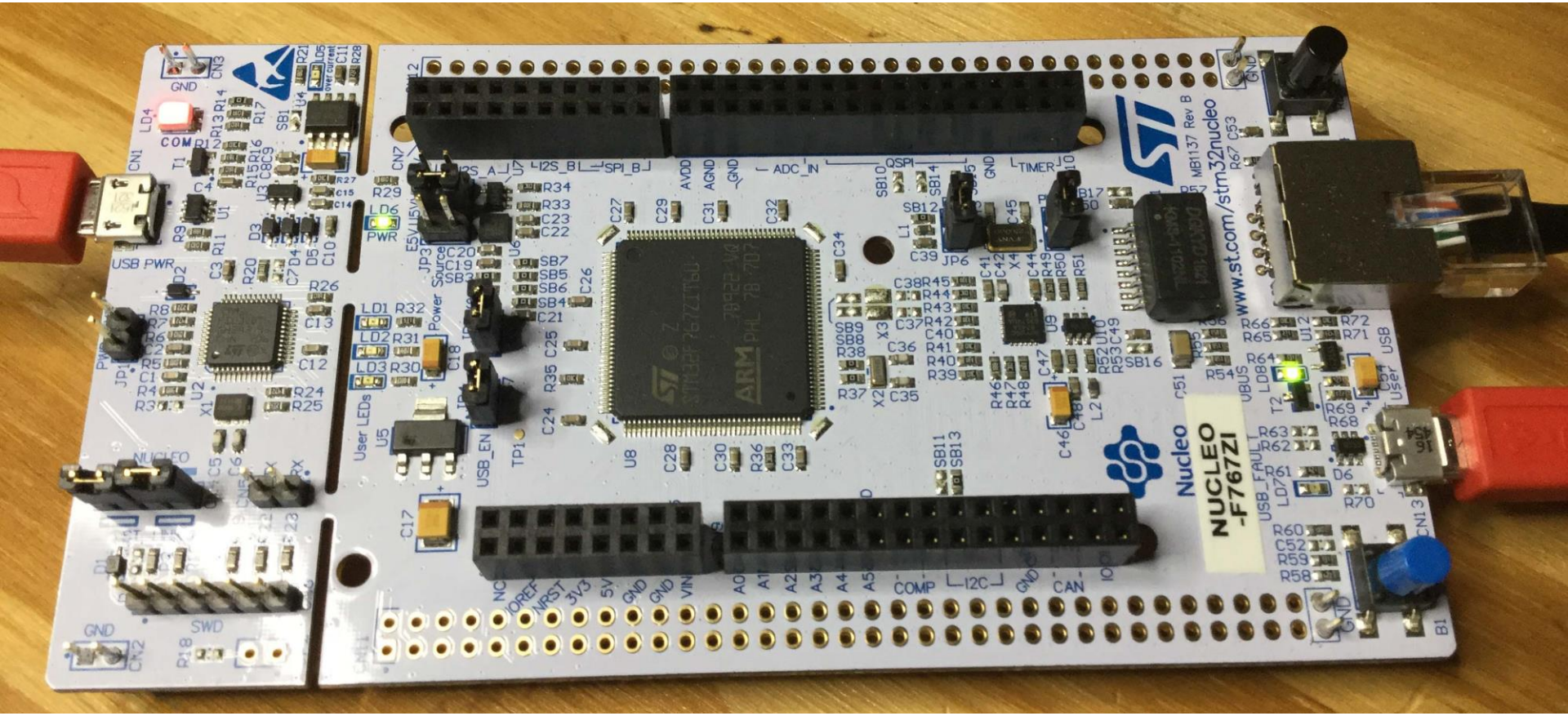
Easy TCP/IP for IoT



Implementing TCP/IP on STM32 Devices

October 24, 2019

Fred Eady

DesignNews

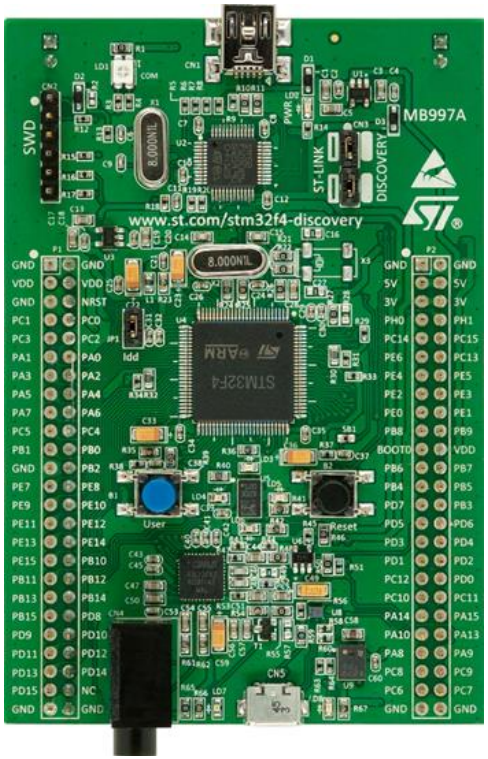
CEC CONTINUING EDUCATION CENTER

Presented by: Digi-Key ELECTRONICS

Easy TCP/IP for IoT

AGENDA

- Hardware – The NUCLEO-F767ZI
- Firmware – STM32CubeMX: NUCLEO-F767ZI
- Hardware – STM32F4-Discovery
- Firmware – STM32CubeMX:STM32F407VG
- Day 4 Summary



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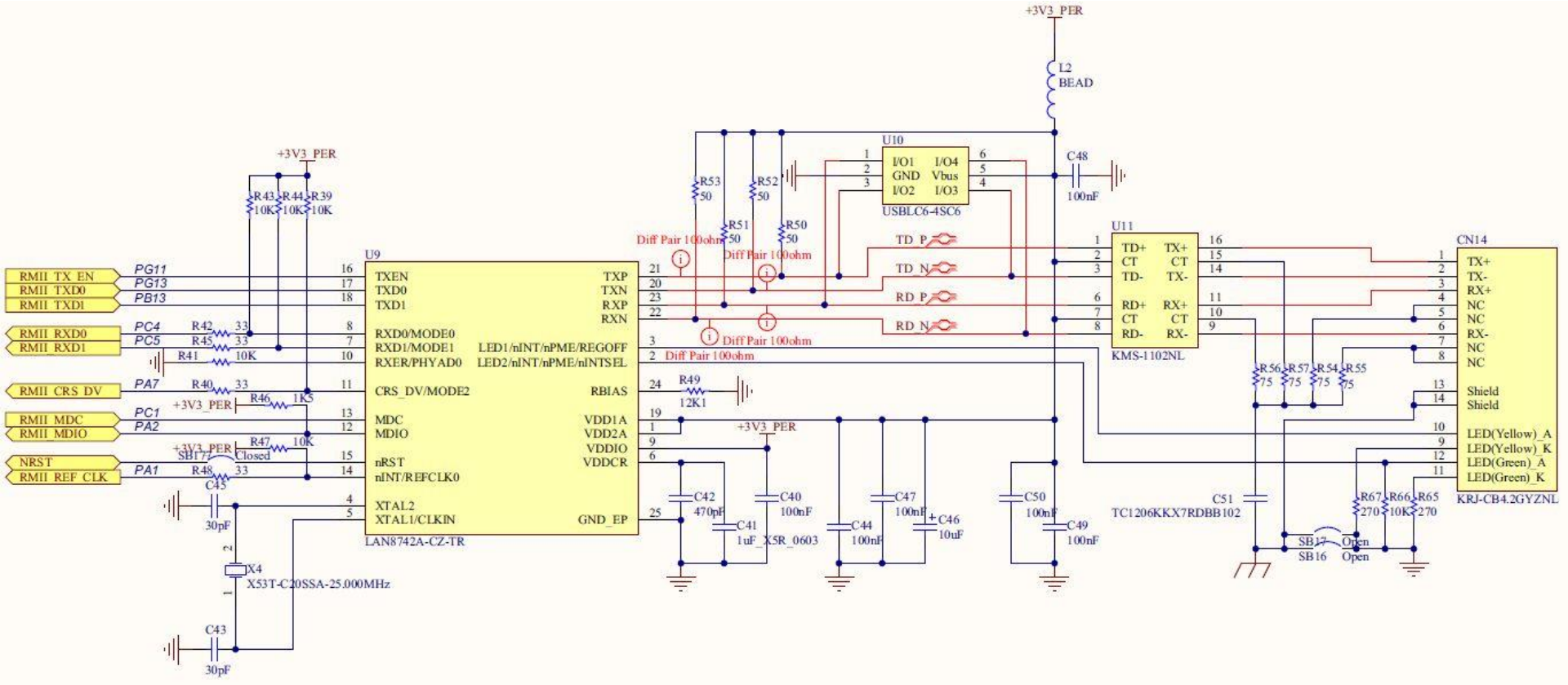
Hardware – NUCLEO-F767ZI: Ethernet Module - LAN8742A



