Ethernet_1
for KIT_AURIX_TC375_LK

Echo application via TCP/IP

AURIX™ TC3xx Microcontroller Training
V1.0.0

Please read the Important Notice and Warnings at the end of this document

Scope of work

The Gigabit Ethernet Media Access Controller (GETH) module and the Lightweight IP (LwIP) stack are used to implement a network echo application.

The TCP/IP protocol provided by the Lightweight IP (LwIP) is used to exchange strings between the board and a remote client terminal.
The board obtains an IP address and publishes its hostname using the DHCP protocol.
The System Timer Module (STM) is used to update the internal LwIP timers.
The Asynchronous/Synchronous Interface (ASCLIN) module is used for debug logging.

Introduction

- The Gigabit Ethernet Media Access Controller (GETH) implements a data link layer according to IEEE-802.3 standard, allowing the board to connect to a Local Area Network (LAN) through the onboard Ethernet PHY interface

- The PHY is the physical interface transceiver, which implements the physical layer and is an external integrated circuit mounted on the board

- Higher level protocols like the Internet Protocol (IP), the Transmission Control Protocol (TCP) and the Dynamic Host Configuration Protocol (DHCP) are implemented by software

Introduction

› The following table relates the ISO/OSI model levels with their implementation in this training

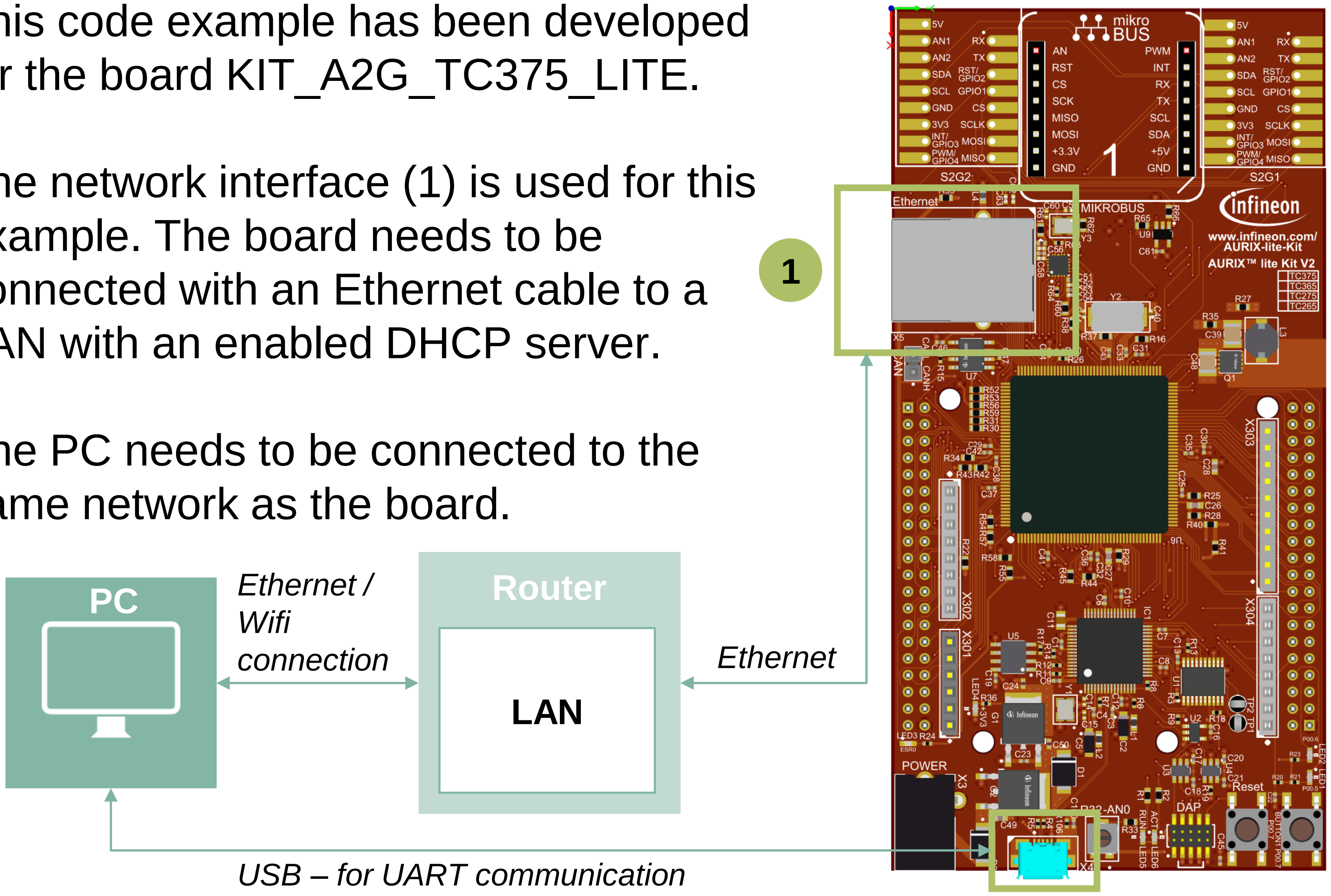
Layer	ISO/OSI Model Level	Used protocol	Implemented by
7 – High Level	Application	ASCII characters	Echo application
6	Presentation	Not used	
5	Session	Not used	
4	Transport	Transmission Control Protocol	LwIP stack
3	Network	Internet Protocol	LwIP stack
2	Data Link	Media Access Control	AURIX™ GETH MAC
1 – Low Level	Physical	Electrical signals	PHY chip

