UCSD Embedded C Final Project

By

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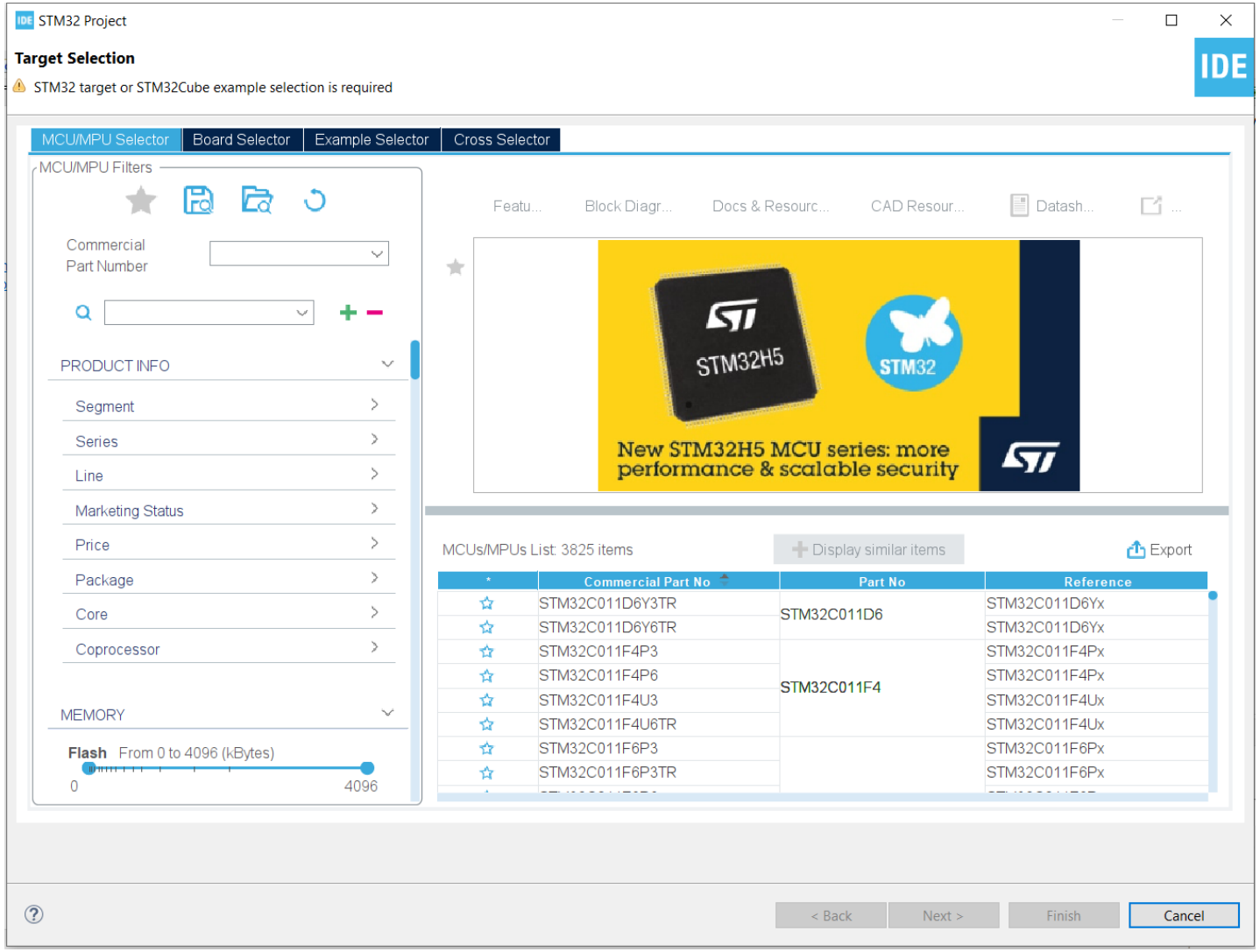
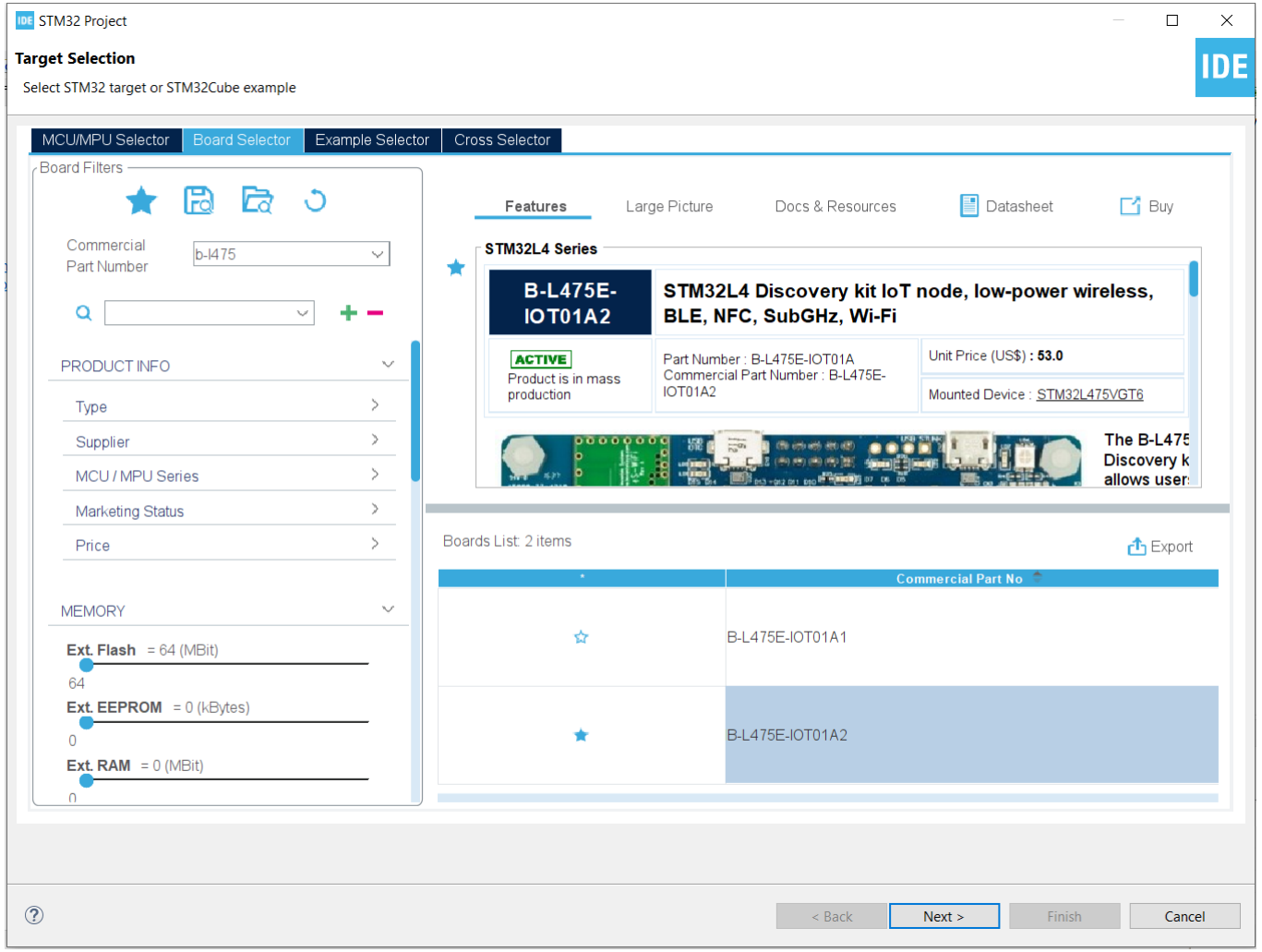
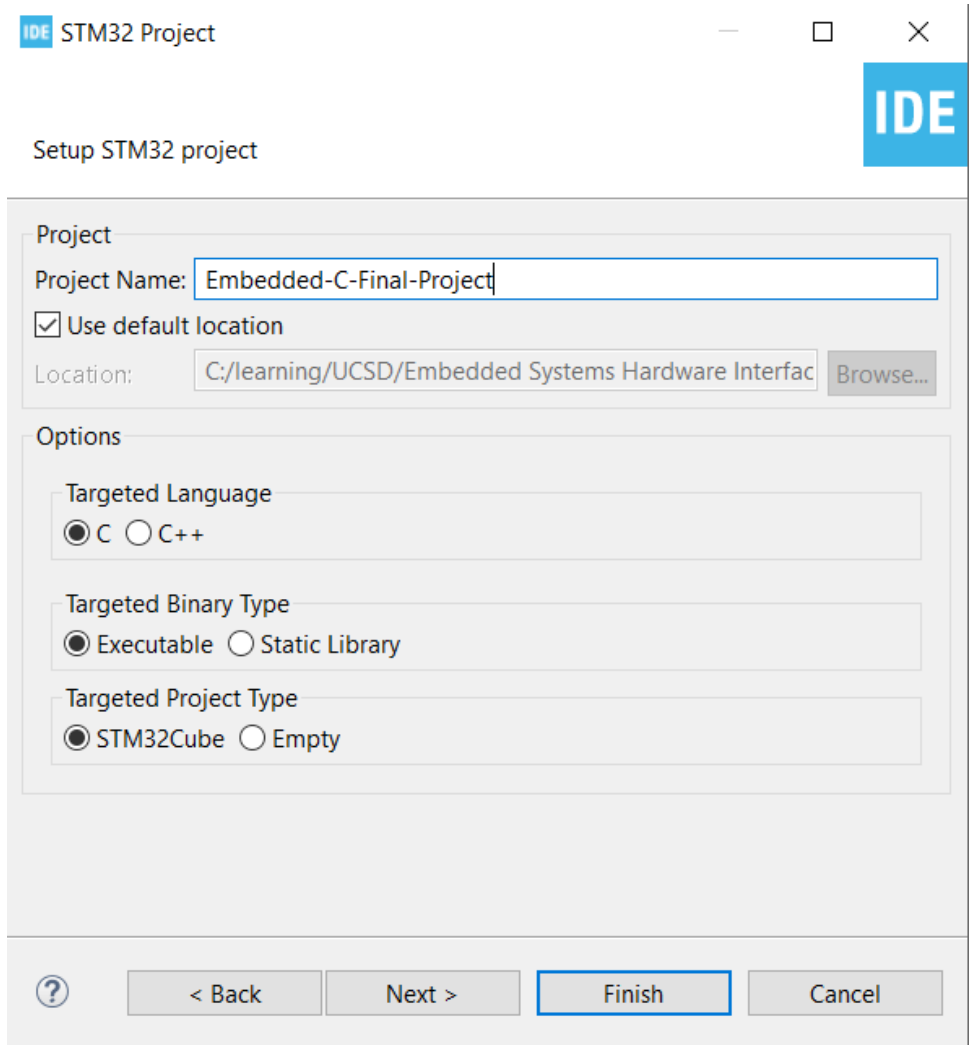
Step 1. Startup STM32CubeIDE and create new STM32 project



