CAN Physical Layer Analyser

CANwatch

User Manual

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specifications may be changed at any time and without
announcement.

WARNING: **CAN**watch **and software may not be used in
applications where damage to life, health
or private property may result from failures
in or caused by these components.**

Content

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1   Overview

1.1   Attributes

- Analyser for the physical layer of CAN based systems
- Designed for systems according to ISO 11898 high speed
- Diagnosis of signal shape and level
- Indication of the percent frequency of error frames
- Easy operation, usable by installers and plant operators
- LED display for error indication

1.2   General Description

CANwatch is an analyser supporting easy detection of errors during installation and operation of CAN networks. CANwatch monitors the analogue signals on the bus and detects errors like e.g. invalid levels, overshoots, slow slopes and short circuits of signal lines to supply lines.

Besides the diagnosis of problems during installation, CANwatch allows recognition of signal deficiencies below the level causing failures. This allows preventive error recognition and thus an increase in the availability of automated systems.

CANwatch offers an easy solution for installers and plant operators for detection and correction of errors on the physical layer of a CAN based system. Until now this was usually left to CAN specialists using expensive and bulky hardware equipment.

1.3   Ordering Information

12-10-001-20	**CANwatch** CAN physical layer analyser for rail mount application with LED display

2 Operation

2.1 Measuring Principle

CANwatch is a passive device whose function is based on the analysis of static and dynamic parameters of the CAN signal. The evaluation of the signal shape is mainly based on the difference level between the signals CAN High and CAN Low. The protocol based information of the CAN telegrams has no influence on the function of the device (except error frames) and therefore CANwatch is suitable for all CAN based higher layer protocols.

2.2 Connection

Connection

CANwatch has two Sub-D-9 plugs for the connection to the CAN. The CAN connector is also used for the power supply of CANwatch. CAN bus cables can alternatively be plugged into connector 1 (upper-left plug) or connector 2 (upper-right plug). Optional extensions (in the planning stage) can be operated at connector 1 exclusively.

Attention In addition to the contacts for CAN signal and supply CANwatch uses additional control lines. These are also connected to the Sub-D-plugs. The corresponding contacts may only be connected to permitted accessories, connection to other signals may cause permanent damage of CANwatch or other devices.

Initialisation

For the analysis process CANwatch is connected to the bus via connector 1 or 2. After successful initialisation of the processor, the device performs a test of the LEDs. These are simultaneously switched on for a short period of time (about 0.5 sec.). Thereafter CANwatch starts with the determination of the baud rate.

The other measurements (level test, testing for over-/undershoots, slow slopes, error-frames) are started after the determination of the baud rate and repeated cyclically as long as CANwatch is connected to the supply voltage.

2.3 Display

CANwatch shows the result of the analysis on a display consisting of twelve LEDs. Each LED represents a bus state or a warning. The meaning of the different displays is as follows.

CAN Ok

CANwatch sets this LED with each recognized telegram and resets it cyclically. During normal operation this LED will be flickering according to telegram traffic: the brighter it lights, the more telegrams are evaluated.

Serious CAN Failure

CANwatch lights this LED to indicate basic errors on the CAN (e.g. short circuit of GND and CAN High or CAN Low respectively).

CAN-High locked

This LED is activated if CANwatch recognizes a short circuit of the CAN High line to a fixed level. This is assumed by the actual software at levels of the CAN High signal of about 0V against ground. The LED remains set until the failure is no longer detected after a new evaluation or a difference signal occurs between CAN High and CAN Low. This test is performed with a cycle time of about 6 seconds.

CAN-Low locked

This LED is activated if CANwatch recognizes a short circuit of the CAN Low line to a fixed level. This is assumed by the actual software at levels of the CAN Low signal of about 0V against ground. The LED remains set until the failure is no longer detected after a new evaluation or a difference signal occurs between CAN High and CAN Low. This test is performed with a cycle time of about 6 seconds.

Over-/Undershoots

CANwatch lights this LED, if the CAN difference signal of a registered telegram is affected by over-/undershoots in a degree that undisturbed communication on the bus can no longer be guaranteed.

Slow Slopes

If CANwatch sets this LED, the CAN difference signal of a registered telegrams is affected by slow signal slopes in a degree that undisturbed communication on the bus can no longer be guaranteed.

Invalid Dominant Level

If CANwatch lights this LED, a telegram with dominant level above or below the threshold level of ISO 11898 was registered. The valid range of dominant levels for receiver nodes is specified between 0.9V and 5V.

Invalid Recessive Level

If CANwatch activates this LED, a telegram with recessive level above or below the permitted level according to ISO 11898 was registered. The valid range of recessive levels for receiver nodes is specified between -1V and 0.5V.

Error-Frame Display

The indication of the error frames is the percentage of errors compared to the number of registered telegrams. E.g. 0.1 - 1% errors means that the number of error frames related to the number of registered and evaluated telegrams is 0.1 - 1%. The display is divided into the ranges 0.1 - 1%, 1 - 5%, 5 - 100%.

Invalid Termination

The LED Invalid Termination is not supported at present. Invalid bus termination can be recognised from signal deformations (over-/undershoots, invalid dominant level, invalid recessive level).

2.4 Guidelines for Interpretation

An absolute statement regarding the function of a CAN net in the (broad) range between correct signals and severely disturbed signals is not possible. Therefore results from evaluations of CANwatch should not be used for decisions between valid and invalid, but as hints on possible problems. If CANwatch gives a warning concerning critical signal shapes, the communication on the bus is not definitely disturbed.

