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DeviceNet Detective 2

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Operation of this equipment in a residential area is likely to cause interference in which case the user, at his or her own expense, will be required to take whatever measures may be required to correct the interference.

Changes or modifications to this device not explicitly approved by Grid Connect will void the user's authority to operate this device.

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Date	Rev.	Author	Comments
June 26, 2013	1.01	JVK	Initial Release

Table of Contents

1. Overview

1.1 Introduction

The DeviceNet Detective 2 is a comprehensive, diagnostic and configuration tool specifically designed for factory floor personnel.

The DeviceNet Detective quickly solves network problems and eliminates the need for expensive notebook computer tools for DeviceNet.

To use the DeviceNet Detective, simply plug it into any DeviceNet network. Use the rotary dial to scroll through the functions shown on the menus on each screen. The Detective quickly and easily reveals critical data that previously was hidden. Simplicity of operation is the key feature.

A 320 x 240 pixel OLED display presents the detailed diagnostic and configuration information needed to support DeviceNet network installations. The DeviceNet Detective provides a complete listing of all devices on the network and provides easy to understand information about all nodes such as address, baud rate, error conditions and messaging attributes. The Bus Diagnostics feature provides a wealth of information about the dynamics of the network, and helps users focus on solving network node problems.

Other functionality of the DeviceNet Detective includes detection of the CAN bitrate, bus load measurement, and termination measurement. As well as receiving CAN messages, it can transmit either individual messages or entire sequences of them. In addition, the internal memory card allows tracing of the CAN/DeviceNet message traffic.

The integrated two-channel oscilloscope enables visualization of the CAN signals. Single CAN IDs and various events can be used as triggers. The CAN frames are decoded from the recorded signal, for example, to detect errors in the frame.

Each DeviceNet Detective is delivered with 3 cables / connectors that may be required by your network, and a rugged carrying case.

1.2 DeviceNet Detective Features

The DeviceNet Detective is a tool designed to support DeviceNet installations. The DeviceNet Detective provides rapidly accessible, updated information on network-installed devices as follows:

General

- High-speed CAN ISO 11898-2
- CAN connection D-Sub 9-pin
- 3 Cables: D-Sub 9-pin to each of the 3 standard DeviceNet connectors – Open, Sealed Mini, Sealed Micro
- OLED display with 320 x 240 pixel resolution
- Voltage supply with (rechargeable) batteries (4 x AA) or with enclosed D-Sub to DeviceNet cable (no charging function for inserted rechargeable batteries)
- Internal memory card (at least 1 GB) for saving scope images and message trace files; can also be used as a mass storage device during a USB connection to a PC
- Operating temperature range of 0 to 50 ℃ (32 to 1 22 ℉)

- Context sensitive help for data explanation wherever possible

DeviceNet Detective Functions

- Offline utilities to change network node configuration.
- Detect baud rates and node addresses (MAC ID's)
- Display high, low and present 24VDC network supply voltage.
- Display range of high & low CAN bus voltages
- Reference "Help" for Detective menus, plus DeviceNet wiring pinouts & LED function screens
- Report CAN errors per second and total CAN errors detected
- Log CAN errors from each node
- Error "Logbook" function
- Detect % traffic load on the network
- Detect all node objects on the network and report results
- Monitor and identify group 1, 2, 3 and 4 traffic
- Offline control of I/O

CAN Functions

- Recording of incoming CAN messages to the internal memory card
- Conversion of trace data to various output formats using a Windows program
- Transmission of CAN messages or message lists
- Decimal, hexadecimal, or binary entering of CAN data; data change of a single transmission message during runtime
- Measurement of CAN bus load, displayed by means of a time diagram
- A bus load time diagram can be saved as bitmap
- Measurement of CAN termination for High-speed CAN bus, even while the system is running
- Switchable CAN termination for the connected bus
- Voltage measurement for all pins of the CAN connector (D-Sub)

Oscilloscope Function

- Two independent channels having a maximum sampling frequency of 20 MHz each
- Memory depth can be set to up to 64 kSamples
- Display of the CAN-High and the CAN-Low signal as well as the difference of both signals
- Time measurement with a resolution of up to 50 ns
- Inspection of external signals (with frequencies up to 1 MHz) with a probe via the BNC connection
- Configuration of trigger to frame start, frame end, CAN errors, CAN ID, or signal edges.
- External measurement devices can be triggered using the BNC connector

- Depiction of raw CAN frames
- Decoding of CAN frames from the recorded signal course
- Current view can be saved as bitmap screenshot
- Saving the recorded sample data as CSV file

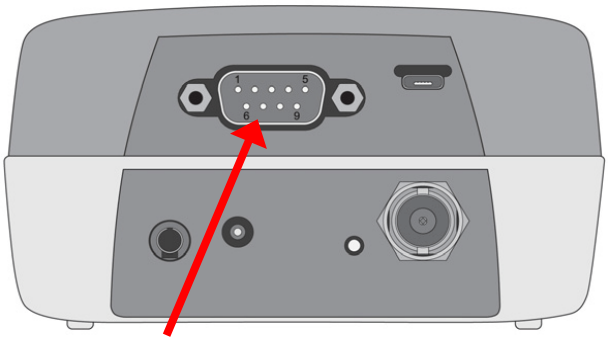
1.3 Scope of Supply

- DeviceNet Detective 2
- D-Sub 9-pin to DeviceNet Open Connector cable, with power connector
- D-Sub 9-pin to DeviceNet Sealed Mini Connector cable, with power connector
- D-Sub 9-pin to DeviceNet Sealed Micro Connector cable, with power connector
- Conversion software PEAK-Converter for Windows
- Batteries (4 x 1.2 V AA)
- Manual in PDF format
- Carrying case for the device and accessories

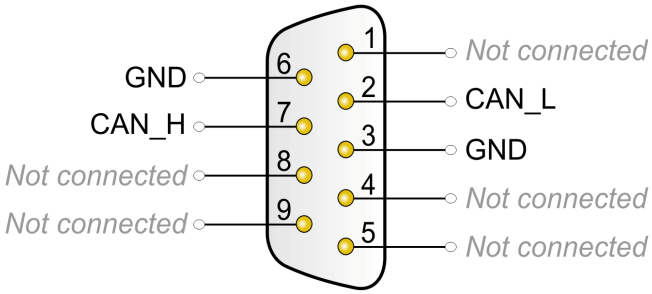
2. Setting up the DeviceNet Detective

For operation of the DeviceNet Detective, go through the sections of this chapter in order.

2.1 CAN Connection (D-Sub)



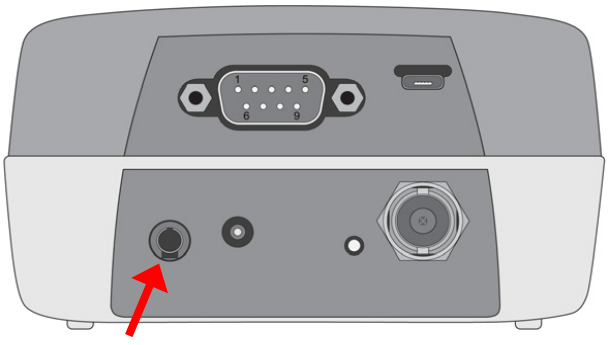
CAN connector (D-Sub) on the rear of the device



Pin assignment for the DeviceNet Detective with High-speed CAN transceiver, according to specification CiA® 102 (additional notes in the following subsections)

2.1.1 Ground Connection

For separate ground connection to other CAN nodes or measuring objects an additional 4-millimeter GND socket is provided on the rear of the device.



GND socket (4 mm) on the rear of the device

2.2 DeviceNet Cables

Three cables are included with the DeviceNet Detective:

- D-Sub 9-pin to DeviceNet Open Connector cable, with power connector
- D-Sub 9-pin to DeviceNet Sealed Mini Connector cable, with power connector
- D-Sub 9-pin to DeviceNet Sealed Micro Connector cable, with power connector

The barrel connector on each cable can be used to supply 24V DeviceNet power to the DeviceNet Detective.

2.3 Power Supply

The DeviceNet Detective can be supplied in two ways:

- externally via the supply socket (section 2.3.1)
- temporarily by (rechargeable) batteries (section 2.3.2)

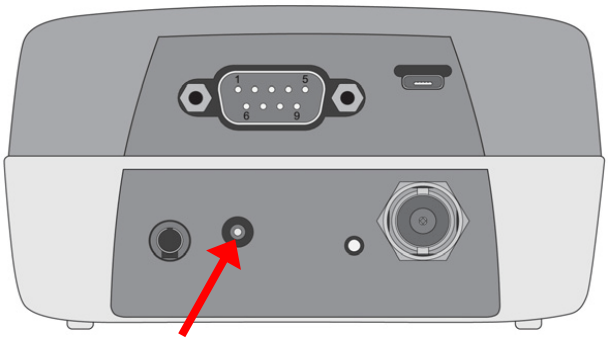
During operation, supply status is shown on the screen's upper status bar.

Symbol	Meaning
	The device is connected to an external voltage source (e.g. DeviceNet Power)
	The device is supplied by the inserted (rechargeable) batteries. An estimate of the remaining capacity is given.

Note: Inserted rechargeable batteries are not charged by the external supply.

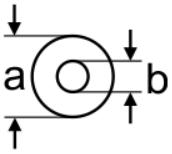
2.3.1 Supply Socket

Supplying the DeviceNet Detective via the designated socket can be done using the enclosed DeviceNet cables that have a barrel connector attached (using the 24V DeviceNet power) or another DC source.



Supply socket on the rear of the device for the connection by a barrel connector

Supply voltage:
12 V DC nominal, 24V DeviceNet
(8 - 50 V possible)



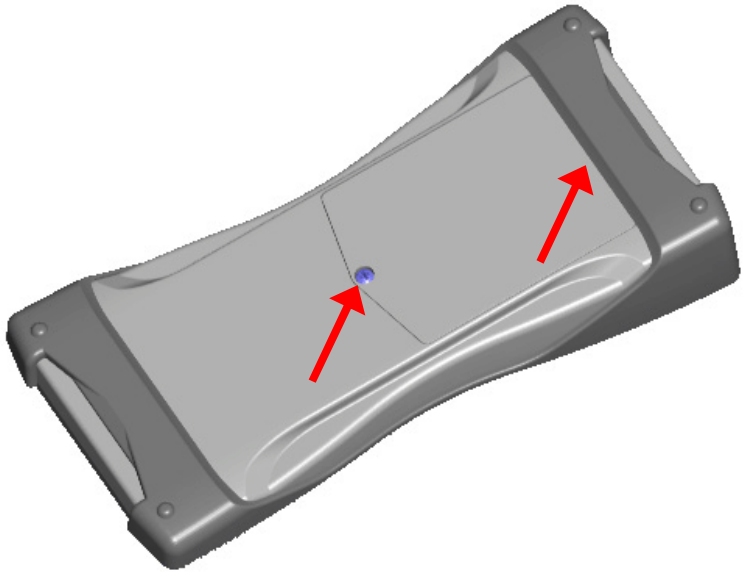
Diameter of barrel connector:
a = 5.5 mm, b = 2.1 mm;
minimum length: 11 mm

2.3.2 Batteries

For mobile use, the DeviceNet Detective can be supplied by (rechargeable) batteries:

- Size: AA
- Quantity: 4
- Single voltage: nominal 1.2 V or 1.5 V

The battery compartment is located on the device's bottom side. The lid is fixed with two screws.



Positions of the screws for the lid of the battery compartment
(second screw is located beneath the rubber sleeve)

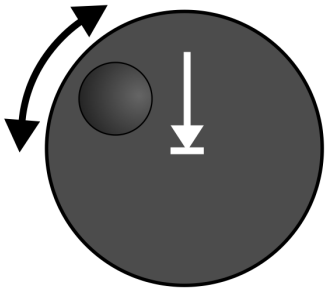
If an external supply is connected to the device, it will be used as primary source. Batteries can stay in the device.

Note: Inserted rechargeable batteries are not charged during external supply. For charging, please remove the empty rechargeable batteries and use a separate charger (not in the scope of supply).

2.4 Operation with the Push Dial

Operating the DeviceNet Detective is solely done by a push dial.

Dial:
Move selection;
alter value

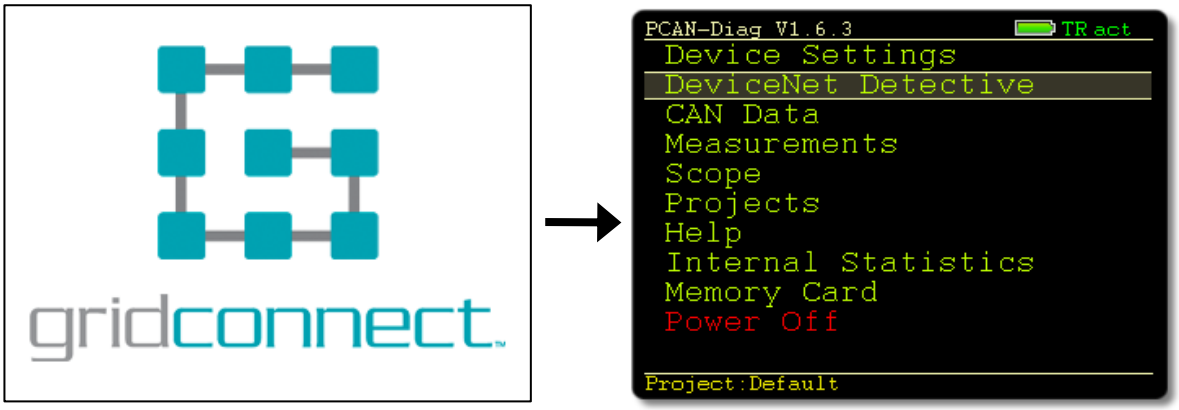


Push:
Power-up device;
execute selected function;
exit current function

2.4.1 Powering Up the DeviceNet Detective

Hold down the push dial for at least half a second.

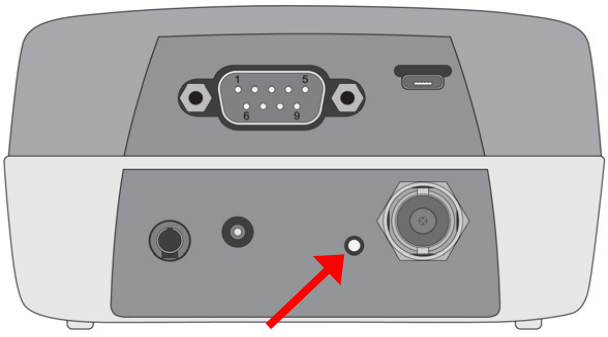
A splash screen appears for a short moment; then it's replaced by the main menu.



Turning off the device is done by selecting **Power Off** from the main menu.

2.4.2 Switch Interlock

Powering-up the device can be blocked by a small knob on the rear in order to prevent the batteries from accidental discharging, e.g. during transport.



Knob on the rear of the device for switch interlock of the push dial

In order to activate the switch interlock, push the knob using a thin object. The device now cannot be powered-up with the push dial.

Unlocking is done likewise: push the small knob again.

2.5 Setting Date and Time

The DeviceNet Detective has an integrated clock. The time stamp is used when a file is saved to the internal memory card. We recommend checking the current date and time after initial start of the device (main menu item **Internal Statistics**) and setting it if required.

Do the following to set the date and time:

1. In the main menu select **Device Settings**.
2. At the entry **Date & time** click on **Set**.
3. At **Date** and at **Time** click on the digits to be adjusted and change the values by dialing.
4. When all digits are adjusted, click on **Set**.

2.6 Status Display

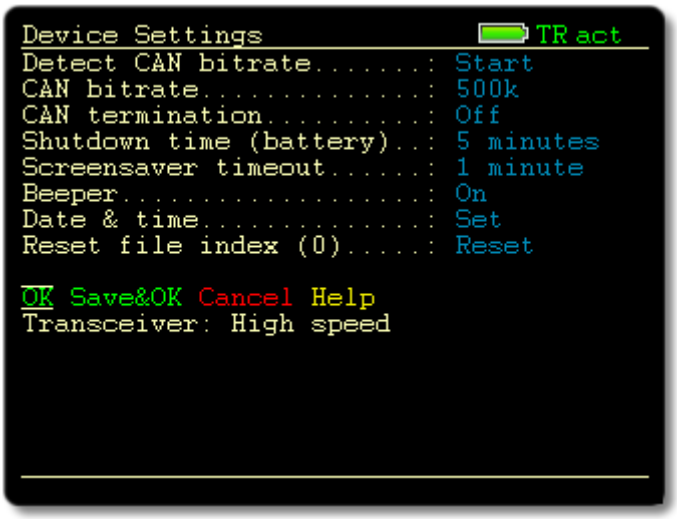
When operating the device, in the upper status bar, some symbols give information on the voltage supply status and about the CAN bus communication. Their meanings are as follows:

Symbol	Meaning
	The device is connected to an external voltage source (e.g. AC adaptor)
	The device is supplied by the inserted (rechargeable) batteries. An estimate of the remaining capacity is given.
T R	CAN traffic: T = Transmit, R = Receive • Blinking: Outgoing/incoming CAN messages • Green: Regular traffic • Yellow, red: Erroneous traffic

Symbol	Meaning
act pas off	Informs about the bus status (active, passive, bus off). When entering bus-off state, due to high (transmission) error rate, no further CAN messages are transmitted or received. In this case, after fixing the bus problem (e.g. a wrong CAN bitrate), a reset of the CAN controller should be performed. You have the following possibilities to do so: • CAN Data > Receive Messages > Rst • CAN Data > Transmit Messages > Reset

3. Device Settings

Main menu entry **Device Settings**



Having changed any settings on this page, make them permanent by clicking **Save&OK**. If you want to use the changed settings only temporarily (during the current session), click **OK**. A subsequent session (after an off-on cycle) uses the initial settings again.

