SOCRATES Series
SHDSL.EVB.1CH

User Manual

Revision: 3.0.0, 2019-02-05
Revision History:

Current Revision: 3.0.0, 2019-02-05

<table>
<thead>
<tr>
<th>Revision</th>
<th>Date</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0.0</td>
<td>2015-02-01</td>
<td>Initial revision for software release 1.0</td>
</tr>
<tr>
<td>1.2.1</td>
<td>2015-04-20</td>
<td>Update to software release 1.2</td>
</tr>
<tr>
<td>1.2.2</td>
<td>2015-04-27</td>
<td>Minor changes</td>
</tr>
<tr>
<td>1.3.1</td>
<td>2015-08-25</td>
<td>Update to software release 1.3</td>
</tr>
<tr>
<td>2.0.0</td>
<td>2017-07-14</td>
<td>Update to software release 2.0</td>
</tr>
<tr>
<td>2.1.0</td>
<td>2017-12-19</td>
<td>Update to software release 2.1</td>
</tr>
<tr>
<td>3.0.0</td>
<td>2019-02-05</td>
<td>Update to software release 3.0</td>
</tr>
</tbody>
</table>
# Table of Contents

1 Introduction .................................................................................................................. 5
   1.1 Scope of this Document ......................................................................................... 5
1.2 General Introduction ................................................................................................. 5
   1.3 Content of the SHDSL.EVB.1CH Evaluation Board Kit ........................................... 6
2 Block Diagram ............................................................................................................. 7
3 Interfaces ...................................................................................................................... 9
   3.1 Design Overview .................................................................................................. 9
   3.2 SHDSL Interface ................................................................................................. 9
   3.3 Ethernet Interface .............................................................................................. 10
   3.4 Power Supply Input .......................................................................................... 11
   3.5 Power Consumption .......................................................................................... 12
   3.6 Serial Interface (UART) .................................................................................... 12
   3.7 Debug interface .................................................................................................. 13
   3.8 Control and Monitoring Interface ....................................................................... 13
      3.8.1 Buttons ......................................................................................................... 13
      3.8.2 DIP switches ............................................................................................... 14
      3.8.3 Rotary switch ............................................................................................. 14
      3.8.4 LEDs ........................................................................................................ 15
4 Software .................................................................................................................... 17
   4.1 Updating Firmware ............................................................................................. 17
      4.1.1 Preparation ................................................................................................ 17
      4.1.2 Using the in-system programmer ................................................................. 17
   4.2 SHDSL.EVB.1CH Firmware 3.0 ......................................................................... 19
   4.3 Functions and packages ..................................................................................... 20
5 User Interfaces ........................................................................................................... 21
   5.1 Establish a Connection ....................................................................................... 21
   5.2 BSI - Basic Status/SHDSL Interface .................................................................. 21
   5.3 CLI - Command Line Interface .......................................................................... 23
      5.3.1 Login ............................................................................................................ 23
      5.3.2 CLI commands ............................................................................................ 24
      5.3.3 Password modification .............................................................................. 25
      5.3.4 Configuring the system ............................................................................. 25
6 Operation .................................................................................................................... 28
   6.1 Start-up with two boards ................................................................................... 28
7 Using SHDSL.EVB.1CH as Module ......................................................................... 29
   7.1 Scope ............................................................................................................... 29
   7.2 Connection ........................................................................................................ 29
   7.3 Protection .......................................................................................................... 30
8 Literature ................................................................................................................... 31
Appendix A. Quick Start-up guide .............................................................................. 32
List of Figures

Figure 1: Structure of SHDSL Link ................................................................. 5
Figure 2: Components of SHDSL.EVB.1CH Evaluation Board ......................... 6
Figure 3: Block Diagram of the SHDSL.EVB.1CH Evaluation Board .................... 7
Figure 4: Design of the SHDSL.EVB.1CH Evaluation Board ................................ 9
Figure 5: SHDSL Interface ............................................................................. 9
Figure 6: (Extract from) Schematic of SHDSL Hybrid .................................... 10
Figure 7: Ethernet interface ............................................................................ 10
Figure 8: Pin Definition of X202 .................................................................... 11
Figure 9: Schematic of Ethernet Interface .......................................................... 11
Figure 10: SAM-BA menu: select connection and board ..................................... 18
Figure 11: SAM-BA menu: select firmware image and download them ................ 18
Figure 12: SAM-BA menu: press execute ......................................................... 19
Figure 13: CLI menu tree .................................................................................. 24
Figure 14: CLI example: config/show ? ............................................................ 25
Figure 15: CLI example: password modification ................................................. 25
Figure 16: CLI example for show modified SHDSL configuration ....................... 26
Figure 17: CLI example for net configuration .................................................... 27
Figure 18: Dimension of SHDSL.EVB.1CH and position of Connectors ............. 30
1 Introduction

1.1 Scope of this Document

This document describes the hardware and software to get started with the SHDSL 1-Channel Evaluation Board from the Teleconnect SOCRATES series. The product code “SHDSL.EVB.1CH” used for this document. Teleconnect (http://www.teleconnect.de/xdsl/socrates-evb) provides all necessary documentations for recreating of the hardware. This includes schematic, components layout placement, board outline, PCB layout, bill of materials and available software features. Gerber files are available upon request.

1.2 General Introduction

The new SHDSL.EVB.1CH reference design targeting industrial designs enables customers to take advantage of Intel® SHDSL Chipset (previously known as “Lantiq SOCRATES™-1E”) for long reach broadband connectivity. It is the first ever ready-to-copy reference design developed for the Intel® SHDSL Chipsets. The SHDSL/Ethernet Bridge Modem was developed by Teleconnect and measures only about 9 x 5 cm. It is available for online purchase through:

- Würth Elektronik webshop (http://www.we-online.com/socratesdemo)

Teleconnect offers dedicated support for board and software customizations. With this Evaluation Board you get an Evaluation License for the Software Package 1 (basic communication). You can request some evaluation licenses for different features at shdsl@teleconnect.de. With this, for the first time ever, even smaller companies without DSL expertise can include SHDSL and Long-Reach-Ethernet connectivity into their designs. SHDSL’s unique rate/reach performance makes it the product of choice in an ever more diversified field of applications ranging from business broadband access to enterprise networks and industrial communications.