Hardware setup

This code example has been developed for the board KIT_A2G_TC375_LITE.

The network interface (1) is used for this example. The board needs to be connected with an Ethernet cable to a LAN with an enabled DHCP server.

The PC needs to be connected to the same network as the board.



Implementation

Link between LwIP and the GETH module

› To enable the LwIP stack to use the GETH module as network hardware, it is needed to implement the necessary drivers according to the LwIP interfaces. The driver implementation is contained in the folder ***Libraries/Ethernet/lwip/port***

Configuration of LwIP

› LwIP is configured by means of macros, which can be found in the file ***Configurations/lwipopts.h***

› This project makes use of the TCP protocol (enabled by default) and uses the LwIP “raw” API (Netconn and Socket APIs are disabled, macros ***LWIP_NETCONN*** and ***LWIP_SOCKET***)

› The DHCP Protocol is used to obtain an IP address by a DHCP server in the network (macro ***LWIP_DHCP***)

› Operating System support by the LwIP is disabled, a single thread will be used (macro ***NO_SYS***)

Implementation

Initialization of GETH module

› The Gigabit Ethernet module is enabled with the function ***IfxGeth_enableModule()*** from the iLLD ***IfxGeth_Eth.h***

Initialization of LwIP

› LwIP is initialized calling the function ***Ifx_Lwip_init()*** from the driver implementation ***Ifx_Lwip.h***

LwIP operation

› LwIP stack functions and protocols are triggered by its internal timers, which need to be regularly increased. LwIP timers are increased every millisecond by an ISR (***updateLwIPStackISR()***) triggered by the STM module

› After updating the timers, the LwIP can execute its active protocols (e.g. DHCP, TCP, ARP) calling the function ***Ifx_Lwip_pollTimerFlags()*** and read the received data (function ***Ifx_Lwip_pollReceiveFlags()***)

Implementation

Debugging through UART interface

In this tutorial, the UART connection is used to make the debugging more convenient and easier to understand.

› The LwIP macro ***LWIP_PLATFORM_DIAG***, which is used by the debug macro ***LWIP_DEBUG*** to print a debug message, has been redefined in the LwIP driver implementation (file ***Libraries/Ethernet/lwip/port/include/arch/cc.h***) to use UART communication through the AURIX™ ASCLIN module

› Any debug message and state message can be read by connecting the board through a serial terminal

Implementation

The Echo application

› The application layer, which implements the “Echo“ logic, is contained in the file ***Echo.c***

› The implementation is based on the LwIP RAW (or native) API, which allows the maximum performance and lowest memory footprint. On the other side the RAW API is not thread safe, and shall not be used from multiple threads. The RAW API execution is driven by callback functions which are invoked when application-related events occur

› The following callbacks function are registered at initialization time:
  - ***echoAccept()***: Executed every time a new network connection is established
  - ***echoRecv()***: Executed every time data is received from the remote client
  - ***echoSent()***: Executed every time data is successfully sent to the remote client
  - ***echoError()***: Executed in case of an unrecoverable network error
  - ***echoPoll()***: Executed periodically according to the LwIP internal TCP timer

Implementation

- The state of every Echo session is stored in the ***EchoSession*** structure. In particular, it contains the following information:
  - The ***EchoSession.state*** parameter, which describes if the session is currently initializing (***ES_ACCEPTED***), already receiving data (***ES_RECEIVING***), or is going to be disposed (***ES_CLOSING***)