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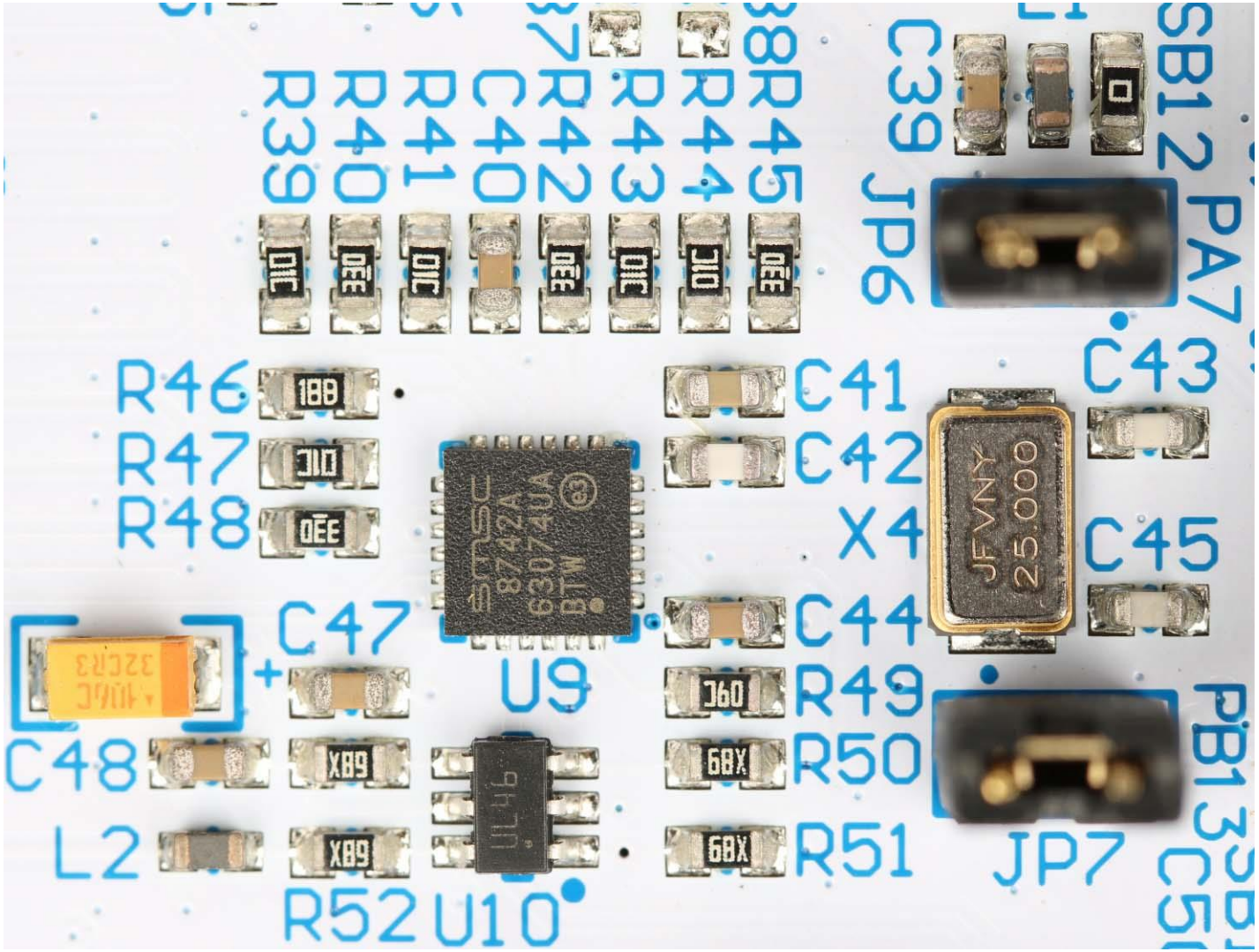
Hardware – NUCLEO-F767ZI: Ethernet Module



Easy TCP/IP for IoT

Hardware – NUCLEO-F767ZI: Ethernet Module

ETH Mode and Configuration

Mode

Mode: RMII

☐ Activate Rx Err signal

Configuration

Reset Configuration

Parameter Settings | Advanced Parameters | User Constants | NVIC Settings | GPIO Settings

Search Signals

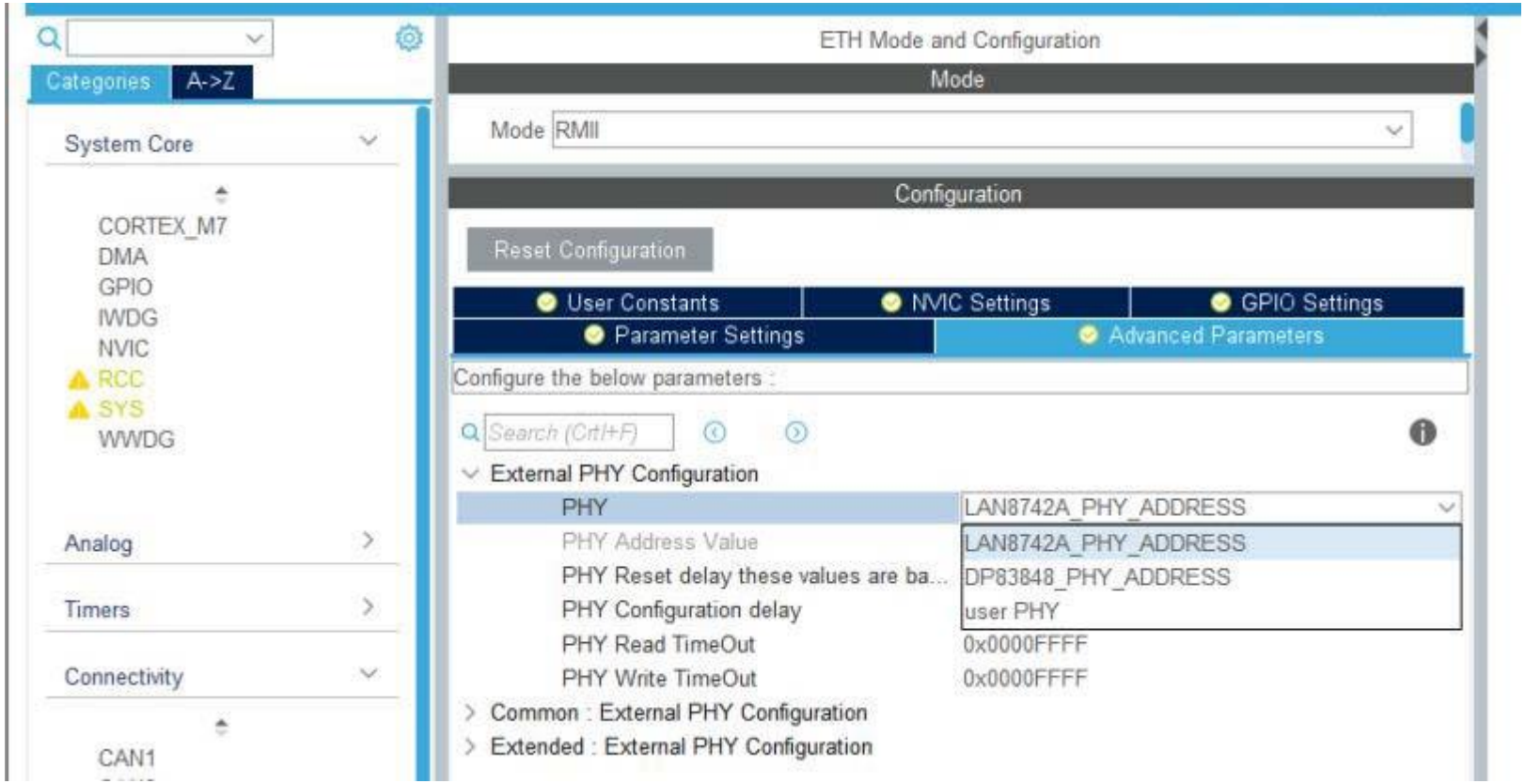
Search (Crtl+F)

