AC-EDP6

Evaluation and Development Platform

User Guide

AC-EDP6 User Guide

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1. Introduction

This guide is intended for users of AC-EDP6 to become familiar with the operating modes of the evaluation platform and start developing applications using the PLM-1 modem.

The AC-EDP6 is a multi-interface reference platform that allows using the Ariane powerline communication (PLC) technology in various environments. It features operation modes for quick demonstration, detailed evaluation, and easy development of new applications. Hardware configurable active filters in transmission and reception allow testing different PLC frequencies and data rates. The platform features multifunctional interfaces (USB, RS232, RS485, SPI, Digital I/O) and enables communication on AC, DC or un-powered lines.

The standard kit includes the following components:

- Two PLC transceivers
- Two Power Supply & Coupling Units
- ACES evaluation software
- Documentation, schematics and programming tools
- USB driver and USB cables

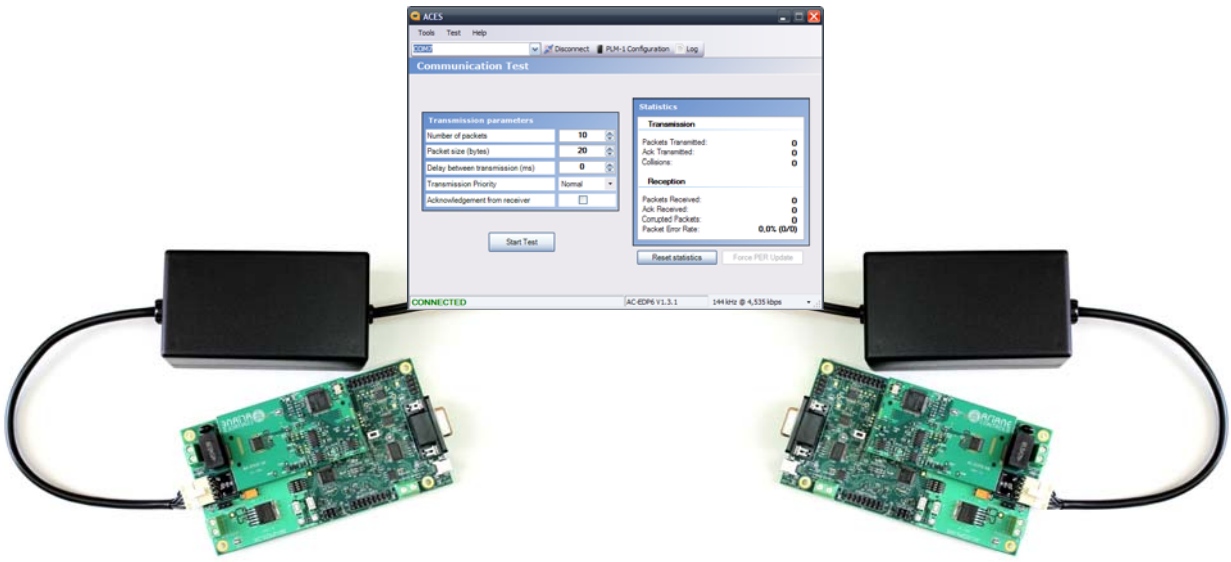

Fig. 1 The AC-EDP6 kit

2. System overview

This section presents the hardware of the AC-EDP6 platform and introduces the available operating modes.

