User Guide

ECUsim™ 5100

Professional Multiprotocol 3-PIM OBD-II ECU Simulator

OBD SOLUTIONS

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1.0 Overview

ECUsim 5100 is a small, lightweight, benchtop simulator that can be used for testing and development of OBD devices and software. It supports all legislated OBD protocols, fixed and user adjustable parameter IDs (PIDs), diagnostic trouble codes (DTCs), freeze frames, and many other SAE J1979 services.

The unit has five knobs assigned to common PIDs, a "fault event" button, and indicator lights for power, connection, and MIL (Malfunction Indicator Light). Physical connection to the scan tool is made through a standard SAE J1962 female connector.

The simulator can accept from one to three plug-in modules (PIMs), each configured for a different OBD protocol. The user is able to select any one of the three protocols using a three position switch, or make them active at the same time.

ECUsim 5100 features a USB connection which can be used to configure the PIMs and to monitor OBD traffic.

1.1 General Features

- Support for all legislated OBD-II protocols:
  - SAE J1850 PWM
  - SAE J1850 VPW
  - ISO 9141-2
  - ISO 14230-4 (KWP2000)
  - ISO 15765-4 (CAN 250/500kbps, 11/29 bit)
- Functional and physical addressing
- Three PIM slots
- Each PIM supports three virtual ECUs: ECM, TCM, and ABS
- Five knobs assigned to frequently used PIDs:
  - Coolant Temperature
  - Engine Speed (RPM)
  - Vehicle Speed
  - Oxygen Sensor Voltage
  - Mass Airflow (MAF)
- Fixed SAE J1979 modes and PIDs
- "MIL", "Link" and "Power" indicators
- "FAULT" button
- USB connection for PIM configuration and OBD traffic monitoring
- On-the-fly OBD protocol switching
- Standard J1962F connector
- Firmware upgradeable

1.2 Package Contents

- ECUsim 5100 unit (with 1, 2, or 3 installed PIMs)
- 110/220 VAC to 12 VDC switching power supply
- US style power cable
- OBD connector dust cover
- USB cable

2.0 User Interface

ECUsim 5100 can be used as a stand alone simulator, or in conjunction with a PC. It features a number of interface elements on both the front and back of the unit.

2.1 Front Panel

1. Power LED
2. Link LED
   The function of this LED depends on the protocol in use:
   a. ISO 9141-2 and ISO 14230-4 protocols: the LED is on while at least one ECU is initialized. The LED dims when an OBD message is received.
   b. J1850 and CAN protocols: the LED blinks when an OBD message is received.
3. Malfunction Indicator Light
4. Knobs assigned to the five commonly used Mode 1 PIDs.
5. FAULT button
   When pressed, the following happens:
   a. Set MIL and number of stored DTCs (Mode 1, PID 01)
   b. Generate pending, stored, and permanent* DTCs
   c. Generate freeze frame data
6. PIM indicators
   a. OFF: PIM not present
   b. RED: PIM is present, not selected
   c. GREEN: PIM is active

*SAE J1979 defines permanent DTCs only for ISO 15765-4 (CAN)

2.2 Back Panel

1. PIM Select switch
2. USB connector
3. Diagnostic Link Connector (DLC)
4. Configuration DIP switch
    a. PIM ALL. Down position: makes all three PIMs active at the same time. Up position: PIM selection is controlled by the PIM Select switch
    b. 5BAUD/FAST. Selects the type of initialization for ISO 14230-4. Down: 5 baud init, up: fast init.
    c. 11/29 BIT. Selects the CAN frame ID type. Down: 11-bit, up: 29-bit.
    d. 250K/500K. Selects the CAN baud rate. Down: 250 kbps, up: 500 kbps.
5. Power jack (12 VDC)

Use only the provided power supply to power the simulator. Using a different power supply may cause permanent damage which is not covered under the warranty.

3.0 Basic Operation

ECUsim is configured at the factory according to your specifications (number of PIMs, assigned protocols) and is ready to be used out of the box. For custom configuration, see Section 5.0, PIM Configuration.

3.1 Setup

To set up the simulator, follow these steps:

1. Use the Configuration DIP switch to set the desired options.
2. Plug the power supply into an available electric outlet.
3. Plug the 12 volt end of the power supply into the power jack of the simulator.
4. Select the desired PIM using the PIM Select switch. The corresponding LED on the front panel will turn green.
5. Connect the OBD connector of your OBD tester or OBD interface to the DLC.

