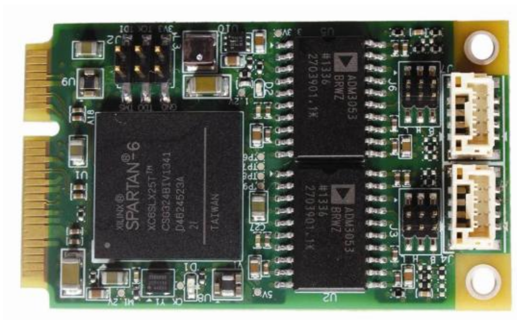
DS-MPE-CAN2L

PCIe MiniCard Dual CAN 2.0 Port Module

Rev A.1 April 2015



Revision	Date	Comment
A.0	4/25/2014	Initial release
A.1	4/09/2015	Updated Windows installation procedure

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1. IMPORTANT SAFE HANDLING INFORMATION

WARNING!

ESD-Sensitive Electronic Equipment

Observe ESD-safe handling procedures when working with this product.

Always use this product in a properly grounded work area and wear appropriate ESD-preventive clothing and/or accessories.

Always store this product in ESD-protective packaging when not in use.

Safe Handling Precautions

This board contains a high density connector with many connections to sensitive electronic components. This creates many opportunities for accidental damage during handling, installation and connection to other equipment. The list here describes common causes of failure found on boards returned to Diamond Systems for repair. This information is provided as a source of advice to help you prevent damaging your Diamond (or any vendor's) embedded computer boards.

ESD damage – This type of damage is usually almost impossible to detect, because there is no visual sign of failure or damage. The symptom is that the board eventually simply stops working, because some component becomes defective. Usually the failure can be identified and the chip can be replaced. To prevent ESD damage, always follow proper ESD-prevention practices when handling computer boards.

Damage during handling or storage – On some boards we have noticed physical damage from mishandling. A common observation is that a screwdriver slipped while installing the board, causing a gouge in the PCB surface and cutting signal traces or damaging components.

Another common observation is damaged board corners, indicating the board was dropped. This may or may not cause damage to the circuitry, depending on what is near the corner. Most of our boards are designed with at least 25 mils clearance between the board edge and any component pad, and ground / power planes are at least 20 mils from the edge to avoid possible shorting from this type of damage. However these design rules are not sufficient to prevent damage in all situations.

A third cause of failure is when a metal screwdriver tip slips, or a screw drops onto the board while it is powered on, causing a short between a power pin and a signal pin on a component. This can cause overvoltage / power supply problems described below. To avoid this type of failure, only perform assembly operations when the system is powered off.

Sometimes boards are stored in racks with slots that grip the edge of the board. This is a common practice for board manufacturers. However our boards are generally very dense, and if the board has components very close to the board edge, they can be damaged or even knocked off the board when the board tilts back in the rack. Diamond recommends that all our boards be stored only in individual ESD-safe packaging. If multiple boards are stored together, they should be contained in bins with dividers between boards. Do not pile boards on top of each other or cram too many boards into a small location. This can cause damage to connector pins or fragile components.

Power supply wired backwards – Our power supplies and boards are not designed to withstand a reverse power supply connection. This will destroy each IC that is connected to the power supply (i.e. almost all ICs). In this case the board will most likely will be unrepairable and must be replaced. A chip destroyed by reverse power or by excessive power will often have a visible hole on the top or show some deformation on the top surface due to vaporization inside the package. **Check twice before applying power!**

Overvoltage on digital I/O line – If a digital I/O signal is connected to a voltage above the maximum specified voltage, the digital circuitry can be damaged. On most of our boards the acceptable range of voltages connected to digital I/O signals is 0-5V, and they can withstand about 0.5V beyond that (-0.5 to 5.5V) before being damaged. However logic signals at 12V and even 24V are common, and if one of these is connected to a 5V logic chip, the chip will be damaged, and the damage could even extend past that chip to others in the circuit

2. INTRODUCTION

2.1 Description

DS-MPE-CAN2L implements a CAN protocol bus controller that performs serial communications according to the CAN 2.0A and CAN 2.0B specifications. The protocol uses a multi-master bus configuration for the transfer of frames between nodes of the network and manages error handling with no burden on the host processor.

2.2 Features

- 2 CAN 2.0B ports with a 1Mbps data rate and programmable interrupts
- 31 receive buffers for improved performance
- 1 high priority transmit buffer and 16 standard priority transmit buffers
- 16 programmable acceptance filters
- 11-bit and 29-bit identifiers
- 500V port-to-port and input-to-output isolation
- Driver supports dual-independent and dual-redundant modes
- Latching connectors for increased ruggedness

2.3 Operating System Support

- Linux 2.6.16, 2.6.27, 2.6.31 and 2.6.32
- Windows 7, XP

2.4 Mechanical, Electrical, Environmental

- PCIe MiniCard full size format
- Dimensions: 50.95mm x 30mm (2” x 1.18”)
- -40°C to +85°C ambient operating temperature
- Power input requirements: +3.3VDC +/- 5%

3. PACKING LIST

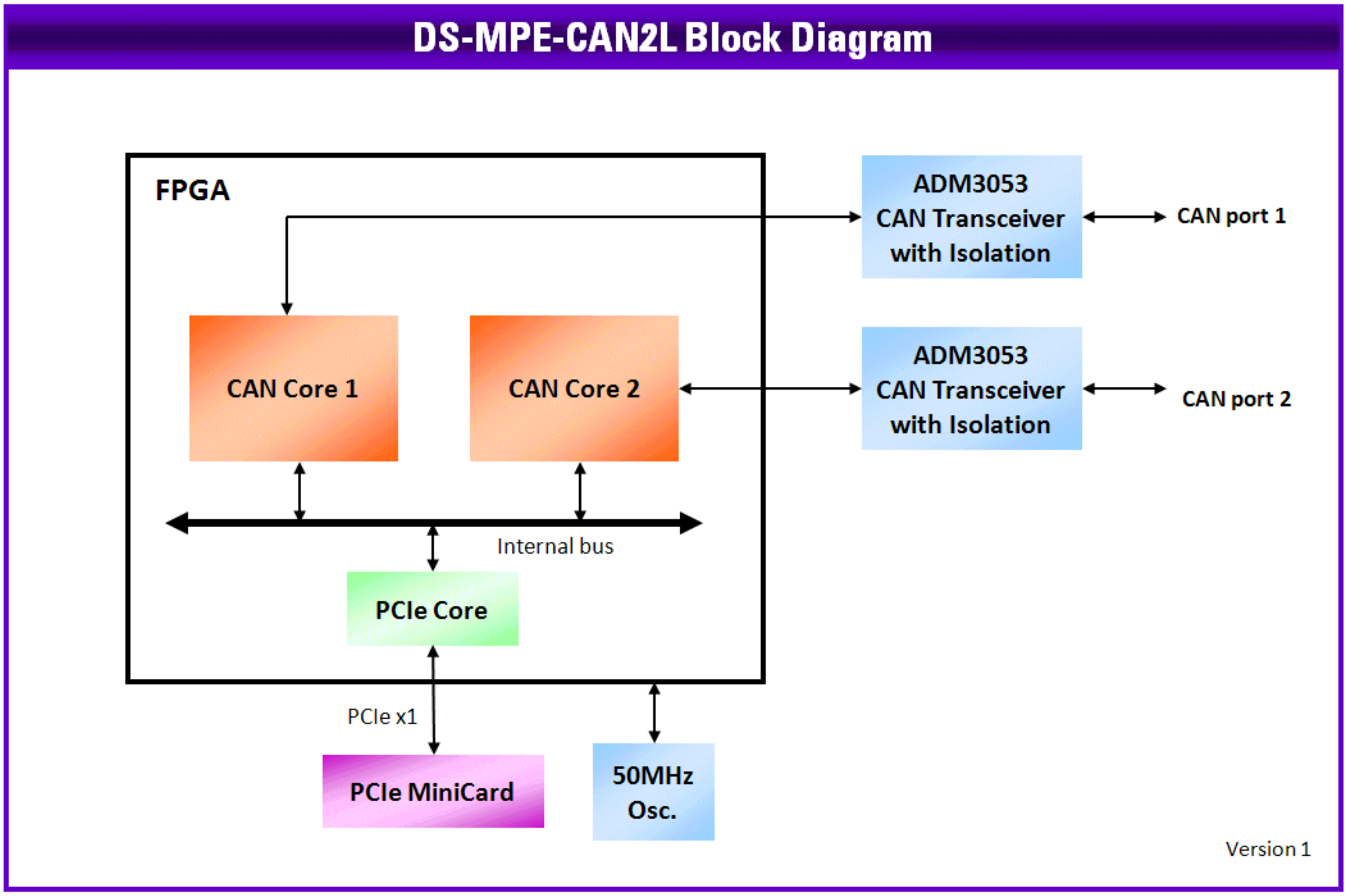
The DS-MPE-CAN2L product comes with the PCIe MiniCard hardware assembly, a cable kit with two dual serial cables, and a hardware kit containing jumpers and mounting screws.