3.1.1 Detect CAN bitrate

If the bitrate of the DeviceNet bus connected to the Detective is unknown, the Detective can automatically detect it. This requires data traffic on the DeviceNet bus.

The following bitrates are available (kbps): 500; 250; 125

3.1.2 CAN bitrate

Selection from a series of DeviceNet bitrates: 500, 250, 125 kbps

3.1.3 CAN Termination

The internal CAN termination can be switched.

(Display **Transceiver: High speed**)

A High-speed CAN bus needs to be electrically terminated on both ends using resistors of 120 Ω. If the Detective is connected to an un-terminated end of a CAN bus, the internal terminating resistor of 124 Ω can be engaged here.

Setting	Resistor	Description
Off	None	Termination is already correctly applied to the High-speed CAN bus and the device is connected to a tap within the CAN bus.

Setting	Resistor	Description
On	124 Ω	The device is connected to a CAN bus whose termination isn't complete yet.

Tip: If you want to check that a connected High-speed CAN bus is terminated correctly, you can use the following function: Measurements > CAN Termination (section 6.2)

3.1.4 Shutdown time (battery)

If the Detective is run with (rechargeable) batteries, battery sources can be preserved by switching off the device automatically after a set period, as long as the push dial hasn't been used. Setting to Never causes the device to stay alive all the time.

If operating the device with an external supply, for example with the enclosed AC adaptor, this setting does not have any effect.

3.1.5 Screensaver timeout

The brightness of the display will be reduced whenever the device is not operated for a certain period. This can prolong the lifetime of the OLED display.

3.1.6 Beeper

The Detective can give acoustic feedback to several events. Among other, a change of the CAN bus status is signalized. The Off setting disables the acoustic signal function of the Detective.

3.1.7 Date & time

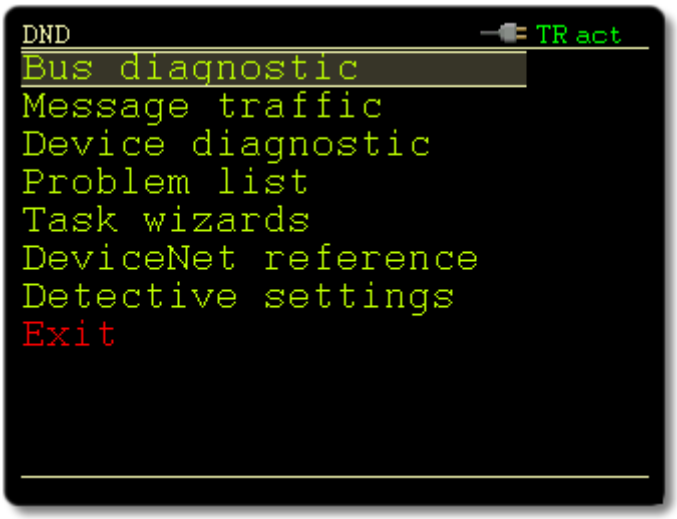
With Set the device date and time are adjusted. Date and time are used when saving files to the internal memory card.

3.1.8 Reset file index

File names of bitmaps or scope data to be saved get a number coming from a counter. The current count is indicated in parentheses and can be set to 0 by clicking Reset.

4. DeviceNet Detective

Main menu item **DeviceNet Detective**

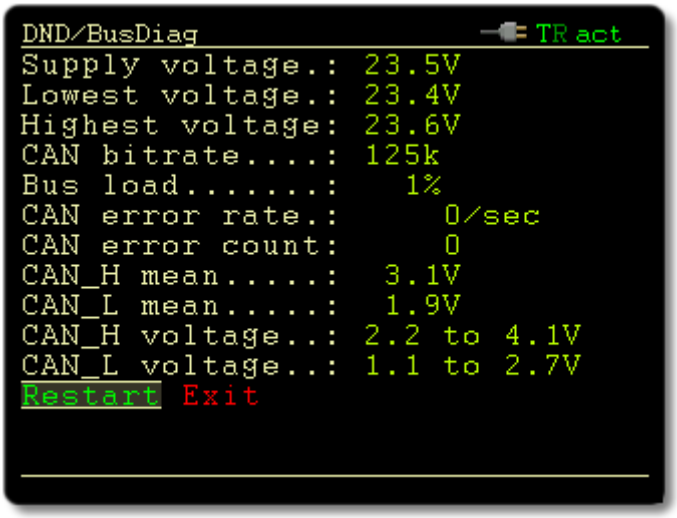


The following lists show all the main menu selections, their major function, and menu options. The next sections describe the menu selections in detail.

4.1 Bus Diagnostic

Menu item **DeviceNet Detective** > **Bus diagnostic**

The Bus Diagnostic shows all the major signal levels and bus condition.



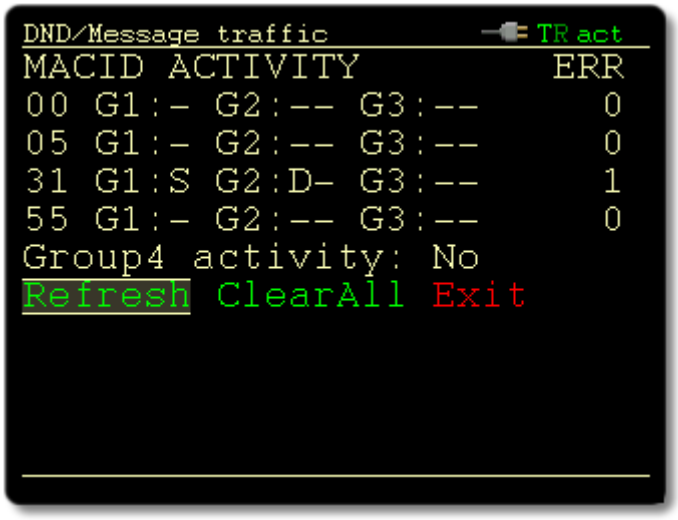
- Supply Voltage: current voltage (monitored at approximately 100 samples per second, with the primary purpose of detecting overload)
- Lowest Voltage: lowest values recorded during the last 60 seconds. Will automatically reset.
- Highest Voltage: highest values recorded since installation. Does not record high frequency noise. Will automatically reset.

- CAN Baud Rate: 125, 250, 500 kbps
- Bus Load: amount of traffic (expressed in percent); bandwidth of the CAN bus currently in use.
- CAN error rate: number of errors expressed per second.
- CAN error count: Total CAN errors since power-on.
- CAN_L mean: Mean level for CAN_L
- CAN_H mean: Mean level for CAN_H
- CAN_L voltage: Voltage level for CAN_L
- CAN_H voltage: Voltage level for CAN_H. Sample time is 1-2 secs.

4.2 Message Traffic

Menu item **DeviceNet Detective** > **Message traffic**

This menu component indicates which nodes are actively accepting or creating messages and which nodes are inactive.



Notes: A “DUP MAC ID Check Request” is sent for the operational baud rate. The first node detected of DUP MAC ID nodes will be listed in the message traffic screen. Remaining duplicate nodes are not listed. If a DUP MAC ID node is not listed, this node requires a MAC ID change.

Because the message groups are normally used for specific data flow, the state of the whole network can be understood this way.

G1 = mostly used for slave device’s IO data

G1:S = Group 1 Source

G1:- = Group 1, not source

G2 = master/slave config. and master’s polling slaves

G2: S = Group 2 Source

G2: D = Group 2 Destination

G3 = additional explicit connections

G4 = recovery of ‘communication faulted’ devices

The source and destination flags are updated periodically. Once a device is found, it remains in the activity list even if it’s neither source nor destination of any messages. All devices can be cleared out by pressing the soft key ClrAll. A check for new devices is performed by pressing the soft key Refrsh. The occurrence of a device in the ‘DeviceNet activity’-List is independent of the occurrence in the scan list. For instance, a master may sent repeated messages to a non existing device due to a setup-failure. This device will appear in the ‘DeviceNet-activity’ list as destination of group 2 messages, but will not appear in the ‘device’ list.

The number listed as “Errors” indicates, how often the device sent a message, which followed a bus error. If a message is received after a bus error, it is very likely the retransmission of n erroneous message. So the error counter displays, how often messages of the device where disturbed by bus errors. The interpretation of those error counts is not easy, but two situation can be detected by those numbers:

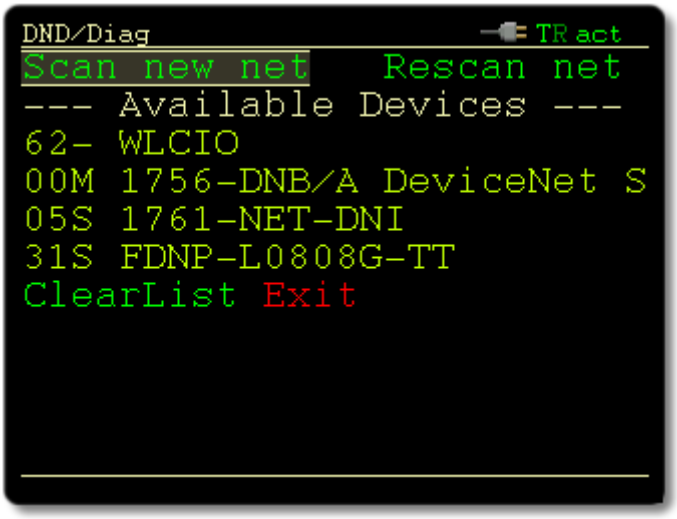
- if there’s only one defective device on the network, and it has a defect in its receiver circuitry, every other device gets its error counter incremented (because the device erroneously marks good messages from other devices as bad by generating bus error flags). The device with the lowest error count is probably the defective one.
- if there’s only one defective device on the network, and it has a defect in its transmitter circuitry, the error counter of the defective device itself will increment (because it sends bad messages, which are marked as bad by all other devices). The device with the highest error count is the defective one.

Because bus errors may have several sources, which overlay each other, the error ratio between different devices may not always be clear enough to identify bad devices.

4.3 Device Diagnostic

Menu item **DeviceNet Detective** > **Device diagnostic**

DeviceNet Detective will scan/detect all installed devices and will display all information provided by the node object. The user can either make a new network scan or request an update to an existing scan to refresh the original data scanned.



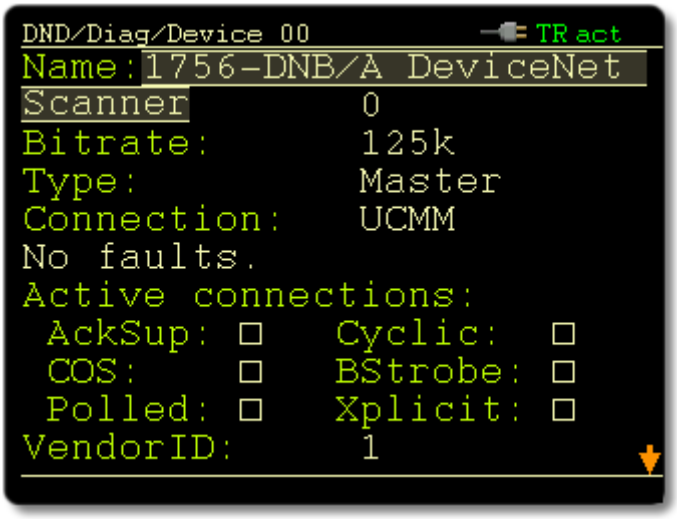
After scan, one device is displayed per screen line. Example: “11 S? TheDeviceName”

- “11” is the MACID of the device
- “S” means, it is a slave device owned by a Master. “M” would denote a Master device, “-” stands for “don’t know”.
- “?” is an error flag: the device has some error(s). This may be a wrong baud rate setting, or some DeviceNet defined error states, as queried out of the device.
- “TheDeviceName” is the name of the device type, as queried from the device. If no explicit connection could be opened, “*limited info avail*” is displayed. If a explicit connection could be opened, but data transmission was disturbed, “*limited info avail*” is displayed. You should try a slower setting of the “Msg delay” parameter in the “Settings.”

“Rescan net” initiates a scan. It is assumed that you have scanned the same net before. The list devices of devices will be compared with the result of a previous scan (held in EEPROM memory), any differences (lost devices or new devices) will be shown as errors.

“Scan new net” should be used if the Detective was just moved to a different network. In this case, there is no comparison with the last scan result.

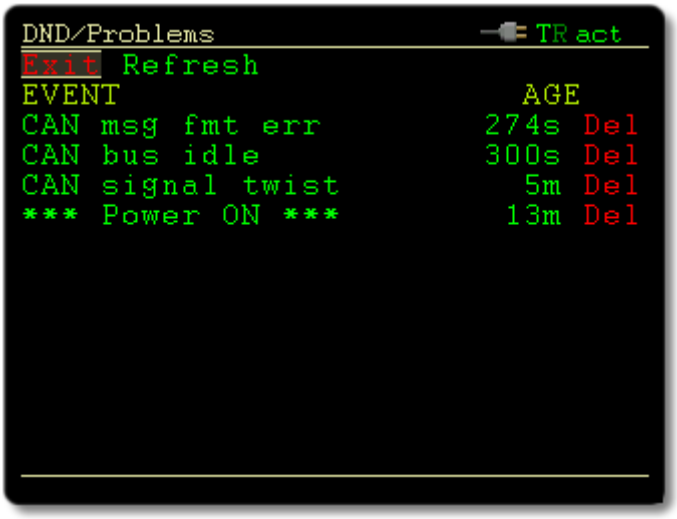
By highlighting a device and selecting it, the user will receive additional configuration information available from device. Specific information lists provide detail on the master device connection, faults, capabilities, connections, device types, product codes, revisions, serial numbers, etc.



This list is also updated, if DUP MACID Check requests and responses are detected on the DeviceNet. These are always displayed as 'no contact'. If for a certain device only a request is found, it is displayed without MACID setting. This list is sorted: Masters are sorted by MACID, below each masters are all slaves listed, also sorted by MACID.

4.4 Problem List

Menu item **DeviceNet Detective** > **Problem list**



This menu component is a working field that will report major errors detected and the duration of time in seconds, minutes, or hours, since the event was first detected. Press the "Refresh" button to update any events that have occurred while "Problem List" is open. Although some events generate new screen lines for each occurrence, generally, duration updates and description changes will be revised relative to subsequent events. Use delete key to remove a list item. Use select key to get more information about the error.

The following tables list the errors that are recognized.

Error	Detected on	New entry	Description
Supply voltage dropped below xx V	Periodically	Always	The DeviceNet supply voltage dropped below the alarm limit. The timestamp is important.
Supply voltage is higher than xx V	Periodically	Always	The DeviceNet supply voltage is higher than a fixed upper limit (28 V). The timestamp is important.
CAN bus idle	Periodically	Always	No messages are found on the bus, bus is silent. Normally no problem.
Msg overrun on CAN	Periodically	Always	Too many messages, message are lost.
CAN msg fmt err	Periodically	Always	Illegal formed messages were received. This may have many reason ranging from physical bus distortion to devices with wrong baud rate settings.
CAN msg bit err	Periodically	Always	See above.
General CAN err	Periodically	Always	See above.
BUS OFF	Periodically	Always	Bus is extremely heavily disturbed, the Detective itself went bus off. Perhaps a baud rate problem.
BR set to xxx kbps	After BUS OFF, on first bus access	Always	The Detective detected another baud rate on the DeviceNet and changed its own baud rate setting. See ‘baud rate detection’ below.
Device xx was detected to use wrong baud rate	On scan	Only for newest for each device	A scan detected a device using another baud rate as the current one.
Unknown device	On scan	Only for newest	A scan detected for a certain baud rate at least one device, but no further contact could be made.