3.2 Using the Simulator

Once the simulator is set up and configured, you can use the PIM Select switch on the back of the unit, to switch between PIM1, PIM2, and PIM3. When you switch to a new PIM, two things should happen:

1. The corresponding PIM indicator LED should change from red to green.
2. The Power, Link, and MIL LEDs will turn on and off in sequence, as the PIM starts up.

To generate a malfunction event, press the FAULT button.

The Link light should be flashing or dimming as the messages are exchanged between the tester and the simulator.

For more details, see the respective descriptions in Section 2.1.

4.0 UART Communication

ECUsim 5100 features a USB connection. On a Windows or Linux PC, the drivers create virtual COM ports which allow communication using any suitable serial port terminal (e.g., HyperTerminal).

Set PIM ALL switch to OFF
In order to communicate with a PIM, the PIM ALL switch must be in the "up" (off) position.

4.1 Installing USB Drivers

To communicate with the ECUsim, make sure it is powered on, and connect it to any available USB port. If the operating system does not find & install the drivers automatically, you can download them from FTDI's website.

FTDI Virtual Com Port Drivers
http://www.ftdichip.com/Drivers/VCP.htm

4.2 Terminal Setup

Almost any serial port terminal emulation program can be used to communicate with the ECUsim. Some of the popular terminals include the HyperTerminal, RealTerm, and TeraTerm.

The default communication settings are:

- Baud rate: 115200 bps
- Data bits: 8
- Parity: none
- Stop bits: 1

Turn off local echo
ECUsim echoes back what you type, so you may want to turn off local echo to avoid "seeing double."

5.0 PIM Configuration

On startup or reset, the PIM prints the welcome banner that looks similar to this:

```
STSP300 v3.1.3
(C) 2013 OBD Solutions

>
```

The PIM is now ready to accept user commands.

5.1 Supported Commands

For a list of supported commands, see the ***ECUsim Programming Manual*** that can be found on the ECUsim 5100 product page, at:

http://ecusim.com/5100

6.0 Advanced Operation

This section describes the operation of the simulator in different protocol modes. It assumes that the simulator is connected to a PC running terminal emulation software.

6.1 ISO 9141-2 and ISO 14230-4 (5 Baud Init)

After switching to the ISO 9141-2 protocol (or ISO 14230-4 with 5 baud init option) the PIM will print the following status message:

```
<WAITING FOR 5 BAUD INIT>
```

It will not respond to any requests until the bus is initialized. After a successful initialization sequence, the PIM will print:

```
<5 BAUD INIT: OK>
```

At this point, the virtual ECUs will start responding to OBD requests. However, if five seconds pass without a supported request (or a keep-alive message) being received, the ECUs will time out and the PIM will go back to waiting for initialization:

```
<ALL ECUS TIMED OUT>
<WAITING FOR 5 BAUD INIT>
```

6.2 ISO 14230-4 (Fast Init)

After switching to the ISO 14230-4 protocol with fast init option, the PIM will print the following status message:

```
<WAITING FOR FAST INIT>
```

It will not respond to any requests until the bus is initialized. After a successful initialization sequence, the PIM will print:

```
<FAST INIT: OK>
```

At this point, the virtual ECUs will start responding to OBD requests. However, if five seconds pass without a supported request (or a keep-alive message) being received, the ECUs will time out and the PIM will go back to waiting for initialization:

```
<ALL ECUS TIMED OUT>
<WAITING FOR FAST INIT>
```

6.3 SAE J1850 and ISO 15765-4

Protocols 1, 2, and 5 do not require initialization. Once the PIM reboots after the set protocol command and prints the configuration summary, it will immediately start listening to, and responding to OBD requests.

