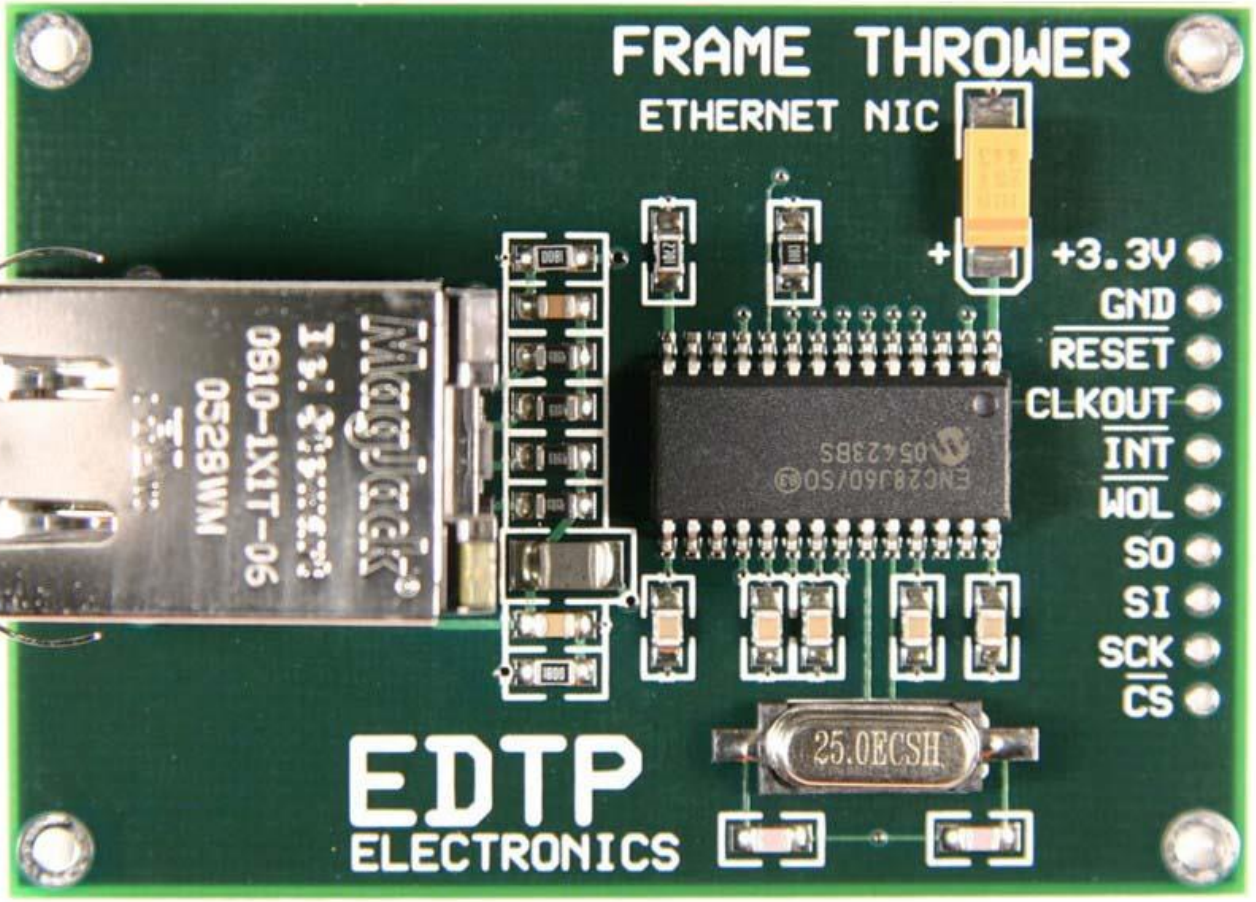
Easy TCP/IP for IoT



TCP/IP Fundamentals

October 21, 2019

Fred Eady

Presented by:

AGENDA

- Firmware – TCP/IP 101
- Hardware – Curiosity and Click
- Firmware – TCP/IP Lite
- Day 1 Summary

ABCDBUGS

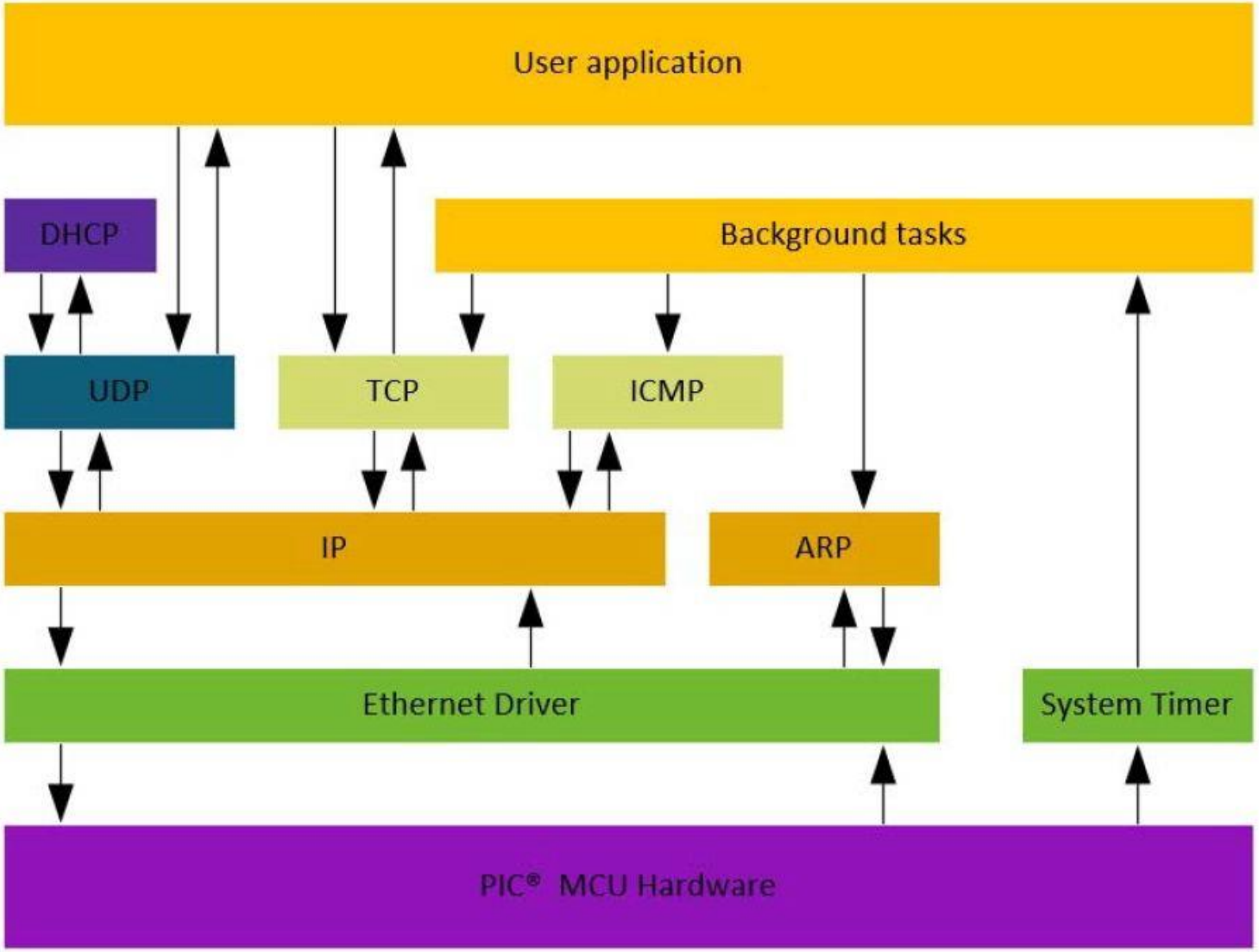
LMRNOBUGS

OSARBUGSCDEDBDIS

LILBMRBUGS

Easy TCP/IP for IoT

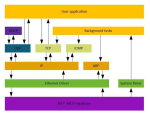
Firmware – TCP/IP 101



Easy TCP/IP for IoT

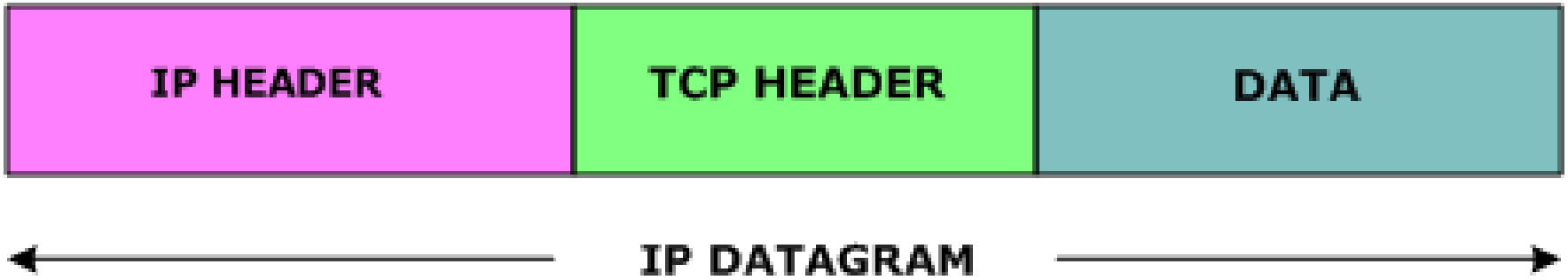
Firmware – TCP/IP 101 - Protocols

- IP – Internet Protocol
- ARP – Address Resolution Protocol
- UDP – User Datagram Protocol
- TCP – Transmission Control Protocol
- ICMP – Internet Control Message Protocol