Known as long haul Ethernet, SHDSL was included in the Ethernet standard IEEE 802.3-2008 [1], where it is named 2BASE-TL. Standard Ethernet has a maximum reach of 100 m. SHDSL has a reach beyond 15 kilometers.

Using SHDSL enables customer to transmit Ethernet over only one unshielded twisted wire pair or over any other cable. The general structure of SHDSL is shown at Figure 1.

![Figure 1: Structure of SHDSL Link](image-url)
1.3 Content of the SHDSL.EVB.1CH Evaluation Board Kit

The evaluation kit contains the SHDSL.EVB.1CH Evaluation Board shown in Figure 2. Beside this you need a power source provided via micro USB cable. For Ethernet and SHDSL connection, standard Ethernet patch cables can be used.

![Components of SHDSL.EVB.1CH Evaluation Board](image)

Please consider the changes for the chip manufacturers (Lantiq was acquired by Intel®). In the past, the SHDSL transceiver PEF 21628 E was offered by Lantiq as SOCRATES™-1E with identical PEF number. Now the SHDSL chipset is offered by Intel® as Intel® SHDSL Chipset. This also applies to the Ethernet PHY. In the past, the XWAY™ PHY11G was offered by Lantiq, now the chip is called Intel® Ethernet Network Connection GPY112 and offered by Intel®. In 2016, Microchip agreed to buy Atmel®. That’s the reason why the Atmel® microcontroller ATSAM4S is now part of Microchip product spectrum.
2 Block Diagram

Figure 3 shows the block diagram of the SHDSL.EVB.1CH Evaluation Board.

The SHDSL.EVB.1CH Evaluation Board consists of the following blocks:

- SHDSL transceiver Intel® SHDSL Chipset (PEF 21628 E) (previously known as "Lantiq SOCRATES-1E" with same PEF number).
  The functionality of the Evaluation Board could also be realized with the 2ch or 4ch versions of the Intel® SHDSL Chipsets (PEF 22628 E and PEF 24628 E). Teleconnect provides 4ch SHDSL Evaluation Board also (product code: SHDSL.4CH.EVB [2]). In any case only one channel is used by SHDSL.EVB.1CH.
- Intel® Ethernet Network Connection GPY112 (PEF 7072), Version 1.6 (previously known as "Lantiq PHY11G").
  The GPY112 is a Gigabit Ethernet PHY. However, in this application only 10/100BaseT is available.
- Microcontroller Microchip ATSAM4SA16C (previously known as "Atmel ATSAM4SA16C").
  The microcontroller is used for configuration, controlling and monitoring. The requirements of the microcontroller are very low, e.g. an 8-bit controller has enough performance for SHDSL. We use the ARM® based microcontroller to provide a highly flexible evaluation platform.
- RJ45 connectors (shielded for Ethernet and unshielded for SHDSL), both from Würth Elektronik eiSos GmbH
- Micro USB connector Type B (Würth Elektronik eiSos GmbH),
- SHDSL Hybrid including SHDSL transformer (Würth Elektronik eiSos GmbH),
- Ethernet magnetics (Würth Elektronik eiSos GmbH),
• DC/DC converter from 5 V to 3.3 V, 1.5 V and 1.0 V. Three voltage regulators from MPS (Mini-Module Family) are used.
• XTAL for SHDSL-transceiver, Ethernet-PHY and Microcontroller (Geyer Electronic),
• Input and Output components (Würth Elektronik eiSos GmbH):
  o Rotary switch and DIP switches,
  o Push buttons,
  o ISP pin header for debugging of the microcontroller,
  o LEDs.
3 Interfaces

This chapter describes the interfaces and header pinouts of the SHDSL.EVB.1CH Evaluation Board.

3.1 Design Overview

The design with its main function blocks and important components are shown in Figure 4. The description for it is given in the following section.

![Figure 4: Design of the SHDSL.EVB.1CH Evaluation Board](image)

3.2 SHDSL Interface

The SHDSL interface is divided in SHDSL connector, SHDSL Transformer, Protection, Hybrid and SHDSL data pump (see Figure 5).

![Figure 5: SHDSL Interface](image)

Additional primary protection is necessary depending on requirements. There is no primary protection on the evaluation board available.

The connector X102 is an unshielded RJ45 connector. It is used for connecting the SHDSL.EVB.1CH to one SHDSL line (according ITU-T G.991.2 [3]). Table 1 shows the pin definition of X102.

<table>
<thead>
<tr>
<th>Pin Number</th>
<th>Pin Name / Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ... 3</td>
<td>Not connected</td>
</tr>
<tr>
<td>4</td>
<td>SHDSL line – Tip</td>
</tr>
<tr>
<td>5</td>
<td>SHDSL line – Ring</td>
</tr>
<tr>
<td>6 ... 8</td>
<td>Not connected</td>
</tr>
</tbody>
</table>

Table 1: Pin Definition of X102
Typical lines are unshielded twisted pair cables. Any standard Ethernet cable is also usable. Beside the RJ45 connector X102 SHDSL.EVB.1CH provides the possibility to use the pin header X101 spaced 2.54 millimeters (0.1 in). Table 2 gives the pin definition.

Table 2: Pin Definition of X101

<table>
<thead>
<tr>
<th>Pin Number</th>
<th>Pin Name / Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SHDSL line – Tip</td>
</tr>
<tr>
<td>2</td>
<td>SHDSL line – Ring</td>
</tr>
</tbody>
</table>

The pin header X101 is not mounted by default. It is possible to mount it on both PCB sides to get an easy test adapter for evaluation or to use the SHDSL.EVB.1CH as a module.

Figure 6 shows the schematic of the SHDSL hybrid with line transformer L101 and SHDSL data pump V101 (PEF 21628 E).

Figure 6: (Extract from) Schematic of SHDSL Hybrid

Components and layout are influencing the SHDSL performance. Teleconnect can assist you with the selection of additional line protection at raw ambient conditions.

There are pin compatible 2 and 4 channel SHDSL chips available. However, SHDSL.EVB.1CH provides only one operational SHDSL channel, even if more channel capable chips might be mounted. To use up to 4 channels, please refer to Teleconnect SHDSL.EVB.4CH (see [2]).

