

A121 Smart Presence Reference Application

User Guide

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1 Acconeer SDK Documentation Overview

To better understand which SDK document to use, a summary of the documents is shown in the table below.

Name	Description	When to use
RSS API documentation (html)		
rss_api	The complete C API documentation.	• RSS application implementation • Understanding RSS API functions
User guides (PDF)		
A121 Assembly Test	Describes the Acconeer assembly test functionality.	• Bring-up of HW/SW • Production test implementation
A121 Breathing Reference Application	Describes the functionality of the Breathing Reference Application.	• Working with the Breathing Reference Application
A121 Distance Detector	Describes usage and algorithms of the Distance Detector.	• Working with the Distance Detector
A121 SW Integration	Describes how to implement each integration function needed to use the Acconeer sensor.	• SW implementation of custom HW integration
A121 Presence Detector	Describes usage and algorithms of the Presence Detector.	• Working with the Presence Detector
A121 Smart Presence Reference Application	Describes the functionality of the Smart Presence Reference Application.	• Working with the Smart Presence Reference Application
A121 Sparse IQ Service	Describes usage of the Sparse IQ Service.	• Working with the Sparse IQ Service
A121 Tank Level Reference Application	Describes the functionality of the Tank Level Reference Application.	• Working with the Tank Level Reference Application
A121 Touchless Button Reference Application	Describes the functionality of the Touchless Button Reference Application.	• Working with the Touchless Button Reference Application
A121 Parking Reference Application	Describes the functionality of the Parking Reference Application.	• Working with the Parking Reference Application
A121 Vibration Example Application	Describes the functionality of the Vibration Example Application.	• Working with the Vibration Example Application
A121 STM32CubeIDE	Describes the flow of taking an Acconeer SDK and integrate into STM32CubeIDE.	• Using STM32CubeIDE
A121 Raspberry Pi Software	Describes how to develop for Raspberry Pi (aarch64).	• Working with Raspberry Pi (64-bit application)
A121 Raspberry Pi armv7l Software	Describes how to develop for Raspberry Pi (armv7l).	• Working with Raspberry Pi (32-bit application)
A121 Ripple	Describes how to develop for Ripple.	• Working with Ripple on Raspberry Pi
A121 ESP32 User Guide	Describes how to develop with A121 and ESP32 targets.	• Working with ESP32 targets
XM125 Software	Describes how to develop for XM125.	• Working with XM125
XM126 Software	Describes how to develop for XM126.	• Working with XM126

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Name	Description	When to use
I2C Distance Detector	Describes the functionality of the I2C Distance Detector Application.	• Working with the I2C Distance Detector Application
I2C Presence Detector	Describes the functionality of the I2C Presence Detector Application.	• Working with the I2C Presence Detector Application
I2C Breathing Reference Application	Describes the functionality of the I2C Breathing Reference Application.	• Working with the I2C Breathing Reference Application
I2C Cargo Example Application	Describes the functionality of the I2C Cargo Example Application.	• Working with the I2C Cargo Example Application
A121 Radar Data and Control (PDF)		
A121 Radar Data and Control	Describes different aspects of the Acconeer offer, for example radar principles and how to configure	• To understand the Acconeer sensor • Use case evaluation
Readme (txt)		
README	Various target specific information and links	• After SDK download

Table 1: SDK document overview.

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2 Smart Presence Reference Application

Smart presence is based on the presence detector, see Presence Detector. The algorithm divides the presence detection range into multiple zones. Furthermore, it has the possibility to change configuration based on detection, as well as configure how many zones that need to have detection before switching configuration. This is perfect to utilize when a low power configuration is wanted for scanning and a more robust configuration is wanted to, e.g., track a person walking through the zones. Smart presence has the same configuration possibilities as the presence detector, with the additions to create multiple zones in the range, utilize the wake up mode and to set how many zones that need to have detection before switching configuration.

