

USER MANUAL

Automotive Ethernet to CAN Converter

P/N: AX141530

ACRONYMS

A	Ampere
ARP	Address Resolution Protocol
°C	Celsius (degree)
CAN	Controller Area Network
CE	Conformité Européenne (European Conformity)
EA	The Axiomatic Electronic Assistant PC Application Software
EEPROM	Electrically Erasable Programmable Read-Only Memory
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharge
FCC	Federal Communications Commission
G	Acceleration in Gravity Units
GPL	General Public License
hr	hour
HTTP	Hypertext Transfer Protocol
ICMP	Internet Control Message Protocol
ID	Identifier
IEC	International Electrotechnical Commission
IP	Internet Protocol or Ingress Protection (for housing)
ISO	International Organization for Standardization
L	Length (for size)
LAN	Local Area Network
LED	Light-Emitting Diode
m	meters
MAC	Media Access Control (address)
MDIX	Medium Dependent Interface Crossover (MDI-X)
ms	millisecond
PA	Polyamide
PHY	Physical Layer Transceiver (Ethernet chip)
P/N	Part Number
PoE	Power Over Ethernet
RoHS	Restriction of Hazardous Substances
RTOS	Real-Time Operating System
SP	Service Pack
SSP	Software Support Package
SW	Software
TCP	Transmission Control Protocol
UDP	User Datagram Protocol
UL	Underwriters Laboratories (safety organization)
USB	Universal Serial Bus
V	Volt
VDC	Volt Direct Current
W	Watt or Width (for size)
WAN	Wide Area Network

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1 CONVERTER DESCRIPTION

The following user manual describes architecture, functionality, and configuration parameters of the Automotive Ethernet to CAN Converter. It also contains technical specifications and installation instructions of the converter.

The Automotive Ethernet to CAN Converter is a simple device converting CAN frames into UDP or TCP IP datagrams and sending them over the Automotive Ethernet network. The device can also convert UDP or TCP datagrams into CAN frames.

The converter has one CAN and one Automotive Ethernet port. It supports a high-speed CAN with baud rate up to 1Mbit/s and a fast 100Mbit/s Ethernet. All standard and extended CAN frames, including data and remote frames, are supported.

The power can be passed through to the CAN port. Protection is provided.

The converter contains a web server to setup configuration parameters and monitor the internal state of the converter using a web browser. The user can also update the converter firmware using the web browser.

A simple command-line `AxioDisc.exe` Windows application is provided to locate a converter on the LAN.

To ensure low latency in processing CAN and Automotive Ethernet messages, the converter software runs under control of a real-time operating system.

The converter is designed to work on off-road machinery or in a harsh industrial environment with power transients, high humidity, and vibrations.

1.1 Hardware Block Diagram

The converter hardware block diagram is presented in Figure 1.

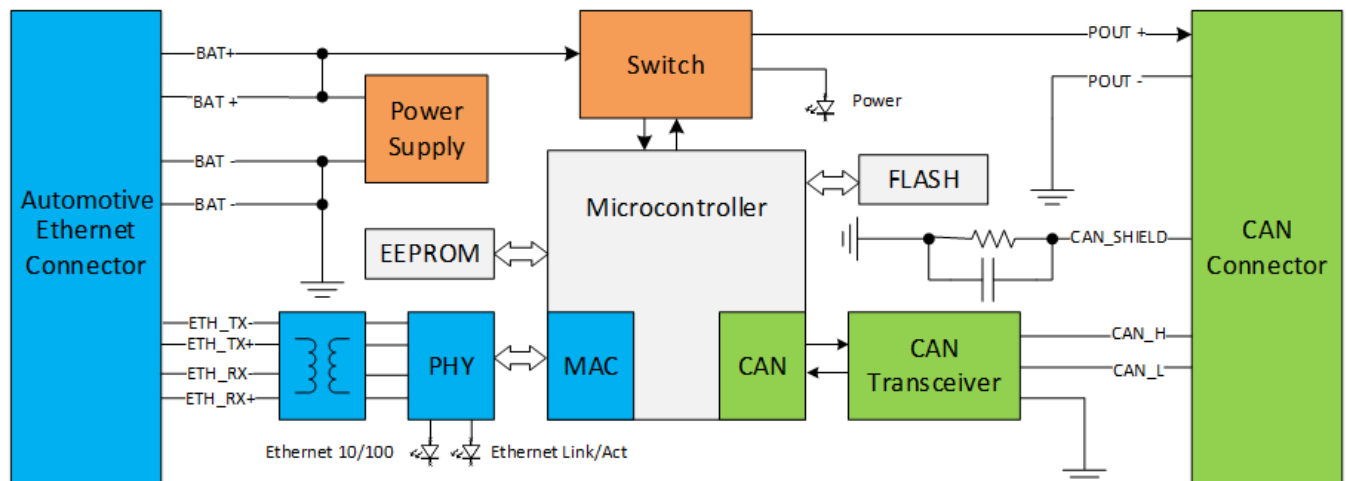


Figure 1. The Converter Hardware Block Diagram

The converter is powered from the Automotive Ethernet connector using dedicated power lines. The power from the Automotive Ethernet connector can be delivered to the CAN connector through a switch controlled by a microcontroller.

The Automotive Ethernet transformers with PHY, together with the CAN transceiver, provide Automotive Ethernet and CAN physical interfaces.

A powerful ARM Cortex-M4 microcontroller runs IP protocol stack and all Ethernet to CAN conversion logic.

The converter uses Texas Instruments' Automotive Ethernet transceiver, and the part number is DP83TC811S-Q1.

1.2 LED Indicators

There are three LED indicators on the front panel of the converter. A bicolor "Power" indicator shows whether the unit is powered. It turns red when there is an error on the CAN power output.

The two Automotive Ethernet LED indicators are hardwired to the PHY chip and show the transmission speed "Automotive Ethernet 10/100" and the link/activity status "Automotive Ethernet Link/Act", see Table 1:

Table 1. Converter LED Indicators

Name	Color	Description	
Power	Green/Red	Off	The converter is not powered.
		Green	The converter is powered. CAN Power Output is in normal condition.
		Red	CAN Power Output is in a fault condition.
Ethernet Link	Green	On	Automotive Ethernet is in Master Mode
	Yellow	On	Automotive Ethernet is in Slave Mode
	None	Off	Connection is down
Ethernet Activity	Green	On	Automotive Ethernet link is established
		Off	Automotive Ethernet link is down
		Blinking	Automotive Ethernet link is up and active

1.3 Firmware Organization

The Automotive Ethernet to CAN Converter firmware contains two independent parts: the *Communication Device* and the *Web Server*, see Figure 2:

The converter requires an external Automotive Ethernet to Ethernet Converter (AX141500-M/AX141500-S) to access the web server running on the device.

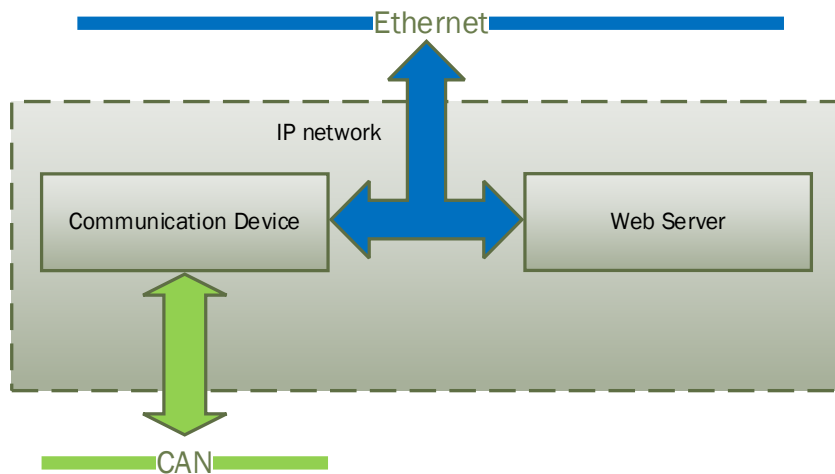


Figure 2. Converter Firmware Architecture

The *Communication Device* is responsible for the protocol conversion between CAN and Automotive Ethernet networks and the *Web Server* provides the converter user interface.

Both the *Communication Device* and the *Web Server* use the same IP network interface. The IP address resolution is provided by the ARP protocol.

1.3.1 Communication Device

The *Communication Device* utilizes a proprietary communication protocol to communicate CAN messages and other auxiliary information over the Automotive Ethernet. It supports a client/server communication model. In this model, the *Communication Device* has a primary server role, allowing external clients to establish independent connections with the device.

In addition to the server role, the device can also act as a client, if the *Auto Connect to Remote* configuration parameter is set to *Yes*. In this case, the device will try to establish a connection with a customer specified remote server.

The total number of remote connections is limited to 10. If the CAN network traffic is high, this number should be further reduced, or the connections will become unstable due to limited internal resources of the microcontroller, which are dynamically allocated between open connections.

The *Communication Device* can use either UDP or TCP internet protocol (IP), depending on the value of the *Device Port Type* configuration parameter.

1.3.1.1 UDP Protocol

The UDP protocol is set by default. Since it is a connectionless protocol, one data socket serves all device communication needs, see Figure 3.

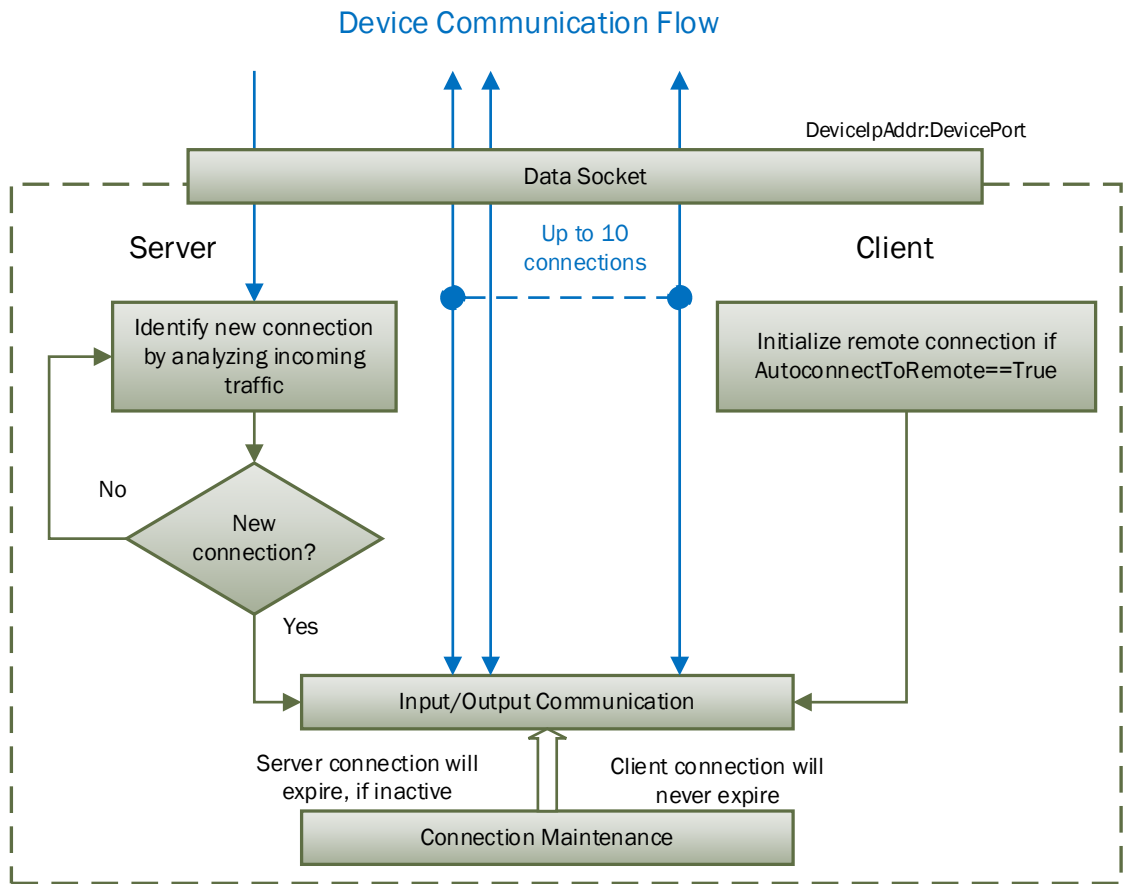


Figure 3. Communication Device. UDP Protocol

All connections with the device are virtual. On the server side, the device analyzes the incoming traffic to check for the new connections. Once a new IPAddress:Port combination is detected, the connection is established and the device starts sending CAN data with Heartbeat messages to the new node.

