



**DesignNews**

# Embedded Studio Primer

## DAY 5 : Nordic DFU

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# Webinar Logistics

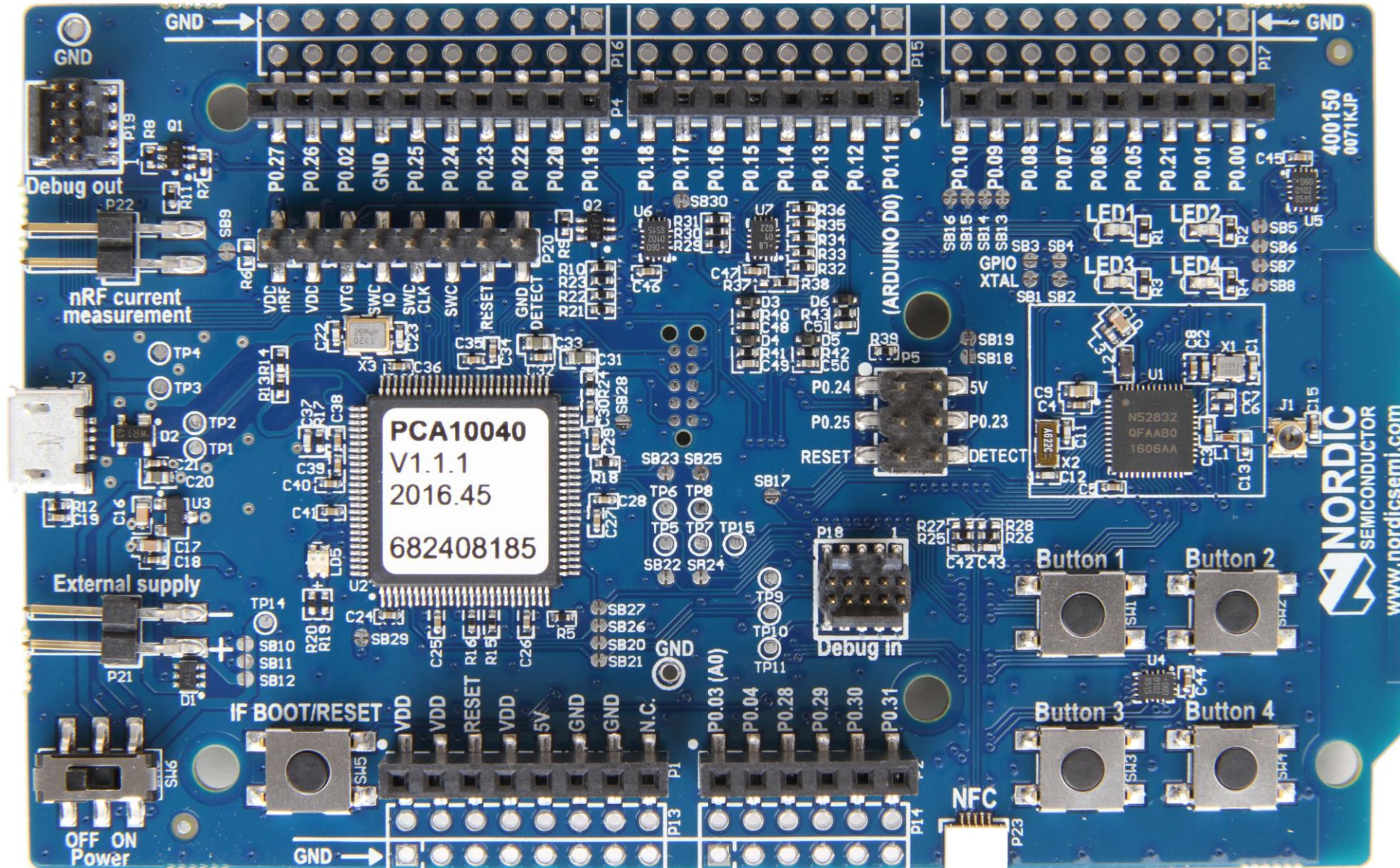
- Turn on your system sound to hear the streaming presentation.
- If you have technical problems, click “Help” or submit a question asking for assistance.
- Participate in ‘Group Chat’ by maximizing the chat widget in your dock.
- Submit questions for the lecturer using the Q&A widget. They will follow-up after the lecture portion concludes.