2.1 Detection zones

The chosen range will be divided into the specified number of detection zones with equal size. The maximum number of detection zones is the number of measured points in the chosen range. To increase the maximum number of zones without extending the range, the step size can be decreased. This will increase the number of sampling points at the cost of increased power consumption. To get better distance resolution for the triggered zones, the chosen profile can be decreased. However, it should be remembered that the chosen profile needs to be large enough to get sufficient SNR in the complete range. Furthermore, the pulse extends outside the chosen detection range, hence it is possible to detect presence slightly outside of the chosen range. The extended detection range is dependent on the profile and is bounded by twice the full width at half maximum envelope power, see Radial Resolution.

2.2 Detection types

As for the presence detector, both fast and slow motions are considered. The triggered zones are reported back as a separate vector for fast motion detection, `intra_zone_detections` and for slow motion detection, `inter_zone_detections`, as well as one vector for the combined detections, `total_zone_detections`. For both slow and fast motions, the zone with the highest presence score is returned. The default for smart presence is to use both fast and slow motion detection to get a responsive detection, while at the same time having a stable detection when someone is being still. Since the fast presence detection has lower time constants in the filtering it is more responsive than the slow motion detection, thus the triggered zones for fast and slow motions can differ. The `max_presence_zone` is the zone with the most presence. However, the fast presence is prioritized due to faster responsiveness, i.e., if fast presence is detected (regardless of if slow presence is detected or not), the zone with the highest fast presence score is returned. If only slow presence is detected, the zone with the highest slow motion presence score is returned.

2.3 Wake up mode

If `wake_up_mode` is enabled, the application will change configuration based on whether presence is detected or not. The wake up configuration has the possibility to divide the range into multiple zones, as well as setting how many zones that need detection in a two second period before switching configuration. The two seconds period is created by having the zone linger its trigger for two seconds when the detection is lost. When presence is detected, switching is automatically done to the nominal configuration. After switching, it takes some time before the nominal detector has gained detection due to the filtering in the presence detector. Because of this, there is a latency when switching. During this time, presence is assumed detected. The maximum latency time is set based on the filter constants in the nominal presence configuration. All the settings in the nominal configuration can be set differently compared to the wake up configuration if that is needed. However, the nominal configuration does not have the parameter for setting the number of zones needed for switching, since this is not relevant. The application will switch back to the wake up configuration when the presence detection is lost.

2.4 Tests

2.4.1 Test cases

1. Human walking from Zone 3 → Zone 1 (1-3 meters range)

2. Human walking through all zones from the side (1-3 meters range)

3. Human walking from Zone 3 → Zone 1 (1-5 meters range)

4. Human walking through all zones from the side (1-5 meters range)

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5. Human walking into wake up config and confirm detection. Continue walking and confirm detection is done with nominal config.

6. Human walking into wake up config and stops. Confirm detection in both wake up config and nominal config.

7. Ceiling mounted sensor. Human walking into wake up config and confirm detection. Continue walking and confirm detection is done with nominal config.

8. Ceiling mounted sensor. Human walking into wake up config and stops. Confirm detection in both wake up config and nominal config.

2.4.2 Test setup

In these tests the A121 EVK was used. In the first test cases, the EVK was mounted on a wall at the same height as the test person's torso, see Figure 1.

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Figure 1: Sensor mounted on the wall. Setup used for test cases 1-6.

In the later test cases, the EVK was mounted on the ceiling, see Figure 2.

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Figure 2: Sensor mounted on the ceiling about 3 m up from the floor. Setup used for test cases 7 and 8.

2.4.3 Configuration

For test cases 1-4, the configuration in Table 2 was used.

