
ST87MXX ADC Application Note

Purpose and scope

This document provides detailed instructions on how to configure and use the ADCs.

Document status
Official

1 General information

1.1 Acronyms and terms

Table 1 Definitions of terms

Term	
ADC	Analog to Digital Conversion
GPIO	General Purpose Input Output
NVM	Non-Volatile Memory
UART	Universal Asynchronous Receiver Transmitter

1.2 Reference documents

The documents listed in Table 2 provide further information.

Table 2 Document references

Reference	Document
[1]	ST87MXX UM AT commands description
[2]	ST87Mxx-GUI-UM
[3]	ST87MXX datasheet

1.3 Revision history

Table 3 Document revision history

Date	Version	Changes
2025-09-01	V1.0	- Creation

1.4 Table of contents

Purpose and scope.....	1
1 General information	2
1.1 Acronyms and terms.....	2
1.2 Reference documents	3
1.3 Revision history	3
1.4 Table of contents.....	4
1.5 List of tables	4
2 ADCs control.....	5
2.1 Preamble.....	5
2.2 Configuration command for general purpose ADC	5
2.2.1 Overview.....	5
2.2.2 How to configure ADC	6
2.3 Convert a general-purpose ADC channel	7
2.3.1 Overview.....	7
2.3.2 How to get general-purpose ADC level	7
2.4 Get the battery level	7
2.4.1 Overview.....	7
2.4.2 How to get VBAT level	7
2.5 Get the temperature level	8
2.5.1 Overview.....	8
2.5.2 How to get Temperature level	8
3 ADCs additional features	9
3.1 Preamble.....	9
3.2 Configuration command for temperature Warning and Shutdown.....	9
3.2.1 Overview.....	9
3.2.2 How to configure TEMPLIMIT	10
3.3 Configuration command for voltage Warning and Shutdown	11
3.3.1 Overview.....	11
3.3.2 How to configure VBATLIMIT.....	12

1.5 List of tables

Table 1 Definitions of terms	2
Table 2 Document references.....	3
Table 3 Document revision history.....	3

2 ADCs control

2.1 Preamble

The ST87Mxx offers multiple ADCs for converting the following:

- Internal temperature
- Battery voltage
- General-purpose ADC

The general-purpose ADCs are connected to GPIOs.

The battery voltage and the internal temperature do not require configuration; only commands are available to retrieve their values.

2.2 Configuration command for general purpose ADC

2.2.1 Overview

The configuration of the GPIO for general-purpose ADC can be set and retrieved using the AT command:

AT#GPIOADCCFG=<adc_number>,<state>

By default, the parameter settings are not retained after a reset. To make them permanent, the command **AT#RESET=1** must be sent so that the new setting will be saved in the NVM and kept after a reset.

adc_number : Specifies the ADC number, which can be either 1 or 2.
State: Indicates whether the GPIO is configured in ADC mode or not.

2.2.2 How to configure ADC

To set the ADC1 enable, send the following command

```
AT#GPIOADCCFG=1,1  
  
OK
```

Before configuring an ADC or after configuring an ADC, you can read its configuration.
To read the configuration, send the following command

```
AT#GPIOADCCFG=1  
  
#GPIOADCCFG: 1,1  
  
OK
```

By default, the parameter settings are not retained after a reset. To make them permanent, the command **AT#RESET=1** must be sent so that the new setting will be saved in the NVM and kept after a reset.

2.3 Convert a general-purpose ADC channel

2.3.1 Overview

The ADC Analog level is read using the AT command:
AT#ADCGETUSER=<channel>,<divider>,<format>

The channel parameter specifies the ADC channel
The divider parameter defines the input divider:

- 0: fits with maximum input voltage of 1.1V and full scale at 1.1V
- 1: fits with maximum input voltage of 1.8V and full scale at 1.8V
- 1: fits with maximum input voltage of 3.3V and full scale at 3.3V

The format parameter specifies the format of the output conversion:

- 0: conversion in ADC steps (between 0 and 2047)
- 1: conversion in mV

Ensure that the ADC is configured beforehand.

2.3.2 How to get general-purpose ADC level

For example, ADC1 is connected to an analogue output with a maximum excursion of 1.1 V, and the conversion must return in ADC steps. Send the following command

```
AT#ADCGETUSER=1,0,1
#ADCGETUSER: 1,156
OK
```

2.4 Get the battery level

2.4.1 Overview

The battery voltage is connected to an ADC channel allowing its value to be read at any time. It is read using the AT command:

AT#GETVBAT?

The value returned is in mV.

2.4.2 How to get VBAT level

Send the following command

```
AT#GETVBAT?
#GETVBAT: 2486
OK
```

2.5 Get the temperature level

2.5.1 Overview

The internal temperature is connected to an ADC channel allowing its value to be read at any time.

It is read using the AT command:

AT#GETTEMP?

The value returned is in degree Celsius.

2.5.2 How to get Temperature level

Send the following command

```
AT#GETTEMP?
```

```
#GETTEMP: 22.28
```

```
OK
```

3 ADCs additional features

3.1 Preamble

The ST87Mxx independently performs battery voltage and temperature measurements.

Based on these measurements, it is possible to request the ST87Mxx to provide information or shut down if the voltage or temperature conditions are outside the normal operating range.

3.2 Configuration command for temperature Warning and Shutdown

3.2.1 Overview

At each wakeup, the temperature is evaluated. If the temperature is outside the user-defined thresholds (lower or higher), it generates a URC warning or forces a power-down.

The configuration is performed by using the AT command:

AT#TEMPLIMIT=<low_temp>,<high_temp>,<low_temp_shutdown>,<high_temp_shutdown>,<shutdown>,<display>

The parameters `low_temp`, `high_temp` define the thresholds for the warning display

The parameters `low_temp_shutdown`, `high_temp_shutdown` define the thresholds for the shutdown action.