6.4 Monitoring OBD Traffic

By default, each PIM prints incoming and outgoing OBD messages including the message headers, but without the checkbyte. Here is an example of communication between a tester and the PIM on J1850 PWM:

```
Rx: 616AF1 01 00
Tx: 416B10 41 00 BE 1B 30 13
Tx: 416B18 41 00 88 18 00 10
Tx: 416B28 41 00 00 08 00 10
```

J1850 VPW, ISO 9141-2, and ISO 14230-4 messages follow the same format: each message has a three byte header followed by data bytes. ISO 15765-4

messages have either 11-bit or 29-bit headers. So a typical 11-bit exchange would appear as follows:

```
Rx: 7DF 01 00
Tx: 7E8 41 00 BE 1B 30 13
Tx: 7E9 41 00 88 18 00 10
Tx: 7EA 41 00 00 08 00 10
```

Same exchange on 29-bit CAN:

```
Rx: 18DB33F1 01 00
Tx: 18DAF110 41 00 BE 1B 30 13
Tx: 18DAF118 41 00 88 18 00 10
Tx: 18DAF128 41 00 00 08 00 10
```

Monitoring can be turned off using the MON 0 command to increase the refresh rate. To enable monitoring again, issue MON 1.

6.5 Status Messages

<UART TX OVERFLOW>
UART transmit buffer overflow detected.

<MALFUNCTION EVENT>
User pressed the FAULT button.

<WAITING FOR 5 BAUD INIT>
The simulator is waiting for an ISO 9141-2 or ISO 14230-4 5 baud initialization sequence.

<WAITING FOR FAST INIT>
The simulator is waiting for an ISO 14230-4 fast initialization sequence.

<5 BAUD INIT: OK>
Detected a successful 5 baud initialization sequence.

<FAST INIT: OK>
Detected a successful ISO 14230-4 fast initialization sequence.

<ALL ECUS TIMED OUT>
All virtual ECUs had timed out, because a supported request had not been received within $P3_{MAX}$.

7.0 Virtual ECUs

There are three virtual ECUs: Engine Control Module (ECM), Transmission Control Module (TCM), and Anti-lock Braking System module (ABS). The ECUs support both physical and functional addressing, as specified in the SAE J2178, Part 1 and ISO 15765-4 documents.

Functional address supported by the ECUs depend on the selected protocol and, in the case of ISO 15765-4, the ID type (11-bit or 29-bit):

Protocol(s)	Functional Address
J1850 PWM J1850 VPW ISO 9141-2	$6A
ISO 14230-4 ISO 15765-4 (29-bit)	$33
ISO 15765-4 (11-bit)	$7DF

Physical address assignments also depend on the protocol and CAN ID in use, and are summarized in the following table:

ECU	ISO 15765-4 (11-bit ID)	Other Protocols
Engine Control Module (ECM)	$7E0	$10
Transmission Control Module (TCM)	$7E1	$18
ABS Module (ABS)	$7E2	$28

29-bit ISO 15765-4, SAE J1850, ISO 9141-2, and ISO 14230-4 addresses follow the physical address assignments outlined in SAE J2178, Part 1.

7.1 Engine Control Module (ECM)

The following summarizes modes, PIDs, and Infotypes supported by the PCM.

7.1.1 ECM: Mode 1

PID	Description	Fixed/Variable	Hex Value	Scan Tool Display
00	Supported PIDs 01-1F	fixed	BE1B3013	
01	Monitors/DTC Count/MIL	fixed[1]	0007EF80	***See PID 01 Monitors table***
03	Fuel System Status	fixed	0201	Closed Loop/ Open Loop
04	Calculated Load Value	fixed	32	20%
05	Engine Coolant Temperature	variable, knob #1	00 to FF	-40°C to +215°C
06	Short Term Fuel Trim: Bank 1	fixed	3C	-53.1%
07	Long Term Fuel Trim: Bank 1	fixed	46	-45.3%
0C	Engine RPM	variable, knob #2	0000 to FFFF	0.00 to 16383.75 rpm
0D	Vehicle Speed Sensor	variable, knob #3	00 to FF	0 to 255 km/h
0F	Intake Air Temperature	fixed	41	25°C
10	Mass Air Flow	variable, knob #4	0000 to FFFF	0.00 to 655.35 g/s
13	Location of Oxygen Sensors	fixed	01	Bank 1, Sensor 1
14	Oxygen Sensor Voltage	variable, knob #5	00 to FF	0.000 to 1.275 V
14	Short Term Fuel Trim	fixed	80	0%
1C	OBD Type	fixed	01	OBD II (CARB)

[1] When FAULT button is pressed, the MIL bit and DTC count bits change.