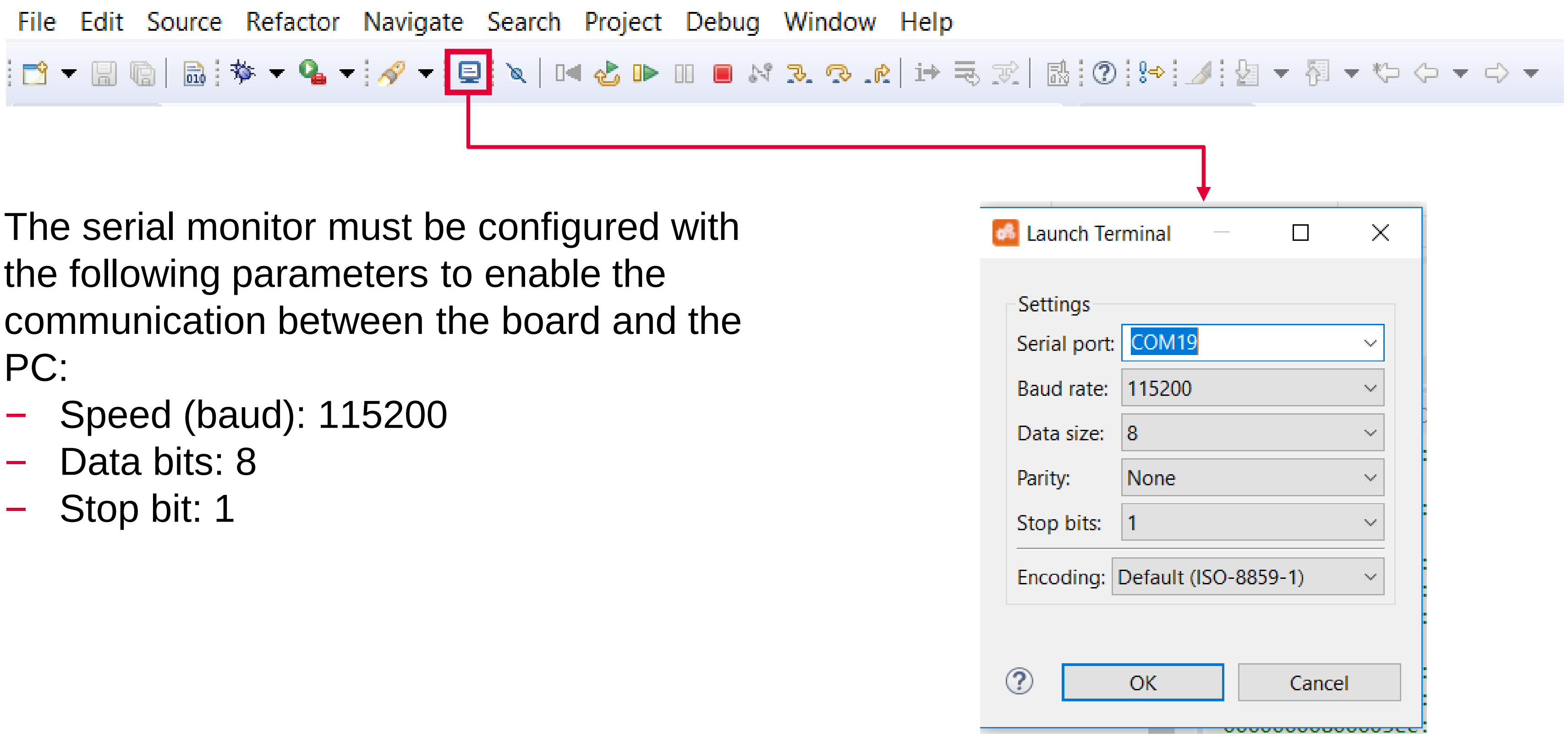
  - A pointer to the TCP control block which was assigned to this session (***EchoSession.pcb***). This represents the TCP connection managed by LwIP, which is used to send and receive data

  - A pointer to a chain of packet buffers (***EchoSession.p***) that stores the raw data sent by the remote client which has been received and saved in memory by LwIP, but has not been yet processed by the Echo implementation

  - The processed data (***EchoSession.storage***) which is waiting to be sent back to the remote client, and the index of the next free position where the new received data can be written to (***EchoSession.nextFreeStoragePos***)

Run and Test

- For this training, a serial monitor is required for communicating with the device. The monitor can be opened inside the AURIX™ Development Studio using the following icon:



Settings

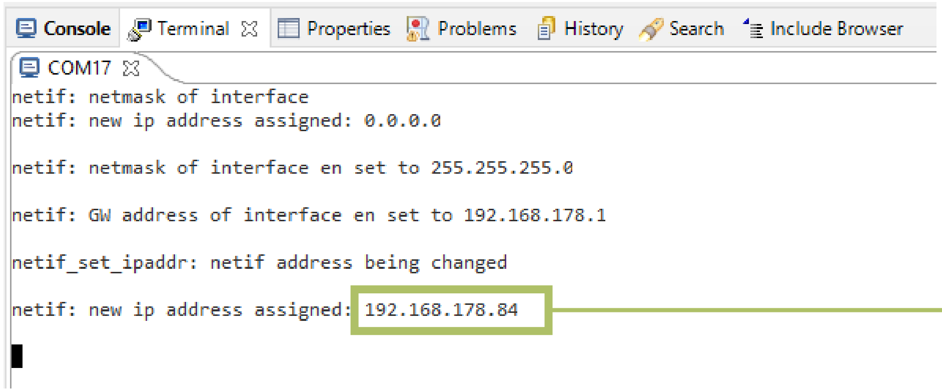
Serial port: COM19
Baud rate: 115200
Data size: 8
Parity: None
Stop bits: 1
Encoding: Default (ISO-8859-1)

- The serial monitor must be configured with the following parameters to enable the communication between the board and the PC:
  - Speed (baud): 115200
  - Data bits: 8
  - Stop bit: 1

Run and Test

After code compilation and flashing the device, perform the following steps:

- Ensure that the connections presented in the Hardware Setup slide are established
- Open a connection with the board using the serial terminal with the previous configuration
- Resume the debug session and observe the terminal output to verify the board was successful in obtaining an IP address from the DHCP server:

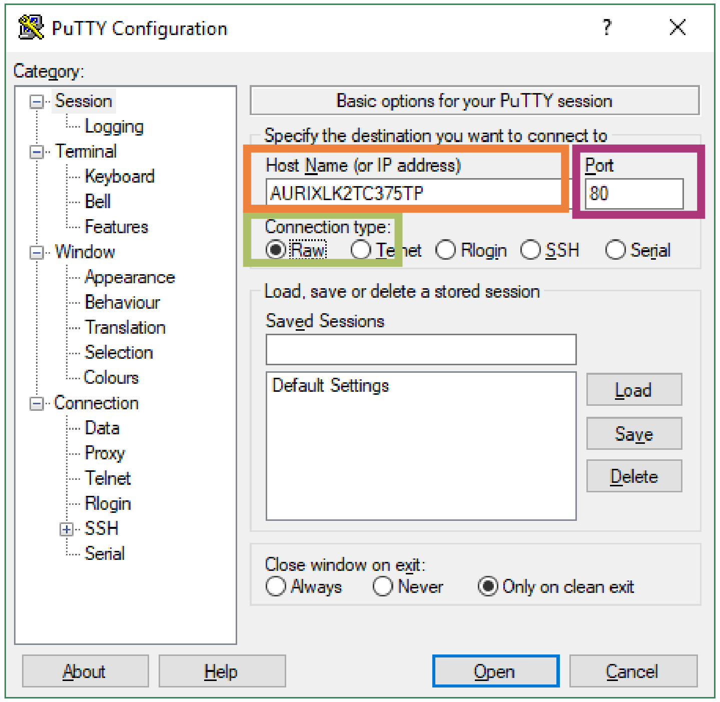


```
netif: netmask of interface
netif: new ip address assigned: 0.0.0.0

netif: netmask of interface en set to 255.255.255.0

netif: GW address of interface en set to 192.168.178.1

netif_set_ipaddr: netif address being changed

netif: new ip address assigned: 192.168.178.84
```

e.g. The board has been assigned the IP address 192.168.178.84

Run and Test

› Connect to the board using a protocol which supports ASCII characters. For this example **PuTTY** is used, which supports data streams of RAW characters.