Flash Codes   The LEDs "Invalid Dominant Level", "Invalid Recessive Level", "Slow slopes", "Over-/Undershoots" and the LEDs for the frequency of error frames indicate the time of error events by means of flash codes.

When CANwatch detects an error, the corresponding LED lights up. The error indication is done by four different LED states:

LED-state	flashing-mode	meaning
on		error happened < 1 second ago
quickly flashing	100ms on 100ms off	error happened < 5 seconds ago
slowly flashing	100ms on 300ms off	error happened > 5 seconds ago
off		no error

Repeated Indications   It may happen that one error causes several error indications at the same time. If e.g. a signal line is drawn to a fixed potential and this causes invalid levels in addition, the LEDs CAN High locked or CAN Low locked and invalid dominant level or invalid recessive level will light up.

3   Technical Data

3.1   Configuration of Connectors

Pin Configuration Connector 1

Connector 1 is made up of a Sub-D-9 plug configured to comply with CiA DS 102 version 2.0. In addition to this specification, contacts are used for additional purposes.

Pin	Signal	Description
1		reserved by CiA
2	CAN_L	CAN Low bus line
3	CAN_GND	Ground
4	S1	Control line (do not connect)
5	S2	Control line (do not connect)
6	(GND)	(optional ground)
7	CAN_H	CAN High bus line
8	S3	Control line (do not connect)
9	V+CAN	Power supply

Attention   The control lines are reserved for compatible accessories and may not be connected to signals of the system which is to be tested.

Pin Configuration Connector 2

According to connector 1, however the pins 4, 5, 8 (control lines S1 - S3) are not used.

Hint   The pins 2, 3, 6, 7, 9 of connector 1 are connected with the corresponding pins of connector 2. The shields of both Sub-D-plugs are connected to each other.

3.2   Absolute Limiting Values

Exceeding the specified limiting values my cause permanent damage on CANwatch.

| Parameter	Min.	Max.	Unit
Storage temperature	-20	80	C
Operating temperature	0	60	C
Power supply (Pin 9)	-100	35	V
Input voltage (Pin 2, 7)	-2	7	V

Attention: Due to requirements of measurement technology the inputs of CANwatch are not equipped with overvoltage protection (including ESD). Connection to overvoltage and electrostatic discharge must be avoided.

3.3   Nominal values

Parameter	Min.	Max.	Unit
Supply voltage (Pin 9, V+CAN)	10	30	V
Current consumption (Pin 9, V+CAN =24V)	20	65	mA
Input voltage (Pins 2, 7)	-2	7	V
baud rates	10	1000	kBit/s

3.4 Evaluation characteristics

The number of telegrams that CANwatch can maximally register and evaluate are shown in the figure. The values are related to telegrams with standard format and one byte of data.
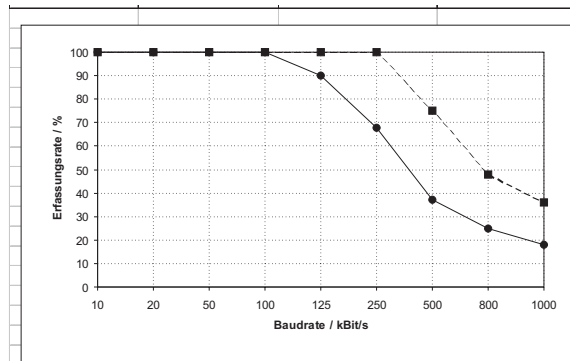
Percentage of registered telegrams depending on the baud rate
——- Busload50% (constant distance of telegrams
___ Busload 10% (constant distance of telegrams)

4 Small CAN Troubleshooting Guide

To support troubleshooting of CAN networks, the following list includes possible reasons for errors indicated by CANwatch.

Over-/Undershoots

The diagnosis/indication of over-/undershoots can be triggered by the following installation defects:

- Impedance mismatch with resulting reflections (number and position of termination resistors, bus topology ...).
- Interferences with strong electric or magnetic fields near cables (e.g. caused by electric motors, power lines).

Interferences are not over-/undershoots in a classical sense, but the effects on the signal shape are quite similar.

Slow Slopes

Slow slopes can be caused by correlation of several parameters. Influence on slopes results from:

- Capacitance (cables, devices)
- Resistance (line and drivers), filter inductivities
- Slow slope settings in the transmitter

Short Circuits

Short circuits can be caused by:

- Damage of the bus cables
- Wiring errors

Invalid Dominant Levels

Invalid dominant levels can be caused by:

- Too high line resistance
- Too many or faulty termination resistors
- Output resists in the transceiver drivers
- Mislead currents

Invalid Recessive Levels

Invalid recessive levels may be caused by:

- missing termination resistors
- Mislead currents

Invalid Bus Termination

Under certain conditions, invalid bus termination may be detected by measuring DC resistance. The following cases have to be distinguished:

- The terminating resistors are totally missing
- Only one bus termination resistor is installed
- More than two bus termination resistors are installed

A reliable indication of correct termination cannot be given through measurement of DC resistance. E.g. there is no possibility to recognize placement of both resistors at the same end of a cable.

Other termination errors may arise from the topology of the net.

A reliable statement concerning valid termination has to consider the high frequency behaviour. This may be achieved by evaluation of the signal shapes by means of the indicators Slow Slopes and Over-/Undershoots.