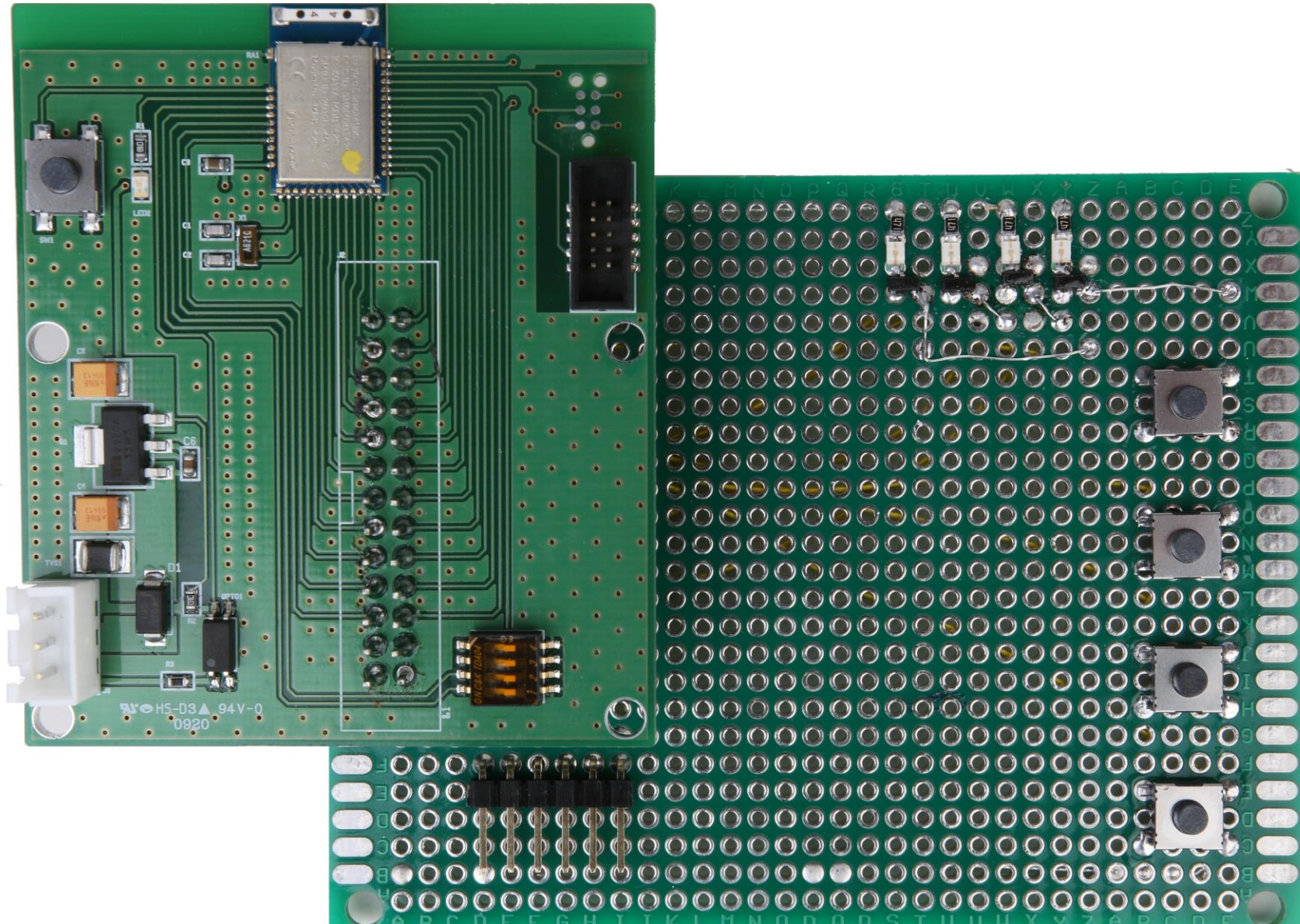
## **Fred Eady**

Visit 'Lecturer Profile' in your console for more details.





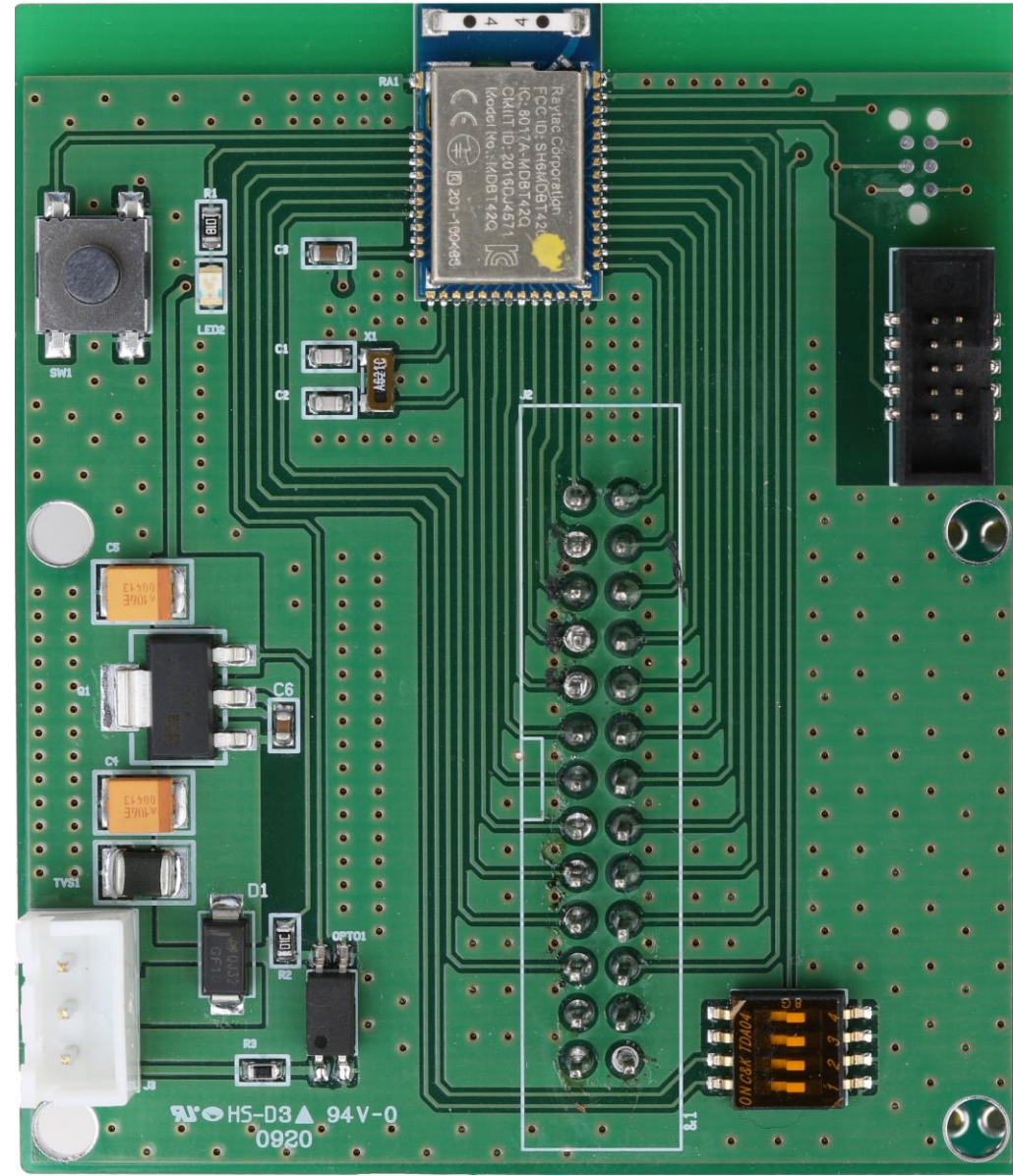






# AGENDA

- **DFU Prerequisites**
- **Private/Public Key Generation**
- **Build the Bootloader**
- **Generate DFU .zip Package**
- **Executing a DFU**



## SOFTWARE COMPONENTS:

- nRF5 SDK v17
- Python 3 with PIP
- nRFutil (python -m pip install nrfutil)
- GNU ARM Embedded Toolchain
- MinGW (Make)

## HARDWARE COMPONENTS:

- nRF5x Board
- BLE-Equipped Phone

NORDIC  
SEMICONDUCTOR



# Private/Public Key Generation

```
C:\WINDOWS\system32\cmd.exe
```

```
Microsoft Windows [Version 10.0.18363.900]  
(c) 2019 Microsoft Corporation. All rights reserved.
```

```
C:\Users\fred>nrfutil.exe keys generate private.key  
Generated private key and stored it in: private.key
```

```
C:\Users\fred>nrfutil keys display --key pk --format code private.key --out_file public_key.c
```

```
C:\Users\fred>
```



# Embedded Studio Primer

## Build the Bootloader

secure\_bootloader\_ble\_s132\_pca10040 - SEGGER Embedded Studio for ARM V4.52c (64-bit) - Licensed to Frederick Eady - Ongoing Systems LLC