☐ Show only Modified Pins

Pin Name	Signal on Pin	GPIO output l...	GPIO mode	GPIO Pull-up/...	Maximum out...	Fast Mode	User Label	Modified
PA1	ETH_REF_CLK	n/a	Alternate Fun...	No pull-up and...	Very High	n/a	RMII_REF_CL...	☑
PA2	ETH_MDIO	n/a	Alternate Fun...	No pull-up and...	Very High	n/a	RMII_MDIO [L...	☑
PA7	ETH_CRS_DV	n/a	Alternate Fun...	No pull-up and...	Very High	n/a	RMII_CRS_D...	☑
PB13	ETH_TXD1	n/a	Alternate Fun...	No pull-up and...	Very High	n/a	RMII_TXD1 [L...	☑
PC1	ETH_MDC	n/a	Alternate Fun...	No pull-up and...	Very High	n/a	RMII_MDC [L...	☑
PC4	ETH_RXD0	n/a	Alternate Fun...	No pull-up and...	Very High	n/a	RMII_RXD0 [L...	☑
PC5	ETH_RXD1	n/a	Alternate Fun...	No pull-up and...	Very High	n/a	RMII_RXD1 [L...	☑
PG11	ETH_TX_EN	n/a	Alternate Fun...	No pull-up and...	Very High	n/a	RMII_TX_EN [...	☑
PG13	ETH_TXD0	n/a	Alternate Fun...	No pull-up and...	Very High	n/a	RMII_TXD0 [L...	☑

