after selecting another gateway, press the “Secondary” button to configure the secondary connection.



2.1.2 Port

The available ports are 7235 and 7236. Unless otherwise specified, the port should be left at the default value “7235”.

2.1.3 Node Remapping

The “Node Remapping” feature is available for the secondary connection. This helps to simplify the hardware setup of the Copilot subsystem. The CANopen NodeIDs are kept the same as for the Pilot subsystem, and *CANopen Tunnel* remaps the NodeIDs accordingly.

The *CANopen Tunnel* will remap secondary connection Pilot NodeIDs to Copilot NodeIDs as follows:

CLS Device	Pilot NodeID	Copilot NodeID
Aileron	1	3
Elevator	2	4
Rudder	5	6
Collective	7	8
DMS	20	21
DMS	30	31
DMS	40	41
DMS	60	61
I/O	25	35
I/O	26	36
I/O	27	37
I/O	28	38
I/O	29	39

Important: While “Node Remapping” is enabled, Pilot NodeIDs won’t be tunneled from the primary to the secondary connection, and Copilot NodeIDs won’t be tunneled from the secondary to the primary connection.

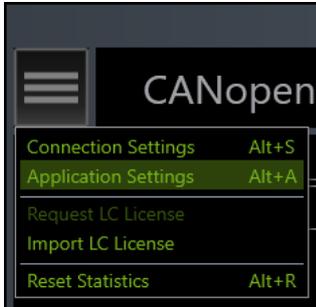
When “Node Remapping” is activated, the Master (e.g. *CLS2Sim*) should only be connected to the primary connection. Unless the system has a dual Master setup.

2.1.4 Apply Settings

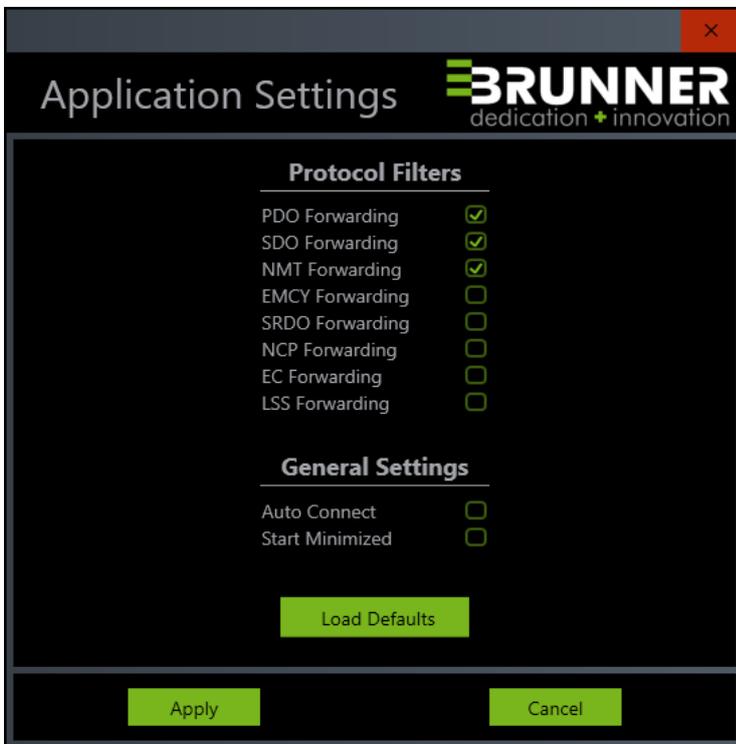
Hit “Apply” to accept the selected settings, and “Cancel” to discard the settings.

2.2 Application Settings

The Application Settings can be accessed from the navigation bar in the upper left corner, or by pressing the ALT+A hotkey.



The application settings can only be changed when the application isn't connected to the gateways.



Press “Load Defaults” to set the default application settings.

Hit “Apply” to accept the selected settings, and “Cancel” to discard the settings.

2.2.1 CANopen Protocol Filters

The CANopen protocol filters can be configured using the appropriate checkboxes. If enabled the corresponding CAN-ID ranges will be tunneled.



Protocol Filters:

Protocol Filter	CAN-ID Range
PDO Forwarding	0x180 ... 0x57F
SDO Forwarding	0x580 ... 0x67F
NMT Forwarding	0x000 ... 0x07F
EMCY Forwarding	0x080 ... 0x0FF
SRDO Forwarding	0x100 ... 0x17F
NCP Forwarding	0x680 ... 0x6FF
EC Forwarding	0x700 ... 0x77F
LSS Forwarding	0x780 ... 0x7FF

2.2.2 Auto Connect

When the “Auto Connect” option is enabled, the application will automatically attempt to connect during startup.



2.2.3 Start Minimized

With the “Start Minimized” feature enabled, the application will start minimized to the system tray. This is usually used in conjunction with the “Auto Connect” option.



To open up the application, right click on the system tray icon and select “Show”, or double click the system tray icon.