3.3 Ethernet Interface

The Ethernet interface is divided in connector, transformer (magnetics) and Ethernet PHY (see Figure 7).

Figure 7: Ethernet Interface

The shielded RJ45 connector X201 is a standard Ethernet interface. It is compatible with 10BASE-T and 100BASE-TX Ethernet according to IEEE 802.3 [1] can be connected to a twisted pair medium such as CAT5 cable infrastructure.
Beside the RJ45 connector, SHDSL.EVB.1CH provides the possibility to use the pin header X202 spaced 2.54 millimeters (0.1 in). Figure 8 and Table 3 gives the pin definition.

### Table 3: Pin Definition of X202

<table>
<thead>
<tr>
<th>Pin Number</th>
<th>Pin Name / Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>TX/RX1 +</td>
</tr>
<tr>
<td>2</td>
<td>TX/RX1 -</td>
</tr>
<tr>
<td>3</td>
<td>TX/RX2 +</td>
</tr>
<tr>
<td>4</td>
<td>TX/RX2 -</td>
</tr>
<tr>
<td>5</td>
<td>Not used for 10/100BASE-TX</td>
</tr>
<tr>
<td>6</td>
<td>Not used for 10/100BASE-TX</td>
</tr>
<tr>
<td>7</td>
<td>Not used for 10/100BASE-TX</td>
</tr>
<tr>
<td>8</td>
<td>Not used for 10/100BASE-TX</td>
</tr>
</tbody>
</table>

The pin header X202 is not mounted by default. It is possible to mount it on both PCB sides to get an easy test adapter for evaluation or to use the SHDSL.EVB.1CH as module (see chapter 7).

The transformer L201 connects the connector to the Ethernet PHY GPY112 V201 (PEF7072). The connection to the SHDSL data pump Intel® SHDSL Chipset V101 is realized via standard MII interface.

Figure 9 shows the schematic of the Ethernet interface.

### 3.4 Power Supply Input

For the power supply a Micro USB connector Type B with standard pin assignment (according to USB specification) is used. This enables the EVB to utilize a standard 5V USB plug-in power supply as power source. We recommend using power supply with at least 500 mA (better: 750 mA) output current and a cable with low voltage-drop. Please note the power consumption of the SHDSL.EVB.1CH with PEF 24628 E is (when finished booting) like EVB with PEF 21628 E mounted (Firmware working in 1 channel operation mode).
As from our tests it is also possible to connect the Micro USB connector to any self-powered USB host interface with a short and high-quality USB cable. Beside the Micro USB connector SHDSL.EVB.1CH provides the possibility to use the pin header X601 spaced 2.54 millimeters (0.1 in) for power supply. Table 4 gives the pin definition.

Table 4: Pin Definition of X601

<table>
<thead>
<tr>
<th>Pin Number</th>
<th>Pin Name / Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>+ 5 V (4.7 ... 6.0 V)</td>
</tr>
<tr>
<td>2</td>
<td>- (Ground)</td>
</tr>
</tbody>
</table>

The pin header X601 is not mounted by default. It is possible to mount it on both PCB sides getting an adapter or using the SHDSL.EVB.1CH as module. The Micro USB connector is also usable for data transmission to the processor. In that case UART emulation provides a serial interface.

### 3.5 Power Consumption

The power consumption of the SHDSL.EVB.1CH Evaluation Board is nearly independent from the traffic on the line. It is maximum 2.9 W. During booting, the maximum number of channels are active when e.g. PEF 24628 E might be mounted. This will stabilize as soon as the configuration of the 1-channel-operation is set. Then the values listed in Table 5 apply.

Boundary conditions:
- Intel® SHDSL Chipsets (PEF 24628 E)
- Firmware: 3.0-R2569
- Function: CO
- Cable length: 1 m
- Power Back Off inactive
- Power 5 V

Table 5: Power Consumption of the SHDSL.EVB.1CH Evaluation Board

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>no connection</td>
<td>229</td>
<td>1.14</td>
<td>auto</td>
<td>no</td>
</tr>
<tr>
<td>192</td>
<td>247</td>
<td>1.24</td>
<td>16</td>
<td>yes</td>
</tr>
<tr>
<td>512</td>
<td>248</td>
<td>1.24</td>
<td>16</td>
<td>yes</td>
</tr>
<tr>
<td>2048</td>
<td>259</td>
<td>1.30</td>
<td>16</td>
<td>yes</td>
</tr>
<tr>
<td>5696</td>
<td>267</td>
<td>1.34</td>
<td>32</td>
<td>yes</td>
</tr>
<tr>
<td>15288</td>
<td>268</td>
<td>1.34</td>
<td>128</td>
<td>yes</td>
</tr>
</tbody>
</table>

### 3.6 Serial Interface (UART)

SHDSL.EVB.1CH features a serial interface (UART) for controlling and monitoring purposes. The interface is usable in two ways: UART emulation via USB interface and TTL-compatible interface via connector X401. Both interfaces have the same function and can work simultaneously. The pin header X401, also named “UART”, is not mounted by default. It is possible to mount any 2.54 millimeters (0.1 in) spaced pin header at both sides of the PCB. So, the soldering pads are usable as an easy test adapter for evaluation or as a module placed on a host board. Table 6 shows the pin definition of X401.
### 3.7 Debug Interface

The controlling processor of SHDSL.EVB.1CH is Microchip ATSAM4SA16C. Based on the powerful ARM® Cortex®-M4 core, the SAM4S series gives improved performance, low power consumption and an easy to use processor. The processor gives much more performance and periphery than SHDSL chipset needs. This offers a good basis for the development of own software.

With the connector X402 ("JTAG") SHDSL.EVB.1CH provides a compatible interface to Microchips development and debugging tools. For example, the SAM-ICE™, Microchips JTAG Emulator for ARM® core-based microcontrollers is usable.

X402 is a 2.54 millimeter (0.1 in) spaced pin header. The pin definition is given at Table 7.

### 3.8 Control and Monitoring Interface

SHDSL.EVB.1CH provides on board software usable for many standard applications. For configuration and status information, several buttons, switches and LEDs are available. The following section gives more information.

