# MMA9553L Pedometer

## Power Consumption Optimization

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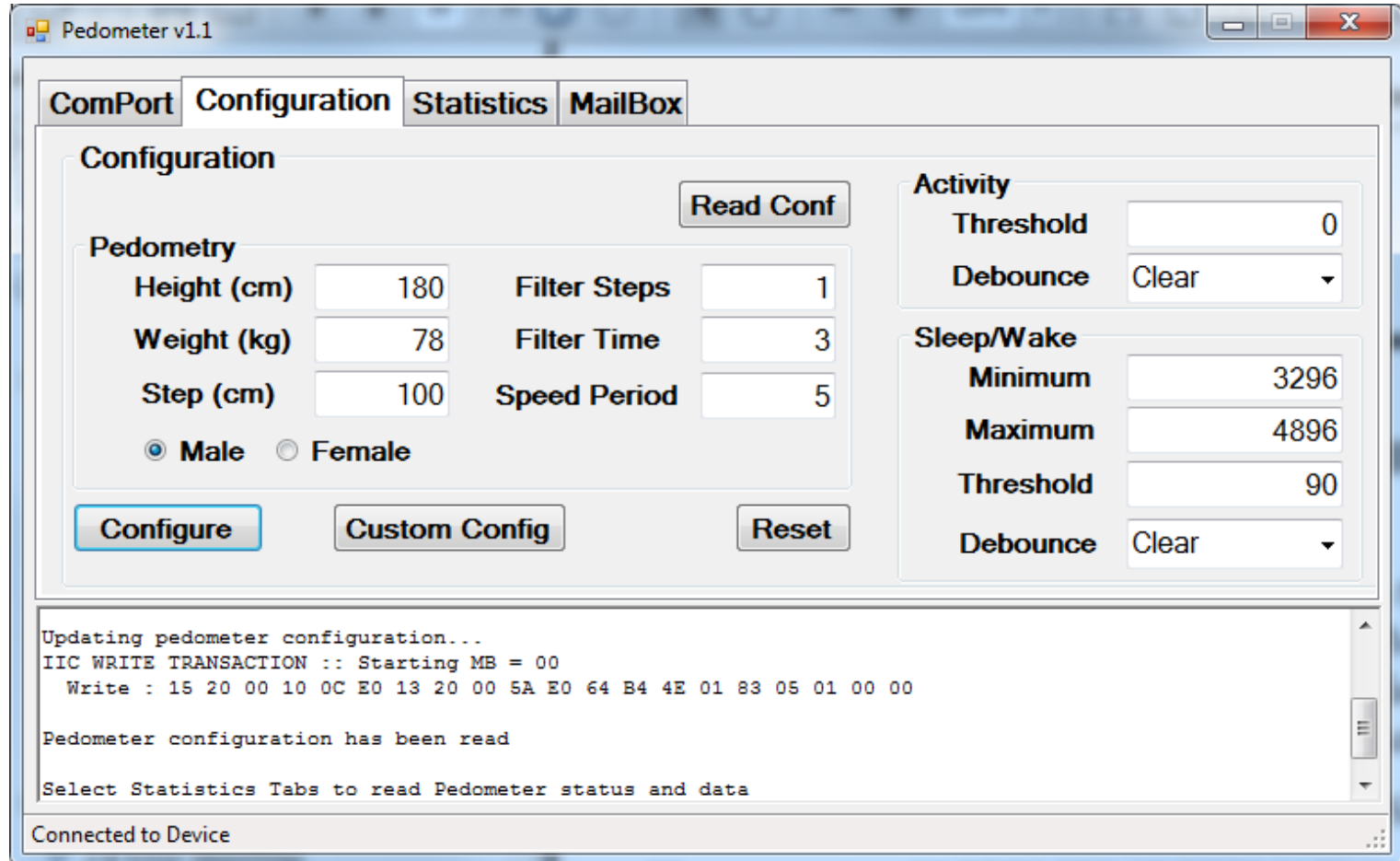
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External Use

# Content

- This document briefly describes how to optimize MMA9553L current consumption in different ways:

  - using the autonomous Suspend feature of the pedometer application, see §2.2.7 in MMA9553L_SWRM (Software Reference Manuel)

  - using the sleep/wake application (AppID 0x12) which is already a standard feature of both MMA9550L and MMA9551L Freescale Firmware, see chapter 17 in MMA955xL_SWRM

