TEXAS INSTRUMENTS

User's Guide

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XDS110 EnergyTrace™ HDR Debug Probe Add-On

The XDS110 ETHDR is an add-on expansion module to the XDS110 Debug Probe that provides an enhanced HDR (high dynamic range) EnergyTrace™ (ET) capability to the capability that exists on the base XDS110 Debug Probe.

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1 Overview

The XDS110 ETHDR is an add-on expansion module to the XDS110 Debug Probe. It provides an enhanced HDR EnergyTrace (ET) capability to the capability that exists on the base XDS110 Debug Probe.

1.1 XDS110 ETHDR Feature Summary

- Target supplied power From 1.8 V to 3.6 V
  - Up to 800 mA
- Power profiling features
  - Support for TI EnergyTrace HDR in two ranges:
    - 1 µA to 120 mA – Higher accuracy but lower peak current
    - 1 µA to 800 mA – Higher peak current but lower accuracy
  - Current sampling at 256k sample per second

1.2 XDS110 ETHDR System Summary

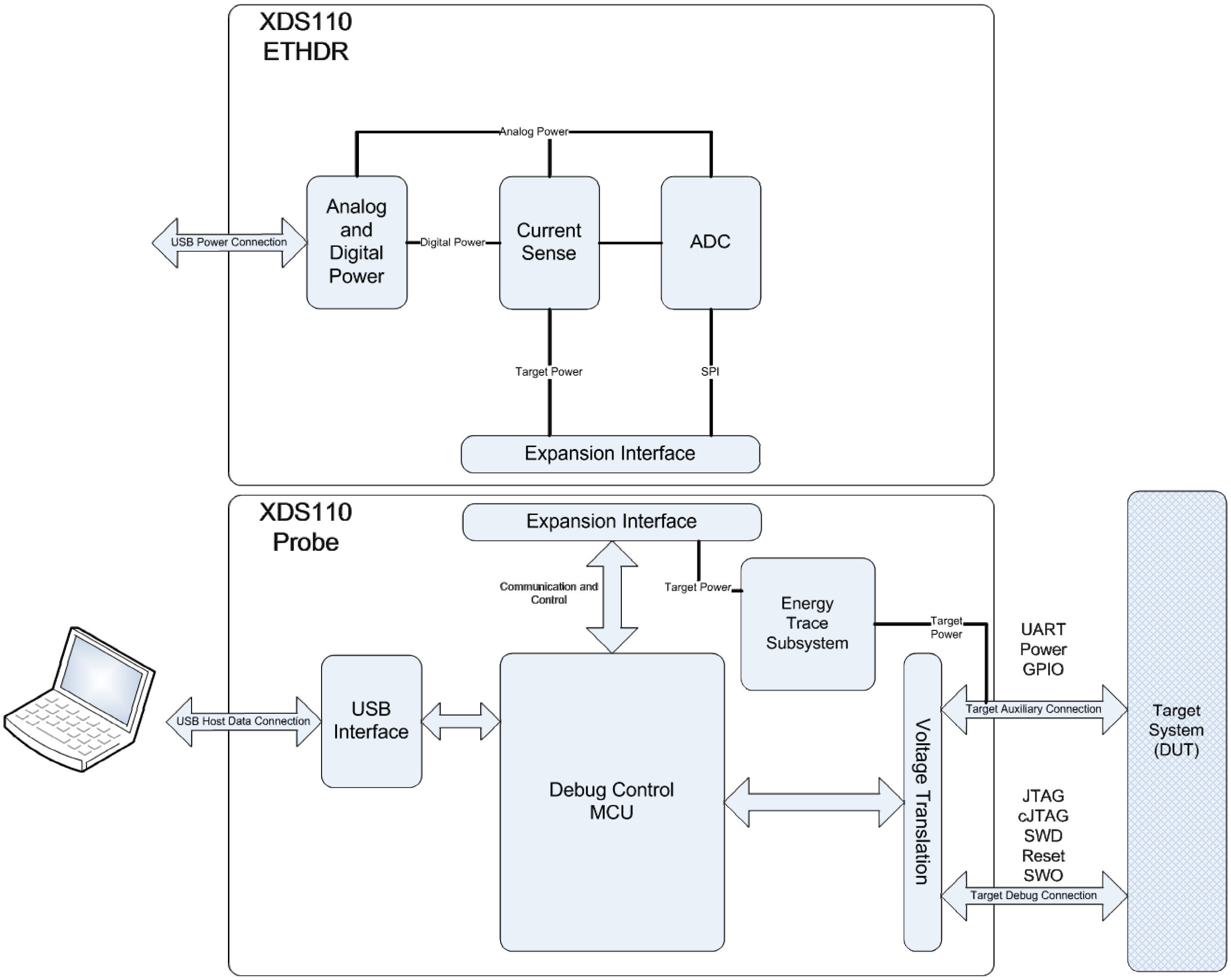
The following features are for the combined XDS110 Probe with the XDS110 ETHDR system:

- Host platforms supported:
  - The system supports various versions of Windows®, OS X™, and Linux® operating systems. Consult the documentation for CCS and other development environments for more details.
- IDE versions supported:
  - TI CCS v7.0 and later
  - IAR (see IAR documentation)
  - Keil (see Keil documentation)
- TI platforms, devices, and ISAs supported:
  - MSP432 MCUs
  - CC26xx/13xx Wireless MCUs
  - CC32xx/31xx Wi-Fi® MCUs
  - TM4C12x MCUs

1.3 XDS110 ETHDR Overview

Figure 1 shows a high-level diagram of the major functional areas and interfaces of the XDS110 Probe XDS110 ETHDR system. Details of these are described in Section 2.

Figure 1. XDS110 Probe High-Level Block Diagram



1.4 XDS110 ETHDR Parts List

The XDS110 ETHDR system consists of the following hardware:

- The XDS110 ETHDR add-on pod
- USB cable (only used for auxiliary power to the ETHDR)

1.5 PCB Breakoff Sections and Compliance

The different sections of the EVM may be broken apart for ease of prototyping and development. Note that breaking apart the sections voids the warranty. In addition, the stated performance and compliance specifications of the EVM cannot by guaranteed when sections have been broken apart.

If provided, the shielded USB cable is longer than 3m in length. If not, and one is to be purchased for use with this EVM, it is required to be no logner than 3m to retain the stated performance and compliance.

CAUTION

This debug probe contains components that can potentially be damaged by electrostatic discharge. Always transport and store the debug probe in the supplied ESD bag when not in use. Handle using an antistatic wristband. Operate on an antistatic work surface. For more information on proper handling, refer to Electrostatic Discharge (ESD) (SSYA010).

1.6 Environmental Information

Supply voltage: 4.75 V to 5.5 V at 500 mA

Temperature: 0°C to 40°C

Humidity: 50% RH

2 Probe Interfaces

2.1 USB Power Interface

Additional power for the XDS110 ETHDR add-on is provided through a female Micro-USB B-type connector. The USB interface provides additional power to the entire system, and no additional functionality. For target systems drawing more than 400 mA, connect this USB connector to a power source providing at least 500 mA at 5 V DC.