There are no restrictions on the IP address and port for the incoming connections.

If a client-side is activated by the *Auto connect to Remote* configuration parameter, the device will automatically start sending CAN data with Heartbeat messages to the remote node on start-up.

To ensure that the device does not send data to not functioning (dead) or disconnected nodes, the server side connections will expire in 10 sec of inactivity, when no valid data is received from the remote node. The client-side connection will never expire.

1.3.1.2 TCP Protocol

When TCP protocol is used, the *Communication Device* opens an individual data socket for each device connection, see: Figure 4.

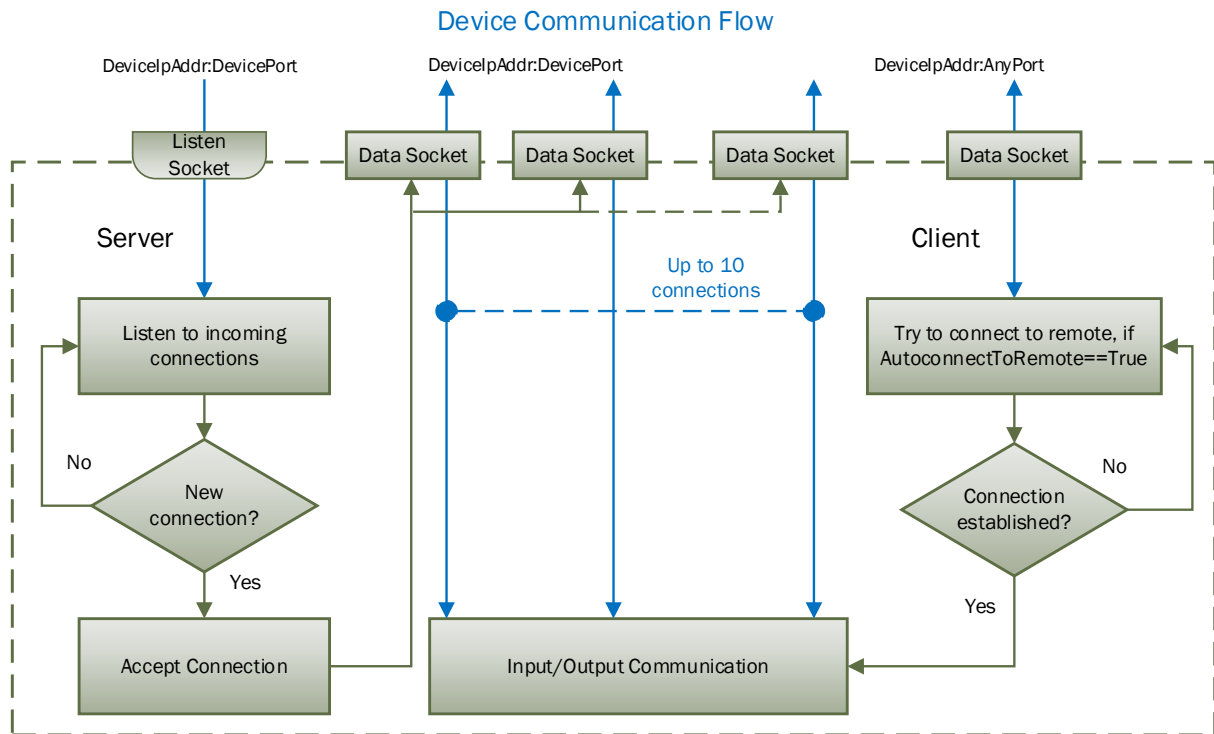


Figure 4. Communication Device. TCP Protocol

The server side opens a listening socket for incoming connections. Once a connection is accepted, a new data socket is created to handle input/output communication with the remote node. There are no restrictions on the IP address and port for the incoming connections, similar to the UDP mode.

On the client side, if *Auto Connect to Remote* is set to *Yes*, a data socket is created for connection with the remote node. A random free port number is assigned to the socket. If the connection drops, the device will try to automatically reconnect with the node to maintain the client connection.

1.3.2 Web Server

The *Web Server* provides a user front-end interface with the converter. It runs a dynamic website that shows: the converter general information, configuration parameters, and the converter real-time diagnostics.

The user can also change configuration parameters and upload the new firmware through this website.

The web browser should support JavaScript.

The web server requires an Automotive ethernet to Ethernet (AX141500-M/ AX141500-S) converter connected externally with CAN to Automotive Ethernet Converter, as web server can not be accessed with Automotive Ethernet.

1.3.3 Firmware Updates

The firmware can be remotely updated through the web server.

1.3.4 Network Discovery

The firmware supports a proprietary Axiomatic discovery protocol. It allows to locate a converter with unknown IP address and/or web server port on a LAN using a simple Axiomatic discovery application `AxioDisc.exe`.

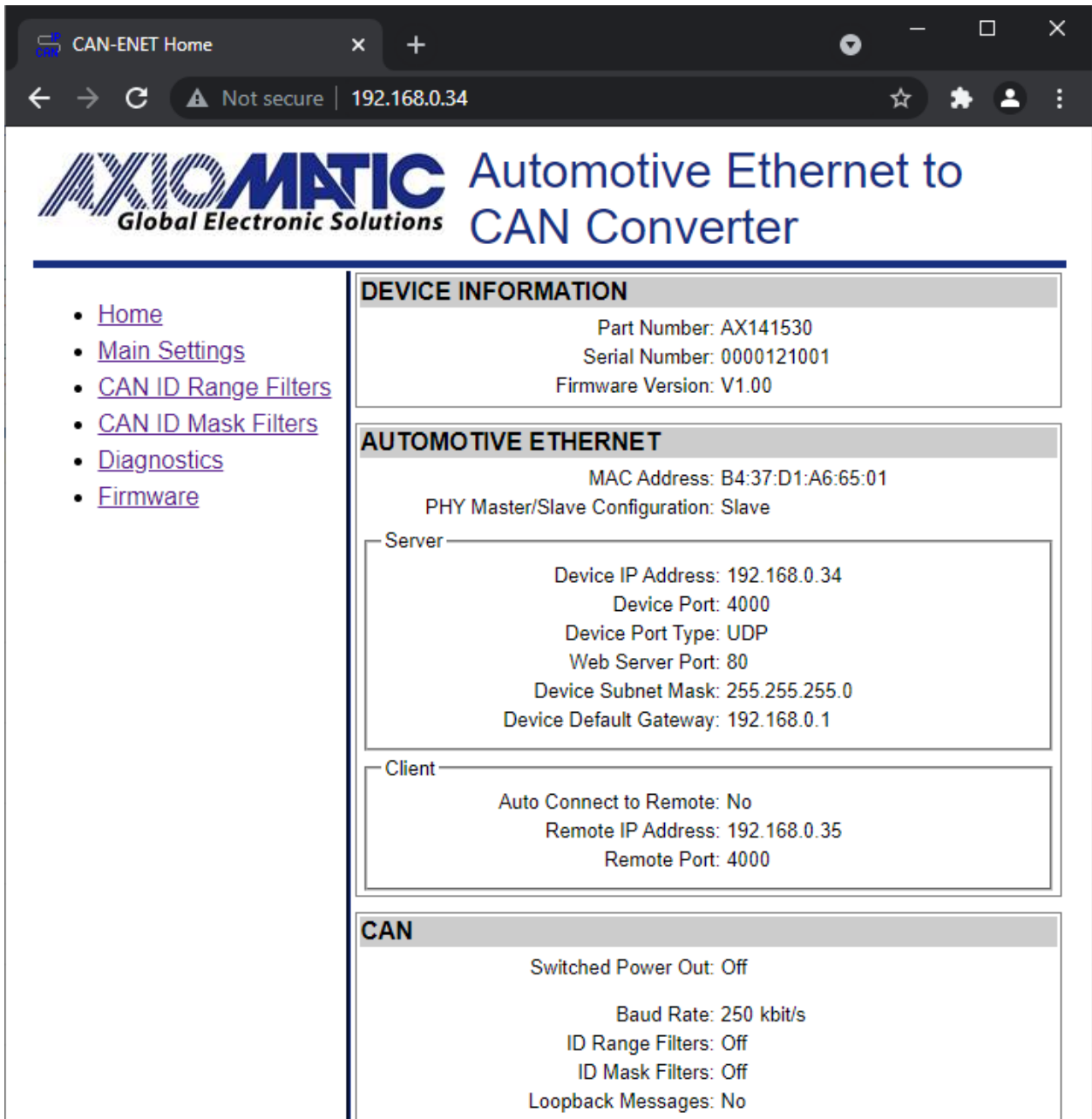
Network Discovery also requires an external Automotive Ethernet to Ethernet (AX141500-M/AX141500-S) Converter connected in cascade with CAN to Automotive Ethernet Converter.

2 CONVERTER CONFIGURATION

The converter supports configuration over the internal website running on the device embedded web server. The default *Device IP Address* is *192.168.0.34* and the default *Web Server Port* is *80*. Please, make sure that there are no other devices on this IP address when connecting the converter for the first time to your LAN for configuration.

To connect to the device, run any web browser and point it to the *Device IP Address*. It is not necessary to specify the *Web Server Port* if the web server uses a standard port *80*.

After a successful connection, you will see the device home page, see: Figure 5.



The screenshot shows a web browser window with the address bar displaying "192.168.0.34". The page title is "CAN-ENET Home". The main content area features the "AXIOMATIC Global Electronic Solutions" logo and the heading "Automotive Ethernet to CAN Converter". A navigation menu on the left includes links for Home, Main Settings, CAN ID Range Filters, CAN ID Mask Filters, Diagnostics, and Firmware. The main content is organized into three sections: "DEVICE INFORMATION", "AUTOMOTIVE ETHERNET", and "CAN".