File Edit View Search Navigate Project Build Debug Target Tools Window Help

Project: secure\_bootloader\_b Frame: Not debugging

Project Explorer

Project Items	Code	Data
Solution 'secure_bootloader_ble_s132_pca10040'		
Project 'secure_bootloader_ble_s132_pca10040'	21.8K	523.2K
Application 3 files	[170 bytes]	[64 bytes]
main.c	170 bytes	
public_key.c		64 bytes
sdk_config.h		
Board Definition 1 file	[358 bytes]	[8 bytes]
nano-pb 2 files		
None 3 files		
nRF_BLE 1 file		
nRF_Bootloader 7 files		
nRF_Crypto 5 files		
nRF_Crypto backend nRF sw 1 file		
nRF_Crypto backend Oberon 7 files		
nRF_Crypto backend uECC 3 files		
nRF_DFU 13 files		
nRF_Drivers 2 files		
nRF_Libraries 20 files		
nRF_Log 2 files		
nRF_micro-ecc 1 file		
nRF_Oberon_Crypto 1 file		
nRF_SoftDevice 3 files		
nRF_SVC 3 files		
Segger Startup Files 1 file		
Output Files		

main.c

```
120     break;
    default:
        break;
    }
}

/**@brief Function for application main entry. */
int main(void)
{
    uint32_t ret_val;

130    // Must happen before flash protection is applied, since it edits a protected page.
    nrf_bootloader_mbr_addr populate();

    // Protect MBR and bootloader code from being overwritten.
    ret_val = nrf_bootloader_flash_protect(0, MBR_SIZE);
    APP_ERROR_CHECK(ret_val);
    ret_val = nrf_bootloader_flash_protect(BOOTLOADER_START_ADDR, BOOTLOADER_SIZE);
    APP_ERROR_CHECK(ret_val);

140    (void) NRF_LOG_INIT(nrf_bootloader_dfu_timer_counter_get);
    NRF_LOG_DEFAULT_BACKENDS_INIT();

    NRF_LOG_INFO("Inside main");

    ret_val = nrf_bootloader_init(dfu_observer);
    APP_ERROR_CHECK(ret_val);

    NRF_LOG_FLUSH();

150    NRF_LOG_ERROR("After main, should never be reached.");
    NRF_LOG_FLUSH();

    APP_ERROR_CHECK_BOOL(false);
}

/**
 * @}
 */
```

# Embedded Studio Primer

## Build the Bootloader

This PC > Acer (C:) > Users > Public > nRF5\_SDK\_17.0.0\_9d13099 > external > micro-ecc

Name	Date modified	Type	Size
micro-ecc	7/6/2020 3:48 PM	File folder	
nrf51_armgcc	6/27/2020 2:31 PM	File folder	
nrf51_iar	6/27/2020 2:31 PM	File folder	
nrf51_keil	6/27/2020 2:31 PM	File folder	
nrf52hf_armgcc	6/27/2020 2:31 PM	File folder	
nrf52hf_iar	6/27/2020 2:31 PM	File folder	
nrf52hf_keil	6/27/2020 2:31 PM	File folder	
nrf52nf_armgcc	6/27/2020 2:31 PM	File folder	
nrf52nf_iar	6/27/2020 2:31 PM	File folder	
nrf52nf_keil	6/27/2020 2:31 PM	File folder	
build_all.bat	6/12/2020 9:52 PM	Windows Batch File	1 KB
build_all.sh	6/12/2020 9:52 PM	Shell Script	1 KB
license.txt	6/12/2020 9:52 PM	Text Document	2 KB



# Embedded Studio Primer

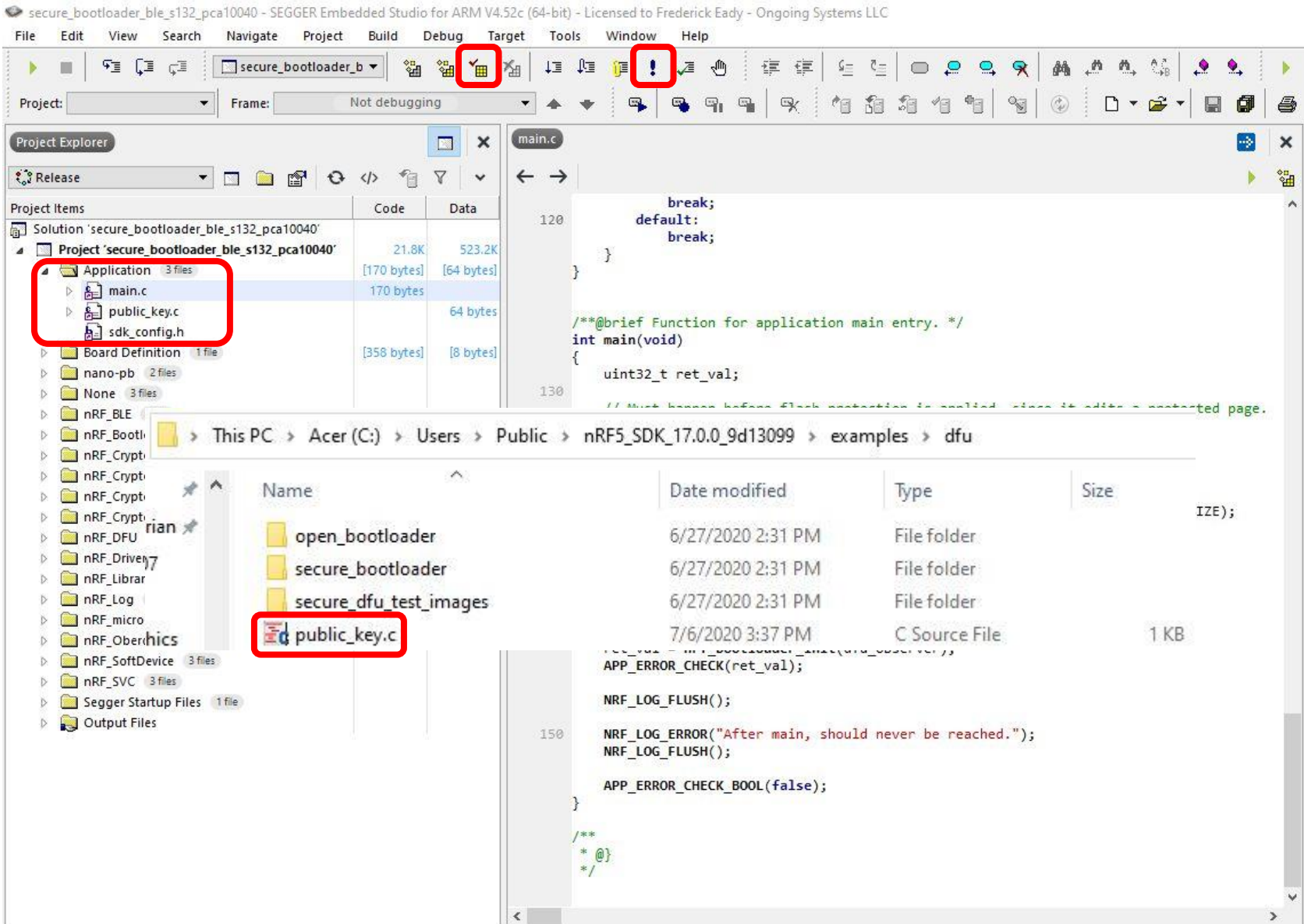
## Build the Bootloader

This PC > Acer (C:) > Users > Public > nRF5\_SDK\_17.0.0\_9d13099 > external > micro-ecc > micro-ecc