Error	Detected on	New entry	Description
Duplicate MACID	Periodically	Always	A message pattern for a device with duplicate MACID was detected. The device itself switched off and is no longer detectable.
xx has dup serial no	On scan	Only newest for each MACID	During a device scan, two devices with different MACIDs and same Vendor ID / Serial no were detected.
Device xx new	On scan	Only newest for each MACID	A scan detected a new device, which is not yet in the EEPROM-save live list.
Device xx lost.	On scan	Only for newest for each MACID	A scan detected the loss of a device.
No free MACID	On scan	Only for newest	All MACIDs 0..63 are in use. The Detective could not be connected to that DeviceNet. See below 'MACID assignment.'
MACID adjusted	On scan	Only for newest	The Detective changed its own MACID to an unused one. See below 'MACID assignment.'
Limited info for xx	On scan	Only for newest for each MACID	A explicit connection to the device could not be opened. Call customer support.
Master xx not found	On scan	Only for newest for each master	Slave devices claim to be owned by a certain master, but that master could not be found.
CAN_L/CAN_H shortcut to V+/V-	Periodically	Only one per event	The voltages levels on the siganl wires CAN_L or CAN_H were exceeding the normal range and were very close to ground or supply power voltage.
CAN_L/CAN_H twisted	Periodically	Only newest	The voltage on signal wire CAN_L/CAN_H was not always lower than the voltage on CAN_H. This is an illegal condition and may be caused by twisted CAN-wires.

Error	Detected on	New entry	Description
Busy voltage on CAN_L/CAN_H	Periodically	Only newest	The difference between max and min voltage on signal wire CAN_L/CAN_H was greater then 2.5V. This indicates a busy bus with abnormally high signal levels. The typical voltage difference should be 2.0V. (may be caused by a defective transceiver circuit)
Idle voltage on CAN_L/CAN_H	Periodically	Only newest	On an idle bus the average voltage on signal wire CAN_L/CAN_H was found to be lower than 2.0V or higher than 3.0 V. (may be caused by a defective transceiver circuit)

4.5 Task Wizards

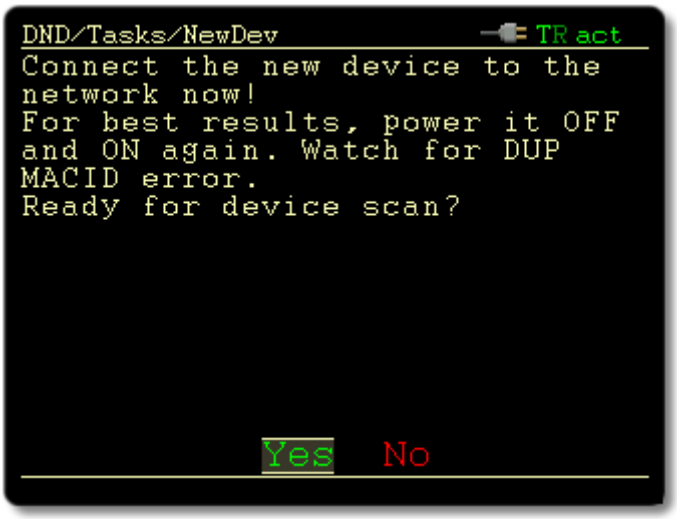
Menu item **DeviceNet Detective** > **Task wizards**

Use Task Wizards to:

- Install a new device: when adding an out-of-box device to the bus. Communications on the bus must be stopped to correctly configure the new device to MAC ID and Baud rate.
- Configure an installed device: to change the MAC ID or Baud rate of a device already configured in the project. Communications must be stopped to correctly configure the device.

- Reset an installed device: select the device and change settings. Note: This command requires node support of software reset.
- Test I/O: Establish a connection to a slave device, observe its Input data and modify its Output data. Communications with any existing master must be stopped first. **Warning: This command allows you to modify outputs which may be connected to actuators in the physical installation! Use with caution!**

4.5.1 Install New Device

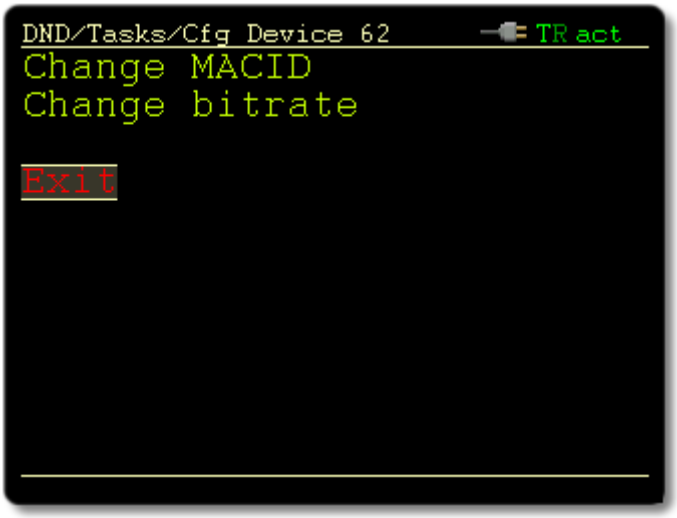


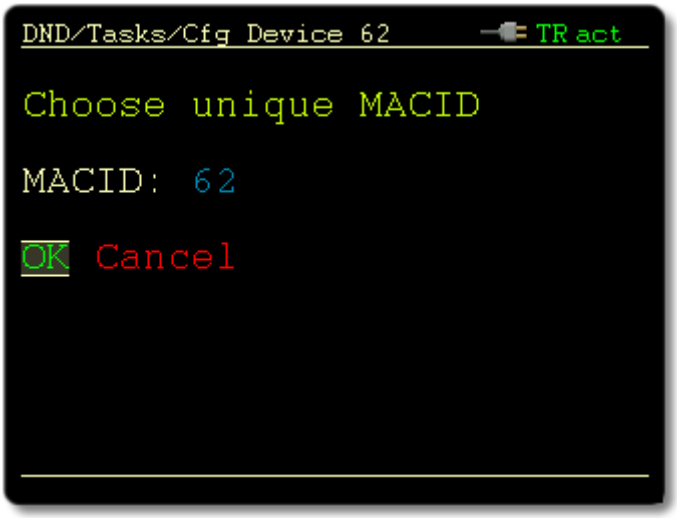
When installing a new device with unknown settings for baud rate and MACID, the DeviceNet Detective will do the following:

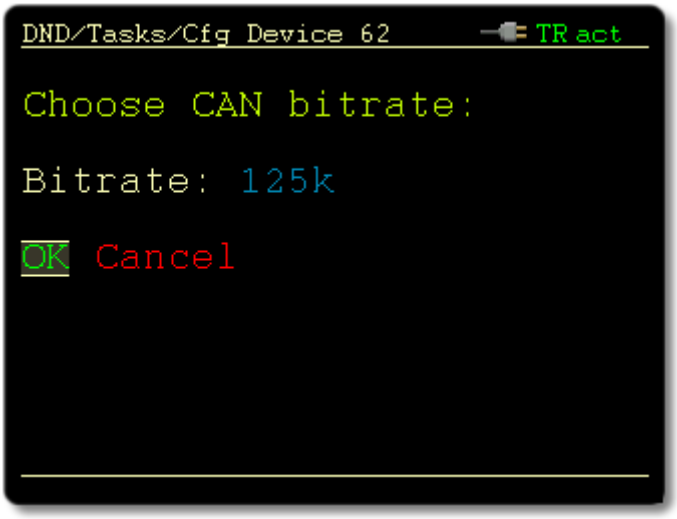
1. 'initial scan': preparation and network scan. Tells the user NOT to connect the new device and stop DeviceNet. Disconnecting the new device is necessary because the new device will later be found by a network scan. Stopping DeviceNet is necessary because a new device with wrong baud rate settings may immediately switch off if connected to a running net. To shorten the process, the initial scan can be skipped if the current device list is known to be up to date.
2. Checks for silent bus: If messages are still found, the user is asked to stop the net.
3. Request the user to connect the new device: It should be repowered to reset it from error states, and to clear the CAN interface. If the new device has a duplicate MACID, this will be detected by the background scanning process of the Detective. The error is shown slightly delayed (5 sec). The user should then abort the process.
4. 'device scan' is performed.: If only one new device is found, it is assumed to be the newly connected one. Otherwise, the process stops. (Steps 5 and 6 are skipped, if the device has already the right baud rate)
5. Setup baud rate: At first, the Detective tries to program the device to the current baud rate. If this fails, the user is requested to set the baud rate manually (via switches). An auto baud device will fail, but will switch to the right baud rate after reset.
6. Reset device: The device is reset, and it is monitored to come back to life again. If this fails, the user is requested to reset the device manually.

7. MACID setup: The user is requested to choose an unique MACID (used MACIDs aren't allowed to be selected). Then the Detective tries first to set the MACID, if he fails he prompts the user to do so.
8. Reset device.

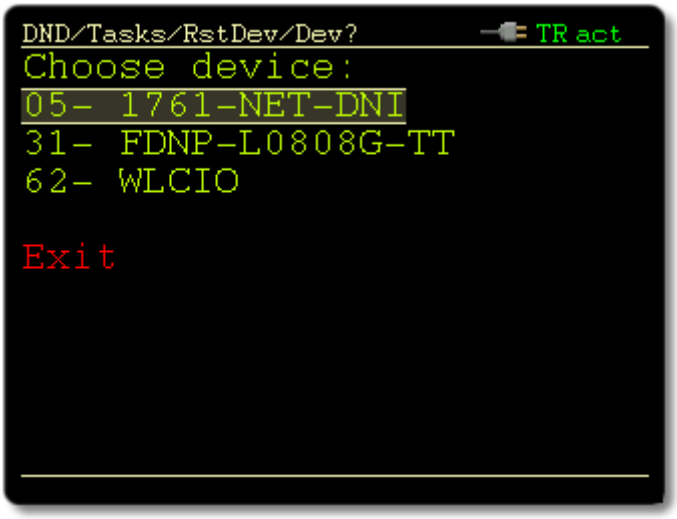
4.5.2 Configure Installed Device





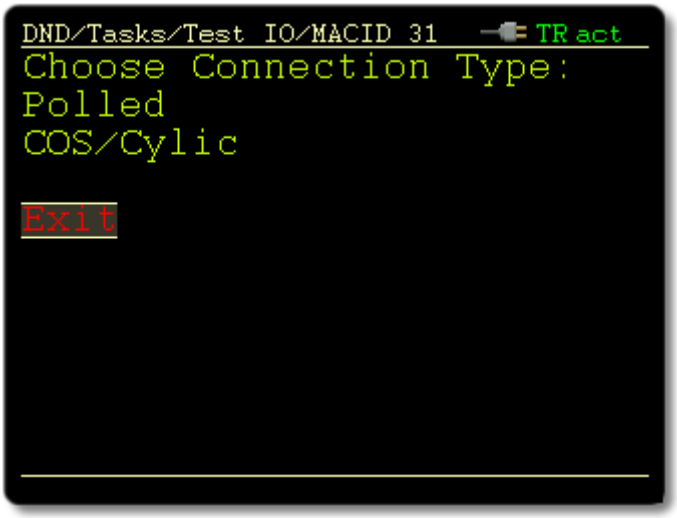


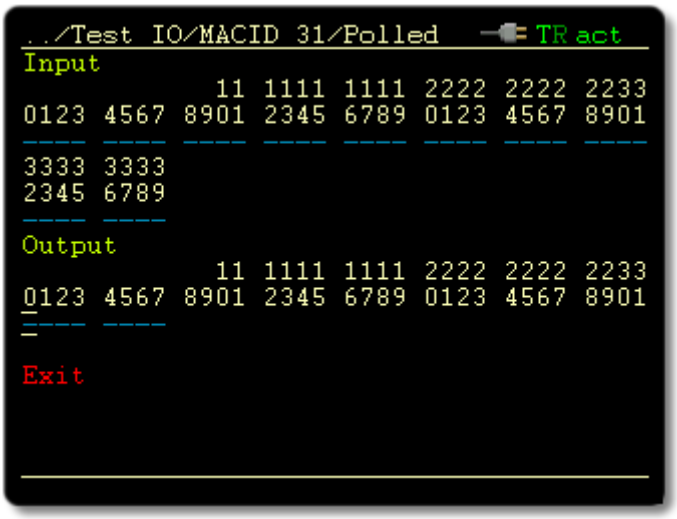
4.5.3 Reset Device



Every reset includes monitoring of the device coming back to life again. To catch auto baud devices on an otherwise silent DeviceNet, the Detective causes some message traffic while waiting for the device to return.

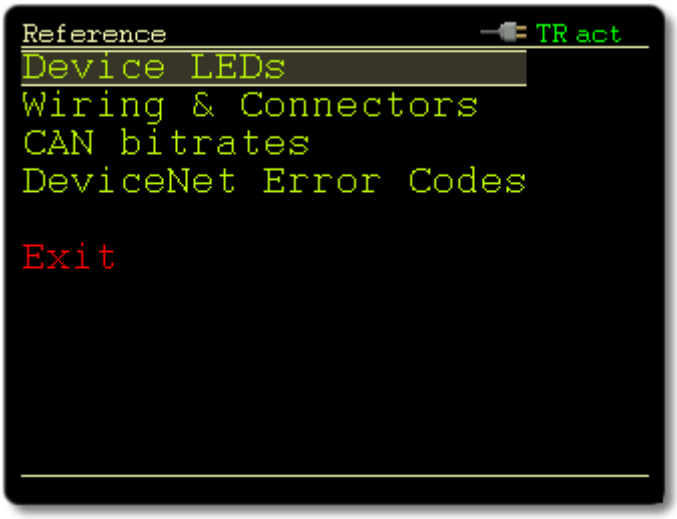
4.5.4 Test I/O





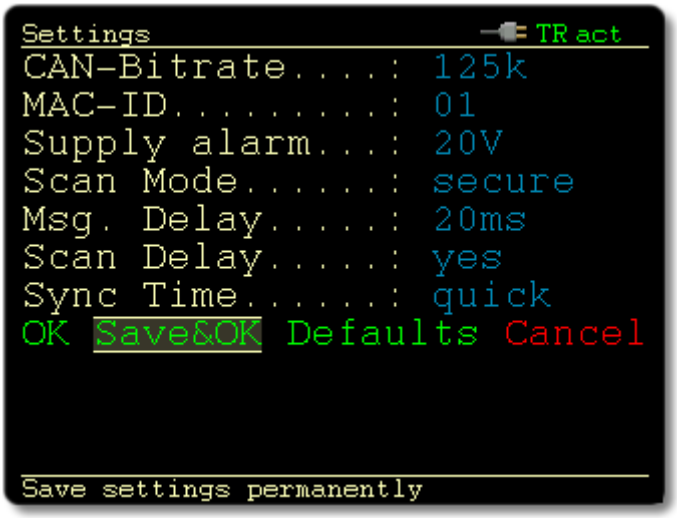
4.6 DeviceNet Reference

Menu item **DeviceNet Detective** > **DeviceNet Reference**



Use DeviceNet Reference to obtain information on: node LEDs (solid, blinking, cyclic), connector pinouts, CAN baud rates and DeviceNet error codes.

4.7 DeviceNet Detective Settings



- CAN Bitrate: Default baud rate for the Auto-Baud sequence. It will be changed if another baud rate is detected.
- MAC ID: The DeviceNet Detective normally finds the lowest available MACID on the network and listens using this node number. If the number that was last used is available when connected, the Detective will stay with that number. The Detective doe not appear in the Master's scan list.
- Supply Alarm: Set this parameter to the lowest supply voltage acceptable to the application. If the supply voltage drops below this value, an entry in the 'problem list' is generated.
- Scan Mode: Set to secure to prevent you from taking the network down by changing the MACID or Baud Rate while the bus is on. Set to secure if scanning a live network or BUS OFF conditions may occur.

- Msg Delay: This is the minimal period of time between two transmissions onto the CAN bus. A larger value forces the Detective to use less bandwidth while scanning the net, but on the other hand slows the scanning process down. Many devices have been found to fail if “Msg delay” was to small. 10 ms is a good value for lightly loaded networks, up to 100ms may be suitable for heavy loaded networks. Increment this value if you experience “*limited info avail*” after a network scan. If you set this value too low, device failures may occur, possibly stopping network operation!
- Scan Delay: A delay of 12 seconds is inserted between two attempts to open the same explicit connections. In field testing it was found that some devices need this delay to get their explicit connections cleared up by timeout. Normally, you should switch this value to “Y”, if you experience “*limited info avail*” during a network scan. Switching it to “N” speeds the scan process by 12 seconds.
- Sync Time: This determines how fast the Detective will perform the network scan for the Device Diagnostic feature. It is recommended to use “secure” on an active network so as not to add a burst of traffic to the network.

5. CAN Traffic

Main menu item **CAN Data**

The DeviceNet Detective can display the CAN data of incoming CAN messages either in a simple way in hexadecimal format (section 5.1).

