Ethernet/CAN Interface

EtherCAN CI

User Manual

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Documentation for Ethernet/CAN interface EtherCAN CI version 2.1.

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This documentation is not valid for EtherCAN CI version 2.0 and earlier versions.

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Our products are continuously improved. Due to this fact specifications may be changed at any time and without announcement.

WARNING: **EtherCAN CI hardware 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

EtherCAN CI User Manual

1 Overview

1.1 Attributes

EtherCAN CI offers a range of features which make it valuable for many CAN based applications:

- Connection of CAN systems to Ethernet networks
- Coupling of CAN networks over Ethernet
- CAN interface for industrial applications
- CiA DS-102 and IS0 11898 compatible physical layer
- Microcontroller Winbond W90N740 (32 Bit ARM7/80MHz) with additional CAN controller NXP SJA1000
- NXP PCA82C251 CAN transceiver
- Galvanic decoupling between Ethernet and CAN bus
- Filtering and buffering of CAN traffic
- Supports CAN protocols 2.0A and 2.0B
- Serial interface for configuration
- Embedded Linux operating system

1.2 General Description

The rail mountable Ethernet/CAN interface EtherCAN CI transmits signals between a CAN system and an Ethernet network.

Utilizing the Ethernet standard, EtherCAN is usable in a wide range of applications. It can be used as a standard CAN interface in a LAN environment. Or two EtherCAN devices, working back to back, can bridge two CAN networks over an Ethernet connection.

1.3 Sample Applications

The field of application for EtherCAN CI is wide. Some sample applications are detailed in the following and supported by corresponding software:

- Online configuration of CAN networks
- Network setup and analysis
- Visualisation of process parameters in CAN based systems.

1.4 Ordering Information

12-20-302-20	**EtherCAN CI-ARM7/RMD** Ethernet/CAN interface with 32 bit microcontroller (ARM7 core) and CAN controller NXP SJA1000
12-20-305-20	**EtherCAN CI-ARM7/RMD - M4D** Ethernet/CAN interface with 32 bit microcontroller (ARM7 core), CAN controller NXP SJA1000 and CANopen software M4D

2 Hardware

EtherCAN CI includes a Winbond W90N740 (ARM7 core) with 80MHz clock. In addition, the device has 16MB SDRAM and 2MB Flash. The connection to the CAN bus is provided by a CAN controller of type NXP SJA1000 and supports the CAN protocols 2.0A and 2.0B.

EtherCAN CI includes a CAN segment with two connectors of type D-Sub 9, the pin assignment complies to CiA DS-102 standard. Besides the CAN signals the connectors also carry the power supply for EtherCAN CI. EtherCAN CI includes an Ethernet connector (Twisted Pair, 10/100MBit/s) and a serial connector (D-Sub).

LED's

Explanation of the different LED's on EtherCAN:

CAN Active: this LED flickers in case of traffic on the CAN bus.
Eth. Active: this LED flickers in case of traffic on the Ethernet network.
Eth. Link: this LED is lit if another device was detected within the network.

There are three status LEDs on EtherCAN CI usable by application software. Currently cansrv, cansrv_udp and led are using them. Please refer to the related program documentation for details.

3 Software

3.1 Built-in Capabilities

- an Embedded Linux operating system
- a powerful TCP/IP stack
- a CAN server application
- Watchdog functionality

3.2 Communication and General Software

The communication software normally consists of two parts. One part is executed by the processor inside EtherCAN CI (server application). The other part (client application) runs on a device connected to EtherCAN CI via the Ethernet. This device can be a PC or any other device supporting IP networking.

Server and client use an ASCII protocol when communicating via TCP or UDP. This protocol is not included in this document, but can be obtained on demand.

EtherCAN CI is delivered with a monitor program running under Windows OS as client application.

3.2.1 cansrv

The CAN server application cansrv is intended to provide a point to point communication link with a client over a TCP connection.

While the main purpose is the connection with a PC based client application, cansrv can also be used in a back to back configuration with another EtherCAN CI device. In this configura-

tion one device acts as a server and the other as a client, they form a transparent link for the CAN networks connected.

Once it is started as server it listens on a port for incoming connections. After the connection is established the client is able to send and receive CAN messages and to configure the CAN parameters of the remote CAN controller.

The use of a configuration file allows to specify more detailed CAN controller register values and to configure a software filter for standard identifier CAN messages.