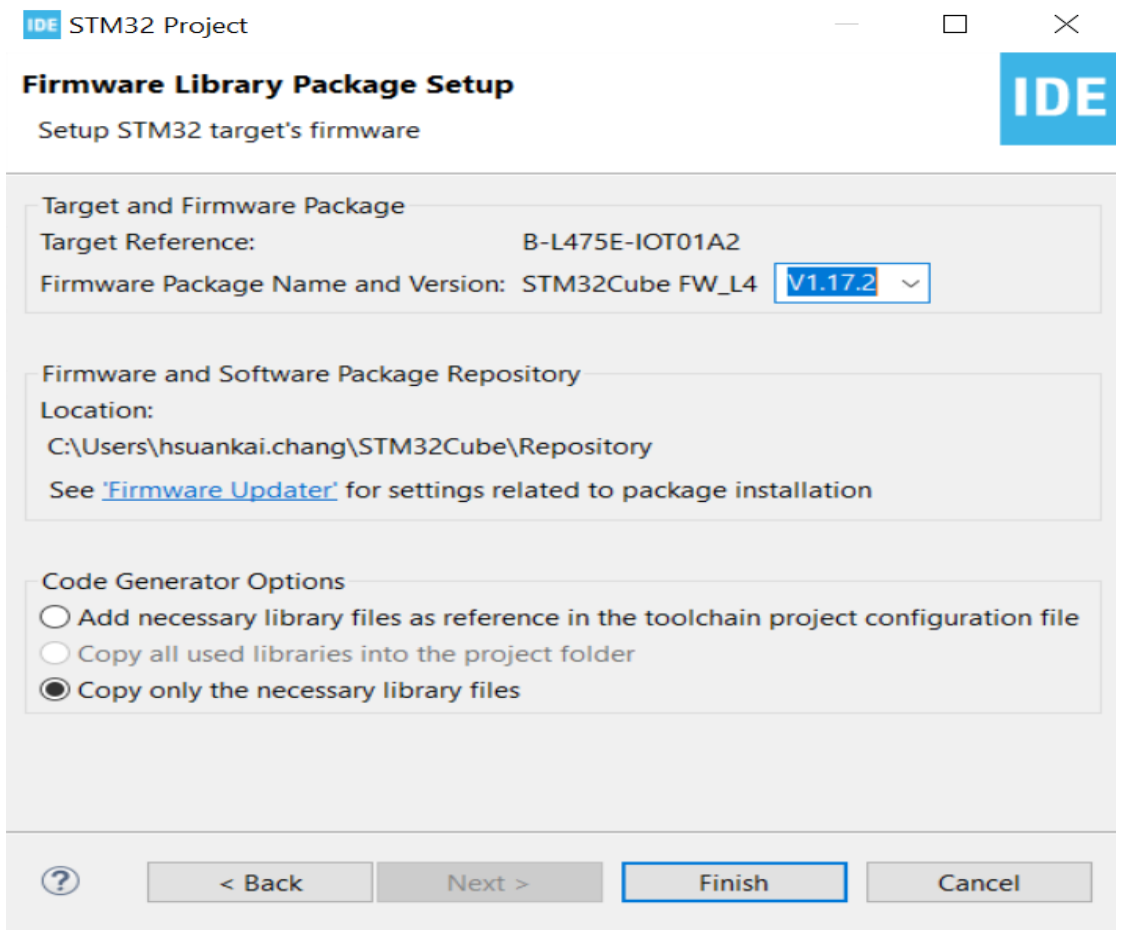
Step 2. Access board selector and type in the board you use, click Next



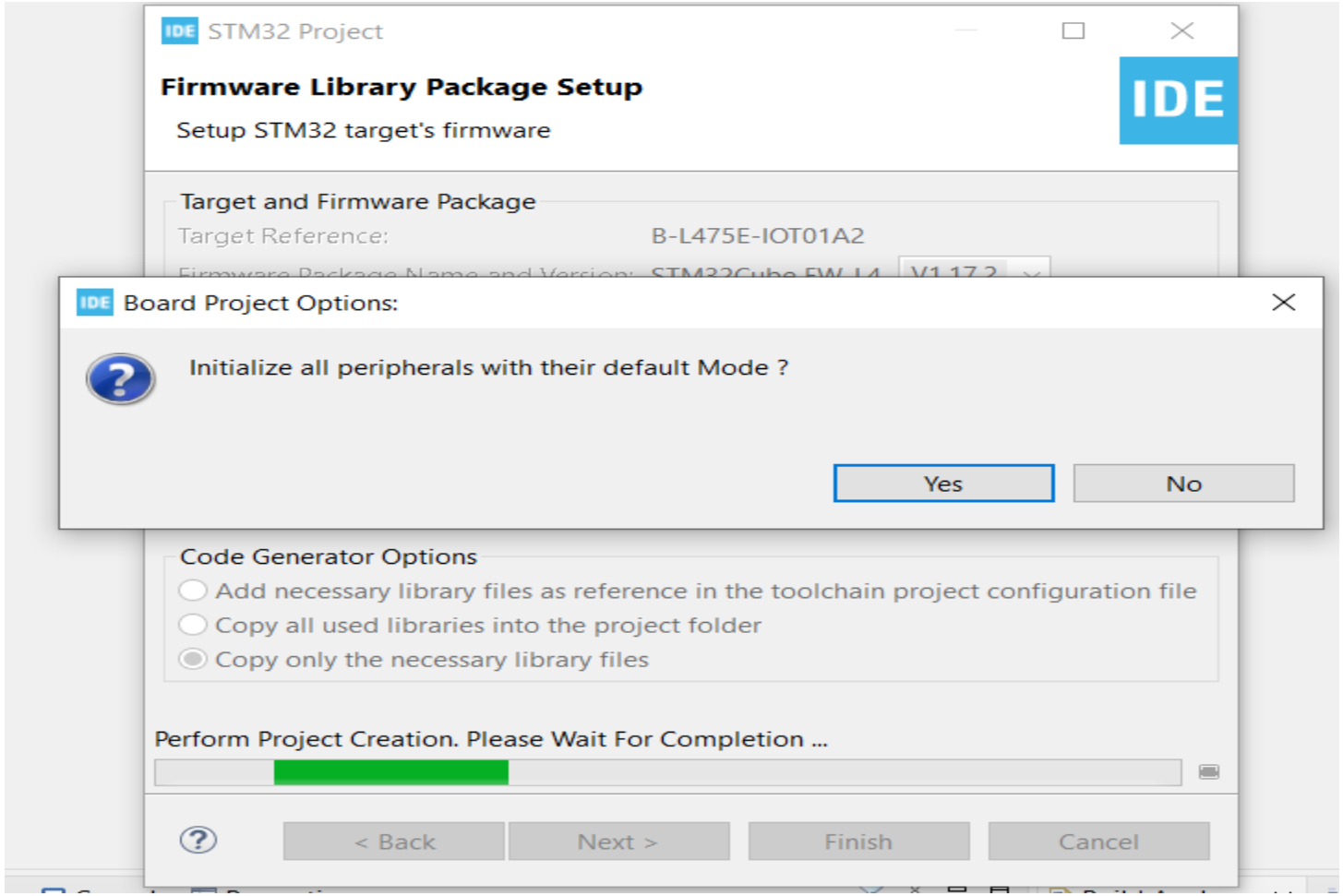
Step 3. Enter the project name then click Next