The other way it is possible to transmit prepared CAN messages periodically or manually (sections 5.2/5.3).

In addition there's the possibility to record incoming CAN traffic to files on the internal memory card (section 5.4). The recorded data can later be converted to various output formats and evaluated (section 5.5).

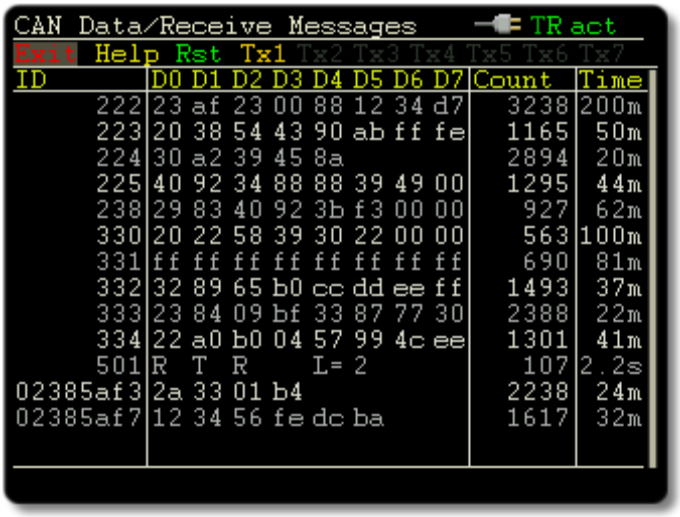
5.1 Displaying Incoming CAN Messages

Menu item **CAN Data** > **Receive Messages**

Incoming CAN messages are displayed as a list, sorted by CAN ID (column **ID**). The representation of the CAN data bytes (**D0**…**D7**) is in hexadecimal format. Each occurrence of a CAN message increments its counter (**Count**). The counting starts with the invocation of the CAN message view. The **Time** column indicates the period between the last two occurrences of a CAN message.

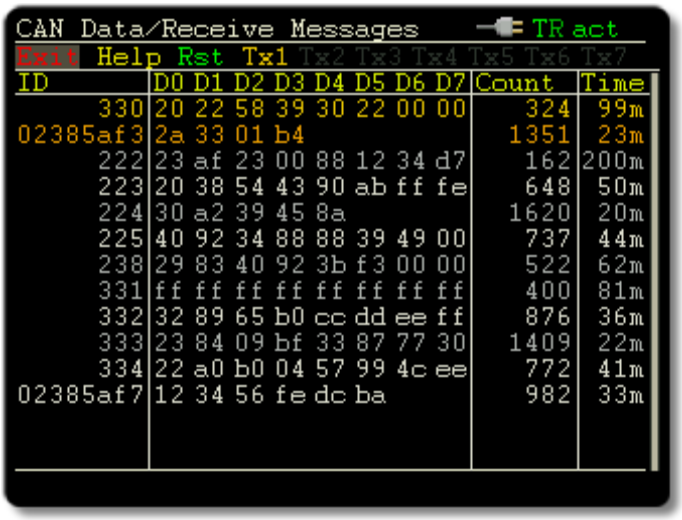
Indicated units for time:

Indication	Unit	Display if Time…
u	µs	0 - 999 µs
m	ms	1 - 999 ms
s	s	from 1 s



Simple view of incoming CAN messages.

You can **manipulate sorting** in the table by clicking on CAN messages. By doing so these messages are moved to the top of the list and marked **orange**. Clicking on an orange CAN message takes back the emphasis, meaning that is sorted by CAN ID again.



Emphasized display of CAN messages (orange)

Red list entries indicate CAN errors that are reported by the CAN controller.

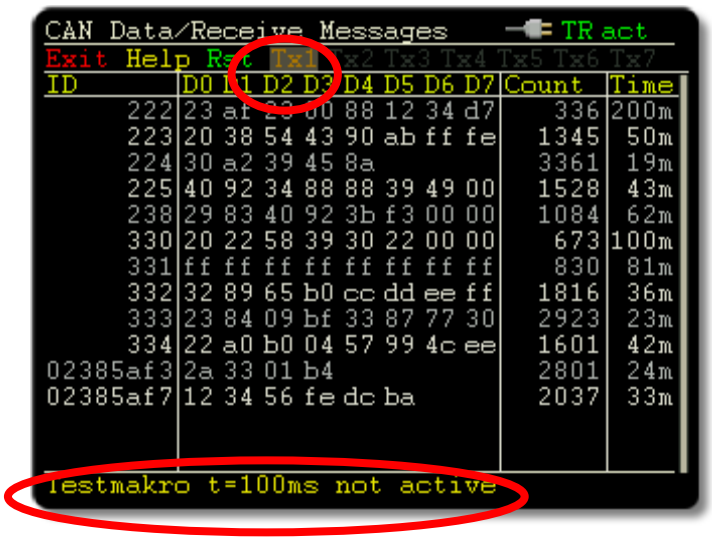
Rst

Clears the list of incoming CAN messages and resets the CAN controller. Latter is useful after fault maintenance on the CAN bus.

Tx1 … Tx7

These items represent the first seven transmit lists that are defined under **CAN Data** > **Manage Transmit Lists** (see section 5.3).

The lower status line informs about the selected transmit list: name of the transmit list, defined cycle time, “Single” standing for a transmit list to be triggered manually. A click activates the selected transmit list for cyclic transmission or triggers a single transmission depending on the type of the transmit list.



Information about the first transmit list

Display	Color	Meaning
Tx3	brown	inactive transmit list with defined cycle time
Tx3	orange	transmit list transmitted periodically or transmit list is ready for manual transmission (“Single”)
Tx3	dimmed	no transmit list available for this item

5.2 Transmitting CAN Messages

Menu item **CAN Data** > **Transmit Messages**

The transmission of CAN messages is done with transmit lists that have been created either with the menu command **Manage Transmit Lists** (see following section). The enabled lists are listed here.

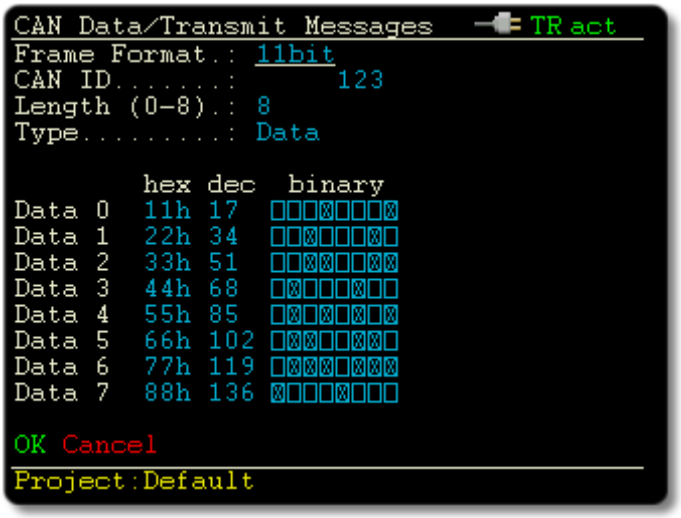
Display	Color	Meaning
Name	brown	inactive transmit lists with defined cycle time (Cycle time > 0)

Display	Color	Meaning
Name	orange	transmit list transmitted periodically or transmit list is ready for manual transmission (Cycle time = 0)

Activate a transmit list for single or cyclic transmission by clicking on the desired entry in the list.

Edit

(only for transmit lists with a single CAN message)



If the transmit list only contains a single CAN message, the data bytes of that message can be changed on the fly by this function, meaning, changes have an immediate effect, also during periodic transmission of the list.

There are columns for hexadecimal, decimal, and binary representation for each data byte of the CAN message where the values can be altered.

You **alter** the value of a data byte by

- clicking on the value in either the **hex** or **dec** column, turning the push dial, and clicking again afterwards to apply the set value, or
- clicking on a binary digit in the **binary** column to toggle its status and moving the marker afterwards.

With **OK** the value changes are kept until switching off the device, with **Cancel** the changes are discarded. In both cases the setting field is quit.

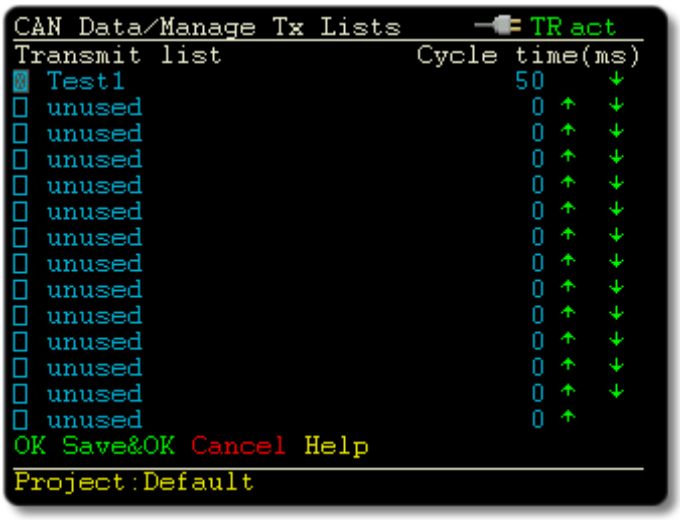
Reset

Resets the counters for the transmit lists (column **Count**) to 0 and resets the CAN controller. Latter is useful after fault maintenance on the CAN bus.

5.3 Managing Transmit Lists

Menu item **CAN Data** > **Manage Transmit Lists**

This function shows an overview of all available transmit lists.

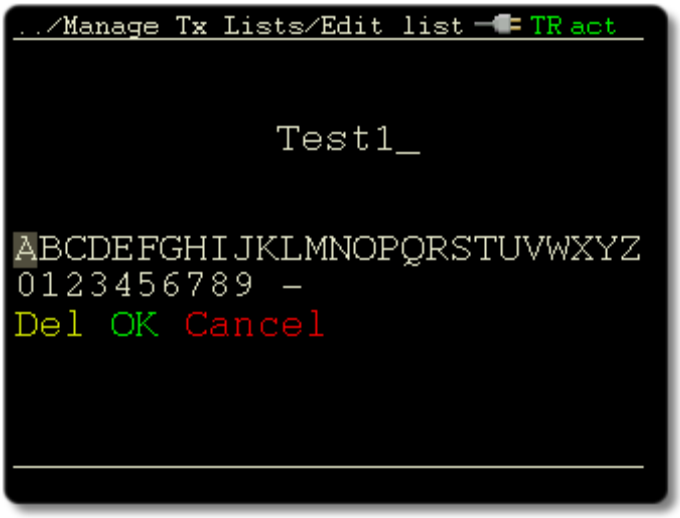


An enabled entry is marked with a cross **[X]**. This means that the entry's properties can be modified and that the list is available for transmission under **CAN Data** > **Transmit Messages**.

Do the following to create one or more transmit lists:

1. Enable an entry below **Transmit list** by checking the corresponding box.
2. Click on the list entry's name in order to edit the properties. If the entry hasn't been used yet, the name is **unused**. An edit view is shown.

3. Modify the list's name by clicking on it.



Characters are deleted with **Del**.
Keep the push dial pushed for automatic repetition.

4. By default, the list already contains one entry. With the mnemonics **EID** on the right you can do following actions:

Mnemonic	Action	Description
E	Edit	Shows a CAN message's properties to be modified.
I	Insert	Adds a new CAN message to the list at the given position. Content is taken from the current CAN message.
D	Delete	Removes this CAN message from the transmit list.

5. The value in the **Offset** column is indicating a duration in milliseconds whereafter the CAN message is transmitted. The offset refers to the previously transmitted CAN message, thus this is a relative designation.
6. Note the given value for **Min. required cycle time** below the transmit list. This indicates the lowest cycle time for the transmit list resulting from the sum of all transmit offsets. You'll set the cycle time for a transmit list later in the overview of all transmit lists.
7. Confirm your modifications to the transmit list with **OK**. The overview of transmit lists is shown again.
8. Set the **Cycle time** for each transmit list in the corresponding column. The value 0 ms means that the transmit list is only initiated manually.
9. Having created and enabled the desired transmit lists, click on **OK** or **Save&OK**.

Note: The cycle time of a transmit list should not be lower than the sum of all offsets in the transmit list. The Detective finishes the transmission cycle of a transmit list, even if the defined cycle time is exceeded.

5.4 Recording CAN Traffic

Menu item **CAN Data** > **Trace Messages**

With this function, the whole incoming CAN traffic including RTR frames and error frames is recorded to a trace file on the internal memory card of the Detective. Also the timing is regarded.

Note: When invoking the function and during the recording of the incoming CAN traffic, the transmission of CAN messages is suspended.

Later, a trace file can be converted on a PC to another format for further use and for evaluation (see section 5.5).

Do the following to record:

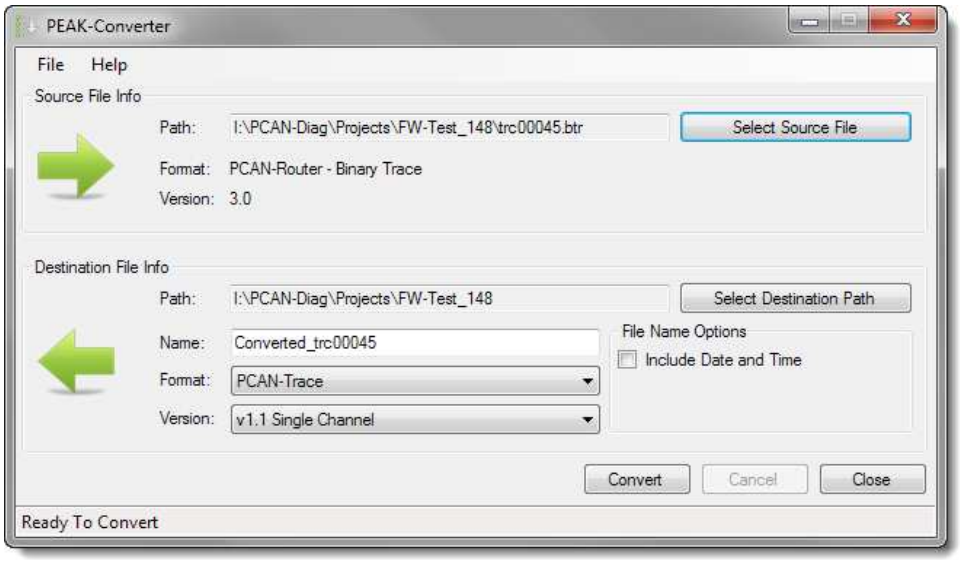
1. Make sure that no USB connection is present between the Detective and a PC.
2. Press **Start**. The recording is done to the indicated **File**.
3. End the recording with **Stop tracing**.

Indication	Meaning
File	Name of the trace file for the current recording. The file name is automatically put together with a sequential number.
CAN queue level in %	Current and maximum fill level of the receive queue (latter in parentheses). If the queue has reached a fill level of 100 percent, most likely some incoming CAN messages were not recorded.
CAN messages total	Number of CAN messages that are already recorded to the trace file
File size	Current size of the trace file in kB and already used storage space in percent of the maximum possible file size

5.5 Using the Recorded CAN Traffic on the PC

The recorded CAN traffic can be read by a PC via an USB connection from the internal memory card of the Detective. It is stored in binary-coded trace files `trc00000.btr` (sequential numbers).

For further use you must convert the data in an appropriate format. The Windows program PEAK-Converter is on the supplied CD and on the internal memory card of Detective for this purpose.



User interface of the PEAK-Converter

Possible conversion targets:

Target format	File extension	Explanation/usage
PCAN-Trace	`.trc`	Text-based trace format by PEAK-System; viewing of the data in the PCAN-Explorer or playback of the CAN messages with the PCAN-Trace program. **Tip:** In connection with the trace files of the Detective, we recommend using the format version 1.1., because the recordings of the Detective only have one channel and because this format version is usable in all programs from PEAK-System.
Vector ASC Trace	`.asc`	Text-based trace format by the Vector company that also can be used by some third-party programs.
Character Separated Values (CSV)	`.csv`	Common, text-based format for import into a spreadsheet (semicolon as separator).

For further use of the trace data proceed as follows:

1. Connect the Detective to the PC with the provided USB cable. The Detective does not need to be switched on.
2. Under Windows, start the `PEAK-Converter.exe` program from the internal memory card of the Detective which resides in the `/PCAN-Diag/Tools` directory.
3. Select a trace file (`trc00000.btr`) as source. You can find the trace files in a project directory: `/PCAN-Diag/Projects/<Project Name>`
4. Specify a destination file and select the desired target format (see above).