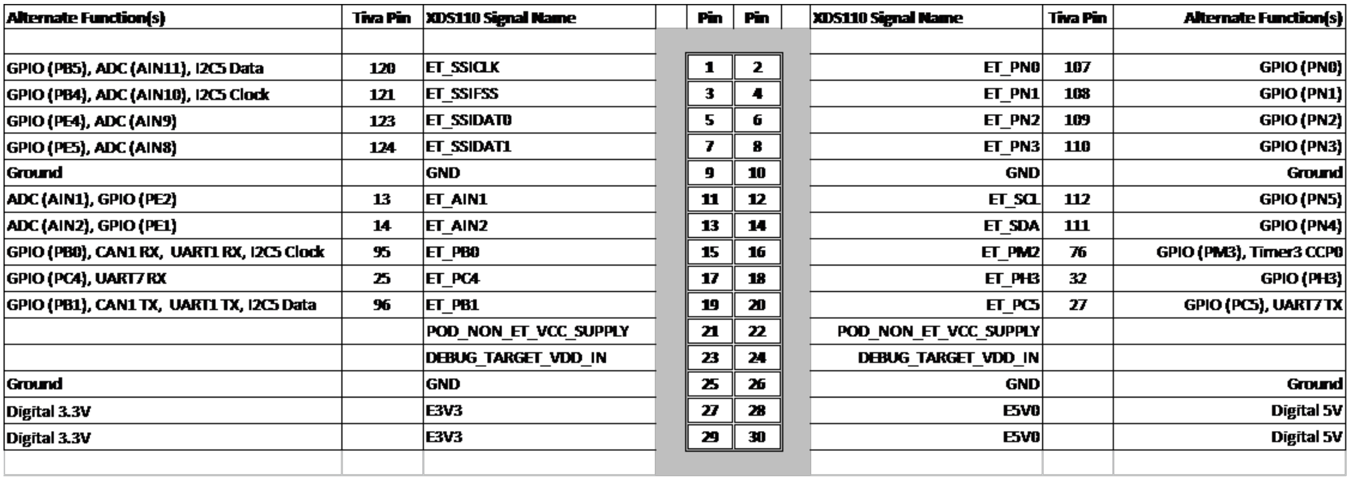
2.2 Probe Expansion Header

The XDS110 ETHDR interfaces to the XDS110 system through the probe expansion header. The header exposes a number of functional interfaces of the TM4C129 debug control CPU, as shown in Figure 2. The use of these signals is reserved for the ETHDR or other add-on modules designed by TI, or designated third parties.

2.2.1 Physical Connection for the Expansion Interface

The XDS110 ETHDR supports a 30-pin IDC male socket with .100-inch pitch. The signal mapping for this connection can be found in Figure 2.

Figure 2. Expansion Header Signal Mapping



Alternate Function(s)	Tiva Pin	XDS110 Signal Name	Pin	Pin	XDS110 Signal Name	Tiva Pin	Alternate Function(s)
GPIO (PB5), ADC (AIN11), I2C5 Data	120	ET_SSICLK	1	2	ET_PN0	107	GPIO (PN0)
GPIO (PB4), ADC (AIN10), I2C5 Clock	121	ET_SSIFSS	3	4	ET_PN1	108	GPIO (PN1)
GPIO (PE4), ADC (AIN9)	123	ET_SSIDAT0	5	6	ET_PN2	109	GPIO (PN2)
GPIO (PE5), ADC (AIN8)	124	ET_SSIDAT1	7	8	ET_PN3	110	GPIO (PN3)
Ground		GND	9	10	GND		Ground
ADC (AIN1), GPIO (PE2)	13	ET_AIN1	11	12	ET_SCL	112	GPIO (PN5)
ADC (AIN2), GPIO (PE1)	14	ET_AIN2	13	14	ET_SDA	111	GPIO (PN4)
GPIO (PB0), CAN1 RX, UART1 RX, I2C5 Clock	95	ET_PB0	15	16	ET_PM2	76	GPIO (PM3), Timer3 CCP0
GPIO (PC4), UART7 RX	25	ET_PC4	17	18	ET_PH3	32	GPIO (PH3)
GPIO (PB1), CAN1 TX, UART1 TX, I2C5 Data	96	ET_PB1	19	20	ET_PC5	27	GPIO (PC5), UART7 TX
		POD_NON_ET_VCC_SUPPLY	21	22	POD_NON_ET_VCC_SUPPLY		
		DEBUG_TARGET_VDD_IN	23	24	DEBUG_TARGET_VDD_IN		
Ground		GND	25	26	GND		Ground
Digital 3.3V		E3V3	27	28	E5V0		Digital 5V
Digital 3.3V		E3V3	29	30	E5V0		Digital 5V

3 Functional Description and Operation

3.1 Physical Connection

The XDS110 ETHDR is connected to the XDS110 Debug Probe by stacking the enclosures, as shown in Figure 3 and Figure 4.

Figure 3. Stacking the ETHDR on the XDS110 Probe

Figure 4. The XDS110 Probe and ETHDR System

The target power and debug connections are managed through the existing debug and AUX connectors on the XDS110 Probe. No direct connection between the ETHDR and the debug target exists.

3.2 Basic Setup for the Debug Connection

The presence of the XDS110 ETHDR does not impact the basic debug connectivity of the system, and the instructions in Section 3.1 of the *XDS110 Debug Probe Users Guide* (SPRUI94) are still valid.

3.2.1 Probe Supplied Power and ETHDR

The addition of the ETHDR enables the XDS110 Debug Probe to supply current up to 800 mA. No additional steps are required to support this, and the power configuration steps in Section 3.1.2.2. of the *XDS110 Debug Probe Users Guide* (SPRUI94) are still valid.