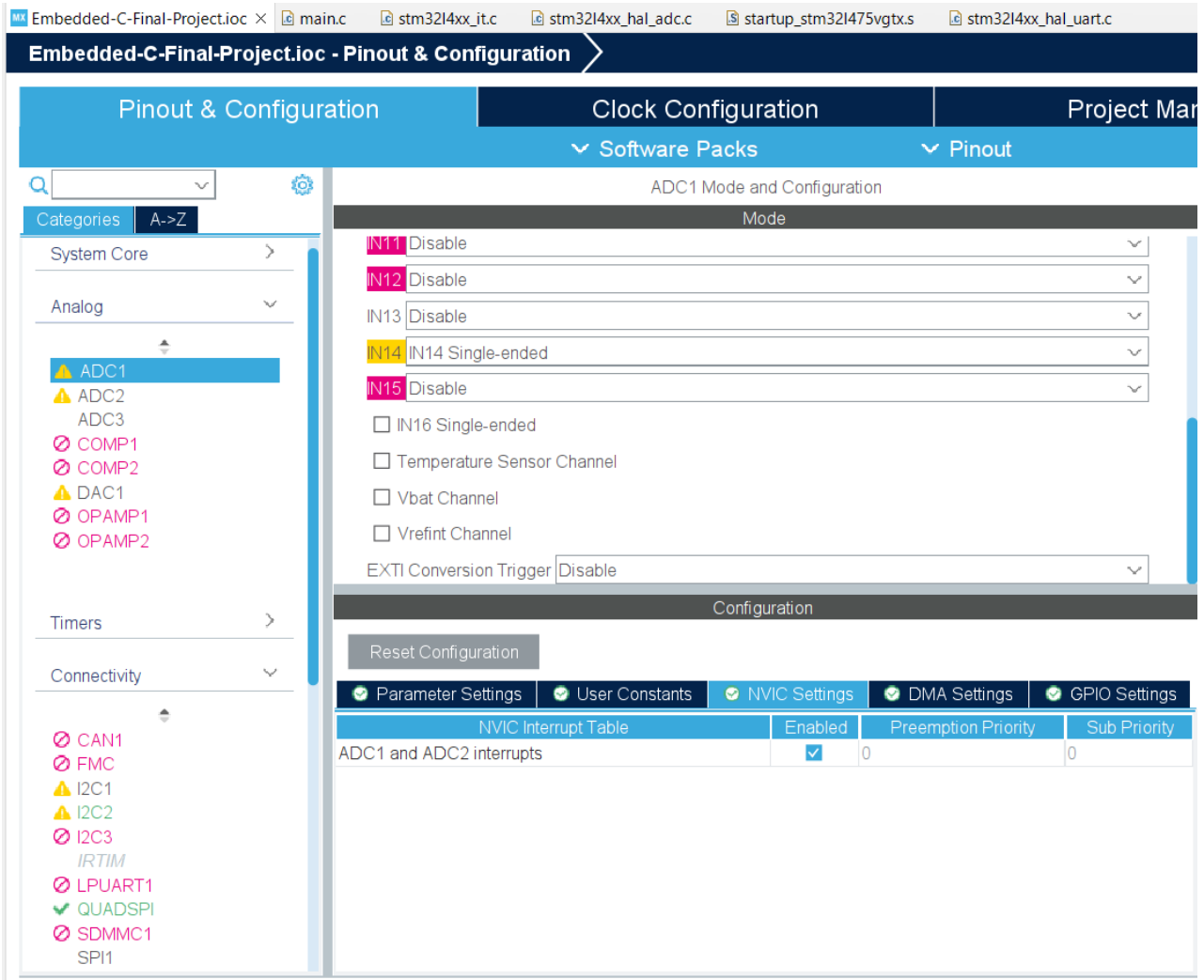
Step 4. See the firmware package name, version and location



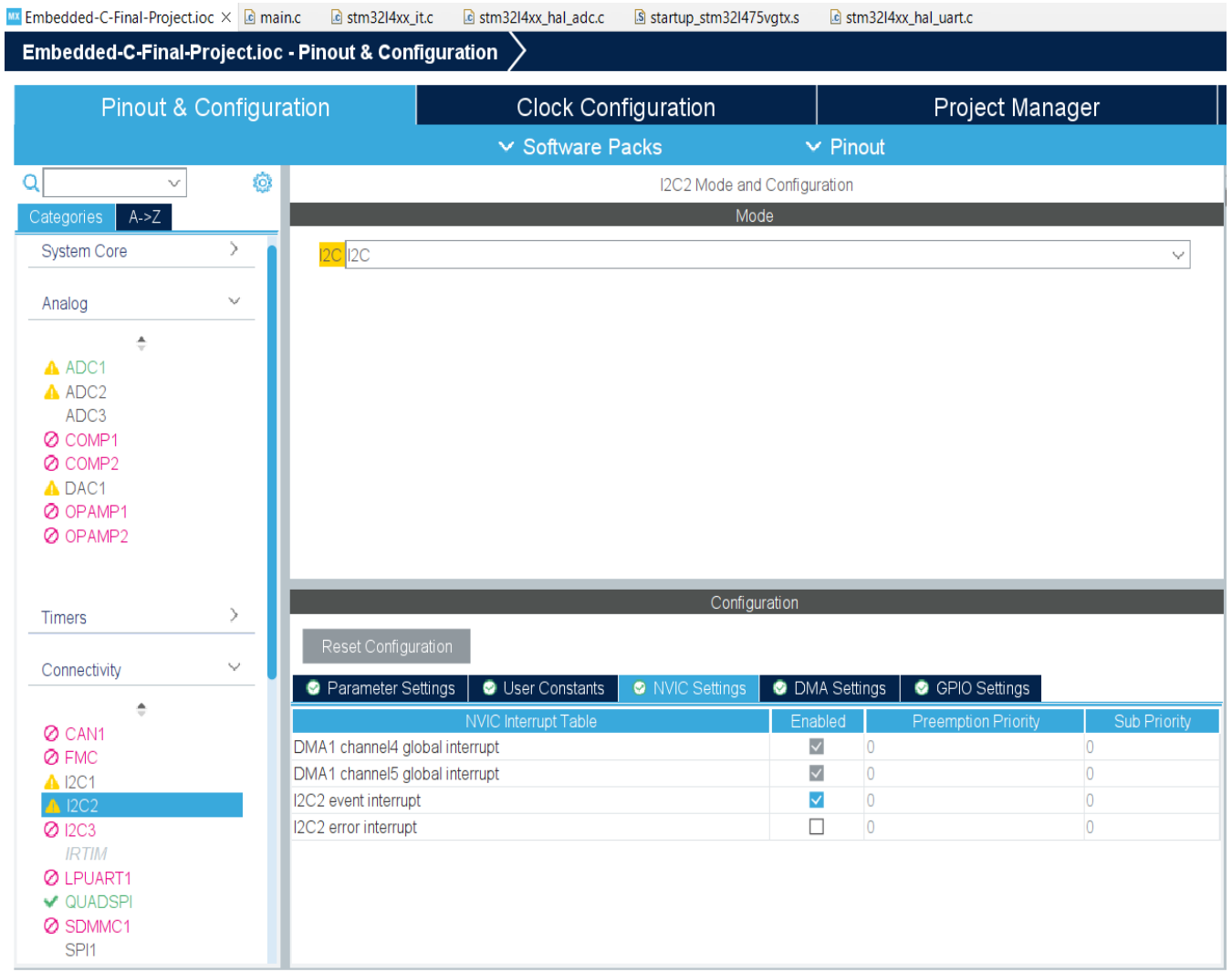
Step 5. Click yes to initialize all peripherals to default

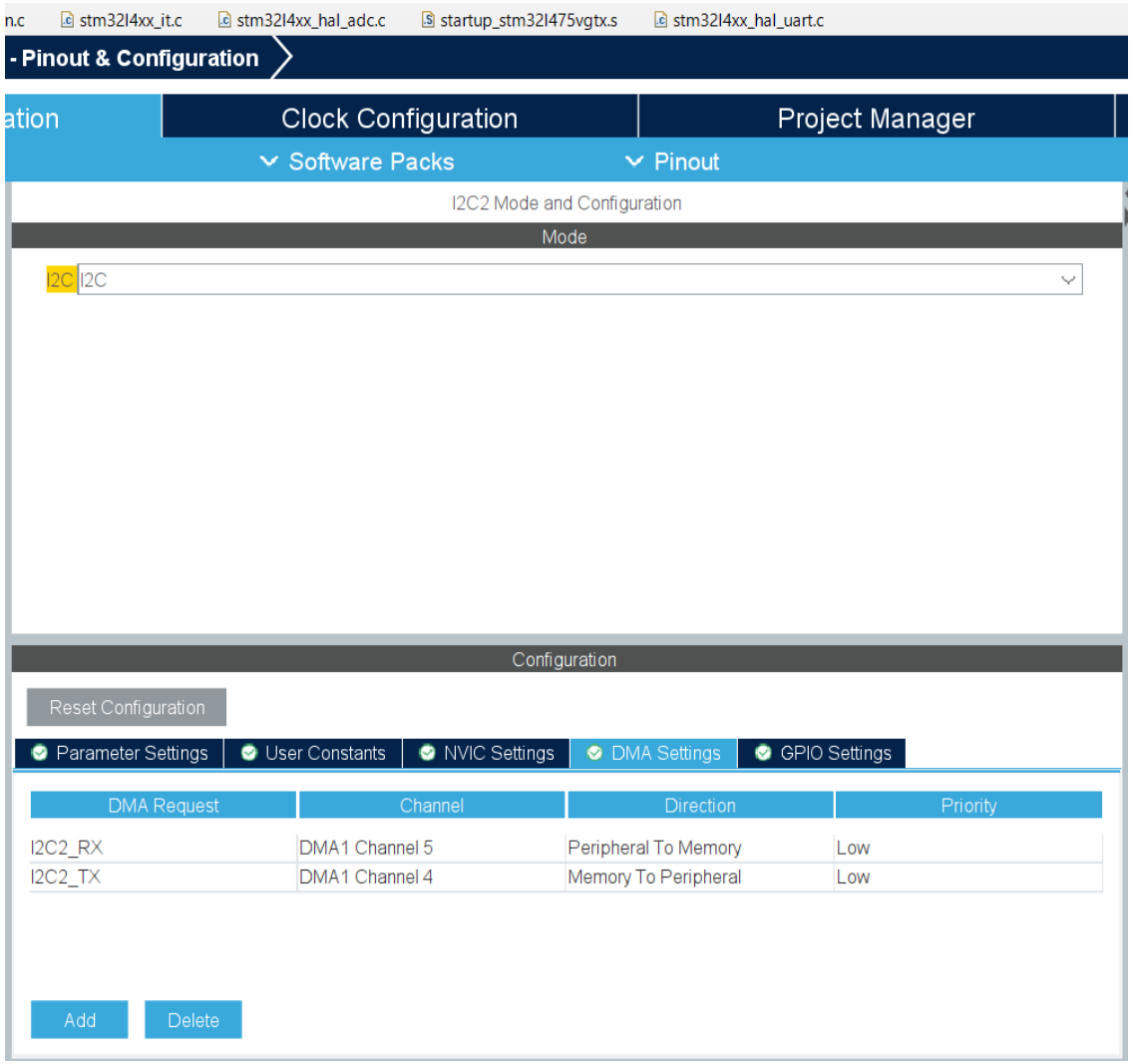


Step 6. In the final project, I decide to demonstrate ADC reading in polling and interrupt mode, I2C temperature reading with HST221 using polling, interrupt and DMA mode, also using UART to transmit and receive message, and GPIO to toggle the LED pin. First start to enable ADC settings