6. Measuring Functions for the CAN Bus

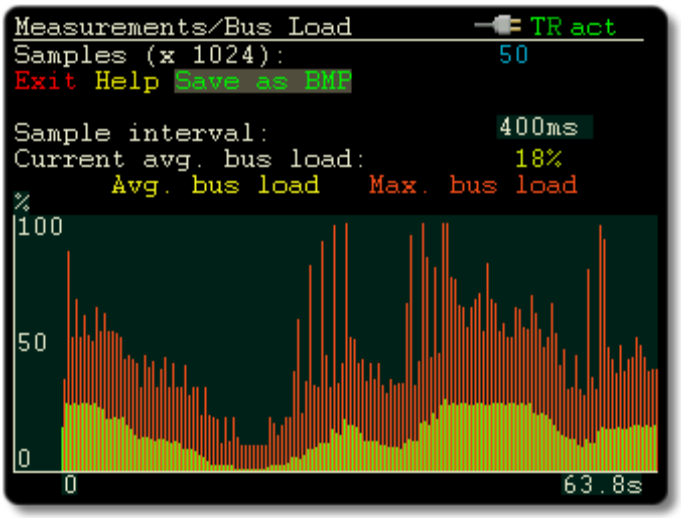
Main menu item **Measurements**

This chapter describes the measurement functions of the DeviceNet Detective. The oscilloscope function is covered in the following chapter 7.

6.1 Bus Load

Menu item **Measurements** > **Bus Load**

The percentage utilization of the CAN bus with CAN messages is shown in a graph over a period of time and is continuously updated.



Bus load diagram

The graph is put together out of sampling intervals whose duration results from the set CAN bitrate and the given number of **Samples**.

Per sample value an average and a maximum value of the bus load are calculated and shown as bars.

You can counter a high bus load with the following measures:

- Raise the bitrate of all CAN nodes on the bus.
- Increase the cycle time of specific messages in the CAN net in order to reduce their emergence (less CAN messages per time).

Save as BMP

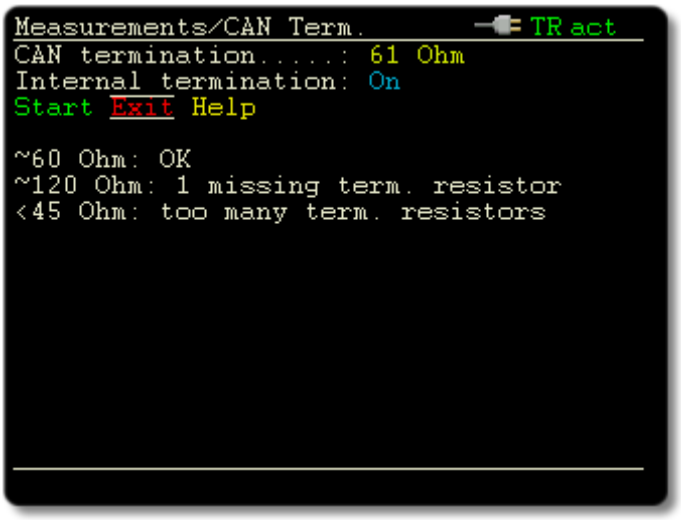
A bitmap screenshot of the bus load screen is saved on the internal memory card (file name: `pict000.bmp` with sequential number).

On the memory card the files are written to the directory of the active project (`Projects` > `<project name>`). Get the name of the active project from the lower status bar in the main menu.

Access to the saved files is achieved from a PC via a USB connection. See chapter 11.

6.2 CAN Bus Termination

Menu item **Measurements** > **CAN Termination**



The function measures the resistance value between the CAN_L and CAN_H lines. While doing so the CAN traffic is not affected.

A High-speed CAN bus (ISO 11898-2) must be terminated with 120 Ω on both ends between the CAN lines CAN_L and CAN_H. This measure will prevent signal reflections at the cable ends and a correct function of CAN transceivers attached to the CAN bus is assured.

The two termination resistors in parallel result in a total resistance of 60 Ω. The measurement of the total resistance provides information about a correct CAN bus termination.

CAN termination

Indicates the measured resistance value.

Measurement	Interpretation
~ 60 Ohm	The termination at the CAN bus is ok in terms of measurement. Make sure that the termination resistors are positioned at each end of the bus and not, for example, at taps in the middle of the bus.
missing	The CAN bus is missing any termination resistor, or the used resistor is too large. Set up a correct termination as described above.
~ 120 Ohm	Only one termination resistor is present. Install a further 120-Ohms resistor at the opposite bus end.
< 45 Ohm	Too many termination resistors are present at the CAN bus. A reason may be that on one bus end both a separate termination resistor as well as a CAN node with internal termination are installed.
--- Ohm	The measurement was not successful.

Measurement	Interpretation
not cal. (after the resistance value)	The measurement facility is not calibrated, meaning that the indicated measuring value may have a larger deviation from the actual resistance value. Please contact our support about a calibration.

Internal termination

If **On**, the internal termination resistor (124 Ω) is activated.

Altering the setting at this place is only temporary (until switching off the device). The internal termination can be set permanently in the **Device Settings**.

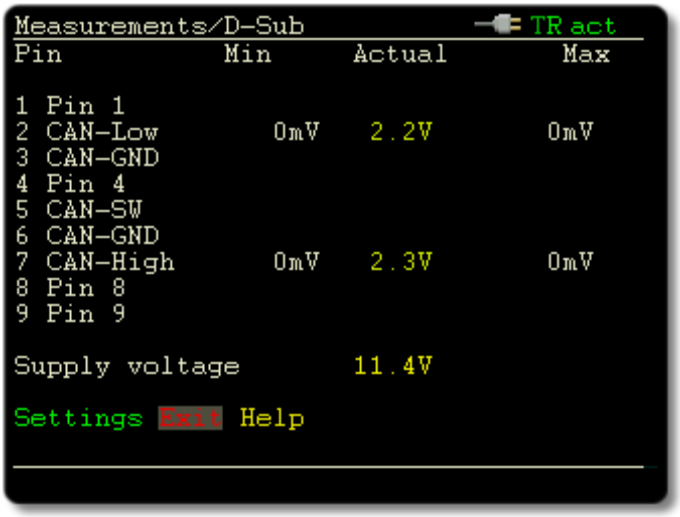
Start

The measurement is repeated. This may be useful after doing changes on the CAN bus.

6.3 Voltages on the D-Sub Connector

Menu item **Measurements** > **D-Sub Connector**

The voltage levels for each pin of the D-Sub connector are measured and listed under **Actual** in the table. On the basis of the voltage levels on the pins conclusions can be made about the correct installation or function of the CAN bus.



Example: When a High-speed CAN transceiver is idling (no CAN traffic), the signal lines CAN_High and CAN_Low have about 2.5 Volts. If the measured voltage differs significantly, the CAN transceiver of a CAN node may be defect.

Note: Because of a delay at voltage measurement due to technical reasons, transient voltage fluctuations cannot be detected reliably.

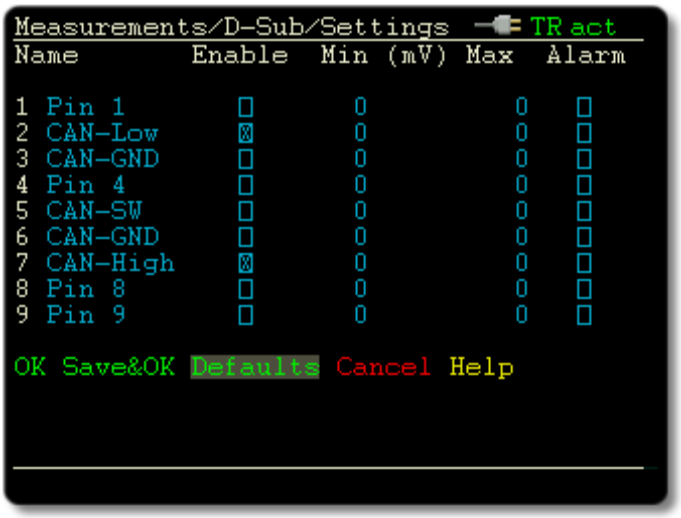
Supply voltage

Displays the measured supply voltage. The used voltage source is shown in the top line:

Symbol	Voltage source
	Externally via supply socket (e.g. with the supplied AC adaptor)
	Inserted (rechargeable) batteries

Settings

Customize the view for each pin.

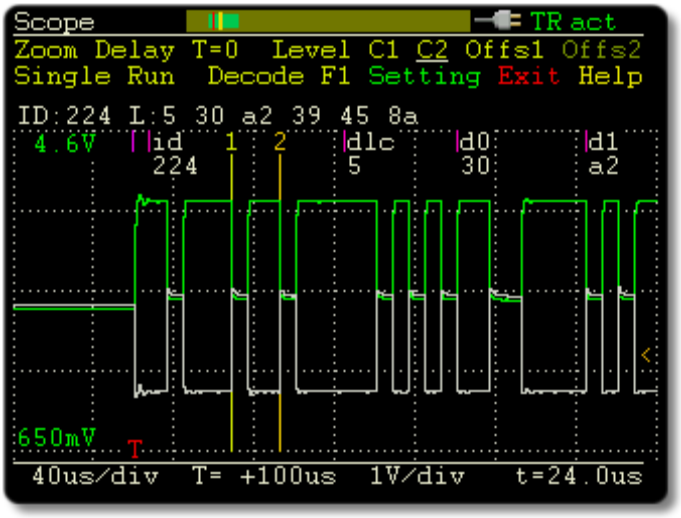


Element	Function	Comment
Name	Arbitrary pin name	
Enable	Measurement and display of the pin's voltage value (on or off)	The measurements at the pins are done in succession. If only a few pins are enabled, the measurements for an individual pin are happening more often.
Min Max	Valid voltage range for that pin, designation in mV (-32000 to 32000)	This designation is only for display and does not have a functional background (beside alarm).
Alarm	Alarm sound when exceeding the valid voltage range (on or off)	- Not at transient voltage fluctuations - Device setting for beeps (**Device Settings** > **Beeper**) must be activated
Defaults	Resets the whole measurement display to defaults	

7. Oscilloscope Function

Main menu item **Scope**

The oscilloscope function is used for in-depth diagnosis of the CAN signals on the connected lines. The handling of the function is similar to a standard storage scope.

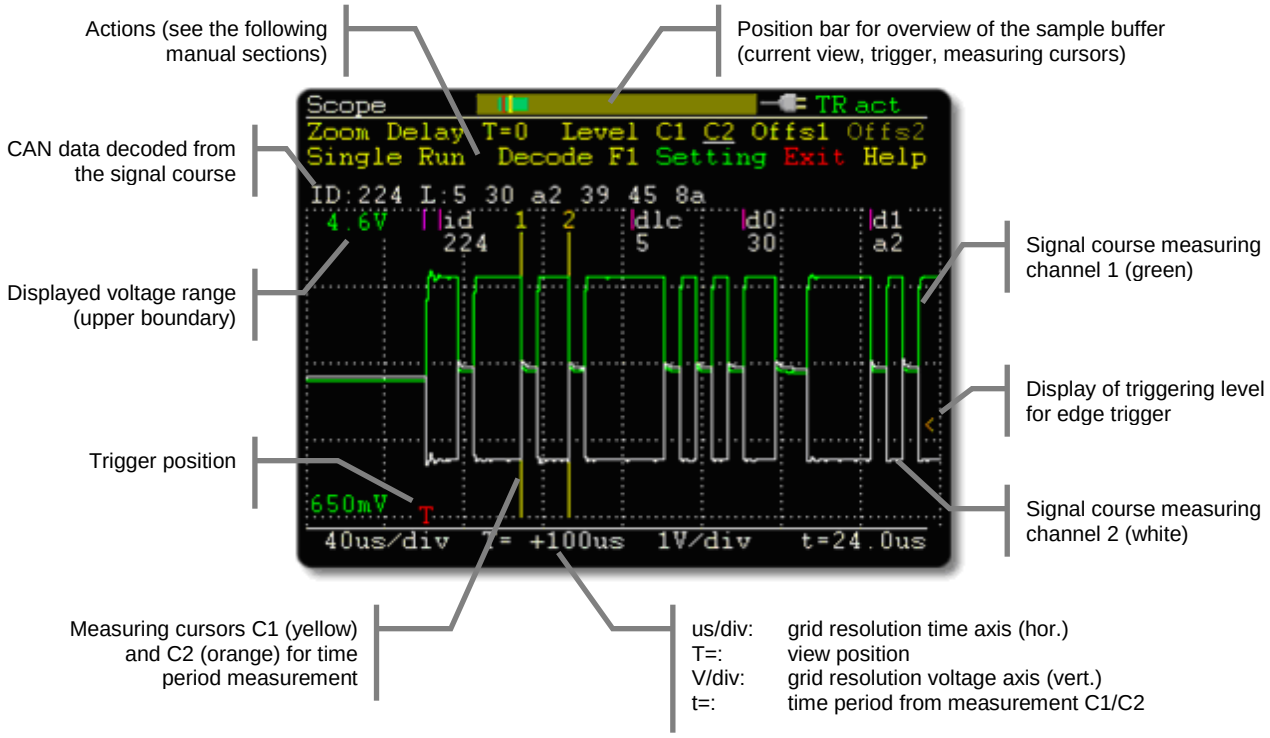


Recorded CAN signal in the oscilloscope function

7.1 Properties of the Oscilloscope Function

- Two independent channels having a maximum sampling frequency of 20 MHz each
- Memory depth can be set to up to 64 kSamples
- Display of the CAN-High and the CAN-Low signal as well as the difference of both signals
- Time measurement with a resolution of up to 50 ns
- Inspection of external signals (with frequencies up to 1 MHz) with a probe via the BNC connection
- Configuration of trigger to frame start, frame end, CAN errors, CAN ID, or signal edges.
- External measurement devices can be triggered using the BNC connector
- Depiction of raw CAN frames
- Decoding of CAN frames from the recorded signal course
- Current view can be saved as bitmap screenshot
- Saving the recorded sample data as CSV file

7.2 Elements of the Scope Screen

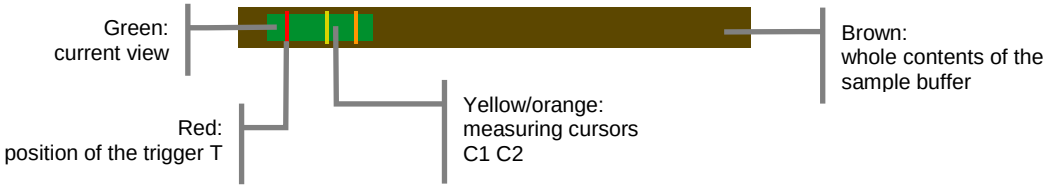


7.3 Adjusting the View

With the following functions the current view on the horizontal axis (time axis) is adjusted.

Element	Function
Zoom	Zooming in or out horizontally. The reference point for zooming (left, middle, right) can be set under **Setting** > **Zoom**.
Delay	Shifting the view horizontally. The indicator **T=** in the lower status bar shows the position of the view related to the trigger.
T=0	Aligns the view centered to the trigger position. The trigger position is always the origin of the time axis.

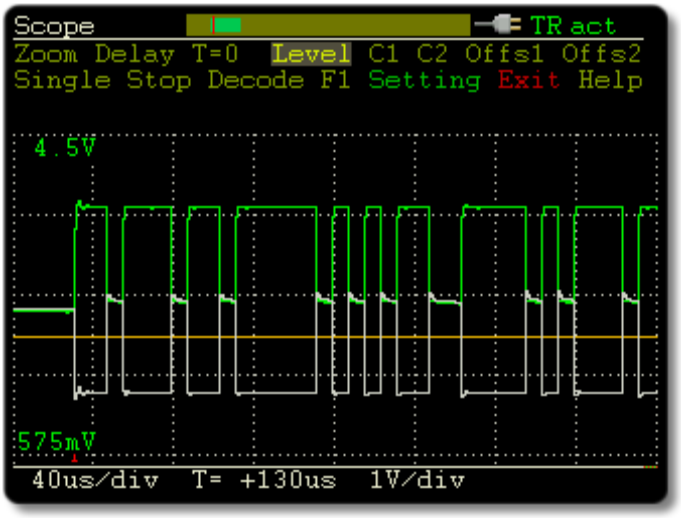
The position bar on the top of the scope screen gives an overview.



7.4 Adjusting the Trigger Level

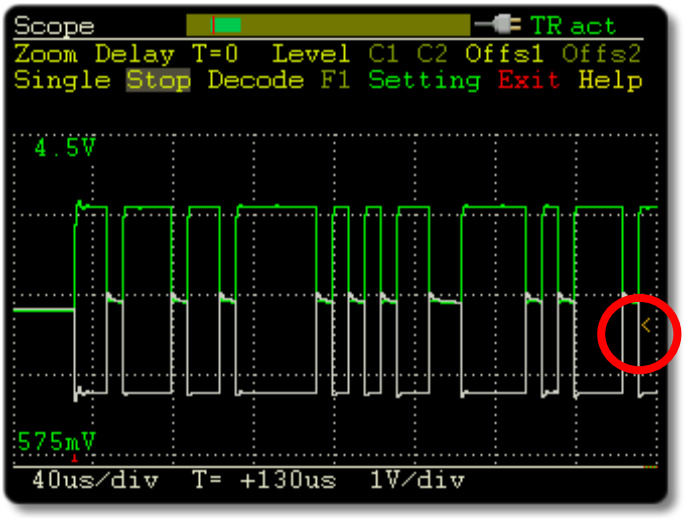
If the oscilloscope trigger is set to a rising or falling edge (**Setting** > **Trigger** > **pos./neg. edge Ch2**), the voltage level for triggering can be adjusted with **Level**. This is done by moving the orange horizontal line.