3.3 Energy Trace HDR

3.3.1 Introduction

When combined with the XDS110 Debug Probe, the XDS110 ETHDR provides an enhanced system that can be used for measuring the current consumption of the target. These current consumption measurements can be used to develop power and energy use profiles of the target system. The ETHDR expands the ET capabilities of the XDS110 Debug Probe, and these may be required for higher current use cases, or when precise temporal correlation of power transitions is required. Table 1 shows a high level comparison of the capabilities of the two ET capture types.

Table 1. Base ET and ETHDR Comparison

Capability	Base ET on XDS110 Probe	ETHDR
Measurement range	500 nA to 100 mA	• 1 µA to 120 mA – low current high accuracy • 1 µA to 800 mA – high current range lower accuracy range
Sampling frequency	2 ksps	256 ksps
Supply ripple	Some ripple due to SW DCDC	None

3.3.2 Specifications

Other than accuracy and sampling frequency, the specifications for a system utilizing the XDS110 ETHDR are identical to the ET specifications found in the *XDS110 Debug Probe Users Guide* (SPRUI94).

3.3.2.1 Accuracy

Table 2 lists the accuracy and range of the ETHDR.

Table 2. ETHDR Measurement Performance

Low Range High Accuracy		High Range Low Accuracy	
Range	Accuracy	Range	Accuracy
1 µA to 15 µA	±700 nA	1 µA to 70 µA	±3.5 µA
15 µA to 120 mA	±5%	70 µA to 800 mA	±5%

3.3.2.2 Sampling Frequency

The XDS110 ETHDR samples target current consumption a 256k samples per second. Thus, the system can reliably catch target power transitions that last 10 microseconds or longer.

3.3.3 Hardware Setup

Other than the stacked connection of the XDS110 Probe and the XDS110 ETHDR, the hardware setup is identical to that which is described in Section 3.1 of the *XDS110 Debug Probe Users Guide* (SPRUI94).

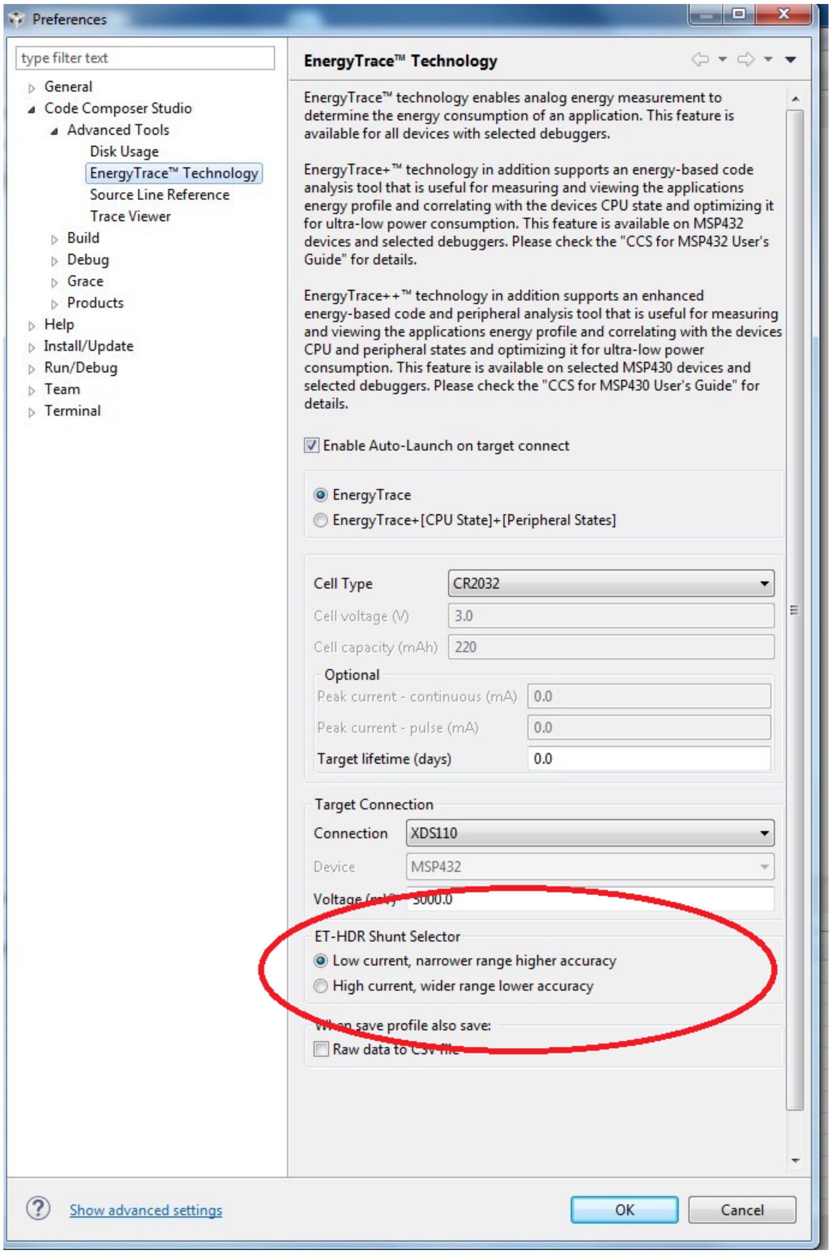
3.3.4 XDS110 ETHDR Usage in Code Composer Studio