Name	Date modified	Type	Size
scripts	7/6/2020 3:48 PM	File folder	
test	7/6/2020 3:48 PM	File folder	
.gitignore	6/19/2017 6:52 PM	Text Document	1 KB
asm_arm.inc	6/19/2017 6:52 PM	INC File	29 KB
asm_arm_mult_square.inc	6/19/2017 6:52 PM	INC File	98 KB
asm_arm_mult_square_umaal.inc	6/19/2017 6:52 PM	INC File	51 KB
asm_avr.inc	6/19/2017 6:52 PM	INC File	32 KB
asm_avr_mult_square.inc	6/19/2017 6:52 PM	INC File	909 KB
curve-specific.inc	6/19/2017 6:52 PM	INC File	50 KB
emk_project.py	6/19/2017 6:52 PM	Python File	5 KB
emk_rules.py	6/19/2017 6:52 PM	Python File	1 KB
library.properties	6/19/2017 6:52 PM	PROPERTIES File	1 KB
LICENSE.txt	6/19/2017 6:52 PM	Text Document	2 KB
platform-specific.inc	6/19/2017 6:52 PM	INC File	2 KB
README.md	6/19/2017 6:52 PM	MD File	3 KB
types.h	6/19/2017 6:52 PM	JetBrains CLion	3 KB
uECC.c	6/19/2017 6:52 PM	C Source File	55 KB
uECC.h	6/19/2017 6:52 PM	JetBrains CLion	14 KB
uECC_vli.h	6/19/2017 6:52 PM	JetBrains CLion	7 KB

# Embedded Studio Primer

## Build the Bootloader



secure\_bootloader\_ble\_s132\_pca10040 - SEGGER Embedded Studio for ARM V4.52c (64-bit) - Licensed to Frederick Eady - Ongoing Systems LLC

File Edit View Search Navigate Project Build Debug Target Tools Window Help

Project: secure\_bootloader\_b Frame: Not debugging

Project Explorer

Project Items	Code	Data
Solution 'secure_bootloader_ble_s132_pca10040'		
Project 'secure_bootloader_ble_s132_pca10040'	21.8K	523.2K
Application (3 files)		
main.c	[170 bytes]	[64 bytes]
public_key.c	[170 bytes]	[64 bytes]
sdk_config.h		
Board Definition (1 file)	[358 bytes]	[8 bytes]
nano-pb (2 files)		
None (3 files)		
nRF_BLE		
nRF_Bootl		
nRF_Crypt		
nRF_Crypt		
nRF_Crypt		
nRF_Crypt		
nRF_DFUs		
nRF_Driver		
nRF_Librar		
nRF_Log		
nRF_micro		
nRF_Ober		
nRF_SoftDevice		
nRF_SVC		
Segger Startup Files (1 file)		
Output Files		

```
main.c
120     break;
121     default:
122     break;
123 }
124
125 /**@brief Function for application main entry. */
126 int main(void)
127 {
128     uint32_t ret_val;
129
130     // Must know before flash operation is applied, since it edits a protected page.
131
132     APP_ERROR_CHECK(ret_val);
133
134     NRF_LOG_FLUSH();
135
136     NRF_LOG_ERROR("After main, should never be reached.");
137     NRF_LOG_FLUSH();
138
139     APP_ERROR_CHECK_BOOL(false);
140 }
141
142 /**
143 * @}
144 */
```

This PC > Acer (C:) > Users > Public > nRF5\_SDK\_17.0.0\_9d13099 > examples > dfu

Name	Date modified	Type	Size
open_bootloader	6/27/2020 2:31 PM	File folder	
secure_bootloader	6/27/2020 2:31 PM	File folder	
secure_dfu_test_images	6/27/2020 2:31 PM	File folder	
public_key.c	7/6/2020 3:37 PM	C Source File	1 KB



## Generate DFU .zip Package

ble\_app\_blinky\_pca10040\_s132 - SEGGER Embedded Studio for ARM V4.52c (64-bit) - Licensed to Frederick Eady - Ongoing Systems LLC

File Edit View Search Navigate Project Build Debug Target Tools Window Help

Project: ble\_app\_blinky\_pca1 Frame: Not debugging

Project Explorer

Release

Project Items	Code	Data
Solution 'ble_app_blinky_pca10040_s132'		
Project 'ble_app_blinky_pca10040_s132'	18.9K	182.7K
Application 2 files	[1.0K]	[299 bytes]
main.c	1.0K	299 bytes
sdk_config.h		
Board Definition 1 file		
None 3 files		
nRF_BLE 6 files		
nRF_BLE_Services 1 file		
nRF_Drivers 8 files		
nRF_Libraries 22 files		
nRF_Log 6 files		
nRF_Segger_RTT 3 files		
nRF_SoftDevice 3 files		
Segger Startup Files 1 file		
UTF8/UTF16 converter 1 file		
Output Files		

main.c

```
static void idle_state_handle(void)
{
    if (NRF_LOG_PROCESS() == false)
    {
        nrf_pwr_mgmt_run();
    }
}

/**@brief Function for application main entry.
*/
int main(void)
{
    // Initialize.
    log_init();
    leds_init();
    timers_init();
    buttons_init();
    power_management_init();
    ble_stack_init();
    gap_params_init();
    gatt_init();
    services_init();
    advertising_init();
    conn_params_init();

    // Start execution.
    NRF_LOG_INFO("Blinky example started.");
    advertising_start();

    // Enter main loop.
    for (;;)
    {
        idle_state_handle();
    }
}
```

# Generate DFU .zip Package



C:\Users\Public\nRF5\_SDK\_17.0.0\_9d13099\components\toolchain\gcc\Makefile.windows - Notepad++

File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?

Wire.cpp x main.c x main\_I2C\_READ\_ID.c x Makefile x build\_all.bat x ext\_micro\_ecc\_gcc\_nRF5x.ld x Makefile x Makefile.windows x

```
1 GNU_INSTALL_ROOT := C:/Program Files (x86)/GNU Arm Embedded Toolchain/9 2020-q2-update/bin/  
2 GNU_VERSION := 9.3.1  
3 GNU_PREFIX := arm-none-eabi
```



