BLE Beacon

Power Consumption Overview and Optimization

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[Kurstitel]

Inhalt

[2 Baseline 10](#_Toc7209577)

[3 The baseline for the device is measured with only the Softdevice and no app flashed. 10](#_Toc7209578)

[4 According to Specification 10](#_Toc7209579)

[5 Nrf52 according to spec TDB 10](#_Toc7209580)

[6 **Device KX022** high power mode 145 uA@2.5V low power mode 10 uA standby 0.9 uA 10](#_Toc7209581)

[7 **Device SHT3** idle state 0.2 uA (max 2 uA) Average 2 uA while measuring w/lowest repeat.+single shot) 10](#_Toc7209582)

[8 Case 1: Softdevice flashed, no app flashed 11](#_Toc7209583)

[9  11](#_Toc7209584)

[10 Case 2: Softdevice, just go to idle mode 11](#_Toc7209585)

[11  11](#_Toc7209586)

[12 Case 3: Softdevice, init bsp (led off), and just go to idle mode 11](#_Toc7209587)

[13  11](#_Toc7209588)

[14 Case 3b: as case 3 w/one led on 11](#_Toc7209589)

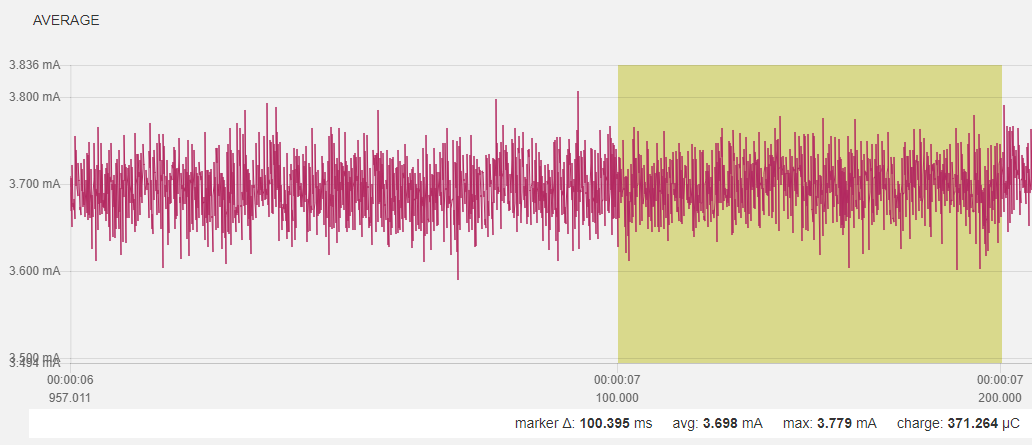
[15  12](#_Toc7209590)

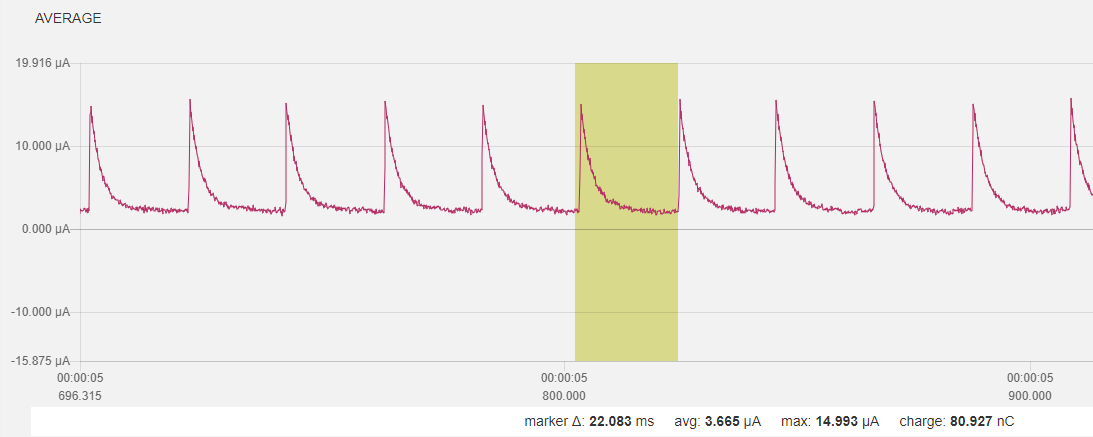
[16 Case 4: as case 3 (led off) + twi\_config + (both) sensor\_init 12](#_Toc7209591)

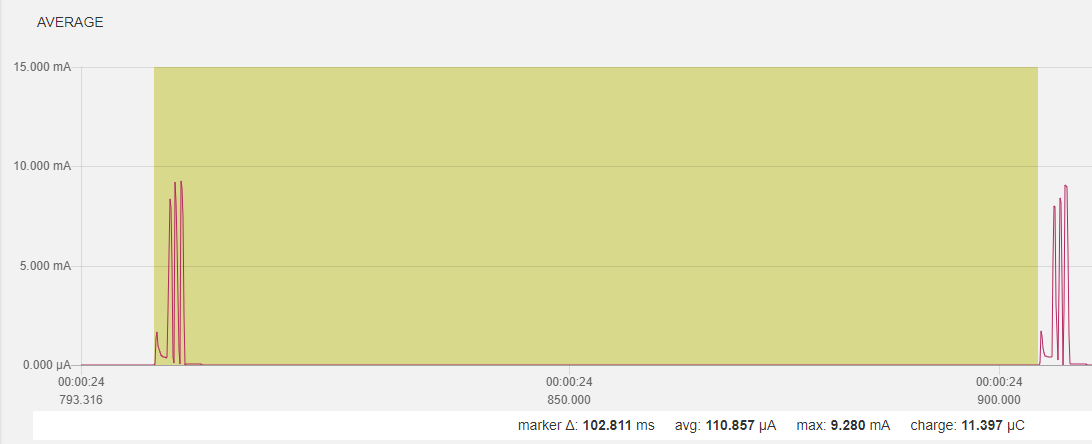
[17  12](#_Toc7209592)

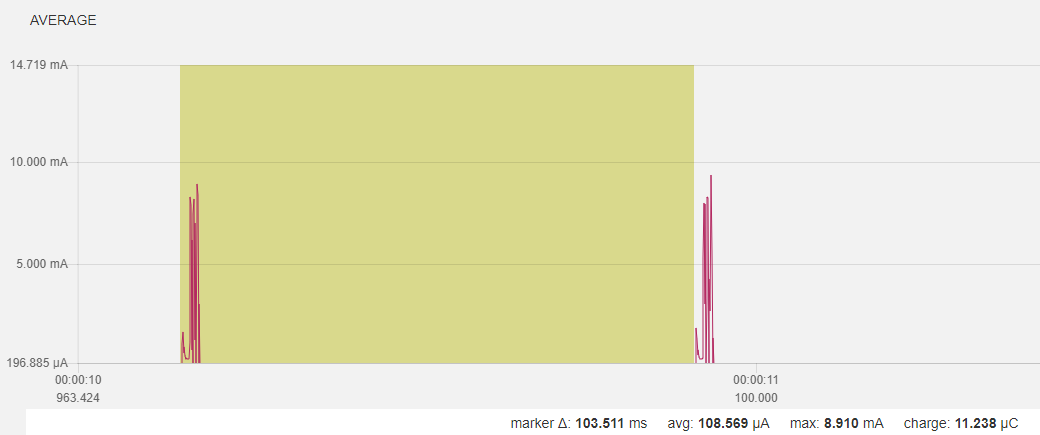
[18 Case 4a: as case 4 but no sensor\_init 12](#_Toc7209593)

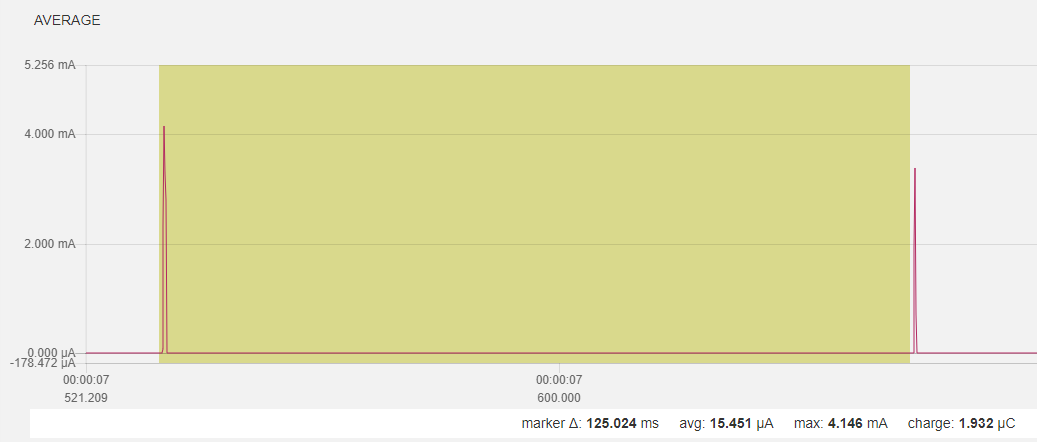
[19  12](#_Toc7209594)