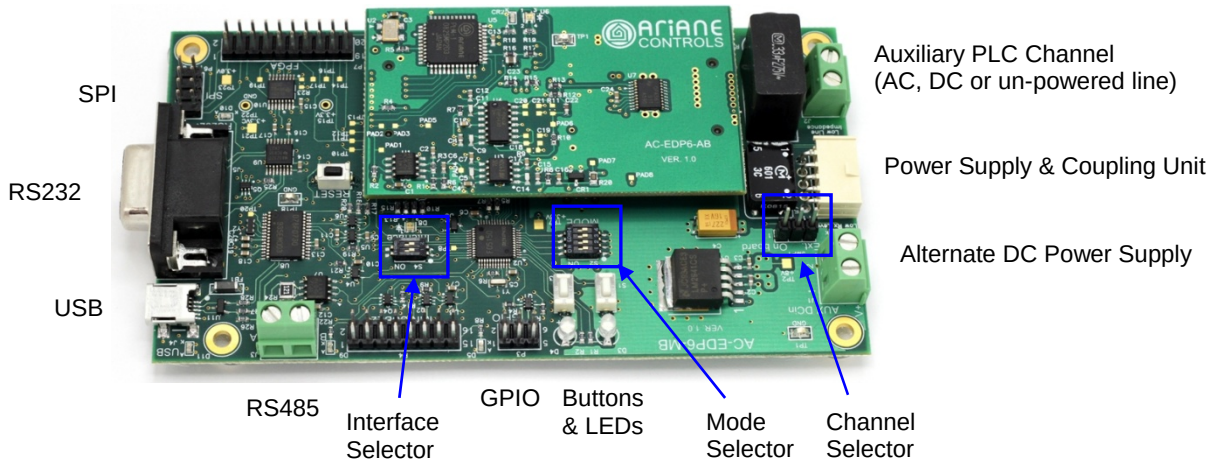

Fig. 2 The AC-EDP6 hardware platform

The AC-EDP6 transceiver is designed as a two-board hardware platform:

- A motherboard holds the main microcontroller and interfaces with external devices.
- A small daughterboard accommodates the PLM-1 modem and the Analog Front End.

Below are presented the AC-EDP6 interfaces and user configuration tools:

Power Supply & Coupling Unit (P1)	External Power Supply and Coupling unit connects the AC-EDP6 board to the mains power line and supplies the board with required DC power. It also couples the PLC signals with the AC line voltage, when JMP1 is in *Ext* position. Two models are available: ▪ Lin120 - operates with line voltage between 110Vac-120Vac, 50/60Hz. ▪ Uni - operates with line voltage between 100Vac-240Vac, 50/60Hz. Check your model and use it according to its rating.
Alternate DC Power Supply (J1 – AUX DCin)	An alternate power supply can be connected to J1 (AUX DCin) to provide DC power to AC-EDP6. The voltage and current requirements are: 10Vdc to 12Vdc, 500mAdc min. When using an alternate DC Power Supply, the Auxiliary PLC Channel is available for communication. This can be convenient when one wants to communicate on a different line from that which provides the power supply.

Auxiliary PLC Channel (J2 – AUX Line)

The AC-EDP6 includes an on-board coupling circuit that allows communicating on AC or DC power lines (up to 275V), as well as on un-powered channels.

Channel Selector (JMP1)

Allows selecting the PLC channel.

- Set JMP1 in *Ext* position to communicate on the mains power line through the Power Supply & Coupling Unit.
- Set JMP1 in *On-board* position to communicate on a different channel. Connect the board to this channel using the J2 connector (AUX Line).

Mode Selector (S2)

Allows selecting one of the four operating modes of AC-EDP6:

- Stand-alone: Simple operation using the on-board buttons and LEDs
- PC Interface: For comprehensive testing using the ACES software
- Transparent: For interface with external devices via RS232, RS485 or USB port
- SPI: For interface with external MCU via SPI to develop custom applications with PLM-1

Buttons & LEDs

The AC-EDP6 features two push-buttons (S1, S3) and two LEDs (D3, D4) intended for use in the Stand-alone mode.

GPIO (P3)

The AC-EDP6 features 2 General Purpose Digital Inputs (3.3V) and 2 General Purpose Digital Outputs (3.3V, 50mA).