The parameter `shutdown` enables the ST87MXX to shut down after sending the `#OVERTEMP_SHUTDOWN` or `#UNDERTEMP_SHUTDOWN` URC if the temperature exceeds the thresholds.

The parameter `display` enables the ST87MXX to indicate the `#OVERTEMP_WARNING` or `#UNDERTEMP_WARNING` URC if the temperature exceeds the thresholds.

The input parameters are verified to ensure they do not block the platform:

- **low_temp** and **low_temp_shutdown** must be less than 0°C.
- **high_temp** and **high_temp_shutdown** must be greater than 55°C.
- If these conditions are not met, the AT command returns error code 1087 or 1088.

By default, the parameter settings are not retained after a reset. To make them permanent, the command **AT#RESET=1** must be sent so that the new setting will be saved in the NVM and kept after a reset.

3.2.2 How to configure **TEMPLIMIT**

The ST87MXX operates in a product with a normal temperature range of 0°C to 60°C. If the product operates outside this range, the host must be informed.

To meet this requirement, send the following command

```
AT#TEMPLIMIT=0,60,-45,110,0,1
```

```
OK
```

The ST87MXX operates in a product with a normal temperature range of 0°C to 70°C and must shut down if the temperature drops below -20°C or exceeds 100°C. If the product operates outside this range, the host must be informed and shut down when the shutdown limit is reached.

To meet this requirement, send the following command

```
AT#TEMPLIMIT=0,70,-20,100,1,1
```

```
OK
```

Before configuring the thresholds or after configuring them, you can read their configuration. Send the following command

```
AT#TEMPLIMIT?
```

```
#TEMPLIMIT: -40,85,-45,110,0,1
```

```
OK
```

Only the warning is activated not the shutdown with normal usage between -40°C and 85°C

By default, the parameter settings are not retained after a reset. To make them permanent, the command **AT#RESET=1** must be sent so that the new setting will be saved in the NVM and kept after a reset.

3.3 Configuration command for voltage Warning and Shutdown

3.3.1 Overview

At each wake-up, the battery voltage is measured and if it is out of scope (lower or higher) threshold defined by the user, it generates URC warning or forced a power down.

The configuration is performed using the AT command:

AT#VBATLIMIT=<low_vbat>,<high_vbat>,<low_vbat_shutdown>,<high_vbat_shutdown>,<shutdown>,<display>,<bor_lp>

The parameters low_vbat, high_vbat define the thresholds for the warning display
The parameters low_vbat_shutdown, high_vbat_shutdown define the thresholds for the shutdown action.

The parameter shutdown enables the ST87MXX to shut down after sending the #OVERVOLTAGE_SHUTDOWN or #UNDERVOLTAGE_SHUTDOWN URC if the voltage is outside the thresholds.

The parameter display enables the ST87MXX to indicate the #OVERVOLTAGE_WARNING or #UNDERVOLTAGE_WARNING URC if the voltage is outside the thresholds.

The parameter bor_lp enables the POR hardware block in low-power mode. When enabled, the current increases during the sleep mode period.

The input parameters are verified to ensure they do not block the platform:

- **low_vbat** and **low_vbat_shutdown** must be less than 2.3V.
- **high_vbat** and **high_vbat_shutdown** must be greater than 2.8V.
- If these conditions are not met, the AT command returns error code 1085 or 1086.

By default, the parameter settings are not retained after a reset. To make them permanent, the command **AT#RESET=1** must be sent so that the new setting will be saved in the NVM and kept after a reset.

3.3.2 How to configure VBATLIMIT

The ST87MXX operates within a normal voltage range of 2.2 V to 2.8 V. If the product operates outside this range, the host must be informed.

To meet this requirement, send the following command

```
AT#VBATLIMIT=2200,2800,2000,3200,0,1,0
```

```
OK
```

The ST87MXX operates within a normal voltage range of 2.2 V to 2.8 V and must shut down if the voltage drops below 2.1 V or exceeds 2.8 V. If the voltage goes outside this range, the host must be informed.

To meet this requirement, send the following command

```
AT#VBATLIMIT=2200,2800,2100,2800,1,1,0
```

```
OK
```

Before configuring the thresholds or after configuring them, you can read their configuration. Send the following command

```
AT#VBATLIMIT?
```

```
#VBATLIMIT: 2200,3000,2000,3200,0,1,0
```

```
OK
```

Only the warning is activated not the shutdown with normal usage between 2.2V and 3.0V.

By default, the parameter settings are not retained after a reset. To make them permanent, the command **AT#RESET=1** must be sent so that the new setting will be saved in the NVM and kept after a reset.

IMPORTANT NOTICE – PLEASE READ CAREFULLY

STMicroelectronics NV and its subsidiaries (“ST”) reserve the right to make changes, corrections, enhancements, modifications, and improvements to ST products and/or to this document at any time without notice. Purchasers should obtain the latest relevant information on ST products before placing orders. ST products are sold pursuant to ST’s terms and conditions of sale in place at the time of order acknowledgement.

Purchasers are solely responsible for the choice, selection, and use of ST products and ST assumes no liability for application assistance or the design of Purchasers’ products.

No license, express or implied, to any intellectual property right is granted by ST herein. Resale of ST products with provisions different from the information set forth herein shall void any warranty granted by ST for such product.

ST and the ST logo are trademarks of ST. For additional information about ST trademarks, please refer to www.st.com/trademarks. All other product or service names are the property of their respective owners.

Information in this document supersedes and replaces information previously supplied in any prior versions of this document.

© 2025 STMicroelectronics – All rights reserved