Cellular Engine TC35

The extra compact module for voice and data transmission

Application Note: **Charging of Battery Pack**

Version: **02.00**
Date: **09.05.2001**

Technical Support: **wm.support@mch.siemens.de**

Doc Id: **TC35-AN-09-V02.00**
Status: **Released**

Table of contents

Figures

1 Introduction

Further to the "TC35 Hardware Interface Description" and the "TC35 Battery Pack application note TC35-AN-07", this document provides additional information on charging and discharging Li-ion batteries used with the Siemens TC35 GSM engine.

Specifications are subject to change without notice. This product is an original Siemens product protected by US, European and other patents.

1.1 References

"TC35 Hardware Interface Description" (filename: TC35_HW_Interface_description.pdf)
"Application Note: Battery Pack" (filename: TC35-AN-07_V0200_battery.pdf)

1.2 Terms and abbreviations

NTC resistor	Negative temperature coefficient resistor
FFC	Flat Flexible Cable
ZIF	Zero Insertion Force
Li-Ion	Lithium-Ion

2 Recommendations for battery charging and discharging

To ensure proper operation of the GSM engine along with a Li-Ion battery, it is strongly recommended that you carefully read this application note and the two documents listed in section 1.1.
This document explains the behavior of the GSM engine while the charging or discharging of a Li-Ion battery is in progress. Technical requirements for external chargers are also described in detail.

2.1 Temperature

In the following the ambient temperature is 25°C, unless otherwise stated.

2.2 AT command to query the remaining capacity

The final charge voltage of Li-Ion batteries is required to be 4.2V. Final discharge voltage depends on several factors, such as the chemical structure and the nominal capacity of the cell.
When you use AT commands to query the battery capacity, take into account that no nominal values are presented along with the measured values since these vary with the battery type used. Exact nominal values pertaining to a specific battery type can, therefore, only be obtained by mathematical or electronical calculations.

3 Key features of the battery pack

3.1 Battery cell

- Lithium Ion (Li-Ion) type
- Final charge voltage 4.2V
- Capacity 600...1000mAh
- Ambient temperature range for charging 0°C...+45°C (see **Figure 3**)
- Ambient temperature range for discharging -20°C...+60°C

3.2 Protection circuit (built-in):

- Polyfuse (reversible type for overcurrent and overtemperature detection)
- NTC resistor (10kOhm @ +25°C, B=3370, ±3%)

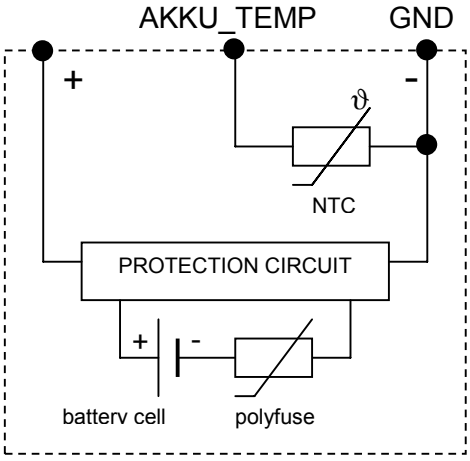

Figure 1: Battery pack

ATTENTION: The built-in NTC between AKKU_TEMP and GND is indispensable to enable the charging functionality.

Additional protection elements are required inside a Li-Ion battery to detect overvoltage (against overcharging), undervoltage (against deep discharging), overcurrent and overtemperature. This protection circuit of the battery pack must be insensitive to pulse loading as described in 4.2 and Figure 2.

Furthermore, the battery cell itself must be insensitive to rupture, fire and gasing under extreme conditions of temperature and charging (voltage, current). Please note that this is essential to security. Therefore, take care that the battery type you want to integrate into your application meets these requirements.

4 Charging process

The following sections describe the functions implemented in the GSM engine TC35.