Interface Selector (S4)

Allows selecting one of the three serial interfaces of AC-EDP6:

	Switch S4-1	**Switch S4-2**
▪ USB	**ON**	**ON**
▪ RS232	OFF	**ON**
▪ RS485	**ON**	OFF

RS485 (J3)

Allows interfacing with external devices via RS485 in the Transparent mode. The default serial configuration of AC-EDP6 is 9600 8-N-1.

USB (J4)

Allows interfacing with external devices in the Transparent mode or with the computer in the PC Interface mode.

RS232 (J5)

Allows interfacing with external devices in the Transparent mode or with the computer in the PC Interface mode.

SPI (P6)

Allows interfacing with an external MCU in the SPI mode.

3. Setting up the boards

This section explains how to get the boards ready for operation.

1. Connect the Power Supply & Coupling Unit to P1 of AC-EDP6.
2. Plug the Power Supply & Coupling Unit into an appropriate outlet. The nominal operating voltage is indicated on the back of the power supply unit.
3. Select the AC-EDP6 communication channel with JMP1:
    a. Set JMP1 in *Ext* position to communicate on the mains power line through the Power Supply & Coupling Unit.
    b. Set JMP1 in *On-board* position to communicate on a different channel and connect the board to this channel using the J2 connector (AUX Line).
4. Select the operating mode with the Mode Selector switch (S2):

	Switch S2-1	**Switch S2-2**	**Switch S2-3**	**Switch S2-4**
Stand-alone	**ON**	OFF	OFF	OFF
PC Interface	OFF	**ON**	OFF	OFF
Transparent	OFF	OFF	**ON**	OFF
SPI	OFF	OFF	OFF	**ON**

5. If the PC Interface or Transparent mode was selected, set the required port with the Interface Selector switch (S4):

	Switch S4-1	**Switch S4-2**
USB	**ON**	**ON**
RS232	OFF	**ON**
RS485	**ON**	OFF

6. Press the Reset button (S5) to activate the new operating mode.

3.1 Using alternate DC power supply

An alternate DC power supply (10Vdc to 12Vdc, 500mAdc min) can be used instead of the standard Power Supply & Coupling Unit. In this case, the first three installation steps are:

1. Connect the alternate DC supply voltage to J1 (AUX DCin) of AC-EDP6. The polarity of the DC input voltage is indicated on the board.
2. Select the Auxiliary PLC channel on AC-EDP6 by setting JMP1 in *On-board* position.
3. Attach the J2 connector (AUX Line) of AC-EDP6 to the communication channel (AC or DC up to 275V or un-powered channel).

4. Getting started using the Stand-alone mode

This section explains how to start using the kit in the shortest time with the Stand-alone operating mode.

The standard AC-EDP6 comes set in the Stand-alone mode. This approach makes use of the on-board buttons and LEDs and is convenient for demos and connectivity tests.

1. Power-up the two boards, as described in section 3. Ensure that the Mode Selector switch (S2) is set for the Stand-alone operation:

	Switch S2-1	**Switch S2-2**	**Switch S2-3**	**Switch S2-4**
Stand-alone	**ON**	OFF	OFF	OFF

2. Use one of the following two operating approaches:
   a. Single transmission:
      - Push the on-board buttons S1 and S3 to send commands over the line and turn On and Off the LEDs D3 and D4 of the other board.
   b. Continuous transmission:
      - Press one button (S1 or S3) for 2 seconds to start a continuous sequence of On-Off commands. Press once S1 or S3 to stop the transmitting sequence.

Fig. 3 AC-EDP6 in Stand-alone operation

5. PC Interface mode

This section explains how to install the software tools and how to use the AC-EDP6 in the PC-Interface operating mode. A presentation of the ACES evaluation software is also included.

The PC Interface mode allows performing comprehensive analysis of the Ariane powerline communication solution. With the ACES evaluation software, the user has control over the transmission settings, as well as over the PLM-1 configuration. During the test, the software displays real-time information regarding the communication performance.