When the XDS110 ETHDR is attached to the XDS110 Debug Probe, the ETHDR is used as the power measurement system. The procedure for configuring an ET session, capturing, and displaying data are identical to that defined in Section 3.6 of the *XDS110 Debug Probe Users Guide* (SPRUI94), with the exception noted below.

3.3.4.1 CCS Setup for ETHDR

The ETHDR supports two capture ranges, as noted above. The selection changes the size of the shunt resistor used to measure the target current consumption. The desired range must be specified in the EnergyTrace Technology Preferences dialog that is reached through CCS → Advanced Tools → EnergyTrace Technology. Figure 5 shows this dialog, and highlights the selection radio buttons.

Figure 5. Shunt Range Selection



EnergyTrace™ Technology

EnergyTrace™ technology enables analog energy measurement to determine the energy consumption of an application. This feature is available for all devices with selected debuggers.

EnergyTrace+™ technology in addition supports an energy-based code analysis tool that is useful for measuring and viewing the applications energy profile and correlating with the devices CPU state and optimizing it for ultra-low power consumption. This feature is available on MSP432 devices and selected debuggers. Please check the "CCS for MSP432 User's Guide" for details.

EnergyTrace++™ technology in addition supports an enhanced energy-based code and peripheral analysis tool that is useful for measuring and viewing the applications energy profile and correlating with the devices CPU and peripheral states and optimizing it for ultra-low power consumption. This feature is available on selected MSP430 devices and selected debuggers. Please check the "CCS for MSP430 User's Guide" for details.

☑ Enable Auto-Launch on target connect

● EnergyTrace
○ EnergyTrace+[CPU State]+[Peripheral States]

Cell Type: CR2032
Cell voltage (V): 3.0
Cell capacity (mAh): 220

Optional
Peak current - continuous (mA): 0.0
Peak current - pulse (mA): 0.0
Target lifetime (days): 0.0

Target Connection
Connection: XDS110
Device: MSP432
Voltage (mV): 3000.0

ET-HDR Shunt Selector
● Low current, narrower range higher accuracy
○ High current, wider range lower accuracy

When save profile also save:
☐ Raw data to CSV file

3.3.5 XDS110 ETHDR Usage Usage With Command Line Utility – soctune

The Windows-based CCS installation has an interactive command line utility called stune which can be used for capturing EnergyTrace data to a CSV file. The procedure for using stune is the same as defined in Section 3.6.5 of the *XDS110 Debug Probe Users Guide* (SPRUI94), with the addition that the ETHDR capture range can be specified using the range option –r “lo | hi” with the energytrace command. The “lo” range selection maps to “Low current, narrower range higher accuracy” and the “hi” range selection maps to “High current, wider range lower accuracy”. If the range option is not specified, the range is set to “lo” by default.

For example:

To capture 5 seconds of EnergyTrace with the range set to low range enter the following command:

```
energytrace -D 5000 -o output.csv -r lo et
```

The –D option specified the time in milliseconds.

The –o option specifies the output filename. The file format is fixed as CSV.

The –r option specifies the range low (lo) or high (hi).

To capture 5 seconds of EnergyTrace with the range set to high range enter the following command:

```
energytrace -D 5000 -o output.csv -r hi et
```

The –D option specified the time in milliseconds.

The –o option specifies the output filename. The file format is fixed as CSV.

The –r option specifies the range low (lo) or high (hi).

Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

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