  - using the scheduler application (AppID 0x01) to change the activity level of unused applications, see §4.6.4 in MMA955xL_SWRM

  - using the AFE application (AppID 0x06) to change the ADC resolution, see §8.2 in MMA955xL_SWRM

  - using any combination of the above features

- In order to quantify the current saving associated to the various options, current drain measurement has been done with KITMMA955xL controlled with Pedometer GUI v1p1

# Idd Optimization using Pedometer Autonomous Suspend

- Below is a typical example of Autonomous Suspend settings with a 3sec delay (threshold count = 90). It corresponds to the "Custom Config" button. MailBox Tool log shows the associated I2C write transaction

# Idd Optimization using the Sleep/Wake application

- Sleep/Wake application gives the Scheduler the possibility to operate in an intermittent mode called Doze mode. More specifically it decreases the repetition rate of the scheduler to slow down the application execution recurrence and lower the consumption

- Transition between Run and Doze mode is autonomous and based on movement detection

**Sleep/Wake Application**
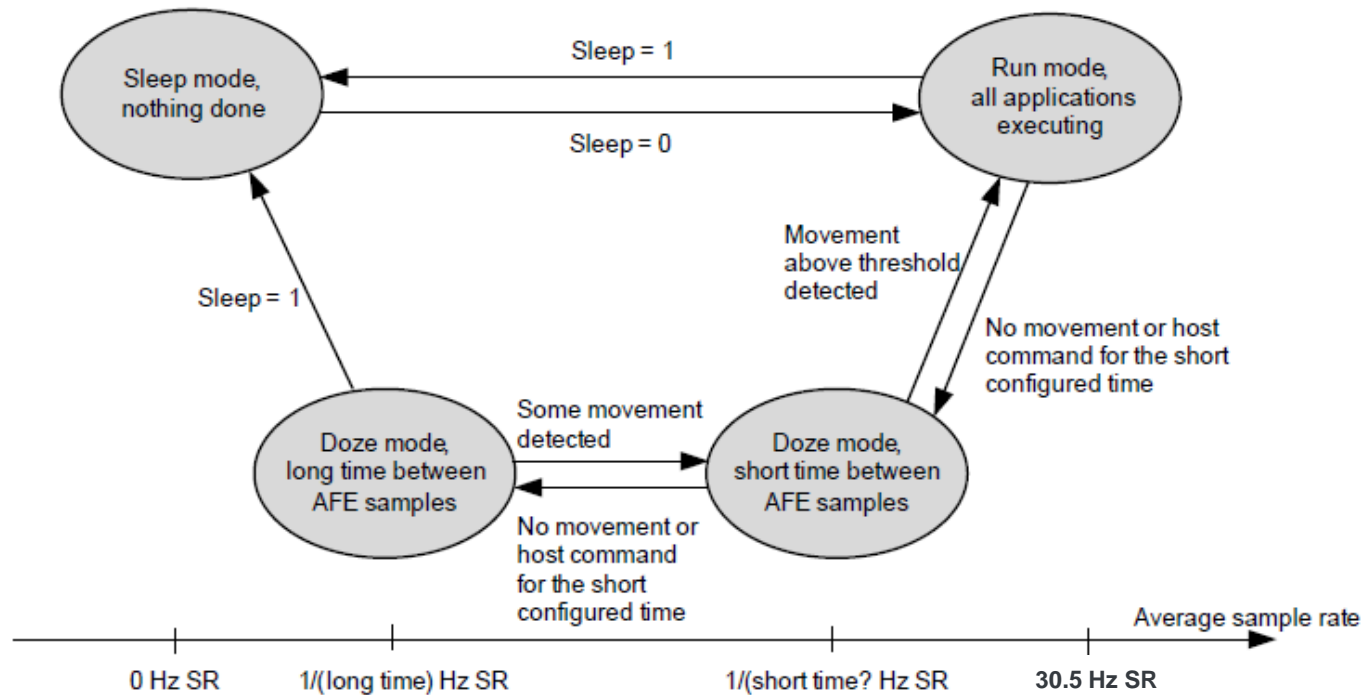


Figure 17-1. Platform's power modes state diagram

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# Sleep/Wake application - Settings