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Parameter	Test cases 1-4	Short range wake up / nominal	Medium range wake up / nominal	Long range wake up / nominal	Ceiling wake up / nominal
Range start	1 m	0.5 m / 0.06 m	1.5 m / 0.3 m	3 m / 2 m	2 m / 1.5 m
Range end	3 m / 5 m	1 m	2.5 m	5 m	3.5 m
Frame rate	10 Hz	2 Hz / 10 Hz	2 Hz / 12 Hz	2 Hz / 12 Hz	4 Hz / 12 Hz
Sweeps per frame	32	16	16	32	24 / 18
HWAAS	16	16	32	48	32 / 18
Inter frame idle state	Deep sleep	Deep sleep	Deep sleep	Deep sleep	Deep sleep
Enable intra frame detection	True	True	True	True	True
Intra detection threshold	1.30	1.50 / 1.40	1.50 / 1.30	1.40 / 1.20	1.50 / 1.20
Intra time constant	0.15 s	0.15 s	0.15 s	0.15 s	0.15
Intra output time constant	0.50 s	0.30 s	0.30 s	0.30 s	0.25 s / 0.3 s
Enable inter frame detection	True	True	True	True	True
Inter detection threshold	1.0	1.0	1.0	1.0 / 0.8	1.0 / 0.8
Inter fast cutoff frequency	20.0 Hz	5 Hz	6 Hz	6 Hz	6 Hz
Inter slow cutoff frequency	0.2 Hz	0.2 Hz	0.2 Hz	0.2 Hz	0.2 Hz
Inter time constant	0.5 s	0.5 s	0.5 s	0.5 s	0.5 s
Inter output time constant	3.0 s	2.0 s	2.0 s	2.0 s	0.5 s / 2.0 s
Inter presence timeout	3 s	3 s	3 s	3 s	3 s
Number of zones	3	1 / 5	1 / 7	5	1
Number of zones for wake up	•	1	1	2	1

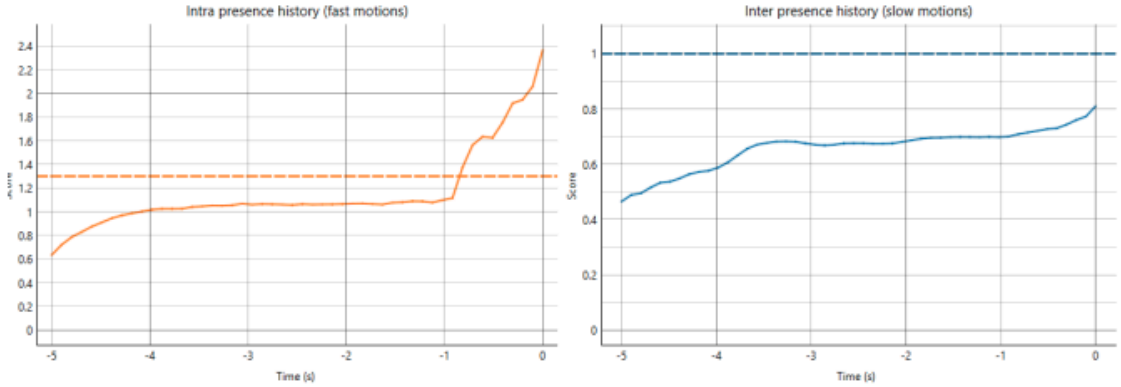
Table 2: Smart presence configurations. Where applicable, if only one value is displayed, the same value was used for both wake up and nominal configuration.

Test cases 5 and 6 were tested for the short range, medium range and long range presets. Test cases 7 and 8 were tested for the ceiling preset.