3. CANopen Tunneling

Press the “ON/OFF” toggle button on the bottom center (or ALT+C) to attempt to connect to the two gateways. If successful, the background will turn green and the connection state will show “Connected”.



3.1 Connection Info

Device Info

- State: connection state
 - o Disconnected: no active connection
 - o Connecting: attempting to connect to the gateway
 - o Connected: connection successfully established
 - o Error: an error occurred; see below for more details
- Name: name of the gateway device
- Firmware: gateway firmware version
- License: license state
 - o License Valid: gateway has a valid *CANopen Tunnel* license
 - o License Invalid: gateway isn't licensed

Network Settings

- Target IP: IP of the gateway
 - o The IP is a clickable link to the web interface of the gateway
- Port: Gateway port
- Host IP: IP of the host computer
- NIC: name of the host network interface controller

CAN:

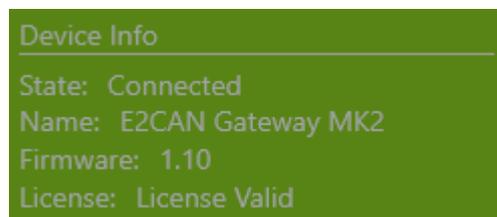
- Status: CAN Status Register
 - o The CAN Status Register is described in detail further below
- PDO Traffic: number of PDO messages per second
- SDO Traffic: number of SDO messages per second
- Bus Load: the CAN bus load
 - o This information isn't available for the "E2CAN LC Gateway" device

Network Delay:

- Connection delay between *CANopen Tunnel* and gateway
- Max: maximum connection delay

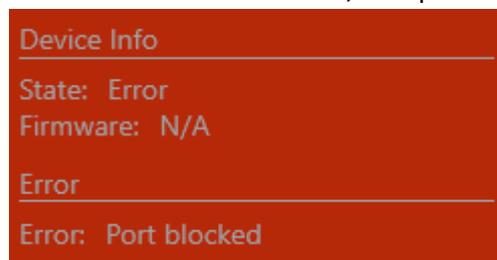
3.1.1 Connection State: Connected

Both gateways need to be successfully connected in order for the *CANopen Tunnel* to operate. If one connection is faulty, the other gateway will automatically be disconnected.



3.1.2 Connection State: Error

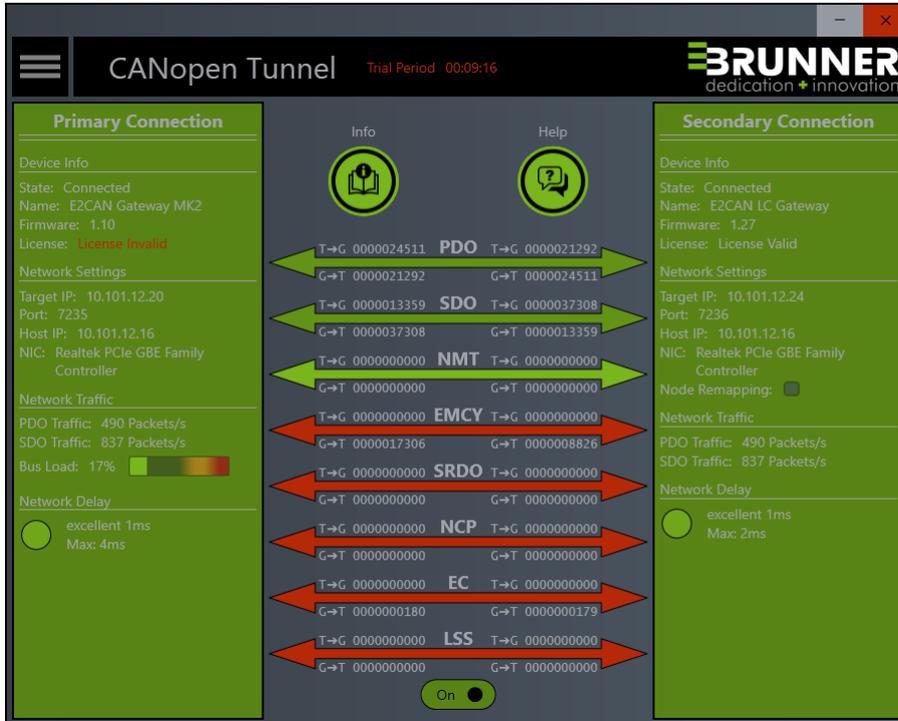
If a connection error occurs, the specific error will be displayed below.



See the *Troubleshooting* section for further details.

3.1.3 CANopen Tunnel License

In order to use the *CANopen Tunnel* without restrictions, both gateways need to have a valid *Tunnel* license. If the license is missing on either or both gateways, the *CANopen Tunnel* will run in trial mode. The trial mode allows full operation for 10 minutes, after which the gateways will automatically disconnect.