Quantity	Part Number	Description
1	9150500	DS-MPE-CAN2L hardware assembly
1	6800500	Hardware Kit with jumpers and screws
1	CK-CAN2L	Cable Kit with two CAN cables

4. FUNCTIONAL OVERVIEW

4.1 Functional Block Diagram

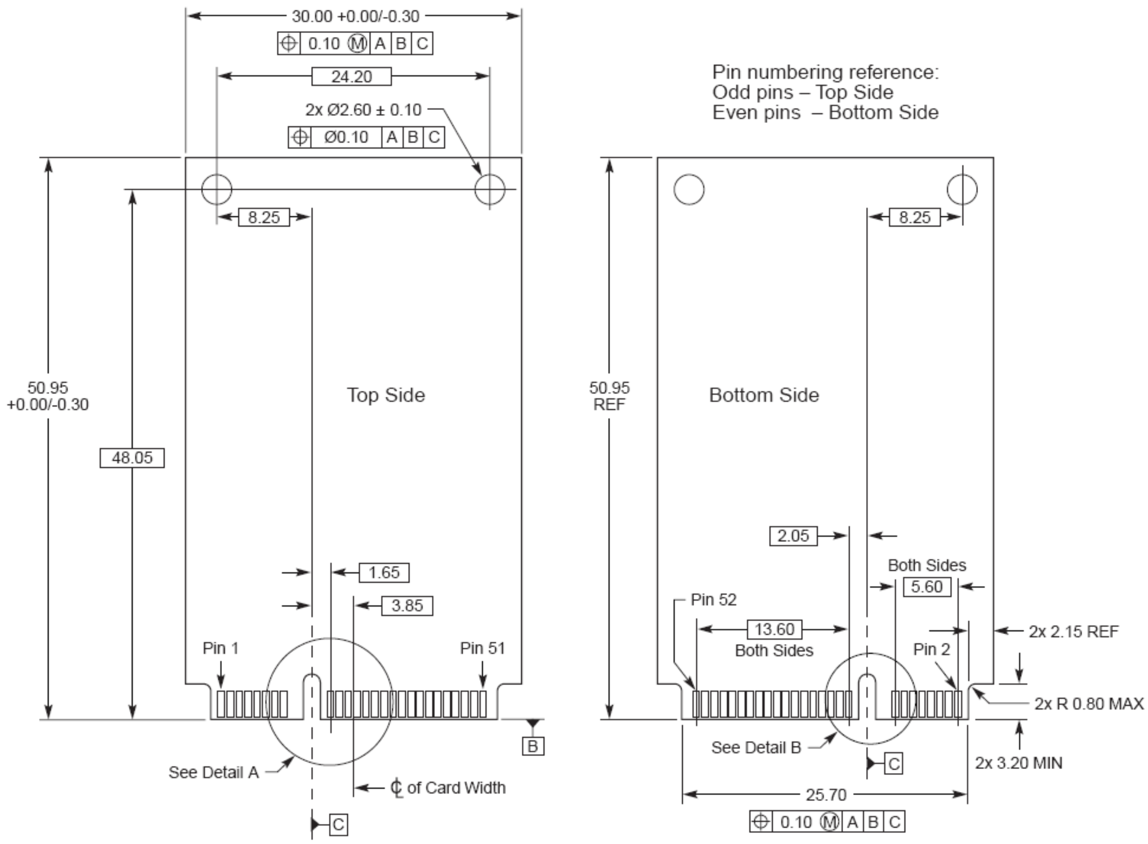
The DS-MPE-CAN2L block diagram is shown below.



4.2 Mechanical Board Drawing

The DS-MPE-CAN2L conforms to the PCIe MiniCard electromechanical specification revision 1.2, full size format. Overall dimensions are 50.95mm L x 30.00mm W.

The two mounting holes are isolated from the CPU ground and not connected to any ground lines.



4.3 CAN Controllers

The module offers two CAN controllers implemented as FPGA cores inside a Xilinx Spartan 6 FPGA. The core provides the following key features:

- Conforms to the ISO 11898 -1, CAN 2.0A, and CAN 2.0B standards
- Supports both standard (11-bit identifier) and extended (29-bit identifier) frames
- Supports bit rates up to 1Mbps
- Transmit message FIFO with a user-configurable depth of up to 64 messages
- Transmit prioritization through one High-Priority Transmit buffer
- Automatic re-transmission on errors or arbitration loss
- Receive message FIFO with a user-configurable depth of up to 64 messages
- Acceptance filtering with a user-configurable number of up to 16 acceptance filters
- Sleep Mode with automatic wake-up
- Loop Back Mode for diagnostic applications
- Maskable Error and Status Interrupts
- Readable Error Counters

4.4 Transceivers

The transceivers are Analog Devices ADM3053 combination isolation and transceiver. It provides isolated +5V to power the isolated side of the transceiver. This isolated +5V is available on the I/O connector.

4.5 Isolation

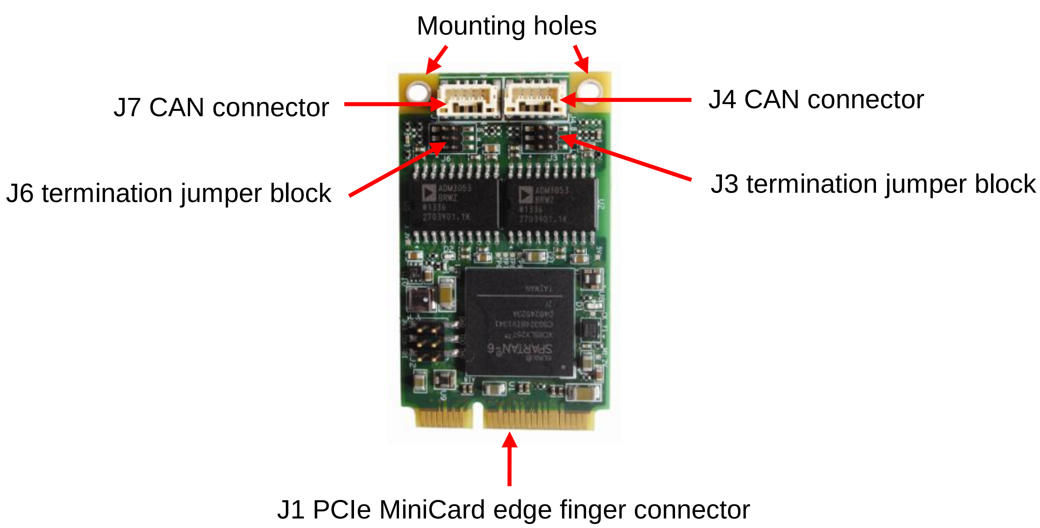
The module supports 500V isolation between each CAN port and the host, and between each CAN port and the other, via the ADM3053 isolated transceiver. An optional high-voltage resistor can be installed across each isolation barrier to enable leakage current flow between the isolated transceiver grounds and the host ground.

4.6 Power Supply

The module is powered by +3.3V from the PCIe MiniCard socket. It provides all other required voltages on board, including +5V for the CAN transceivers and the FPGA core voltages.

5. INSTALLATION

The DS-MPE-CAN2L plugs in to any socket meeting the PCIe MiniCard specifications. It has two connectors, one for each pair of serial ports, a protocol configuration jumper block, and a pair of mounting holes. To install the DS-MPE-CAN2L, fully insert the board into a PCIe MiniCard connector and secure in place by inserting one screw from the hardware kit into each of the mounting holes, see the diagram below.



6. CONNECTOR PINOUT AND PIN DESCRIPTION

6.1 PCIe MiniCard Edge Connector (J1)

The DS-MPE-CAN2L module is compatible with the standard Mini PCIe socket pinout as shown below.

WAKE#	1	2	+3.3VAUX_3
COEX1	3	4	GND9
COEX2	5	6	+1.5V_1
CLKREQ#	7	8	UIM_PWR
GND1	9	10	UIM_DATA
REFCLK-	11	12	UIM_CLK
REFCLK+	13	14	UIM_RESET
GND2	15	16	UIM_VPP
	KEY		
RSVD(UIM_C8)	17	18	GND10
RSVD(UIM_C4)	19	20	W_DISABLE#
GND3	21	22	PERST#
PERN0	23	24	+3.3VAUX_4
PERP0	25	26	GND11
GND4	27	28	+1.5V_2
GND5	29	30	SMB_CLK
PETN0	31	32	SMB_DATA
PETP0	33	34	GND12
GND6	35	36	USB_D-
GND7	37	38	USB_D+
+3.3VAUX_1	39	40	GND13
+3.3VAUX_2	41	42	LED_WWAN#
GND8	43	44	LED_WLAN#
RSVD1	45	46	LED_WPAN#
RSVD2	47	48	+1.5V_3
RSVD3	49	50	GND14
RSVD4	51	52	+3.3VAUX_5

6.2 CAN Ports (J4, J7)

Each of the two CAN ports has its own 4-pin latching connector with the following pin out.