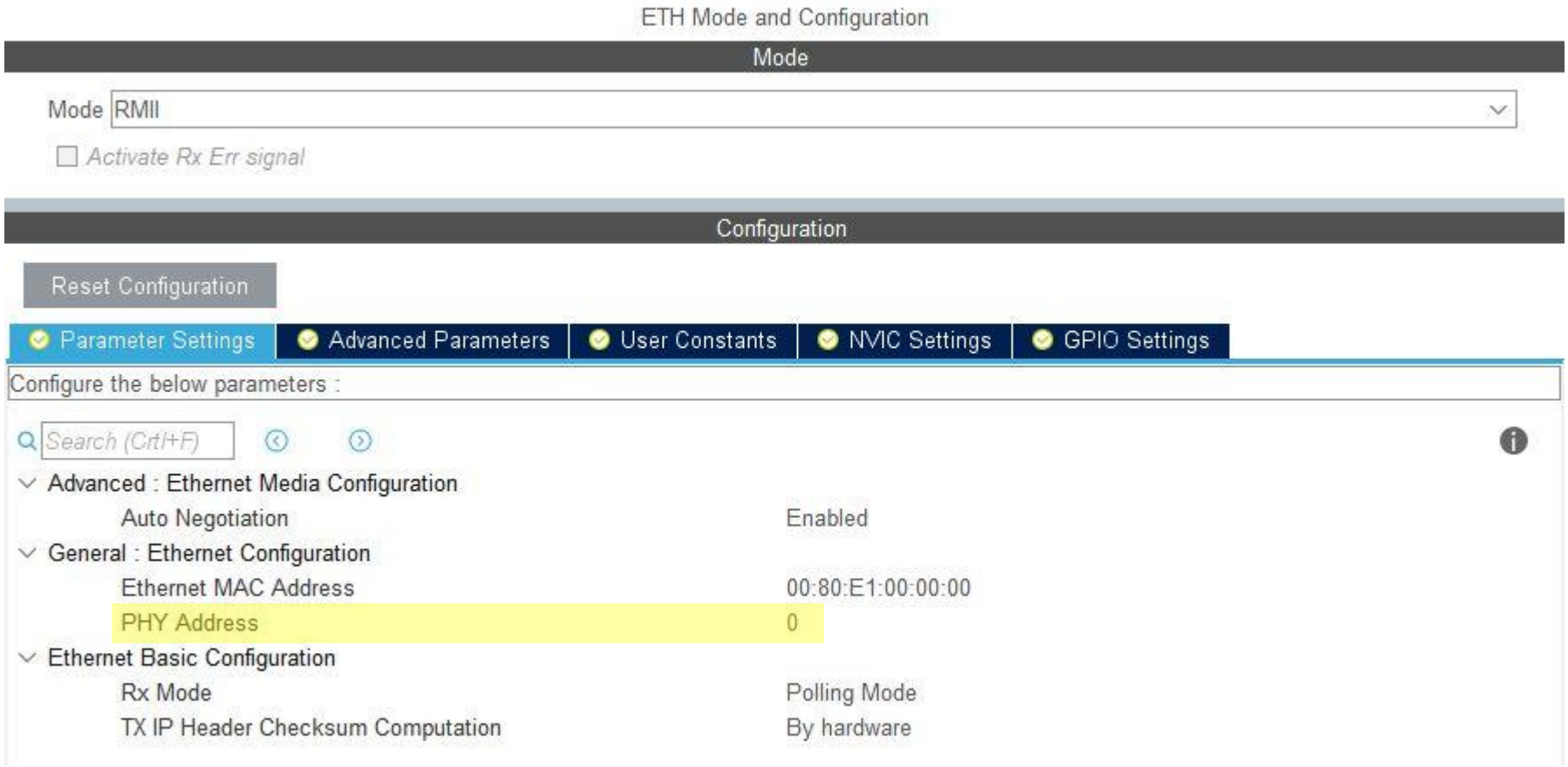
Easy TCP/IP for IoT

Hardware – NUCLEO-F767ZI: Ethernet Module



Easy TCP/IP for IoT

Hardware – NUCLEO-F767ZI: Ethernet Module



Easy TCP/IP for IoT

Firmware – NUCLEO-F767ZI: lwIP Module-DHCP Disabled

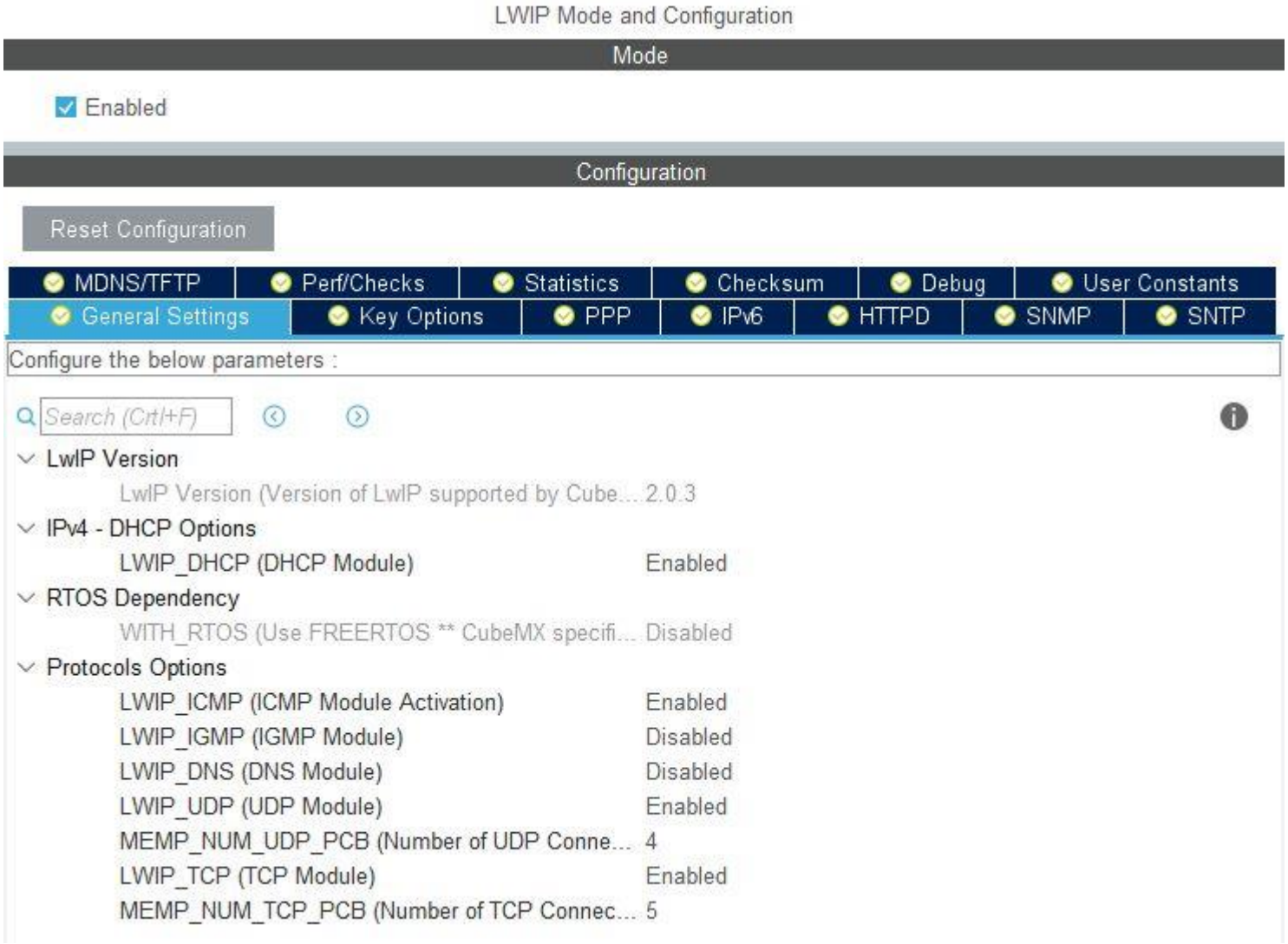
Easy TCP/IP for IoT

Firmware – NUCLEO-F767ZI: lwIP Module-DHCP Disabled

```
/**
  * LwIP initialization function
  */
void MX_LWIP_Init(void)
{
  /* IP addresses initialization */
  IP_ADDRESS[0] = 192;
  IP_ADDRESS[1] = 168;
  IP_ADDRESS[2] = 10;
  IP_ADDRESS[3] = 10;
  NETMASK_ADDRESS[0] = 255;
  NETMASK_ADDRESS[1] = 255;
  NETMASK_ADDRESS[2] = 255;
  NETMASK_ADDRESS[3] = 0;
  GATEWAY_ADDRESS[0] = 192;
  GATEWAY_ADDRESS[1] = 168;
  GATEWAY_ADDRESS[2] = 10;
  GATEWAY_ADDRESS[3] = 1;

  /* Initilialize the LwIP stack without RTOS */
  lwip_init();

  /* IP addresses initialization without DHCP (IPv4) */
  IP4_ADDR(&ipaddr, IP_ADDRESS[0], IP_ADDRESS[1], IP_ADDRESS[2], IP_ADDRESS[3]);
  IP4_ADDR(&netmask, NETMASK_ADDRESS[0], NETMASK_ADDRESS[1] , NETMASK_ADDRESS[2], NETMASK_ADDRESS[3]);
  IP4_ADDR(&gw, GATEWAY_ADDRESS[0], GATEWAY_ADDRESS[1], GATEWAY_ADDRESS[2], GATEWAY_ADDRESS[3]);
```

Easy TCP/IP for IoT

Firmware – NUCLEO-F767ZI: lwIP Module-DHCP Enabled



Easy TCP/IP for IoT

Firmware – NUCLEO-F767ZI: lwIP Module-DHCP Enabled

```
/**
  * LwIP initialization function
  */
void MX_LWIP_Init(void)
{
  /* Initilialize the LwIP stack without RTOS */
  lwip_init();

  /* IP addresses initialization with DHCP (IPv4) */
  ipaddr.addr = 0;
  netmask.addr = 0;
  gw.addr = 0;

  /* add the network interface (IPv4/IPv6) without RTOS */
  netif_add(&gnetif, &ipaddr, &netmask, &gw, NULL, &ethernetif_init, &ethernet_input);

  /* Registers the default network interface */
  netif_set_default(&gnetif);

  if (netif_is_link_up(&gnetif))
  {
    /* When the netif is fully configured this function must be called */
    netif_set_up(&gnetif);
  }
  else
  {
    /* When the netif link is down this function must be called */
    netif_set_down(&gnetif);
  }

  /* Start DHCP negotiation for a network interface (IPv4) */
  dhcp_start(&gnetif);
```

Easy TCP/IP for IoT

Firmware – NUCLEO-F767ZI: lwIP Module-DHCP Enabled

```
uint32_t addr;
extern struct netif gnetif;
//*************************************************************
//* PRINTF
//*************************************************************
int fputc(int ch, FILE *f)
  {
      HAL_UART_Transmit(&huart3, (uint8_t *)&ch, 1, 0xFFFF);
      return ch;
  }
```

Easy TCP/IP for IoT

Firmware – NUCLEO-F767ZI: lwIP Module-DHCP Enabled

```
int main(void)
{
  /* Reset of all peripherals, Initializes the Flash interface and the Systick. */
  HAL_Init();
  /* Configure the system clock */
  SystemClock_Config();
  /* Initialize all configured peripherals */
  MX_GPIO_Init();
  MX_USART3_UART_Init();
  MX_USB_OTG_FS_PCD_Init();
  MX_LWIP_Init();
  /* USER CODE BEGIN 2 */

  /* USER CODE END 2 */

  /* Infinite loop */
  /* USER CODE BEGIN WHILE */
  while (1)
  {
    MX_LWIP_Process();
    if(dhcp_supplied_address(&gnetif) )
    {
      printf("BOUND\r\n");
      addr = gnetif.ip_addr.addr;
    }
  }
}
```

Easy TCP/IP for IoT

Firmware – NUCLEO-F767ZI: lwIP Module-DHCP Enabled

```
BOUND
BOUND
BOUND
BOUND
BOUND
BOUND
BOUND
BOUND
BOUND
BOUND
```