1. Install the software tools, by following the steps described in section 5.1 below.
2. Connect the AC-EDP6 board to the PC via USB or RS232 port using a USB or serial cable.
3. Set-up the boards, by following the steps described in section 3.
   - Make sure that the Mode Selector switch (S2) is set for the PC Interface operation.

	Switch S2-1	**Switch S2-2**	**Switch S2-3**	**Switch S2-4**
PC Interface	OFF	**ON**	OFF	OFF

   - Ensure that the Interface Selector switch (S4) is set for the right port (USB or RS232).

	Switch S4-1	**Switch S4-2**
USB	**ON**	**ON**
RS232	OFF	**ON**

   - Press the Reset button (S5) to activate the new settings.
4. Open the ACES software and start the tests. See section 5.2 below for a presentation of the ACES features.

5.1 Installing the software tools

5.1.1 Requirements

Before using the AC-EDP6 in PC Interface mode, two software tools are required to be installed: the ACES evaluation software and the USB driver.

These software tools can be used on Windows 2000/XP/Vista/7.

The software can be installed on one, two or several computers. Note that it is possible to test bidirectional communication between two AC-EDP6 boards by connecting only one device to a computer and using the Acknowledgement feature in the ACES evaluation software (see section 5.3.1 for details).

5.1.2 Installing the USB driver

5.1.2.1 For Windows 32-bit (2000/XP)

1. Power-up the AC-EDP6 board by connecting the Power Supply & Coupling Unit to P1.
2. Connect the AC-EDP6 board to the PC via the USB interface.
3. The Found New Hardware Wizard will pop up. Select "Install from a list or specific location", then click Next.
4. Click on the Browse button and select the directory Software / USB Driver / Win32 on the provided CD. Click Next.
5. A Windows Security window will pop up. It displays the driver as "Renesas Starter Kit Virtual UART". Click Continue in order to allow the installation of the driver.
6. The driver is installed within a few seconds. The "Found New Hardware Wizard" displays that your new hardware is installed and ready to use.

5.1.2.2 For Windows 64-bit (Vista/7)

1. Power-up the AC-EDP6 board by connecting the Power Supply & Coupling Unit to P1.
2. Connect the AC-EDP6 board to the PC via the USB interface.
3. Click on the Start menu and select Control Panel.
4. In the Control Panel window, select the Device Manager.
5. In the Device Manager, right-click on the Unknown Device, then click on Update Driver. The Update Driver Software pops up.
6. In the Update Driver Software, click on "Browse my computer for driver software".
7. In the next window, click the Browse button and select to directory Software / USB Driver / Win64 on the provided CD. Click Next.
8. A Windows Security window will pop up. It displays the driver as "Renesas Electronics Corporation Ports". Click Install.
9. The driver is installed within a few seconds. The Update Driver Software indicates that your driver is installed and ready to use. It is identified as Renesas Starter Kit Virtual UART.

5.1.3 Installing ACES

1. Open the folder Ariane Evaluation Software > ACES on the CD provided with the AC-EDP6 kit.
2. Double-click on the Setup.exe file.
3. Click the Next button when the ACES Setup Wizard starts.
4. Select the folder where you wish to install the software.
5. Click Next to start the installation.
6. Click Close to exit when the installation is done.

5.2 ACES overview

ACES is an easy-to-use software that helps evaluating the PLM-1 powerline communication with AC-EDP6.

5.2.1 Starting ACES

When started, the software invites the user to select from a drop-down menu the hardware port to which the AC-EDP6 is connected.

If the connection is not possible, an error message is displayed in the status bar at the bottom of the window.

If the message is *NO response from board*, make sure that the Mode Selector switch (S2) is set for the PC Interface mode and the Interface Selector switch (S4) is set for the right port (USB or RS232).

If the error message is *Unable to open port*, verify if you have selected the port to which AC-EDP6 is connected.

Press the Reset button (S5) to activate any changes, and then try again to connect to ACES.