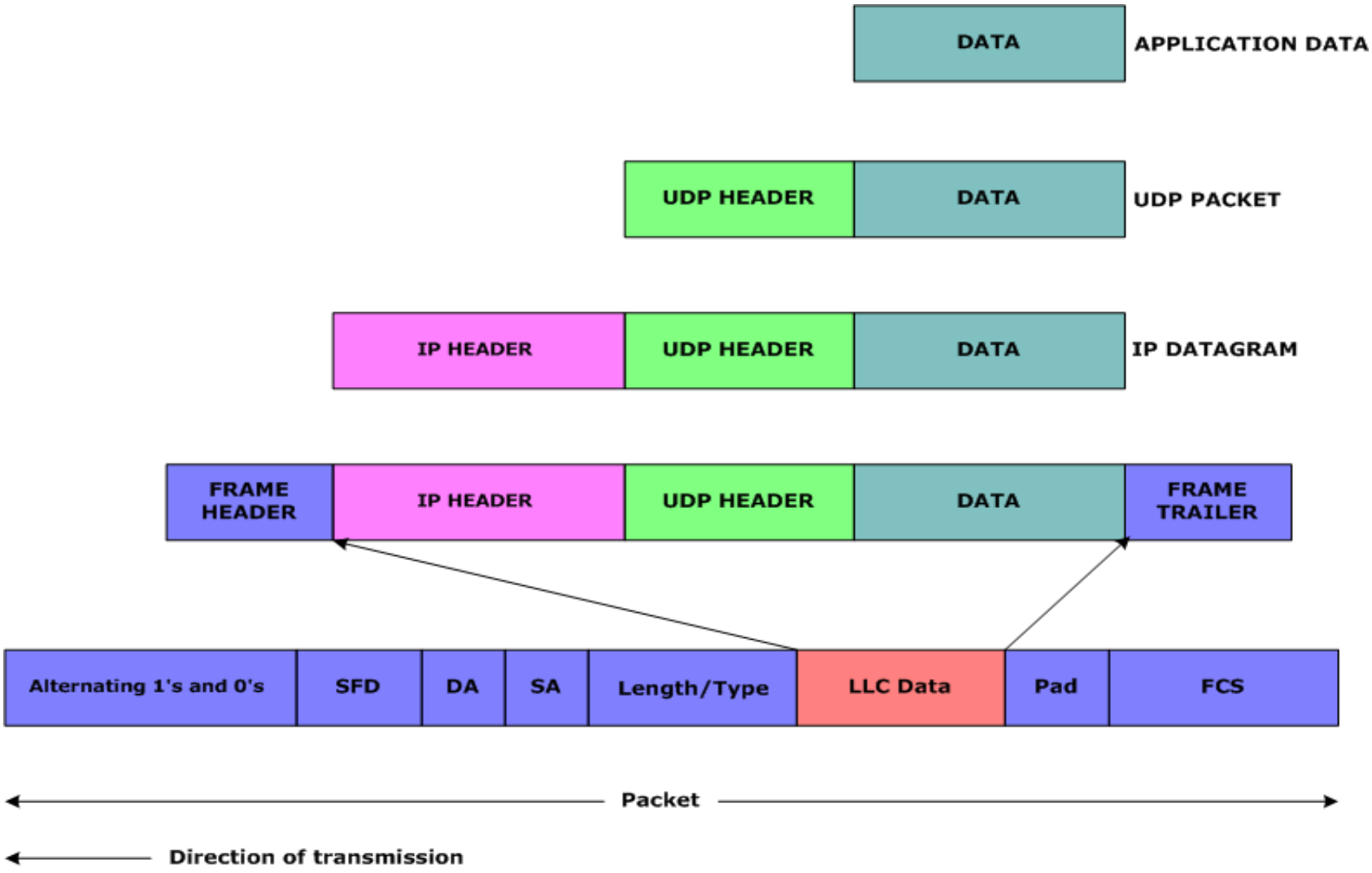
Easy TCP/IP for IoT

Firmware – TCP/IP 101 – IP Datagram



Easy TCP/IP for IoT

Firmware – TCP/IP 101 – UDP Packet

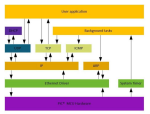


Easy TCP/IP for IoT

Firmware – TCP/IP 101 – TCP Header

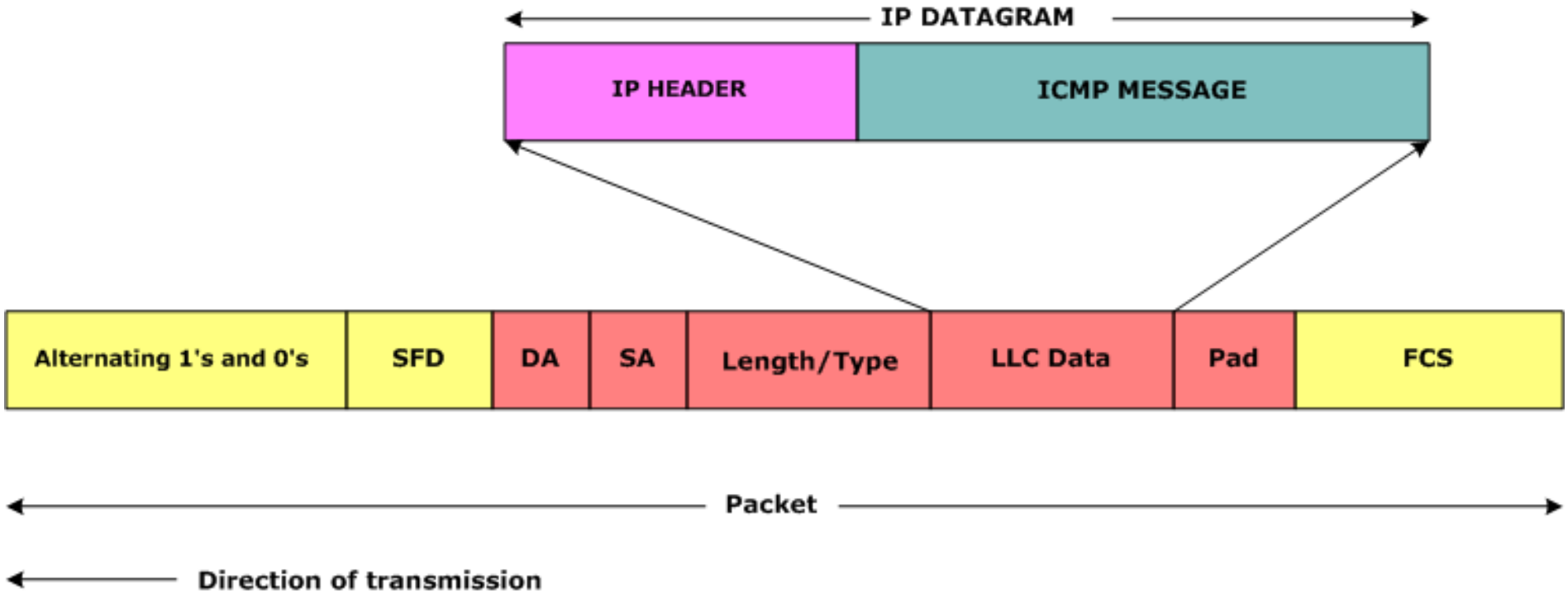
0 – 4	4 – 15	16 – 31
Source Port		Destination Port
32-bit Sequence Number		
32-bit Acknowledgement Number		
Header Length	Reserved	URG ACK PSH RST SYN FIN	Window Size
Checksum		Urgent Pointer
Options		
Data		