The following command line options are available for the CAN server application (both short and long options are supported):

-h (--help)
Show the available options.

-v (--version)
Show the version information.

-b (--baudrate) BAUDRATE
The CAN baudrate used.
1000|800|500|250|125|100|50|25|20|10 kBaud can be set with this option. Please notice that a baudrate specified with this option can not be changed dynamically by a connected client.

-d (--device-file) DEVICE
The device, default is /dev/can0. This option is documented for completeness only. It is used on products where more than one CAN channel is available.

-f (--config-file) CONFIGFILE
Allows the use of a configuration file for baudrate settings and identifier filtering.
A sample configuration file can be found in 5.3.5. A baudrate given within CONFIGFILE cannot be changed dynamically by a connected client.

-p (--port) PORT
The port to listen at for incoming connections (default is 1500).

-w (--trigger-watchdog)
This option triggers the watchdog cyclicly.
If this option is not set, an other application must trigger the watchdog.

-o (--busoff-recovery-time) TIMEOUT
This time specifies the period which is waited after a bus off event before the CAN controller is reinitialized. The time value is given in ms, 0 indicates to immediately go bus on again. As default the option is not set and this means actually “do not go bus on again”.

To form a bridge for two independent CAN networks two EtherCAN devices (connected over their Ethernet interfaces) can be used, one running as server, the other as client. In this case, the following parameters can be used:

-i (--ip-address) IPADDRESS
IP address of the server the client wants to connect to. The parameter ‘-p’ (see above) should then also be used.

-k (--keep-alive)
The connection will be running using a keep

alive mechanism that reestablishes broken connections.
Please notice: In order for the keep alive mechanism to run properly, both applications (server and client) have to be started with the '-k' option.

For debugging purposes the following options can be used. For performance reasons it is not recommended to use them in production systems:

-t (--show-tcp-frames)
Show TCP frames on the serial terminal

-c (--show-cpc-frames)
Show CPC messages on the serial terminal

Server mode:
If option '-i' is not given, EtherCAN will start in servermode and listen on <PORT> for incoming connections.
If options '-b' or '-f' are given a baudrate setting via TCP/IP will be ignored.

Client mode (back-to-back operation only):
If option '-i' is given, the CAN server will start in client mode. It will try to open a connection to <IPADDRESS> and <PORT> of the server.
A baudrate option with '-b' or '-f' is mandatory.
If option '-f' is given and there is a baudrate configured within this file, it will not override <BAUDRATE> given by the -b option.
If option '-k' is set a keep alive mechanism will reestablish a broken connection.

The cansrv program uses the status LEDs as described here:

Status 1: "On" means cansrv program is started.
"Off" means cansrv is not started or has correctly terminated.

Status 2: "Blinking" means cansrv ethernet communication is in state of connecting or listening.
"On" means ethernet communication link is established.

Status 3: "On" means CAN controller state is bus on.
"Off" means CAN controller state is bus off.

Examples:

cansrv -p 1500
This will start cansrv as a server listening on port 1500. This is the default setting.
As no baudrate is specified at the command line, the server will initialize its CAN controller with the parameters sent by the client.

cansrv -p 1500 -i 192.168.0.176 -k -b 500
This will start cansrv as a client which will try to connect to the host with IP address 192.168.0.176 on port 1500. The client will use a baudrate of 500 kBaud and will use the keep alive mechanism. It will also advertise this baudrate to the client. The client takes it, if no -b or -f option is set.

3.2.2 cansrv_udp

The application cansrv_udp is intended to provide a point to point communication link with another EtherCAN CI device. It uses a UDP based protocol, which offers better latency timing than TCP does. The reliability of the messages is handled completely by the application.

Once it is started it listens on a port for incoming connections. After the connection is established the client is able to send and receive CAN messages and to configure the CAN parameters of the CAN controller.

The use of a configuration file allows to specify detailed CAN controller register values and to configure a filter for standard identifier CAN messages.

The command line parameters are described in the following:

-h (--help)
Show the available options.

-v (--version)
Show the version information.

-w (--trigger-watchdog)
This option triggers the watchdog cyclicly. If this option is not set, an other application must trigger the watchdog.

-p (--listen-port) PORT
The port to listen for incoming datagrams.
If this option is not given the default value is 1500.

-e (--dest-port) PORT
The port where the destination udpsrv has to be listening at.
If this option is not given the default value is 1500.