When the connection is achieved, the Communication Test window is displayed. The status bar at the bottom of the window indicates that the software is connected with the board. Also, the status bar displays the current firmware version and the PLC configuration (communication frequency and raw data rate) of the AC-EDP6.

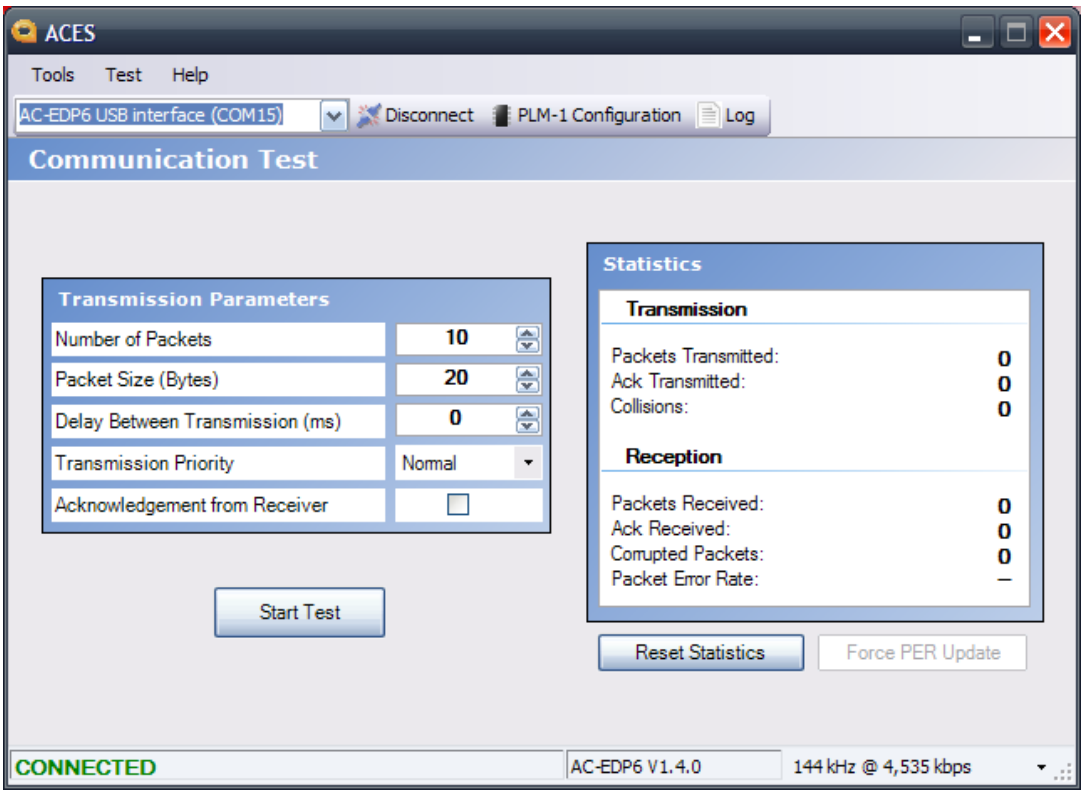

Fig. 4 ACES main window (Communication Test)

5.2.2 Running tests with ACES

Two types of tests are possible with ACES: communication test and data rate test. The two test modes are available in the Test menu.

5.2.2.1 Communication test

This test is intended to evaluate the quality of the communication between two AC-EDP6 devices. It allows calculating the error rate based on the number of incorrectly received data.

Setting the transmission parameters

The user can set the following transmission parameters before starting a test. Once all the parameters set, click on the *Start test* button to run the test.

- **Number of packets:** the number of random data packets to be transmitted.
- **Packet size:** the length in bytes of the actual data transmitted, excluding the physical layer protocol overhead.
- **Delay between transmissions:** time delay in milliseconds between two consecutive packets.
- **Transmission priority:** the priority of the transmitted packets when two or more devices transmit simultaneously. The user can select one of the following four priorities: Highest, High, Normal, and Deferred. The default value is Normal.
- **Acknowledgement from receiver:** when selected, each packet is acknowledged by the receiving AC-EDP6 if correctly received. This feature allows testing bidirectional communication between two AC-EDP6 devices using a single PC. The acknowledgement must be used only in point-to-point communication.