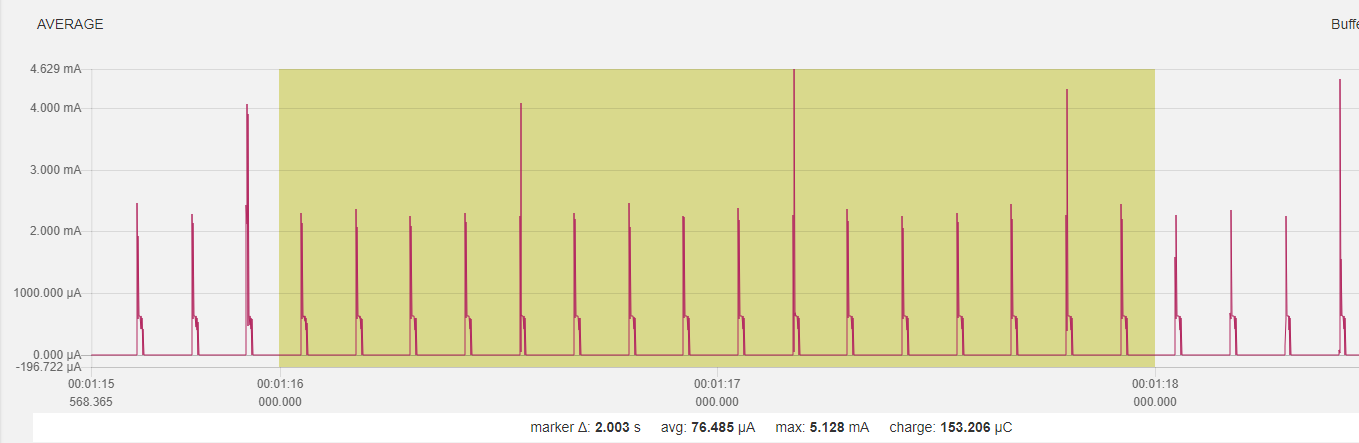
[20 Case 4b: only kx022 init 13](#_Toc7209595)

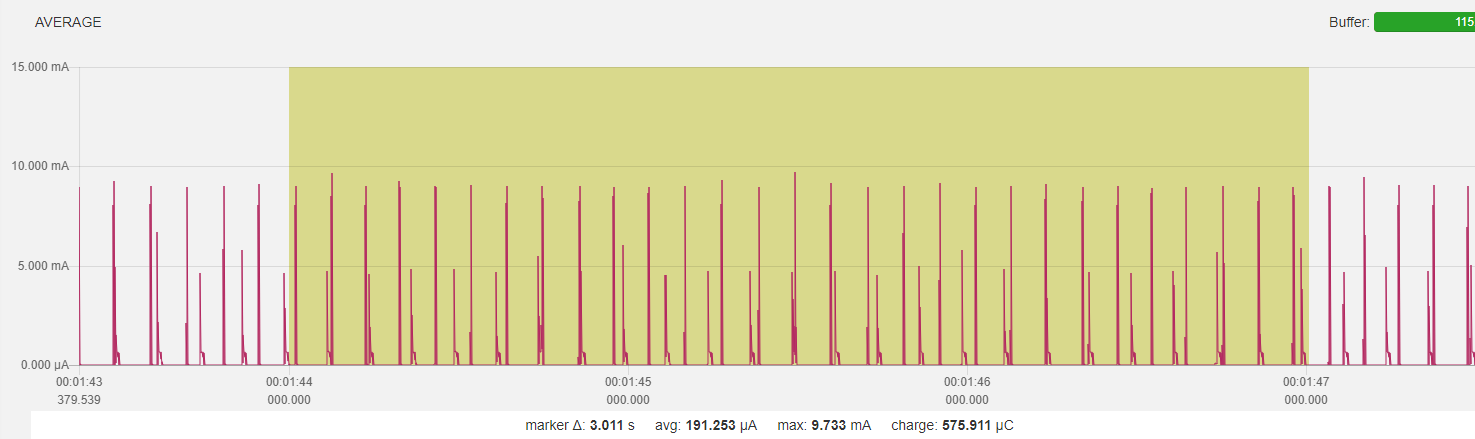
[21 Case 4c: only SHT3 init  13](#_Toc7209596)

[22 Case 5: as case 4c/SHT but no KX022, no sensor data + BLE adv  13](#_Toc7209597)

[23 Case 6: as case 5+ SAADC measurement) 14](#_Toc7209598)

[24 Case 6a: as case 6 w/o BLE init/adv  14](#_Toc7209599)

[25 Case 7: as case 5 + SHT measurement 14](#_Toc7209600)

[26 Case 8: all but KX022 measurement, 1/8 data acquisition for SHT and SAADC  15](#_Toc7209601)

[27 Case 8a 15](#_Toc7209602)

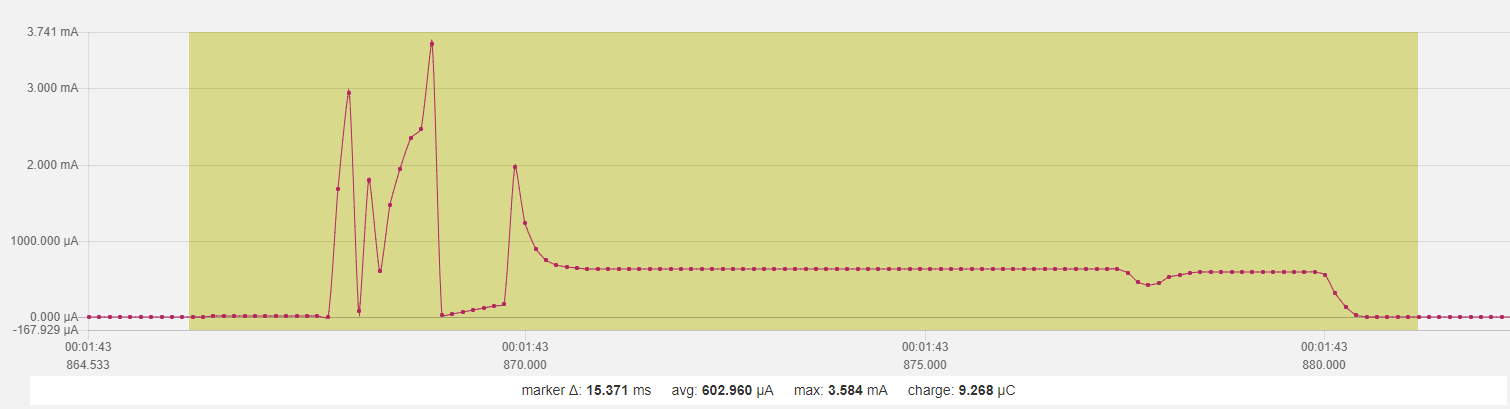
[28 reduce transmit power to 0dBm from +4dBm 15](#_Toc7209603)

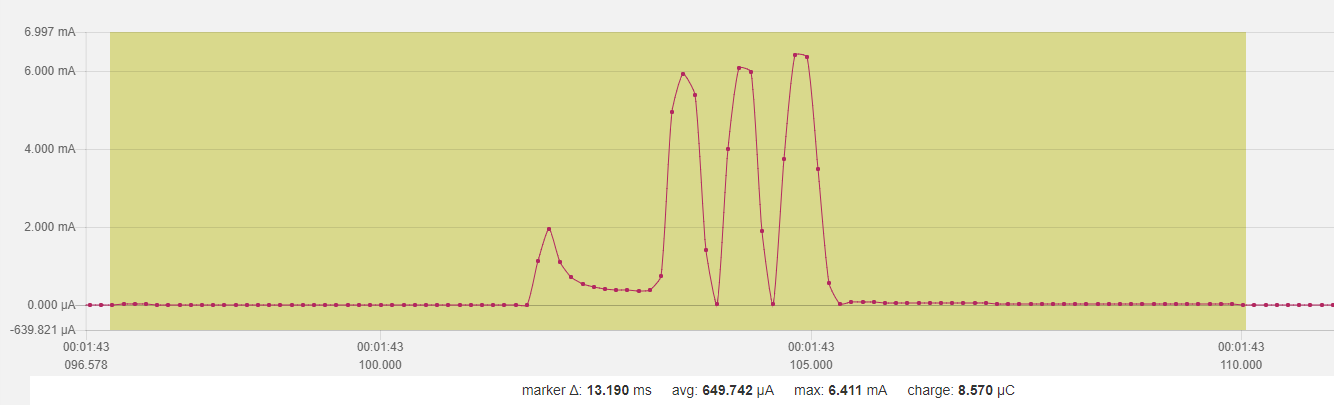
[29 adv int to 1 sec from 1/10 sec 15](#_Toc7209604)