TCP Header



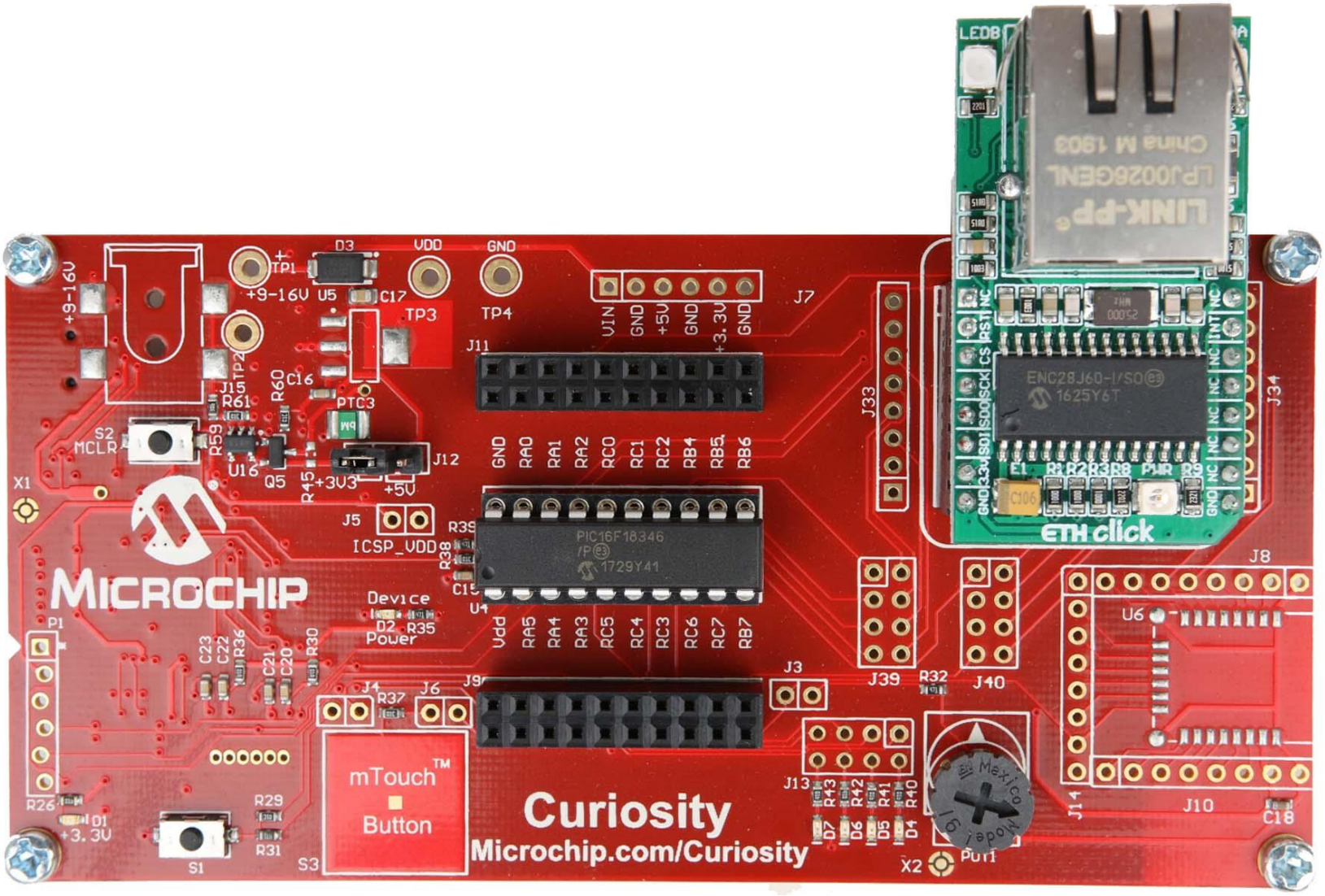
Easy TCP/IP for IoT

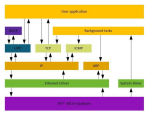
Firmware – TCP/IP 101 – ICMP Packet



Easy TCP/IP for IoT

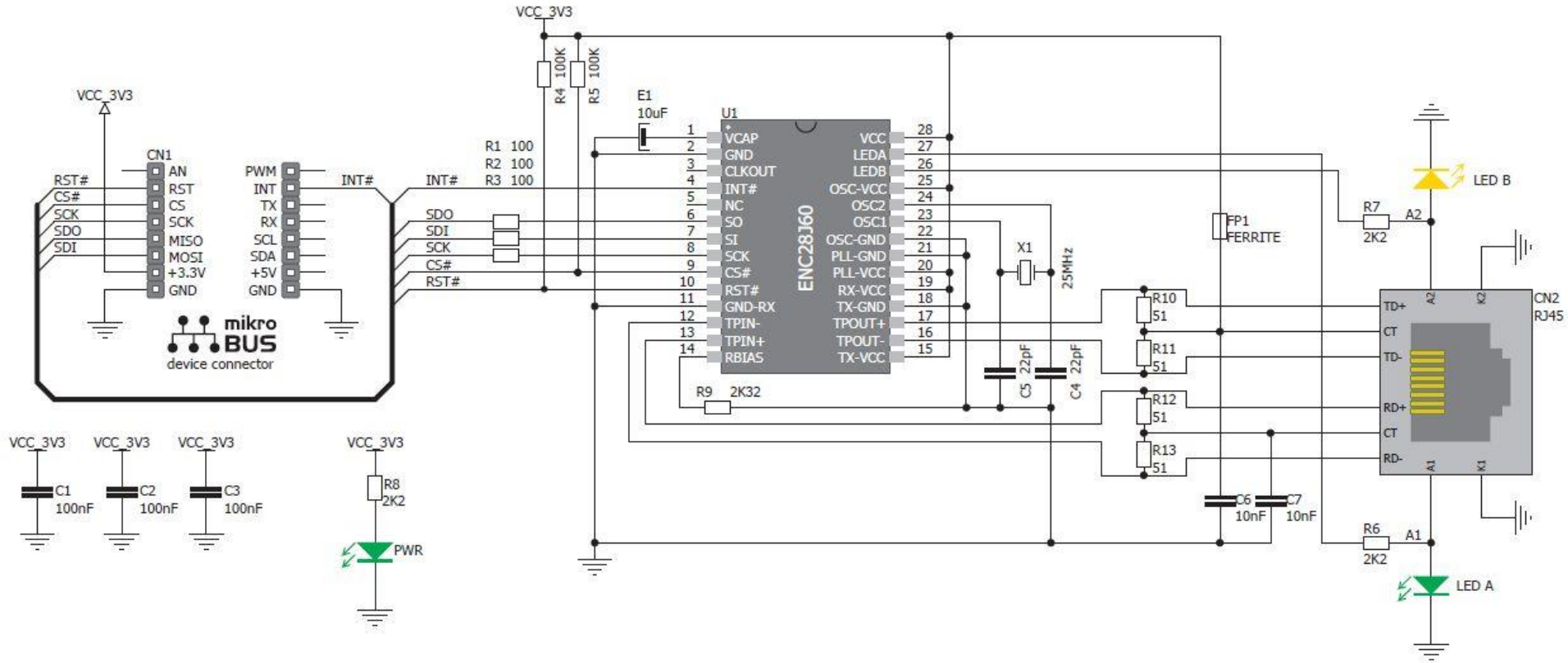
Hardware – TCP/IP 101 – Curiosity and Click