-i (--dest-ip)
The IP address for outgoing datagrams e.g. 172.0.1.2.

-a (--ack-timeout) TIMEOUT
This option changes the acknowledge timeout given in µs.
The acknowledge timeout is the time within which a transmitted UDP datagram packet has to be acknowledged by the receiver.
If this option is not given the default value 10000 is applied.

-d (--device) DEVICE
The device, default is /dev/can0. This option is documented for completeness only. It is used on products where more than one CAN channel is available.

-b (--baudrate) BAUDRATE
The CAN baudrate used on this segment.
1000|800|500|250|125|100|50|25|20|10 kBaud can be set with this option.
A baudrate given will be advertised to the opposite side, where it is used, if option -r is set there.

-f (--configfile) CONFIGFILE
Allows the use of a configuration file for baudrate settings and identifier filtering. A sample configuration file can be found in 5.3.5. The baudrate parameters (btr0 and btr1) given within this file are treated like it is described with option -b.

-x (--btr0) BTR0
Set BTR0 register explicitly.

-y (--btr1) BTR1
Set BTR1 register explicitly.

-r (--accept-remote-baudrate)
If this option is set a baudrate given from the

remote side is always accepted.
As default this option is not set.

-o (--busoff-recovery-time) TIMEOUT
This time specifies the period which is waited after a bus off event before the CAN controller is reinitialized. The time value is given in ms, 0 indicates to immediately go bus on again. As default the option is not set and this means actually “do not go bus on again”.

The cansrv_udp program uses the status LEDs as described here:

Status 1: “On” means cansrv_udp program is started.
“Off” means cansrv_udp is not started or has correctly terminated.

Status 2: “Blinking” means cansrv_udp ethernet communication is in state of connecting or listening.
“On” means ethernet communication link is established.

Status 3: “On” means CAN controller state is bus on.
“Off” means CAN controller state is bus off.

Example:

EtherCAN “A” with IP address 192.168.1.94:
cansrv_udp -i 192.168.1.95 -b 500

EtherCAN “B” with IP address 192.168.1.95:
cansrv_udp -i 192.168.1.94 -b 500

This will establish a connection between two EtherCAN CI where unit “A” has the IP address 192.168.1.94 and unit “B” has the IP address 192.168.1.95. A baudrate of 500 kbaud is used on both sides.

3.2.3 Client Application

The client application (’monitor.exe’) currently only runs on a PC with Windows OS. Please refer to the manual for the monitor application which is available separately. This client needs the cansrv program to be run on EtherCAN CI.

3.2.4 m4d

The documentation for the CANopen software m4d is not included in this manual, it can be obtained separately.

3.2.5 User Accessible Flash

There are 128kByte of flash memory reserved (/dev/rom5) for the user to store application specific data. It can be used to hold a configuration file for the cansrv and cansrv_udp program. It can also be used to be filled with html files, if EtherCAN CI is run as a CAN based web server. The usage of /dev/rom5 is very versatile. To explain the usage two examples are given.

Example 1: cansrv configuration file

Step 1: On a host PC a cansrv configuration file is created, i.e. “canconf”.

If the gzip utility is available, it may now be compressed, the file name changes to “canconf.gz”.

Step 2: The file is transferred with ftp to EtherCAN CI, using the binary transfer mode. If it is not yet compressed, it must be done now: “gzip canconf”.

Step 3: The file is flashed using the flashw command “flashw -f canconf.gz /dev/rom5".

Step 4: The cansrv or cansrv_udp may now use this file. As both programs are able to read a gziped file, they may be started with the option: -f /dev/rom5.

Example 2: Store html files

Step 1: Some html files in one or more directories are assumed, which shall be used on EtherCAN CI.

Step 2: On the host PC a cramfs image using the mkcramfs tool is created: “mkcramfs <your_directory> <output_filename>”

Step 3: The file is transferred with ftp to the EtherCAN CI, using the binary transfer mode.

Step 4: The file is flashed using the flashw command “flashw -f <output_filename> /dev/rom5".

Step 5: This cramfs image can be mounted at boot time using a fltool USER_x entry:
“fltool -w USER_x ”mount -t cramfs /dev/rom5 /mnt""

3.2.6 wdog

EtherCAN CI incorporates a hardware watchdog. It has to be triggered periodically by an application. The most common applications cansrv and cansrv_udp offer a command line option to do so. There is a standalone program called wdog, which may also be used. It is started without any command line options. If triggering stops EtherCAN CI will reboot after 180s.