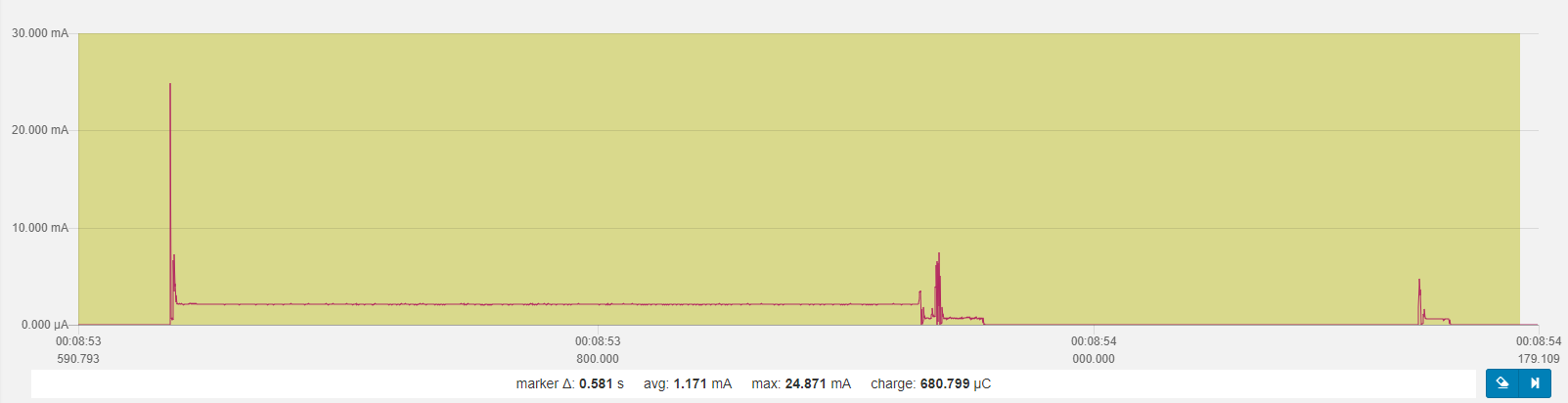
[30 SHT update int to 5 sec from 1/8 sec 15](#_Toc7209605)

[31 SADC update int to 10 sec from 1/8 sec 15](#_Toc7209606)

[32  15](#_Toc7209607)

[33 Sensor update (all 5 sec) 15](#_Toc7209608)

[34 Adv (all 1 sec) 16](#_Toc7209609)

[35 Startup 16](#_Toc7209610)

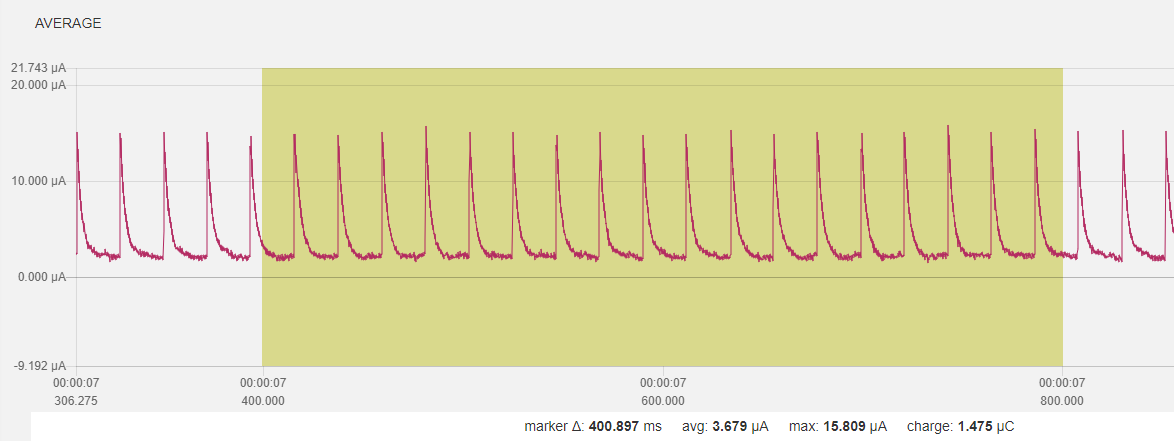
[36 Peaks 16](#_Toc7209611)

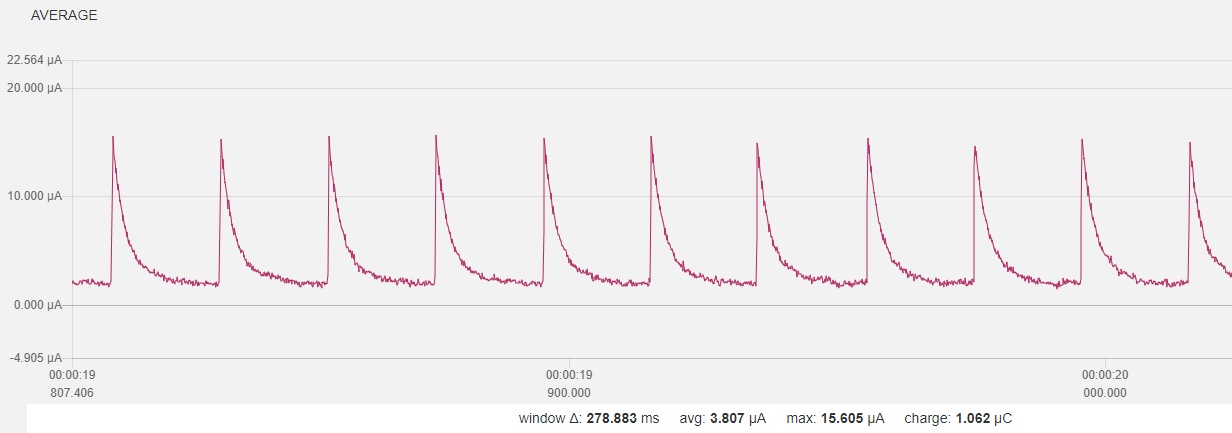
[36.1 Power on peak 16](#_Toc7209612)

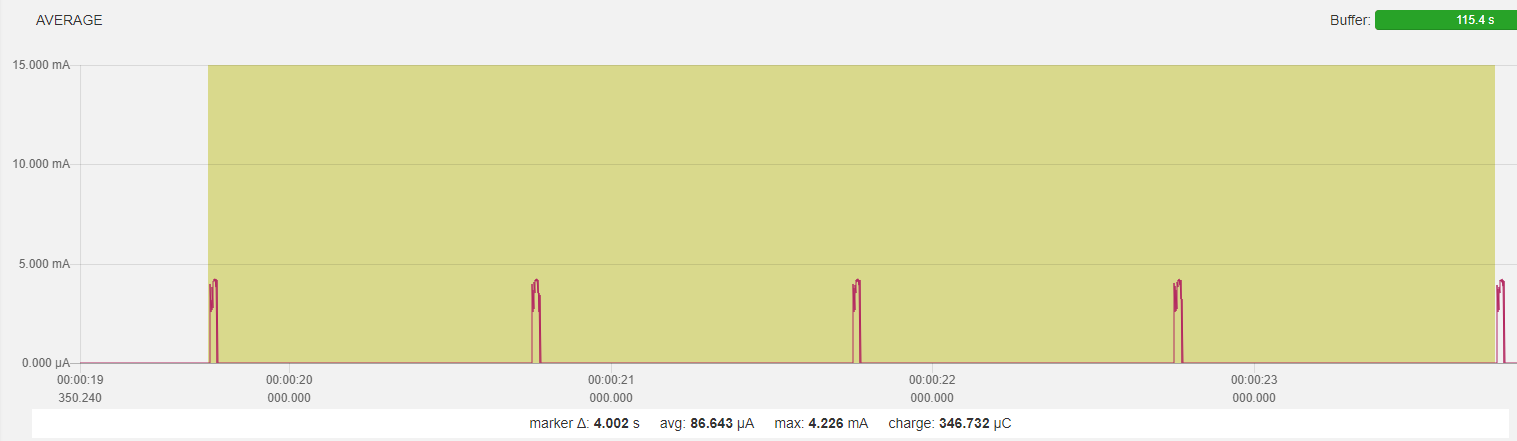
[36.2 First adv 16](#_Toc7209613)