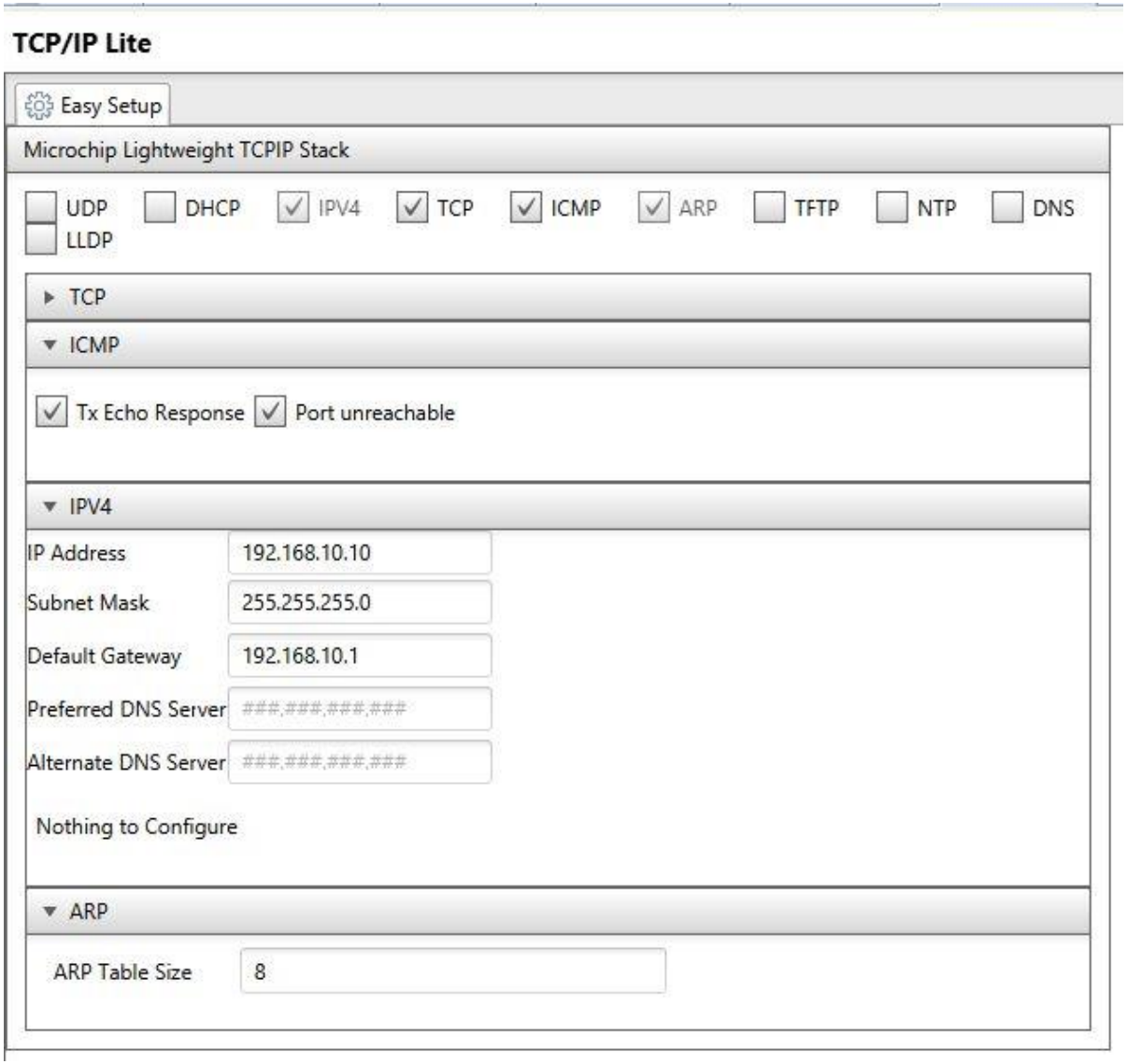
Easy TCP/IP for IoT

Hardware – TCP/IP 101 – Click



Easy TCP/IP for IoT

Firmware – TCP/IP 101 – TCP/IP Lite – Configuration



Easy TCP/IP for IoT

Firmware – TCP/IP 101 – TCP/IP Lite - Configuration

MSSP1

Easy Setup

Hardware Settings

☐ Enable I2C ☑ Enable SPI

SPI Settings

Default SPI Clock Frequency	125	kHz
Actual Clock Frequency	125.0	kHz

MAC

Easy Setup

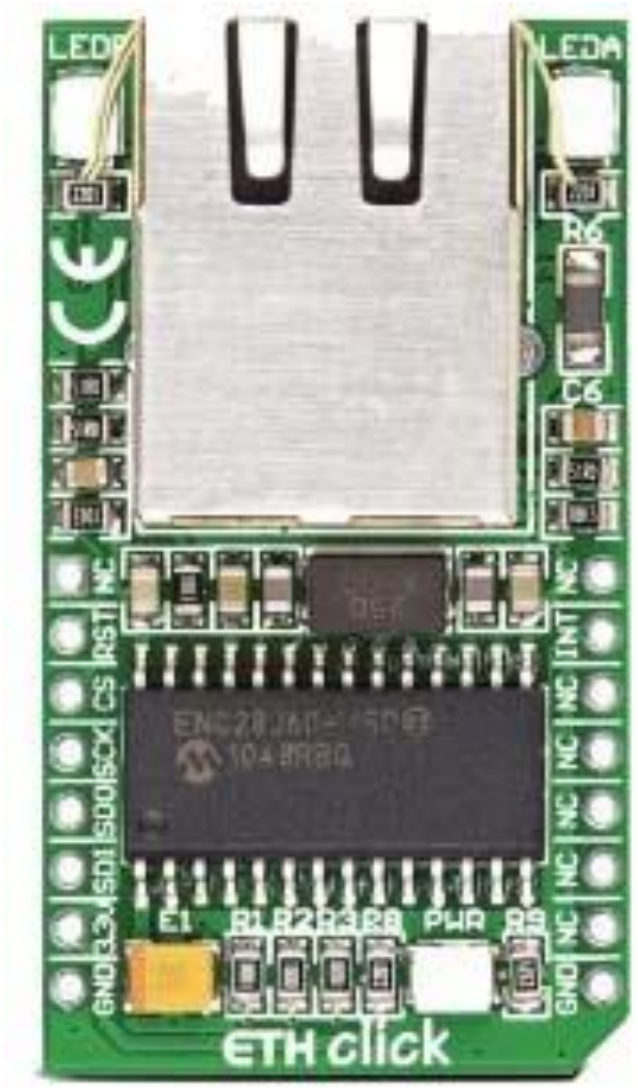
Media Access Controller

ENC28J60

02:00:00:00:00:01

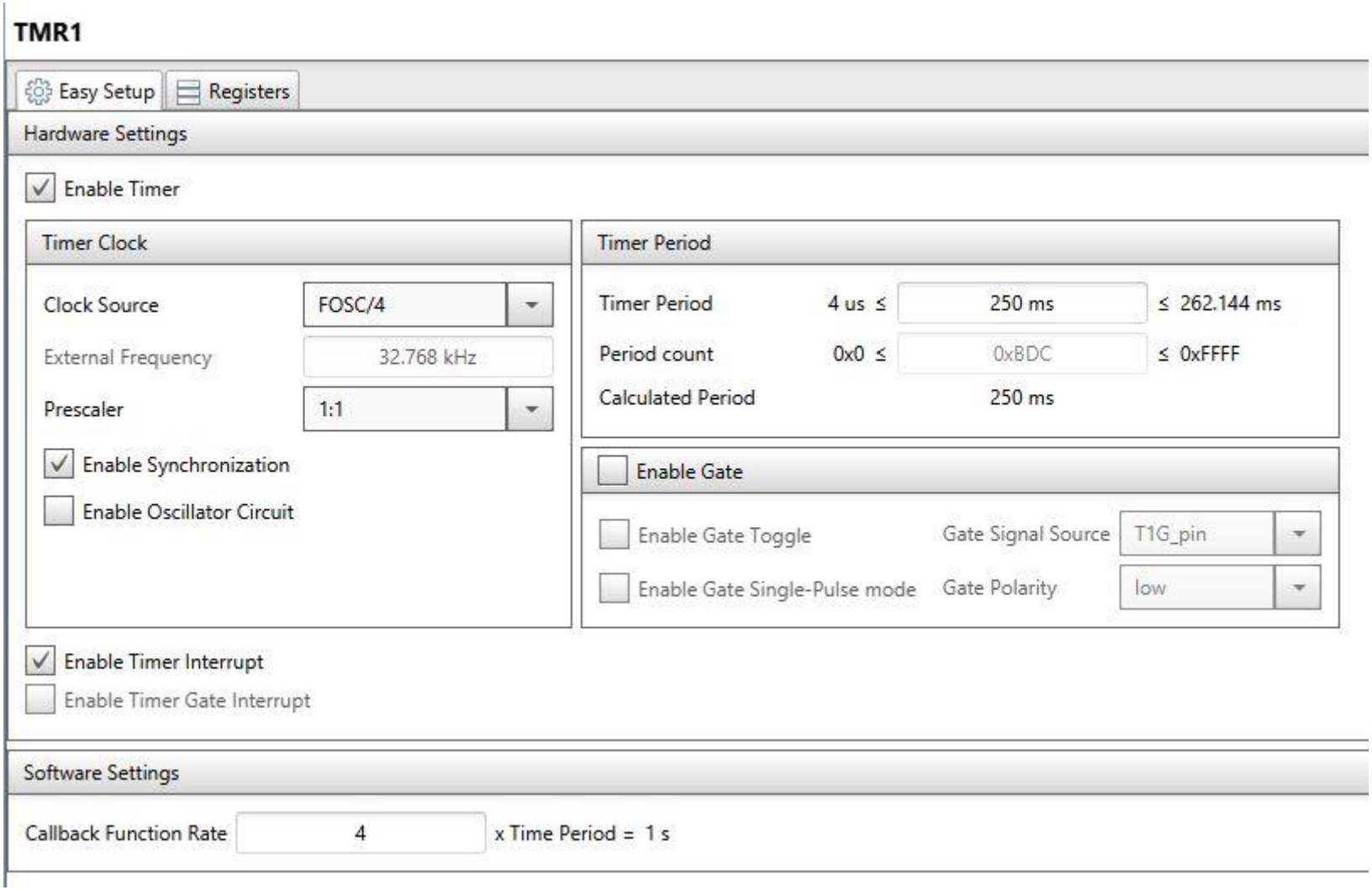
SPI Configuration

Name	SPI Mode	SPI Data Input...	
MASTER0	MODE0	MIDDLE	12
MAC	MODE0	END	80



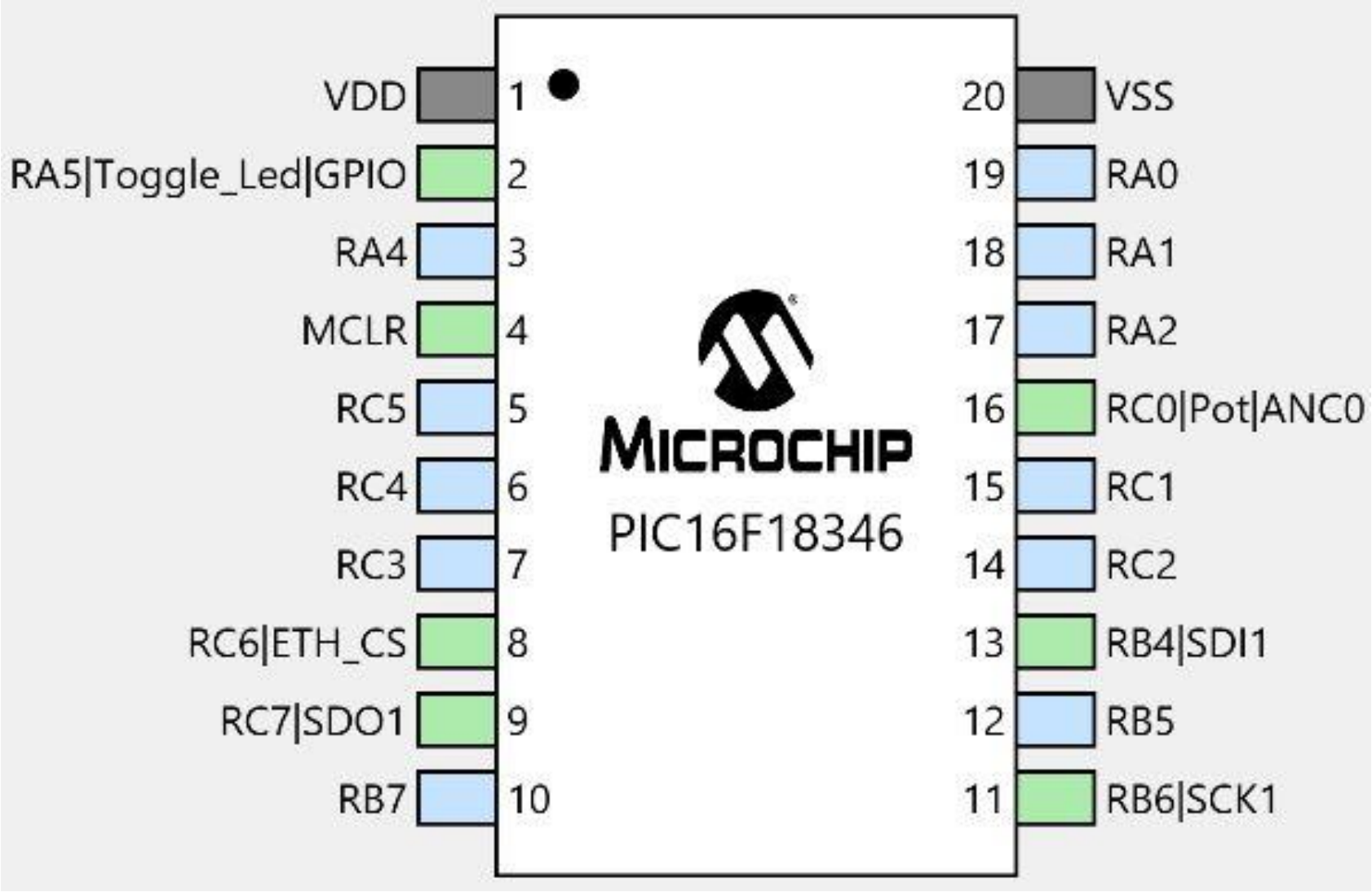
Easy TCP/IP for IoT

Firmware – TCP/IP 101 – TCP/IP Lite – Configuration



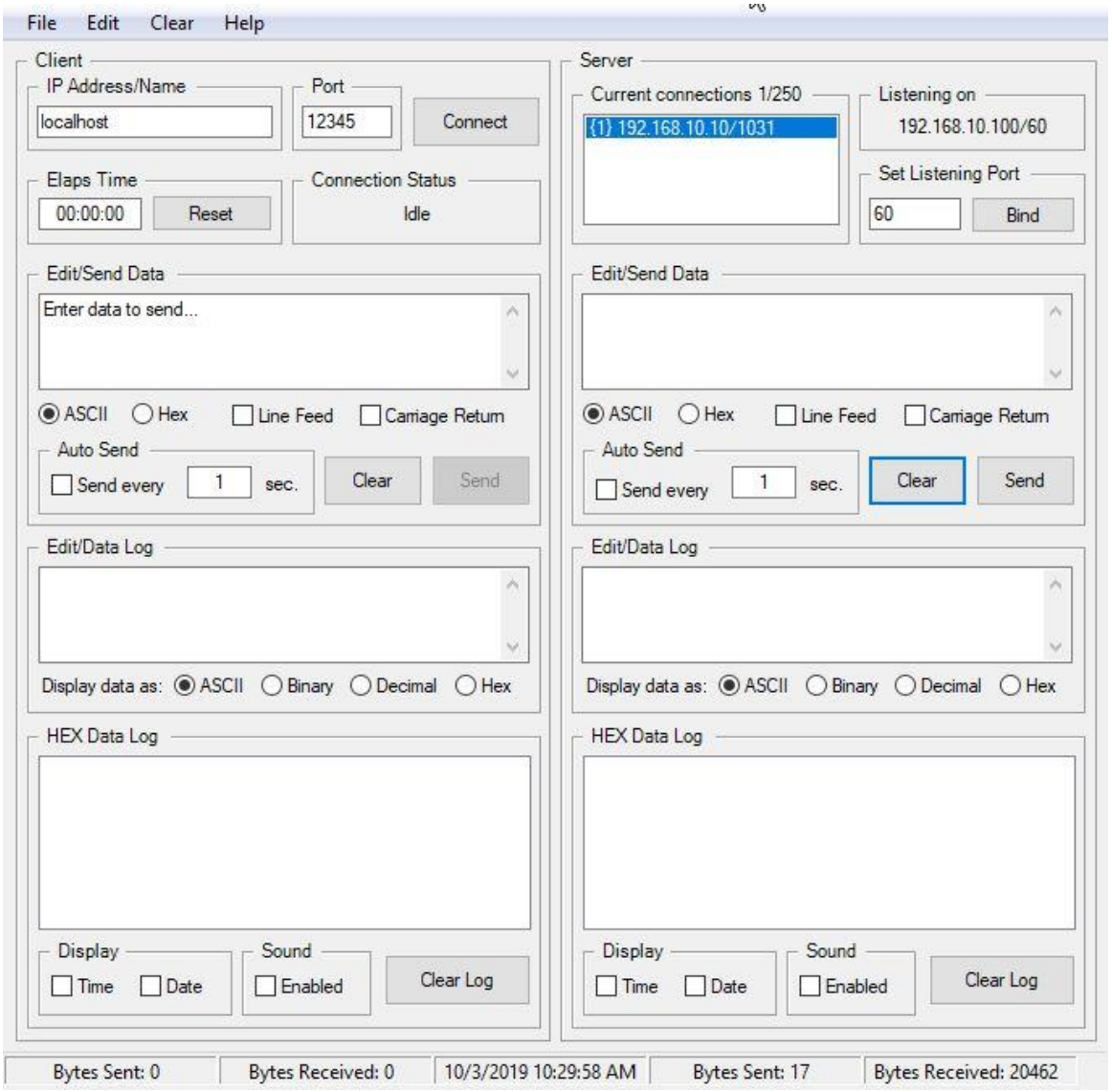
Easy TCP/IP for IoT

Firmware – TCP/IP 101 – TCP/IP Lite – Configuration



Easy TCP/IP for IoT

Firmware – TCP/IP 101 – TCP Server



Easy TCP/IP for IoT

Firmware – TCP/IP 101 – Application Code

Transmit Code

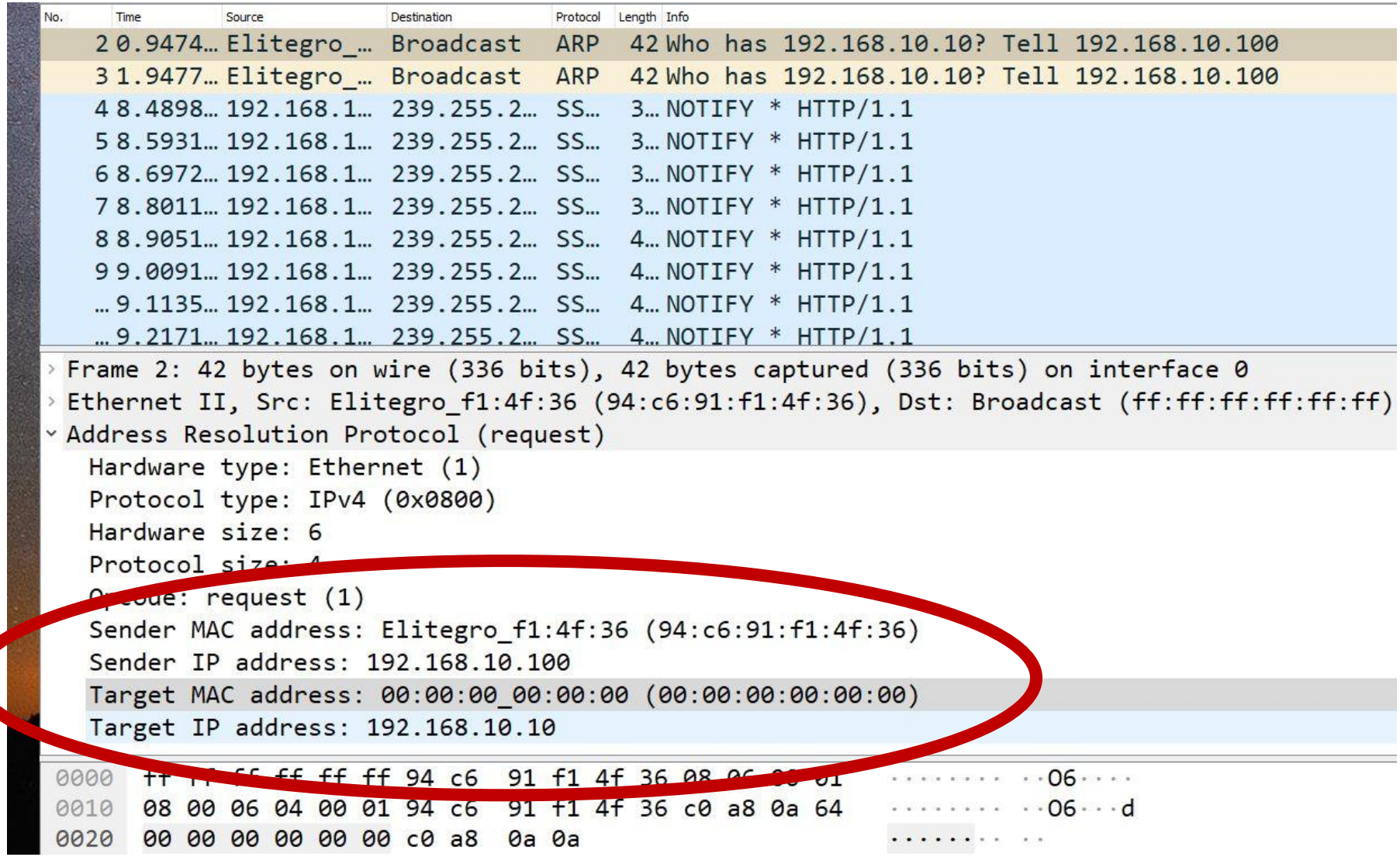
```