#### 3.8.1 Buttons

There are two buttons available. The first is the button S402 called “RESET”. Pressing this button triggers hardware reset of the processor and the SHDSL interface. The software restarts and makes new initialization of SHDSL.EVB.1CH.

The second button is the button S403 called “ERASE” with two functions. During reset (Reset button is also pressed) the whole flash memory will be cleared. This is necessary to reload a new Firmware version via processor’s SAM-BA interface. During runtime and active BSI mode (DIP switch 3 = 0), additional information about software, SHDSL firmware version and SHDSL configuration will be printed to serial interfaces (UART and USB) if the button “ERASE” is pressed.

Please see Figure 4 for the location of the buttons.
3.8.2 DIP switches

The dual in-line package switch S401 is used for selection of operation mode. If the switch position is stable for more than four seconds the software will accept the new setting and reconfigure the SHDSL chipset.

There are five switches available. Table 8 describes the function of the DIP switch called “MODE”.

Table 8: Function of “MODE” Switch S401

<table>
<thead>
<tr>
<th>Switch number</th>
<th>Description</th>
<th>Switch function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Device Mode</td>
<td>On: STU-C (Master, CO mode)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Off: STU-R (Slave, CPE mode)</td>
</tr>
<tr>
<td>2</td>
<td>Extended Rates</td>
<td>On: Enables extended bitrates (64...15336kbps)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Off: ITU-T standard bitrates (192...5696kbps)</td>
</tr>
<tr>
<td>3</td>
<td>User Interface Mode</td>
<td>On: CLI is active (only with SW Packages P3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Off: BSI is active</td>
</tr>
<tr>
<td>4</td>
<td>Test mode (TM1)</td>
<td>Both off: no test mode (normal function)</td>
</tr>
<tr>
<td>5</td>
<td>Test mode (TM2)</td>
<td>TM1 on, TM2 off: PSD test</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TM1 off, TM2 on: idle (Silent State)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Both on: Loopback</td>
</tr>
</tbody>
</table>

SHDSL is a point to point connection. SHDSL interconnections need two different device modes, called SHDSL Termination Unit Central Office (STU-C) and SHDSL Termination Unit Remote (STU-R). Switch 1 is usable for device mode selection. Please ensure to switch one modem to STU-C and the other to STU-R. Otherwise no data transmission will be established.

Beside the standard data rates according to ITU-T G.991.2 [4] Intel® SHDSL Chipset provides higher (and lower) data rates. Intel® SHDSL Chipset is capable to use about three times higher transmission speed compared to high speed standard SHDSL connections. The lower bitrates, for example, match better to ISDN-BRI. Switch 2 selects full performance or compatibility to other SHDSL equipment. For SHDSL systems with Intel® SHDSL Chipset on both sides Intel® recommend using the extended bitrates (switch 2 on). For highest interoperability let switch 2 off.

SHDSL.EVB.1CH provides helpful features for the evaluation of the SHDSL equipment. Therefore, two switches for test mode selection are available. Three test modes provide PSD test, idle and loopback functions. PSD test initiates the SHDSL transmitter sending data without a counterpart station. This function supports the transmit spectrum measurement. For this feature a fixed bitrate must be selected (rotary switch position other than 0, see section 3.8.3 also) because the spectrum is depending on bit rate. In idle mode (also called Silent State), the transceiver does not send any data. This test mode is useful for Idle Noise Measurement.

The loopback mode activates a loopback inside the Intel® SHDSL Chipset. (so-called xMII Egress Loop Back, xMII_EL). The xMII Egress Loop Back loops the Ethernet data received from the SHDSL line interface back to the SHDSL line interface. The looped back data is not visible on MII interface, thus the xMII Egress Loop Back is non-transparent. Nevertheless, during loopback mode the Ethernet LED may display data traffic. Data from the SHDSL interface goes back to the SHDSL interface. This loop back simplifies the analysis of an established data connection.

There is a protective tab on top of DIP switch. Please remove it from the DIP switch before first use.

3.8.3 Rotary switch

The rotary switch S404 (named “BITRATE”) is used for selection of the bitrates. Table 9 shows choice of bitrates.
If the switch position is stable for more than 4 seconds the software will accept the new setting and reconfigure the SHDSL chipset. An established data transmission will be interrupted during reconfiguration.

Table 9: Selectable Bitrates of SHDSL.EVB.1CH

<table>
<thead>
<tr>
<th>Switch position</th>
<th>Extended Rates (DIP switch 2)</th>
<th>Line probing</th>
<th>Bitrate [Kbps]</th>
<th>PAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (default)</td>
<td>Off</td>
<td>Enabled</td>
<td>192…5696</td>
<td>Auto</td>
</tr>
<tr>
<td>1</td>
<td>Off</td>
<td>Disabled</td>
<td>192</td>
<td>16</td>
</tr>
<tr>
<td>2</td>
<td>Off</td>
<td>Disabled</td>
<td>384</td>
<td>16</td>
</tr>
<tr>
<td>3</td>
<td>Off</td>
<td>Disabled</td>
<td>512</td>
<td>16</td>
</tr>
<tr>
<td>4</td>
<td>Off</td>
<td>Disabled</td>
<td>768</td>
<td>16</td>
</tr>
<tr>
<td>5</td>
<td>Off</td>
<td>Disabled</td>
<td>1536</td>
<td>16</td>
</tr>
<tr>
<td>6</td>
<td>Off</td>
<td>Disabled</td>
<td>2048</td>
<td>16</td>
</tr>
<tr>
<td>7</td>
<td>Off</td>
<td>Disabled</td>
<td>2304</td>
<td>32</td>
</tr>
<tr>
<td>8</td>
<td>Off</td>
<td>Disabled</td>
<td>3072</td>
<td>32</td>
</tr>
<tr>
<td>9</td>
<td>Off</td>
<td>Disabled</td>
<td>5696</td>
<td>32</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Switch position</th>
<th>Extended Rates (DIP switch 2)</th>
<th>Line probing</th>
<th>Bitrate [Kbps]</th>
<th>PAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (default)</td>
<td>On</td>
<td>Enabled</td>
<td>64…15336</td>
<td>Auto</td>
</tr>
<tr>
<td>1</td>
<td>On</td>
<td>Disabled</td>
<td>64</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>On</td>
<td>Disabled</td>
<td>192</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>On</td>
<td>Disabled</td>
<td>192</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>On</td>
<td>Disabled</td>
<td>2496</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>On</td>
<td>Disabled</td>
<td>5056</td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td>On</td>
<td>Disabled</td>
<td>7616</td>
<td>16</td>
</tr>
<tr>
<td>7</td>
<td>On</td>
<td>Disabled</td>
<td>10176</td>
<td>32</td>
</tr>
<tr>
<td>8</td>
<td>On</td>
<td>Disabled</td>
<td>12736</td>
<td>64</td>
</tr>
<tr>
<td>9</td>
<td>On</td>
<td>Disabled</td>
<td>15288</td>
<td>128</td>
</tr>
</tbody>
</table>

