eBLOCKS®

LEARN·DESIGN·BUILD

Embedded Internet Communications

EB921-80-07

MATRIX

www.matrixmultimedia.com

EB921

TCP/IP Solution

Course notes

Contents

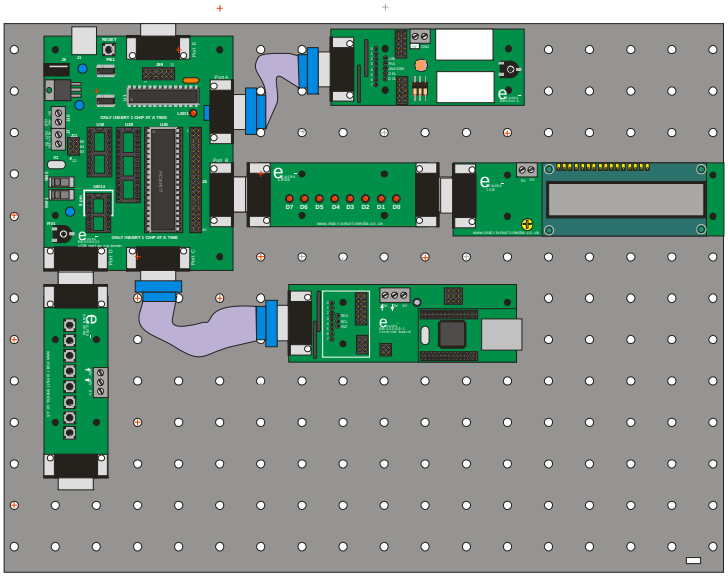
1 Getting started

The following information is designed to aid you in getting the E-blocks internet solution up and running.

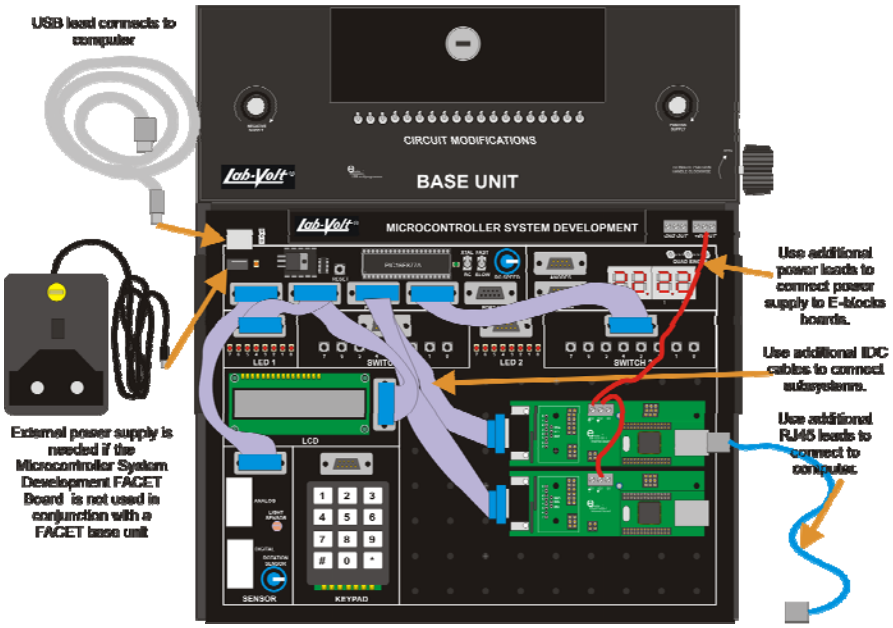
1.1 Required hardware

This document is designed for use with either of the following hardware systems:

- EB643 E-blocks internet solution



- FACET board with additional EB-023 IINTERNET BOARD(s)



Install and setup instructions for the E-blocks internet solution can be found on the datasheets supplied on the E-Blocks support section of the Matrix website.
http://www.matrixmultimedia.com/eblocks/index.php

1.2 Test routine

A test routine for the internet board and internet solution is supplied on the internet solution CD in the Test_file folder. Details on testing the internet solution can be found in the internet board datasheet.