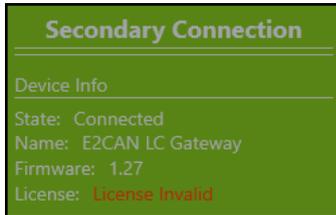


Trial period expired:

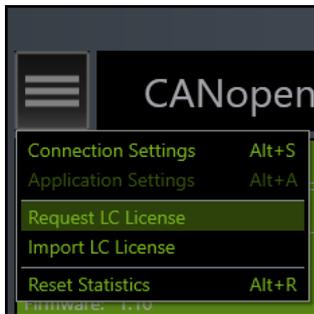


3.1.4 E2CAN LC Gateway – CANopen Tunnel License

The *Tunnel* licenses of *E2CAN LC Gateways* are managed using license files.

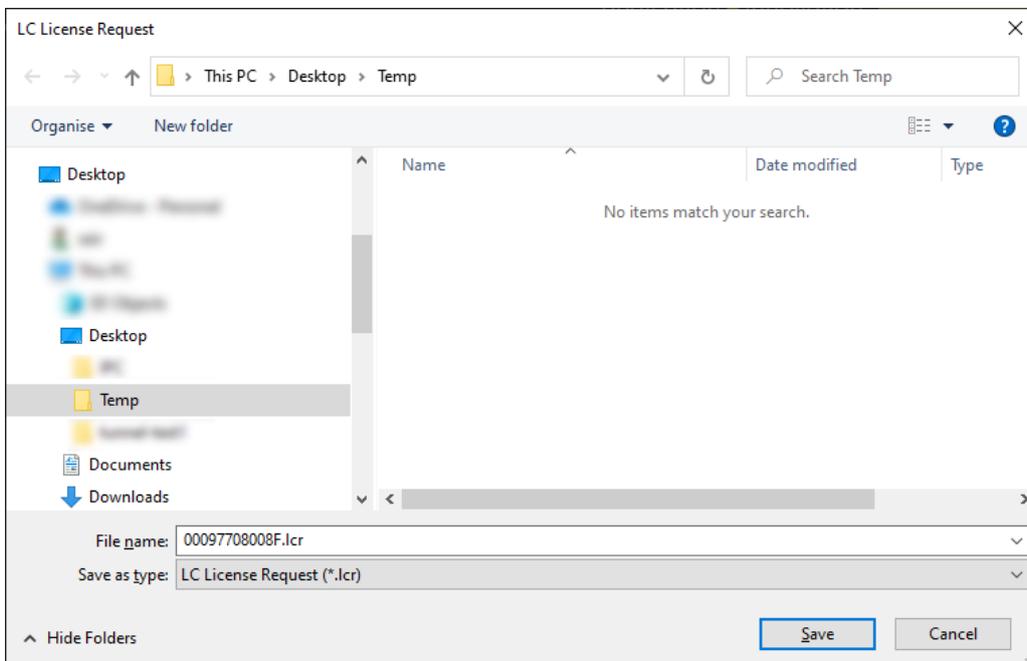


If the *E2CAN LC Gateway* doesn't have a valid *Tunnel* license, it can be requested from the navigation bar in the upper left corner. Select "Request LC License".



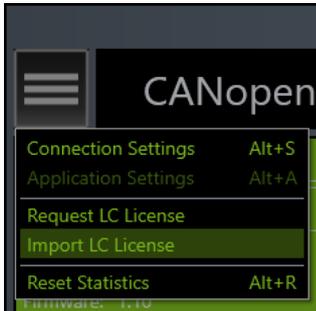
This option is only available if a connected *E2CAN LC Gateway* has an invalid *Tunnel* license.

After selecting this option, you need to specify where the license request will be stored.