Watch 1

Name	Value	Type
gnetif	0x20000564 &gnetif	struct netif
next	0x00000000	struct netif *
ip_addr	0x20000568	struct ip4_addr
addr	0x6A0AA8C0	uint
netmask	0x2000056C	struct ip4_addr
addr	0x00FFFFFF	uint
gw	0x20000570	struct ip4_addr
addr	0x010AA8C0	uint
input	0x08005011 ethernet_i...	char f(struct pbuf *,str...
output	0x08004869 etharp_ou...	char f(struct netif *,str...
linkoutput	0x08006589 low_level_...	char f(struct netif *,str...
state	0x00000000	void *
[0]	0x00000000	void
client_data	0x20000584	void *[1]
rs_count	0x03	uchar
mtu	0x05DC	ushort
hwaddr_len	0x06	uchar
hwaddr	0x2000058D ""	uchar[6]
[0]	0x00	uchar
[1]	0x80 '€'	uchar
[2]	0xE1 'á'	uchar
[3]	0x00	uchar
[4]	0x00	uchar
[5]	0x00	uchar
flags	0x0F	uchar
name	0x20000594 "st"	uchar[2]
num	0x00	uchar
(null)	<cannot evaluate>	uchar
addr	0x6A0AA8C0	uint
<Enter expression>		

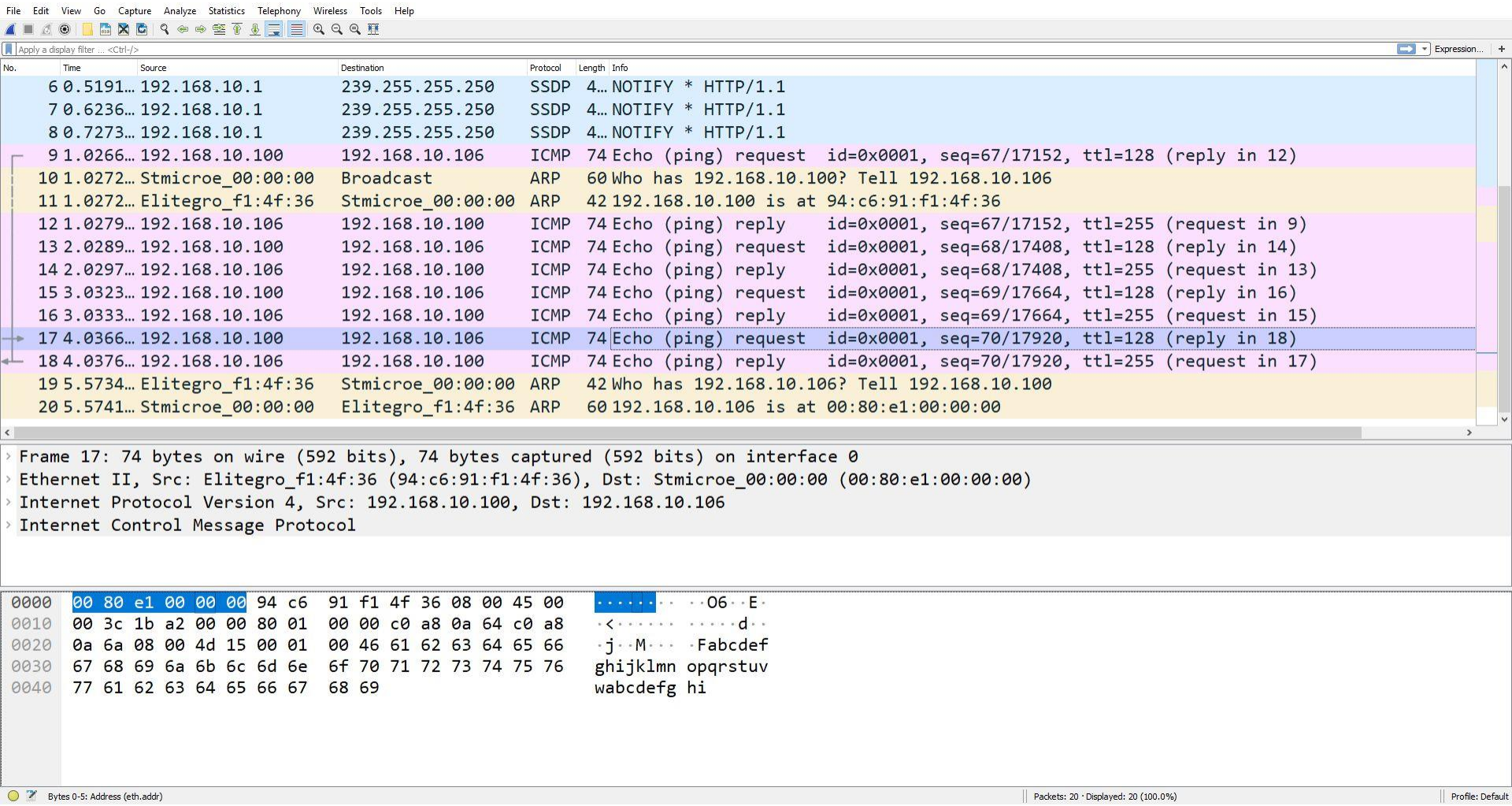
Easy TCP/IP for IoT

Firmware – NUCLEO-F767ZI: lwIP Module-DHCP Enabled

```
Microsoft Windows [Version 10.0.17763.737]
(c) 2018 Microsoft Corporation. All rights reserved.

C:\Users\fred>ping 192.168.10.106

Pinging 192.168.10.106 with 32 bytes of data:
Reply from 192.168.10.106: bytes=32 time<1ms TTL=255
Reply from 192.168.10.106: bytes=32 time<1ms TTL=255
Reply from 192.168.10.106: bytes=32 time<1ms TTL=255
Reply from 192.168.10.106: bytes=32 time<1ms TTL=255

Ping statistics for 192.168.10.106:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\Users\fred>_
```