Analysing the statistics

The following information is displayed in real-time during the test when the device is transmitting.

- **Packets transmitted:** the number of data packets transmitted following a Start Test command.
- **Ack transmitted:** the number of acknowledgements sent by a receiving AC-EDP6. This information is displayed only when the transmission parameter *Acknowledgement from receiver* has been selected for the other AC-EDP6 device.
- **Collisions:** indicates that another communication has been detected when trying to send a packet. This information may be displayed if several devices transmit simultaneously or in presence of noise at the communication frequency.

The following information is displayed in real-time during the test when the device is receiving. Click *Reset statistics* before running a new test.

- **Packets received:** the number of data packets received.
- **Ack received:** the number of acknowledgements received when the *Acknowledgement from receiver* feature is selected.
- **Corrupted packets:** the number of packets received incorrectly.
- **Packet Error Rate:** the ratio (in percent) of the number of missed packets to the number of expected packets. The Packet Error Rate (PER) is also calculated for the Ack received. The PER value is displayed in italic during a test. If the PER value remains italic at the end of the test, click *Force PER Update* to display the final result.

5.2.2.2 Data rate test

This test allows calculating the effective data rate when transmitting a specific packet size. It can be run on a single AC-EDP6 device or with two (or more) devices transmitting simultaneously.

The user can set the following parameters before starting the test:

- **Duration:** the length of the test (in seconds). Longer tests may provide better data rate estimation.
- **Packet size:** the length in bytes of the actual data transmitted.
- **Transmission priority:** the priority of the transmitted packets when two or more devices transmit simultaneously. Higher priority should provide higher data rate.

The following information is displayed at the end of the test:

- **Data rate:** the effective data rate (in bits per second) calculated for the specified packet size transmitted on the communication link.
- **Duration:** the actual length of the test (in seconds).
- **Transmitted packets:** the number of packets transmitted during the test.
- **Transmitted data bytes:** the number of data bytes transmitted during the test.