DEVICE INFORMATION
Part Number: AX141530
Serial Number: 0000121001
Firmware Version: V1.00

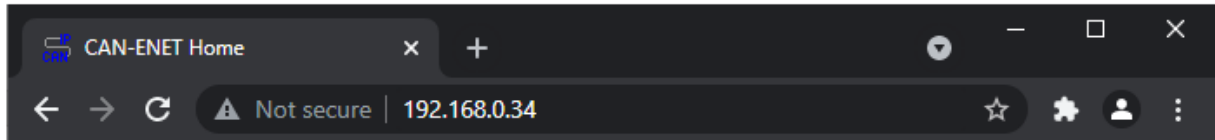
AUTOMOTIVE ETHERNET
MAC Address: B4:37:D1:A6:65:01
PHY Master/Slave Configuration: Slave
Server
Device IP Address: 192.168.0.34
Device Port: 4000
Device Port Type: UDP
Web Server Port: 80
Device Subnet Mask: 255.255.255.0
Device Default Gateway: 192.168.0.1
Client
Auto Connect to Remote: No
Remote IP Address: 192.168.0.35
Remote Port: 4000

CAN
Switched Power Out: Off
Baud Rate: 250 kbit/s
ID Range Filters: Off
ID Mask Filters: Off
Loopback Messages: No

Figure 5. Converter Home Page

The home page shows the device information, including the converter part number, serial number, and firmware version. It also shows *Automotive Ethernet* and *CAN* configuration parameters including Automotive Ethernet transceivers' master/slave configuration, the status of CAN ID range, and mask input filters.

You will need to allow the site to run JavaScript (this setting is default in most web browsers). If JavaScript is disabled, the website will show a message asking to activate JavaScript at the top of the web page, see Figure 6.



The Ethernet to CAN Converter interface **requires** JavaScript!
Use the following [instructions](#) to enable JavaScript in your web browser.

Figure 6. Enable JavaScript Prompt

The *Automotive Ethernet* configuration parameters are combined into *Server* and *Client* groups for convenience.

The *Automotive Ethernet* and *CAN* configuration parameters have tooltips clarifying their meaning, see Figure 7.

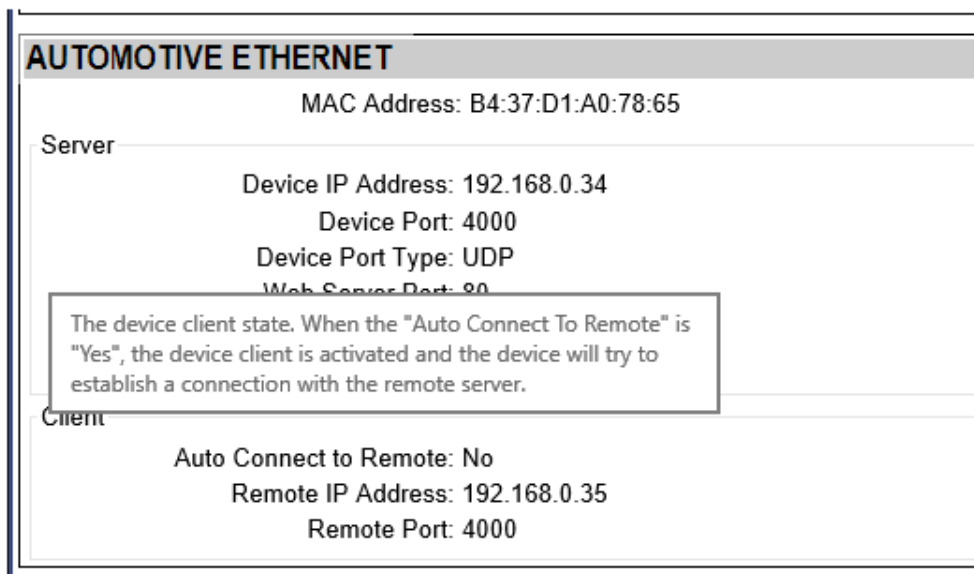


Figure 7. A Tooltip for the "Auto Connect to Remote" Configuration Parameter

2.1 Changing Configuration Parameters

All configuration parameters except the CAN ID range and mask filter settings can be changed through the *Main Settings* web page. The CAN ID range and mask filters have their own configuration pages: *CAN ID Range Filters* and *CAN ID Mask Filters*, see Figure 8.

The configuration pages can be reached by clicking on their links on the left side of the website.

Each configuration web page has fields to enter values of the configuration parameters and three buttons: *Save Settings*, *Discard Settings* and *Set Defaults*.

The *Save Settings* button will save configuration parameters to non-volatile memory and apply the new settings. The appropriate converter subsystems will be restarted without rebooting of the whole converter. The rebooting is available from the *Diagnostics* screen.

The *Discard Settings* button will bring back the original converter settings before editing, and the *Set Defaults* button will load the default values of the configuration parameters into the data fields on the page.

The screenshot shows a web browser window titled "CAN-ENET Settings" with the address bar displaying "192.168.0.34/settings.shtml". The page header features the "AXIOMATIC Global Electronic Solutions" logo and the title "Automotive Ethernet to CAN Converter". A left sidebar contains a navigation menu with links: Home, Main Settings, CAN ID Range Filters, CAN ID Mask Filters, Diagnostics, and Firmware. The main content area is divided into three sections: "CONVERTER SETTINGS" with buttons for "Save Settings", "Discard Changes", and "Set Defaults"; "AUTOMOTIVE ETHERNET" with sub-sections for "Server" (Device IP Address: 192.168.0.34, Device Port: 4000, Device Port Type: UDP selected, Web Server Port: 80, Device Subnet Mask: 255.255.255.0, Device Default Gateway: 192.168.0.1), "Client" (Auto Connect to Remote: No, Remote IP Address: 192.168.0.35, Remote Port: 4000), and "PHY Mode" (PHY Master/Slave Configuration: Slave); and "CAN" (Switched Power Out: Off, Baud Rate: 250 kbit/s, Loopback Messages: No).

Figure 8. Converter Main Settings Page

The configuration parameters have tooltips for the user convenience. The *Remote IP Address* and *Remote Port* are disabled when *Auto Connect to Remote* is set to *No*.

The page runs a script to check the validity of the new configuration parameters before uploading them to the web server. For example, the following alert message will be displayed if the user enters the same value for the *Device Port* and the *Web Server Port*:

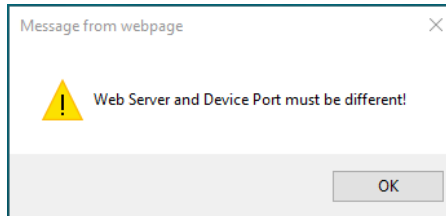


Figure 9. Settings Alert. Error in Configuration Parameters

The website messages should be enabled (not suppressed) in the browser to see this and other feedback messages.

After pressing the *Save Settings* button and saving the configuration parameters, the converter replies with a confirmation message showing a result of the saving operation. For example, if the user has successfully changed the *Device Port* value, the following message will appear:

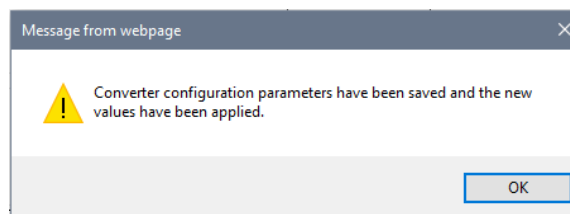


Figure 10. Settings Alert. Configuration Parameters have been Changed Successfully

The new configuration parameters are applied immediately after saving. The converter performs all necessary internal reconfigurations and resets on the fly. If the user changed the *Device IP Address* or the *Web Server Port*, the website will be automatically re-loaded at the new location.

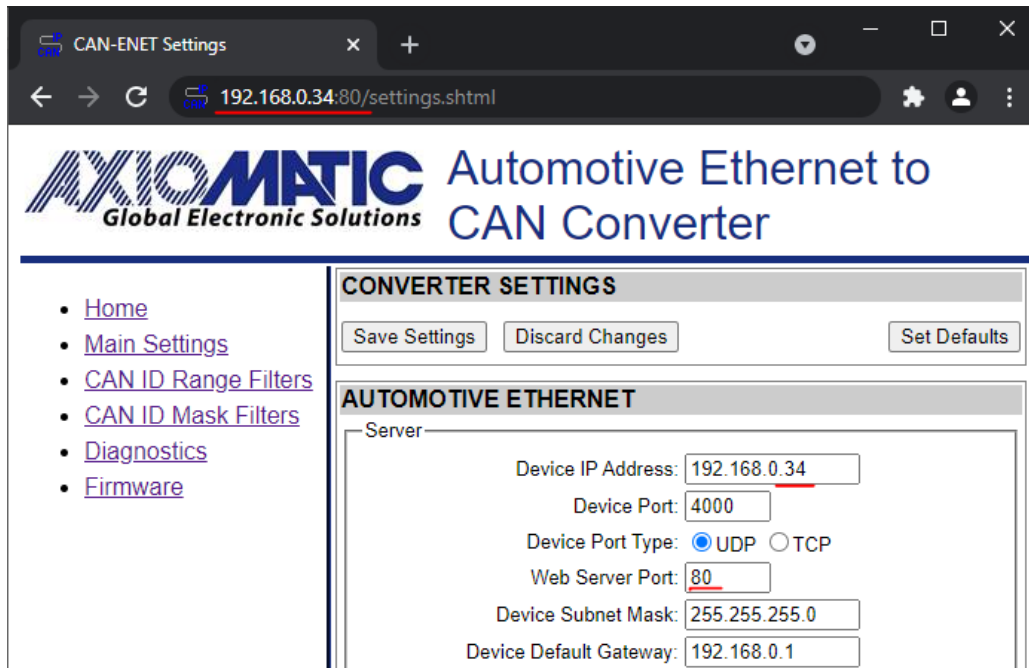


Figure 11. Website Automatic Relocation

In case the user leaves the page without saving, all changes will be discarded. The user can also discard changes by pressing the *Discard Changes* button.

2.2 Automotive Ethernet Configuration

All *Automotive Ethernet* configuration parameters can be changed through the *Main Settings* web page, except the *MAC Address*, which is programmed at the factory. The user-changeable configuration parameters are presented in Table 2.

If the converter is in master mode than the other device connected with this converter should be in slave mode. Same way if this converter is in slave mode, then the other device connected with this converter should be in master mode.

Table 2. Ethernet Configuration Parameters

Configuration Parameter	Default Value	Range	Description
<i>Device IP Address</i>	192.168.0.34	Any IP address	The device IP address. The embedded web server uses the same IP address.
<i>Device Port</i>	4000	Any port value except the <i>Web Server Port</i> and the <i>Discovery Protocol Port</i>	The device server port. The device is listening to this port for incoming connections. The Discovery Protocol Port (35100) and the <i>Web Server Port</i> should not be used.
<i>Device Port Type</i>	UDP	{UDP, TCP}	Type of the IP protocol used by the device. The device server and client use the same IP protocol.
<i>Web Server Port</i>	80	Any port value except the <i>Device Port</i> and the <i>Discovery Protocol Port</i>	The communication port of the embedded web server.

Configuration Parameter	Default Value	Range	Description
<i>Device Subnet Mask</i>	255.255.255.0	Any IP address	The device subnet mask. Used also by the embedded web server.
<i>Device Default Gateway</i>	192.168.0.1	Any IP address	The device default gateway. Used also by the embedded web server.
<i>Auto Connect to Remote</i>	No	{No, Yes}	The device client state. When the <i>Auto Connect to Remote</i> is <i>Yes</i> , the device client is activated, and the device will try to establish a connection with the remote server.
<i>Remote IP Address</i>	192.168.0.35	Any IP address	The remote server IP address. Used by the device client when the <i>Auto Connect to Remote</i> is <i>Yes</i> .
<i>Remote Port</i>	4000	Any port value	The remote server ports. Used by the device client when the <i>Auto Connect to Remote</i> is <i>Yes</i> .
<i>PHY Master/Slave Configuration</i>	Slave	{Slave, Master, Hardware Switch}	The Master/Slave configuration can be selected via the internal web server. The option <i>Hardware Switch</i> refers to an internal switch inside the device which is not accessible in the field. When this option is selected, the device will be in Master mode or in Slave mode depending on the position of the switch at the factory. Selecting <i>Slave</i> or <i>Master</i> will override the internal switch.