1	Ground Iso
2	CAN L
3	CAN H
4	Ground Iso

Connector Part Number / Description

BM04B-GHS-TBT 4 pos, 1.25mm, vertical, latching, SMD

7. JUMPER CONFIGURATION

The DS-MPE-CAN2L module has two line termination jumper blocks, one for each port. Jumper block J3 is for port J4, and jumper block J6 is for port J7. Jumper blocks J3 and J6 are identical. The default is no jumpers installed. To add termination for a port's bias line (jumper position B), CAN-H line (jumper position H), or CAN-L line (jumper position L), add a jumper at B, H or L location respectively.

B	H	L
O	O	O
O	O	O

8. LINUX DRIVER INSTALLATION

8.1 Installing the Software

The following steps are used to install the CAN interface utility software under the Linux operating system.

Step-1:

Unzip the DSC_CAN2_PCI_V1.0.6_15_09_14.zip file on the enclosed CD using the below commands.

```
Unzip DSC_CAN2_PCI_V1.0.6_15_09_14.zip
```

A pci_can directory will be created where the zip file is extracted. The pci_can directory contains the following files.

```
ls –l
```

1. CAN_Monitor : CAN Monitor demo application directory
2. CANLib : CAN Linux shared library.
3. dsc_can2_pci_driver: Linux CAN driver.
4. qt-opensource-linux-x86-5.2.1.run : Qt Installer which is required by the PCI CAN Interface utility.

Step-2:

Install the Qt shared libraries using the Qt Installer. Execute the command below and follow the Qt Installer instructions. Use the command below to install the Qt shared libraries. Install Qt at the default locations.

```
cd DSC_CAN2_PCI_V1.0.6_15_09_14
./qt-opensource-linux-x86-5.2.1.run
```

Note: The Qt shared libraries should be installed only once.

Step-3:

PCI CAN Utility is based on the CANLib library. Copy the shared library to "/lib" directory.

```
cd CANLib
cp libCAN.so    /lib
```

Step-3 should be done only once.

Step-4:

Load the PCI CAN interface driver using the command below from the dsc_can2_pci_driver directory where the zip file is extracted.

```
cd dsc_can2_pci_driver
insmod dsc_can2_pci.ko
```

Step-5:

Start the PCI CAN Utility using the command below from the CAN_Monitor directory where the zip file is extracted.

```
cd CAN_monitor
./CAN
```

The above command will open the CAN interface utility.

Note: To start CAN utility in the future, follow Steps 4 and 5 only.

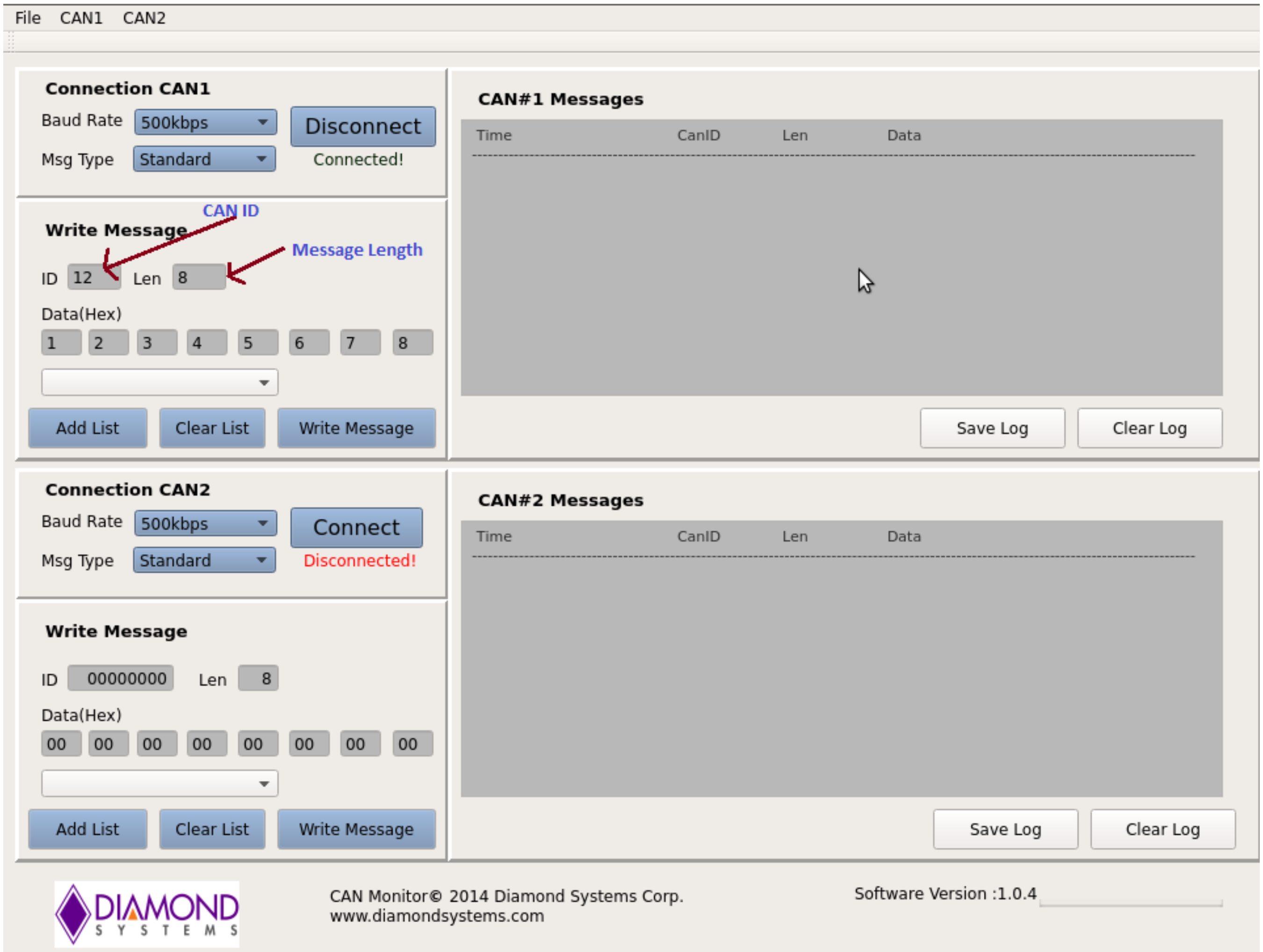
8.2 Setting the Baud Rate

Using the CAN interface utility software, the baud rate for each port can be selected. On the desired CAN port, select the baud rate from the Baud Rate drop-down menu. After selecting the desired baud rate, press "**Connect**" to connect with specified baud rate as shown in below figure.

To change the baud rate, click on "**Disconnect**" and select a new baud rate.

8.3 Setting the CAN ID and Message Length

Set the CAN ID and CAN message length for each CAN port by entering the desired numbers into the ID and Len fields respectively for that port.



8.4 Writing a Message

To write a message on a CAN port, define the CAN message by entering the desired data into the Data (Hex) fields. Then click on **"Write Message"** as shown in the below figure.

To transmit to a different CAN ID, change the data in the CAN ID field, enter the desired data into the Data (Hex) fields, and click on "**Write Message**".