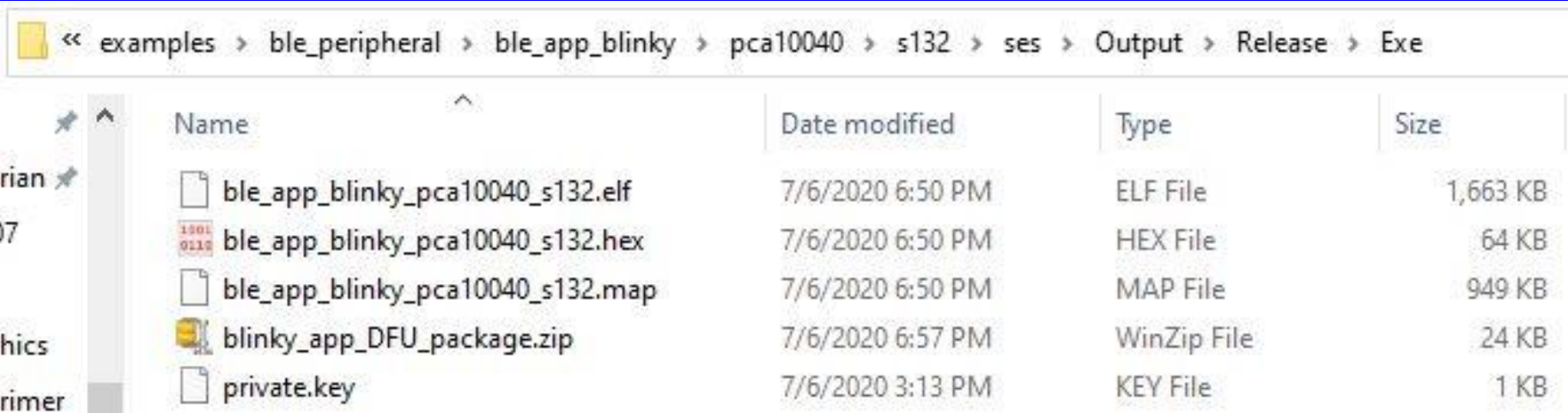
# Generate DFU .zip Package

```
C:\WINDOWS\system32\cmd.exe
Microsoft Windows [Version 10.0.18363.900]
(c) 2019 Microsoft Corporation. All rights reserved.

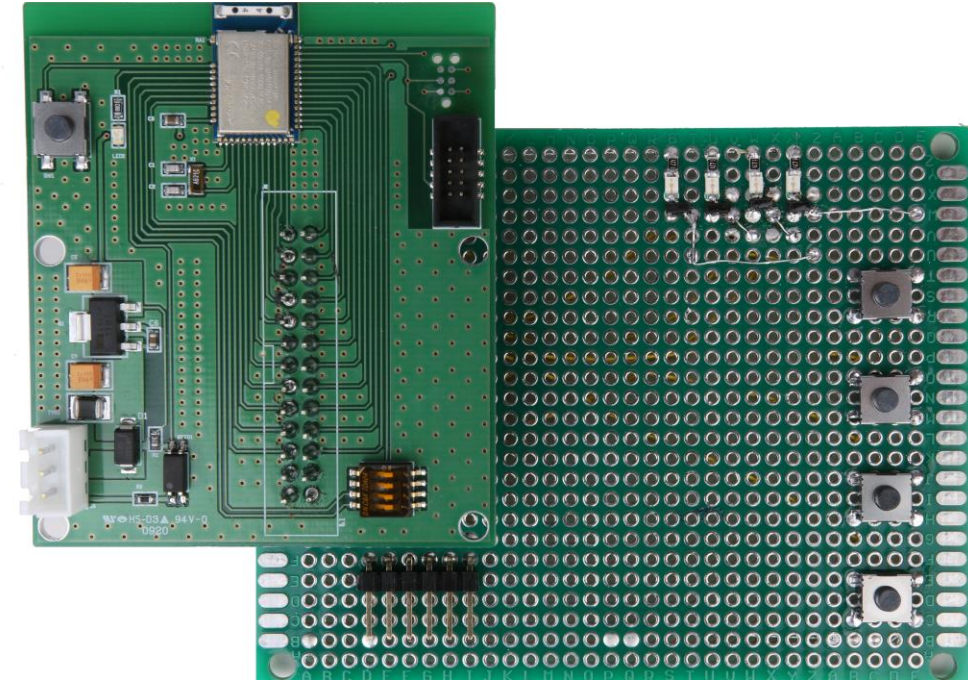
C:\Users\fred>cd C:\Users\Public\nRF5_SDK_17.0.0_9d13099\examples\ble_peripheral\ble_app_blinky\pca10040\s132\ses\Output\Release\Exe

C:\Users\Public\nRF5_SDK_17.0.0_9d13099\examples\ble_peripheral\ble_app_blinky\pca10040\s132\ses\Output\Release\Exe>nrfutil pkg generate --hw-version 52 --application-version 1 --application ble_app_blinky_pca10040_s132.hex --sd-req 0xCB --key-file private.key blinky_app_DFU_package.zip
Zip created at blinky_app_DFU_package.zip

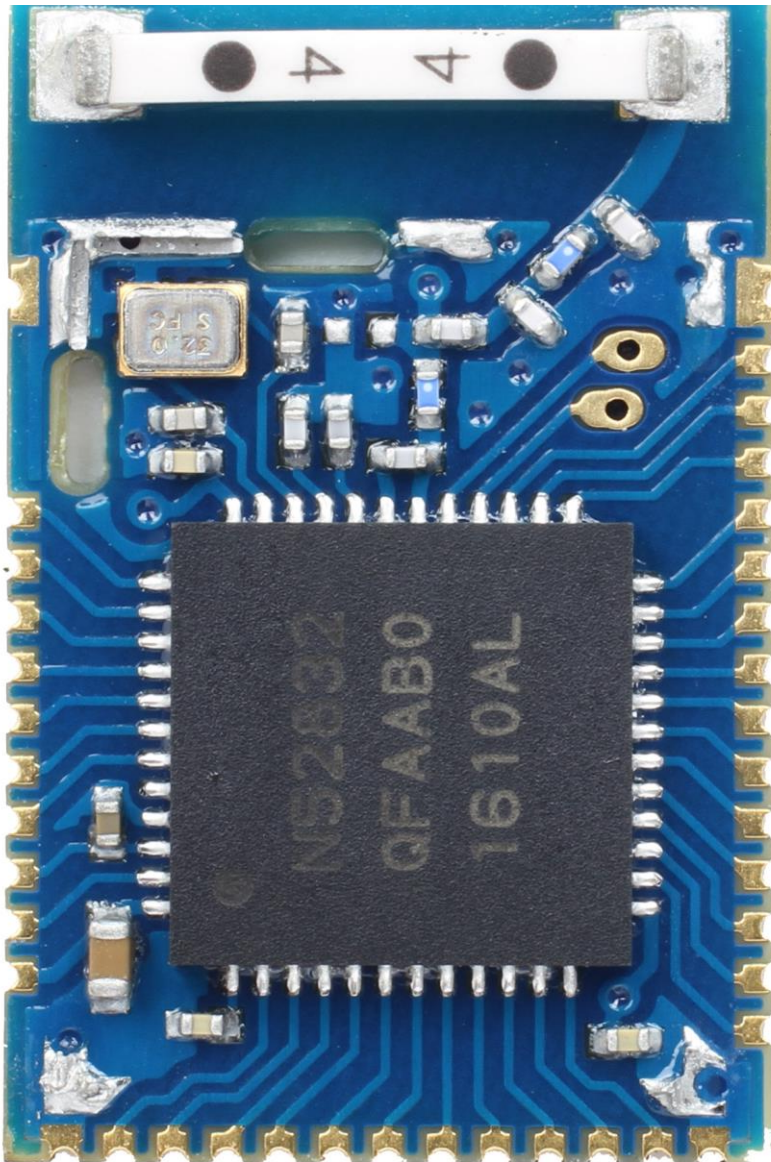
C:\Users\Public\nRF5_SDK_17.0.0_9d13099\examples\ble_peripheral\ble_app_blinky\pca10040\s132\ses\Output\Release\Exe>
```