2.3 CAN Configuration

The CAN configuration parameters can be changed through the *Main Settings*, *CAN ID Range Filters*, and *CAN ID Mask Filters* web pages.

The main CAN configuration parameters are available through the *Main Settings* web page, see Table 3.

Table 3. Main CAN Configuration Parameters

Configuration Parameter	Default Value	Range	Description
<i>Switched Power Out</i>	Off	{Off, On}	State of the switch delivering power to the CAN connector.
<i>Baud Rate</i>	250 kbit/s	{1000, 666.6(6), 500, 250, 125, 100, 83.3(3), 50, 20, 10} ¹	The CAN baud rate.
<i>Loopback Messages</i>	No	{No, Yes}	Specifies, whether the messages received over the Ethernet and transmitted on the CAN bus, are sent back to the Automotive Ethernet. Setting this value to <i>Yes</i> can create an eternal loop when the same messages are bounced between two or more converters. Use with caution.

¹ 666.6(6) and 83.3(3) kbit/s are set as 667 and 83 kbit/s, respectively, in the drop-down menu.

The CAN filters have their own web pages for setting configuration parameters. If all filters are disabled, all input CAN messages will be output on the Automotive Ethernet network.

2.3.1 CAN ID Range Filters

The CAN ID range filters are set through the *CAN ID Range Filters* configuration web page.

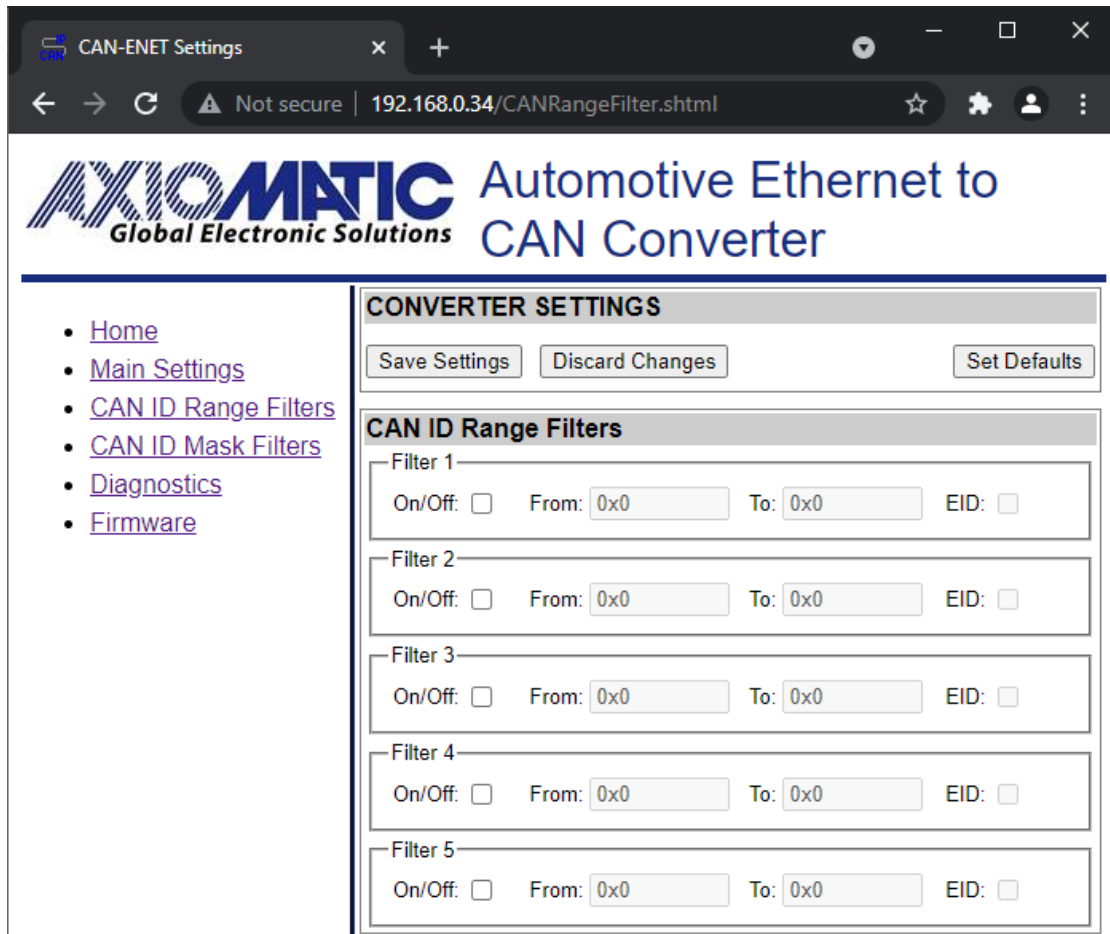


Figure 12. Converter CAN ID Range Filters Page

The user can independently configure five CAN ID range filters: *Filter 1*, *Filter 2*, ..., *Filter 5*.

Once the filter is activated by checking the *On/Off* box, the CAN input messages will pass through to the Automotive Ethernet network only if their CAN ID is within the range specified by *From* and *To* configuration parameters.

If $ID_{CAN} \in [From; To]$, then the message is accepted. (1)

Where: ID_{CAN} – CAN message ID,
 $From$ – *From* configuration parameter,
 To – *To* configuration parameter.

The *EID* box (*Extended ID* box) defines whether the CAN message ID is regular or extended.

All CAN ID range filters run in parallel. It is sufficient to satisfy requirements of any active filter to pass the CAN message to the Automotive Ethernet network.

If no active filters are defined, it is considered that the CAN ID range filters are disabled, and do not participate in the message filtering process. In this case, *ID Range Filters* are *Off* on the home page, and, if other filters are also disabled, all CAN input messages will be sent to the Automotive Ethernet network.

2.3.2 CAN ID Mask Filters

The CAN ID mask filters are set through the *CAN ID Mask Filter* configuration web page.

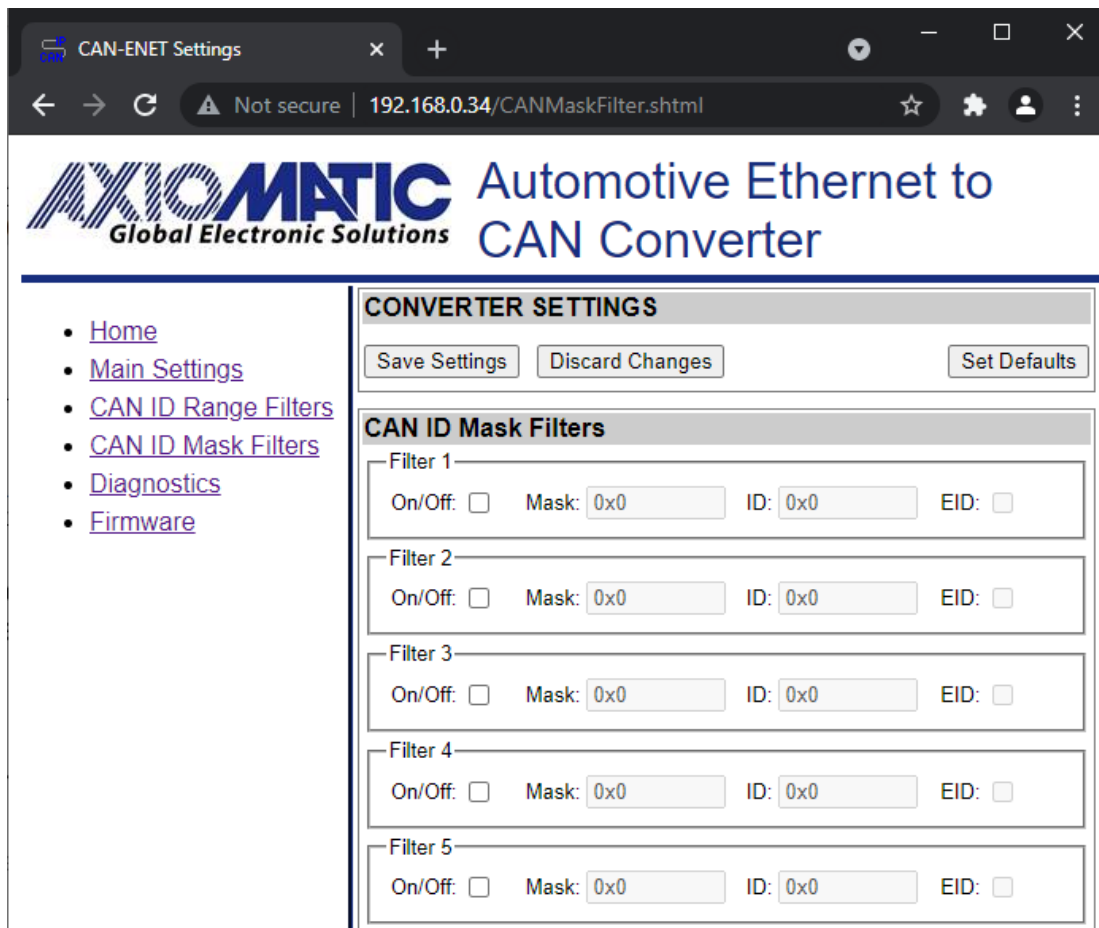


Figure 13. Converter CAN ID Mask Filters Page

There are five independent CAN ID mask filters: *Filter 1*, *Filter 2*, ..., *Filter 5* available to the user.

Once the filter is activated by checking the *On/Off* box, the CAN input messages will pass through the filter to the Automotive Ethernet network only if their CAN ID satisfies the following condition:

If $ID = ID_{CAN}$ & Mask, then the message is accepted. (2)

Where: ID_{CAN} – CAN message ID,
 $Mask$ – *Mask* configuration parameter,

ID – *ID* configuration parameter,
& – Bitwise AND operator.

The *EID* box (*Extended ID* box) defines whether the CAN message ID is regular or extended.

All CAN ID mask filters run in parallel the same way as CAN ID range filters. It is sufficient to satisfy requirements of any active filter to send the CAN message to the Automotive Ethernet network.

If no active filters are defined, it is considered that the CAN ID mask filters are disabled, and do not participate in the message filtering process. In this case, *ID Mask Filters* are *Off* on the home page, and, if other filters are also disabled, all CAN input messages will be sent to the Automotive Ethernet network.

3 CONVERTER DIAGNOSTICS

The user can see a real-time diagnostic information on the *Diagnostics* page on the converter internal website. The connection to the converter embedded web server is described in the [Converter Configuration](#) section.

To see the *Diagnostics* page, Figure 14, the user should click on the *Diagnostics* link on the left side of the web page.