// send board status message only once at 2 seconds
socketTimeout = t_client + 2;
pot = ADC_GetConversion(Pot);
sprintf(txdataPort60,"Pot: %d\n LED's state: %d\n", pot, LATAbits.LATA5);
//send data back to the source
TCP_Send(&port60TCB, txdataPort60, strlen(txdataPort60));
```

Receive Code

```
if(rxdataPort60[0] == 'l' && rxdataPort60[1] == 'e' && rxdataPort60[2] == 'd') {
    if(rxdataPort60[6] == 'o' && rxdataPort60[7] == 'n') {
            Toggle_Led_SetHigh();
    }else {
        if(rxdataPort60[6] == 'o' && rxdataPort60[7] == 'f' && rxdataPort60[8] == 'f') {
            Toggle_Led_SetLow();
        }
```

Easy TCP/IP for IoT

Firmware – TCP/IP 101 – ARP



No.	Time	Source	Destination	Protocol	Length	Info
2	0.9474…	Elitegro_…	Broadcast	ARP	42	Who has 192.168.10.10? Tell 192.168.10.100
3	1.9477…	Elitegro_…	Broadcast	ARP	42	Who has 192.168.10.10? Tell 192.168.10.100
4	8.4898…	192.168.1…	239.255.2…	SS…	3…	NOTIFY * HTTP/1.1
5	8.5931…	192.168.1…	239.255.2…	SS…	3…	NOTIFY * HTTP/1.1
6	8.6972…	192.168.1…	239.255.2…	SS…	3…	NOTIFY * HTTP/1.1