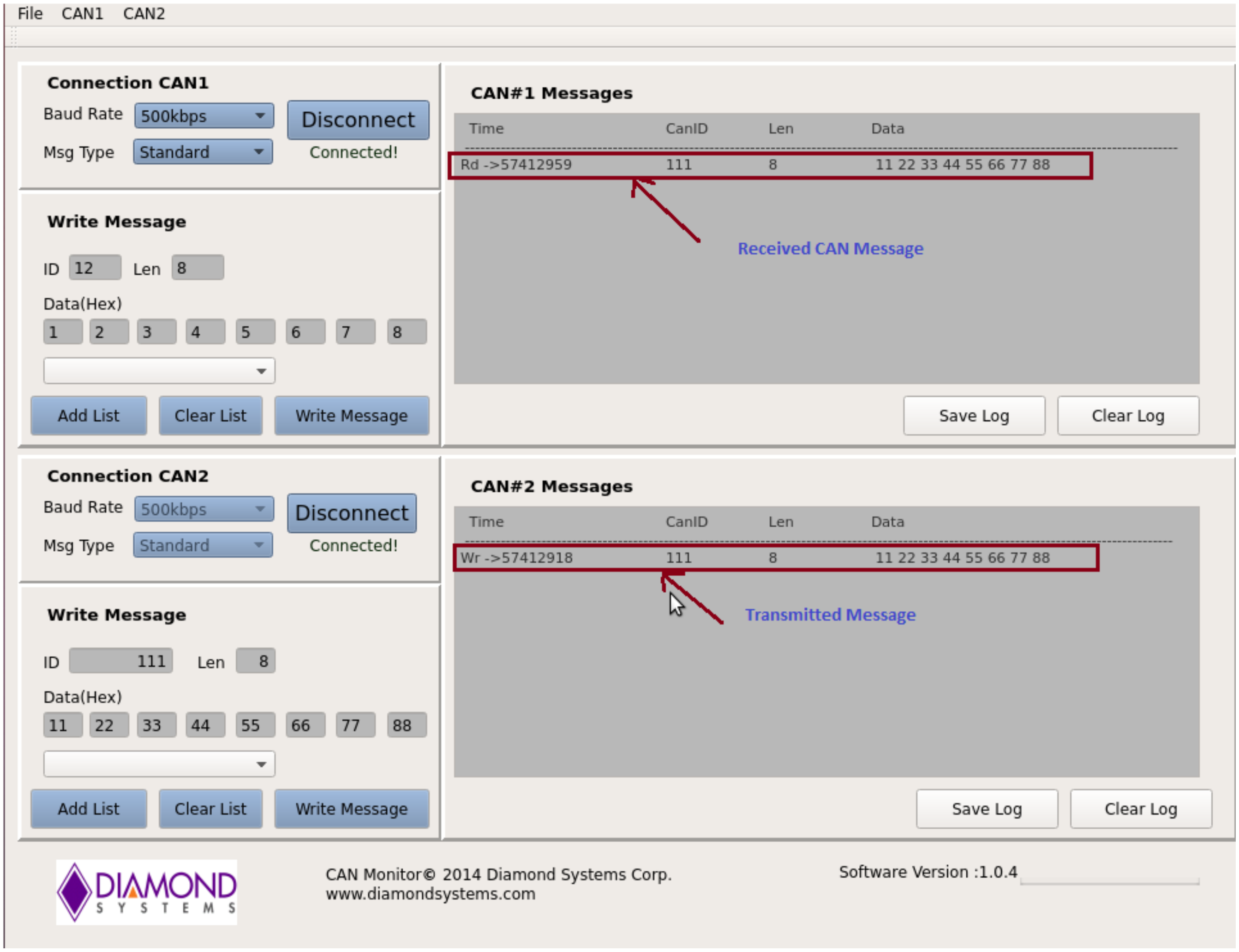
To change the message length, change the CAN message length to the new length, enter the desired data into the Data (Hex) fields, and click on "**Write Message**".

To transmit a different CAN message to the same CAN ID, change the CAN message to the desired data, and click on "**Write Message**".

8.5 Viewing Messages

Transmitted messages are listed in the CAN message box for the sending CAN port as shown in below figure.

Received CAN messages are listed in the CAN message box for the CAN port receiving the message as shown in below figure.



9. CONFIGURE AND MANAGE THE PORTS USING LINUX

The CANLib library provides the set of APIs to configure and manage the CAN ports. The CANLib library can be used to build the CAN application. It is a shared library built on top of Linux platform. To compile the CANLib shared library, use the below command

```
cd CANLib
make
```

All the CAN APIs prototypes are defined in the can.h file. This file is located in the CANLib directory. Include the can.h file in the application to use all these APIs.

9.1 API to Configure and Manage CAN Ports

init_can0() & **init_can1()** : These function will initialize the CAN#0 & CAN#1 ports respectively.

Both these functions return the CAN file descriptor (fd). The return value of these functions should be retained for all subsequent operations. Its prototypes are defined in the can.h file. Declare two CAN file descriptors and retains its return values.

```
#include "can.h"
…
int  can0_fd;
int  can1_fd;
…
can0_fd = init_can0() ;
if ( can0_fd < 0 )
{
   printf("Error while initializing the CAN#0\n") ;
   exit(0) ;
}
…
can1_fd = init_can1() ;
if ( can1_fd < 0 )
{
   printf("Error while initializing the CAN#1\n") ;
      exit(0) ;
}
```

Baud Rate Configuration

set_baudrate() : This function configures the baud rate for the specified CAN port. By default it will not configure any baud rate.

```
// Set 500k Baud rate for CAN#0
ret_val = set_baudrate(can0_fd, CAN_SPEED_500K ) ;
if ( ret_val < 0 )
{
   printf("Error while setting the baud rate \n") ;
   exit(0) ;
}
// Set 500k Baud rate for CAN#1
ret_val = set_baudrate(can1_fd, CAN_SPEED_500K ) ;
if ( ret_val < 0 )
{
   printf("Error while setting the baud rate \n") ;
      exit(0) ;
}
```

Use below macros for setting the different baud rates. These macros can also be found in can.h file.

```
CAN_SPEED_1M
CAN_SPEED_800K
CAN_SPEED_500K
CAN_SPEED_250K
CAN_SPEED_125K
CAN_SPEED_100K
CAN_SPEED_50K
CAN_SPEED_20K
CAN_SPEED_10K
```

CAN Transmit & Receive

can_tx() & can_rx() : These functions are be used to Transmit and Receive the CAN messages respectively.

CAN Transmit Prototype

```
int can_tx( int can_fd, unsigned char  msgType, unsigned int can_id, int
len,unsigned char *data) ;
```

Assign the appropriate values, before calling the can_tx function.

```
can0_fd : CAN descriptor, return value from init_can0() function
msgType = MSG_STANDARD ; //  or MSG_EXTENDED .
can_id = 0x12 ; // CAN ID, if the msgType is MSG_STANDARD then it should be 11-Bit
CAN Message ID
      // if the msgType is MSG_EXTENDED then it should be 29-Bit CAN Message ID
len = 4 ; // CAN Transmit Data Length
data : CAN message data.
data[0] = 0x1A ;
data[1] = 0xAB ;
data[2] = 0x22 ;
data[3] = 0x4D ;

ret_val = can_tx(can0_fd, msgType, can_id, dlc, data) ;
if ( ret_val < 0 )
{
      printf("Error while transmitting the CAN message.\n") ;
      close(can1_fd) ;
      exit(0) ;
}
```

The above sample code will transmit the CAN standard message with CAN ID=0x12 of data length=4 and message data = {0x1A, 0xAB, 0x22, 0x4D } ;

CAN Receive Prototype

```
int can_rx(int can_fd, unsigned char  *msgType, unsigned char *rx_data, unsigned
int *can_id, unsigned char *can_msg_len) ;
```

Pass the appropriate pointers for calling the can_rx function:

```
if ( can_rx(can0_fd, &msgType, data, &can_id, &dlc) )
{
      If (msgType == MSG_STANDARD )
      {
            // Received message is CAN Standard Message.
      }
      else if  (msgType == MSG_EXTENDED)
      {
            // Received message is CAN Extended Message.
      }
      // dlc : Received CAN Data Length
      // can_id : Will contain the CAN Message ID
      // Data of dlc length
      printf("ID=%x DLC=%d Data : ", can_id, dlc) ;
      for (i=0; i< dlc; i++ )
            printf("%x ", data[i] ) ;
      printf("\n") ;
}
```

The sample example programs for both transmit and receive can be found in the CANLib directory for the reference.

Compiling CAN Application using CANLib Library

Export the library path using the following command:

```
export LD_LIBRARY_PATH=$ LD_LIBRARY_PATH:/path-to-CANLib
```

To compile the application, use the following command:

```
g++ can_app.c -lCAN –L/path-to-CANLib  -o can_app
```