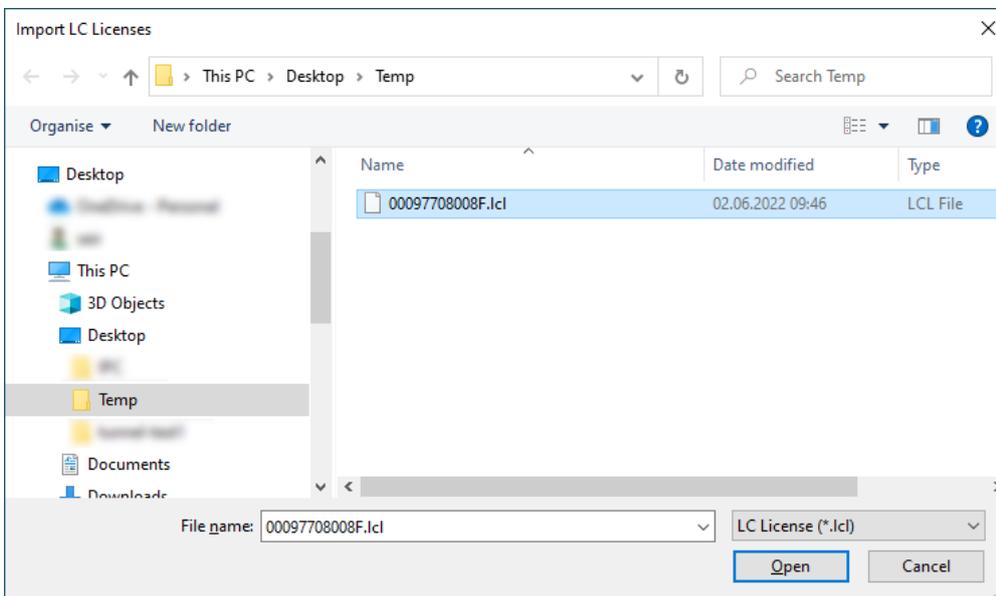


Please send this file *Brunner Elektronik* at support@brunner-innovation.swiss to request an *LC License* file.

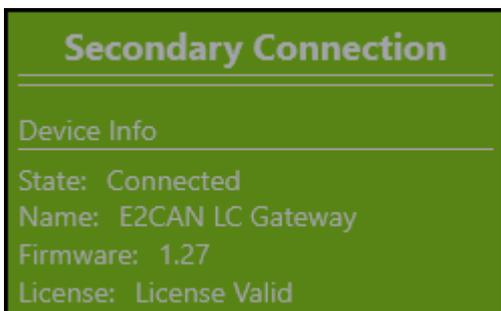
In response, *Brunner Elektronik* will send you a license file. To install this license, you need to head to the navigation bar and select “Import LC License”.



Navigate to the file’s location and press “Open”.

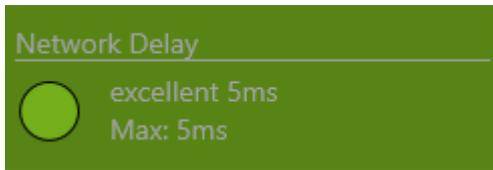


In order to activate this license, you only need to restart the connection.

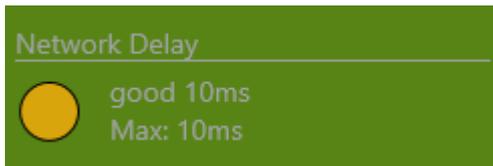


3.1.5 Network Delay

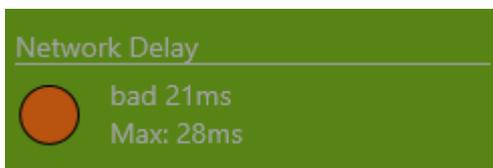
A network delay up to 5ms is considered excellent.



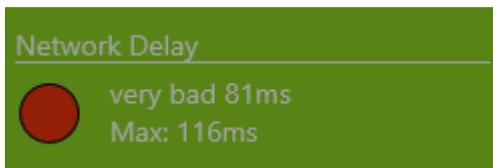
A network delay from 6ms up to 15ms is considered good.



A network delay from 16ms up to 30ms is considered bad.



A network delay from 31ms up to 100ms is considered very bad.



A network delay above 100ms is critical. The connection will be dropped if it stays in this critical range. However, if the network recovers from this state, the *CANopen Tunnel* will continue to operate normally.

3.1.6 CAN Status Register

This indicates the overall status of the CAN controller. The CAN status is derived from the CAN receive error counter (REC) and CAN transmit error counter (TEC).

CAN Status: Bus OFF



TEC exceeded 255. The CAN controller disconnects itself from the CAN bus, resulting in no CAN communication at all.

CAN Status: Error Passive



Any one of the error counters (REC, TEC) exceeded 127. The CAN transmitter is disabled.

CAN Status: Warning

CAN
Status: Warning

Any one of the error counters has reached or exceeded 96. The CAN controller is still in active state.