7	8.8011…	192.168.1…	239.255.2…	SS…	3…	NOTIFY * HTTP/1.1
8	8.9051…	192.168.1…	239.255.2…	SS…	4…	NOTIFY * HTTP/1.1
9	9.0091…	192.168.1…	239.255.2…	SS…	4…	NOTIFY * HTTP/1.1
…	9.1135…	192.168.1…	239.255.2…	SS…	4…	NOTIFY * HTTP/1.1
…	9.2171…	192.168.1…	239.255.2…	SS…	4…	NOTIFY * HTTP/1.1

```
> Frame 2: 42 bytes on wire (336 bits), 42 bytes captured (336 bits) on interface 0
> Ethernet II, Src: Elitegro_f1:4f:36 (94:c6:91:f1:4f:36), Dst: Broadcast (ff:ff:ff:ff:ff:ff)
v Address Resolution Protocol (request)
    Hardware type: Ethernet (1)
    Protocol type: IPv4 (0x0800)
    Hardware size: 6
    Protocol size: 4
    Opcode: request (1)
    Sender MAC address: Elitegro_f1:4f:36 (94:c6:91:f1:4f:36)
    Sender IP address: 192.168.10.100
    Target MAC address: 00:00:00_00:00:00 (00:00:00:00:00:00)
    Target IP address: 192.168.10.10
```

```
0000  ff ff ff ff ff ff 94 c6  91 f1 4f 36 08 06 00 01   ........ ..O6....
0010  08 00 06 04 00 01 94 c6  91 f1 4f 36 c0 a8 0a 64   ........ ..O6...d
0020  00 00 00 00 00 00 c0 a8  0a 0a                     ........ ..
```