- In order to help settings selection and computation, you can use below XL spreadsheet (double click on it)

| write in reg 00-06: | | | 00 3C 01 31 08 05 06 | | | | DR(Hz) | 30.5 |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| | register | | | | time (sec) | SR (Hz) | long/ short | time (sec) | |
| | name | address | | | | | 0 | 0.0041 | |
| **0** | sensi_th_M | 0x00 | 00 | | | | 1 | 0.0082 | |
| **1** | sensi_th_L | 0x01 | 3C | 60 | | | 2 | 0.0164 | |
| **2** | time_th_M | 0x02 | 01 | | | | 3 | 0.0328 | |
| **3** | time_th_L | 0x03 | 31 | 305 | 10 | | 4 | 0.0656 | |
| **4** | long_off | 0x04 | 08 | 8 | 1.049 | 0.953 | 5 | 0.1311 | |
| **5** | short_off | 0x05 | 05 | 5 | 0.131 | 7.625 | 6 | 0.2623 | |
| **6** | cfg | 0x06 | 06 | 6 | | | 7 | 0.5246 | |
| | | | | | | | 8 | 1.0492 | |
| | | cells: | input | | | | 9 | 2.0984 | |
| | | | results | | | | 10 | 4.1967 | |

# Using Sleep/Wake application - practical example

- Mailbox Tool log below shoes 2 transactions meant to exercise doze mode with Pedometer
  - 01 20 41 01 93 //set pedometer activity High (so it won't run in doze mode)
  - 12 20 00 07 00 3C 01 31 08 05 06 //set SleepWake configuration: sensi_th=60, time_th=10s, Doze mode enabled

# Idd Optimization using the scheduler application

- Table at the right shows the default settings (activity & priority) of MMA9553L applications

- If some of them are definitely not needed by the user, their activity can be changed to never so that they do not run

- In particular, we suggest the following list
  - Status
  - Event Queue
  - Data FIFO

| Pedometer default settings | | | | | |
|---|---|---|---|---|---|
| in Scheduler Application: | | | | | |
| read conf reg 2C to 3B => | | **00** 17 D3 D3 D3 17 D3 00 00 00 00 00 00 00 00 D3 | | | |
| read conf reg 3C to 4B => | | D3 D3 D3 00 00 D3 00 D3 00 00 00 00 00 00 00 00 | | | |

| Freescale application | APP_ID | MMA9553L | Activity | Priority / Task | Idd saving if Activity = Never |
|---|---|---|---|---|---|
| Version | 0x00 | X | Never | P0 | |
| Scheduler | 0x01 | X | Never | T488 | |
| Communications | 0x02 | X | Always | T30.5 | |
| GPIO | 0x03 | X | Always | T30.5 | * |
| Mailbox | 0x04 | X | Always | T30.5 | * |
| Analog Front End | 0x06 | X | Always | T30.5 | |
| user application | 0x0C | | Never | P0 | |
| user application | 0x0D | | Never | P0 | |
| Data FIFO | 0x0F | X | Always | T30.5 | ** |
| Event Queue | 0x10 | X | Always | T30.5 | ** |
| Status Register | 0x11 | X | Always | T30.5 | ******** |
| Sleep Wake | 0x12 | X | Always | T30.5 | |
| user application | 0x13 | | Never | P0 | |
| user application | 0x14 | | Never | P0 | |
| Pedometer | 0x15 | | Always | T30.5 | |
| Pedo Wrapper I/F | 0x16 | | Never | P0 | |
| Reset Suspend Clear | 0x17 | X | Always | T30.5 | |
| MBOX Config | 0x18 | X | Never | P0 | |
| user application | 0x19 | | Never | P0 | |

# Idd Optimization using the scheduler – practical example

- In order to prevent execution of App_ID 0xF, 0x10, 0x11 (Data_FIFO, Event_Queue & Status_Reg), you can send the following string with the Mailbox Tool:

01 20 3B 03 13 13 13 //set Data_FIFO, Event_Queue & Status_Reg AppID activity to Never
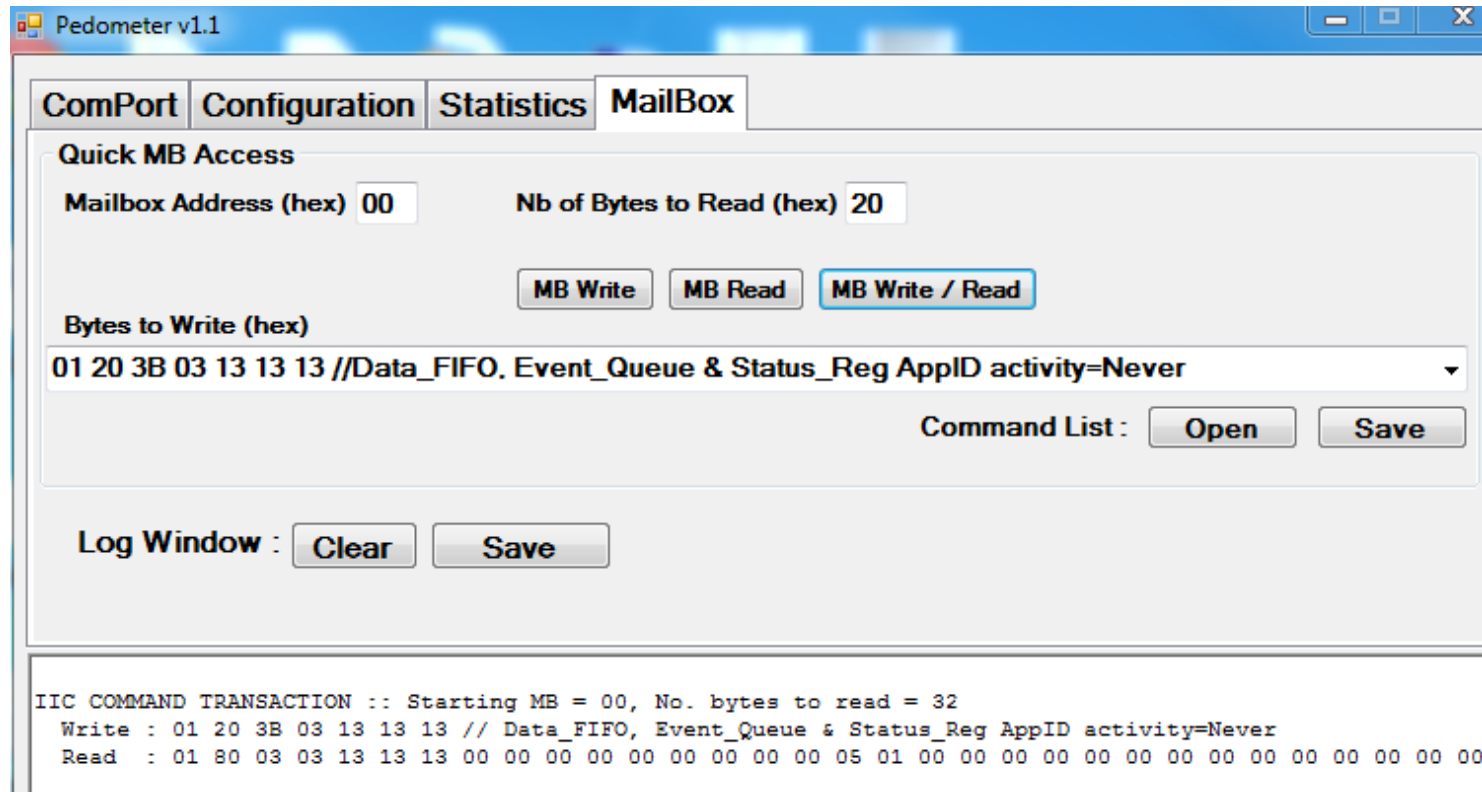
# Idd Optimization through AFE ADC resolution