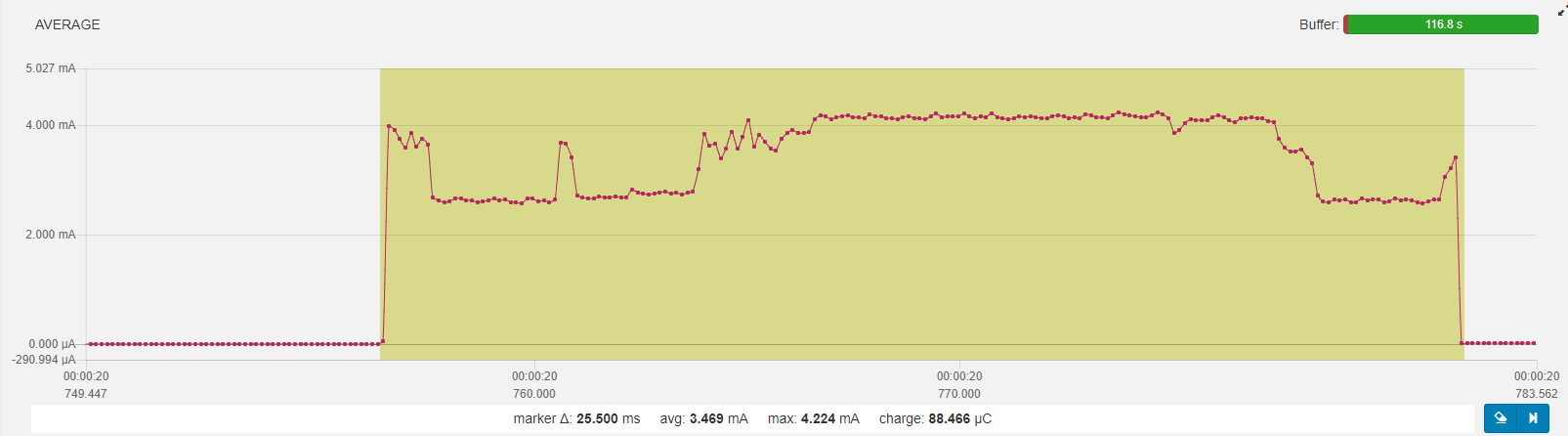
[36.3 First sensor acquisition 16](#_Toc7209614)

[37 Part 2 – Power Optimization KX022 Accelerometer 16](#_Toc7209615)

[38 Baseline, no BLE, no sensor init 16](#_Toc7209616)

[39 Change to TWI without transaction manager, SHT3 init and KX022 init to standby 17](#_Toc7209617)

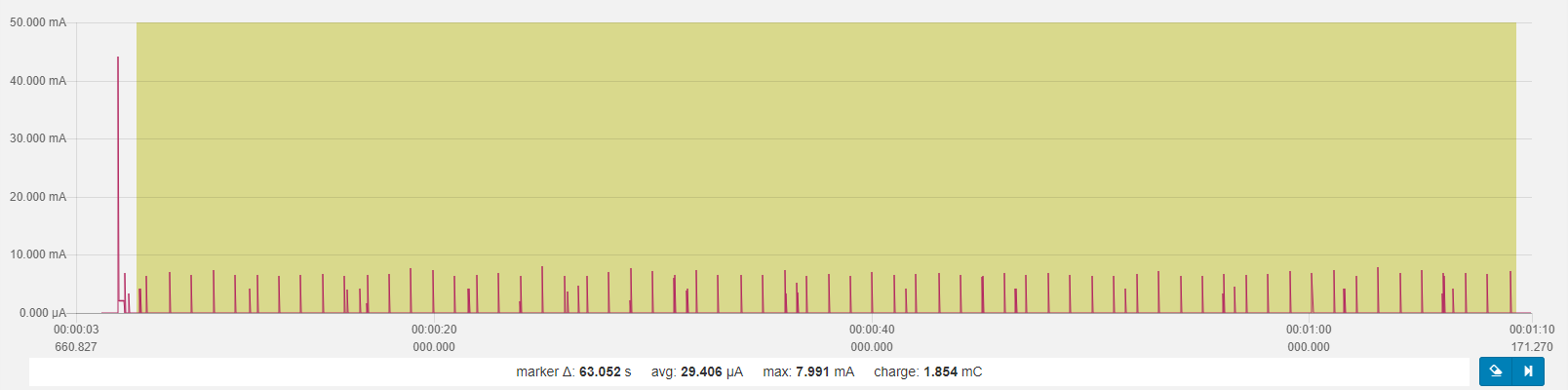
[40 With KX022 and SHT3 “one shot” measurement, 1 Hz 17](#_Toc7209618)

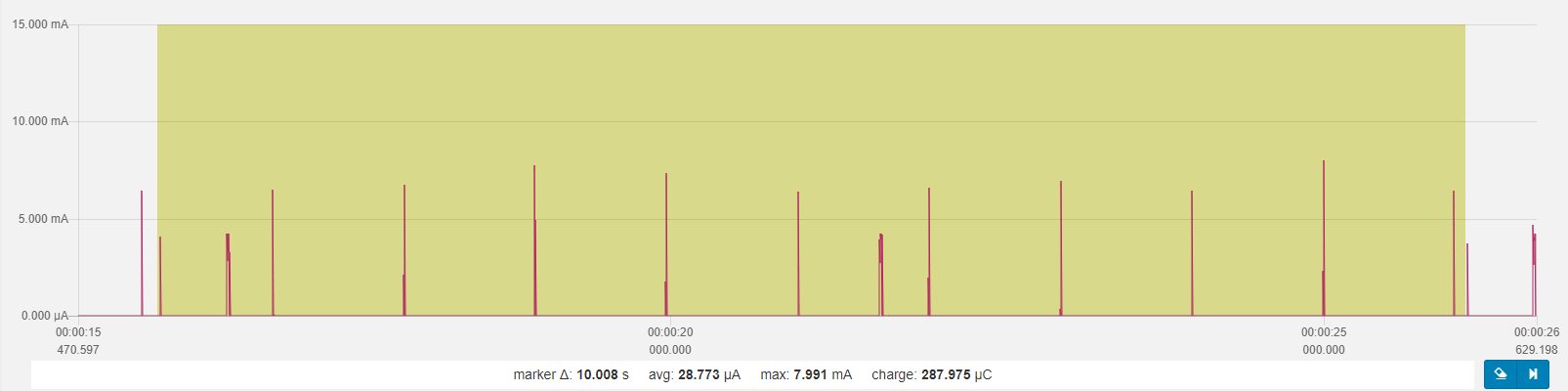
[41 One measurement  18](#_Toc7209619)

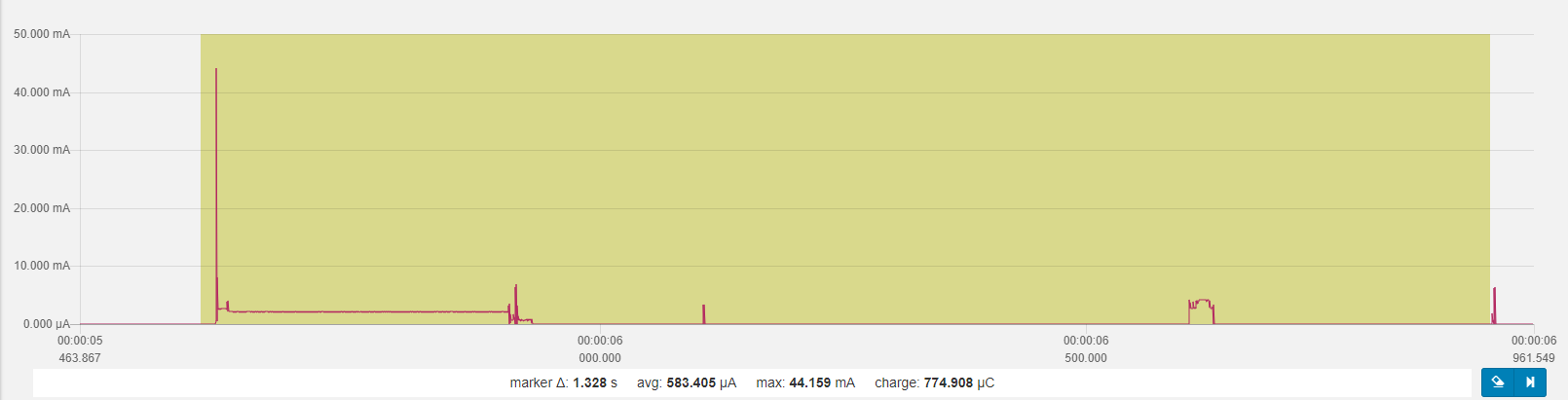
[42 Init KX022, Standby 1,2ms wait 1.2/ODR 3ms set to operate 0,5ms wait 1.2/ODR for value 3ms read accel values … SUM ~8ms 18](#_Toc7209620)