Easy TCP/IP for IoT

Firmware – TCP/IP 101 – 3-Way Handshake

0	4						15	16	31
Source Port								Destination Port	
32-bit Sequence Number									
32-bit Acknowledgement Number									
Header Length	Reserved		URG	ACK	PSH	RST	SYN	FIN	Window Size
Checksum								Urgent Pointer	
Options									
Data									

TCP Header

No.	Time	Source	Destination	Protocol	Length	Info
9	4.4006…	02:00:00:00:0…	Broadcast	ARP	60	Who has 192.168.10.100? Tell 192.168.10.10
…	4.4006…	Elitegro_f1:4…	02:00:00:00:00:01	ARP	42	192.168.10.100 is at 94:c6:91:f1:4f:36
…	6.1148…	02:00:00:00:0…	Broadcast	ARP	60	Who has 192.168.10.100? Tell 192.168.10.10
…	6.1148…	Elitegro_f1:4…	02:00:00:00:00:01	ARP	42	192.168.10.100 is at 94:c6:91:f1:4f:36
…	8.0554…	192.168.10.10	192.168.10.100	TCP	60	1025 → 60 [SYN] Seq=0 Win=50 Len=0
…	8.0554…	192.168.10.100	192.168.10.10	TCP	54	[TCP ACKed unseen segment] 60 → 1025 [ACK] Seq=1 Ack=4187 Win=65028 Len=0
…	8.1766…	192.168.10.10	192.168.10.100	TCP	60	1028 → 60 [SYN] Seq=0 Win=50 Len=0
…	8.1767…	192.168.10.100	192.168.10.10	TCP	58	60 → 1028 [SYN, ACK] Seq=0 Ack=1 Win=65392 Len=0 MSS=1460
…	8.2891…	192.168.10.10	192.168.10.100	TCP	60	1028 → 60 [ACK] Seq=1 Ack=1 Win=50 Len=0

Easy TCP/IP for IoT

Firmware - TCP/IP 101 - IP

```
> Frame 48: 81 bytes on wire (648 bits), 81 bytes captured (648 bits) on interface 0
v Ethernet II, Src: 02:00:00:00:00:01 (02:00:00:00:00:01), Dst: Elitegro_f1:4f:36 (94:c6:91:f1:4f:36)
  > Destination: Elitegro_f1:4f:36 (94:c6:91:f1:4f:36)
  > Source: 02:00:00:00:00:01 (02:00:00:00:00:01)
    Type: IPv4 (0x0800)
v Internet Protocol Version 4, Src: 192.168.10.10, Dst: 192.168.10.100
    0100 .... = Version: 4
    .... 0101 = Header Length: 20 bytes (5)
  > Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
    Total Length: 66
    Identification: 0xaa55 (43605)
  > Flags: 0x4000, Don't fragment
    Time to live: 64
    Protocol: TCP (6)
    Header checksum: 0xfaa1 [validation disabled]
    [Header checksum status: Unverified]
    Source: 192.168.10.10
    Destination: 192.168.10.100
> Transmission Control Protocol, Src Port: 1028, Dst Port: 60, Seq: 313, Ack: 1, Len: 26
v Data (26 bytes)
```

```
0000  94 c6 91 f1 4f 36 02 00  00 00 00 01 08 00 45 00   ····O6·· ·····E·
0010  00 42 aa 55 40 00 40 06  fa a1 c0 a8 0a 0a c0 a8   ·B·U@·@· ········
0020  0a 64 04 04 00 3c 00 00  03 92 b0 5d e4 90 50 18   ·d···<·· ···]··P·
0030  00 32 34 82 00 00 50 6f  74 3a 20 31 30 32 33 0a   ·24···Po t: 1023·
0040  20 4c 45 44 27 73 20 73  74 61 74 65 3a 20 30 0a    LED's s tate: 0·
0050  fd                                                 ·
```

Close Help

Easy TCP/IP for IoT

Firmware – TCP/IP 101 – Ethernet

```
> Frame 48: 81 bytes on wire (648 bits), 81 bytes captured (648 bits) on interface 0
v Ethernet II, Src: 02:00:00:00:00:01 (02:00:00:00:00:01), Dst: Elitegro_f1:4f:36 (94:c6:91:f1:4f:36)
  > Destination: Elitegro_f1:4f:36 (94:c6:91:f1:4f:36)
  > Source: 02:00:00:00:00:01 (02:00:00:00:00:01)
    Type: IPv4 (0x0800)
v Internet Protocol Version 4, Src: 192.168.10.10, Dst: 192.168.10.100
    0100 .... = Version: 4
    .... 0101 = Header Length: 20 bytes (5)
  > Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
    Total Length: 66
    Identification: 0xaa55 (43605)
  > Flags: 0x4000, Don't fragment
    Time to live: 64
    Protocol: TCP (6)
    Header checksum: 0xfaa1 [validation disabled]
    [Header checksum status: Unverified]
    Source: 192.168.10.10
    Destination: 192.168.10.100
> Transmission Control Protocol, Src Port: 1028, Dst Port: 60, Seq: 313, Ack: 1, Len: 26
```

```
0000  94 c6 91 f1 4f 36 02 00  00 00 00 01 08 00 45 00   ····O6·· ·····E·
0010  00 42 aa 55 40 00 40 06  fa a1 c0 a8 0a 0a c0 a8   ·B·U@·@· ········
0020  0a 64 04 04 00 3c 00 00  03 92 b0 5d e4 90 50 18   ·d···<·· ···]··P·
0030  00 32 34 82 00 00 50 6f  74 3a 20 31 30 32 33 0a   ·24···Po t: 1023·
0040  20 4c 45 44 27 73 20 73  74 61 74 65 3a 20 30 0a    LED's s tate: 0·
0050  fd                                                 ·
```