Step 7. Next, start setting up the I2C, notice that I set up both the interrupt and DMA mode





Step 8. Start coding the command line interface using UART

main.c | stm32l4xx_it.c | stm32l4xx_hal_adc.c | startup_stm32l475vgtx.s | stm32l4xx_hal_uart.c

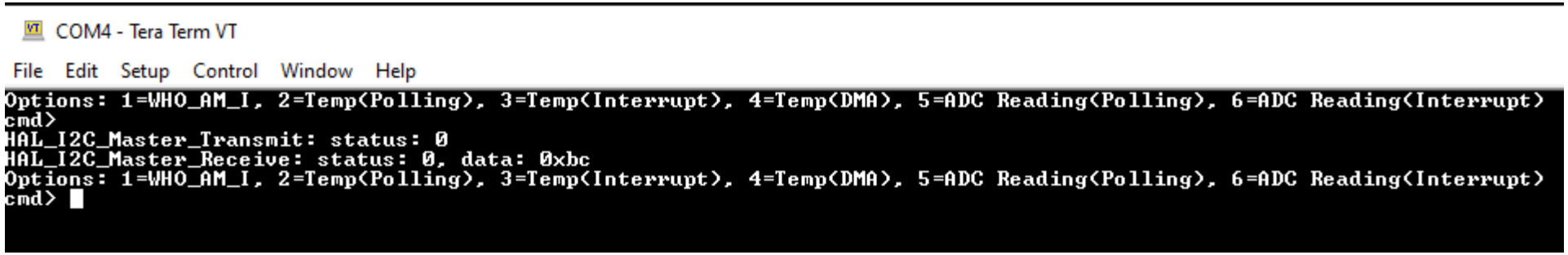
```
476   MX_USB_OTG_FS_PCD_Init();
477   MX_ADC1_Init();
478   /* USER CODE BEGIN 2 */
479   HAL_ADCEx_Calibration_Start(&hadc1, ADC_SINGLE_ENDED);
480   /* USER CODE END 2 */
481
482   /* Infinite loop */
483   /* USER CODE BEGIN WHILE */
484   while (1)
485   {
486     /* USER CODE END WHILE */
487
488     /* USER CODE BEGIN 3 */
489     // Issue command prompt
490     char *prompt = "Options: 1=WHO_AM_I, 2=Temp(Polling), 3=Temp(Interrupt), 4=Temp(DMA), 5=ADC Reading(Polling), "
491             "6=ADC Reading(Interrupt)\n\rcmd> ";
492     HAL_UART_Transmit(&huart1, (uint8_t*)prompt, strlen(prompt), 1000);
493
494     // Wait for a single number entry
495     char ch;
496     HAL_UART_Receive(&huart1, (uint8_t*)&ch, 1, HAL_MAX_DELAY);
497
498     char *msg = "\r\n";
499     HAL_UART_Transmit(&huart1, (uint8_t*)msg, strlen(msg), 1000);
500
501     switch(ch)
502     {
503     case '1': do_who_am_i(); break;
504     case '2': do_temp_polled(); break;
505     case '3': do_temp_interrupt(); break;
506     case '4': do_temp_dma(); break;
507     case '5': adc_polling_average(); break;
508     case '6': adc_interrupt(); break;
509     // Fall through if none
510     }
511   }
512   /* USER CODE END 3 */
513 }
```

Step 9. Start to code up the I2C who am I register reading

main.c | stm32l4xx_it.c | stm32l4xx_hal_adc.c | startup_stm32l475vgtx.s | stm32l4xx_hal_uart.c

```
81
82  /* Private user code ---------------------------------------------------------*/
83  /* USER CODE BEGIN 0 */
84  #define HST221_READ_ADDRESS         0xbf
85  #define HST221_WRITE_ADDRESS        0xbe
86
87  static uint8_t irq_complete = 0;
88  static uint8_t adc_irq_complete = 0;
89  static uint8_t status_flag = 0;
90  static uint16_t data = 0;
91  static uint8_t status_data = 0;
92
93  uint16_t find_max(uint16_t arr[], uint8_t size)
103
104 uint16_t find_min(uint16_t arr[], uint8_t size)
114
115 void do_who_am_i()
116 {
117     // Step 1. send sub address
118     // Write sub address
119     uint8_t who_am_i = 0xf; // WHO_AM_I register
120     HAL_StatusTypeDef status;
121     status = HAL_I2C_Master_Transmit(&hi2c2, HST221_WRITE_ADDRESS, &who_am_i, sizeof(who_am_i), 1000);
122
123     char buf[100];
124     snprintf(buf, sizeof(buf), "HAL_I2C_Master_Transmit: status: %u\r\n", status);
125     HAL_UART_Transmit(&huart1, (uint8_t*)buf, strlen(buf), 1000);
126
127     // Step 2. read from address to get WHO_AM_I
128     uint8_t data = 0x42;
129     status = HAL_I2C_Master_Receive(&hi2c2, HST221_READ_ADDRESS, &data, sizeof(data), 1000);
130
131     snprintf(buf, sizeof(buf), "HAL_I2C_Master_Receive: status: %u, data: 0x%x\r\n", status, data);
132     HAL_UART_Transmit(&huart1, (uint8_t*)buf, strlen(buf), 1000);
133
134 }
135
```

Step 10. Build and test the function, test is successful



Step 11. Start coding the I2C reading in polling mode

main.c | stm32l4xx_it.c | stm32l4xx_hal_adc.c | startup_stm32l475vgtx.s | stm32l4xx_hal_uart.c

```
135
136 void do_temp_polled()
137 {
138     // Setup control register 1
139     uint8_t control_reg1 = 0x20;
140     uint8_t control_data1[] = {control_reg1, 0x85}; // output registers not updated until MSB and LSB reading, 1 Hz
141     HAL_StatusTypeDef status;
142     status = HAL_I2C_Master_Transmit(&hi2c2, HST221_WRITE_ADDRESS, control_data1, sizeof(control_data1), 1000);
143
144     // Start a conversion
145     uint8_t control_reg2 = 0x21;
146     uint8_t control_data2[] = {control_reg2, 0x01};
147     status = HAL_I2C_Master_Transmit(&hi2c2, HST221_WRITE_ADDRESS, control_data2, sizeof(control_data2), 1000);
148
149     char buf[100];
150     snprintf(buf, sizeof(buf), "(One-shot enable) HAL_I2C_Master_Transmit: status: %u\r\n", status);
151     HAL_UART_Transmit(&huart1, (uint8_t*)buf, strlen(buf), 1000);
152
153     // Wait for conversion complete
154     uint8_t status_reg = 0x27;
155     uint8_t status_data = 0;
156     int count = 0;
157     while(count < 10)
158     {
159         // Send read status register sub command
160         status = HAL_I2C_Master_Transmit(&hi2c2, HST221_WRITE_ADDRESS, &status_reg, sizeof(status_reg), 1000);
161         snprintf(buf, sizeof(buf), "[%d] (status_reg) HAL_I2C_Master_Transmit: status: %u\r\n", count, status);
162         HAL_UART_Transmit(&huart1, (uint8_t*)buf, strlen(buf), 1000);
163
164         // Read conversion status
165         status = HAL_I2C_Master_Receive(&hi2c2, HST221_READ_ADDRESS, (uint8_t*)&status_data, sizeof(status_data), 1000);
166         snprintf(buf, sizeof(buf), "Status register: 0x%02x\r\n", status_data);
167         HAL_UART_Transmit(&huart1, (uint8_t*)buf, strlen(buf), 1000);
168
169         // Check for temperature conversion complete
170         if(status_data & 0x1)
171         {
```