Name	Date modified	Type	Size
ble_app_blinky_pca10040_s132.elf	7/6/2020 6:50 PM	ELF File	1,663 KB
ble_app_blinky_pca10040_s132.hex	7/6/2020 6:50 PM	HEX File	64 KB
ble_app_blinky_pca10040_s132.map	7/6/2020 6:50 PM	MAP File	949 KB
blinky_app_DFU_package.zip	7/6/2020 6:57 PM	WinZip File	24 KB
private.key	7/6/2020 3:13 PM	KEY File	1 KB







nRF Connect v3.4.1 - Programmer

000174301702

nRF52832

File memory layout

Region name  
SoftDevice

Address range  
0x00001000 – 0x000258BF

Size  
149696 bytes

File

- Add HEX file
- Reload files
- Clear files

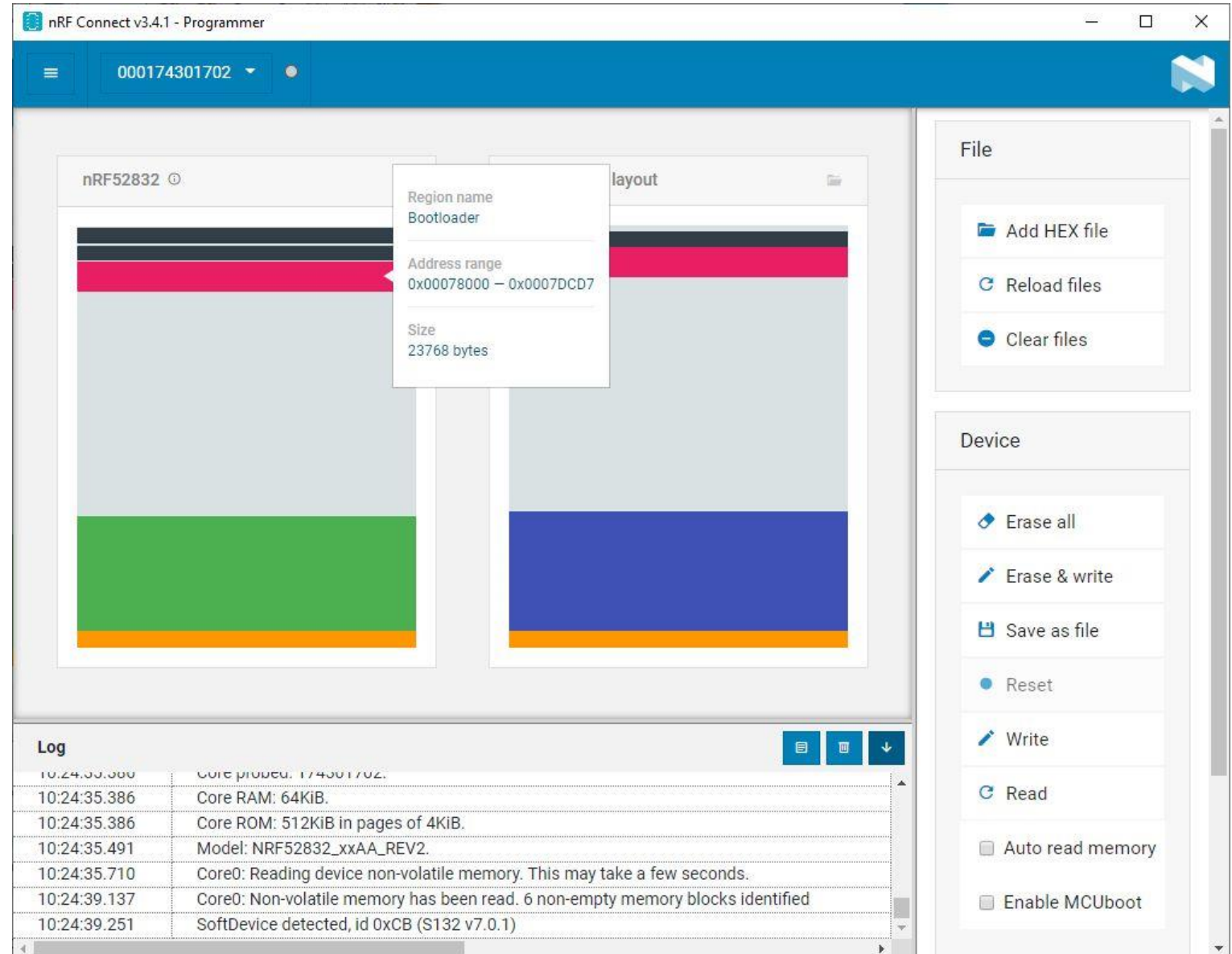
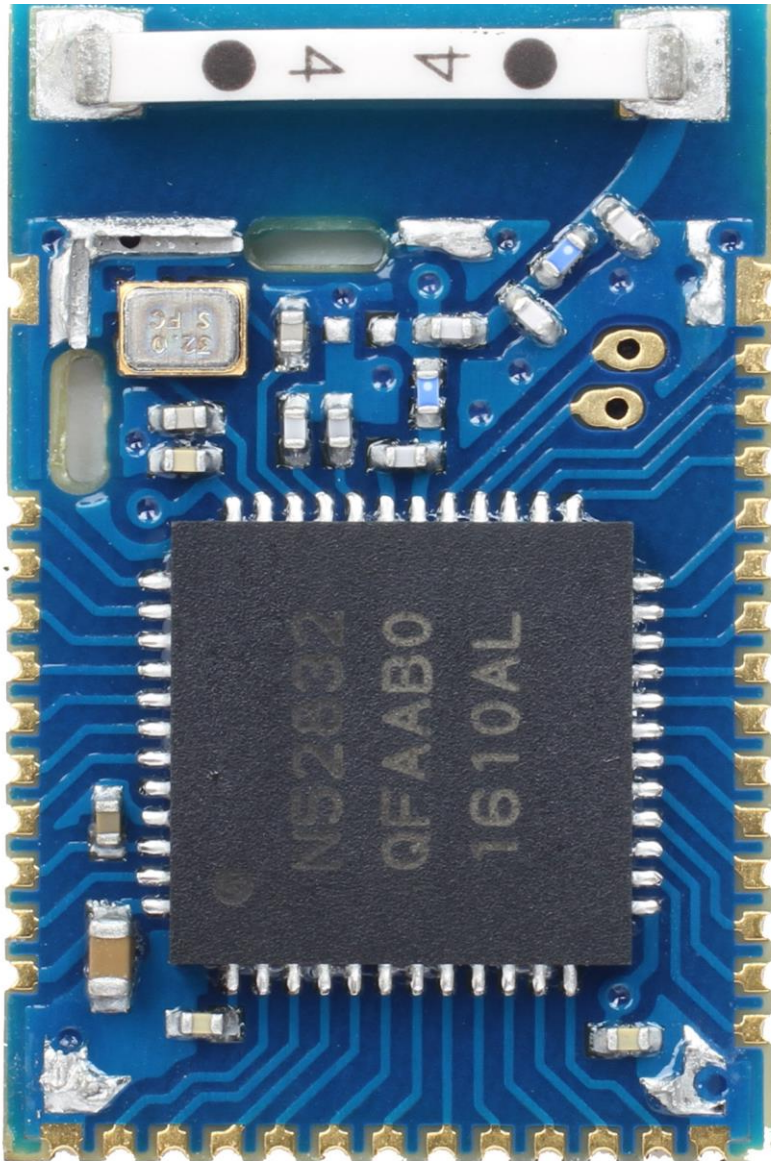
Device