The best choice for most applications is switch position 0 which enables the Power Measurement Modulation Session (PMMS), also called “Line Probing”. PMMS works like an automatic mode, in that case SHDSL chipset selects the highest given bitrate for actual noise floor and loop length. The bitrate differs depending on extended rates that are enabled or not (see Table 8). The target SNR margin is always set to 6 dB.

3.8.4 LEDs

Five LEDs indicate the current state of SHDSL.EVB.1CH. The green LED H601 “POWER” indicates that power is connected. This LED is on if the board is active and off if the SHDSL.EVB.1CH is not powered up.

The next green LED is H401 (“SHDSL STATE”). This LED is off if SHDSL is not active (e.g. during initialization). If the SHDSL chipset is initialized, the LED blinks slowly (approximately 1 Hz). The SHDSL chipset is ready to work and waits for detecting counterpart station. Once the counterpart station is detected, the training process starts and the LED blinks faster (approximately 3 Hz). This process takes some seconds and if the SHDSL chipset can establish a SHDSL link the “SHDSL STATE”-LED goes on.

The state of the Ethernet port is indicated by the green LED H202 (“ETHERNET LINK/ACTIVITY”). This LED is off if the Ethernet PHY hasn’t detected any Ethernet

---

1 The configuration of fixed bitrates in extended rates mode is only possible by SHDSL Master (CO mode, STU-C). The SHDSL Slave (CPE mode, STU-R) ignores the switch position and always uses line probing (switch position 0).
counterpart. The LED goes on if an Ethernet link is established and starts blinking if data transmission is active.
Beside the green LEDs there is amber LED H402 ("ERROR"). For normal operation this LED is off. The LED is on or starts blinking if an error has occurred. The error type will also print to the serial interface (USB UART emulation and hardware UART). Pressing the “ERASE”-button repeats output of error message to serial interface.
For the location of the LEDs please look at Figure 4.
4 Software

4.1 Updating Firmware

The control and monitor processor ATSAM4SA16 supports Microchip SAM Boot Assistance (SAM-BA), an open set of tools for programming the Microchip ARM® core-based microcontrollers. SHDSL.EVB.1CH uses this tool for an easy way to update the processors firmware (including SHDSL firmware).

The following section provides a guide on how to install the in-system programmer and how to use it.

4.1.1 Preparation

If you have already installed the SAM-BA programmer, please go to the next section.

Please regard, that to date SAM-BA revision 2.18 is proven to work correctly with the microcontroller device SAM4S at SHDSL.EVB.1CH. Subject to change without notice.

This is a guide on how to install the in-system programmer on your PC.

1. Download the version 2.18 of SAM-BA in-system programmer from Microchip web page (http://www.microchip.com). (regard comment above)
2. Install the downloaded software on your PC. Follow the instruction of the installer of user interface (more info: see "sam-ba user guide.pdf" or "usb_notice.html")
3. Download at91sam4s16-ek.tcl from Teleconnect Website http://www.teleconnect.de/xdsl/socrates-evb
4. Store the newly downloaded file at91sam4s16-ek.tcl into your installation directory "/<your SAM-BA installation directory>\tcl_lib\at91sam4s16-ek". You must overwrite the existing file.
5. Connect the SHDSL.EVB.1CH with a Micro-USB 2.0 cable (USB-Micro-B connector to USB-A connector) to your PC and clear the whole memory including the firmware of EVB by pressing "RESET" and "ERASE" button at the same time.
6. Install the driver for the unknown device.
(For Microsoft Windows 10 users this step is not necessary.)
Please select "search for driver software at local computer". The driver is located in your installation directory "/<your SAM-BA installation directory>\drv".
Attention: do not select “automatic search for driver software" (search in the internet). Select "Install from ATMEL Rouset" trust. After a while the driver software "AT91 USB to Serial Converter” is installed successfully and assigned to a COM port.
For more information please have a look at "<your SAM-BA installation directory>\doc\usb_NOTICE.html"

If you have installed another revision than 2.18, you may experience errors with the driver.
Or if Windows version loads another driver version via Windows Update called "Bossa Program Port" please do not hesitate to contact us by E-mail: shdsl@teleconnect.de.

4.1.2 Using the in-system programmer

Before starting, prepare the new firmware image. You can generate it by yourself (including your application software) or use the latest firmware image provided by Teleconnect Website (http://www.teleconnect.de/xdsl/socrates-evb). You need the firmware image in *.bin file format.

1. Connect the SHDSL.EVB.1CH to your PC using the micro USB cable.
2. Press both buttons of the EVB (“RESET” and “ERASE”) at the same time. This clears the whole memory including the firmware of EVB.

3. Disconnect and reconnect the USB connection of EVB. After reconnection, the LEDs “SHDSL STATE” and “ERROR” will not light up/flash. This indicates that no firmware is present.

4. Call the SAM-BA programmer

5. Select the connection, e.g. COM1 or \USBserial\COM8, select your board and choose at91sam4s16-ek as board type.

![Figure 10: SAM-BA menu: select connection and board](image)

6. Press button “Connect”.

7. Select the firmware image binary and press “Send File” button.

![Figure 11: SAM-BA menu: select firmware image and download them](image)

8. The file will download. After that you can lock the involved lock regions or not.
9. Press the button “Execute” and close the SAM-BA programmer.

**Figure 12: SAM-BA menu: press execute**

**Remark:** With some SAM-BA versions you may get the following error sometimes:

*ScriptGPNMV 2-E-Set GPNVM1 failed.*

In that case you must disconnect and reconnect the power connection. The SHDSL.EVB.1CH should work normally.