3.2.7 fltool

Device parameters like IP address or netmask are stored in a part of the flash memory. The task to read and write this parameters is done by the fltool application. Although entries are stored immediately in the flash when they are modified, it needs a reboot for the changes to take effect.

The fltool program knows a list of predefined specifiers:

IP
Used for setting the IP address.

NETMASK
Used for setting the netmask parameter.

HOSTNAME
Used for setting the hostname of the device.

USER_[1-10]
The list of USER_1 to USER_10 entries can be used to start applications at boot time. If an entry is set to i.e. “wdog”, wdog is started at the end of the boot process as a background process.

USER_FG[1-10]
USER_FG1 to USER_FG10 entries are started as foreground processes after the USER_[1-10] entries. Please use this with extreme care, because a foreground process occupies the console input until it terminates.

The following command line options are available:

-r <specifier>
This reads out an entry detailed by <specifier>.

-w <specifier> <value>
This sets an entry detailed by <specifier> to <value>.

-e
This erases all entries.

-l
This lists all entries which have a value.

Examples:

fltool -w IP 192.168.1.94
This will set the entry IP to 192.168.1.94. This

value is used at boot time to set the IP address of the device.

fltool -r HOSTNAME
This reads out the entry HOSTNAME and prints it on the terminal.

fltool -w USER_1 “cansrv -p 1500”
This will set the USER_1 entry to “cansrv -p 1500”. At boot time this will start the cansrv with the given parameter.

fltool -w USER_1 “”
This deletes the USER_1 entry. Please note the quotation marks, indicating an empty string.

3.2.8 route

If a default gateway is needed the route command can be used. A USER_x entry is used for that purpose.

Example:

fltool -w USER_2 “route add default gw 192.168.1.1”
This will set the IP address 192.168.1.1 as the address for the default gateway.

3.2.9 led

The led application can be used to explicitly set the status LED on and off from the command line. The command line options are:

- r <register>
This reads out the value of a LED register. Currently only register 0 is supported.

-w <register> <value> <mask>
This sets the bit positions of <register> to <value>, at which the bits of <mask> are 1. This scheme allows to modify a single LED without the need to know the status of the others. Currently only register 0 is supported.

-v
This reads out the version information of the program.

Example:

led -w 0 1 7
This activates only status LED 1.

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4 Electrical Characteristics

4.1 Absolute Limiting Values

Any (also temporary) stress in excess of the limiting values may cause permanent damage on EtherCAN CI. Exposure to limiting conditions for extended periods may affect the reliability and shorten the life time of the device.

Parameter	Min.	Max.	Unit
Storage temperature	–25	+70	°C
Operating temperature	0	+60	°C
Supply voltage	–100	+35	V
Voltage on bus connections	–30	+30	V

4.2 Nominal Values

Parameter	Min	Typ	Max	Unit
Current consumption*	–	70	150	mA
Supply voltage	10	24	30	V

*: at nominal supply voltage of 24V

5 Operating Instructions

5.1 Connection Scheme

The pin usage of the CAN connectors is detailed in the following table:

Pin	Name	Function
1	–	Reserved by CiA
2	CAN_L	CAN_L bus-line (dominant low)
3	GND	Ground
4	–	Reserved by CiA
5	–	Reserved by CiA
6	(GND)	Optional ground, internally connected to Pin 3
7	CAN_H	CAN_H bus-line (dominant high)
8	–	Reserved by CiA (error line)
9	V+	Positive power supply

The following table shows the assignment of the RS232 connector:

Pin	Name	Function
2	RxD	Receiving data line
3	TxD	Sending data line
4	DSR	Data-Set-Ready line (not supported at this time)
5	GND	Ground line
6	DTR	Data-Terminal-Ready line (not supported at this time)

5.2 Installation

To setup and use EtherCAN CI within a network, the following is needed:

- A PC running Windows 95/98/NT/2k/XP or Linux, connected to the Ethernet network.
- An Ethernet network with a free twisted pair connection for EtherCAN CI
- A DC power supply (see chapter 'electrical characteristics'), fed over the CAN connectors
- A terminal program connected to the RS232 port of EtherCAN CI

Since EtherCAN CI supports Auto-MDIX, it is able to detect the cable type, whether it is a cross over or a regular twisted pair Ethernet cable.