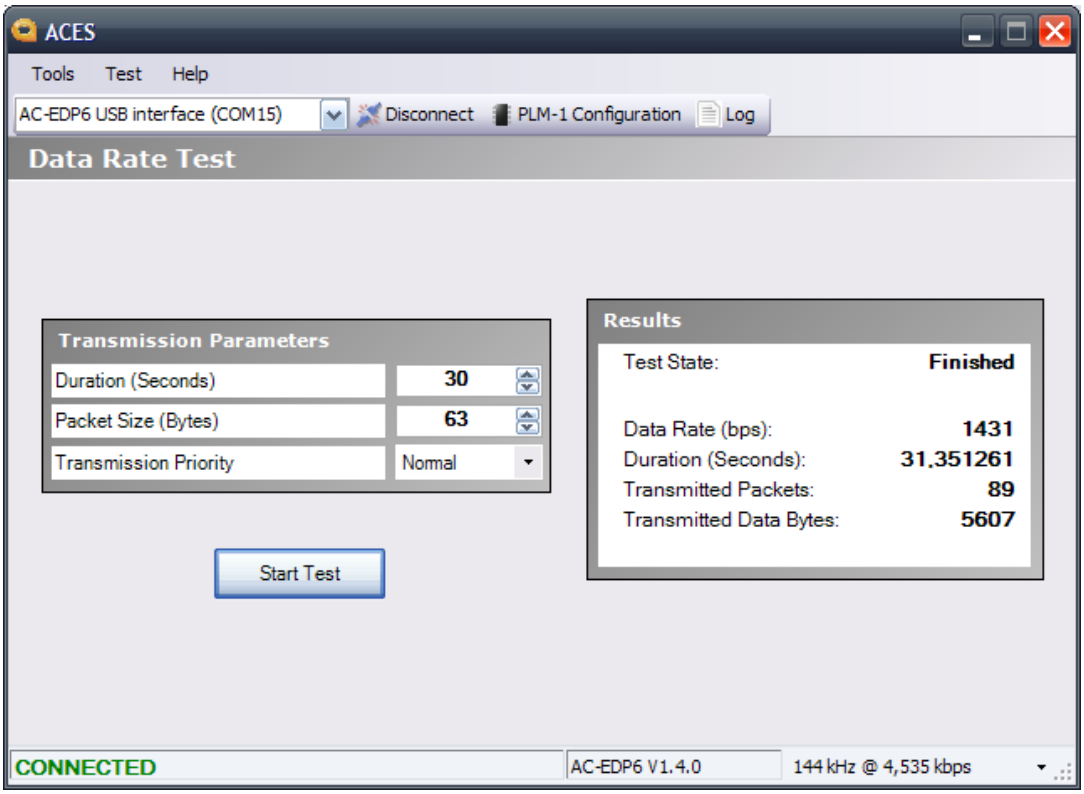

Fig. 5 ACES Data Rate Test window

5.2.3 Tools

This section presents an overview of the Tools menu featured in ACES.

5.2.3.1 Log

While running tests, every packet transmitted or received is logged in the Logger window.

5.2.3.2 Transparent Mode

This tool allows setting the AC-EDP6 serial communication parameters for the Transparent operating mode. See section 6.1 for more details.

5.2.3.3 PLM-1 Configuration

Three tools are available for managing the PLM-1 configuration.

PLM-1 Configuration Tool Lite

The Configuration Tool Lite allows changing the PLC data rate of the AC-EDP6 device. The new data rate can be selected among a list of predefined values. The main characteristics of the selected configuration are displayed, as well as the configuration string (in bytes). This tool can only be used when an AC-EDP6 device is connected to ACES.

PLM-1 Advanced Configuration Tool

The Advanced Configuration Tool allows exploring among all possible configurations of the PLM-1, based on user-defined input parameters: desired communication frequency, available oscillator, and required data rate. The tool is mainly intended for designers of new PLM-1 transceivers and can be used stand-alone, with no AC-EDP6 device connected to ACES. For a comprehensive description of the configuration parameters, the user should refer to the PLM-1 User Manual.

Configuration Manager

This tool allows saving new configurations found with the Advanced Configuration Tool, for easy access during the tests. The new added configurations become available in the PLM-1 Configuration Tool Lite.

6. Transparent mode

This section describes how to configure and use the AC-EDP6 in the Transparent operating mode.

In the Transparent mode, the AC-EDP6 acts as a bridge between the communication line and an external device (e.g. PC, meter, counter, etc). This mode is useful when want to test the AC-EDP6 in a real application and transmit specific data to one or more devices.

1. Set the AC-EDP6 serial communication parameters using the PC Interface mode and the ACES software. Follow the steps described in section 6.1 below.
2. Connect the AC-EDP6 board to the external device via RS232, RS485 or USB.
3. Set-up the boards, by following the steps described in section 3.
   - Make sure that the Mode Selector switch (S2) is set for the Transparent operation.

	Switch S2-1	**Switch S2-2**	**Switch S2-3**	**Switch S2-4**
Transparent	OFF	OFF	**ON**	OFF

   - Make sure that the Interface Selector switch (S4) is set for the right port.

	Switch S4-1	**Switch S4-2**
USB	**ON**	**ON**
RS232	OFF	**ON**
RS485	**ON**	OFF

   - Press the Reset button (S5) to activate the new settings.

6.1 Setting the AC-EDP6 serial configuration

Before using the AC-EDP6 in the Transparent mode, make sure that the board's serial communication parameters match the configuration of the external device. The default AC-EDP6 settings are 9600-8-N-1 with hardware flow control.