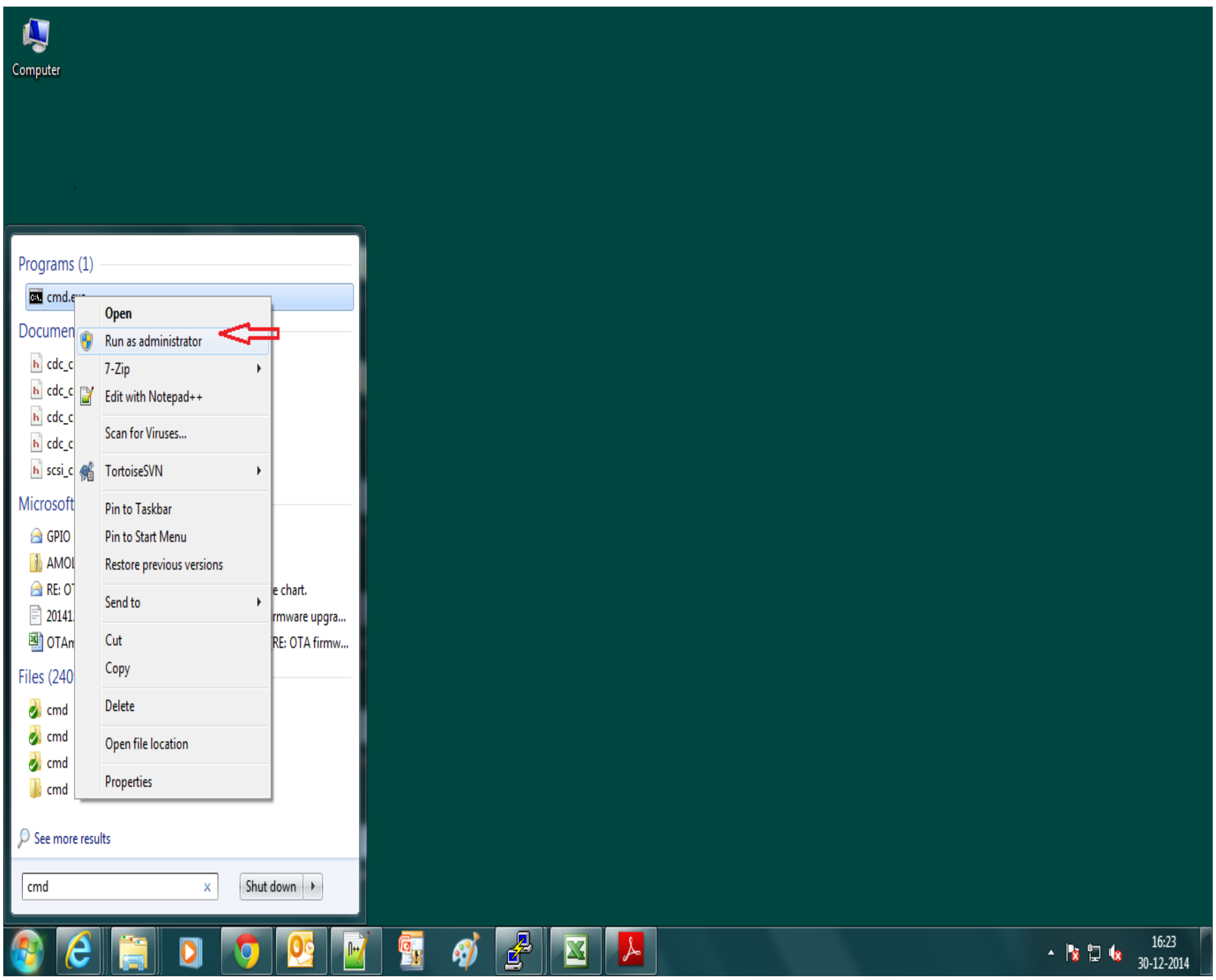
10. DRIVER INSTALLATION AND DEMO APPLICATION FOR WINDOWS

The “DSC_CAN2_PCI_V1.0.2_2015_01_13” directory contains the CAN application, library, and driver for testing the 2-CAN interfaces.

1. APP : CAN Monitor demo application directory
2. DSC_CAN2_PCI_V1.0.2_2015_01_13: CAN Windows library
3. dsc_can2_pci_driver: Windows CAN driver

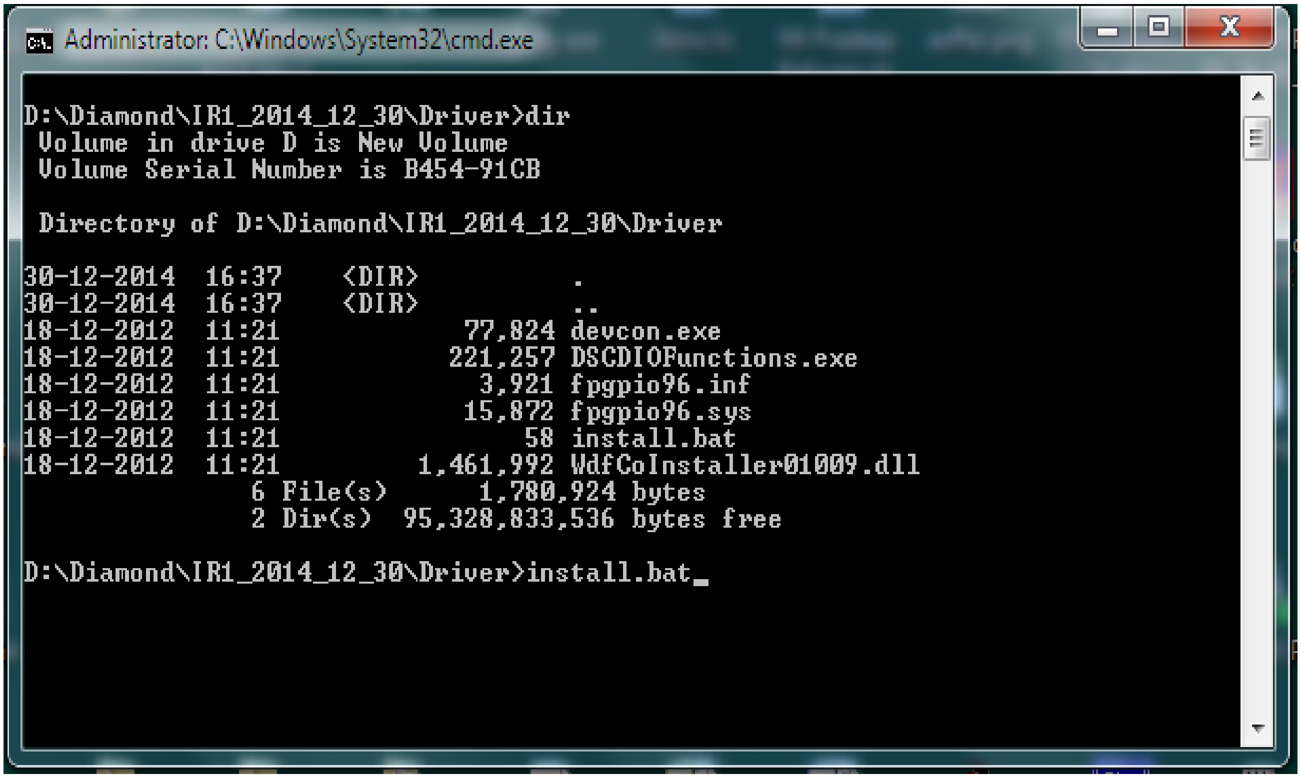
10.1 Installing the PCI-CAN Driver

Step-1:
Open Windows command prompt with Administrator privileges.
Click on Windows start button and type cmd in the search box and right click on the cmd.exe and click on “Run as administrator”. Please refer to the screenshot given below.



Step-2:
Change the working directory from the command prompt to the "DSC_CAN2_PCI_V1.0.2_2015_01_13\ dsc_can2_pci_driver" directory where the software is copied.

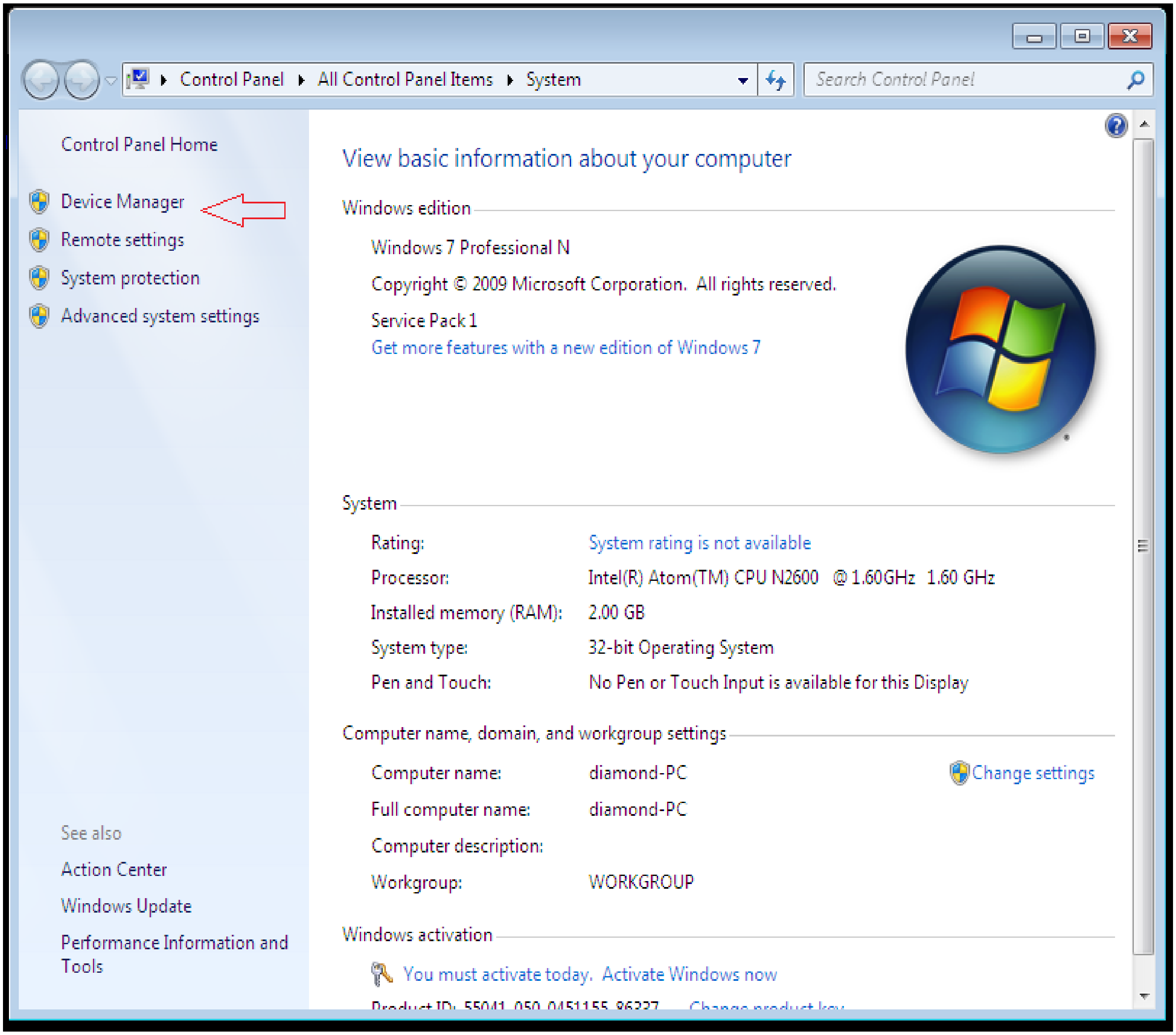
Step-3:
Execute **"install.bat"**. Please see the below screenshot for details. After executing, follow the next steps to install the driver.