10. Disconnect and reconnect the USB connection of SHDSL.EVB.1CH. Ready.

### 4.2 SHDSL.EVB.1CH Firmware 3.0

SHDSL.EVB.1CH comes with on-board software “Firmware 3.0” ready to use. It works autonomous without connection to host controller. The configuration is selectable by switches (see section 3.8).

The firmware includes the following main features:

- Adjust the line rate with enabled Line probing,
- Select several fixed line rates (see Quick Start Guide),
- Support for EFM-CU,
- Line coding: 16 and 32 TC-PAM according to ITU-T G.991.2 [2],
- Extended rates configuration (min rate: 64kbps, max rate: 15336kbps)
- Monitoring of basic SHDSL line parameters,
- Different test modes: PSD test, idle and loopback

Teleconnect provides this free firmware image for evaluation proposes only. You can buy software license for commercial use from Teleconnect. Beside this, Teleconnect can assist you in SHDSL software development. For further information please contact us at shdsl@teleconnect.de.

The firmware revision 3.0 of SHDSL.EVB.1CH includes PEF24628 driver by Intel. You can use this driver for your own software development.
4.3 Functions and packages

The following chapter should give you a short overview over functionalities provided by Teleconnect. All packages are included in this free firmware image for evaluation purposes. For further information and prices please contact us at shdsl@teleconnect.de.

Table 10: Available software packages and functions

<table>
<thead>
<tr>
<th>Package number</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>basic software</td>
</tr>
<tr>
<td>P2</td>
<td>basic management (BSI)</td>
</tr>
<tr>
<td>P3</td>
<td>advanced management (CLI)</td>
</tr>
<tr>
<td>P5</td>
<td>networking (Telnet, Webserver etc.)</td>
</tr>
<tr>
<td>P7</td>
<td>ATM support (only on request and additionally customization needed)</td>
</tr>
<tr>
<td>P8</td>
<td>advanced operation (Emergency freeze, EOC handling, VLAN, BERT etc.)</td>
</tr>
<tr>
<td>S</td>
<td>predefined configurations</td>
</tr>
</tbody>
</table>
5 User Interfaces
There are two management versions available:

1. BSI - Basic Status/SHDSL Interface (P2 is needed) (more information in chapter 5.2),
2. CLI - Command Line Interface (P3 is needed) (more information in chapter 5.3).

The two different user interface versions can be activated via DIP switch 3:
• On: CLI is active,
• Off: BSI is active (more in information in Table 8).

5.1 Establish a Connection
SHDSL.EVB.1CH provides user interface via serial interface (UART) and Telnet interface.

For serial interface are two equal alternatives available: TTL compatible interface and emulation via USB (see section 3.6). The baud rate is 115.2 kbaud/s with 8 data bits, 1 stop bit and none parity. With a Terminal Emulation Software like PuTTY and Minicom or other VT-100 compatible software program you can establish a connection to the evaluation board.

To establish a connection via the Telnet interface please use following settings: IPv4 address: 10.10.10.1 (default IP), Netmask: 255.255.255.0.

5.2 BSI - Basic Status/SHDSL Interface
In the software version V1.3 and V2.1 only a monitoring interface is provided. This interface is also available in software version V3.0 called BSI interface. The BSI provides a cyclic printout of SHDSL status to UART and / or USB.

During startup you will see for example the following print out:

-- Startup --

=======================================================================
SW-Ver#:  3.0-R2569
PHY-Ver#:  1.1-2.1.0__001
IDC-Ver#:  2.1.0.0
Serial#:  0123.0B60.6638.9C8F
Vendor:    Teleconnect GmbH
           Am Lehmberg 54 - 01157 Dresden - Germany
           shdsl@teleconnect.de

           Copyright (c) Teleconnect GmbH 2013-2018.
           All rights reserved.
=======================================================================
SHDSL Configuration:
========================================================================
Active: yes
Lines: 1
Masterline: 1
Testmode: Disabled
CO/CPE: CO
TC Layer: EFM
Ext. rates: Enabled
Lineprobing: Enabled
Bitrate min: 64 kbps
Bitrate max: 15336 kbps
PAM: Auto
Annex: ANNEX_B
SNRM: 6 dB
========================================================================
IDC download ... ok.
SDFE download ... ok.
IDC start ... ok.
Linestate: DOWN_NOT_READY
Mode: STU-C (CO)
========================================================================
If the hardware configuration is changed (e.g. new switch position of rotary switch) you get a confirmation print out like that:

HW Config changed (dip:0x03, rot:1)
SHDSL config activate successful

During operation you get a cyclic status print out like that:

Linestate: UP_DATA_MODE
Mode: STU-C (CO)
Bitrate/PAM: 15288 kbps/128-TCPAM
SNRM/LATN(NE): 10 dB/ 2 dB
========================================================================
If you press the “ERASE” button, you will get a summary of state information. It looks like this:

#######################################################
SW-Ver#: 3.0-R2569
PHY-Ver#: 1.1-2.1.0__001
IDC-Ver#: 2.1.0.0
Serial#: 0123.0B60.6638.9C8F
Vendor: Teleconnect GmbH
Am Lehmberg 54 - 01157 Dresden - Germany
shdsl@teleconnect.de

Copyright (c) Teleconnect GmbH 2013-2018.
All rights reserved.
#######################################################
SHDSL Configuration:
===============================================
Active:       yes
Lines:        1
Masterline:   1
Testmode:     Disabled
CO/CPE:       CO
TC Layer:     EFM
Ext. rates:   Enabled
Lineprobing:  Enabled
Bitrate min:  64 kbps
Bitrate max:  15336 kbps
PAM:          Auto
Annex:        ANNEX_B
SNRM:         6 dB
===============================================
Please note, there is a special behavior in Microsoft Windows environment. The COM port initializing happens during the connection to the USB port. During this process you get the COM port number and then you can assign a terminal program. So, it is possible you miss the first notifications. Further a reset of SHDSL.EVB.1CH initiates a new initialization of the COM port. Your connection to the terminal program will be lost.