[43 Set SHT3 to SHT3\_MEAS\_HIGHREP\_STRETCH wait clock stretch 12,5ms read temperature and humidity 2,8ms SUM ~15ms 18](#_Toc7209621)

[44 Process data and sleep again… Overall cycle 25ms, avg. power consumption 3,5mA, idle < 4uA 18](#_Toc7209622)

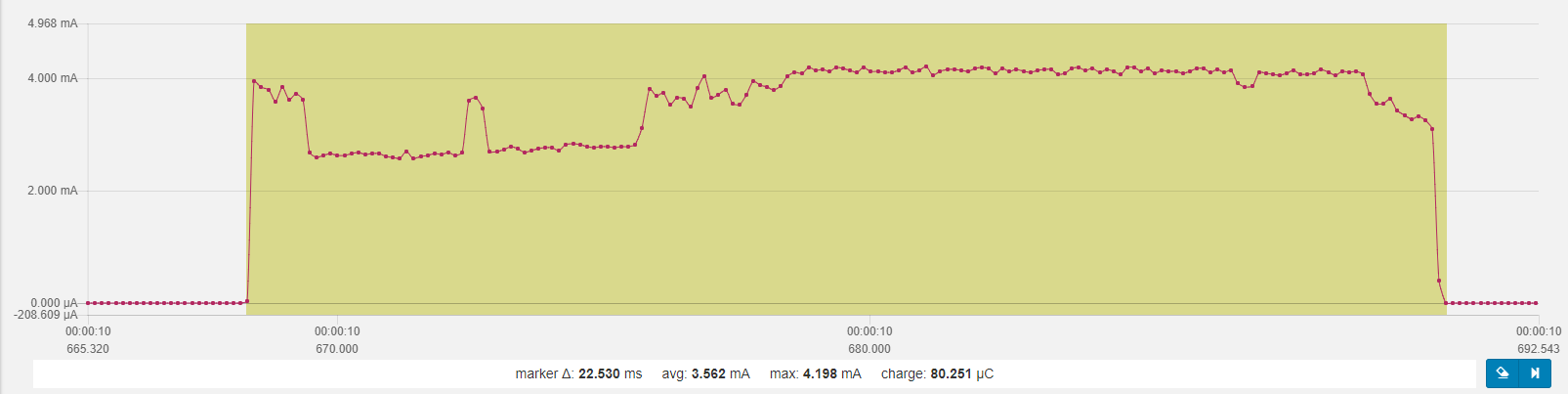
[45 Overall  18](#_Toc7209623)

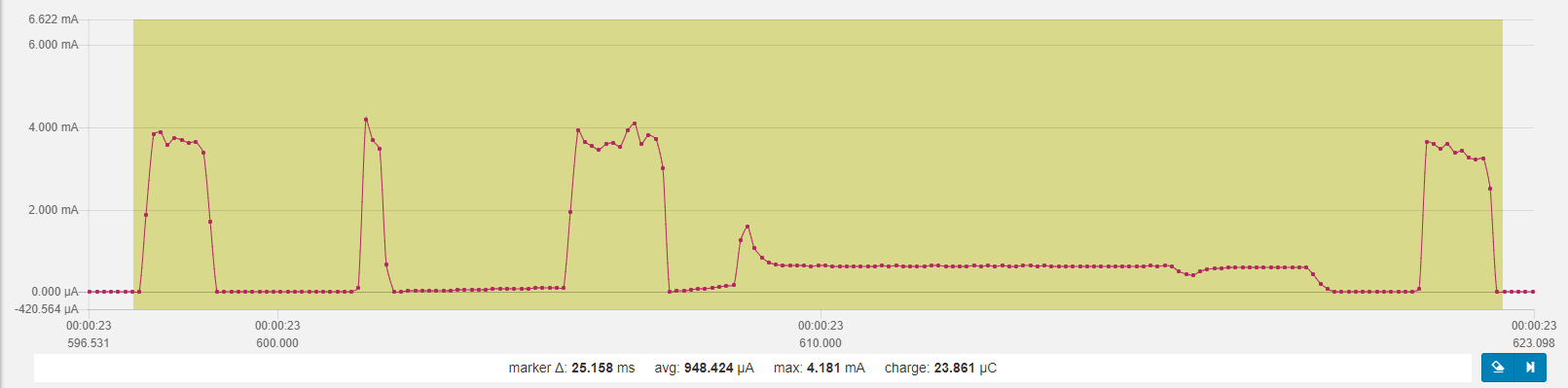
[46 One 10sec cycle  19](#_Toc7209624)

[47 cycle  19](#_Toc7209625)

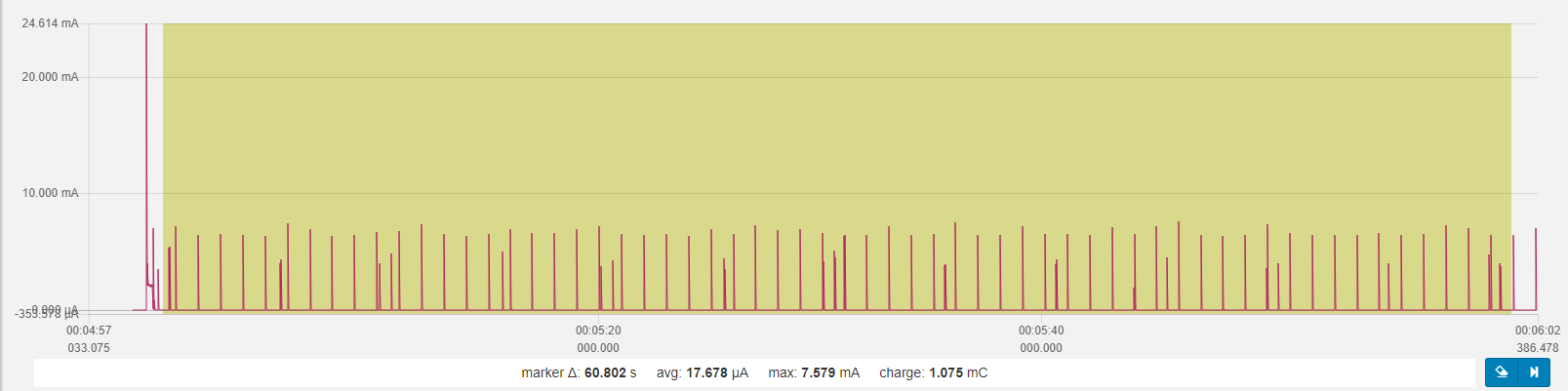
[48 BLE 0 dBm, adv. interval 1s sensor (SHT3 and KX022) interval 5s SAADC (battery level) interval 10s overall power consumption ~30uA (28,77uA) idle power consumption 3,5uA 19](#_Toc7209626)

[49 Part 3 – Use RTC INT for while waiting for accel data 19](#_Toc7209627)

[50 Baseline  19](#_Toc7209628)