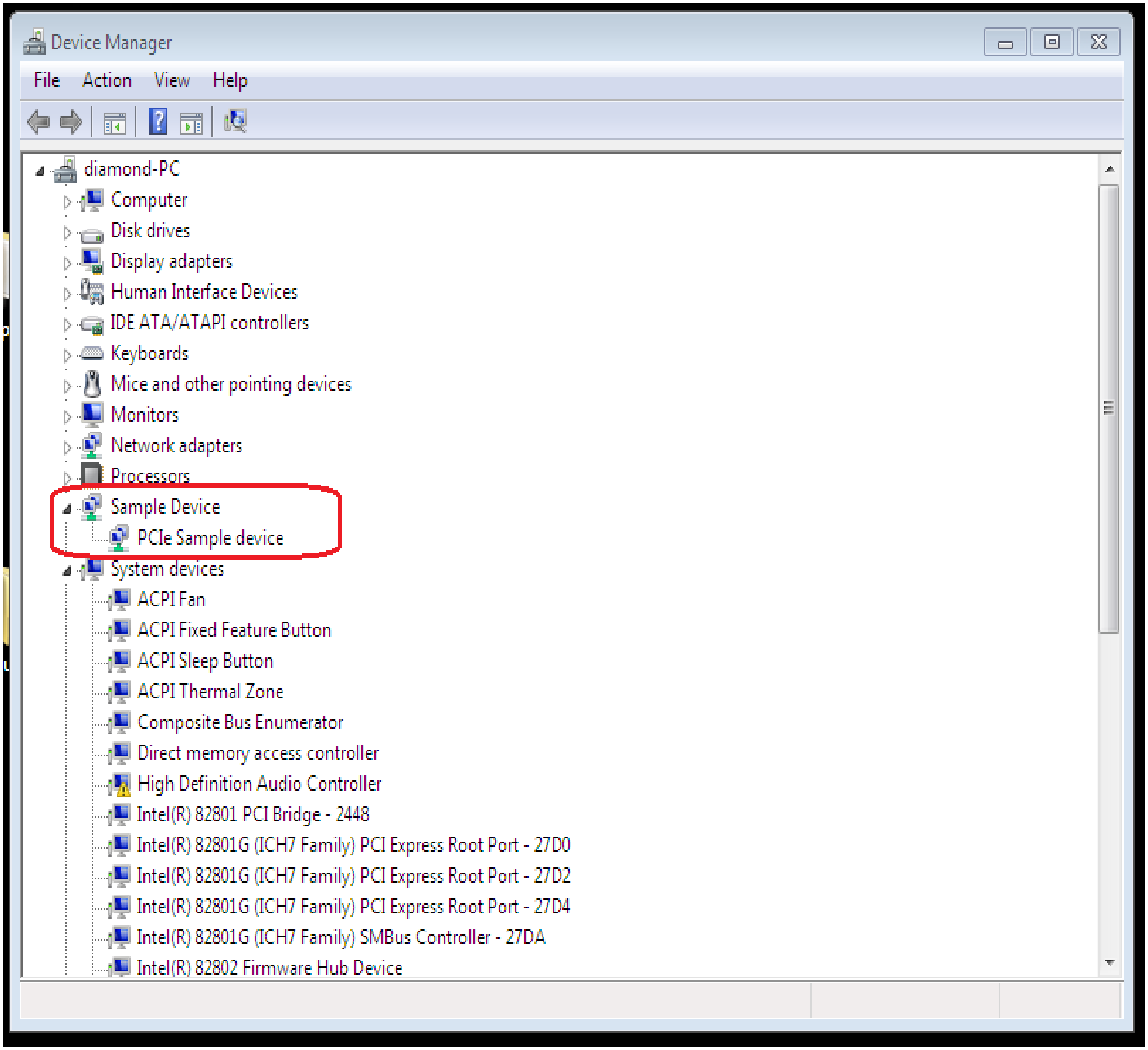
Step-4:
Restart the system.

Step-5:
Check whether the driver is installed properly or not by opening the device manager.

Right Click on My Computer => Click on Properties => Device Manager. Please refer to the screenshot below.

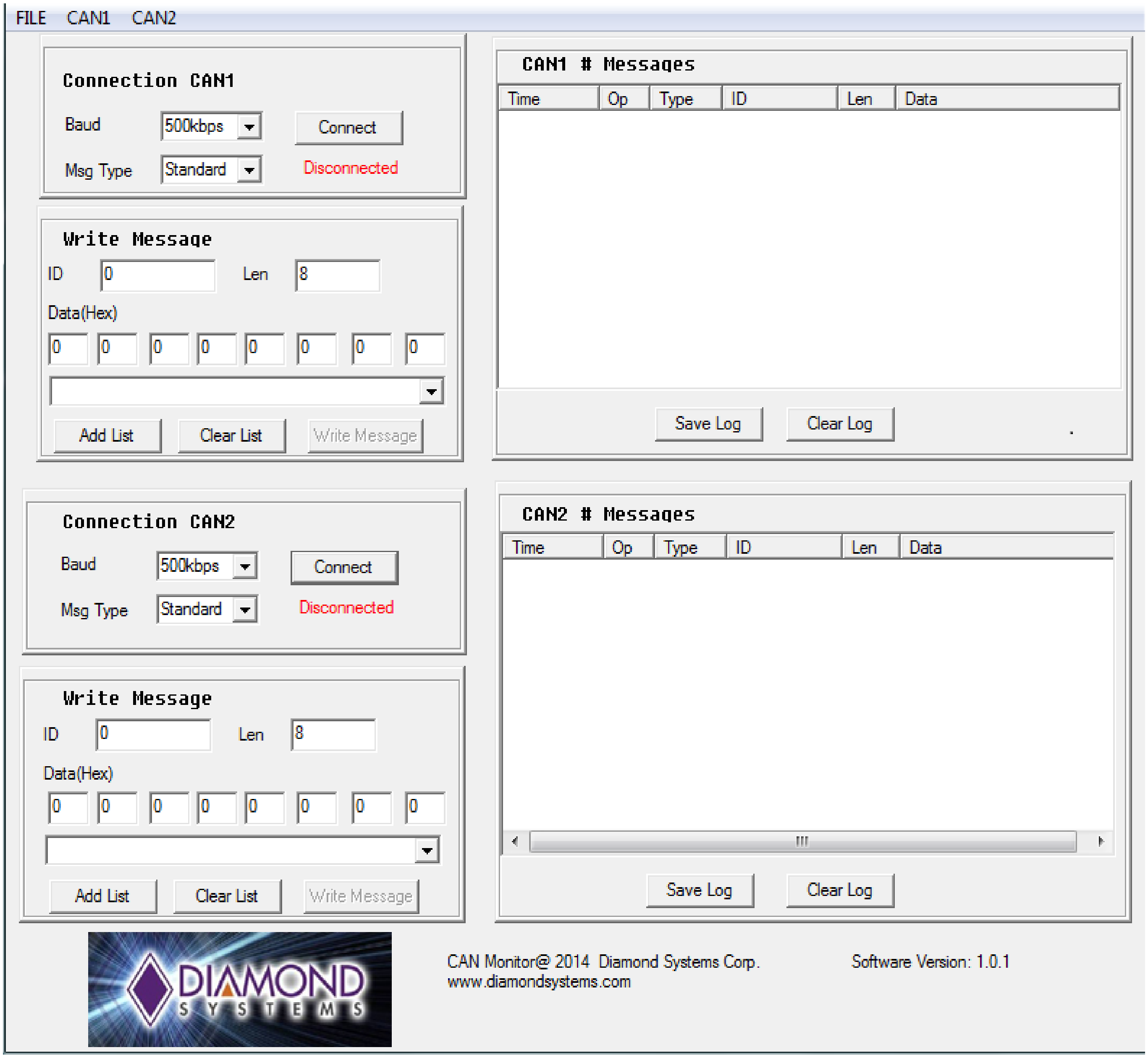


If the driver is installed properly then the device manager will show the device as **"PCIe Sample device"** under **"Sample Device"** as shown in the screenshot below.