5.3 CLI - Command Line Interface
The command line interface (CLI) is an advanced user interface with session-management and auto-completion. The CLI has a CISCO®-like syntax. With it an advanced configuration and status management is possible. You can request an Evaluation License for CLI (Software Package 3) at shdsl@teleconnect.de.
The CLI has a VT100 emulation for UART, USB and Telnet.

The focus of the CLI was at:

- a hierarchical organization of (sub-)menus and commands,
- a command history,
- auto-completion of commands which are unique,
- password protection.

5.3.1 Login
The login to SHDSL.EVB.1CH via CLI is password protected. Every unit has its own password and it depends on your serial number. The following output will be displayed:

```
## Thanks for using our SHDSL evaluation board. Please register ##
## to get your password for free. Send your serial number and ##
## your contact information to shdsl@teleconnect.de       ##
please enter password
password:
```

Please contact us at shdsl@teleconnect.de, and we can provide you your password. When you have changed the first password into your individual password the output will be deactivated (please see chapter 5.3.3).

The next password input will be delayed after wrong password.

If a user was successfully authenticated his session is exclusive - Simultaneous login attempts from other interfaces will be suppressed. Unused CLI sessions will be terminated after 5 minutes of inactivity.
5.3.2 CLI commands

The CLI commands are organized hierarchical in various directories. The amount of functions and menus in the CLI depends on the enabled features during compilation. For instance, it is possible to disable Networking (no package P5). Consequently, the CLI menu "iface net" is not available.

The following diagram gives an overview of the menu hierarchy.

Figure 13: CLI menu tree

Table 11 gives an overview of the CLI menus and their function.

Table 11: CLI menus

<table>
<thead>
<tr>
<th>Menu</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>/config/</td>
<td>Manage system configuration sets</td>
</tr>
<tr>
<td>/config/upload/</td>
<td>Upload new configuration sets</td>
</tr>
<tr>
<td>/iface/</td>
<td>Manage interfaces</td>
</tr>
<tr>
<td>/iface/net/</td>
<td>Manage network interface</td>
</tr>
<tr>
<td>/iface/shdsl/</td>
<td>Manage SHDSL interface</td>
</tr>
<tr>
<td>/sys/</td>
<td>Get the system information</td>
</tr>
<tr>
<td>/sys/syslog/</td>
<td>Access the systems error log</td>
</tr>
</tbody>
</table>
In addition to the menu specific functions, the following navigation functions are available in every menu:

- exit (exit the current menu and move up in the menu hierarchy)
- logout (end the CLI session)

To get a list of available subdirectories and functions in the current menu enter a question mark (“?”) directly following the prompt. It is also possible to get context sensitive help for your entered command. This can be achieved by pressing question mark after typing a command. Depending on whether the command refers to a directory of a function, a list of available subdirectories and functions or the function-specific help will be shown.

Figure 14: CLI example: config/show ?

When typing commands, it is always possible to shorten subdirectory or function names. By pressing <tab> the entered command will be completed. If a command is ambiguous CLI will provide a list of possible completions.

5.3.3 Password modification

Via command „sys/password“ the password can be changed into an individual one. The current password is needed to change it. It will be saved at flash memory after the confirmation of the new password and is active for the next login. The password needs between 5 and 20 characters.

Figure 15: CLI example: password modification

5.3.4 Configuring the system

Changing settings is done in two steps. First the configuration is changed and in a second step it must be activated. The show command provided in the /iface/shdsl directory will display both, the current configured and the active (currently running) settings. Differences between them are indicated by an “#” sign.
The following example shows SHDSL parameters, after the mode has been modified from
CO to CPE (with command: "iface/shdsl/mode cpe")

![CLI example for show modified SHDSL configuration](image)

Figure 16: CLI example for show modified SHDSL configuration

All configuration options related to the IP interface can be found in the directory /iface/net.
Network can either be used on SHDSL line side or system side (Ethernet port) of one
SHDSL Configuration.

The following example changes IP address, netmask, gateway and side of the network
interface.
Figure 17: CLI example for net configuration

```
/ #> iface/net/
  --> iface/net/
  /iface/net/ #> ip 102.168.1.2
  --> ip 102.168.1.2
  ip address set to 102.168.1.2.
  /iface/net/ #> netmask 255.255.255.0
  --> netmask 255.255.255.0
  netmask address set to 255.255.255.0.
  /iface/net/ #> gateway 192.168.1.1
  --> gateway 192.168.1.1
  gateway address set to 192.168.1.1.
  /iface/net/ #> side line
  --> side line
  network interface setting successful.
  /iface/net/ #> show
  --> show

  Network:                      configured    active
  - network enabled:           yes           yes
  - device MAC address:        02:10:E:0B:4C:0B:04
  - ip address:                102.168.1.2   # 10.10.10.1
  - netmask address:           255.255.255.0 # 255.255.255.0
  - gateway address:           192.168.1.1   # 0.0.0.0
  - vlan:                      off
  - network side:              SHDSL side    # system port

/iface/net/ #> check
  --> check
  all config setting combination OK
/iface/net/ #> activate
  --> activate
  activation in progress ...
  network config activate successful
/iface/net/ #> _
```
6 Operation

The following description gives an easy way to make a data connection using SHDSL. You need at least one Intel® SHDSL Chipset and one other standard compliant SHDSL modem. However, the easiest way to make a SHDSL connection is to use two SHDSL.EVB.1CH.

6.1 Start-up with two boards

1. Verify settings: DIP switch 2 on (for highest possible data rate up to 15 Mbps), all other DIP switches off, rotary switch on 0 (exempt you wish a special bit rate).
2. Switch on Device Mode (DIP switch 1) for master mode (STU-C) at one board, the other stays in slave mode (STU-R, DIP switch 1 off).
3. Connect both SHDSL connectors together. You can use a standard Ethernet patch cable.
4. Power up both boards, e.g. connect the micro USB plugs to PC.
   • The power LED, Error LED and the SHDSL LED go on.
   • After some seconds the amber Error LED and SHDSL LED go off.
   • The SHDSL LED starts blinking slowly after some seconds.
   • The SHDSL LED blinks fast during SHDSL Training.
   • The SHDSL LED is on if the SHDSL connection is established.
5. Disconnect the Ethernet cable from your computer; plug it into the Ethernet connector of the first board. Connect the wall outlet to the Ethernet connector to the second board.
   • The Ethernet LED is on if Ethernet connection was established.
   • The Ethernet LED starts blinking indicating Ethernet traffic.
6. Ready! You are using SHDSL for your data connection.
7 Using SHDSL.EVB.1CH as Module

7.1 Scope
The main goal of SHDSL.EVB.1CH is a simple evaluation platform of the Intel® SHDSL Chipset. Beside this it is possible to use SHDSL.EVB.1CH as SHDSL EFM module. That is why SHDSL.EVB.1CH is made in a small form factor, not typical for evaluation platforms. This may be interesting for small volume applications.