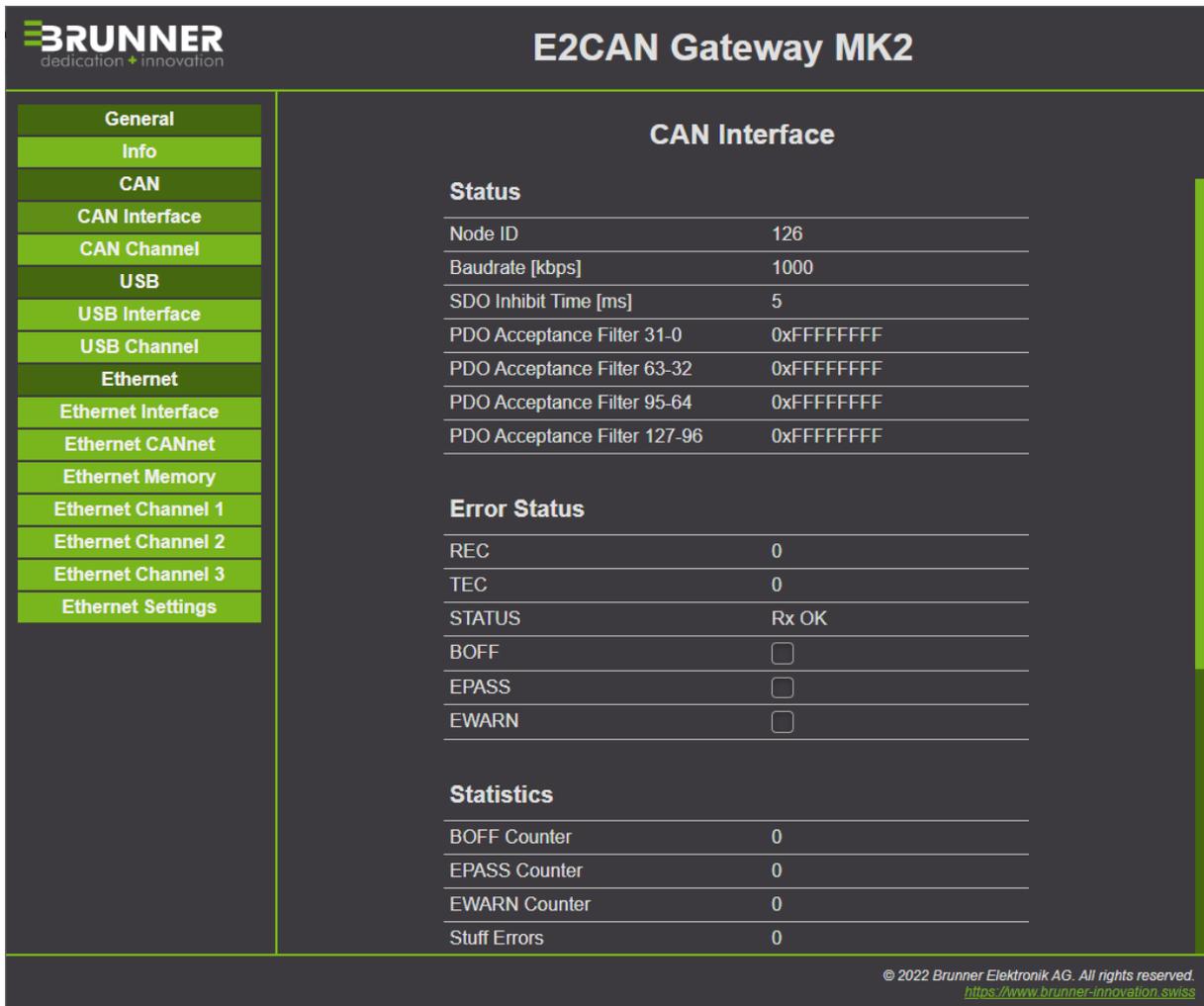
CAN Status: OK

CAN
Status: OK

Both error counters are below 96. The CAN controller is in active state.

CAN Status Troubleshooting: Web Interface

For further details, click on the IP link to open up the web interface and select the “CAN Interface” page.



The screenshot shows the web interface for the E2CAN Gateway MK2. The left sidebar contains a navigation menu with the following items: General, Info, CAN, CAN Interface, CAN Channel, USB, USB Interface, USB Channel, Ethernet, Ethernet Interface, Ethernet CANnet, Ethernet Memory, Ethernet Channel 1, Ethernet Channel 2, Ethernet Channel 3, and Ethernet Settings. The main content area is titled "CAN Interface" and is divided into three sections: Status, Error Status, and Statistics.

Status	
Node ID	126
Baudrate [kbps]	1000
SDO Inhibit Time [ms]	5
PDO Acceptance Filter 31-0	0xFFFFFFFF
PDO Acceptance Filter 63-32	0xFFFFFFFF
PDO Acceptance Filter 95-64	0xFFFFFFFF
PDO Acceptance Filter 127-96	0xFFFFFFFF

Error Status	
REC	0
TEC	0
STATUS	Rx OK
BOFF	<input type="checkbox"/>
EPASS	<input type="checkbox"/>
EWARN	<input type="checkbox"/>

Statistics	
BOFF Counter	0
EPASS Counter	0
EWARN Counter	0
Stuff Errors	0

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E2CAN LC Gateway has a different web interface.

E2CAN Gateway

Product Info

Device Type	GER1088
Firmware Type	PRG1074
Firmware Version	1.27
USB VID/PID	0x255bb/0x0069
MAC Address	00:09:77:08:00:8f
S/N	1518919
License State	licensed