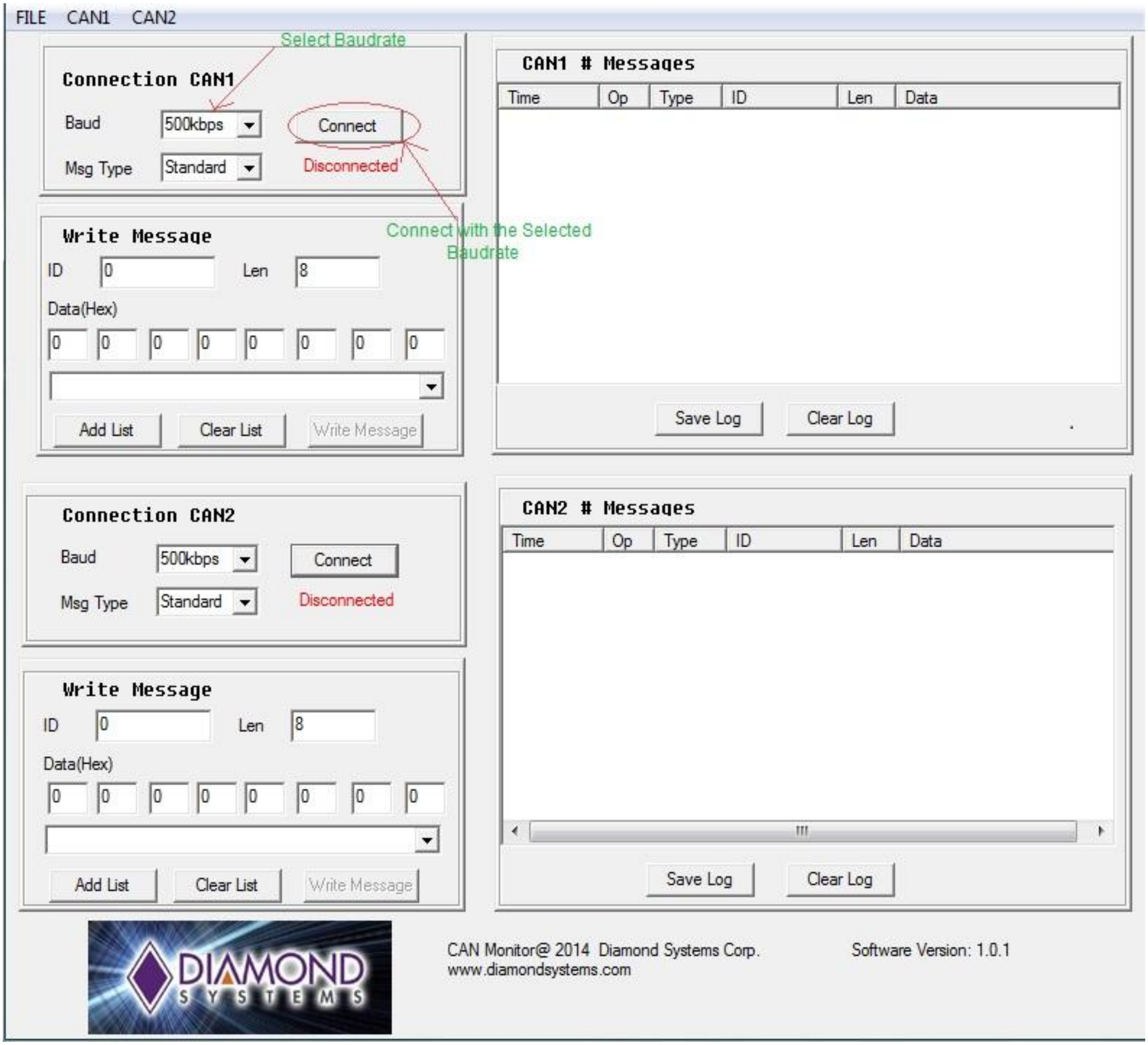
10.2 Run the Windows Application

The application is stored in the “App” directory. Double click on **“dsc_can2_pci.exe”.** The application window will open as shown in the below screenshot.



10.3 Setting the Baud Rate

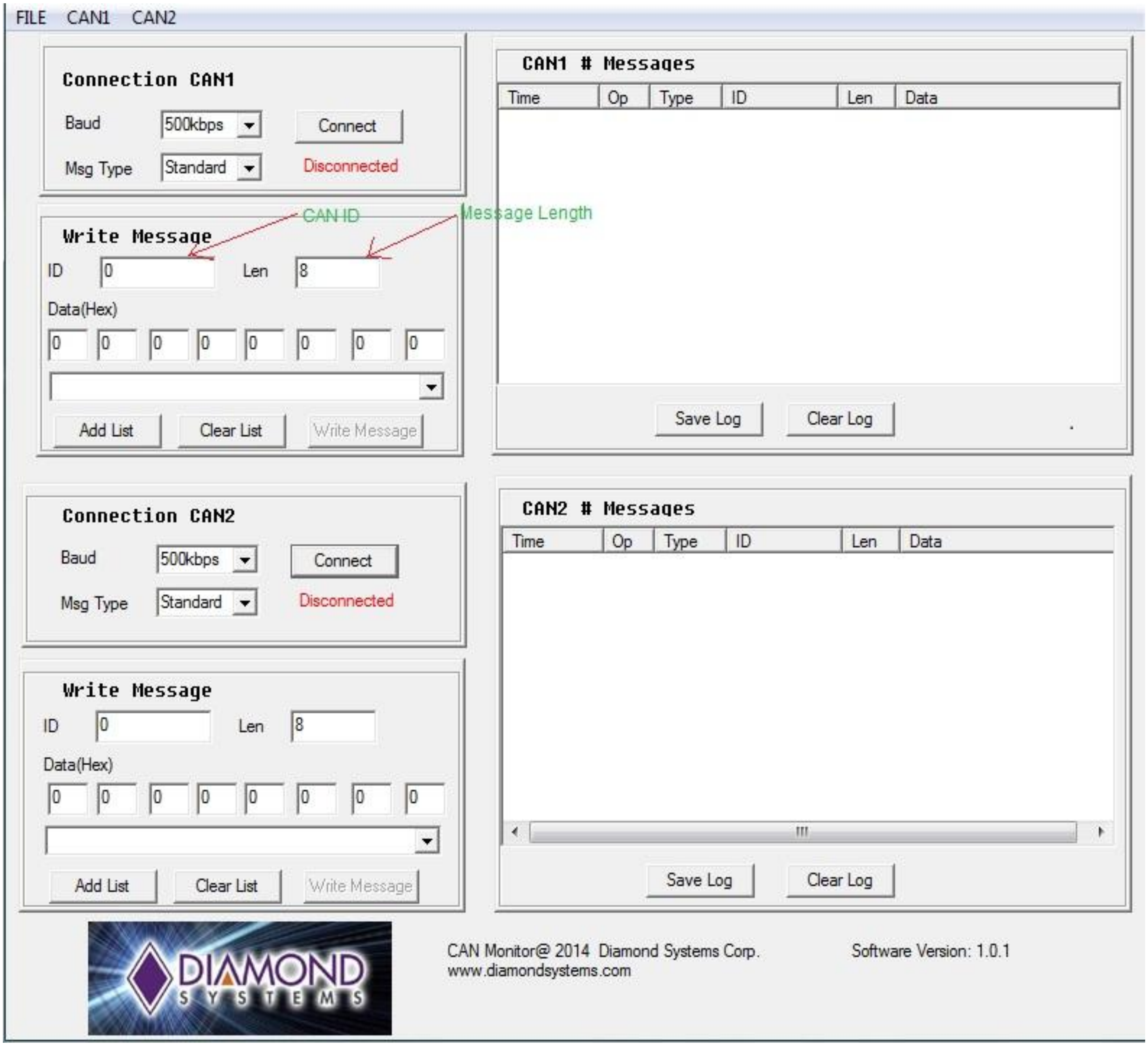
Using the CAN interface utility software, the baud rate for each port can be selected. On the desired CAN port, select the baud rate from the Baud Rate drop-down menu. After selecting the desired baud rate, press "**Connect**" to connect with specified baud rate as shown in below figure.



To change the baud rate, click on "**Disconnect**" and select a new baud rate.

10.4 Setting the CAN ID and Message Length

Set the CAN ID and CAN message length for each CAN port by entering the desired numbers into the ID and Len fields respectively for that port.