Note: The level triggering always refers to the measuring channel 2 (white signal course on the scope screen).



Adjustment of the trigger level (line)

During measurement operation the currently set trigger level is indicated by an orange arrow on the right screen border.



Indication of the trigger level on the right

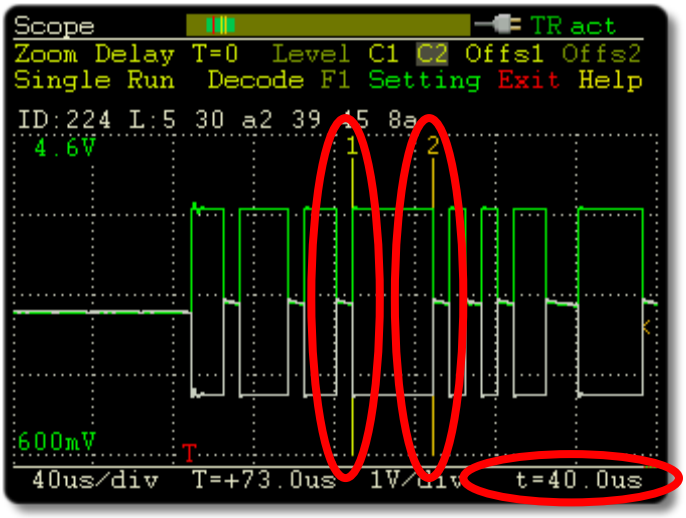
7.5 Measuring a Time Period

A section of the time axis can be marked on the screen with the two cursors C1 and C2 (vertical lines) in order to measure a time period.

Do the following to measure a time period:

1. If the menu entries **C1** and **C2** are not available (brown), activate the cursor display by setting **Setting** > **Show cursors** to **Yes**.
2. Select **C1** and set the desired start point of the time period by dialing and finally pushing the button.
3. Repeat the procedure with **C2** in order to set the end point of the time period. This must be positioned to the right of the start point.
4. In the lower status bar read the length of the time period from **t=**.

Tip: You can measure a large time period with the highest possible time resolution by zooming in (**Zoom**) before positioning the cursor. Then the cursor can be positioned with a finer time resolution that will not be lost when zooming out afterwards.



Time period measurement with cursors C1 and C2

7.6 Vertically Moving Curves

The vertical offset for the display of the signal courses of both measuring channels is either determined automatically (**Setting** > **Auto offset** > **Yes**) or can be adjusted manually with **Offs1** and **Offs2**. The vertical shifting is either done together or separately for the two measuring channels (**Setting** > **Separate offsets Ch1/2**).

Note: When adjusting manually with **Offs1** or **Offs2**, an activated auto-offset function is deactivated.

7.7 Recording Signals

Single

Waiting for the set trigger event and single recording of the signal (filling the sample buffer).

Run

Repeated waiting for the set trigger event and recording of the signal until **Stop** is clicked.

The trigger event to be used is selected with **Setting** > **Trigger**.

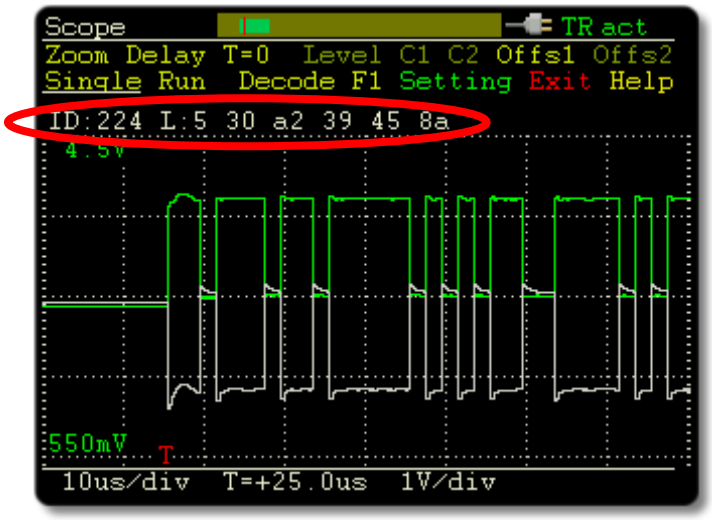
Settings related to the recording (sampling) are adjusted with **Setting** > **Sample rate**, **Pretrigger**, and **Sample buffer size**.

7.8 Decoding the CAN Signal Course

A CAN frame detected in the signal course is automatically decoded. The start of a CAN frame must lie in the current view. If several CAN frames are shown, the first one is used.

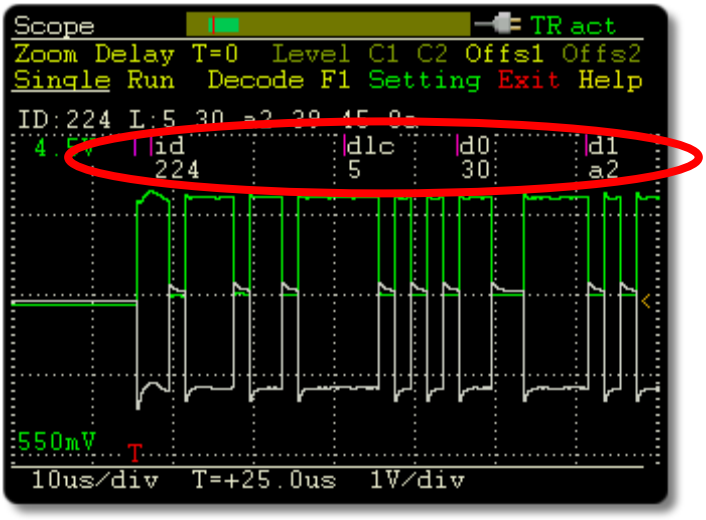
The following information is displayed above the grid in white letters:

- CAN ID (ID)
- data length (L)
- data in hexadecimal format or RTR (Remote Transmission Request)



Decoded signal course

Additionally to the data in the CAN frame, the segments of the CAN frame can be displayed with markers in the signal course: **Setting** > **Show decoded segments** > **Yes**



Additional segment indication at decoding

Decode

Triggers a manual decode action. This function is intended for cases where no automatic decoding happens, e.g. after shifting the current view to another CAN frame in the sample buffer.

7.8.1 Troubleshooting at Decoding

Decoding display	Meaning	Possible measure(s)
Red data	Faulty CAN frame	Set the device's CAN bitrate to the one on the connected CAN bus: - **Device Settings** > **CAN bitrate** - **Device Settings** > **Detect CAN bitrate**
	No remote CAN node transmitting an acknowledge*	- Running more than one active node on the CAN bus - Running Detective without listen-only mode
Empty	No CAN frame detected	Shift the current view with **Delay** until the beginning of a CAN frame is shown; execute **Decode** afterwards.

* If the frame segments are displayed at decoding, the error “noack” appears at the end of the frame.

7.9 Saving Recorded Data

With the special function **F1** the screen contents is saved as bitmap or the current sample buffer is saved as CSV file, both to the internal memory card. The actual function is depending on **Setting** > **Function F1**.

Note: The saving can take several seconds.

On the memory card the files are written to the directory of the active project (`Projects` > `<project name>`) and can be read later from a connected PC via USB. Get the name of the active project from the lower status bar in the main menu.

Note: As long as a USB connection to a PC is established, recorded data cannot be saved with the F1 function.

7.9.1 Structure of the CSV File

A CSV file contains data in lines in text format. As separator the semicolon (;) is used. For further use the file can be taken into an arbitrary spread sheet, for example.

Row	Contents	Structure
1	Device name and firmware version	string
2	Transceiver type	string
3 – 4	Signal source measuring channels 1 and 2	string
5	Number of samples	name;count
6 – 7	Voltage scale measuring channels 1 and 2	name;value

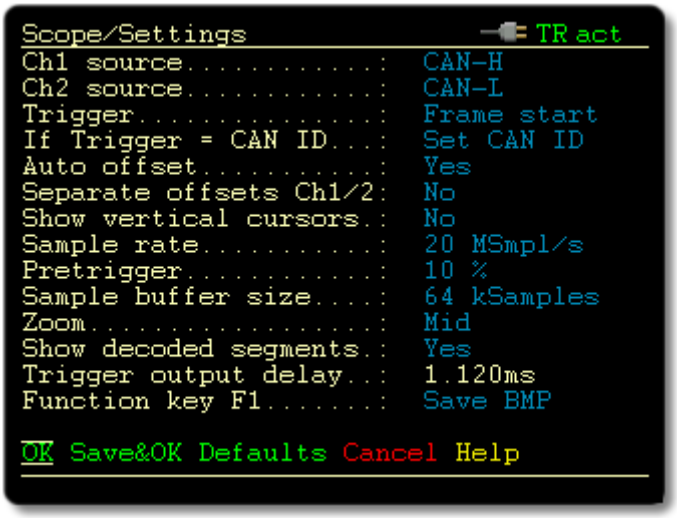
Row	Contents	Structure
8 – 9	Voltage offset measuring channels 1 and 2	name;value
10	Time scale samples values [s]	name;value
11	Time offset samples values [s]	name;value
12	Column name for the following sample values	name;name;name
13+	Numbered sample values	number;value;value

Calculations for a sample value (in brackets: row):

- Time:
  `Time(13+) * Timebase(10) + Time Offset(11)`
- Voltage, for measuring channels 1 and 2 each:
  `Channel(13+) * Scale Channel(6/7) + Offset Channel(8/9)`

7.10 Settings for the Oscilloscope Function

Menu item **Scope** > **Setting**



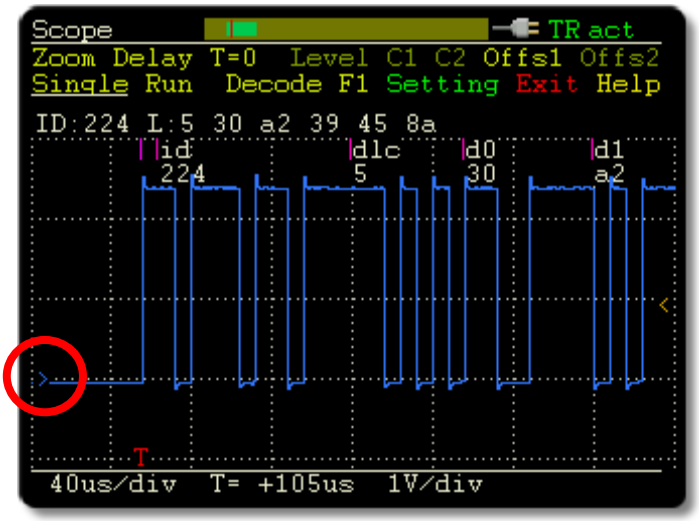
7.10.1 Ch1 source

Selection of the signal source for the display of measuring channel 1 (green course).

Setting	Description
CAN-H	CAN_High signal from the D-Sub connector (High-speed CAN, Low-speed CAN)
Off	Measuring channel 1 is not shown

7.10.2 Ch2 source

Selection of the signal source for the display of measuring channel 2 (white course).

Setting	Description
CAN-L	CAN_Low signal from the D-Sub connector (High-speed CAN, Low-speed CAN)
Probe (low)	External signal from the BNC connector, voltage range -3 to +15 V
Probe (high)	External signal from the BNC connector, voltage range -10 to +50 V
CAN-L CAN-Diff CAN-Diff	Difference of CAN_High and CAN_Low (High-speed CAN, Low-speed CAN); display as blue course on the scope screen, either in addition to the CAN_Low signal or alone  Display of the difference of CAN_High and CAN_Low with indicator for the zero line (marker)
Off	Measuring channel 2 is not shown

Attention! The voltage of an external signal may have a **maximum of ±50 V**. Higher voltages can lead to a defect of the device.

Depending on this setting the BNC connection is either used as trigger output or as signal input. More information in chapter 10.

7.10.3 Trigger

Selection of the event that triggers the sampling of the signals (trigger event).

Setting	Description
FrameStart	Start of a recognized CAN frame
FrameEnd	End of a recognized CAN frame
Free-running	Free-running sampling without trigger, the sample buffer is filled repeatedly
CAN ID	CAN frame with the CAN ID being indicated in the following setting (item 6.10.4)
CAN Error	A faulty CAN frame
pos. edge Ch2 neg. edge Ch2	Rising or falling edge of the signal from measuring channel 2. The trigger level is adjusted with Level on the scope screen.

Tip: The edge control can also be used for triggering by an external source if Ch2 source is either set to Probe (low) or to Probe (high).

Triggering runs independently from the setting of the signal source for the two measuring channels (Ch1 source/Ch2 source).

7.10.4 If Trigger = CAN ID

If CAN ID is selected as trigger event, the CAN ID indicated here is used. Via set CAN ID you get to the corresponding settings.

Setting	Description
Frame format	Length of the CAN ID (11 bit or 29 bit)
Frame type	Data frame or remote frame (RTR)
CAN ID	Enter the CAN ID in hexadecimal format

7.10.5 Auto offset

Setting	Description
Yes	Automatic vertical offset for the measuring channels 1 and 2
No	Manual adjustment of the offset on the scope screen with Offs1 and Offs2

Note: When adjusting manually with Offs1 or Offs2, an activated auto-offset function is deactivated.

7.10.6 Separate offsets Ch1/2

Setting	Description
Yes	Separate vertical offsets for the measuring channels 1 and 2
No	Common offset for both measuring channels. The manual adjustment on the scope screen is done with Offs1 for both measuring channels. Offs2 is not available.

7.10.7 Show cursors

Activates cursors for measurement of a time period. The cursors are moved on the scope screen with C1 and C2.

7.10.8 Sample rate

Sets the oscilloscope's sample rate for both measuring channels. Lower sample rates than 20 MS/s may be useful if you want to monitor a broader signal course. However, the resolution also decreases.

7.10.9 Pretrigger

A part of the signal course is shown before the trigger point. The percentage indicates the part of the whole course. Possible ratios: 10:90, 50:50, 90:10

7.10.10 Sample buffer size

Changes the buffer size and with this the record length. Smaller buffer sizes are useful if the repetition of the sampling run shall be faster.

The record length results from the quotient of the sample buffer size and the sample rate.

Example: 64 kSamples / 20 MS/s = 3.2 ms

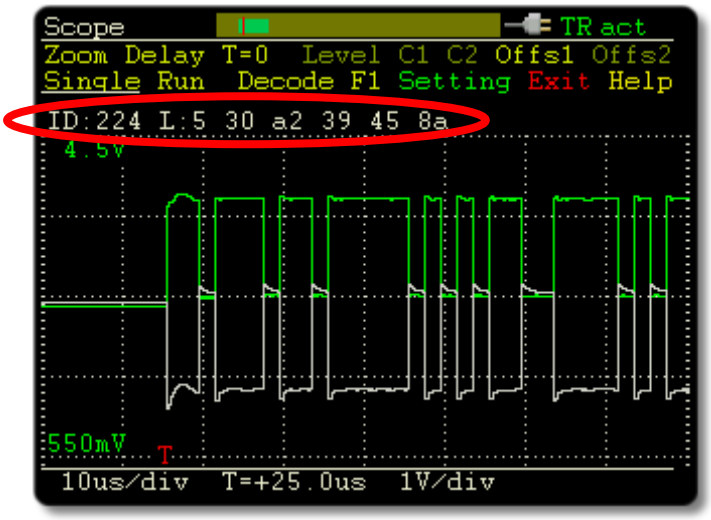
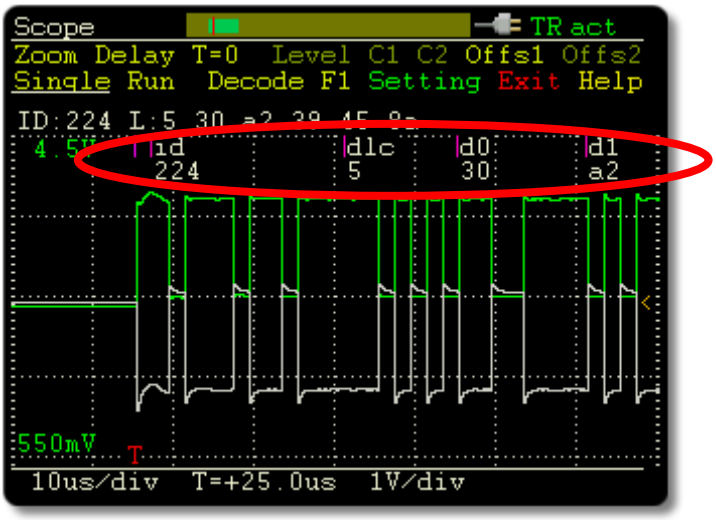
7.10.11 Zoom

Selects the fixpoint for zooming: left border, right border, or center.