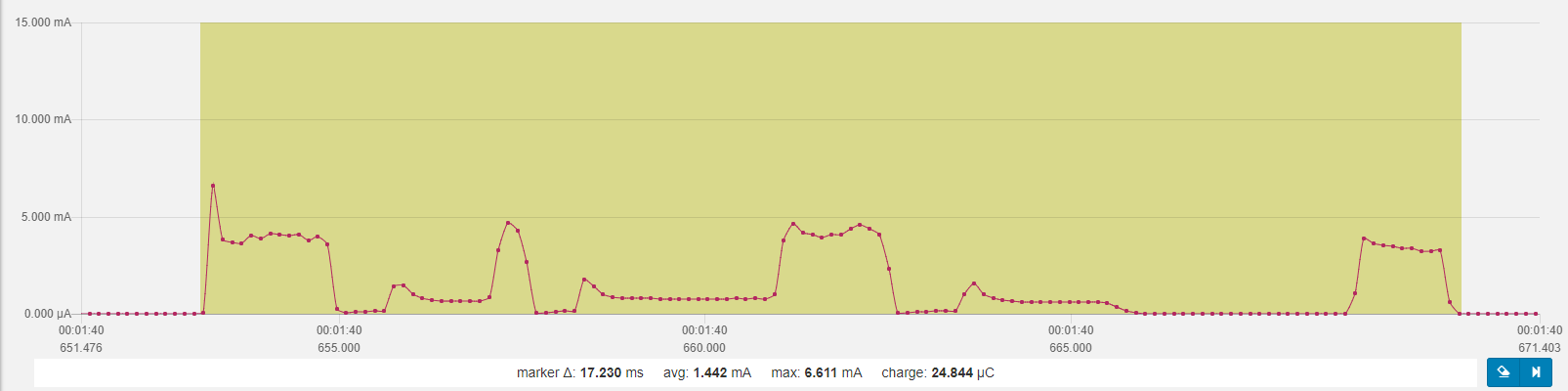
[51 Use RTC counter (freq 1/256) for KX022 “put to operation”, “wait for accel data”, and during SHT3 temp/hum measurement (w/max. 15ms time)  20](#_Toc7209629)

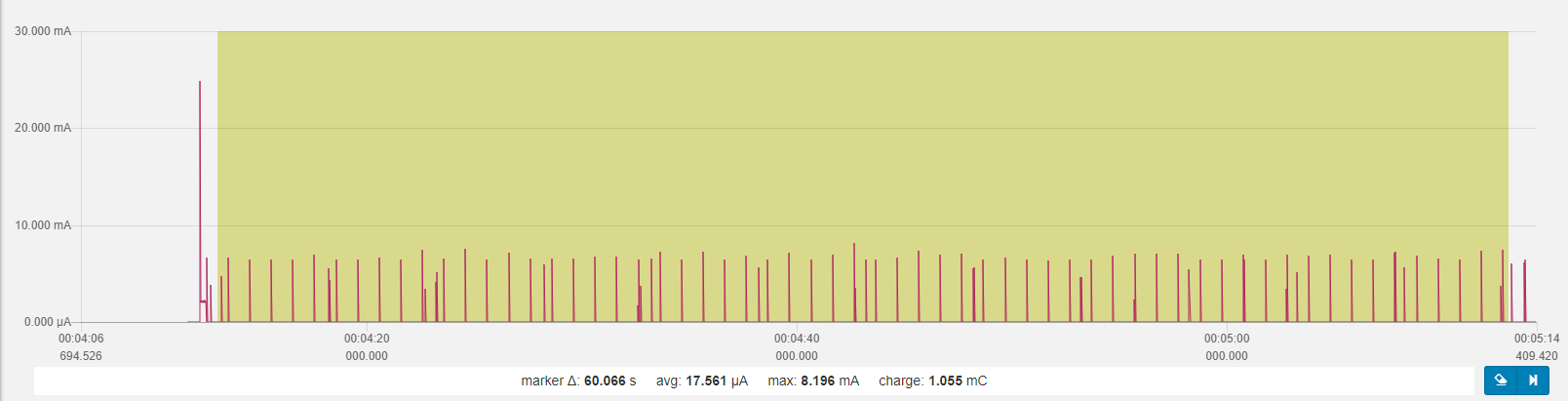
[51.1 20](#_Toc7209630)

[52 one minute, analog to Part 2 overall  20](#_Toc7209631)

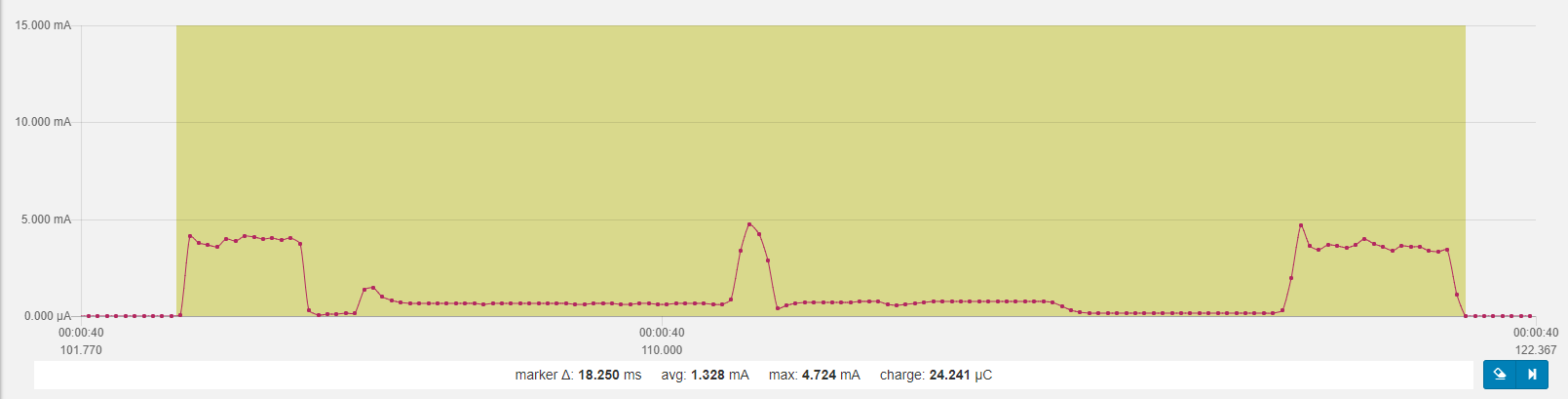
[53 Optimization summary (Part 3 🡪 Part 4) BLE 0 dBm, adv. interval 1s sensor (SHT3 and KX022) interval 5s SAADC (battery level) interval 10s overall power consumption ~30uA (28,77uA) 🡪 17,68uA idle power consumption 3,5uA 🡪 3,5 uA 20](#_Toc7209632)

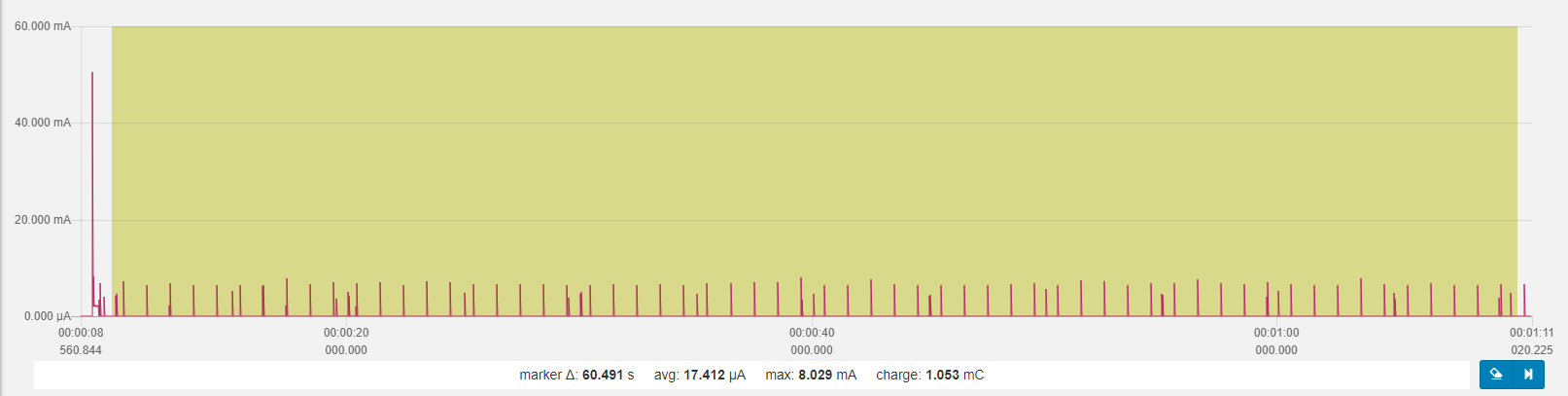
[54 Part 4 – Further optimization 20](#_Toc7209633)

[**55** Using nested approach: start long running SHT3 first, complete KX022 tasks and read SHT3 values **KX022: ODR 1600 -> delay time 3ms**  21](#_Toc7209634)

[56 one minute, analog to Part 3 overall  21](#_Toc7209635)