- Erase all
- Erase & write
- Save as file
- Reset
- Write
- Read
- Auto read memory
- Enable MCUboot

Log

10:22:05.300	Core RAM: 64KIB.
10:22:05.368	Core ROM: 512KIB in pages of 4KIB.
10:22:05.477	Model: NRF52832_xxAA_REV2.
10:22:05.698	Core0: Reading device non-volatile memory. This may take a few seconds.
10:22:09.129	Core0: Non-volatile memory has been read. 3 non-empty memory blocks identified
10:22:09.235	SoftDevice detected, id 0xCB (S132 v7.0.1)
10:22:09.236	SoftDevice detected, id 0xCB (S132 v7.0.1)





nRF Connect v3.4.1 - Programmer

000174301702

nRF52832

layout

Region name  
Bootloader

Address range  
0x00078000 – 0x0007DCD7

Size  
23768 bytes

File

- Add HEX file
- Reload files
- Clear files

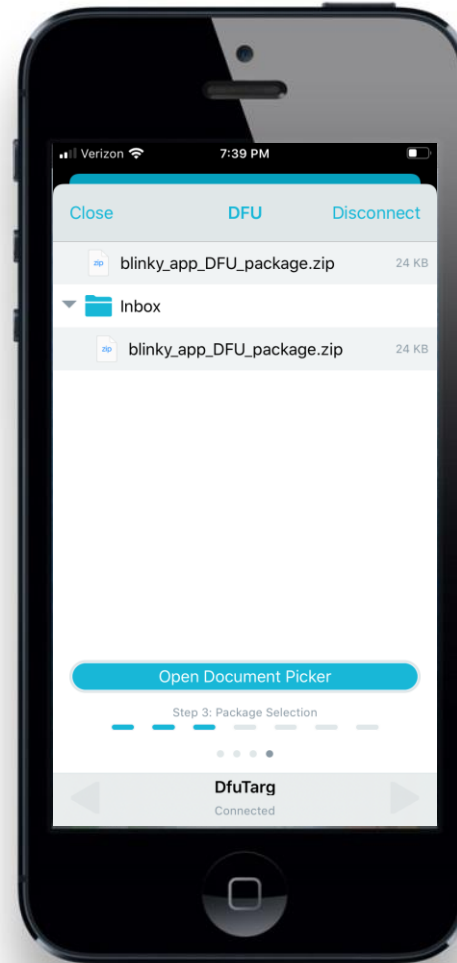
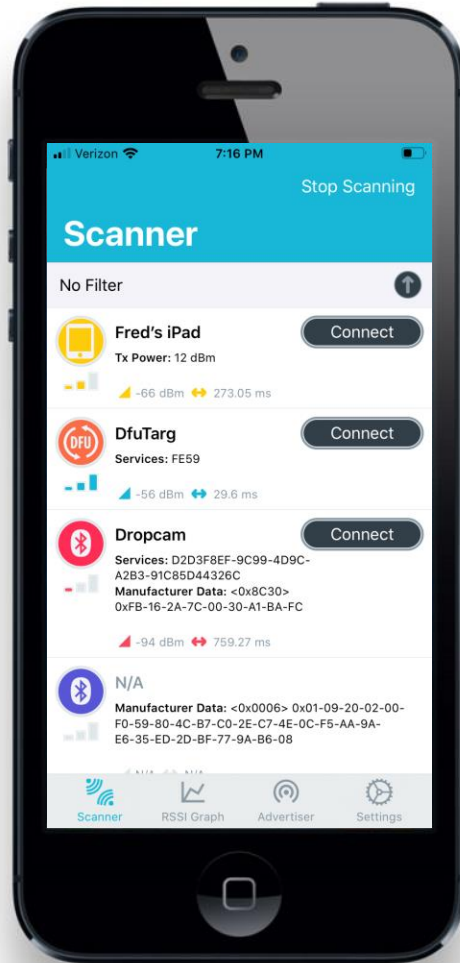
Device

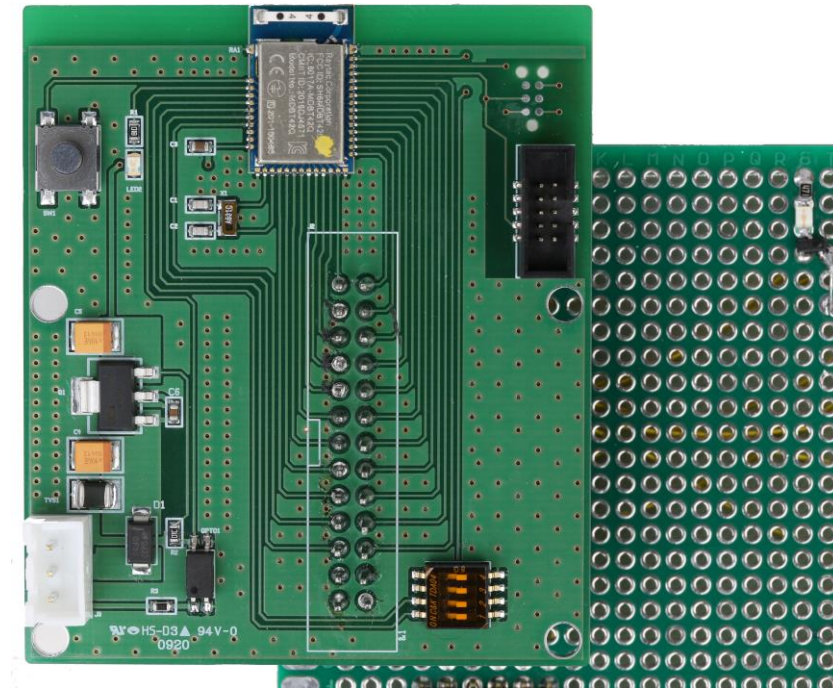
- Erase all
- Erase & write
- Save as file
- Reset
- Write
- Read
- Auto read memory
- Enable MCUboot