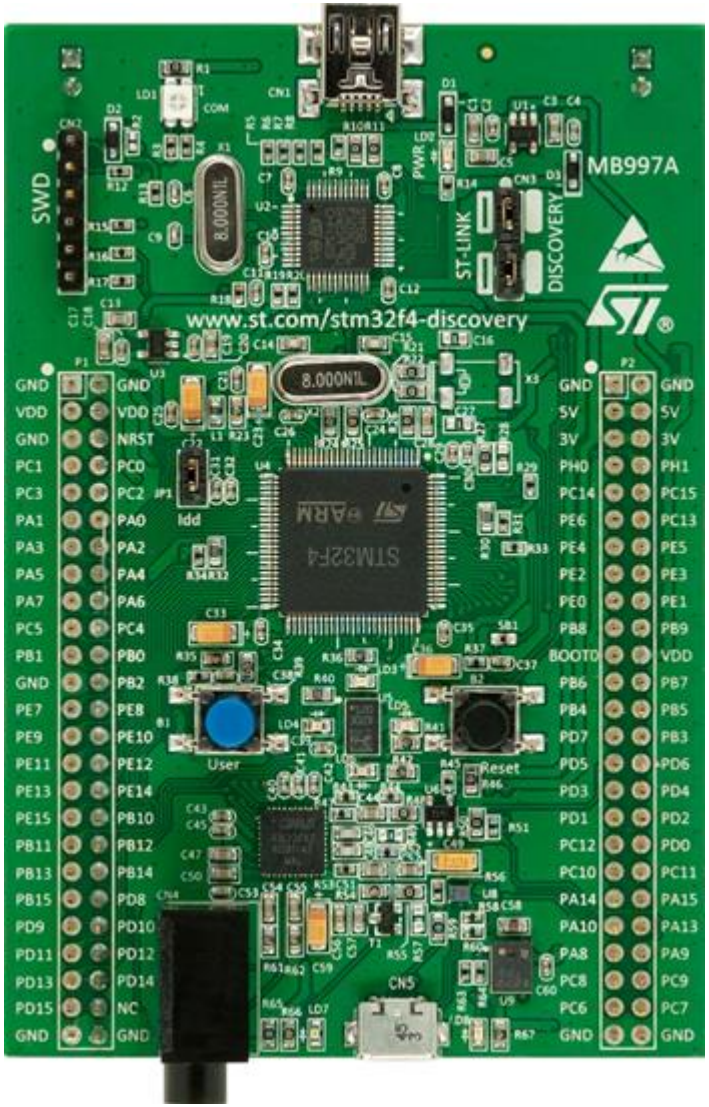
Easy TCP/IP for IoT

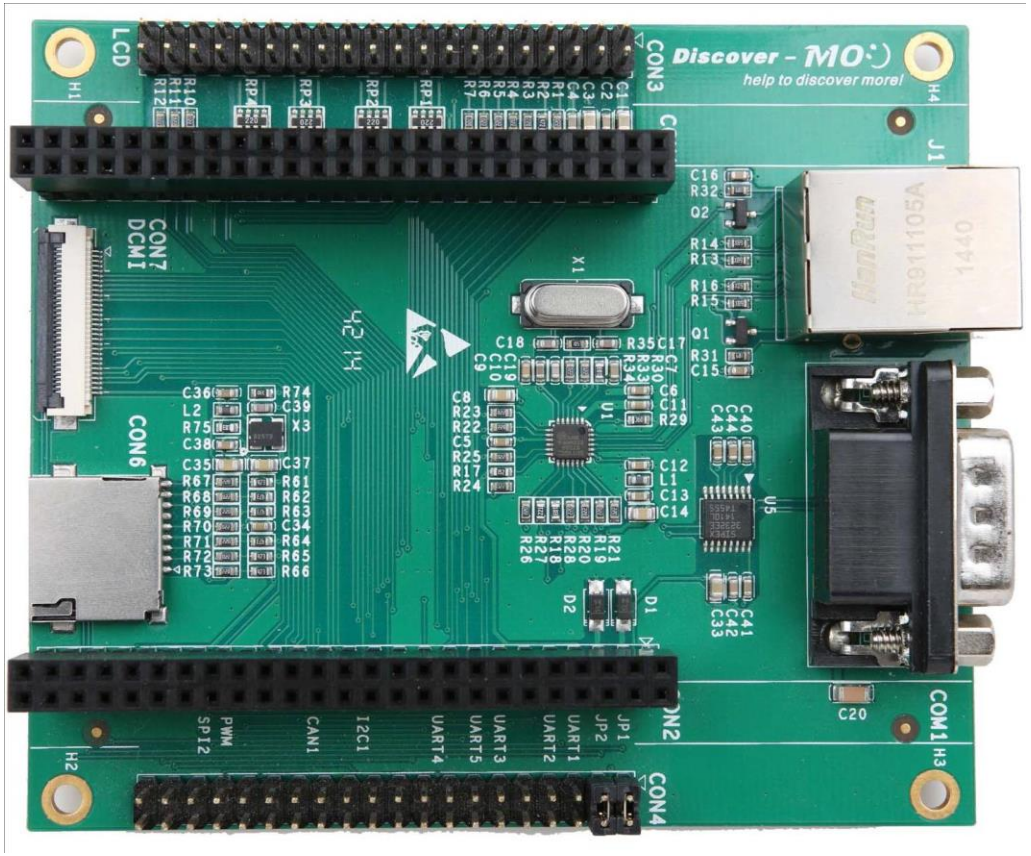
Firmware - NUCLEO-F767ZI: lwIP Module-DHCP Enabled