Device Status

Ethernet Service Port 7235	connected
Ethernet Sniffer Port 7236	connected
Ethernet: Tx, Rx	15114568, 12524050
ARP: Tx, Rx, Ign	1, 1, 170
ICMP: Tx, Rx	0, 0
UDP unicast: Tx, Rx	0, 0
UDP broadcast: Tx, Rx, Ign	3, 4, 1254
TCP: Tx, Rx	15114564, 12514774
IP Drop: Vers, Proto, Foreign, Malf, Fragn, Crc	0, 0, 3587, 0, 0, 0
TCP Tx: Dat, Ack, Rst, ReTx, ReTxAck	13630651, 1483905, 0, 0, 0
TCP Rx: Dat, Ack, Rst, BsySyn, Malf, FReTxRq, SqEr	9332011, 3182746, 1, 0, 0, 0, 0
TCP Drop: Port, Busy, Crc	0, 0, 0
TCP: Fin, Rst, TxWin	0x0000, 0x0000, 0, 0
USB Connection	connected
USB: Tx, Rx	1, 0
USB Events: Con, Dis, Rsm, Susp, Ign, Err	1, 0, 0, 2, 0, 0
CAN State: TEC, REC, STS	0, 0, 0x18 (RXOK TXOK)
CAN Baudrate [kBit/s]	1000
CAN: Tx, Rx, Ign, Kick, BOFF	9445790, 7776899, 0, 2782, 0
CAN Pkg/s: Tx, Rx, Ign	1238, 1038, 0
CAN Buf Ovf: Tx, Rx0, Rx1, RxUsb	3056, 0, 0, 17222177
CAN Buf Usage: Tx, Rx0, Rx1, RxUsb, FifoLvl	512/512, 8/512, 10/512, 512/512, 3
CAN IRQ: None, Tx, Rx, Sts, Unsup	8335148, 9411378, 7776802, 11894, 0
Uptime [s]	21302.340
Visible Nodes	1 2 3 4
SDOs/Node: Tx, Tx-Rx	2047410, +3 4125221, +28360 26, +1 26, +1
PDO Allow Filter: Node 127..0	ffffff ffffffff ffffffff ffffffff

Read
Clear Statistics
Bus Scan

Active Ethernet Settings

State	IP Address assigned by DHCP
IP Address	10.101.12.14
Subnet Mask	255.255.252.0
Default Gateway	10.101.12.1

Ethernet Configuration

Static IP Address	<input style="width: 90%;" type="text" value="10.100.69.11"/>
Subnet Mask	<input style="width: 90%;" type="text" value="255.255.0.0"/>
Default Gateway	<input style="width: 90%;" type="text" value="10.100.0.1"/>
DHCP Enable	<input checked="" type="checkbox"/>

Apply Settings

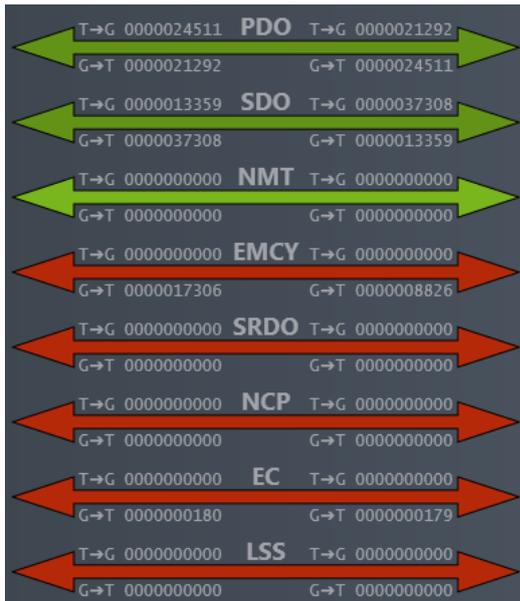
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3.2 Tunnel Info

The center of the screen displays tunneling status info.

A green arrow indicates that the corresponding CANopen protocol will be tunneled from the primary to the secondary connection, and vice versa. A red arrow means that the CANopen protocol won't be tunneled.

In the example below PDO, SDO and NMT messages will be tunneled, while EMCY, SRDO, NCP, EC and LSS messages will be dropped.



Protocol Specifier:

Specifier	Protocol	Function Code	CAN-ID Range
PDO	Process Data Object Protocol	3 ... 10	0x180 ... 0x57F
SDO	Service Data Object Protocol	11 ... 12	0x580 ... 0x67F
NMT	Network Management Protocol Global Failsafe Command Flying Master Indicate Active Interface	0	0x000 ... 0x07F
EMCY	Synchronization Object Protocol Emergency Object Protocol	1	0x080 ... 0x0FF
SRDO	Time Stamp Safety-Relevant Data Object Protocol	2	0x100 ... 0x17F
NCP	Dynamic SDO Request Node Claiming Procedure	13	0x680 ... 0x6FF
EC	NMT Error Control Protocols: Heartbeat, Node Guarding	14	0x700 ... 0x77F
LSS	Layer Service Settings	15	0x780 ... 0x7FF

Protocol statistics are displayed for each CANopen protocol individually:

- Left T→G: messages transmitted from the *CANopen Tunnel* (T) to the primary connection gateway (G)
- Left G→T: messages transmitted from the primary connection gateway (G) to the *CANopen Tunnel* (T)
- Right T→G: messages transmitted from the *CANopen Tunnel* (T) to the secondary connection gateway (G)
- Right G→T: messages transmitted from the secondary connection gateway to the *CANopen Tunnel* (T)



Important: If the 'Node Remapping' feature is enabled, Pilot PDOs and SDOs won't be tunneled from the primary connection to the secondary connection. Simultaneously, Copilot PDOs and SDOs won't be tunneled from the secondary connection to the primary connection.