Log

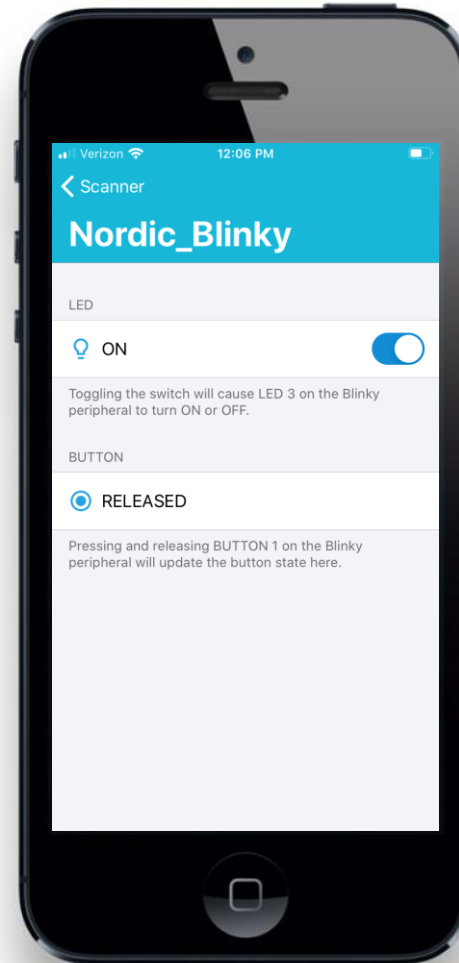
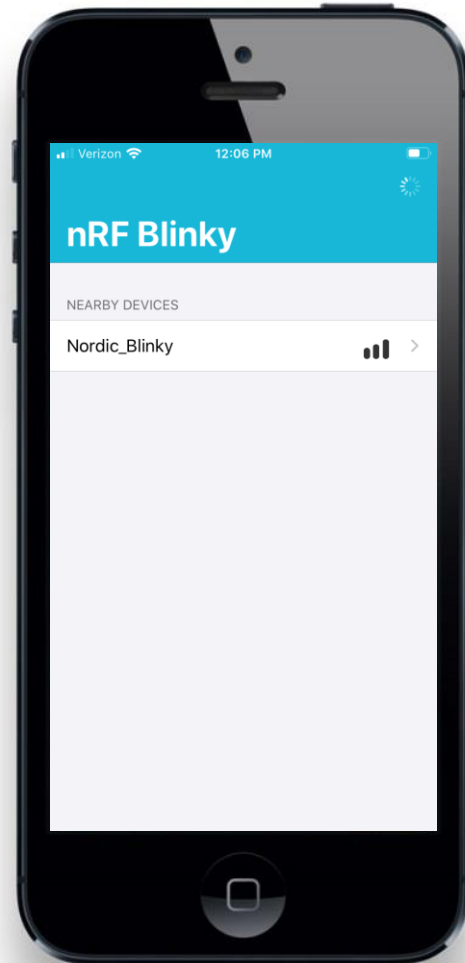
10:24:35.388	Core probed: 174301702.
10:24:35.386	Core RAM: 64KiB.
10:24:35.386	Core ROM: 512KiB in pages of 4KiB.
10:24:35.491	Model: NRF52832_xxAA_REV2.
10:24:35.710	Core0: Reading device non-volatile memory. This may take a few seconds.
10:24:39.137	Core0: Non-volatile memory has been read. 6 non-empty memory blocks identified
10:24:39.251	SoftDevice detected, id 0xCB (S132 v7.0.1)

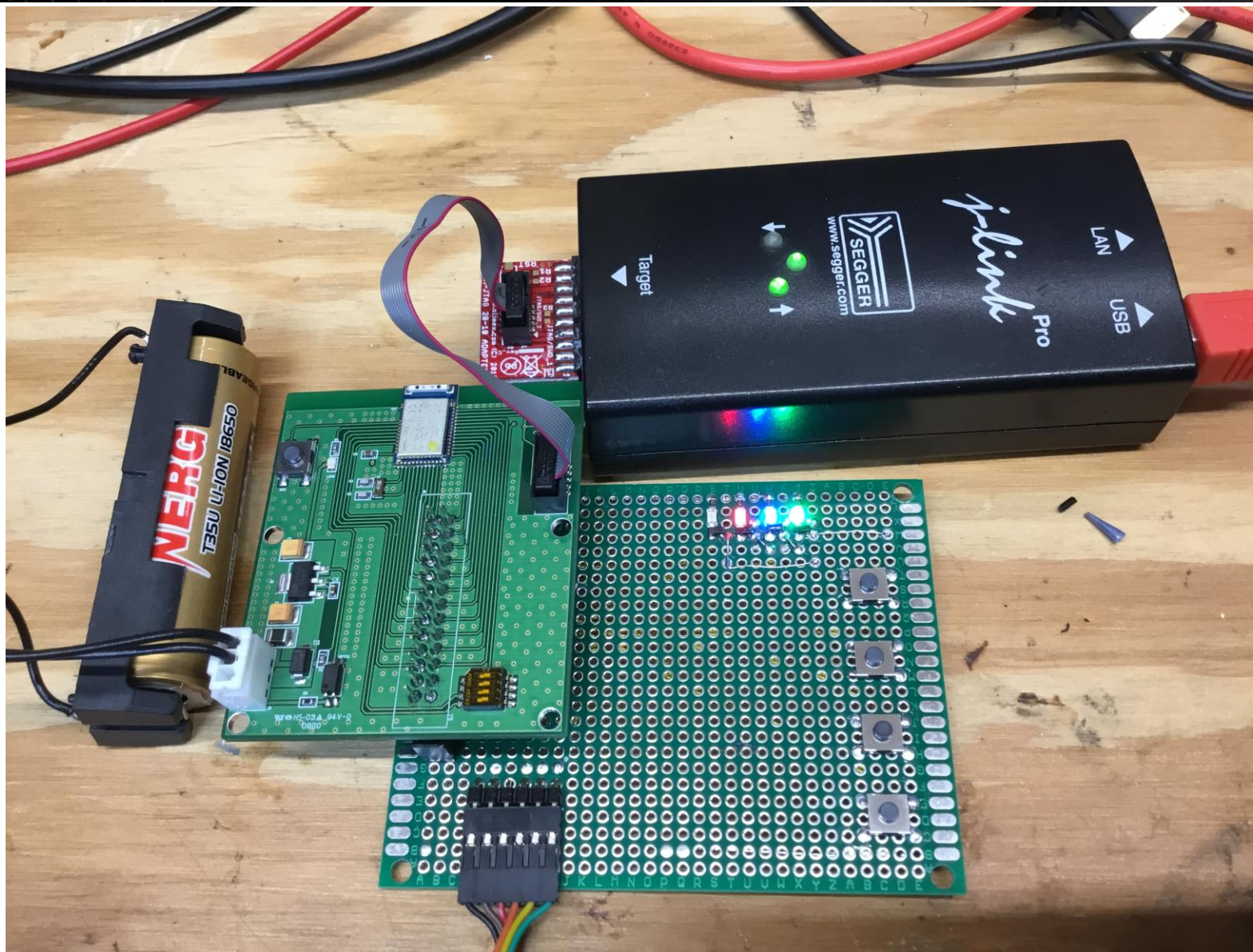














# Thank you for attending

Please consider the resources below:

- [http://developer.nordicsemi.com/nRF5\\_SDK/](http://developer.nordicsemi.com/nRF5_SDK/)
- <http://docs.python-guide.org/en/latest/>
- <https://developer.arm.com/tools-and-software/open-source-software/developer-tools/gnu-toolchain/gnu-rm/downloads/9-2020-q2-update>
- <http://www.mingw.org/>
- <https://github.com/NordicSemiconductor/pc-nrfutil/releases>
- <https://github.com/kmackay/micro-ecc>



Thank You

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