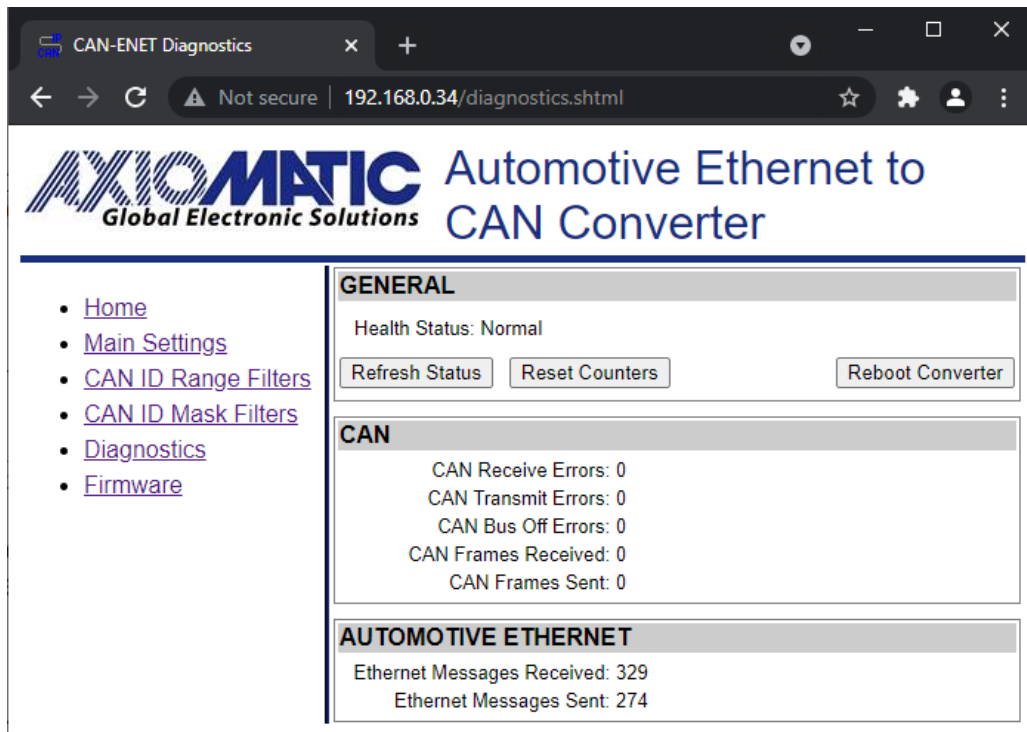


Figure 14. The Converter Diagnostics Page

The *Diagnostics* page shows the *Health Status* of the converter together with the *CAN* and *Automotive Ethernet* statistics.

The user can refresh the values on the page by pressing the *Refresh Status* button or reset the statistic counters by pressing *Reset Counters* button. The *Reboot Converter* button activates the converter rebooting.

The converters do not retain the diagnostic information. All information is lost when the power is shut down.

3.1 Health Status

The converter *Health Status* is an aggregated system run-time parameter calculated on the base of operational statuses of the major device hardware and software components.

The *Health Status* presents the overall operational status of the *CAN to Automotive Ethernet Converter*, based on the following rules, see Table 4.

Table 4. Health Status

Health Status	Condition
<i>Error</i>	<i>Error</i> is reported when at least one operational status is in the <i>Error</i> state.
<i>Warning</i>	<i>Warning</i> is reported when at least one operational status is in the <i>Warning</i> state and there are no operational statuses in the <i>Error</i> state.
<i>Undefined</i>	<i>Undefined</i> is reported when at least one operational status is in the <i>Undefined</i> state and there are no operational statuses in the <i>Error</i> or <i>Warning</i> state.
<i>Normal</i>	<i>Normal</i> is reported when all operational statuses are in the <i>Normal</i> state.

If the *Health Status* is different from *Normal*, the user will see a verbose message on the *Diagnostics* web page below the *Health Status* describing which operational status is causing a problem.

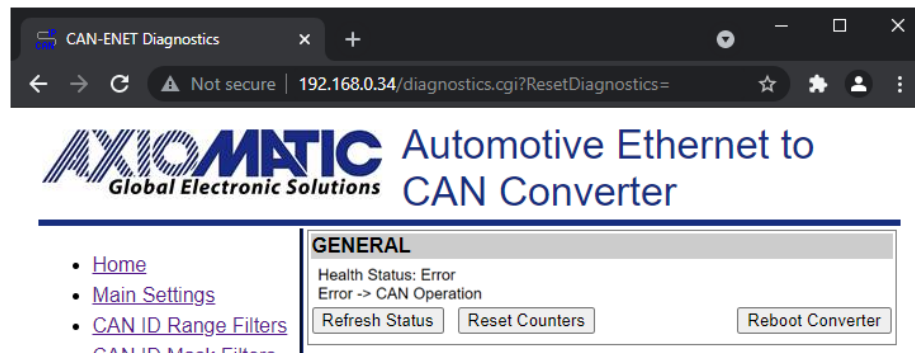


Figure 15. Health Status Message on CAN Error

In case, several operational statuses differ from *Normal*, all of them will be shown on the *Diagnostics* page.

3.2 Converter Rebooting

The user can reboot the converter, when necessary, using the *Reboot Converter* button.

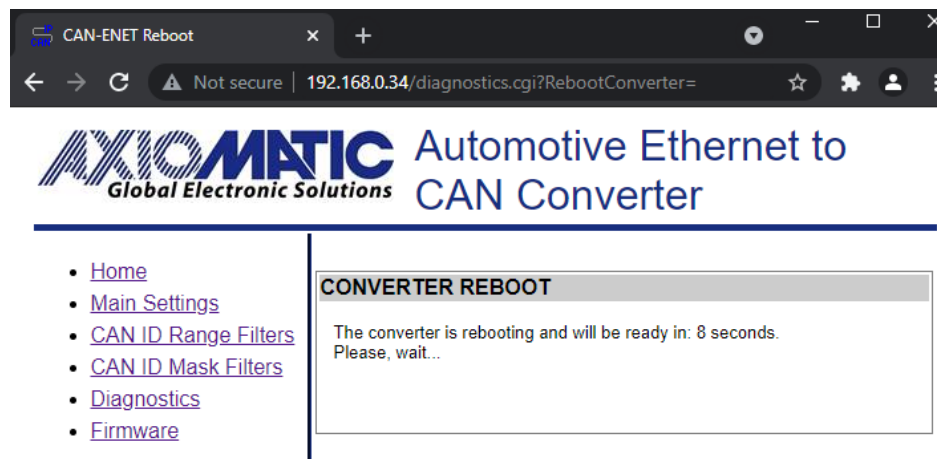


Figure 16. The Converter Reboot Screen

The rebooting operation takes 10 seconds. The user will see the *Reboot* screen with a countdown during this operation.

When rebooting is over, the *Diagnostics* page will be reloaded.

4 FIRMWARE UPDATE

The converter firmware can be updated through the website.

The update procedure is performed in two stages. First, the application firmware is uploaded into the converter internal flash. During this stage, the converter checks the firmware checksum and whether it can be programmed into the unit.

Then, upon the user confirmation, the firmware is programmed into the microcontroller and the unit is restarted. At the end of this process, the user should see the new firmware version number on the converter home page in the browser.

The details of the firmware update are provided below.

4.1 Uploading the New Firmware

To upload the new firmware, the user should activate the *Firmware Uploading* page, Figure 17, by clicking on the *Firmware* link on the left side of the web page.

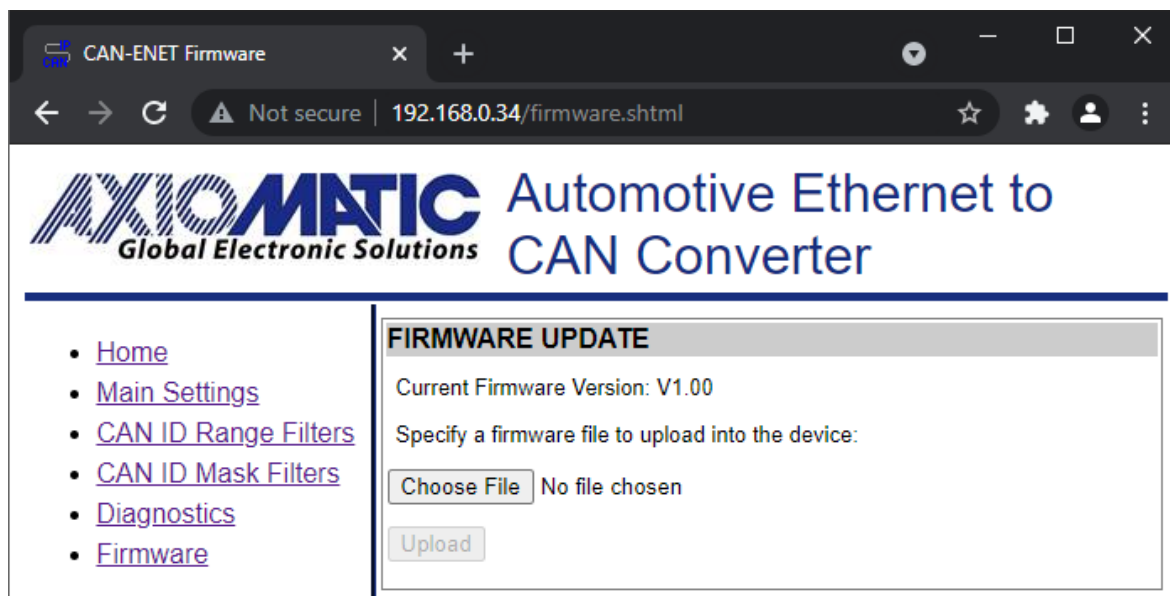


Figure 17. Firmware Uploading Page

Then the user selects the new firmware file using the *Browse...* button.

The firmware file is provided by Axiomatic in a proprietary binary format with extension: *.af*. The file name should have the following format: *AF-21005-X.XX.af*, where the *<X.XX>* field wildcard reflects the firmware version number. We will use *AF-21005-1.00.af* file for illustration of the firmware update process in this manual.

When the file is selected, the user should press the *Upload* button. The user will see the dynamic message: "Loading..." in the bottom of the screen and then, if everything is in order, the converter will switch automatically to the *Firmware Update* page.

4.2 Applying the New Firmware

On the *Firmware Update* page, the user will see the new firmware file information.

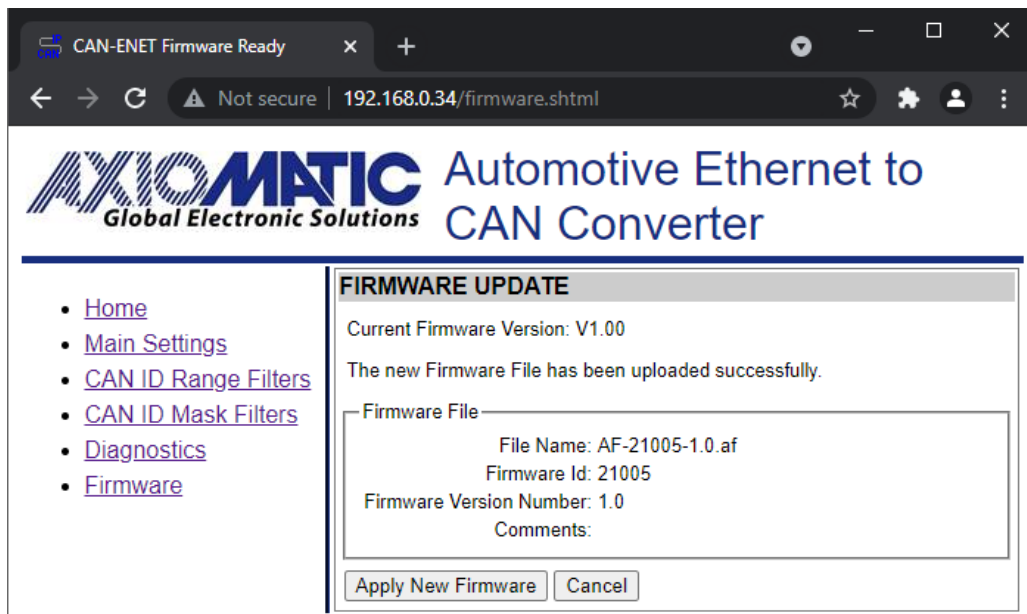


Figure 18. Firmware Update Page

From this point, the user can cancel the firmware update process and keep the old firmware or proceed with flashing the new firmware into the microcontroller by pressing the *Apply New Firmware* button.