This chapter covers using SHDSL.EVB.1CH as a module.

7.2 Connection
Figure 18 shows the dimension of SHDSL.EVB.1CH and the location of the connectors (top side view, all values are millimeters). If SHDSL.EVB.1CH is used as module, it can power up via X601. Please connect pin 1 to + 5 V (4.7 … 6.0 V) and pin two to Ground. The SHDSL line should connect to X101 and the Ethernet interface to X202. Optionally, a control and monitor interface are available to connect at X401. If you want to use it, please connect it to serial interface of host processor. There is one mounting hole at EVB. It can be used for fixing the EVB to the host board via an M2.5 screw. The pin header connectors X102, X201 and X403 are not used and should be left open.

The pin header connectors X101, X202, X401 and X601 are not mounted by default and can be populated if necessary. The connectors X102, X201 and X403 are not used and should be left open.
Figure 18: Dimension of SHDSL.EVB.1CH and position of Connectors

### 7.3 Protection

The SHDSL.EVB.1CH is conceptualized as an evaluation platform. For this, SHDSL.EVB.1CH includes only basic protection. It is possible to add additional protection circuits on the host board to use SHDSL.EVB.1CH in rough environments. For further assistance you can contact Teleconnect at shdsl@teleconnect.de.
8 Literature


Appendix A. Quick Start-up guide

The following description provides an easy way to establish a data connection using SHDSL. You need at least one SHDSL.EVB.1CH and one other standard compliant SHDSL EFM modem. However, the easiest way to make a SHDSL connection is to use two SHDSL.EVB.1CH. The following sections are describing two common use cases.

Realize Long-Reach-Ethernet Connectivity

- Check your existing application for an existing Ethernet (ETH) interface and connect to EVB.
- Select bit rate and operation mode
  - standard (192…5696 Kbps) or extended bit rate (64…15336 Kbps),
  - master mode (STU-C) or slave mode (STU-R).
- Connect 5 V power supply to the Micro USB connector.
  - The power LED, Error LED and the SHDSL LED go on.
  - After some seconds the amber Error LED and SHDSL LED go off.
  - The SHDSL LED starts blinking slowly after some seconds.
- Connect SHDSL lines.
  - The SHDSL LED blinks fast during SHDSL Training.
  - The SHDSL LED is on if the SHDSL connection is established.
- Ready! You are using SHDSL for your data connection.

Start-up using two boards

1. Verify settings: DIP switch 2 on (for highest possible data rate up to 15 Mbps), all other DIP switches off, rotary switch on 0 (exempt you wish a special bit rate).
2. Switch on Device Mode (DIP switch 1) for master mode (STU-C) at one board, the other stays in slave mode (STU-R, DIP switch 1 off).
3. Connect both SHDSL connectors together. You can use a standard ETH patch cable.
4. Power up both boards. E.g. connect the micro USB plugs to PC.
   - The power LED, Error LED and the SHDSL LED go on.
   - After some seconds the amber Error LED and SHDSL LED go off.
   - The SHDSL LED starts blinking slowly after some seconds.
   - The SHDSL LED blinks fast during SHDSL Training.
   - The SHDSL LED is on if the SHDSL connection is established.
5. Disconnect the Ethernet cable from your computer; plug it into the Ethernet connector of the first board. Connect the wall outlet to the Ethernet connector to the second board.
   - The Ethernet LED is on if Ethernet connection was established.
   - The Ethernet LED starts blinking indicating Ethernet traffic.
6. Ready! You are using SHDSL for your data connection.

Table 12: Selection of bit rates with DIP switch and rotary

<table>
<thead>
<tr>
<th>Switch position</th>
<th>Extended Rates (DIP switch 2)</th>
<th>Line probing (PMMS)</th>
<th>Bitrate [Kbps]</th>
<th>PAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (default)</td>
<td>On / Off</td>
<td>Enabled</td>
<td>64..15288 / 192..5696</td>
<td>Auto</td>
</tr>
<tr>
<td>1*</td>
<td>On / Off</td>
<td>Disabled</td>
<td>64* / 192</td>
<td>4 / 16</td>
</tr>
<tr>
<td>2*</td>
<td>On / Off</td>
<td>Disabled</td>
<td>192* / 384</td>
<td>4 / 16</td>
</tr>
<tr>
<td>3*</td>
<td>On / Off</td>
<td>Disabled</td>
<td>192* / 512</td>
<td>8 / 16</td>
</tr>
<tr>
<td>4*</td>
<td>On / Off</td>
<td>Disabled</td>
<td>2496* / 768</td>
<td>4 / 16</td>
</tr>
<tr>
<td>5*</td>
<td>On / Off</td>
<td>Disabled</td>
<td>5056* / 1536</td>
<td>8 / 16</td>
</tr>
<tr>
<td>6*</td>
<td>On / Off</td>
<td>Disabled</td>
<td>7616* / 2048</td>
<td>16</td>
</tr>
<tr>
<td>7*</td>
<td>On / Off</td>
<td>Disabled</td>
<td>10176* / 2304</td>
<td>32</td>
</tr>
<tr>
<td>8*</td>
<td>On / Off</td>
<td>Disabled</td>
<td>12736* / 3072</td>
<td>64 / 32</td>
</tr>
<tr>
<td>9*</td>
<td>On / Off</td>
<td>Disabled</td>
<td>15288* / 5696</td>
<td>128 / 32</td>
</tr>
</tbody>
</table>

* The configuration of fixed bitrates in extended rates mode is only possible by SHDSL Master (CO mode, STU-C). The SHDSL Slave (CPE mode, STU-R) ignores the switch position and always uses line probing (switch position 0).