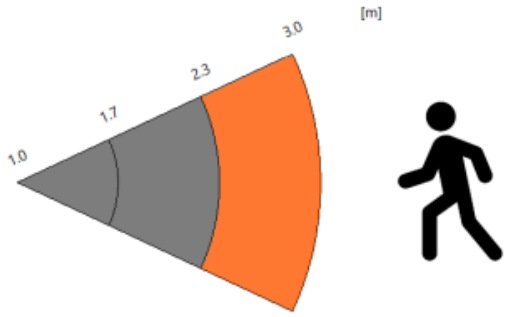
2.4.4 Results

1. Human walking from Zone 3 → Zone 1 (1-3 meters range)

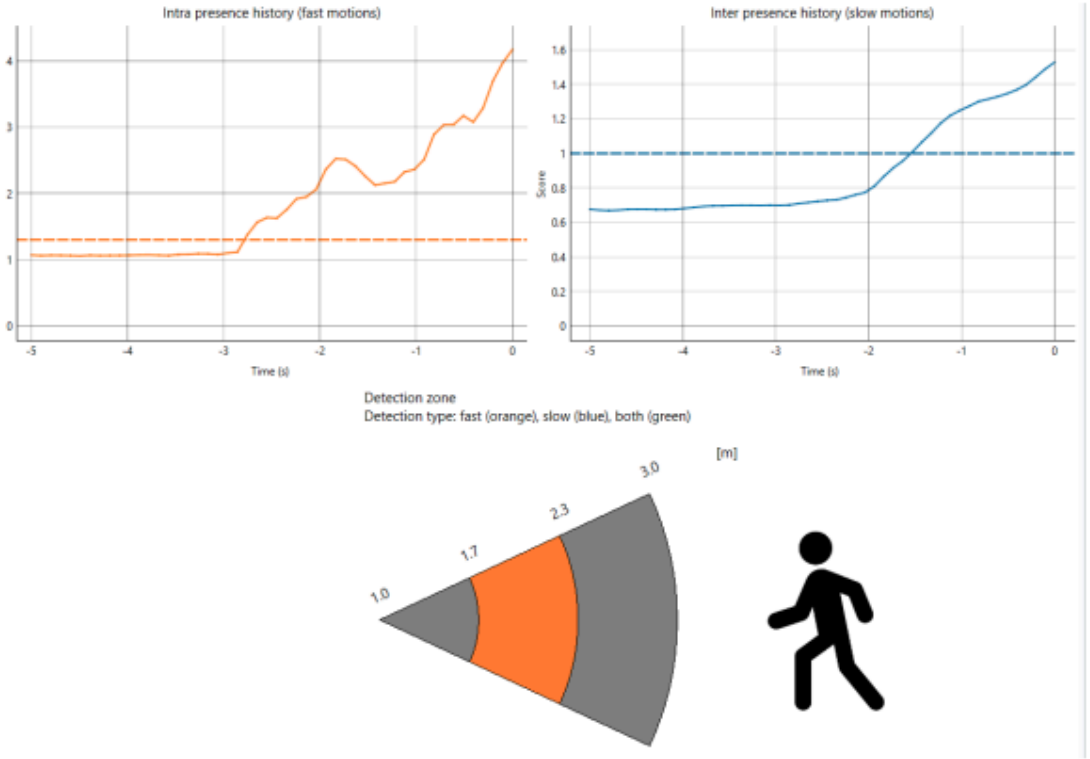
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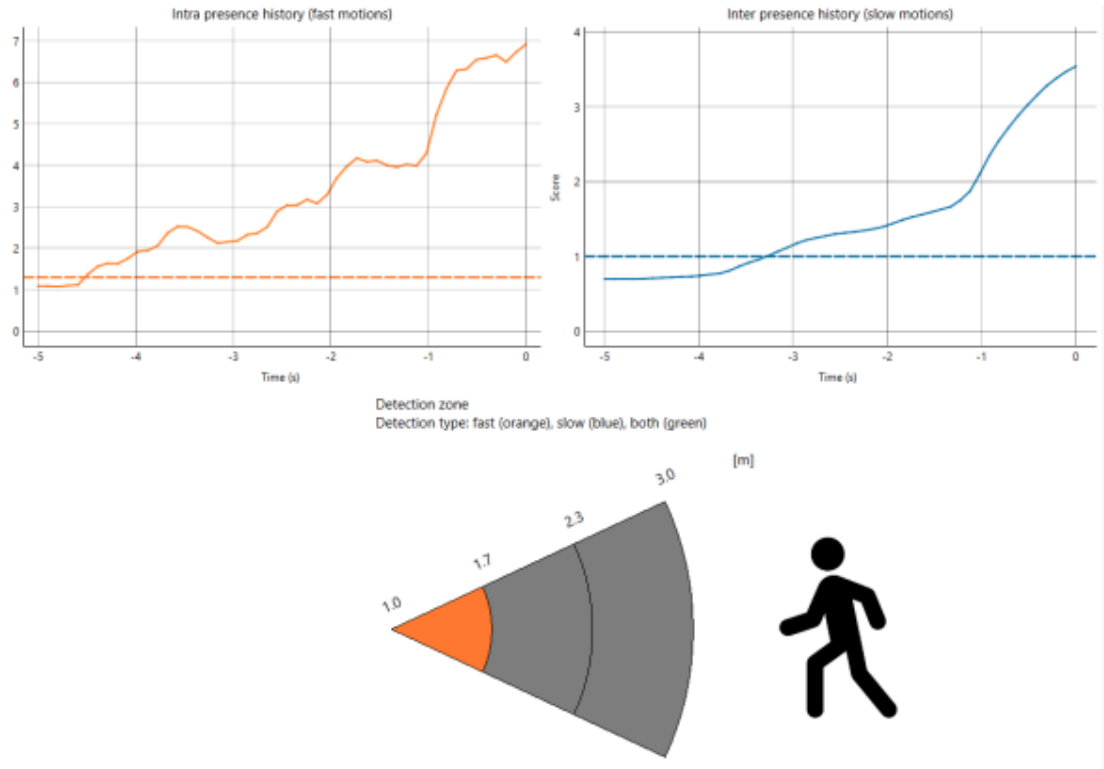