7.10.12 Show decoded segments

Determines the type of display on the scope screen for CAN data being decoded from the signal course.

Setting	Description

Setting	Description
No	The scope screen only shows the data of the decoded CAN frame above the grid. 
Yes	In addition to the data of the CAN frame, the segments of the CAN frame are displayed with markers in the signal course. 

Segment label	Designation in the CAN specification 2.0	Description
| (purple)	SOF bit	Frame start (dominant bit)
Id	Arbitration field	CAN ID and RTR bit
dlc	Control field	Number of data bytes
d0 - d7	Data field	Data bytes

Segment label	Designation in the CAN specification 2.0	Description
crc	CRC field	Check sum
ack	ACK field	Reception control
eof	EOF field	Frame end (7 recessive bits)
ERROR	Error flag	Error frame

7.10.13 Trigger output delay

The internal trigger signal is also available externally on the BNC connector (not with **Ch2 source** = **Probe (low)**, **Probe (high)**). Due to technical reasons the output is delayed. The delay time is indicated here.

You can find details about the delay in section 10.1.

7.10.14 Function key F1

Determines the action when **F1** is selected on the scope screen:

Setting	Description
Save BMP	A bitmap screenshot of the scope screen is saved on the internal memory card (file name: `pict000.bmp` with sequential number).
Save data	The contents of the sample buffer is saved to the internal memory card in CSV format (file name: `data000.csv` with sequential number).
Save BMP&data	A screenshot as well as the contents of the sample buffer are saved to the internal memory card. Both file names get the same number.

Access to the saved files is achieved from a PC via a USB connection. See chapter 11.

8. Maintenance Functions for the Device

Main menu item **Internal Statistics**

The page gives an overview about the device's internals. The specifications are usually used for support.

Furthermore, hardware functions are available for maintenance of the device. They are described briefly in the following.

Important note: Misapplication of these functions can lead to the unavailability of the device. Use the functions only on request of PEAK-System's technical support.

Update Firmware

Firmware updates (`*.bin`) can be placed in the `/PCANDiag/Firmware/` directory on the internal memory card. With the update function a file is selected. Thereupon the update procedure is starting.

Factory Defaults

All settings are reset to their default states defined by the current firmware.

Bootloader

Starts the boot loader for a firmware update via CAN. The screen also shows the serial number of the Detective.

9. Browsing the Internal Memory Card

Main menu item **Memory Card**

The DeviceNet Detective has functions to show directories and bitmaps from the internal memory card.

Note: The Detective cannot access the memory card as long as a USB connection to a PC is established.

Show Directory

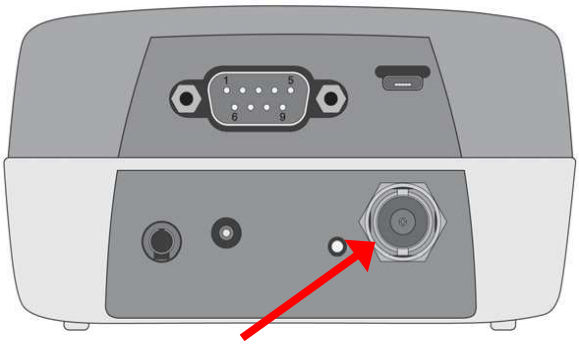
Shows the directories on the memory card in order to see which files exist.

View Bitmap

Only bitmap files (`*.bmp`) are shown in the directories (e.g. screenshots from the scope screen which have been created with the F1 function).

Click on a bitmap to view it; click again to leave the bitmap view.

10. BNC Connector



BNC connector on the rear of the device

The function of the BNC connector depends on the setting for measuring channel 2 (**Scope** > **Setting** > **Ch2 source**).

Setting Ch2	Function BNC	Description in section
Off **CAN-L** **CAN-L CAN-Diff** **CAN-Diff**	Trigger output	10.1
Probe (low) **Probe (high)**	Input for an external signal for inspection and trigger purposes	10.2

Attention! The voltage of an external signal may have a **maximum of ±50 V**. Higher voltages can lead to a defect of the device.

10.1 Trigger Output

Other measuring devices or oscilloscopes, e.g. not capable of CAN-specific measurements, can pick off a trigger signal that is evoked by the internal oscilloscope function of the Detective.

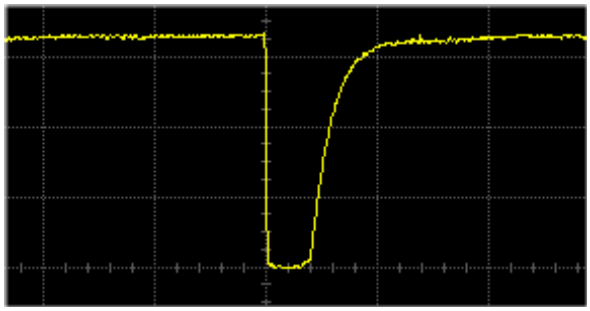
The trigger output is active if the measuring channel 2 (Ch2) of the oscilloscope function is set to the CAN input:

Scope > **Setting** > **Ch2 source** > **CAN-L** / **CAN-L CAN-Diff** / **CAN-Diff**

When a trigger event occurs in the oscilloscope function, a trigger signal is output on the BNC connector with the following properties:

Trigger output	
Idle state	+3.3 V
Trigger event	0 V (falling edge)

Trigger output	
Pulse duration	4 CAN bit timings, actual duration depending on the set CAN bitrate (at 500 kbit/s: 4 * 2 µs = 8 µs)
Delay to the internal trigger	140 CAN bit timings, actual duration depending on the set CAN bitrate; is displayed in the scope settings at **Scope** > **Setting** > **Trigger output delay**



Course of the trigger signal, 20 µs/div

10.2 External Signal

Instead of the CAN signal CAN_Low the measuring channel 2 (Ch2) of the oscilloscope function can sample an external signal for inspection and trigger purposes coming from the BNC connector.

Attention! The voltage of an external signal may have a **maximum of ±50 V**. Higher voltages can lead to a defect of the device.

The BNC connector is used as input if measuring channel 2 (Ch2) of the oscilloscope function is set as follows:

Scope > **Settings** > **Ch2 source** >

Setting	Measuring range	Maximum frequency
Probe (low)	-3 - +15 V	1 MHz
Probe (high)	-10 - +50 V	1 MHz

In addition the external signal is used as trigger if the triggering of the oscilloscope function is set as follows:

Scope > **Settings** > **Trigger** >

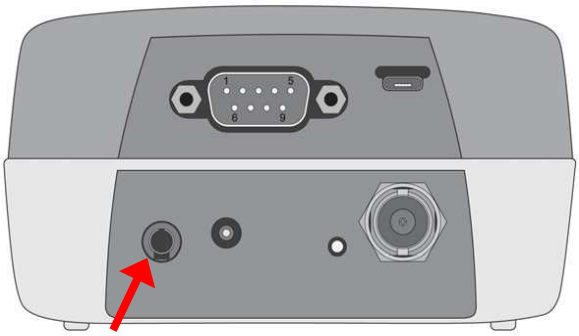
Setting	Triggering
pos. edge Ch2	rising edge
neg. edge Ch2	falling edge

10.2.1 Probe

A probe can be used for the external signal (not in the scope of supply). Suitable is a standard probe without additional electronics, which is operated with setting x1. The x10 cannot be used.

10.3 Ground Socket

In order to establish a separate voltage ground connection between the DeviceNet Detective and the measuring object, a ground socket (4 mm) is provided.



GND socket (4 mm) on the rear of the device

11. USB Connection with a PC

A USB connection to a PC is used for access to the internal memory card of the DeviceNet Detective. The PC's operating system binds the memory card into the file management, e.g. under Windows as mass storage device.

Internal memory card	
Size	at least 1 GB
File system	FAT32
Name of the USB device	PCAN-DIAG

The memory card can also be accessed if the Detective is switched off. At startup of the device the USB connection is briefly interrupted.

11.1 Unplugging the USB Connection

Before unplugging the USB cable from the PC or the Detective, the device should be logged out of the operating system. This procedure ensures that the operating system has correctly finished a write process to the internal memory card of the Detective.

Windows: Safely remove hardware icon in the taskbar notification area

11.2 Purposes of the USB connection

- Access to the trace, bitmap, or CSV files created by the Detective
- Placing a *.bin file for a firmware update into the directory `/PCAN-Diag/Firmware/`
- Storage space at your disposal

11.3 Restriction for Diag Functions

During a USB connection to a PC some functions of the Detective are limited, because the device cannot access the internal memory card at the same time as the connected PC:

- At startup no splash screen is shown.
- The recording of CAN traffic (trace) does not work.
- The commands in the **Memory Card** menu do not work.

- On the scope screen the F1 function for saving screenshots
- and/or sample buffer data cannot be used.
- The bus load diagram cannot be saved as bitmap.
- Help texts are not shown.

11.4 Files on the Internal Memory Card

Directory – file	Function
/PCAN-Diag/	Fixed storage branch for files that are accessed by the Detective or that are related to the device
Projects/<project name>/	Projects; a subdirectory with the project name for each project; Default: project with default settings
*.dpf	Project file; contains: settings, CAN transmit lists, links to symbol files
*.sym	Symbol file in text format; not applicable to the DeviceNet Detective.
*.syb	Symbol file in binary format; not applicable to the DeviceNet Detective.
Intro.bmp	Splash screen at startup of the device (320 x 240 pixels)
pict000.bmp	Screenshots of the scope screen and of the bus load diagram; numbering by the internal counter
data000.csv	Data from the sample buffer; CSV format, used e.g. in spreadsheets; numbering by the internal counter
trc00000.btr	Binary-coded trace data from the recording function, usable for conversion on the PC; numbering by the internal counter
Help/*.dhp	Files with the device help
Tools/	Software tools to be used with the DeviceNet Detective (the following only lists the executables)
PEAK-Converter.exe	Windows program PEAK-Converter for converting of a recorded binary trace file (*.btr) into another format.
Firmware/*.bin	File(s) for updating the firmware
Documentation/	Documentation about the DeviceNet Detective, e.g. this manual

The DeviceNet Detective is operational even without the directory branch `/PCAN-Diag/` on the internal memory card. However, no splash screen and no help texts are displayed. Furthermore, saving of screenshots, data from the sample buffer, or traces is not possible.

Tip: If the directory branch `/PCAN-Diag/` is missing on the internal memory card, you can copy it from the supplied CD:

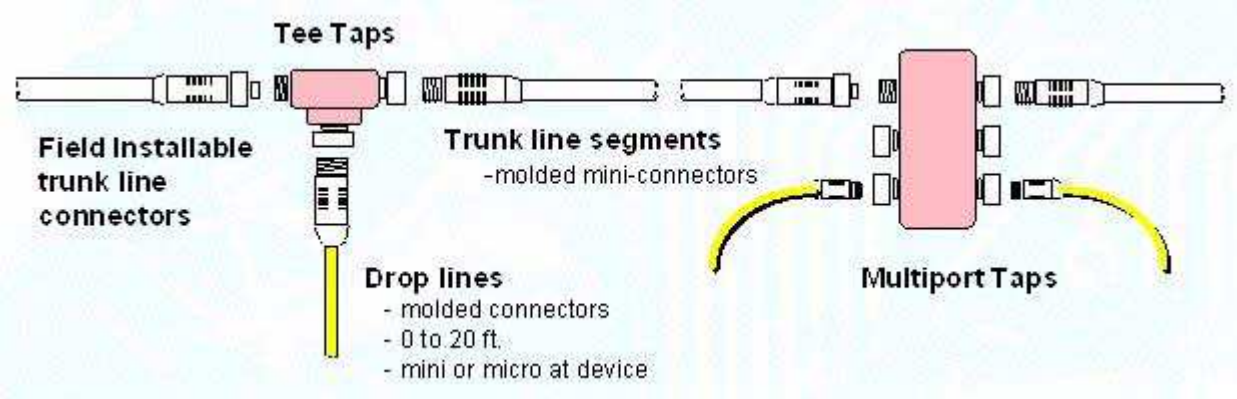
`/DND SDCard Image/PCAN-Diag/PCAN-DiagV2/`

Alternatively, a ZIP package is available for download from the DeviceNet Detective 2 product page of our website:

http://gridconnect.com

12. DeviceNet Reference

12.1 DeviceNet Network Components



12.2 Component Definitions

Trunk Line: The network cable between the terminators. This is usually (but not necessarily) a ‘thick’ cable.

Drop Line: The network cable between the trunk and the nodes.

Tap: A branching point from the trunk line. There may one node on a drop line, as with a tee tap, or multiple drop lines, as with a multi-port junction box.

Terminating Resistor: The 121-ohm resistor that connects to the end of the trunk. There are two terminators per network.

Node: An addressable device that communicates on the network. There may be as many as 64 nodes per network.

Power Supply: The 24 volt DC source that powers network communication. There may be multiple power supplies on a network, and they may be located anywhere on the network.

12.3 DeviceNet Wiring and Pin Definitions

The table below shows the connector pin / color definitions.

Name	Color	Description
Shield	Drain	Bare connection to the shielding in the cable
V+	Red	24VDC Bus Supply
V-	Black	Common Ground OVDC
CAN_H	White	High differential data
CAN_L	Blue	Low differential data

There are three connector types commonly used on DeviceNet systems: mini, micro, and open (screw terminal). The following table shows the voltages measured between pins.

Signal	5-Pole Open Connector	Sealed Mini Connector	Sealed Micro Connector
V– to V+	Pin 5 to Pin 1 ≅24 VDC	Pin 2 to Pin 3 ≅24 VDC	Pin 2 to Pin 3 ≅24 VDC
CAN_H to V-	Pin 4 to Pin 1 ≅3.5 VDC	Pin 4 to Pin 3 ≅3.5 VDC	Pin 4 to Pin 3 ≅3.5 VDC
CAN_L to V-	Pin 2 to Pin 1 ≅2.5 VDC	Pin 5 to Pin 3 ≅2.5 VDC	Pin 5 to Pin 3 ≅2.5 VDC

13. DeviceNet Troubleshooting

13.1 Basic DeviceNet Tips for Beginners

90% of DeviceNet Problems Are Physical Media Problems

You can isolate these problems with simple tests and the right tools. This document walks you through these tests and shows you which tools you can use to get the job done.

Build Your Network One Node At A Time

If you are a first time user, putting in a new system, start by adding one device at a time. Then you can always go back a step, if necessary, and get things working again.

Wherever Possible: Return To The Point Where Everything Worked

The first question to ask is “What has changed?” If you have added or replaced nodes, changed wiring, or configured a scanner, go back to where you were working and look for a problem. If you can’t find a problem where you were just making changes, you need to determine if the problem is caused by the physical media, a node communication fault, or the network power distribution.

Purchase ODVA Conformance Tested Products

Products with this logo have been conformance tested to ODVA specifications. This dramatically reduces your chances of having network problems!

13.2 Know the Layout of Your Network

Look at your network, and determine the location of each component.

Inspect your network topology

- The trunk cabling connects nodes and taps. A 121 Ohm terminating resistor is needed at each end.
- The drop lines are non-terminated cables that connect nodes to the trunk line.

Mark the locations of nodes

- Count the nodes and note their location on the network, and note assigned node numbers.

Locate power supplies

- There may be more than one power supply on a network, located at the end middle, or anywhere along the cable. One of the power supplies must be the sole grounding point for all network power.

Check Wiring

- Check the wiring and pin connections. Refer to the diagrams in a previous section.
- Are your drop Lines too long? If the length of one drop, or the total amount of drops, exceeds the permitted length, you may see large variations on CAN signal amplitude throughout the network.
- Is your trunk line too long? Long trunk lines can cause "transmission line problems" in which delays in the network cause faulty reception of messages. You may see this as CAN frame errors. Also, see “Common Mode Voltage Problems.”

DeviceNet Topology Restrictions	125 kbps	250 kbps	500 kbps
Thick Trunk Length	500m (1640ft)	250m (820ft)	100m (328ft)
Thin Trunk Length	100m (328ft)	100m (328ft)	100m (328ft)
Maximum Length of a Single Drop	6m (20ft)	6m (20ft)	6m (20ft)
Cumulative Length of All Drops	156m (512ft)	78m (256ft)	39m (128ft)

13.3 Check the 24-Volt Power

The following table lists some common network problems and possible solutions.