Step 12. I2C temperature reading code continue, notice like just in assignment, I toggle between one-shot and auto increment mode

main.c | stm32l4xx_it.c | stm32l4xx_hal_adc.c | startup_stm32l475vgtx.s | stm32l4xx_hal_uart.c

```
169         // Check for temperature conversion complete
170         if(status_data & 0x1)
171         {
172             snprintf(buf, sizeof(buf), "New data available!\r\n");
173             HAL_UART_Transmit(&huart1, (uint8_t*)buf, strlen(buf), 1000);
174             break;
175         }
176         HAL_Delay(1000);
177         count++;
178     }
179
180     // Toggle between normal poll and address increment poll
181     static int toggle = 1;
182
183     if(toggle)
184     {
185         toggle = 0;
186
187         // Read temperature LSB
188         uint8_t temperature_lsb = 0x2a;
189         status = HAL_I2C_Master_Transmit(&hi2c2, HST221_WRITE_ADDRESS, &temperature_lsb, sizeof(temperature_lsb), 1000);
190         snprintf(buf, sizeof(buf), "(LSB) HAL_I2C_Master_Transmit: status: %u\r\n", status);
191         HAL_UART_Transmit(&huart1, (uint8_t*)buf, strlen(buf), 1000);
192
193         uint8_t data_lsb = 0x42;
194         status = HAL_I2C_Master_Receive(&hi2c2, HST221_READ_ADDRESS, (uint8_t*)&data_lsb, sizeof(data_lsb), 1000);
195         snprintf(buf, sizeof(buf), "(LSB) HAL_I2C_Master_Receive: status: %u, data_lsb: 0x%02x\r\n", status, data_lsb);
196         HAL_UART_Transmit(&huart1, (uint8_t*)buf, strlen(buf), 1000);
197
198         // Read temperature MSB
199         uint8_t temperature_msb = 0x2b;
200         status = HAL_I2C_Master_Transmit(&hi2c2, HST221_WRITE_ADDRESS, &temperature_msb, sizeof(temperature_msb), 1000);
201         snprintf(buf, sizeof(buf), "(MSB) HAL_I2C_Master_Transmit: status: %u\r\n", status);
202         HAL_UART_Transmit(&huart1, (uint8_t*)buf, strlen(buf), 1000);
203
204         uint8_t data_msb = 0x42;
205         status = HAL_I2C_Master_Receive(&hi2c2, HST221_READ_ADDRESS, (uint8_t*)&data_msb, sizeof(data_msb), 1000);
206         snprintf(buf, sizeof(buf), "(MSB) HAL_I2C_Master_Receive: status: %u, data_msb: 0x%02x\r\n", status, data_msb);
207         HAL_UART_Transmit(&huart1, (uint8_t*)buf, strlen(buf), 1000);
```

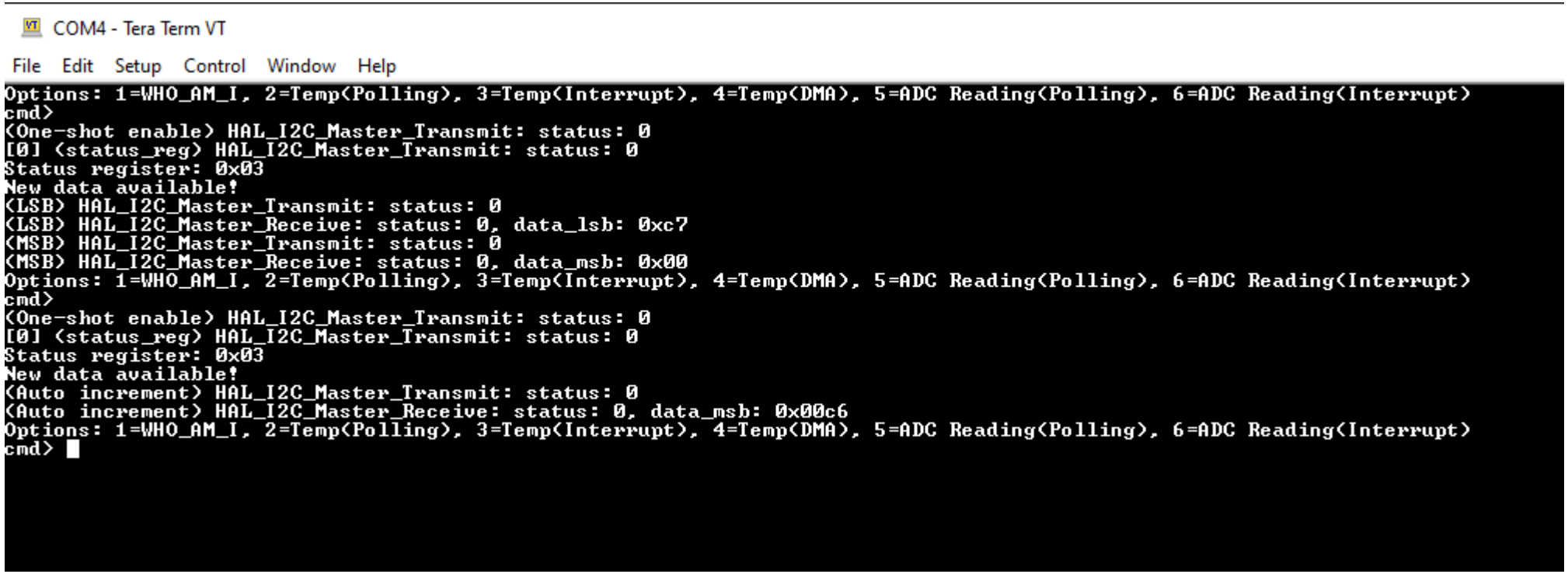
Step 13. I2C polling continue

main.c | stm32l4xx_it.c | stm32l4xx_hal_adc.c | startup_stm32l475vgtx.s | stm32l4xx_hal_uart.c

Embedded-C-Final-Project/Core/Src/stm32l4xx_it.c

```
196         HAL_UART_Transmit(&huart1, (uint8_t*)buf, strlen(buf), 1000);
197
198         // Read temperature MSB
199         uint8_t temperature_msb = 0x2b;
200         status = HAL_I2C_Master_Transmit(&hi2c2, HST221_WRITE_ADDRESS, &temperature_msb, sizeof(temperature_msb), 1000);
201         snprintf(buf, sizeof(buf), "(MSB) HAL_I2C_Master_Transmit: status: %u\r\n", status);
202         HAL_UART_Transmit(&huart1, (uint8_t*)buf, strlen(buf), 1000);
203
204         uint8_t data_msb = 0x42;
205         status = HAL_I2C_Master_Receive(&hi2c2, HST221_READ_ADDRESS, (uint8_t*)&data_msb, sizeof(data_msb), 1000);
206         snprintf(buf, sizeof(buf), "(MSB) HAL_I2C_Master_Receive: status: %u, data_msb: 0x%02x\r\n", status, data_msb);
207         HAL_UART_Transmit(&huart1, (uint8_t*)buf, strlen(buf), 1000);
208     }
209     else
210     {
211         toggle = 1;
212         // Read using auto increment
213         uint8_t temperature_lsb = 0x2a | 0x80;
214         status = HAL_I2C_Master_Transmit(&hi2c2, HST221_WRITE_ADDRESS, &temperature_lsb, sizeof(temperature_lsb), 1000);
215         snprintf(buf, sizeof(buf), "(Auto increment) HAL_I2C_Master_Transmit: status: %u\r\n", status);
216         HAL_UART_Transmit(&huart1, (uint8_t*)buf, strlen(buf), 1000);
217
218         uint16_t data = 0x4242;
219         status = HAL_I2C_Master_Receive(&hi2c2, HST221_READ_ADDRESS, (uint8_t*)&data, sizeof(data), 1000);
220         snprintf(buf, sizeof(buf), "(Auto increment) HAL_I2C_Master_Receive: status: %u, data_msb: 0x%04x\r\n", status, data);
221         HAL_UART_Transmit(&huart1, (uint8_t*)buf, strlen(buf), 1000);
222     }
223
224 }
```

Step 14. Test the I2C polling, test is successful



Step 15. I2C temperature reading interrupt mode coding

main.c | stm32l4xx_it.c | stm32l4xx_hal_adc.c | startup_stm32l475vgtx.s | stm32l4xx_hal_uart.c

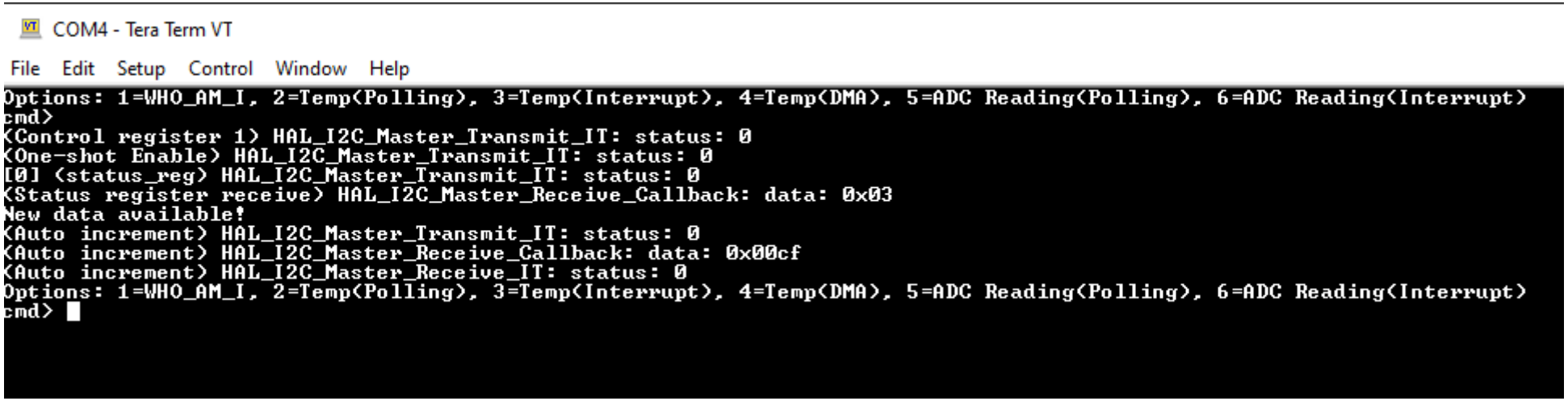
```
225
226 void do_temp_interrupt()
227 {
228     irq_complete = 0;
229     char buf[100];
230     // Setup control register 1
231     uint8_t control_reg1 = 0x20;
232     uint8_t control_data1[] = {control_reg1, 0x85}; // output registers not updated until MSB and LSB reading, 1 Hz
233     HAL_StatusTypeDef status;
234     status = HAL_I2C_Master_Transmit_IT(&hi2c2, HST221_WRITE_ADDRESS, control_data1, sizeof(control_data1));
235     snprintf(buf, sizeof(buf), "(Control register 1) HAL_I2C_Master_Transmit_IT: status: %u\r\n", status);
236     HAL_UART_Transmit(&huart1, (uint8_t*)buf, strlen(buf), 1000);
237     while(0 == irq_complete)
238     {
239         HAL_Delay(1000);
240     }
241
242     irq_complete = 0;
243     // Start a conversion but interrupt driven
244     int control_reg2 = 0x21;
245     uint8_t control_data2[] = {control_reg2, 0x01}; // One-shot enable
246     status = HAL_I2C_Master_Transmit_IT(&hi2c2, HST221_WRITE_ADDRESS, control_data2, sizeof(control_data2));
247     snprintf(buf, sizeof(buf), "(One-shot Enable) HAL_I2C_Master_Transmit_IT: status: %u\r\n", status);
248     HAL_UART_Transmit(&huart1, (uint8_t*)buf, strlen(buf), 1000);
249     while(0 == irq_complete)
250     {
251         HAL_Delay(1000);
252     }
253
254     irq_complete = 0;
255     // Wait for conversion complete
256     uint8_t status_reg = 0x27;
257     int count = 0;
258     while(count < 10)
259     {
260         // Send read status register sub command
261         status = HAL_I2C_Master_Transmit_IT(&hi2c2, HST221_WRITE_ADDRESS, &status_reg, sizeof(status_reg));
262         snprintf(buf, sizeof(buf), "[%d] (status_reg) HAL_I2C_Master_Transmit_IT: status: %u\r\n", count, status);
263         HAL_UART_Transmit(&huart1, (uint8_t*)buf, strlen(buf), 1000);
```