1F	Time Since Engine Start	fixed	0258	600 seconds
20	Supported PIDs 21-3F	fixed	80022001	
21	Distance Traveled While MIL is Activated	fixed	03E8	1000 km
2F	Fuel Level Input	fixed	80	50.2%
33	Barometric Pressure	fixed	64	100 kPa
40	Supported PIDs 41-5F	fixed	44000000	
42	Control Module Voltage	fixed	2EE0	12 V
46	Ambient Air Temperature	fixed	3C	20°C

7.1.1.1 PID 01 Monitors

Continuous Monitors		
Monitor	Supported	Ready
Misfire	Yes	Yes
Fuel System	Yes	Yes
Comprehensive Component (CCM)	Yes	Yes
Compression Ignition Supported	No	
Non-continuous Monitors		
Monitor	Supported	Ready
Catalyst	Yes	Yes
Heated Catalyst	Yes	Yes
Evaporative System	Yes	Yes
Secondary Air System	Yes	Yes
A/C System Refrigerant	No	
Oxygen Sensor	Yes	Yes
Oxygen Sensor Heater	Yes	Yes
EGR System	Yes	No

7.1.2 ECM: Mode 2

When the user generates a malfunction event, the following freeze frame is stored:

PID	Description	Hex Value	Scan Tool Display
00	Supported PIDs 01-1F	48180000	
02	DTC that Caused F.F. Storage	0100	P0100
05	Engine Coolant Temperature	8C	100°C
0C	Engine RPM	4E20	5000 rpm
0D	Vehicle Speed Sensor	78	120 km/h

7.1.3 ECM: Mode 3

When the MIL is on, Mode 3 reports six DTCs:

- P0100
- P0200
- P0300
- C0300
- B0200
- U0100

7.1.4 ECM: Mode 4

Issuing Mode 4 request performs the following operations:

- Turn off MIL (Mode 1, PID 1)
- Erase Freeze Frame (Mode 2)
- Erase stored DTCs (Mode 3)
- Erase pending DTCs (Mode 7)

7.1.5 ECM: Mode 7

When the MIL is on, Mode 7 reports four pending DTCs:

- P0107
- P0207
- P0307
- C0307

7.1.6 ECM: Mode 9

The following infotypes are supported:

Infotype	Description	Scan Tool Display
00	Supported Infotypes	
01	VIN Message Count*	
02	VIN	1G1JC5444R7252367
03	Calibration ID message count*	
04	Calibration ID	JMB*36761500
05	CVN Message Count*	
06	CVN	1791BC82
0A	ECUNAME	ECU1-EngineControl

* Message count infotypes are not supported in ISO 15765-4, per SAE J1979.

7.1.7 ECM: Mode A

After the first MIL event (user pressed the "MIL" button), Mode A reports one permanent DTC:

- P1234

This mode is only available for ISO15765-4.
SAE J1979 does not define Mode A for the SAE J1850, ISO 9141-2, or ISO 14230-4 protocols.

Permanent DTCs cannot be erased using a Mode 04 request.
To erase this DTC, you must reset the PIM by issuing the RESET command, momentarily deselecting it using the PIM Select switch, or power cycling the simulator.

7.2 Transmission Control Module (TCM)

The following summarizes modes, PIDs, and Infotypes supported by the TCM.

7.2.1 TCM: Mode 1

PID	Description	Fixed/Variable	Hex Value	Scan Tool Display
00	Supported PIDs 01-1F	fixed	88180010	
01	Monitors/DTC Count/MIL	fixed*	00000000	All monitors not supported
05	Engine Coolant Temperature	variable, knob #1	00 to FF	-40°C to +215°C
0C	Engine RPM	variable, knob #2	0000 to FFFF	0.00 to 16383.75 rpm
0D	Vehicle Speed Sensor	variable, knob #3	00 to FF	0 to 255 km/h
1C	OBD Type	fixed	01	OBD-II (CARB)

*When the FAULT button is pressed, the MIL bit gets set, and the DTC count bits change to reflect the number of stored DTCs.

7.2.2 TCM: Mode 3

When MIL is on, Mode 3 reports one DTC:

- P0101

7.2.3 TCM: Mode 4

Issuing Mode 4 request performs the following operations on the TCM:

- Erase stored DTCs (Mode 3)
- Erase pending DTCs (Mode 7)

7.2.4 TCM: Mode 7

When MIL is on, Mode 7 reports two DTCs:

- P0102
- U1600

7.3 ABS Control Module (ABS)

The following summarizes modes, PIDs, and Infotypes supported by the ABS.