Close Help

Easy TCP/IP for IoT

Firmware – TCP/IP 101 – Data Transfer – Client to Server

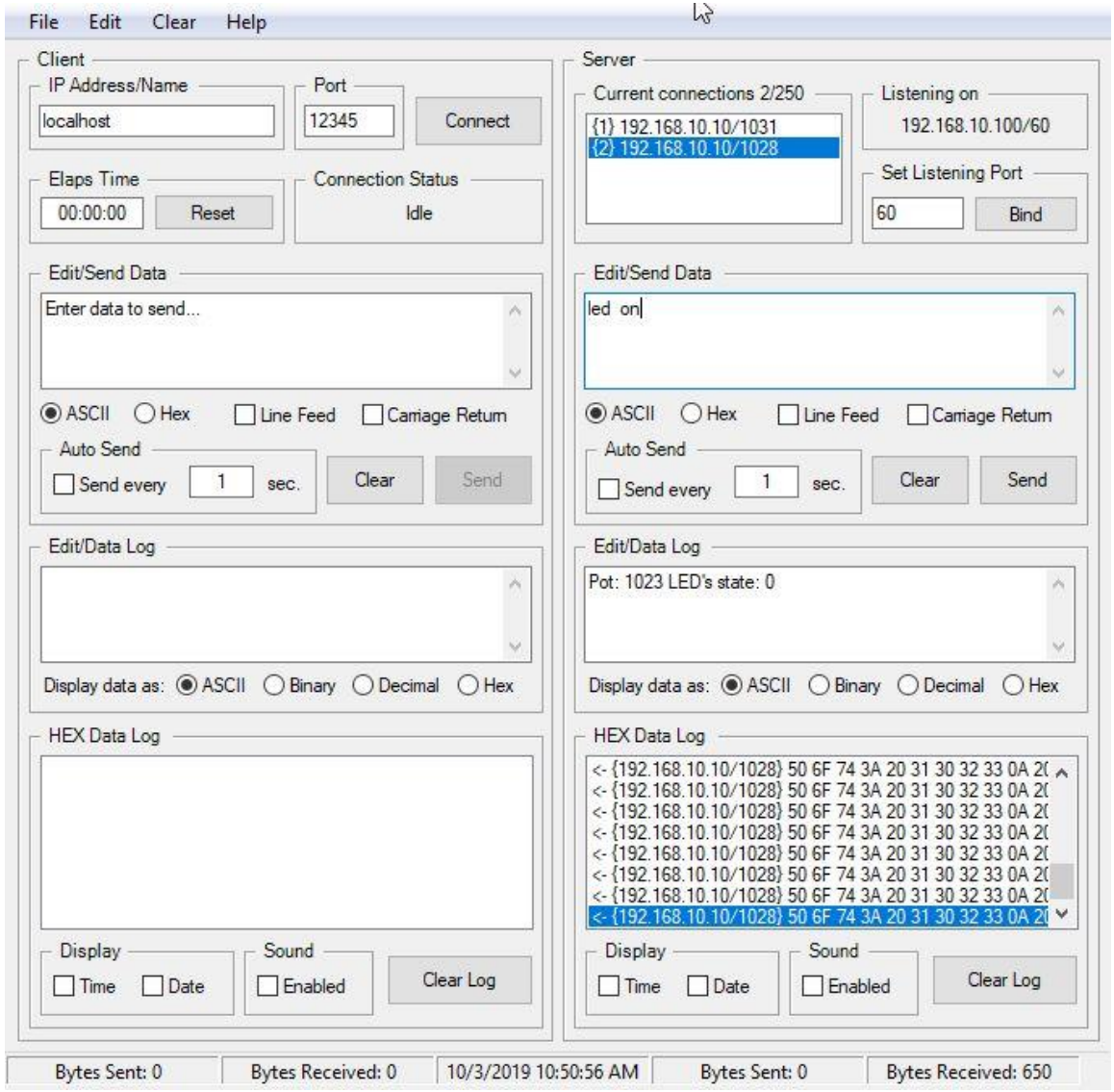
```
   Type: IPv4 (0x0800)
Internet Protocol Version 4, Src: 192.168.10.10, Dst: 192.168.10.100
   0100 .... = Version: 4
   .... 0101 = Header Length: 20 bytes (5)
 > Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
   Total Length: 66
   Identification: 0xaa55 (43605)
 > Flags: 0x4000, Don't fragment
   Time to live: 64
   Protocol: TCP (6)
   Header checksum: 0xfaa1 [validation disabled]
   [Header checksum status: Unverified]
   Source: 192.168.10.10
   Destination: 192.168.10.100
> Transmission Control Protocol, Src Port: 1028, Dst Port: 60, Seq: 313, Ack: 1, Len: 26
v Data (26 bytes)
   Data: 506f743a20313032330a204c4544277320737461746 53a20…
   [Length: 26]
> VSS-Monitoring ethernet trailer, Source Port: 253
```

```
0000  94 c6 91 f1 4f 36 02 00  00 00 00 01 08 00 45 00   ····O6·· ·····E·
0010  00 42 aa 55 40 00 40 06  fa a1 c0 a8 0a 0a c0 a8   ·B·U@·@· ········
0020  0a 64 04 04 00 3c 00 00  03 92 b0 5d e4 90 50 18   ·d···<·· ···]··P·
0030  00 32 34 82 00 00 50 6f  74 3a 20 31 30 32 33 0a   ·24···Po t: 1023·
0040  20 4c 45 44 27 73 20 73  74 61 74 65 3a 20 30 0a    LED's s tate: 0·
0050  fd                                                 ·
```

Close Help

Easy TCP/IP for IoT

Firmware – TCP/IP 101 – Data Transfer – Server to Client



Easy TCP/IP for IoT

Firmware – TCP/IP 101 – Data Transfer – Server to Client

```
Frame 1: 81 bytes on wire (648 bits), 81 bytes captured (648 bits) on interface 0
Ethernet II, Src: 02:00:00:00:00:01 (02:00:00:00:00:01), Dst: Elitegro_f1:4f:36 (94:c6:91:f1:4f:36)
Internet Protocol Version 4, Src: 192.168.10.10, Dst: 192.168.10.100
Transmission Control Protocol, Src Port: 1031, Dst Port: 60, Seq: 1, Ack: 1, Len: 26
Data (26 bytes)
    Data: 506f743a20313032330a204c4544277320737461746573a20…
    [Length: 26]
VSS-Monitoring ethernet trailer, Source Port: 253
```

```
0000  94 c6 91 f1 4f 36 02 00  00 00 00 01 08 00 45 00   ····O6·· ·····E·
0010  00 42 aa 55 40 00 40 06  fa a1 c0 a8 0a 0a c0 a8   ·B·U@·@· ········
0020  0a 64 04 07 00 3c 00 00  20 38 9b c5 52 33 50 18   ·d···<·· 8··R3P·
0030  00 32 bd ce 00 00 50 6f  74 3a 20 31 30 32 33 0a   ·2····Po t: 1023·
0040  20 4c 45 44 27 73 20 73  74 61 74 65 3a 20 31 0a    LED's s tate: 1·
0050  fd                                                 ·
```

Close Help

Easy TCP/IP for IoT

Day 1 Summary

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

not ssdp

No.	Time	Source	Destination	Protocol	Length	Info
33	5.3990…	BelkinIn_b7:c…	Elitegro_f1:4f:36	ARP	60	Who has 192.168.10.100? Tell 192.168.10.1
34	5.3990…	Elitegro_f1:4…	BelkinIn_b7:cb:e0	ARP	42	192.168.10.100 is at 94:c6:91:f1:4f:36
35	14.889…	02:00:00:00:0…	Broadcast	ARP	60	Who has 192.168.10.100? Tell 192.168.10.10
36	14.889…	Elitegro_f1:4…	02:00:00:00:00:01	ARP	42	192.168.10.100 is at 94:c6:91:f1:4f:36
37	16.834…	192.168.10.10	192.168.10.100	TCP	60	1025 → 60 [SYN] Seq=0 Win=50 Len=0
38	16.834…	192.168.10.100	192.168.10.10	TCP	58	60 → 1025 [SYN, ACK] Seq=0 Ack=1 Win=65392 Len=0 MSS=1460
39	16.957…	192.168.10.10	192.168.10.100	TCP	60	1028 → 60 [SYN] Seq=0 Win=50 Len=0
40	18.829…	192.168.10.10	192.168.10.100	TCP	60	[TCP Retransmission] 1028 → 60 [SYN] Seq=0 Win=50 Len=0
41	18.900…	192.168.10.10	192.168.10.100	TCP	60	1031 → 60 [SYN] Seq=0 Win=50 Len=0
42	18.900…	192.168.10.100	192.168.10.10	TCP	58	60 → 1031 [SYN, ACK] Seq=0 Ack=1 Win=65392 Len=0 MSS=1460
43	19.012…	192.168.10.10	192.168.10.100	TCP	60	1031 → 60 [ACK] Seq=1 Ack=1 Win=50 Len=0
44	19.834…	192.168.10.100	192.168.10.10	TCP	58	[TCP Retransmission] 60 → 1025 [SYN, ACK] Seq=0 Ack=1 Win=65392 Len=0 MSS=1460
53	20.890…	192.168.10.10	192.168.10.100	TCP	81	1031 → 60 [PSH, ACK] Seq=1 Ack=1 Win=50 Len=26
54	20.931…	192.168.10.100	192.168.10.10	TCP	54	60 → 1031 [ACK] Seq=1 Ack=27 Win=65366 Len=0
55	22.449…	192.168.10.100	192.168.10.255	BRO…	2…	Host Announcement DESKTOP-5SJRAIJ, Workstation, Server, NT Workstation

```
> Frame 53: 81 bytes on wire (648 bits), 81 bytes captured (648 bits) on interface 0
> Ethernet II, Src: 02:00:00:00:00:01 (02:00:00:00:00:01), Dst: Elitegro_f1:4f:36 (94:c6:91:f1:4f:36)
> Internet Protocol Version 4, Src: 192.168.10.10, Dst: 192.168.10.100
> Transmission Control Protocol, Src Port: 1031, Dst Port: 60, Seq: 1, Ack: 1, Len: 26
v Data (26 bytes)
    Data: 506f743a20313032330a204c4544277320737461746174653a20…
```

```
0000  94 c6 91 f1 4f 36 02 00  00 00 00 01 08 00 45 00   ····O6·· ·····E·
0010  00 42 aa 55 40 00 40 06  fa a1 c0 a8 0a 0a c0 a8   ·B·U@·@· ········
0020  0a 64 04 07 00 3c 00 00  00 06 9b c5 52 2b 50 18   ·d···<·· ····R+P·
0030  00 32 df 08 00 00 50 6f  74 3a 20 31 30 32 33 0a   ·2····Po t: 1023·
0040  20 4c 45 44 27 73 20 73  74 61 74 65 3a 20 30 0a    LED's s tate: 0·
0050  fd                                                 ·
```

Data (data.data), 26 bytes | Packets: 65 · Displayed: 49 (75.4%) · Dropped: 0 (0.0%) | Profile: Default