Detection zone
Detection type: fast (orange), slow (blue), both (green)



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Zone	Walk towards	Pass by
0 (1-3 m range)	OK	OK
1 (1-3 m range)	OK	OK
2 (1-3 m range)	OK	OK
0 (1-5 m range)	OK	OK
1 (1-5 m range)	OK	OK
2 (1-5 m range)	OK	OK

Table 3: Smart presence test results for test cases 1-4. All zones were detected successfully when walking towards the sensor and each zone was successfully detected when passing by.

5. Human walking into wake up config and confirm detection. Continue walking and confirm detection is done with nominal config.

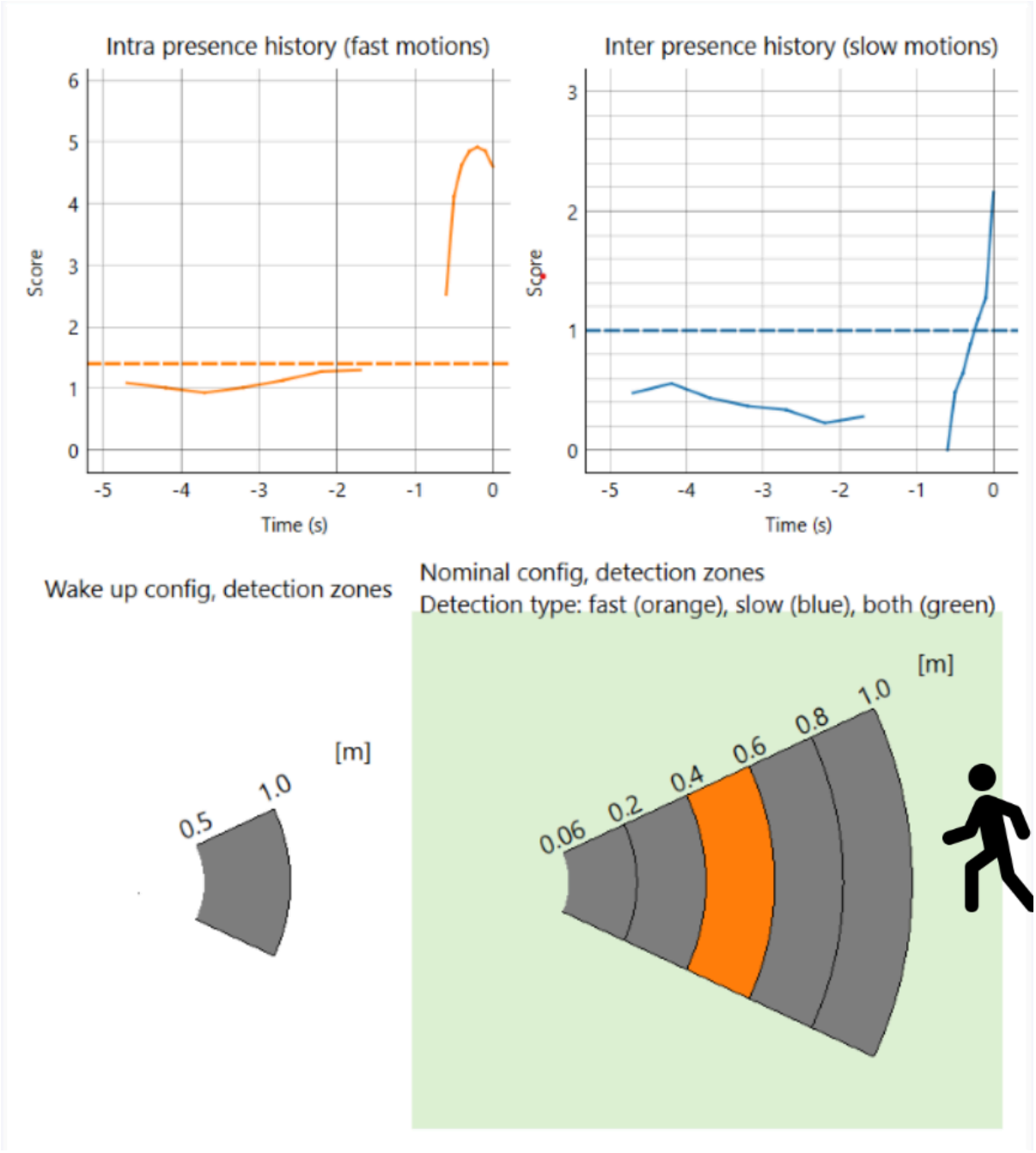


Figure 3: Person detected in the middle detection zone with nominal configuration.

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Preset	Walk	Walk and stop
Short range	OK	OK
Medium range	OK	OK
Long range	OK	OK
Ceiling	OK	OK

Table 4: Smart presence test results for test cases 5-8. Presence was detected and configuration changed successfully for all test cases.

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3 Memory

3.1 Flash

The reference application compiled from `ref_app_smart_presence.c` on the XM125 module requires around 94 kB.

3.2 RAM

The RAM can be divided into three categories, static RAM, heap, and stack. Below is a table for approximate RAM for an application compiled from `ref_app_smart_presence.c`.

RAM	**Size (kB)**				
Preset	*Medium*	*Short*	*Long*	*Ceiling*	*LP Wakeup*
Static	1.5	1.5	1.5	1.5	1.5
Heap	7.1	6.9	7.4	7.2	5.7
Stack	3.5	3.5	3.4	3.5	3.4
Total	12.2	12.0	12.3	12.3	10.7

Table 5: Approximate RAM usage.

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4 Power Consumption

Average current	Current (mA)				
Preset	*Medium*	*Short*	*Long*	*Ceiling*	*LP Wakeup*
Nominal	5.3	3.2	72.8	4.7	0.72
Wakeup	0.7	0.4	2.1	2.1	0.064

Table 6: Average current.

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