- The conversion time of the ADC depends on its resolution settings (default is 16bits). In order to save a few μA, resolution can be lowered to 14bits without compromising the pedometer accuracy. Further decrease of the resolution does not yield significant current saving
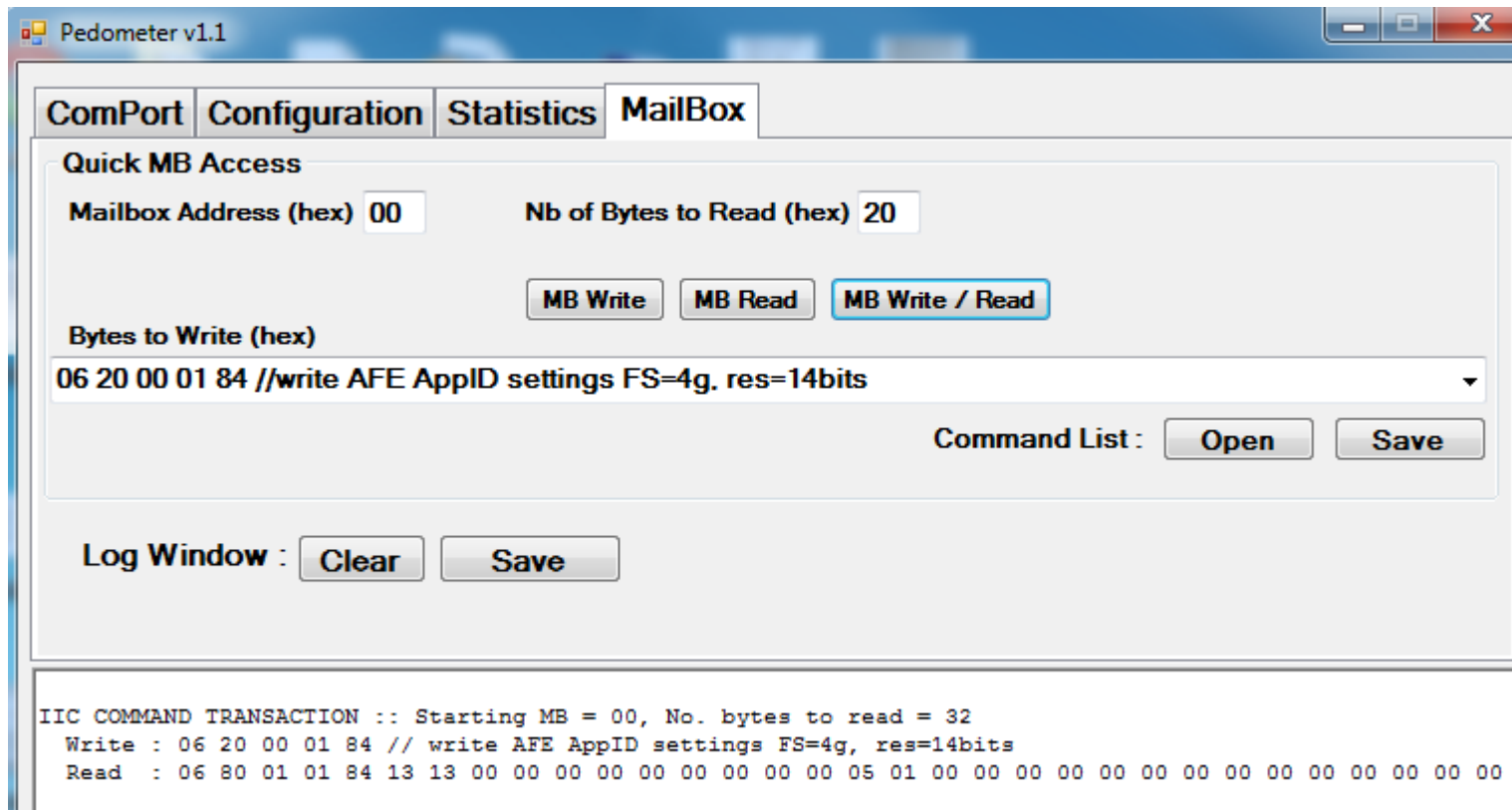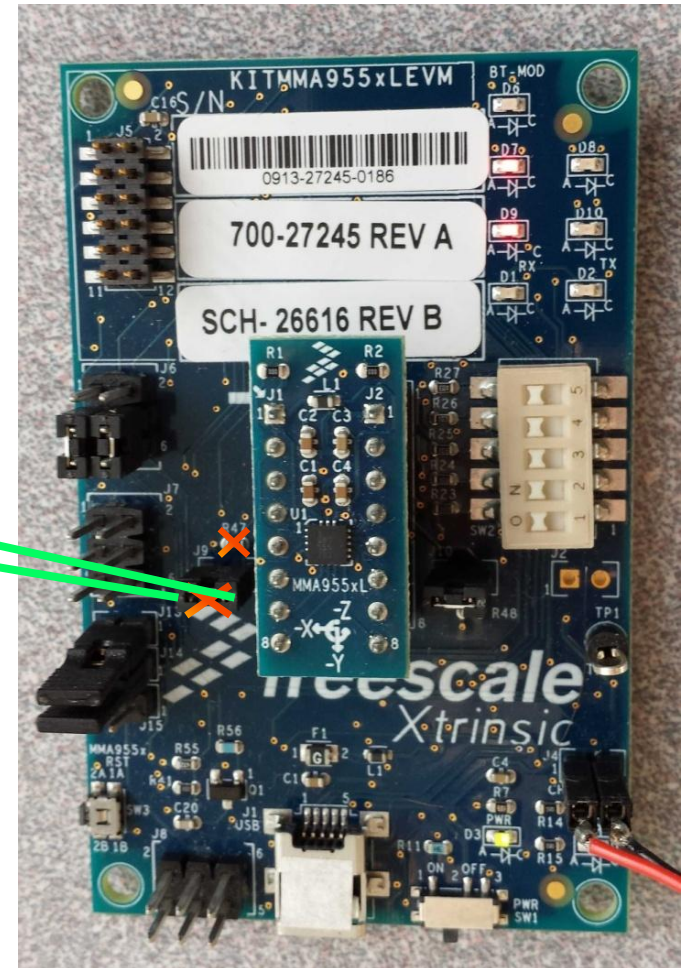
# Using KITMMA955xL for Idd measurements