Step 16. I2C temperature reading interrupt mode coding continue

main.c | stm32l4xx_it.c | stm32l4xx_hal_adc.c | startup_stm32l475vgtx.s | stm32l4xx_hal_uart.c

```
261         status = HAL_I2C_Master_Transmit_IT(&hi2c2, HST221_WRITE_ADDRESS, &status_reg, sizeof(status_reg));
262         snprintf(buf, sizeof(buf), "[%d] (status_reg) HAL_I2C_Master_Transmit_IT: status: %u\r\n", count, status);
263         HAL_UART_Transmit(&huart1, (uint8_t*)buf, strlen(buf), 1000);
264         while(0 == irq_complete)
265         {
266             HAL_Delay(1000);
267         }
268
269         irq_complete = 0;
270         status_flag = 1;
271         // Read conversion status
272         status = HAL_I2C_Master_Receive_IT(&hi2c2, HST221_READ_ADDRESS, (uint8_t*)&status_data, sizeof(status_data));
273         while(0 == irq_complete)
274         {
275             HAL_Delay(1000);
276         }
277
278         // Check for temperature conversion complete
279         if(status_data & 0x1)
280         {
281             snprintf(buf, sizeof(buf), "New data available!\r\n");
282             HAL_UART_Transmit(&huart1, (uint8_t*)buf, strlen(buf), 1000);
283             break;
284         }
285         HAL_Delay(1000);
286         count++;
287     }
288
289     irq_complete = 0;
290     // Read using auto increment
291     uint8_t temperature_lsb = 0x2a | 0x80;
292     status = HAL_I2C_Master_Transmit_IT(&hi2c2, HST221_WRITE_ADDRESS, &temperature_lsb, sizeof(temperature_lsb));
293     snprintf(buf, sizeof(buf), "(Auto increment) HAL_I2C_Master_Transmit_IT: status: %u\r\n", status);
294     HAL_UART_Transmit(&huart1, (uint8_t*)buf, strlen(buf), 1000);
295     while(0 == irq_complete)
296     {
297         HAL_Delay(1000);
298     }
299
300     irq_complete = 0;
301     // Receive using interrupt
302     status = HAL_I2C_Master_Receive_IT(&hi2c2, HST221_READ_ADDRESS, (uint8_t*)&data, sizeof(data));
303     while(0 == irq_complete)
304     {
305         HAL_Delay(1000);
306     }
307     snprintf(buf, sizeof(buf), "(Auto increment) HAL_I2C_Master_Receive_IT: status: %u\r\n", status);
308     HAL_UART_Transmit(&huart1, (uint8_t*)buf, strlen(buf), 1000);
309 }
310
```

Step 20. Test the code, test is successful



Step 18. I2C temperature reading DMA mode coding

main.c | stm32l4xx_it.c | stm32l4xx_hal_adc.c | startup_stm32l475vgtx.s | stm32l4xx_hal_uart.c

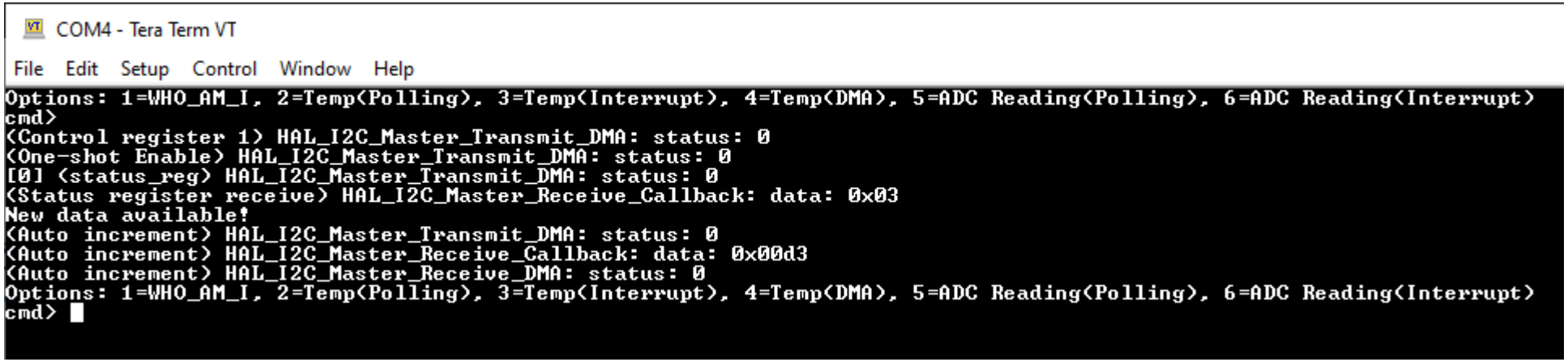
```
311 void do_temp_dma()
312 {
313     irq_complete = 0;
314     char buf[100];
315     // Setup control register 1
316     uint8_t control_reg1 = 0x20;
317     uint8_t control_data1[] = {control_reg1, 0x85}; // output registers not updated until MSB and LSB reading, 1 Hz
318     HAL_StatusTypeDef status;
319     status = HAL_I2C_Master_Transmit_DMA(&hi2c2, HST221_WRITE_ADDRESS, control_data1, sizeof(control_data1));
320     snprintf(buf, sizeof(buf), "(Control register 1) HAL_I2C_Master_Transmit_DMA: status: %u\r\n", status);
321     HAL_UART_Transmit(&huart1, (uint8_t*)buf, strlen(buf), 1000);
322     while(0 == irq_complete)
323     {
324         HAL_Delay(1000);
325     }
326
327     irq_complete = 0;
328     // Start a conversion but interrupt driven
329     int control_reg2 = 0x21;
330     uint8_t control_data2[] = {control_reg2, 0x01}; // One-shot enable
331     status = HAL_I2C_Master_Transmit_DMA(&hi2c2, HST221_WRITE_ADDRESS, control_data2, sizeof(control_data2));
332     snprintf(buf, sizeof(buf), "(One-shot Enable) HAL_I2C_Master_Transmit_DMA: status: %u\r\n", status);
333     HAL_UART_Transmit(&huart1, (uint8_t*)buf, strlen(buf), 1000);
334     while(0 == irq_complete)
335     {
336         HAL_Delay(1000);
337     }
338     irq_complete = 0;
339     // Wait for conversion complete
340     uint8_t status_reg = 0x27;
341     int count = 0;
342     while(count < 10)
343     {
344         // Send read status register sub command
345         status = HAL_I2C_Master_Transmit_DMA(&hi2c2, HST221_WRITE_ADDRESS, &status_reg, sizeof(status_reg));
346         snprintf(buf, sizeof(buf), "[%d] (status_reg) HAL_I2C_Master_Transmit_DMA: status: %u\r\n", count, status);
347         HAL_UART_Transmit(&huart1, (uint8_t*)buf, strlen(buf), 1000);
348         while(0 == irq_complete)
```

Step 19. I2C temperature reading DMA mode coding continue

main.c | stm32l4xx_it.c | stm32l4xx_hal_adc.c | startup_stm32l475vgtx.s | stm32l4xx_hal_uart.c

```
347         HAL_UART_Transmit(&huart1, (uint8_t*)buf, strlen(buf), 1000);
348         while(0 == irq_complete)
349         {
350             HAL_Delay(1000);
351         }
352
353         irq_complete = 0;
354         status_flag = 1;
355         // Read conversion status
356         status = HAL_I2C_Master_Receive_DMA(&hi2c2, HST221_READ_ADDRESS, (uint8_t*)&status_data, sizeof(status_data));
357         while(0 == irq_complete)
358         {
359             HAL_Delay(1000);
360         }
361
362         // Check for temperature conversion complete
363         if(status_data & 0x1)
364         {
365             snprintf(buf, sizeof(buf), "New data available!\r\n");
366             HAL_UART_Transmit(&huart1, (uint8_t*)buf, strlen(buf), 1000);
367             break;
368         }
369         HAL_Delay(1000);
370         count++;
371     }
372     irq_complete = 0;
373     // Read using auto increment
374     uint8_t temperature_lsb = 0x2a | 0x80;
375     status = HAL_I2C_Master_Transmit_DMA(&hi2c2, HST221_WRITE_ADDRESS, &temperature_lsb, sizeof(temperature_lsb));
376     snprintf(buf, sizeof(buf), "(Auto increment) HAL_I2C_Master_Transmit_DMA: status: %u\r\n", status);
377     HAL_UART_Transmit(&huart1, (uint8_t*)buf, strlen(buf), 1000);
378     while(0 == irq_complete)
379     {
380         HAL_Delay(1000);
381     }
382     irq_complete = 0;
383     // Receive using interrupt
384     status = HAL_I2C_Master_Receive_DMA(&hi2c2, HST221_READ_ADDRESS, (uint8_t*)&data, sizeof(data));
385     while(0 == irq_complete)
386     {
387         HAL_Delay(1000);
388     }
389     snprintf(buf, sizeof(buf), "(Auto increment) HAL_I2C_Master_Receive_DMA: status: %u\r\n", status);
390     HAL_UART_Transmit(&huart1, (uint8_t*)buf, strlen(buf), 1000);
391 }
```