7.3.1 ABS: Mode 1

PID	Description	Fixed/Variable	Hex Value	Scan Tool Display
00	Supported PIDs 01-1F	fixed	00080010	
0D	Vehicle Speed Sensor	variable, knob #3	00 to FF	0 to 255 km/h
1C	OBD Type	fixed	01	OBD-II (CARB)

7.3.2 ABS: Mode 4

Issuing Mode 4 request performs the following operations on the ABS:

- Erase pending DTCs (Mode 7)

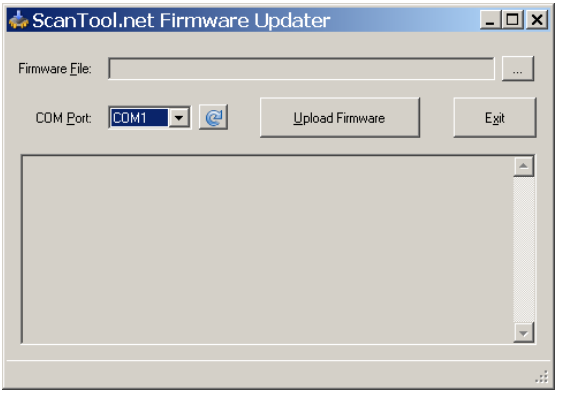
7.3.3 ABS: Mode 7

When MIL is on, Mode 7 reports one DTC:

- B2245

8.0 Firmware Updates

Each PIM features a bootloader, which allows the user to update the device's firmware in the field through the USB port. Updates are posted on the ECUsim internet product page as they become available.



Once you download the update, follow the steps to update the PIM:

1. Extract the contents of the ZIP file to a folder on your computer.
2. Run StnFirmwareUpdater.exe.
3. Set the PIM Select switch to the PIM that you wish to update. Be sure the PIM ALL switch is in the "up" (off) position.
4. Select the COM port associated with the ECUsim.
5. Click the Upload Firmware button to program the PIM with the new firmware.

To update additional PIMs, repeat steps 3 and 4.

ECUsim Product Page
http://www.ecusim.com/5100

Appendix A: Specifications

Dimensions	7.2 x 5.5 x 1.5 in (183 x 140 x 38 mm)
Weight	14 oz (400 g)
Power	12 VDC @ 2A (max)
OBD Protocols	SAE J1850 PWM SAE J1850 VPW ISO 9141-2 ISO 14230-4 (KWP2000) ISO 15765-4 (CAN 250/500 kbps, 11/29 bit)
PC Port	USB Type B
Operating Temperature	-4° to 131°F (-20° to 55°C)
Operating Humidity	10 to 85%, non-condensing
Storage Temperature	-40° to 185°F (-40° to 85°C)
Storage Humidity	5 to 90% non-condensing

Appendix B: Revision History

Revision B (April 23, 2013)

- Updated product page links
- Edited section 5.1 – removed command description and referenced programming manual

Revision A (February 19, 2010)

- Initial release of this document

Appendix C: Warranty

This product is covered by a one year parts and labor warranty.

Appendix D: Contact Information

OBD Solutions
1819 W Rose Garden Ln Ste 3
Phoenix, AZ 85027

sales@obdsol.com
www.obdsol.com

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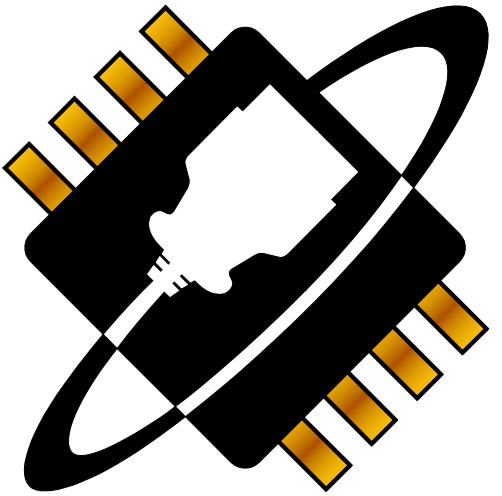

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