10.5 Writing a Message

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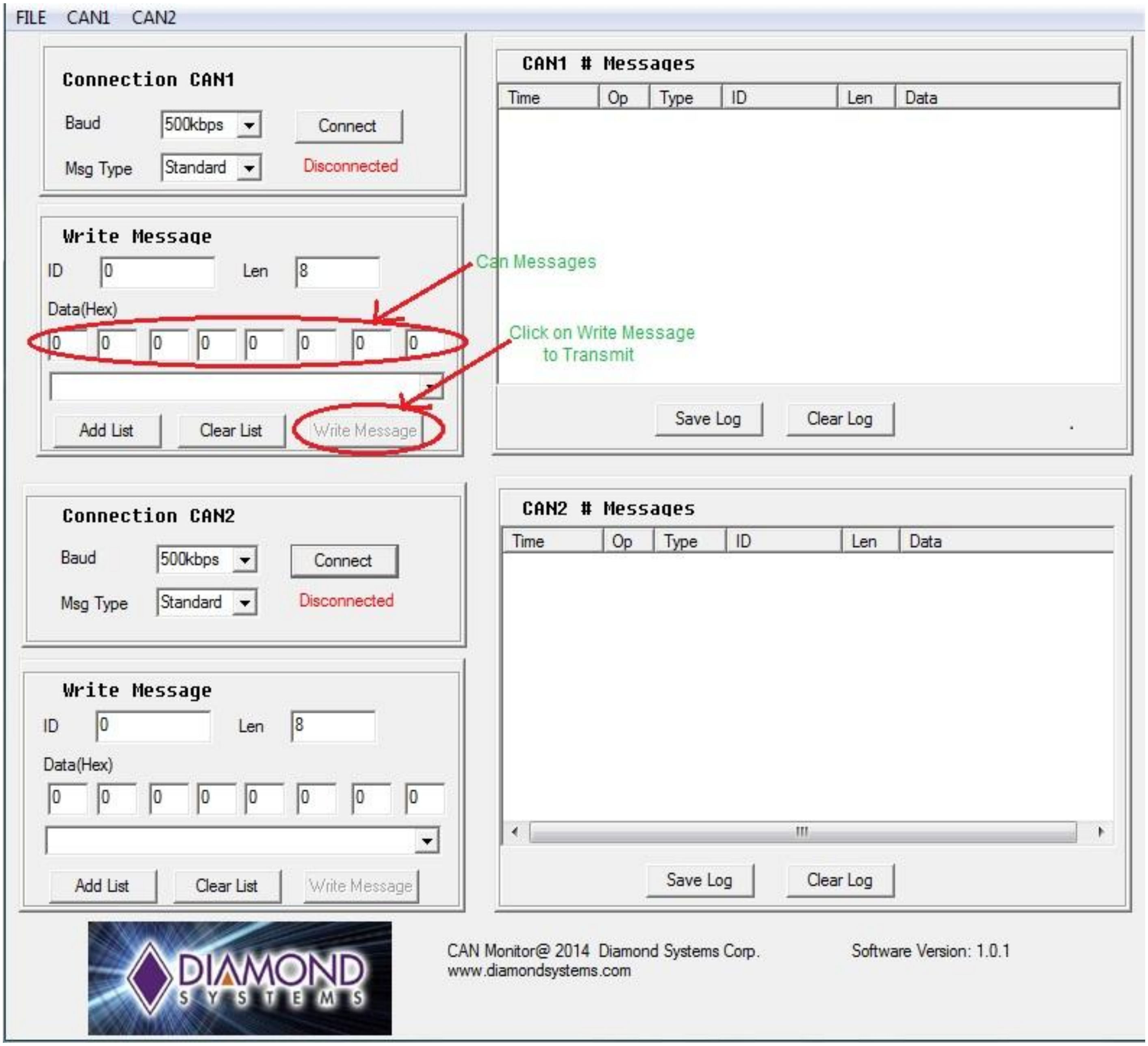


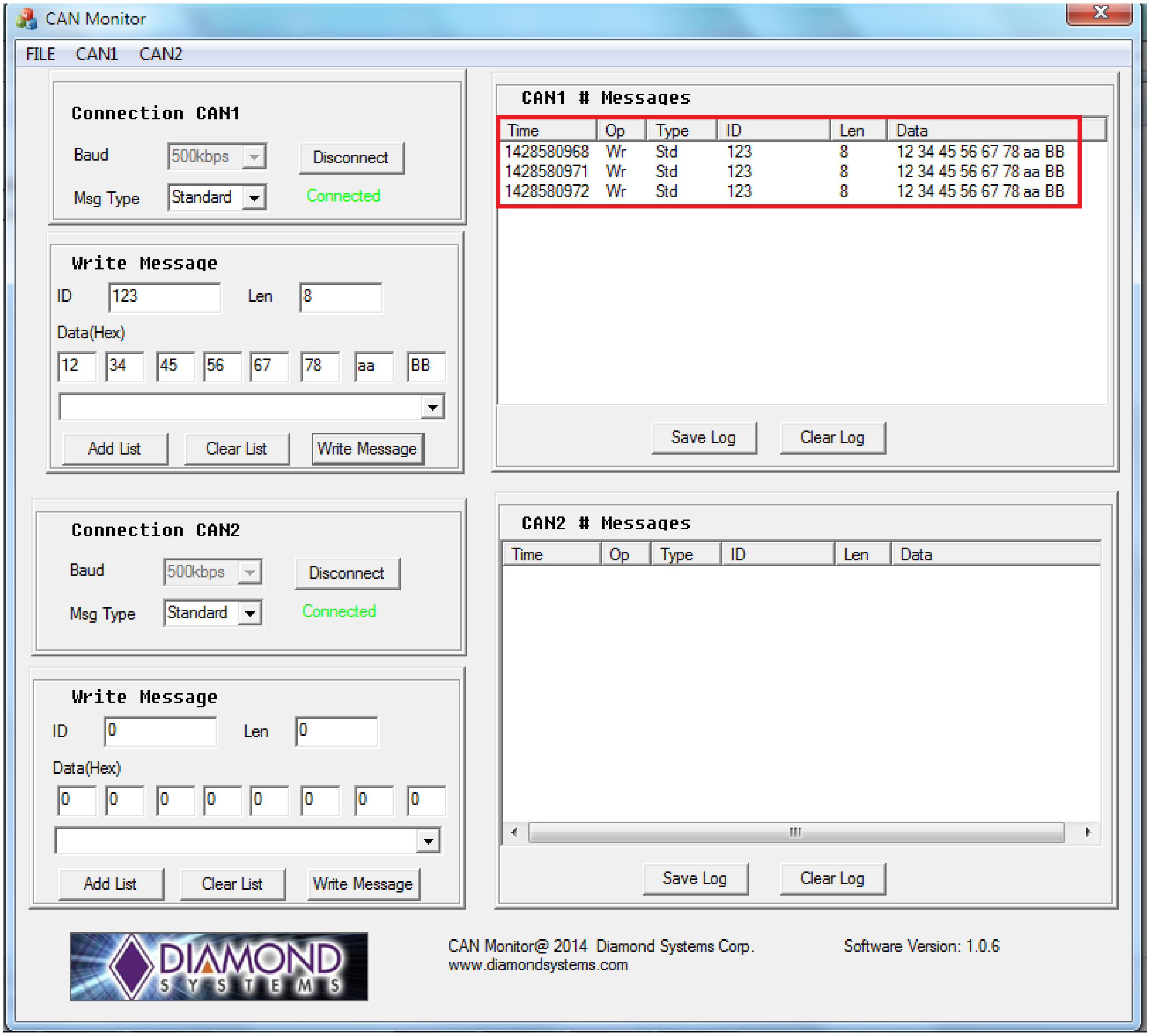
To transmit to a different CAN ID, change the data in the CAN ID field, enter the desired data into the Data (Hex) fields, and click on "**Write Message**".

To change the message length, change the CAN message length to the new length, enter the desired data into the Data (Hex) fields, and click on "**Write Message**".

To transmit a different CAN message to the same CAN ID, change the CAN message to the desired data, and click on "**Write Message**".

10.6 Viewing Messages

Transmitted and received messages are listed in the CAN message box for the sending CAN port as shown in below figure.



11. SPECIFICATIONS

Number of ports	2 CAN 2.0B
Data rate	1Mbps
Number of receive buffers	31
Number of transmit buffers	1 high priority 16 standard priority
Acceptance filters	16 programmable, 29-bit
Identifiers	11-bit and 29-bit
Modes	Dual-independent Dual-redundant
Isolation	500V port-to-port and input-to-output
Input power	+3.3VDC +/-5%
Power consumption	0.462W @ 3.3V
Software drivers	Windows XP Linux 2.6.16, 2.6.27, 2.6.31, and 2.6.32
Operating temperature	-40°C to +85°C
MTBF	1,583,210 hours at 20°C
Dimensions	50.95mm x 30mm (2" x 1.18")
Weight	8.5g (0.3oz)
RoHS Compliant	Yes