When the user presses the *Apply New Firmware* button, the firmware update process is activated and the *Firmware Upload* page will show the countdown timer.

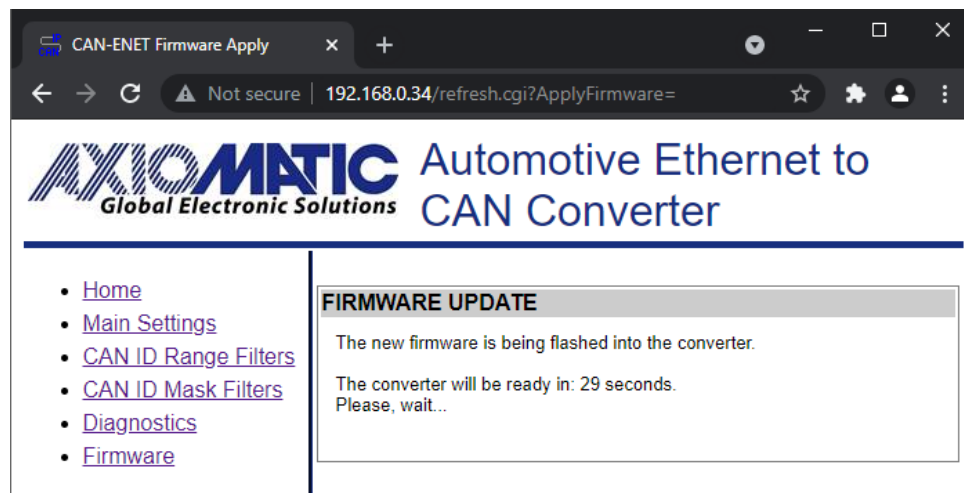


Figure 19. Firmware Update Countdown has been Started

The countdown timer is set for 30 seconds necessary to complete the flashing process and reboot the unit, after which the converter home page will be displayed. The user will see the new application firmware version number in the *Device Information* section on the converter home page.

5 CONVERTER DEPLOYMENT

There are two major approaches in using the Automotive Ethernet to CAN converter. One is to use the converter on its own as a CAN extender or a baud rate converter.

For example, a pair of coupled converters can synchronize two CAN networks. This example can be extended to several CAN networks running at different baud rate in various remote locations, connected together using the Automotive Ethernet to CAN converters.

The second approach is to use the converter together with other IP devices that can directly communicate with the converter over the IP network. This approach requires writing a custom software for interfacing with the converter. Since the converter uses a proprietary communication protocol, Axiomatic provides the CAN-AUTOENET Software Support Package (SSP), p/n AX141530, for interfacing with the converter. The SSP is downloadable from www.axiomatic.com, log-in section.

The majority of Axiomatic PC software tools support the Automotive Ethernet to CAN converter. They can connect to the CAN bus using the Automotive Ethernet to CAN converter the same way as they connect to the bus using the USB to CAN converter. The Axiomatic Electronic Assistant (EA) can communicate with the converter and the CAN Assistant – Scope and CAN Assistant – Visual support the converter.

The use of the Automotive Ethernet to CAN converters for synchronizing CAN networks with or without baud rate conversion is described below. There is no need for custom software for this type of the converter deployment.

5.1 CAN Network Synchronization

To synchronize two remote CAN networks, the user can simply connect an Automotive Ethernet to CAN converter to each of the CAN network and configure the converters the way that they will talk with each other.

5.1.1 Hardware Setup

The converters should be connected together through a local or global IP network, see: Figure 20 and Figure 21.

Note: To connect the converter to a local or global IP Network, converter should be connected to an Automotive Ethernet to Ethernet (AX141500-M/ AX141500-S) converter in cascade and then Ethernet port of Automotive Ethernet to Ethernet (AX141500-M/ AX141500-S) should be connected to the local or global network.

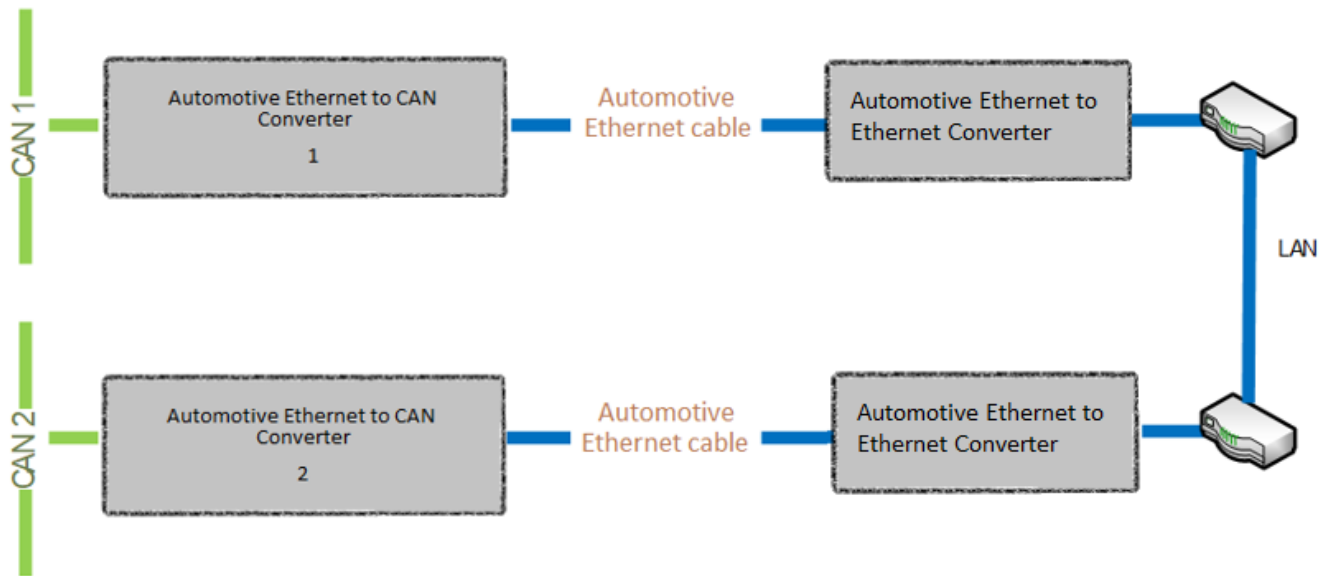


Figure 20. Local Connection through the LAN

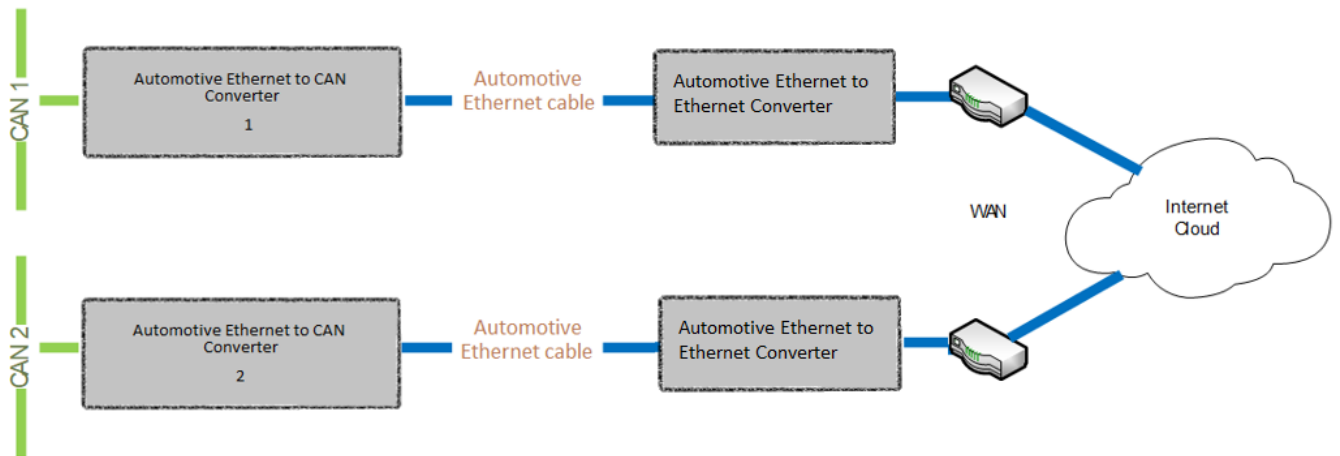


Figure 21. Global Internet Connection through the WAN

In the simplest scenario, two pre-configured converters can be connected by an Automotive Ethernet cable, see: Figure 22. Due to the Auto-MDIX feature, both: the straight and crossover cables can be used.

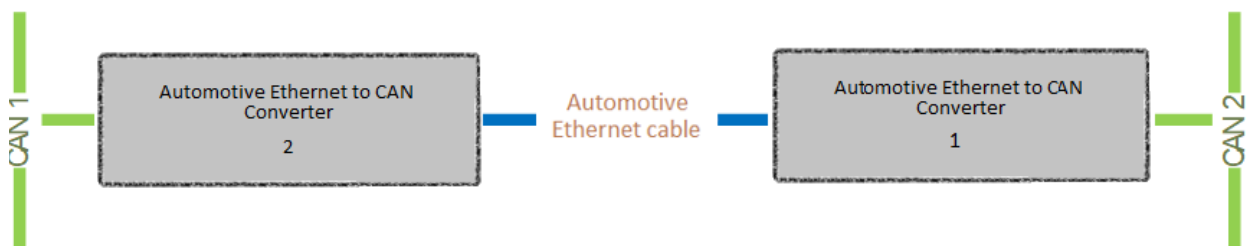


Figure 22. Simple Local Connection

The user can synchronize more than two CAN networks on LAN or WAN. There are practically no limits on the number of synchronized CAN networks, see daisy-chain connection in the [Client Configuration](#) section in Figure 25.

5.1.2 Converter Configuration

After the physical connection is established, the converters should be configured to exchange messages between each other. Since the converters support client/server communication model, one of the converters should be a server and the other one – a client.

5.1.2.1 Server Configuration

To configure the converter as a server, first set: *Device IP Address*, *Device Port*, *Device Subnet Mask* and *Device Default Gateway* to the appropriate values received from your network administrator. Configure the *Device Port Type* to *UDP* or *TCP* depending on the required message reliability and acceptable delays. Use unreliable but fast UDP when speed is a priority or reliable but slow TCP when message reliability is more important than the speed.

Set *Auto Connect to Remote* to *No* to disable the client side of the converter. The *Remote IP Address* and *Remote Port* can be left untouched since they are not used by the converter when the client mode is disabled. They are grayed on the *Settings* page in this mode.

For the CAN network, configure the necessary *Baud Rate* and set *Loopback Messages* to *No*. The *Loopback Messages* configuration parameter must be set to *No* to avoid sending the same messages back and forth between converters, which will lead to network saturation and communication failure.

If Converter 1's phy is configured as a *Slave* then, Converter 2's phy should be configured as a *Master*.

An example of the converter configuration as a server is presented in Figure 23.