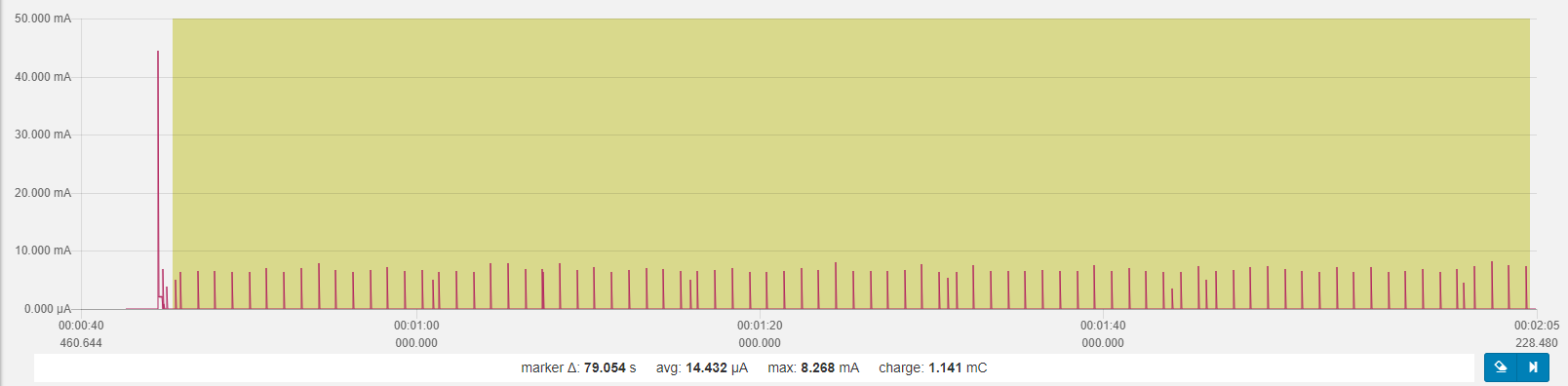
[57 thus, no real further improvement 21](#_Toc7209636)

[58 KX022: ODR 200 -> delay time 7ms  21](#_Toc7209637)

[59 one minute, analog to Part 3 overall  22](#_Toc7209638)

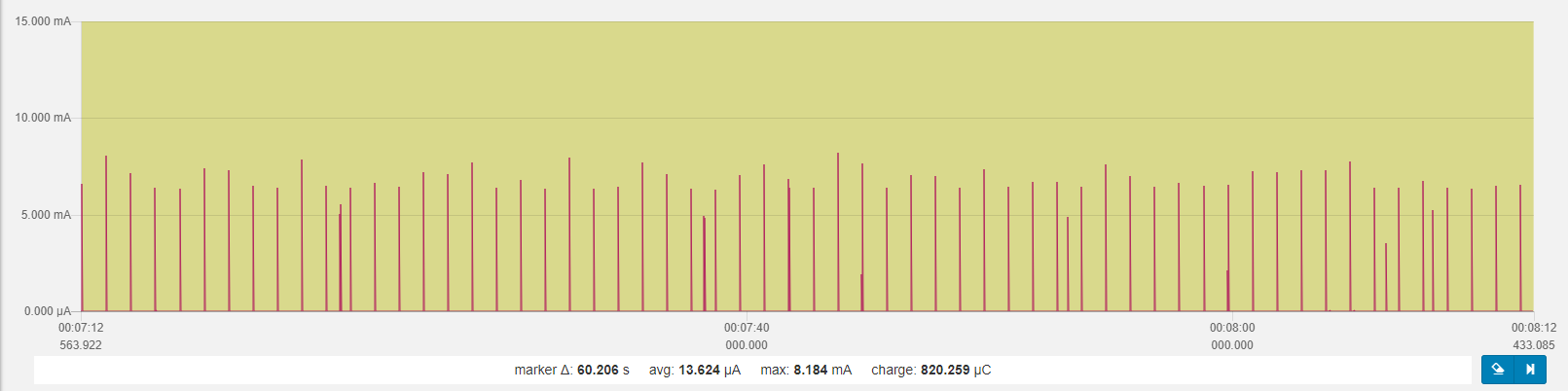
[60 thus, no real further improvement 22](#_Toc7209639)

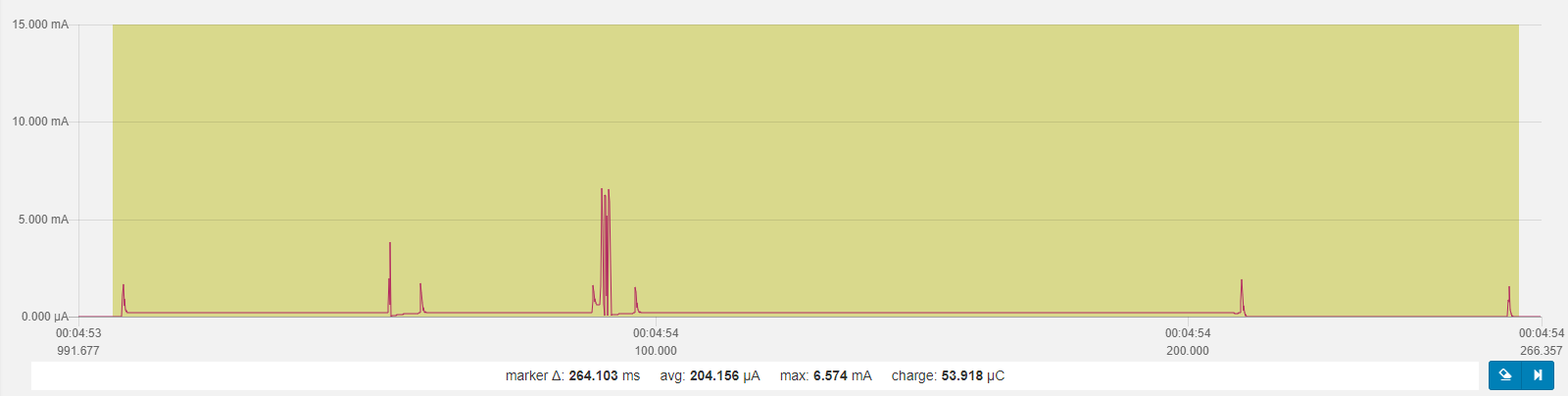
[62 Longer intervals between adv and samples 23](#_Toc7209640)

[63 BLE 0 dBm, adv. interval 1s sensor (SHT3 and KX022) interval 15s SAADC (battery level) interval 60s overall power consumption 14,4uA idle power consumption 3,6 uA 23](#_Toc7209641)

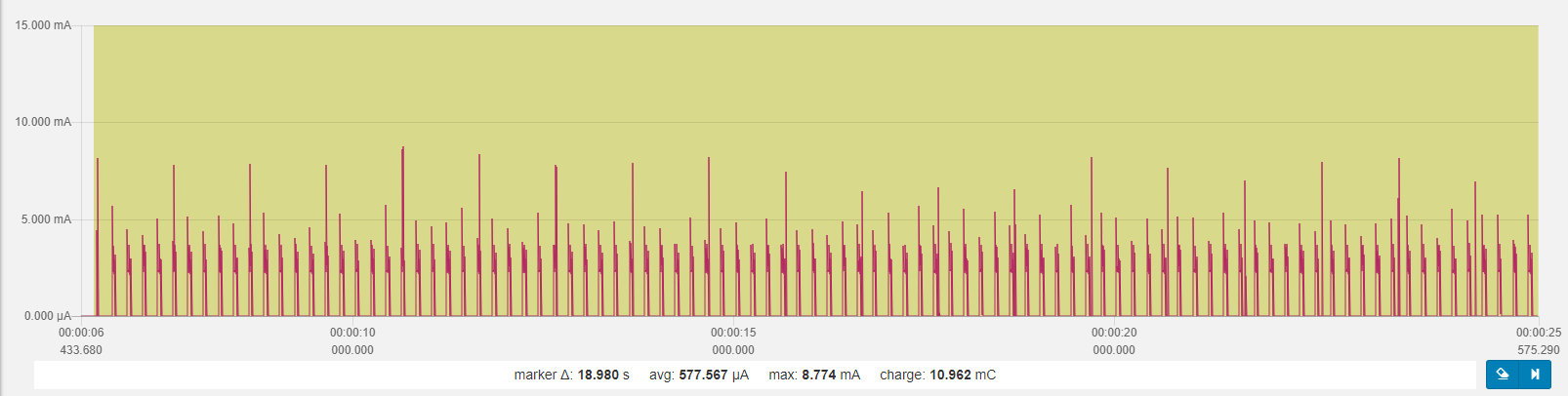
[64 (> 1 Jahr = 365\*24h = 8760h; CR2032 = 220 mAh) 23](#_Toc7209642)