Step 20. Test the code, test is successful



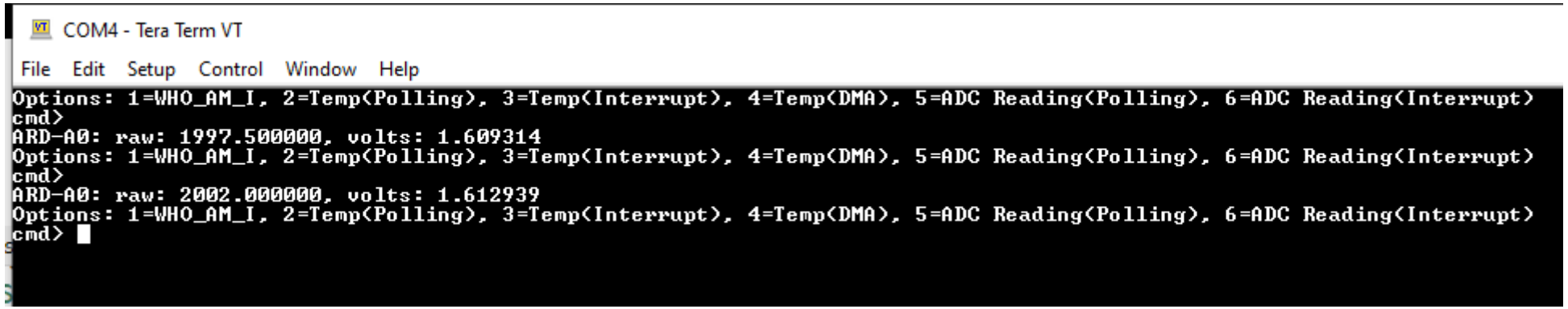
Step 21. ADC polling reading coding

```
393 void adc_polling_average()
394 {
395     HAL_GPIO_TogglePin(LED3_WIFI__LED4_BLE_GPIO_Port, LED3_WIFI__LED4_BLE_Pin);
396     HAL_Delay(1000);
397 
398     uint16_t value[12];
399     uint16_t value_sum = 0;
400 
401     // Poll 12 times
402     for(int i = 0; i < 12; i++)
403     {
404         // ADC start conversion
405         HAL_ADC_Start(&hadc1);
406         // Poll for results, timeout is 10 us
407         HAL_ADC_PollForConversion(&hadc1, 10);
408         value[i] = HAL_ADC_GetValue(&hadc1);
409         value_sum += value[i];
410     }
411 
412     // Sum of value array minus the max and min value
413     float value_avg = (float)(value_sum - find_max(value, 12) - find_min(value, 12)) / 10;
414 
415     float voltage = value_avg * (3.3 / 4096);
416 
417     // Send value to console
418     char buf[100];
419     snprintf(buf, sizeof(buf), "ARD-A0: raw: %f, volts: %f\r\n", value_avg, voltage);
420 
421     HAL_UART_Transmit(&huart1, (uint8_t*)buf, strlen(buf), 1000);
422 }
423 
```

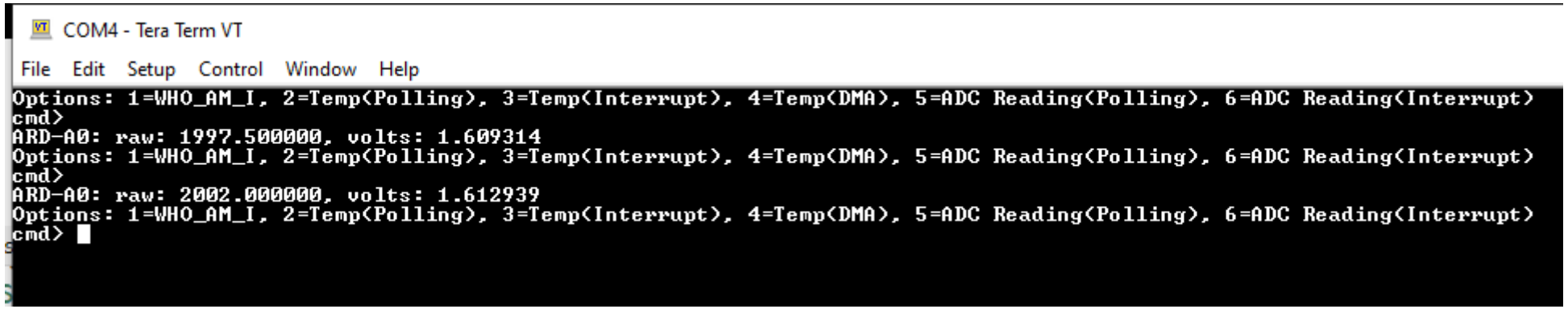
Step 21. ADC polling reading coding continue, find max and min function

```
93  uint16_t find_max(uint16_t arr[], uint8_t size)
94  {
95      int max = arr[0];
96      for(int i = 0; i < size; i++){
97          if(arr[i] > max){
98              max = arr[i];
99          }
100     }
101     return max;
102 }
103
104 uint16_t find_min(uint16_t arr[], uint8_t size)
105 {
106     int min = arr[0];
107     for(int i = 0; i < size; i++){
108         if(arr[i] < min){
109             min = arr[i];
110         }
111     }
112     return min;
113 }
114
```

Step 22. Test the code, test is successful



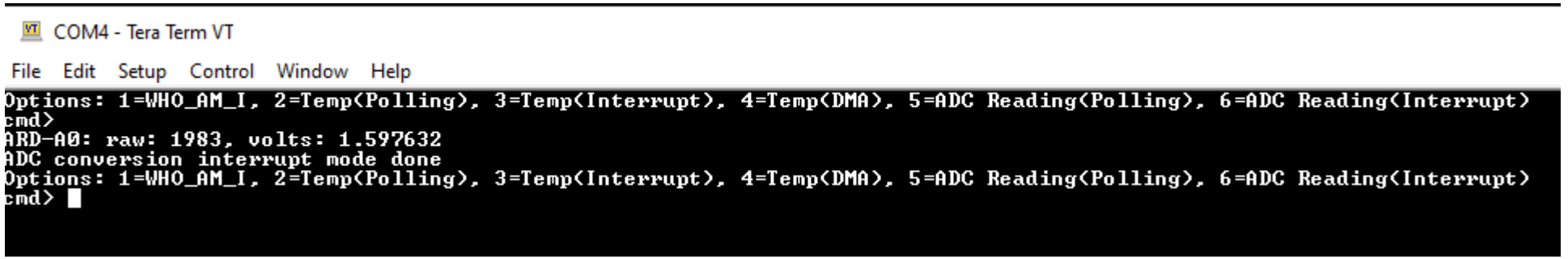
Step 22. Test the code, test is successful



Step 23. ADC interrupt coding

```
424 void adc_interrupt()
425 {
426     adc_irq_complete = 0;
427     HAL_ADC_Start_IT(&hadc1);
428     while(adc_irq_complete == 0){
429         HAL_Delay(1000);
430     }
431     char buf[100];
432     snprintf(buf, sizeof(buf), "ADC conversion interrupt mode done\r\n");
433     HAL_UART_Transmit(&huart1, (uint8_t*)buf, strlen(buf), 1000);
434 }
435
```