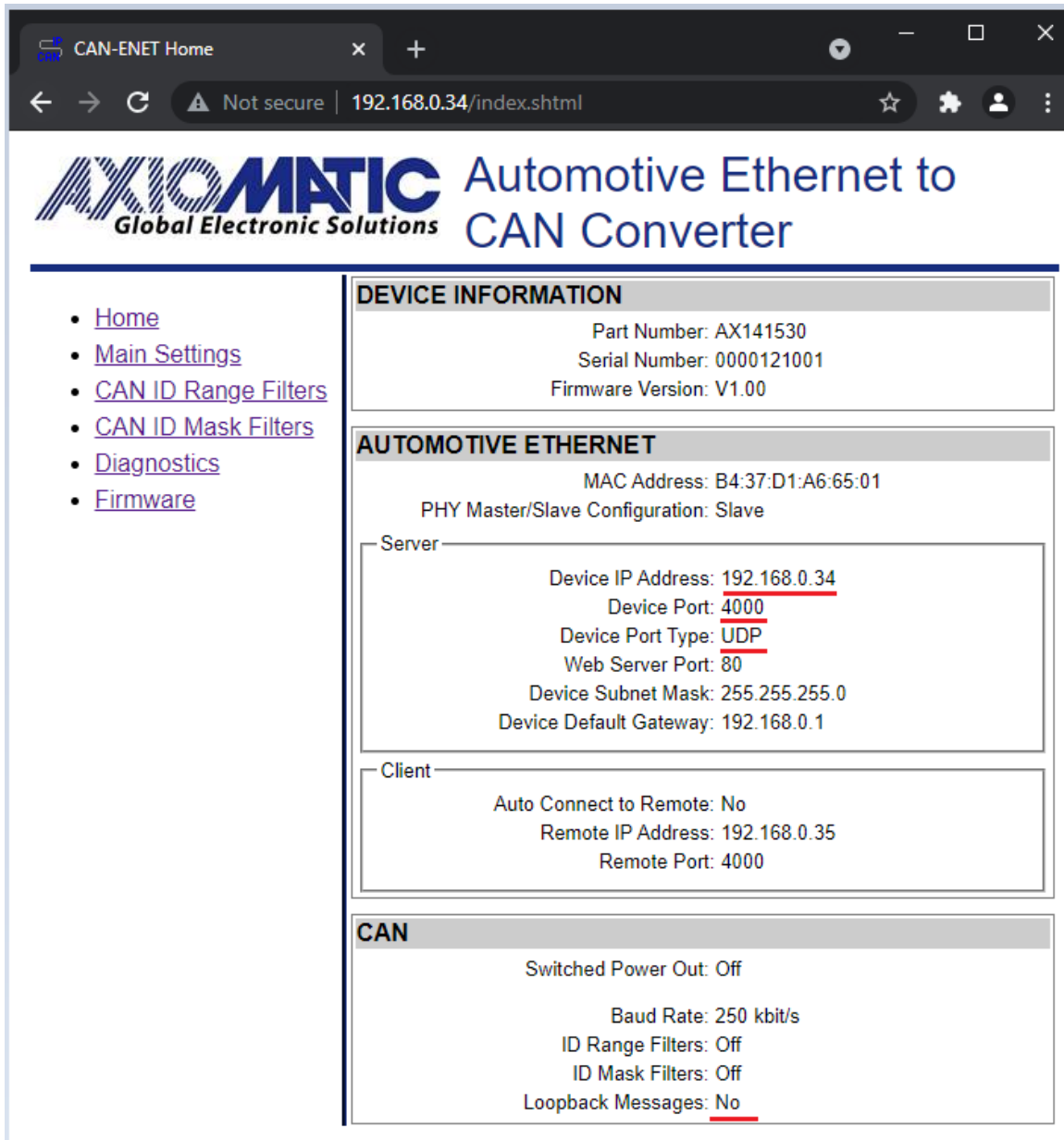


Figure 23. The Converter Server Configuration Example

5.1.2.2 Client Configuration

In the client configuration, the user should set *Device IP Address*, *Device Port*, *Device Subnet Mask* and *Device Default Gateway* to the appropriate values received from the network administrator the same way as with the server configuration. After that, the user should set the *Device Port Type*, *Remote IP Address* and *Remote Port* to match the settings of the converter in the server mode and activate the client mode by setting the *Auto Connect to Remote* to *Yes*.

The CAN network setup is done similarly to the server mode; the *Baud Rate* is set to the desired baud rate (not necessarily the same as on the server) and the *Loopback Messages* is set to *No*.

An example of the converter configuration in a client mode is presented in Figure 24.

The screenshot shows a web browser window with the URL 192.168.0.35/index.shtml. The page header features the AXOMATIC logo and the text "Automotive Ethernet to CAN Converter". A navigation menu on the left includes links for Home, Main Settings, CAN ID Range Filters, CAN ID Mask Filters, Diagnostics, and Firmware. The main content area is divided into three sections:

- DEVICE INFORMATION:**
 - Part Number: AX141530
 - Serial Number: 0000121001
 - Firmware Version: V1.00
- AUTOMOTIVE ETHERNET:**
 - MAC Address: B4:37:D1:A6:65:01
 - PHY Master/Slave Configuration: Master
 - Server:**
 - Device IP Address: 192.168.0.35
 - Device Port: 4000
 - Device Port Type: UDP
 - Web Server Port: 80
 - Device Subnet Mask: 255.255.255.0
 - Device Default Gateway: 192.168.0.1
 - Client:**
 - Auto Connect to Remote: Yes
 - Remote IP Address: 192.168.0.34
 - Remote Port: 4000
- CAN:**
 - Switched Power Out: Off
 - Baud Rate: 250 kbit/s
 - ID Range Filters: Off
 - ID Mask Filters: Off
 - Loopback Messages: No

Figure 24. The Converter Client Configuration Example

The values of the *Device Port Type*, *Remote IP Address* and *Remote Port* of the client on Figure 24 are the same as the *Device Port Type*, *Device IP Address* and *Device Port* of the server in Figure 23.

Please note, that if the converters are connected over the internet, the *Remote IP Address* of the client will be a public IP address of the server, not the internal server IP address presented as the *Device IP Address* on Figure 23. The network administrator on the server side will be required to configure port forwarding to open internet access to the converter in the server mode.

When the converter is configured as a client, it will still act as a server accepting connections on the *Device Port* from other clients. This adds versatility to the converter configurations since the same converter can be used together with both: client and server communication nodes.

As an example, the user can establish an unlimited number of daisy-chain client-server connections, see: Figure 25.

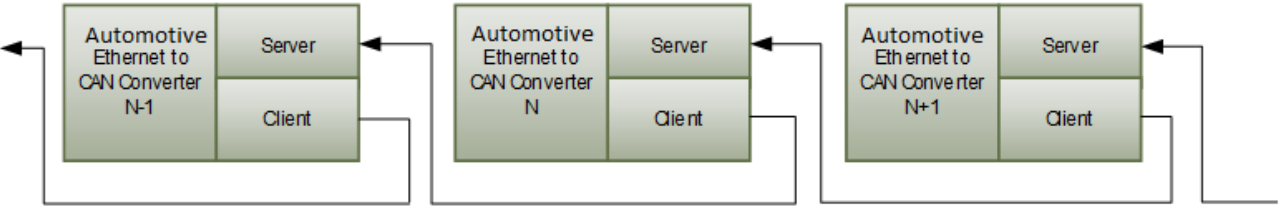


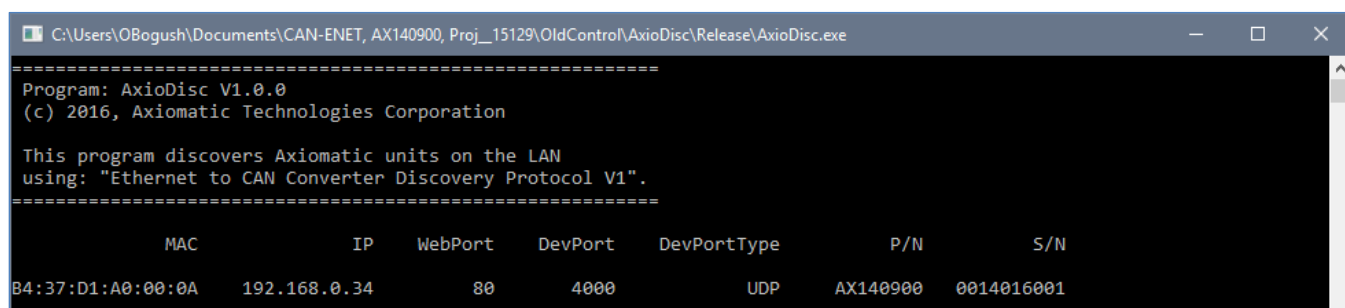
Figure 25. Daisy-Chain Converter Connection

6 CONVERTER DISCOVERY

In case the IP address and/or web server port is unknown or has been lost, the user can recover them using the Axiomatic `AxioDisc.exe` Windows console application. The application uses a proprietary discovery protocol and can recover IP locations of Axiomatic converters on a LAN. The `AxioDisc.exe` application is available upon request.

Converter Discovery requires an Automotive Ethernet to Ethernet converter connected to CAN to Automotive Ethernet Converter in cascade.

The application sends a UDP request to the global IP address `255.255.255.255`, port `35100` and waits for the responses from the converters located on the same local network. The converter discovery response includes the unit MAC Address, IP Address, web server port, device port, device port type, the converter part number and serial number.



```
C:\Users\OBogush\Documents\CAN-ENET, AX140900, Proj_15129\OldControl\AxioDisc\Release\AxioDisc.exe
=====
Program: AxioDisc V1.0.0
(c) 2016, Axiomatic Technologies Corporation

This program discovers Axiomatic units on the LAN
using: "Ethernet to CAN Converter Discovery Protocol V1".
=====
      MAC          IP      WebPort   DevPort   DevPortType      P/N      S/N
-----
B4:37:D1:A0:00:0A  192.168.0.34    80       4000        UDP      AX140900  0014016001
```

Figure 26. `AxioDisc.exe` Converter Discovery Application

The discovery protocol is also supported by the CAN-AUTOENET Software Support Package, p/n AX141530, and can be used for network discovery and plug-and-play connection to Axiomatic Automotive Ethernet to CAN converters.

The `AxioDisc.exe` application can run on Windows starting from Win XP SP3. It was tested on Win XP SP3, Win 7 and Win 10. In case the application cannot find standard dlls, the Visual C++ Redistributable for Visual Studio 2015 x86 must be installed on the user's computer from the Microsoft website: <https://www.microsoft.com/en-ca/download/details.aspx?id=48145>

7 TECHNICAL SPECIFICATIONS

Specifications are indicative and subject to change. Actual performance will vary depending on the application and operating conditions. Users should satisfy themselves that the product is suitable for use in the intended application. All our products carry a limited warranty against defects in material and workmanship. Please refer to our Warranty, Application Approvals/Limitations and Return Materials Process as described on <https://www.axiomatic.com/service/>.

7.1 Power Supply

7.1.1 Input

Power supply input is located on the Automotive Ethernet connector. The power supply uses automotive battery power. It is not compatible with the PoE (Power over Automotive Ethernet) IEEE 802.3 standard.

Table 5. Power Supply Input

Parameter	Value	Remarks
Supply Voltage	9...36 VDC	12V, 24V – nominal
Power Consumption	2W	Maximum at 12V
Protection	Under Voltage Shutdown Over Voltage Shutdown Reverse Polarity Transients	< 6 V > 37V 12V Load Dump

7.1.2 Output

Power supply output is located on the CAN connector.