4. Troubleshooting

4.1 Invalid License

When either or both gateways are unlicensed, the *CANopen Tunnel* will run in trial mode.

```
Device Info
-----
State: Connected
Name: E2CAN Gateway MK2
Firmware: 1.6
License: License Invalid
```

Please contact *Brunner Elektronik* at support@brunner-innovation.swiss for a *CANopen Tunnel* license.

4.2 Bad Ping

If the network delay is very bad over a certain period of time, the connection will be dropped.

```
Network Delay
-----
very bad 113ms
Max: 128ms

Error
-----
Error: Bad Ping
```

Please check your network connection.

4.3 Connection Lost

The 'Connection Lost' error message is shown when the TCP connection experiences a timeout.

```
Device Info
-----
State: Error
Firmware: 1.10

Error
-----
Error: Connection Lost
```

Possible causes:

- Ethernet cable was unplugged (even for a short duration)
- Network problems
- The gateway has been power cycled
- Gateway software reset

4.4 Port blocked

If the TCP port is already in use, following error message will be shown.

```
Device Info
-----
State: Error
Firmware: N/A

Error
-----
Error: Port blocked
```

Possible causes:

- Wrong port configuration
- Another application is already connected to the TCP port

4.5 Socket timed out

TCP connection could not be established.

```
Device Info
-----
State: Error
Firmware: N/A

Error
-----
Error: Socket timed out
```

Possible causes:

- Configured IP is incorrect
- Gateway not connected to the network
- Wrong gateway IP settings

4.6 Generic Socket Error

An unspecified socket error occurred.

```
Device Info
-----
State: Error
Firmware: N/A

Error
-----
Error: Generic Socket Error
```

Please check the log file within the *Log* directory for further info.

4.7 Connection failed

An unspecified connection error occurred.

```
Device Info
-----
State: Error
Firmware: N/A

Error
-----
Error: Connection failed
```

Please check the log file within the *Log* directory for further info.

4.8 Rx Error

A receive error occurred.

```
Device Info
-----
State: Error
Firmware: N/A

Error
-----
Error: Rx Error
```

This error could be an indication of a faulty gateway.

4.9 Old Firmware

The firmware of the gateway is too old and not compatible with the *CANopen Tunnel*.

```
Device Info
-----
State: Error
Firmware: N/A

Error
-----
Error: Old Firmware
```

Please contact *Brunner Elektronik* at support@brunner-innovation.swiss to request the newest gateway firmware.

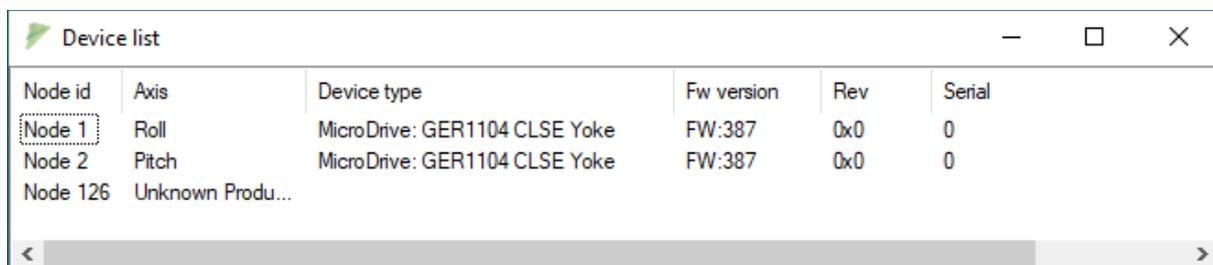
4.10 Wrong “Node Remapping” setting

A symptom of a bad “Node Remapping” setting can be observed when the master does not see the correct number of slave nodes.

4.10.1 Example: “Node Remapping” disabled, when it should be enabled



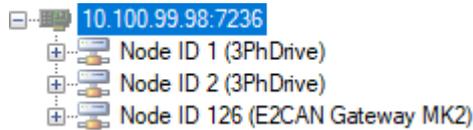
CLS2Sim → Tools → Show device list



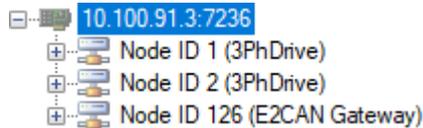
In this example we expect to see Nodes 1, 2, 3 and 4.

Deactivate *CANopen Tunnel* and connect to each gateway individually using *CANopen Commander*. You might need to power cycle the CANopen nodes, because they’re possibly in a bus-off state.

Primary connection:



Secondary connection:



In this case both gateways are connected to Pilot nodes, so “Node Remapping” should be enabled.