Step 24. Test the code, test is successful



Step 25. Interrupt call back function implementation for I2C

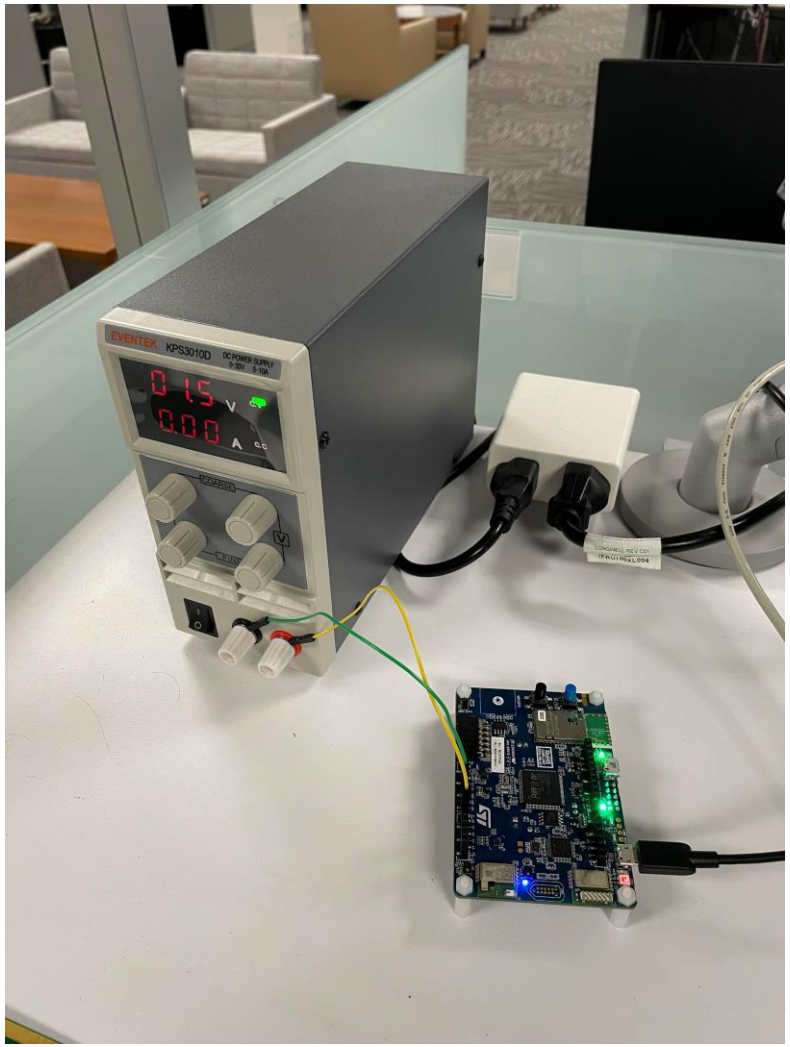
```
1122 /* USER CODE BEGIN 4 */
1123 void HAL_I2C_MasterTxCpltCallback(I2C_HandleTypeDef *hi2c)
1124 {
1125     HAL_GPIO_TogglePin(LED2_GPIO_Port, LED2_Pin);
1126     irq_complete = 1;
1127 }
1128
1129 void HAL_I2C_MasterRxCpltCallback(I2C_HandleTypeDef *hi2c)
1130 {
1131     char buf[100];
1132     if(status_flag == 1)
1133     {
1134         status_flag = 0;
1135         snprintf(buf, sizeof(buf), "(Status register receive) HAL_I2C_Master_Receive_Callback: data: 0x%02x\r\n", status_data);
1136         HAL_UART_Transmit(&huart1, (uint8_t*)buf, strlen(buf), 1000);
1137     }
1138     else
1139     {
1140         snprintf(buf, sizeof(buf), "(Auto increment) HAL_I2C_Master_Receive_Callback: data: 0x%04x\r\n", data);
1141         HAL_UART_Transmit(&huart1, (uint8_t*)buf, strlen(buf), 1000);
1142     }
1143     irq_complete = 1;
1144 }
```

Step 26. Interrupt call back function implementation for ADC

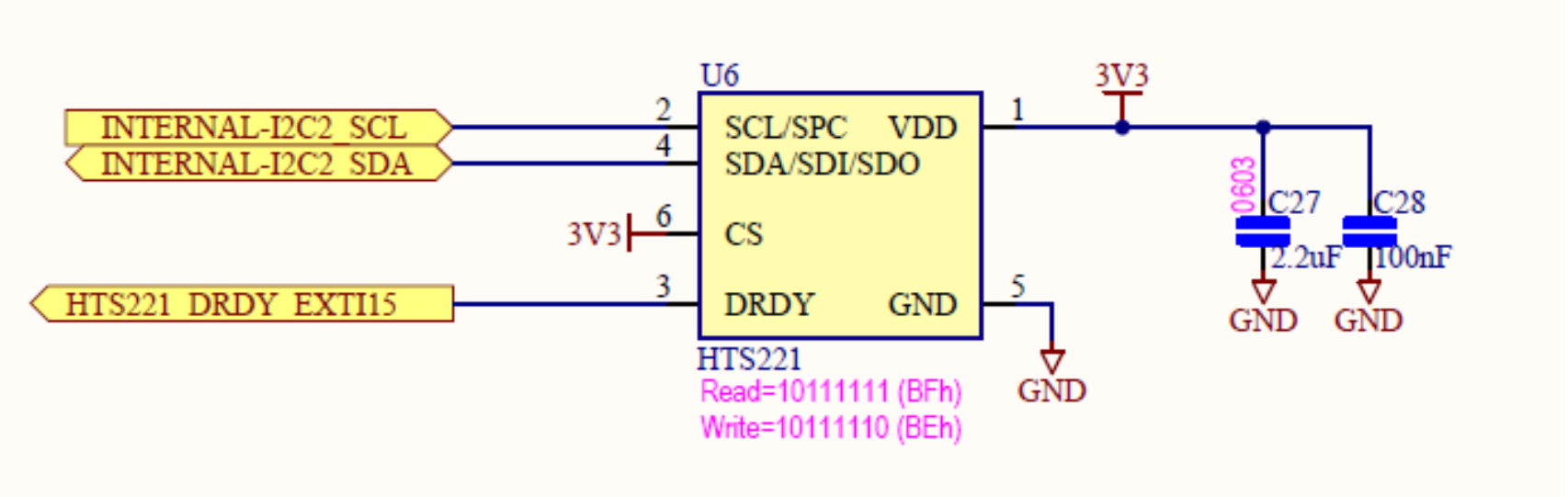
```c
void HAL_ADC_ConvCpltCallback(ADC_HandleTypeDef *hadc)
{
    uint16_t value = HAL_ADC_GetValue(&hadc1);
    float voltage = value * (3.3 / 4096);

    // Send value to console
    char buf[100];
    snprintf(buf, sizeof(buf), "ARD-A0: raw: %u, volts: %f\r\n", value, voltage);
    HAL_UART_Transmit(&huart1, (uint8_t*)buf, strlen(buf), 1000);
    adc_irq_complete = 1;
}
```

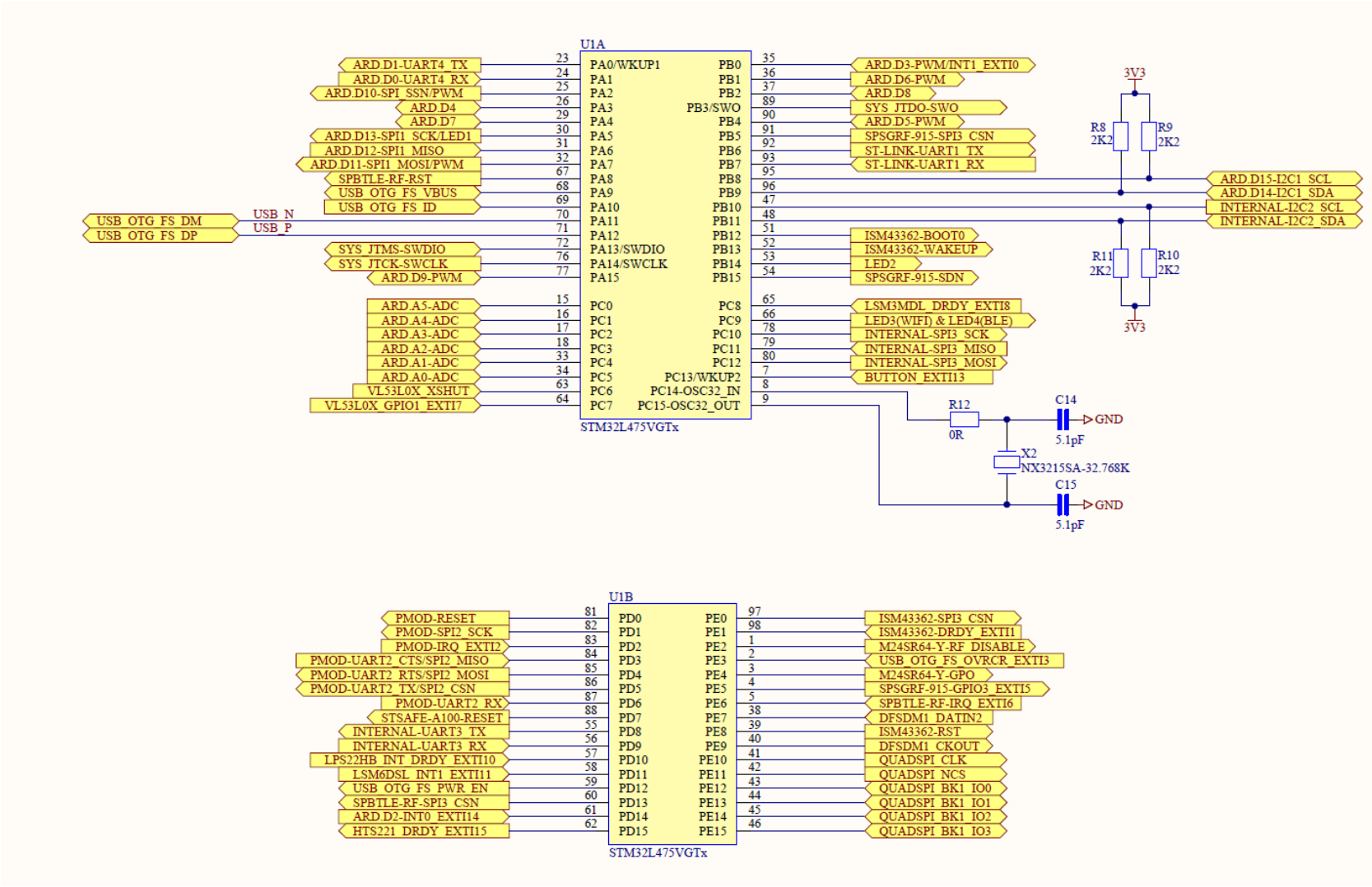
Appendix, wire connection to ARD-A0 pin with 1.5V, note that we actually read 1.6v, since the power supply is not very accurate



Appendix, schematic for HTS221



Appendix, schematic for processor side



Appendix, schematic for ST-LINK UART1