Additional test routines are available for the other E-blocks on the E-blocks support section of the Matrix website: http://www.matrixmultimedia.com/eblocks/index.php

1.3 Required software

The example programs supplied on the TCP/IP Solutions CD require Flowcode V4.1 or higher to be installed on the host PC. A compatible version of Flowcode is supplied with the solution. Please refer to the contents of the Flowcode CD for instructions on installation and operation.

1.4 Additional software

Additional software to aid in learning TCP/IP is included in the Additional_Software folder, and its subfolders, on the FC487 CD supplied as part of the E-block internet solution.
The additional software includes copies of:

- Ethereal Network traffic analyzer
- Excalibur packet injector

Install instructions and details of the additional software will be found in the Additional_Software folder.

1.5 Documentation

Documentation for the various E-blocks and other items supplied as part of the internet solution is provided on the E-blocks members' area of the Matrix Multimedia web site:
http://www.matrixmultimedia.com/eblocks/index.php

1.6 Examples and exercises

The TCP/IP Solution CD contains a folder of example and exercise programs that can be used in conjunction with this document

1.7 Disclaimer

The information contained here is correct at time of going to press (Jan 2007), but may be superseded or changed at a later date. If this information is superseded a revised Getting started document will be issued with the E-blocks internet solution.

2 Introduction

The TCP/IP Course is designed to introduce you to the concepts required to understand the communication protocols generally referred to as TCP/IP, including the Ethernet, TCP, IP, UDP and other protocols.

This course is carried out using Flowcode, which is shipped with the TCP/IP solution.
Flowcode uses the TCP/IP component which has a number of properties and macros to allow the student to build up the system they require. This allows students to learn about TCP/IP without getting bogged down in the problems of programming in C or a lower level language.

2.1 Using this course

This course goes through the various layers of TCP/IP starting with the lowest physical communication layer and moving up to application data communications. The course covers the various TCP/IP layers and protocols and the Flowcode TCP_IP component modes used to implement them.

A number of exercises are included along with notes on how implement the exercise in Flowcode. For the first few protocols the notes are relatively extensive, forming a kind of walkthrough of the exercise. For later exercises the notes become more geared towards explaining specifics and how the protocol differs from those previously covered. By that stage the student should have sufficient understanding of the basics involved to complete the task without extensive notes. Example solutions are provided for the exercises for demonstration, discussion and use as a starting point for further programming.

2.2 Who this course is aimed at

This course is aimed at two main groups: Electronics technicians seeking to use TCP/IP communications and Network technicians seeking to understand TCP/IP data structure.

- Electronics technicians will generally have some experience with Microcontrollers, and will be mostly concerned with implementing TCP/IP communications from a practical point of view – i.e. how to create programs and send data.
  The general goal of the Electronics technician will be to send messages.
- Network technicians and Computer will be more concerned with gaining an understanding of the communications process itself i.e. datagram's and frameworks, and how this relates to the data viewable with network analyzer tools.
  The general goal of the Network technician will be to understand and debug messages on the network, and to troubleshoot communications errors.

Both groups are catered for in equal measure, with both the theory and the practical aspects being covered. It will be up to the teacher involved to place the emphasis during teaching.

3 TCP/IP basic concepts

3.1 What is TCP/IP?

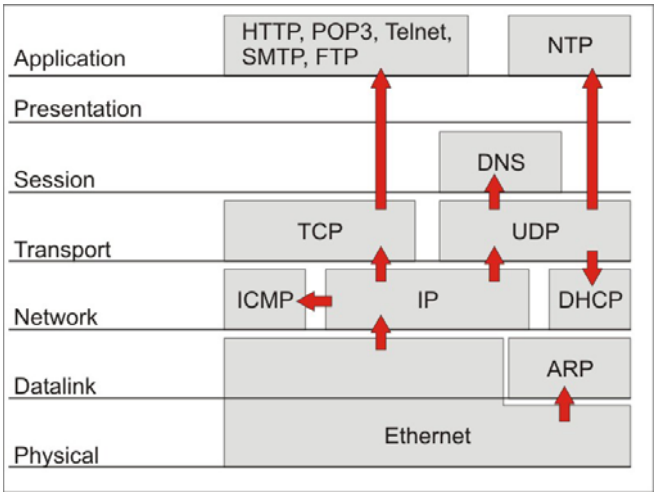
TCP stands for **T**ransmission **C**ontrol **P**rotocol. And IP stands for **I**nternet **P**rotocol. Some other common acronyms that we will be using throughout the course include: MAC – **M**edia **A**ccess **C**ontrol, UDP – **U**ser **D**atagram **P**rotocol, ICMP – **I**nternet **C**ontrol **M**essage **P**rotocol and ARP – **A**ddress **R**esolution **P**rotocol. Other acronyms will be introduced as they occur, and can also be found in the glossary at the end.