4.10.2 Example: “Node Remapping” enabled, when it should be disabled

When the primary connection gateway doesn't receive SDO messages from the *CANopen Tunnel*, and the secondary connection gateway doesn't transmit SDO messages to the *CANopen Tunnel*, it could be an indication that the “Node Remapping” feature is activated when it shouldn't be.

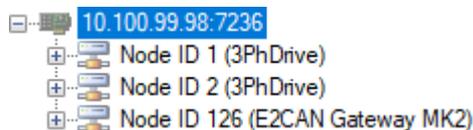
CLS2Sim → Tools → Show device list

Node id	Axis	Device type	Fw version	Rev	Serial
Node 1	Roll	MicroDrive: GER1104 CLSE Yoke	FW:387	0x0	0
Node 2	Pitch	MicroDrive: GER1104 CLSE Yoke	FW:387	0x0	0
Node 126	Unknown Produ...				

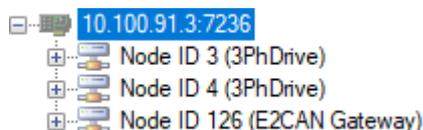
In this example we expect to see Nodes 1, 2, 3 and 4.

Deactivate *CANopen Tunnel* and connect to each gateway individually using *CANopen Commander*. You might need to power cycle the CANopen nodes, because they're possibly in a bus-off state.

Primary connection:



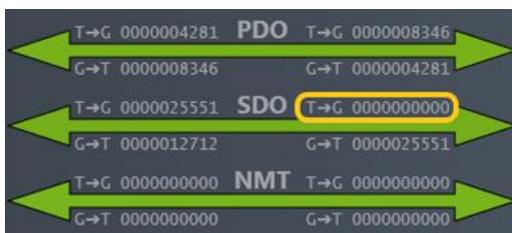
Secondary connection:



In this case the primary gateway sees Pilot nodes, and the secondary gateway sees Copilot nodes. "Node Remapping" should be disabled.

4.11 Master connected to the secondary connection while "Node Remapping" is enabled

When the master is connected to the secondary connection while "Node Remapping" is activated, it can only see the nodes connected to the secondary gateway.



When the secondary connection gateway doesn't receive SDO messages from the *CANopen Tunnel*, it could be an indication that the master is connected to the wrong gateway.

4.12 No CAN node connected to the gateway

When no CAN node is connected to the gateway, the transmitted CAN message won't be acknowledged. This results in an ACK error, which will eventually put the gateway in Error Passive state.

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dedication + innovation

E2CAN Gateway MK2

CAN Interface	
Error Status	
REC	0
TEC	128
STATUS	EPASS
BOFF	<input type="checkbox"/>
EPASS	<input checked="" type="checkbox"/>
EWARN	<input checked="" type="checkbox"/>
Statistics	
BOFF Counter	0
EPASS Counter	380114
EWARN Counter	380114
Stuff Errors	0
Format Errors	0
ACK Errors	380114
Bit 1 Errors	0
Bit 0 Errors	0
CRC Errors	0

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4.13 Library Error

Library Error!

If the application displays “Library Error!” on startup, there is a problem with at least one of the libraries.

Please check the log file for the specific reason.

Possible causes:

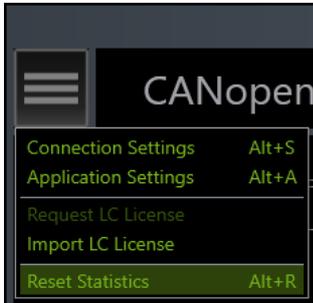
- *ConnectionSettings.dll* isn't available
- *CtLcLicCkLib.dll* isn't available
- The *Microsoft Visual C++ Redistributable package for Visual Studio 2022* isn't installed

The two DLLs and the *Microsoft Visual C++ Redistributable package* should be packaged with this program. If not, please contact *Brunner Elektronik* at support@brunner-innovation.swiss.

5. Misc

5.1 Reset Statistics

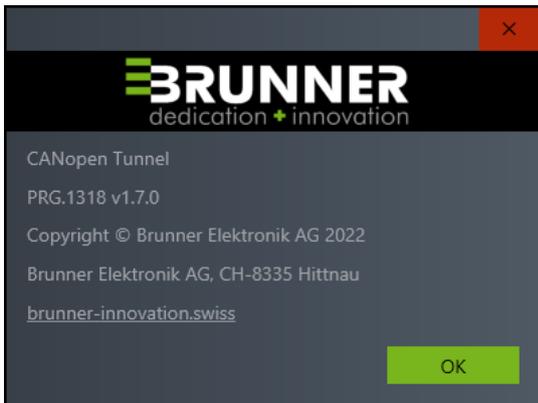
The option to reset statistics can be accessed from the navigation bar in the upper left corner, or by pressing the ALT+R hotkey.



This will reset network traffic, network delay, and protocol statistics.

5.2 Application Info

Click on the “Info” button to check the application info.



5.3 Help

Click on the “Help” button to open up this User Guide.