If your network is doing this…	Then do this…
Nodes near the end of the trunk stop communicating after operating normally.	Check the bus voltage at the node and the common mode voltage at the ends of the bus.
The scanner or multiple nodes go to the bus-off state after operating normally.	Check common mode voltage and power supply/shield grounding.
The scanner does not detect properly configured slave nodes.	Check power supply/shield grounding and common mode voltage.
The network communicates only when the number of nodes is reduced or the trunk length is reduced.	Check the bus voltage at the node and the common mode voltage at the ends of the bus.

If devices on the network draw large amounts of current, then network voltage levels may fluctuate as your equipment cycles.

- Check network voltage a various points across the network, especially at the ends. The voltage drop in the cable between a power supply and each station it supplies does not exceed 5VDC.
- Monitor the network to determine the voltage range of V+ over a period of time.

In the ‘Detective Settings’ menu, set a supply alarm voltage and plug the Detective in at a location far from the power supply. Leave the Detective running as your process runs over time. If the network voltage falls below the set level, the event will appear on the problem list.

Tips on Power Supply Grounding

- Physically connect DC power supply ground wire and the shield together to earth ground at the location of the power supply.

- If you use multiple power supplies, connect this ground only at the power supply closest to the middle of the network. Make sure that all nodes on the network connect to the shield, the signal and power lines
- CAN frame errors are a typical symptom of grounding problems. Monitor CAN Error Messages with a Detective or CAN bus analyzer.

13.4 Check the Signal Voltage Levels

It is extremely helpful to check CAN signal levels. Below are typical values you should see. Numbers differing from this table by more than 0.5V are likely indications of a problem:

Power supply voltage (V+ red to V- black): 24 Volts (11V min / 25V max)			
If Bus Communication is ON		If Bus Communication is OFF (idle)	
CAN_H (white)	~3.2V DC	CAN_H	~2.5VDC
CAN_H differential signal voltage range relative to V-	~2.5V min (never <2.5V) to 4.0V max (Typ. 1.5V p-p)	CAN_H AC voltage range	2.5V min / 2.5V max (0V p-p)
CAN_L (blue)	~2.2V DC	CAN_L	~2.5VDC
CAN_L differential signal voltage range relative to V-	~1V min and 2.5V max (never > 3.2V)	CAN_L AC voltage range	2.5V min / 2.5V max (0V p-p)

Notes:

- CAN_H should never be lower than CAN_L. If this condition occurs, this is a "CAN signal twist" and you should look for a direct physical cause (CAN_H and CAN_L shorted together; CAN_H shorted to ground; faulty transceiver circuitry).
- Typically if the lowest value of CAN_L to the highest value of CAN_H is more than 3 volts, this indicates a problem, either physically or with high bus traffic.

Detecting Intermittent Shorts / Faults

Some shorts may only appear at certain points as a machine cycles, or else randomly. The DeviceNet Detective can monitor the network for intermittent shorts.

How to Detect Ground Loops

- Break the shield at the point where it is connected to the primary GROUND.
- Use an Ohm Meter to check impedance between the shield and ground.
- If the readings are high (K Ohms or more) then your network is OK.

- If the readings are low, then you have other points where the shield is grounded and you'll have ground loop problems.
- NOTE: Grounding problems may also result in CAN errors. Monitoring CAN Error Messages may also point to the source of the problem.
- Break the shield at a few points along the trunk line and insert a DC current meter. If you detect current flow, the shield is connected to DC ground in more than one place, resulting in a ground loop.

Symptoms of Physical Media Problems

If your network is doing this…	You should do this…
All of the nodes on a segment of trunk or on a drop stop communicating, then sometimes recover or go busoff.	Check all wiring and connectors on the segment between the power supply and the terminating resistor.
Nodes sporadically stop communicating, then recover.	Check for loose wiring or a loose connector leading to the node.
The network communicates only when the number of nodes is reduced or the trunk length is reduced.	Check CAN DC resistance, and terminating resistor values; Check common mode voltage.

13.5 Common Mode Voltage Test

Description of the Problem:

When current is drawn through the power pair on the DeviceNet trunk line, resistance from the conductors, and the load on the network, produces the common mode voltage drop. The V+ line decreases from the 24VDC at the power supply as distance from the power supply increases. Most importantly, V- increases from the 0VDC value at the power supply along the length of the trunk line.

This test assumes the V+ decrease and V- increase values are equal. Since CAN_H and CAN_L both are referenced to the V- wire (which is grounded at a single point) then, if the voltage on the V- line varies more than 4.65 VDC at any two points, the CAN transceivers will fail to operate properly.

Procedure for Detecting Common Mode Voltage Problems:

1. Turn all network power supplies on.

2. Configure all nodes for their maximum current draw from network power. Turn on outputs that use network power.

3. Measure and record the DC voltage between V- and the shield.

    < 4.65 volts is the normal range.

    < 3 volts is best.

    > 4.65 volts: Network will not operate properly.

Possible solutions are:

- Shorten the overall length of the network cable.
- Move the power supply in the direction of the overloaded section.
- Move nodes from the overloaded section to a less loaded section.
- Move high current loads close to the power supply.
- Add a second power supply.
- Break the network into two separate networks.

13.6 Test for Termination Resistors

If you want to check that a connected High-speed CAN bus is terminated correctly, you can use the following function: **Measurements** > **CAN Termination**

Refer for section 6.2 for more information.

13.7 Check for Noise

Of course the best way to observe noise itself is with Detective's scope function.

How to Detect Electrical Interference:

The most common symptom of EMI/RFI problems are CAN FRAME ERRORS that can be found both in the message traffic and problem list menus. You will see bursts of CAN frame errors, often connected with specific nodes. Do intermittent problems occur when other non-related equipment is in use?

Use the PROBLEM LIST to track these problems over time, and correlate events with other equipment in your facility, i.e. EMI/RFI from a Variable Frequency Drive that changes state.

13.8 Verify Communication for Each Node

Create a "Live List" to see which nodes show up.

Scan the network with your master configuration tool and create a "live list" or use the Device Diagnostic menu on the DeviceNet Detective. This will provide a list of each properly connected node and its attributes, as well as verifying that all stations are connected, that MACID's are correct, and nodes are capable of communicating with the master.

- Look for "missing" nodes. This indicates physical connection or power problems for that node.
- Check to see if nodes on the "Live List" disappear when the network communication is switched on and off.

Look for excessive Message Traffic

An important indication is the "% BUS LOAD" measurement.

- 0% means that the network is idle.

- 30-70% indicates typical network operation, depending on the configuration of each device and the nature of your process. Numbers higher than 80% should be viewed with concern.

Loads over 90% indicate definite problems. High bus loads can indicate any of the following:

- Some nodes are having difficulty making connections with other nodes and have to re-transmit repeatedly to get messages through. Check termination, bus length, topology, physical connections, grounding.
- Defective nodes can “chatter” and put garbage on the network.
- Nodes supplied with corrupt or noisy power may chatter.
- Change Of State (COS) devices may be busy with rapidly changing data & cause high % bus load. Check the Production Inhibit Timers for these nodes in the master settings.
- Large numbers of explicit messages (configuration / diagnostic data) sent can cause high % bus load.
- Note that tools can add traffic of their own. Take care that the diagnostic tool itself is restricting its message output to a safe level. Use Message Delay in the Detective Settings menu to slow down this traffic if it is excessive while scanning the network.

Identify Message Traffic and Message Types

You should not normally see much Group 1 traffic on most nodes, unless you have Change of State devices on your network. You should see lots of Group 3 traffic from the master and group 2 traffic from slaves. You should only see Group 4 traffic if there are lots of configuration and diagnostic data being exchanged.

13.9 Use LEDs for Node Status

- The LEDs on DeviceNet nodes are excellent for checking the health/status of your nodes.
- The “LED Color Codes” menu on the DeviceNet Detective REFERENCE menu helps you interpret the exact meaning of each LED state.

MODULE STATUS LED (MS)	
OFF	No Power
FLASHING GREEN	Standby, incomplete or incorrect configuration.
GREEN	Operating normally.
FLASHING RED	Has a recoverable fault.
RED	Unrecoverable fault.
FLASHING RED & GREEN	Device in self-test.

NETWORK STATUS (NS)	
OFF	Not on line; Not powered; Has not completed duplicate MACID test.
FLASHING GREEN	Device on-line but not connected to other devices.
GREEN	On-line and connected to other devices.
FLASHING RED	One or more input/output connections in time-out state.
RED	Failed communications caused by duplicate MACID or can-bus-off error.
FLASHING RED & GREEN	Failed communications, device responded to an error.

Note: Combined MS/NS indicators use the Network Status definitions.

I/O STATUS	
OFF	No I/O bus power; all inputs or outputs inactive.
FLASHING GREEN	One or more outputs are idle no outputs are active or faulted.
GREEN	Some inputs/outputs are active & no inputs are faulted.
FLASHING RED	Some inputs/outputs are faulted and may be in fault states.
RED	Some outputs are forced off Some inputs have unrecoverable faults.

13.10 Scanner/Node Settings of Importance

- On a Change Of State (COS) network, the device inhibit times may need adjustment.
- Devices may time out if the Expected Packet Rate (EPR) is not set high enough.
- On a polled network, the Inter Scan Delay (ISD) may need adjustment.
- Use your configuration tool or Detective to note what communication options your device has available.

13.11 Intermittent Communication Problems

- Do some nodes communicate properly while others do not?
- What differences are there between the functioning nodes and the others? (Proximity to the power supply, to the termination resistors, to the master scanner.)
- Faulty devices may be present (are all of your Devices conformance tested by ODVA?)

Log Total CAN Errors

You may have a large accumulated number of CAN errors if you have been connecting and disconnecting nodes. However, if you are still accumulating CAN errors while nodes are connected normally, this indicates physical media, EMI/RFI or topology problems. This could also indicate faulty nodes.

Check for Duplicate Node Addresses (MACIDs)

There is no explicit way to check duplicate addresses. If two nodes are set to the same address, one will go “offline” and just sit there silently. If nodes that should show up but fail to appear in the live list, then look for duplicate addresses for those nodes.

Check for Wrong Baud Rates

The network cannot communicate properly if some nodes have the wrong baud rate. The Detective will indicate that you have multiple baud rates on the network, but will not be able to resolve the problem beyond that point. You must disconnect the device(s) with the wrong baud rate, change their baud rates and re-connect them.

Monitor CAN Error Rate

Use this field to see when the network is in a condition of creating constant CAN errors and when it is not. Cross-reference this to the PROBLEM LIST and MESSAGE TRAFFIC menu for a total picture of the problem.

Change MACID or BAUDRATE

Software settable devices can be changed with the master Configurator, or the Detective TASK WIZARDS menu. Note that you cannot use this function when the bus is “live.” The device must be offline.

Symptoms of Node Problems

If your nodes are doing this	Do this…
Slave node is on-line, but the scanner says it does not exist.	Change the slave node address to match scanner’s scan list.
Slave node will not go online.	Change the slave node data rate to match scanner data rate.
The network communicates only when the node is removed.	Swap the node out to check for defects.
The node is in the I/O timeout state.	Reset the scanner and network power.

Limitation of the Problem List Menu

The Problem List indicates nodes that have come on and off line, bursts of CAN errors, and blatant physical media problems such as shorts. It also indicates if network voltage has gone below the alarm threshold. The Problem List will only log the 20 most recent network ‘events.’ If you have an overload of problems on this list, it indicates an immediate problem that needs to be solved right away, and that the network is not operable.

14. Technical Specifications

Power supply	
Supply voltage	Externally via supply socket: 12 V DC nominal, 8 - 50 V possible Internally with 4 (rechargeable) batteries (size AA): 4 x 1.5 V or 4 x 1.2 V DC **Note:** The device does not charge inserted rechargeable batteries.
Current consumption	External supply: 8 V (min.): 300 mA 12 V (nom.): 200 mA 24 V (DNet): 100 mA 32 V: 83 mA Operation with batteries: 5 V: 400 mA
Voltage auxiliary supply for CAN transceiver (D-Sub, pin 9)	High-speed CAN: no auxiliary supply

D-Sub connector	
Function	CAN connector
Number of pins	9
Measurement	Voltage measurement at each pin for verification purposes

CAN	
Standard transceiver	High-speed CAN ISO 11898-2 (PCA82C251)
Other transceivers	Not available on DeviceNet Detective
Termination	High-speed CAN (ISO 11898-2): 124 Ω between CAN_L and CAN_H, switchable

BNC connector	
Functions	Trigger output or measuring input
Trigger output	
Voltage idle state	+3.3 V
Voltage trigger event	0 V (falling edge)

BNC connector	
Pulse duration	4 CAN bit timings, actual duration depending on the set CAN bitrate (at 500 kbit/s: 4 * 2 µs = 8 µs)
Delay to the internal trigger	140 CAN bit timings, actual duration depending on the set CAN bitrate; is displayed in the scope settings
Signal input	
Use	Oscilloscope function, measuring channel 2 (Ch2), for inspection of signals
Input voltage ranges	-3 - +15 V (low) -10 - +50 V (high)
Maximum input voltage	±50 V
Maximum frequency input signal	1 MHz
Probe usage	Standard probe without additional electronics (not in the scope of supply) Setting x1

Oscilloscope function	
Measuring channels	1: CAN_H 2: CAN_L or BNC connector (max. 1 MHz)
Sampling frequency	max. 20 MS/s per measuring channel
Capacity sample buffer	max. 64,000 samples
Trigger types	CAN frame start/end, CAN ID, CAN error, rising/falling edge measuring channel 2; alternatively free-run mode
Pretrigger	10 %, 50 %, 90 %
Resolution time measurement	50 ns (depending on zoom)
CAN-specific functions	Decoding of the recorded signal course
Data transfer	Screenshot of the current scope screen Contents of the sample buffer as CSV file

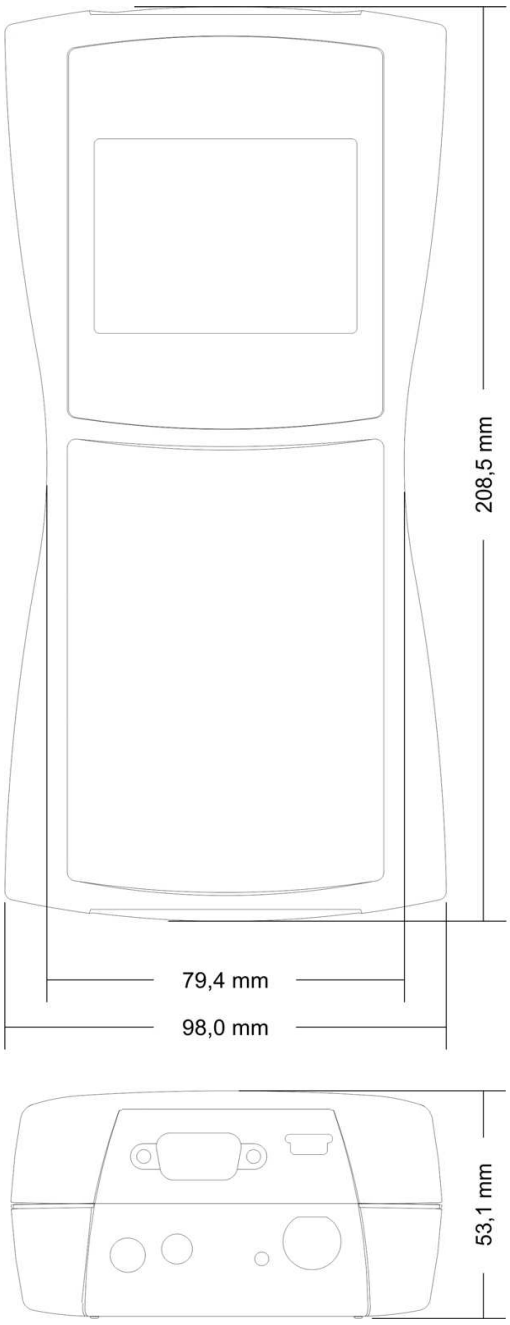
Internal memory card	
Size	at least 1 GB
File system	FAT32
Name of the USB device	PCAN-DIAG

Display	
Type	OLED
Resolution	320 x 240 pixels

Measures	
Size	103 x 58 x 212 (225 with BNC connector) mm (W x H x L) See also dimension drawing in chapter 15.
Weight	400 g (14.1 oz.) (without batteries)

Environment	
Operating temperature	0 - +50 ℃ (+32 - +122 ℉)
Temperature for storage and transport	-40 - +80 ℃ (-40 - +176 ℉)
Relative humidity	15% - 90%, not condensing
EMC	EN 61326-1:2006-10 EC directive 2004/108/EG EN 55011
Ingress protection (IEC 60529)	IP20

15. Dimension Drawing



The figure does not show the original size;
dimensions for case without rubber sleeve