Easy TCP/IP for IoT

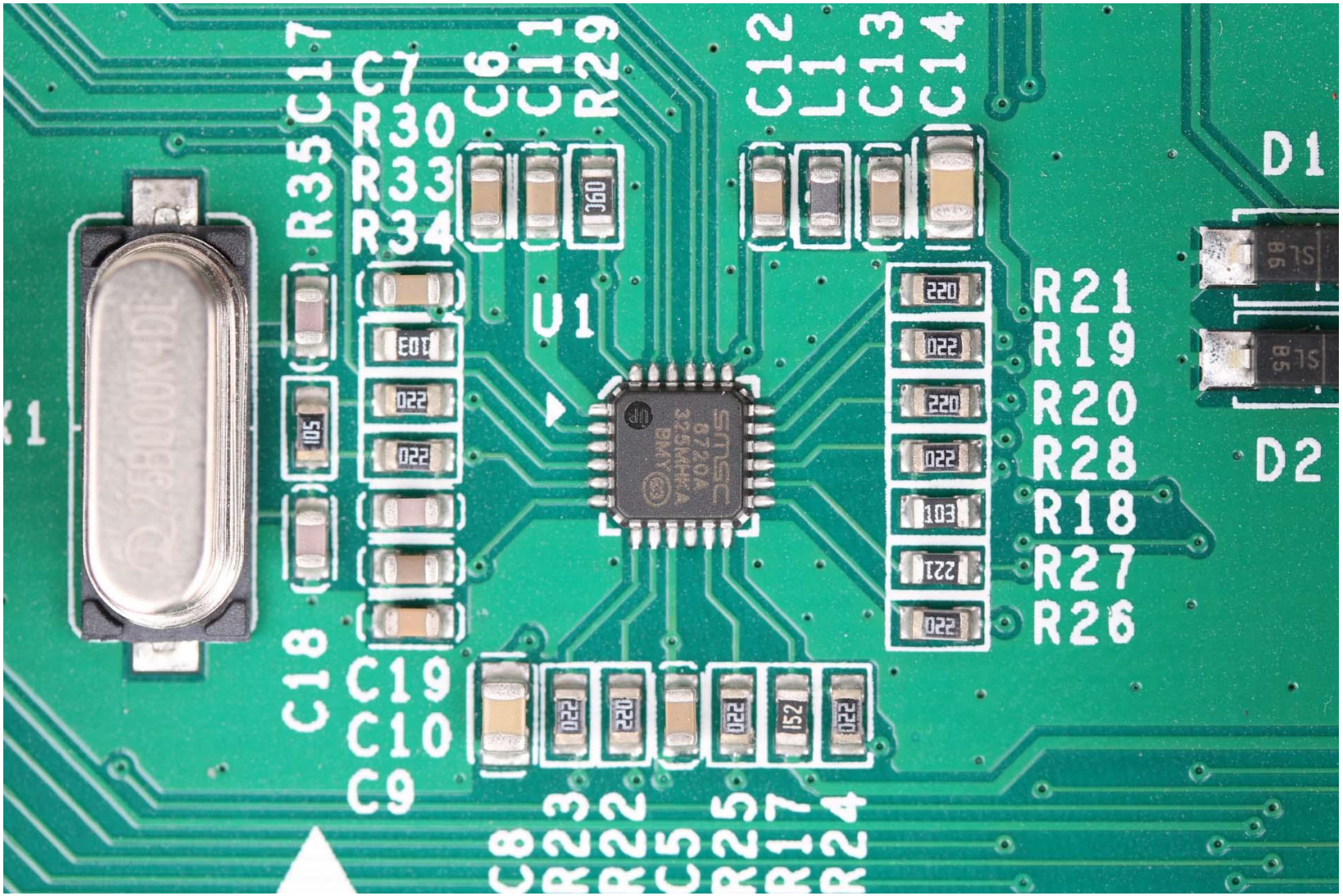
Hardware – STM32F4-Discovery





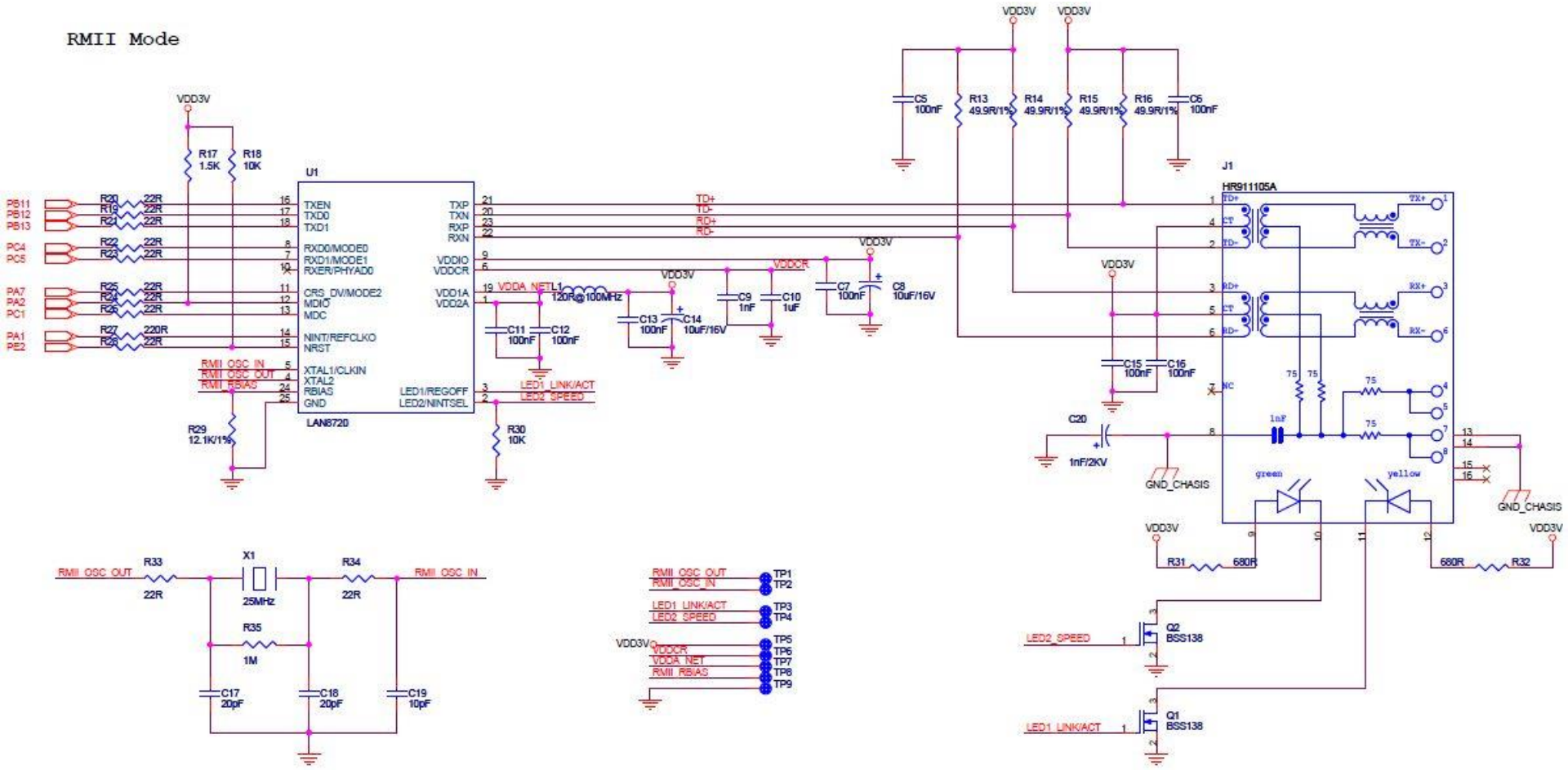
Easy TCP/IP for IoT

Hardware – STMF4-Discovery: Ethernet Module – LAN8720



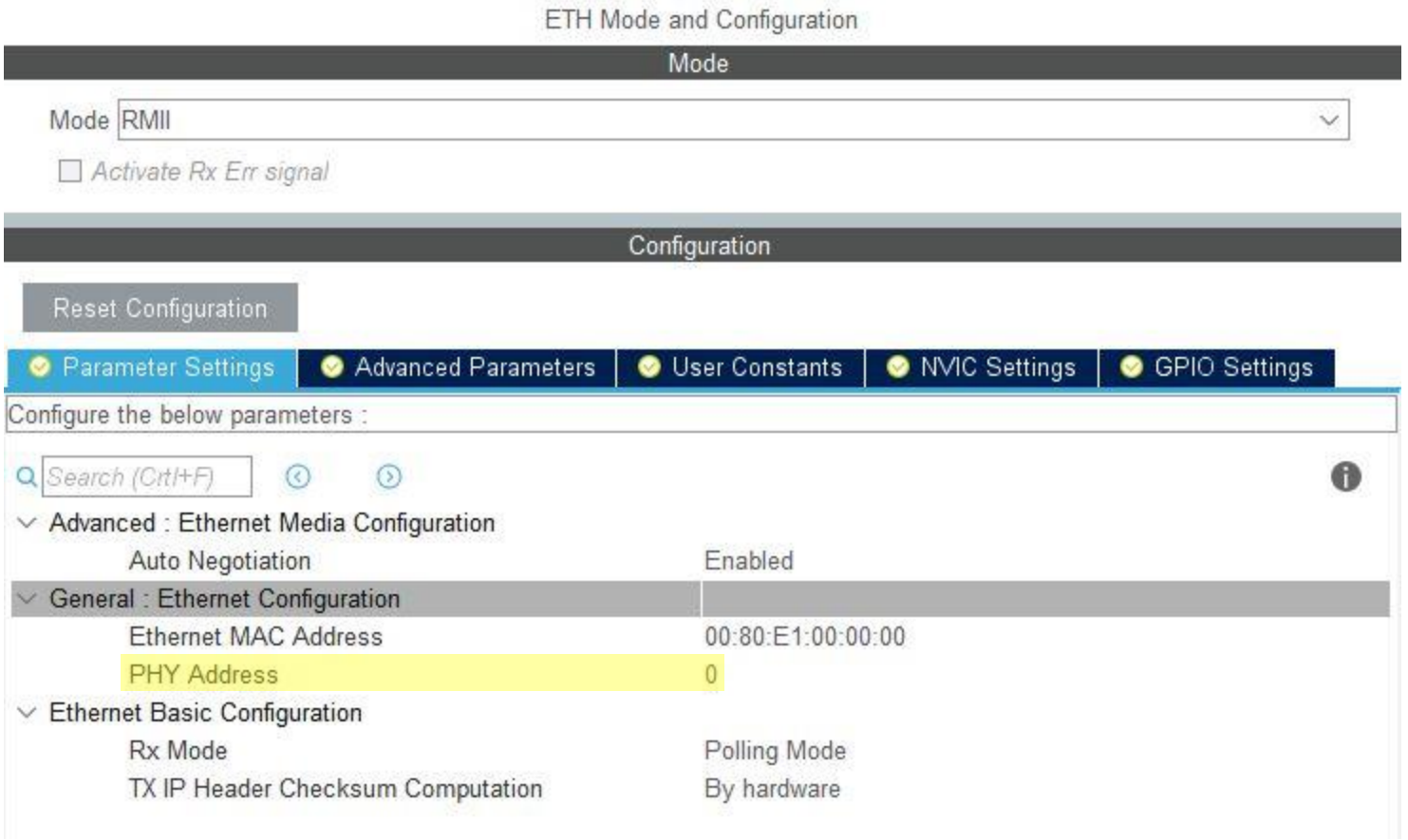
Easy TCP/IP for IoT

Hardware – STMF4-Discovery: Ethernet Module – LAN8720



Easy TCP/IP for IoT

Hardware – STMF4-Discovery: Ethernet Module



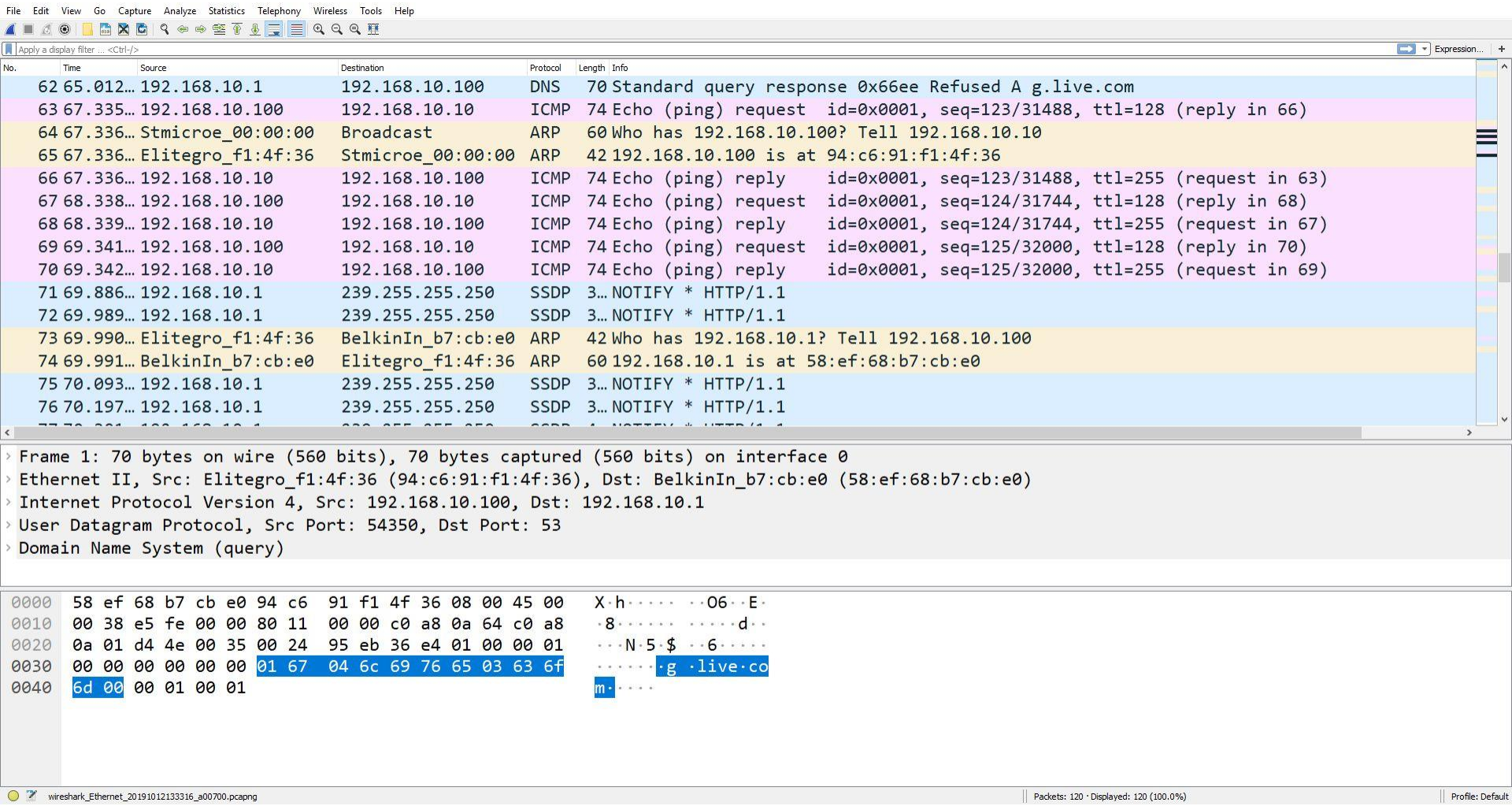
Easy TCP/IP for IoT

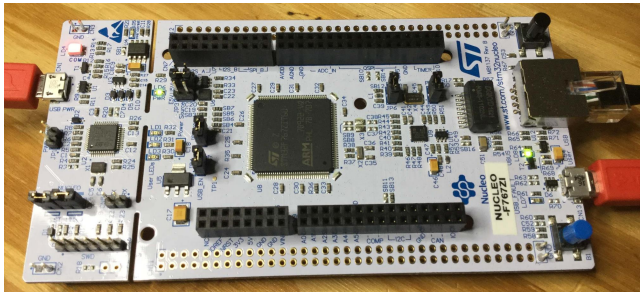
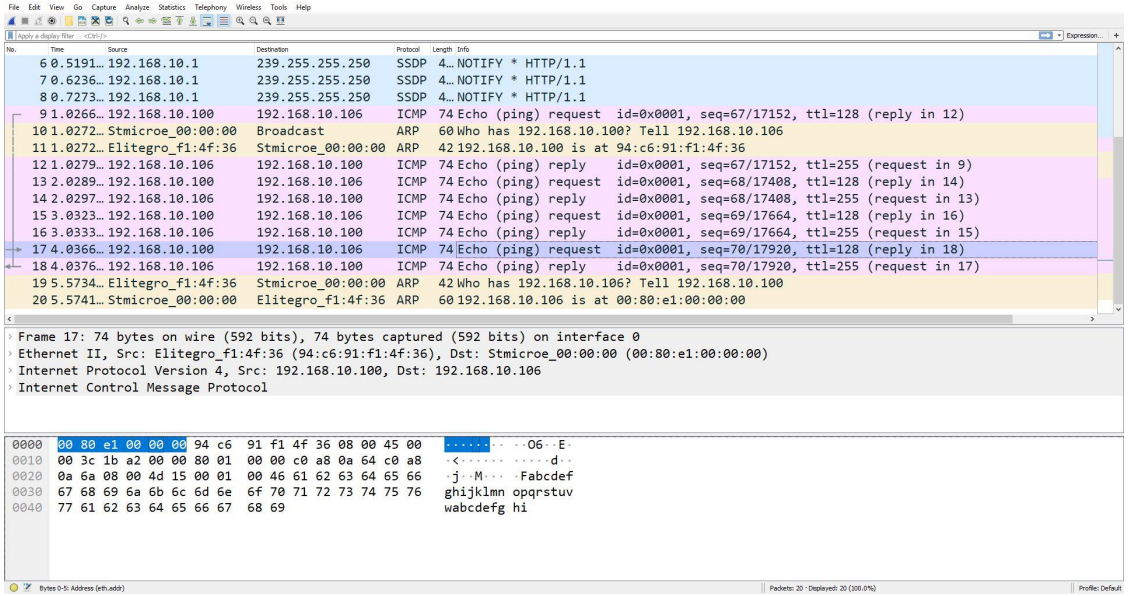
Firmware – STMF4-Discovery: lwIP Module – DHCP Disabled

```
Microsoft Windows [Version 10.0.17763.737]
(c) 2018 Microsoft Corporation. All rights reserved.

C:\Users\fred>ping 192.168.10.10

Pinging 192.168.10.10 with 32 bytes of data:
Reply from 192.168.10.10: bytes=32 time=1ms TTL=255
Reply from 192.168.10.10: bytes=32 time<1ms TTL=255
Reply from 192.168.10.10: bytes=32 time<1ms TTL=255
Reply from 192.168.10.10: bytes=32 time<1ms TTL=255

Ping statistics for 192.168.10.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms

C:\Users\fred>
```

Easy TCP/IP for IoT

Firmware – STMF4-Discovery: lwIP Module – DHCP Disabled



Easy TCP/IP for IoT

Day 4 Summary