We can refer to TCP/IP in both a general and a specific way. The general term TCP/IP is used here to refer to the messaging system that transfers data between computers via the internet. The end result can be Email, web pages, or a data file. The process of transferring the message will involve a number of layered communication protocols. One of these can be TCP. One of them could be IP. And there are others – Ethernet, ICMP, UDP etc. This is where the specific definition of TCP/IP comes in, or rather the specific definition of TCP and the specific definition of IP. TCP and IP are two of the more important protocols used in internet communications, hence the general term TCP/IP to describe the whole process.

Note: Here we will use *TCP/IP* to refer to the general system, and *TCP* and *IP* to refer to the specific protocols.

3.2 OSI layers

TCP/IP is a multi-layered system with higher layers becoming increasingly abstracted from the serial data communications of the first Physical Layer. At the Physical and Datalink layers the prime consideration is shunting the data to and fro between specific nodes – usually a PC and a hub or router. The Network level introduces systems to specify the end receiver thus allowing the network to decide where data goes and how it gets there. Built on top of these the higher level protocols, such as TCP and UDP, are more concerned with getting the data to the computer applications that use the data. Even higher up the level structure are the applications that can either handle the data for us, or start the procedure of sending or requesting a message for us.



In the higher level layers more and more of the data transmission process becomes automated. For example users do not need to know how the routers will find the correct recipient for an IP data transmission – they only need to know that the routers can. Provide the correct IP address and the data will get there whether it's across the room, or across the world.

In the higher level layers more and more consideration is given to error detection and transmission sequencing, and it is likely that the receiving system will expect a two-way dialogue with data being passed in a specific sequence, and with error codes being returned at specific times. Checking for these codes and dealing with any errors means a corresponding increase in data processing.

The Application layer protocols are the parts that we normally associate TCP/IP with – web browsers and email programs etc. Many would think of them as TCP/IP, but in truth they just manipulate and display the raw data sent by TCP/IP. What you see in an email program is not SMTP (Simple Mail Transfer Protocol), but a visual representation of the data sent via TCP/IP in the SMTP format.

3.3 TCP_IP component modes

The TCP_IP component has four modes that can be used as entry points into the OSI model.

- MAC mode
  Brings the user in at the bottom physical level.
- IP mode
  Brings the user in at the Network level.
  Automatically handles the Physical layer procedures.
- UDP mode
  Brings the user in at the Transport level using the UDP protocol.
  Useful for applications such as DNS or DHCP that are built on UDP.
- TCP mode
  Brings the user in at the Transport level using TCP datagram's.
  Useful as a starting point for applications such as SMTP or HTTP that are built on TCP.

The modes automate the levels below them, so implementing the TCP mode for instance will handle the Network (IP) and Physical (MAC) layers automatically. Headers are also handled automatically in all but MAC mode allowing you to concentrate more on the data processes.

3.4 Frames and datagram's - Messages within messages

The most basic message consists of a stream of serial data with a header section giving information about the data. As all messages sent in TCP/IP need this base level, a mechanism is needed to adapt this to serve the many purposes and formats needed for the different protocol layers. The mechanism chosen was to put the message meant for a higher protocol layers inside the data section of a lower layer. A TCP message is put into the data section of an IP message which is put inside the data section of an Ethernet section. As the message gets passed up the layers these outer wrappings can be discarded until the message finally gets to the level that is meant to handle it.