- Remove resistor R47 (10Ohm)

- Insert Ampere-meter instead of Jumper J9
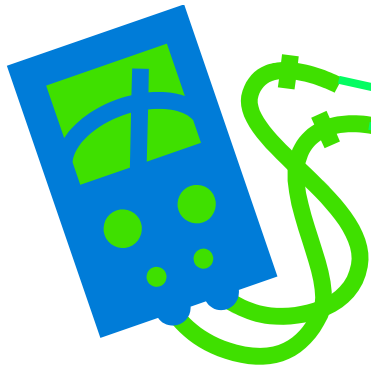
- Use strong and slow averaging on the Ampere-meter as current profile is pulsed and rate can be quite low (e.g. 1s in doze mode)

# Idd Measurement on Pedometer with Optimization

| Optimization Label | Optimization Description | Optimization Combination | Average Idd (µA) | Pedometer Operation |
|---|---|---|---|---|
| 0 | Baseline (ADC resolution 16b) | 0 | 183 | Yes |
| 1 | ADC resol. 14b | 1 | 181 | Y |
| 2 | FIFO & Queue Never | 1+2 | 180 | Y |
| 3 | Status Never | 1+2+3 | 172 | Y |
| 4 | GPIO & Mbox Never | 1+2+3+4 | 171 | Y |
| 5 | Pedometer auto suspend | 1+5 | 83 | No |
|  |  | 1+2+3+5 | 74 | N |
| 6 | Doze 0.5sec | 1+5+6 | 27 | N |
|  |  | 1+2+3+5+6 | 25 | N |
| 7 | Doze 1sec | 1+5+7 | 21 | N |
|  |  | 1+2+3+5+7 | 20 | N |

Note: Current measurement accuracy is about 1µA

# Examples of Command for MMA9553L Idd optimization

**Command List (can be used in the Mailbox tab of the Pedometer GUI)**

12 10 00 07 //read SleepWake AppID config/settings

12 30 00 01 //read SleepWake AppID status/output

12 20 00 07 00 3C 01 31 08 05 06 //set SleepWake configuration: sensi_th=60, time_th=10s, Doze mode enabled

06 10 00 07 //read AFE AppID config/settings

06 20 00 01 84 //write AFE AppID settings FS=4g, res=14bits

01 10 2C 10 //read scheduler parameter registers 0x2C to 0x3B

01 20 41 01 93 //set pedometer activity High (so it won't run in doze mode)

01 20 3B 03 13 13 13 //set Data_FIFO, Event_Queue & Status_Reg AppID activity = Never

15 20 00 10 0C E0 13 20 00 5A E0 64 B4 4E 01 83 05 01 00 00 //pedometer auto-suspend settings

# Pedometer  Idd Optimization Conclusion

- By combining all available features and tricks, the Pedometer current can be significantly reduced, by suspending its algorithm when there's no significant moves from the user and above all taking advantage of the Doze mode to decrease the scheduler execution recurrence

- The parameters settings shown in this document, more specifically for pedometer auto-suspend and Sleep/Wake configuration, should be considered only as a starting point.

- An optimization and validation of those parameters is recommended. In particular it is important to define robust settings to exit reliably from the low power Doze mode when user resumes his moves

- Nonetheless the setting examples give good insight about Pedometer performance and Current drain optimization

- Final qualitative comment about Pedometer step counting versus Idd trade off:
  - The pedometer auto-suspend feature seldom misses steps
  - The sleep/wake feature can cause a few steps to be missed when exiting from doze mode

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