Table 6. Power Supply Output

Parameter	Value	Remarks
Voltage Output	9...36 VDC	Pass-through power from the power supply input.
Current Output	0.7A	Maximum pass-through current.
Voltage Drop	1V	Maximum
Protection	Overcurrent Short to Battery Short to Ground	> 1A

7.2 Automotive Ethernet

Table 7. Automotive Ethernet Parameters

Parameter	Value	Remarks
Number of Ports	1	
Port Type	10BASE-T, 100BASE-TX	Auto-configuration and full-duplex supported.
MDIX	Auto-MDIX	Auto-crossover to eliminate cabling mismatch.
LED Indicators	Speed/Activity	
Protocols	Ethernet IEEE 802.3, IP, ICMP, ARP, UDP, TCP, HTTP, Proprietary	CAN messages are transmitted using a proprietary application protocol running on top of the user selectable UDP or TCP transport protocol. The internal web server uses HTTP protocol. The unit supports a proprietary discovery protocol.
Server Mode	Up to 10 bi-directional simultaneous connections	Up to 9 connections, if the Client mode is enabled.

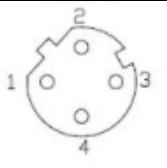
Parameter	Value	Remarks
Client Mode	1 remote bi-directional connection	Auto-connect to a remote server, if connection is dropped or temporarily unavailable. Client mode can be disabled.
Web server	Provided	Always enabled for converter configuration and diagnostics.
Internal Diagnostics	Health Status	Internal health status of the converter is transmitted in heartbeat messages. It is also available from the web server.

7.2.1 Automotive Ethernet Connector

M12 socket, 4-pin, D-coded, female connector, Phoenix Contact, P/N: 1441752.

Table 8. Automotive Ethernet Connector Pinout

PIN #	Description
1	TRD_N
2	BATT $\bar{\bar{}}$ - (GND)
3	TRD_P
4	BATT $\bar{\bar{}}$ + (9-36V)



Use D-coded mating connectors compliant with IEC 61076-2-101:2012.

The AX070534 Automotive Ethernet and Power Cable - 1.7m (5.5 ft.), 4-pin M12 D-coded, Unterminated Leads, Automotive Ethernet Jack, can be used for experimenting. The cable is rated -40...+75 °C.

7.3 CAN

Table 9. CAN Parameters

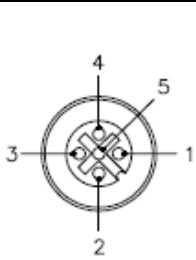
Parameter	Value	Remarks
Number of Ports	1	
Port Type	High Speed, ISO 11898-2 compatible	Twisted pair, up to 1 Mbit/s. Shield connection is provided if shielded cable is used.
Baud Rate	1000, 666.6(6), 500, 250, 125, 100, 83.3(3), 50, 20, 10	[kbit/s]. Programmable through web interface.
Protocol	CAN Bosch 2.0A and B	Data Frames and Remote Frames with Standard and Extended IDs are supported. CAN ID range and mask filtering is provided.

CAN port does not contain 120 Ohm termination resistor.

7.3.1 CAN Connector

M12 socket, 5-pin, A-coded, female connector, Phoenix Contact, P/N: 1441778.

PIN #	Description
1	CAN_SHIELD
2	POUT + (Switch Output)
3	POUT - (GND)
4	CAN_H
5	CAN_L



Use mating A-coded connectors compliant with IEC 61076-2-101:2012.

The AX070532 CAN Cable - 1.5 m (5 ft.), 5-pin M12 A-coded, Unterminated Leads, can be used for experimenting. The cable is rated -40...+105 °C.

7.4 General Specifications

Table 10. General Specifications

Parameter	Value	Remarks
Operating Temperature	-40...+85 °C	Industrial temperature range
Storage Temperature	-40...+85 °C	
Environmental Protection	IP67	IEC 60529
Vibration	Sine sweep, 5-200 Hz, 8.9G peak, 2.5 hr (15 sweeps), each axis. Random, 10-1014 Hz, 6.86 Grms, 5.0 hr, each axis.	Custom profile
Shock	50G peak, 5 shocks, each axis	Custom profile
Size	4.19in x1.82in x1.32in (107mm x 47mm x 34 mm)	See dimensional drawing
Weight	0.15 lb (0.068 kg)	
Compliance	RoHS Directive	

Table 11. Electromagnetic Compatibility (EMC)

Standard	Description
EN61000-6-4:2005	Emission Standard for Industrial Environments
EN61000-6-2:2007	Generic Standards – Immunity for Industrial Environments

7.5 Accessories

Table 12. Accessories

Axiomatic P/N	Description
AX140910	Software Support Package (SSP). Downloadable from www.axiomatic.com , log-in section.
AX070534	AX070534 Automotive Ethernet and Power Cable - 1.7m (5.5 ft.), 4-pin M12 D-coded, Unterminated Leads, Automotive Ethernet Jack.
AX070532	CAN Cable - 1.5 m (5 ft.), 5-pin M12 A-coded, Unterminated Leads.
AX141530K	Service tool kit, contains: <ul style="list-style-type: none"> AX141530 Automotive Ethernet-CAN Converter; AX070534 Automotive Ethernet and Power Cable - 1.7m (5.5 ft.), 4-pin M12 D-coded, Unterminated Leads, Automotive Ethernet Jack; AX070532 CAN Cable - 1.5 m (5 ft.), 5-pin M12 A-coded, Unterminated Leads.

7.6 Housing

Injection molded enclosure and cover. Material: PA66, 30% glass fiber reinforced, flame retardant UL 94 V-0. Ultrasonically welded. For dimensional drawing, see Figure 27.

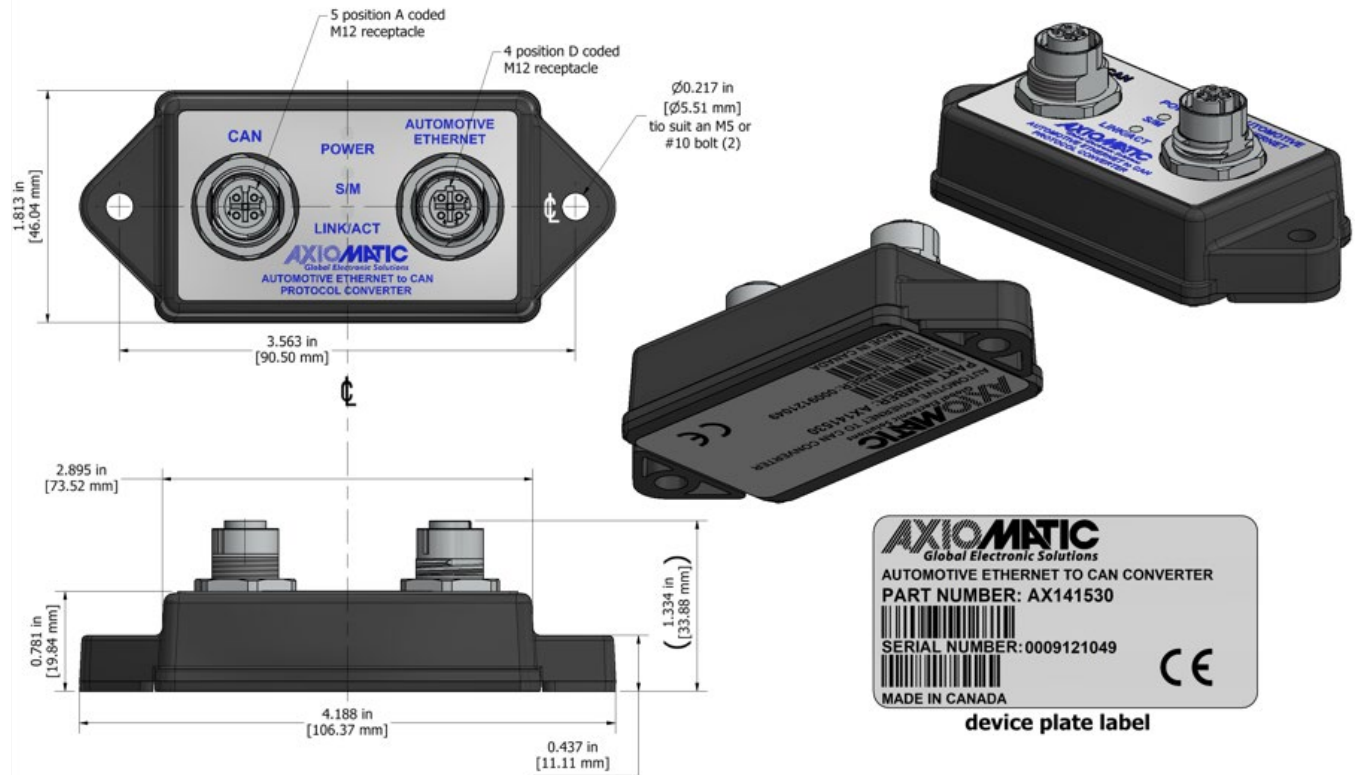


Figure 27. Dimensional Drawing

8 THIRD PARTY SOFTWARE LICENSE NOTICES

This section contains Third Party Software License Notices and/or Additional Terms and Conditions for licensed third-party software components included in the Automotive Ethernet to CAN Converter firmware.

Table 13. Third Party Software License Notices

Third Party Software	License Notice/Terms
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9 VERSION HISTORY

User Manual Version	Firmware version	Date	Author	Modifications
1	1.xx	Aug 17, 2021	Meera Patel	Initial release.
-	-	September 13, 2021	Amanda Wilkins	Marketing Review
2	1.xx	September 23, 2021	Meera Patel	Added the PHY transceivers; information
2.1	-	September 14, 2023	Kiril Mojsov	Performed Legacy Updates

OUR PRODUCTS

AC/DC Power Supplies
Actuator Controls/Interfaces
Automotive Ethernet Interfaces
Battery Chargers
CAN Controls, Routers, Repeaters
CAN/WiFi, CAN/Bluetooth, Routers
Current/Voltage/PWM Converters
DC/DC Power Converters
Engine Temperature Scanners
Ethernet/CAN Converters,
Gateways, Switches
Fan Drive Controllers
Gateways, CAN/Modbus, RS-232
Gyroscopes, Inclinometers
Hydraulic Valve Controllers
Inclinometers, Triaxial
I/O Controls
LVDT Signal Converters
Machine Controls
Modbus, RS-422, RS-485 Controls
Motor Controls, Inverters
Power Supplies, DC/DC, AC/DC
PWM Signal Converters/Isolators
Resolver Signal Conditioners
Service Tools
Signal Conditioners, Converters
Strain Gauge CAN Controls
Surge Suppressors

OUR COMPANY

Axiomatic provides electronic machine control components to the off-highway, commercial vehicle, electric vehicle, power generator set, material handling, renewable energy and industrial OEM markets. ***We innovate with engineered and off-the-shelf machine controls that add value for our customers.***

QUALITY DESIGN AND MANUFACTURING

We have an ISO9001:2015 registered design/manufacturing facility in Canada.

WARRANTY, APPLICATION APPROVALS/LIMITATIONS

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COMPLIANCE

Product compliance details can be found in the product literature and/or on axiomatic.com. Any inquiries should be sent to sales@axiomatic.com.

SAFE USE

All products should be serviced by Axiomatic. Do not open the product and perform the service yourself.



This product can expose you to chemicals which are known in the State of California, USA to cause cancer and reproductive harm. For more information go to www.P65Warnings.ca.gov.

SERVICE

All products to be returned to Axiomatic require a Return Materials Authorization Number (RMA#) from sales@axiomatic.com. Please provide the following information when requesting an RMA number:

- Serial number, part number
- Runtime hours, description of problem
- Wiring set up diagram, application and other comments as needed

DISPOSAL

Axiomatic products are electronic waste. Please follow your local environmental waste and recycling laws, regulations and policies for safe disposal or recycling of electronic waste.

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