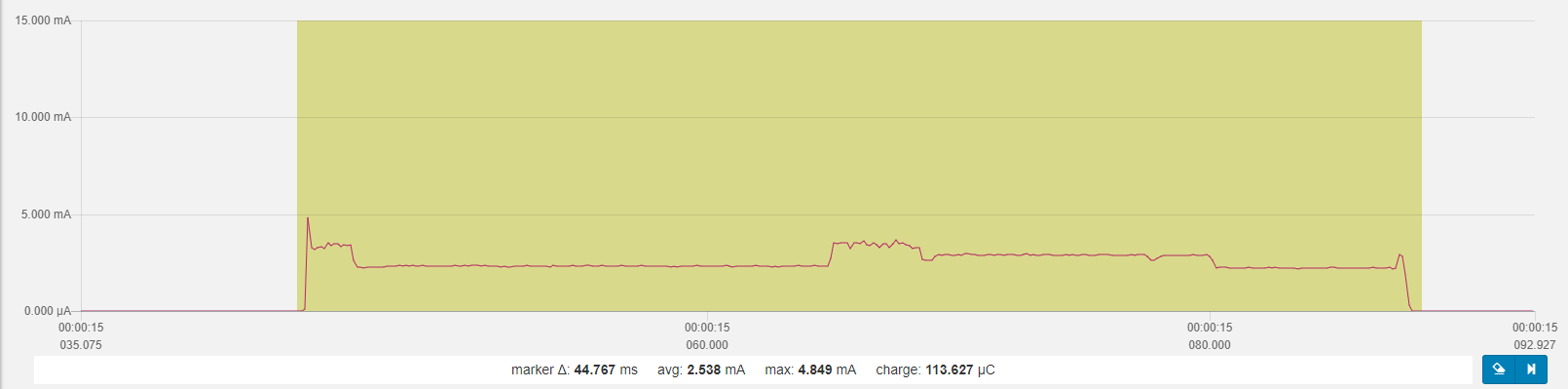
[65 Button functionality introduced 24](#_Toc7209643)

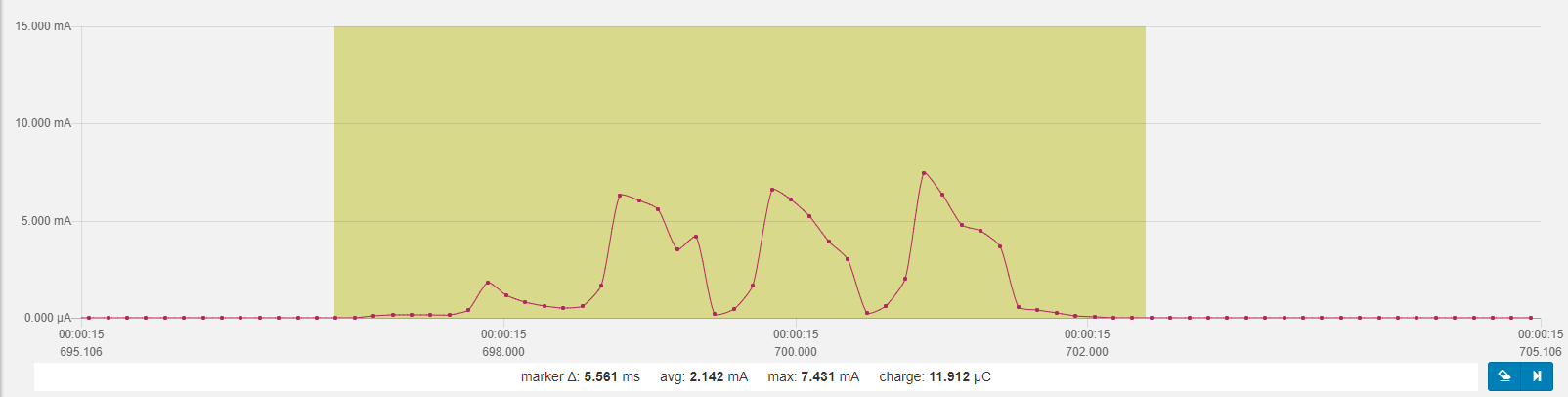
[66  24](#_Toc7209644)

[67 Single button press  24](#_Toc7209645)

[68 Original Beacon Firmware (for comparison) 24](#_Toc7209646)

[69  24](#_Toc7209647)

[70 Frequent spikes (5 Hz) 24](#_Toc7209648)

[71 Larger but rarer spikes (1 Hz) 25](#_Toc7209649)

# Baseline

The baseline for the device is measured with only the Softdevice and no app flashed.

## According to Specification

**Nrf52 according to spec**  
TDB

**Device KX022**

high power mode 145 [uA@2.5V](mailto:uA@2.5V)

low power mode 10 uA

standby 0.9 uA

**Device SHT3**

idle state 0.2 uA (max 2 uA)

Average 2 uA while measuring w/lowest repeat.+single shot)

## Initial Measuring

### Softdevice flashed, no app flashed

### Softdevice, just go to idle mode

Figure 1 Softdevice flashed, no app flashed

# Figure 2 Softdevice, just go to idle mode

# Case 3: Softdevice, init bsp (led off), and just go to idle mode

# 

# Case 3b: as case 3 w/one led on

# 

# Case 4: as case 3 (led off) + twi\_config + (both) sensor\_init

# 

# Case 4a: as case 4 but no sensor\_init

# 

# Case 4b: only kx022 init

# Case 4c: only SHT3 init

# Case 5: as case 4c/SHT but no KX022, no sensor data + BLE adv

# Case 6: as case 5+ SAADC measurement)

# Case 6a: as case 6 w/o BLE init/adv

# Case 7: as case 5 + SHT measurement

# Case 8: all but KX022 measurement, 1/8 data acquisition for SHT and SAADC

# Case 8a

# reduce transmit power to 0dBm from +4dBm

# adv int to 1 sec from 1/10 sec

# SHT update int to 5 sec from 1/8 sec

# SADC update int to 10 sec from 1/8 sec

# 

# Sensor update (all 5 sec)

# Adv (all 1 sec)

# Startup

# Peaks

## Power on peak

## First adv

## First sensor acquisition

# Part 2 – Power Optimization KX022 Accelerometer

# Baseline, no BLE, no sensor init

# Change to TWI without transaction manager, SHT3 init and KX022 init to standby

# With KX022 and SHT3 “one shot” measurement, 1 Hz

# One measurement

# Init KX022, Standby 1,2ms wait 1.2/ODR 3ms set to operate 0,5ms wait 1.2/ODR for value 3ms read accel values … SUM ~8ms

# Set SHT3 to SHT3\_MEAS\_HIGHREP\_STRETCH wait clock stretch 12,5ms read temperature and humidity 2,8ms SUM ~15ms

# Process data and sleep again… Overall cycle 25ms, avg. power consumption 3,5mA, idle < 4uA

# Overall

# One 10sec cycle

# cycle

# BLE 0 dBm, adv. interval 1s sensor (SHT3 and KX022) interval 5s SAADC (battery level) interval 10s overall power consumption ~30uA (28,77uA) idle power consumption 3,5uA

# Part 3 – Use RTC INT for while waiting for accel data

# Baseline

# Use RTC counter (freq 1/256) for KX022 “put to operation”, “wait for accel data”, and during SHT3 temp/hum measurement (w/max. 15ms time)

## 

# one minute, analog to Part 2 overall

# Optimization summary (Part 3 🡪 Part 4) BLE 0 dBm, adv. interval 1s sensor (SHT3 and KX022) interval 5s SAADC (battery level) interval 10s overall power consumption ~30uA (28,77uA) 🡪 17,68uA idle power consumption 3,5uA 🡪 3,5 uA

# Part 4 – Further optimization

# Using nested approach: start long running SHT3 first, complete KX022 tasks and read SHT3 values **KX022: ODR 1600 -> delay time 3ms**

# one minute, analog to Part 3 overall

# thus, no real further improvement

# KX022: ODR 200 -> delay time 7ms

# one minute, analog to Part 3 overall

# thus, no real further improvement

# Longer intervals between adv and samples

# BLE 0 dBm, adv. interval 1s sensor (SHT3 and KX022) interval 15s SAADC (battery level) interval 60s overall power consumption 14,4uA idle power consumption 3,6 uA

#### 220mAh / 0,0144mA \* 0,7 = 10.694 h = ~1.2 Jahre

# (> 1 Jahr = 365\*24h = 8760h; CR2032 = 220 mAh)

# Button functionality introduced

# 

# Single button press

# Original Beacon Firmware (for comparison)

# 

# Frequent spikes (5 Hz)

# Larger but rarer spikes (1 Hz)