5.3 Configuration

5.3.1 General Configuration

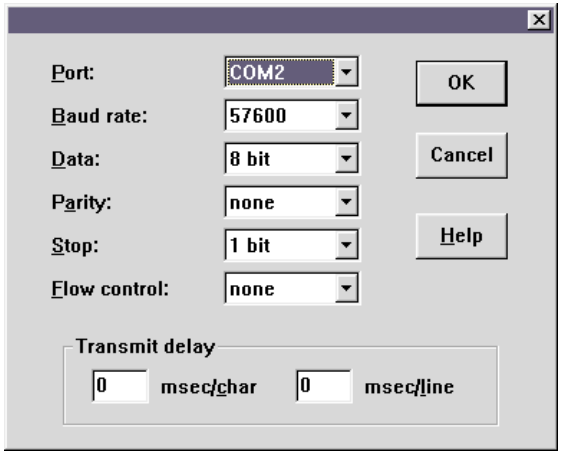
To review or change the IP configuration, EtherCAN CI can be accessed by using a terminal program connected to its RS232 port.

- Connect a serial cable to the RS232 port of EtherCAN CI.

- Connect the other end to a free COM port of your PC.

Note: The serial cable should have the pins 2 and 3 crossed and pins 5 connected directly.

- Start the terminal software. Configure the software for a direct connection using the PC's COM port. See the communication parameters to use in the following image.



Notice that the ‘flow control’ parameter within the serial monitor running on the PC has to be turned off. If this parameter can not be changed, supplemental bridges (between pins 4-6 and pins 7-8) have to be inserted in the PCs side connector of the serial cable described above.

- Power on EtherCAN CI.

- On the terminal window the output from the startup procedure is displayed. If the procedure was successful, a prompt that enables you to input commands is shown.

5.3.2 Device Configuration

EtherCAN CI needs some parameters set correctly to take part in the Ethernet communication. This parameters are the IP address, the netmask and optional the hostname.

To set this parameters the fltool command is used.

```
fltool -w IP 192.168.0.93
fltool -w NETMASK 255.255.255.0
fltool -w HOSTNAME ethcan1
```

To inquire this parameters the following may be used:

```
fltool -r IP
fltool -r NETMASK
fltool -r HOSTNAME
```

or:
```
fltool -l
```


5.3.3 CAN Server Startup Configuration

EtherCAN can be configured to start the CAN server application automatically at boot time. The different command line options are already detailed on page 4 and following. Simply paste the command line into to the option “command” of the fltool.

Example:

fltool -w USER_2 “cansrv -p 1500 -b 500”

This will start the CAN server application as server at boot time listening on port 1500 and using a fixed baudrate of 500 kBaud.

5.3.4 Default Configuration upon Delivery

In the default delivery of EtherCAN CI the following parameters are used:

IP: 192.168.1.94
Netmask: 255.255.255.0
Gateway: none

The above parameters can be changed through serial access to the console of EtherCAN.

The following user commands are also enabled:

USER_1: cansrv -p 1500 -w

5.3.5 Sample cansrv/cansrv_udp Configuration File

```
#######################################
# EMS Dr. Thomas Wuensche 2006
# Configuration file for EtherCAN CI
#######################################
# CAN (SJA1000) controller initialisation
# CAN controller runs with 16MHz
# —- 1000kBaud —-
#btr0=x00
#btr1=x14
# —- 500kBaud ——
btr0=x00
btr1=x1c
# —- 250kBaud ——
#btr0=x01
#btr1=x1c
# —- 125kBaud ——
#btr0=x03
#btr1=x1c
# —- 100kBaud ——
#btr0=x04
#btr1=x1c
# —- 50kBaud ——-
#btr0=x09
#btr1=x1c
# —- 25kBaud ——-
#btr0=x18
#btr1=x1c
# —- 10kBaud ——-
#btr0=x31
#btr1=x1c
#
accCode0=x00
accCode1=x00
accCode2=x00
accCode3=x00
accMask0=xff
accMask1=xff
accMask2=xff
accMask3=xff
mode=0
#
#######################################
# FILTER
# All Identifiers in this list are filtered
#
# Filter on CAN received messages
# both start and end value are included
#FIL: x000-x7e5
#
#
```