1. Set-up the board in the PC-Interface mode, by following the steps described in section 5.
2. In the ACES software, go to the *Tools* menu and select *Transparent Mode*.
3. In the *RS232 Configuration* section, set the value of each parameter to fit the configuration of the external device.
4. Click *OK* and quit the ACES software.

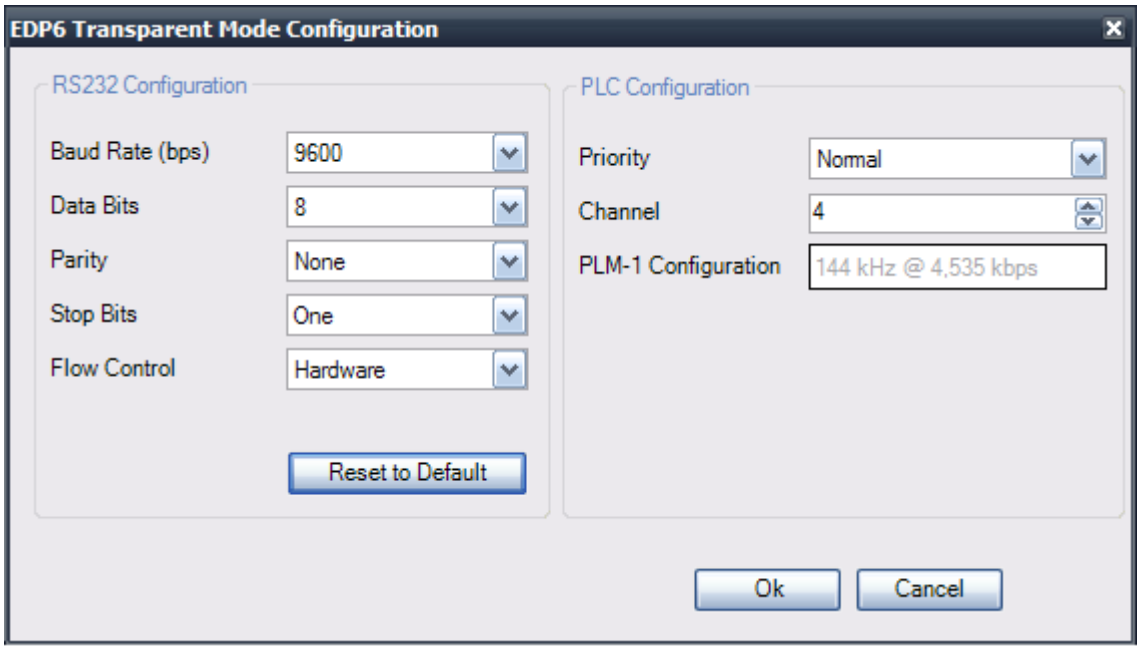

Fig. 6 ACES Transparent Mode Configuration window

If the serial port data rate is higher than one third of the PLC raw data rate, the use of hardware flow control is recommended. However, the flow control can only be used with the RS232 interface.

7. SPI mode

This section describes how to configure the AC-EDP6 for the operation in the SPI mode.

The SPI mode allows linking AC-EDP6 to an external microcontroller. The PLM-1 modem SPI interface is available at the connector P6.

This mode is useful when starting developing a new application with PLM-1.

1. Set-up the boards, by following the steps described in section 3.
   - Make sure that the Mode Selector switch (S2) is set for the SPI operation.

	Switch S2-1	**Switch S2-2**	**Switch S2-3**	**Switch S2-4**
SPI	OFF	OFF	OFF	**ON**

   - Press the Reset button (S5) to activate the new settings.

2. Connect AC-EDP6 to the external platform using the SPI connector P6.

Refer to the PLM-1 User Manual for details about how to interface the PLM-1 modem to a microcontroller.

Also, firmware libraries and sample code are available for download at:

http://www.arianecontrols.com/firmware.php

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