PuTTY Configuration

Category:

- Session
  - Logging
- Terminal
  - Keyboard
  - Bell
  - Features
- Window
  - Appearance
  - Behaviour
  - Translation
  - Selection
  - Colours
- Connection
  - Data
  - Proxy
  - Telnet
  - Rlogin
  - SSH
  - Serial

Basic options for your PuTTY session

Specify the destination you want to connect to

Host Name (or IP address): AURIXLK2TC375TP

Port: 80

Connection type: [✓ Raw] Telnet Rlogin SSH Serial

Load, save or delete a stored session

Saved Sessions

Default Settings

Close window on exit: Always Never [✓ Only on clean exit]

› The connection type must be RAW

› The port needs to be specified

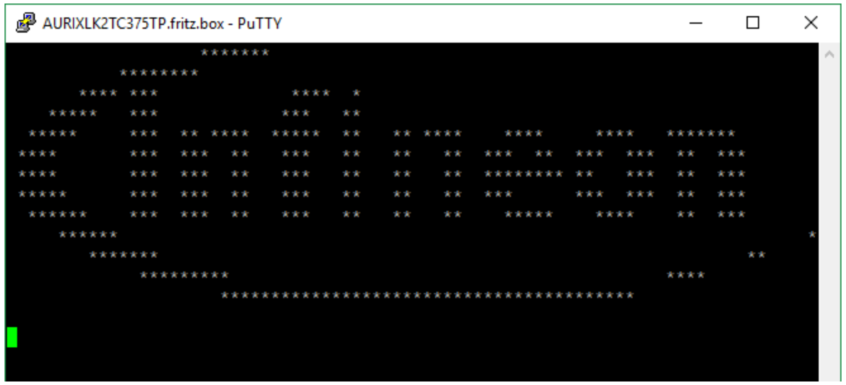
› The board can be addressed using its IP address or its hostname

Note: The hostname option may not work if it is not supported by the network gateway

› Press “Open” to establish a network connection with the board

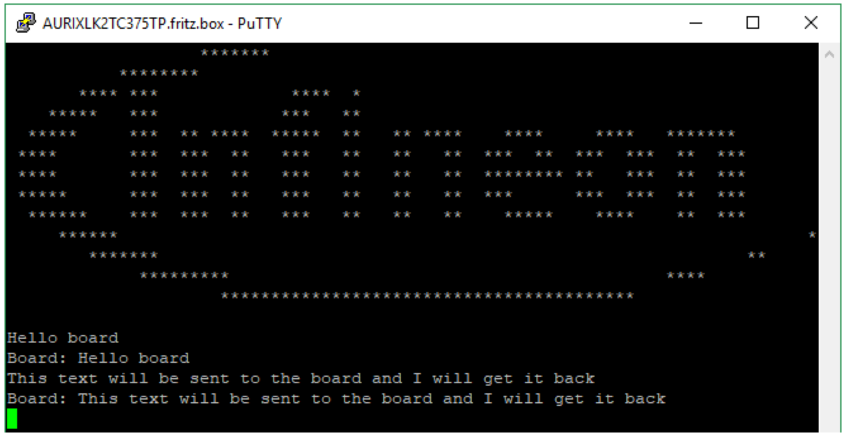
Run and Test

› The board sends the Infineon Logo and waits for an input



```
                   *******
           ********
       **** ***             ****  *
    *****   ***            ***   **
  *****     ***  ** ****  *****  **   ** ****    ****     ****   *******
 ****       ***  ***  **   ***   **   **   **  ***  **  ***  ***  **  ***
 ****       ***  ***  **   ***   **   **   **  ******** **   ***  **  ***
 *****      ***  ***  **   ***   **   **   **  ***      ***  ***  **  ***
  ******    ***  ***  **   ***   **   **   **    *****    ****    **  ***
     ******                                                                    *
        *******                                                          **
             *********                                           ****
                     *****************************************
```

› Write any text and press “Enter”: the board receives it and sends it back through the network



```
                   *******
           ********
       **** ***             ****  *
    *****   ***            ***   **
  *****     ***  ** ****  *****  **   ** ****    ****     ****   *******
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 *****      ***  ***  **   ***   **   **   **  ***      ***  ***  **  ***
  ******    ***  ***  **   ***   **   **   **    *****    ****    **  ***
     ******                                                                    *
        *******                                                          **
             *********                                           ****
                     *****************************************

Hello board
Board: Hello board
This text will be sent to the board and I will get it back
Board: This text will be sent to the board and I will get it back
```

References

- AURIX™ Development Studio is available online:
- https://www.infineon.com/aurixdevelopmentstudio
- Use the „*Import...*“ function to get access to more code examples.

- More code examples can be found on the GIT repository:
- https://github.com/Infineon/AURIX_code_examples

- For additional trainings, visit our webpage:
- https://www.infineon.com/aurix-expert-training

- For questions and support, use the AURIX™ Forum:
- https://www.infineonforums.com/forums/13-Aurix-Forum

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