4.1 Trickle charging

Deeply discharged batteries (voltage measured on the GSM engine) will be charged with a low current from 3 to 9mA (trickle charging). The value of the current depends on the difference between charger and battery voltage. Once the charger has been connected, trickle charging is activated for about one hour. When the battery voltage reaches 3.2V within one hour, the GSM engine switches automatically to fast charging that works in parallel to trickle charging. If the voltage fails to pass the 3.2V limit within one hour, trickle charging proceeds and fast charging can be started manually (only above 3.2V!) by shortly dis- and reconnecting the charger.

4.2 Fast charging

The battery will be charged with a constant current until the voltage reaches 4.2V (see Figure 2). After this, the duty-cycle is reduced so as to prevent overshooting beyond 4.2V. After the pulse width has decreased to its minimum of 100ms it will be kept on a constant level. From this time the battery voltage will regulate on the open-circuit voltage. In this state of operation, the voltage will not exceed a level of 4.3V for 100ms. Charging is completed, if the pulse width does not change within 2 min. The charging process is active only within a temperature range of 0°C...+45°C (see Figure 3).

ATTENTION: The battery manufacturer must guarantee that this charging process does not damage the battery.

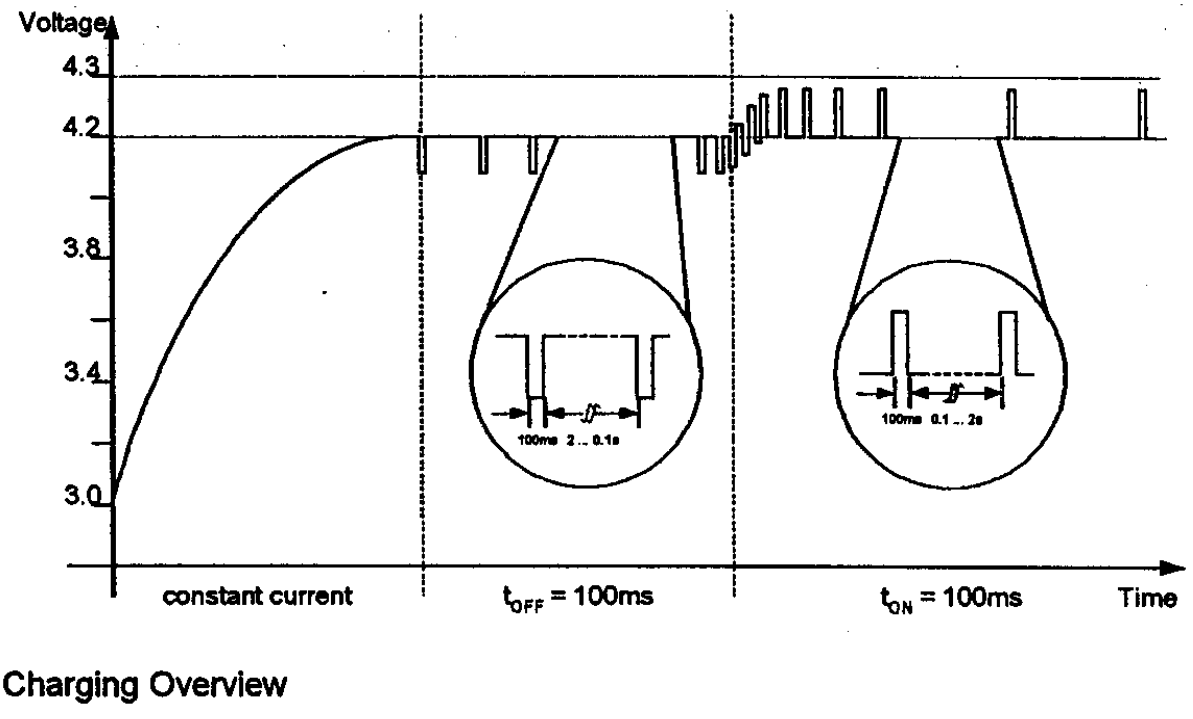

Figure 2: Fast (pulse) charging

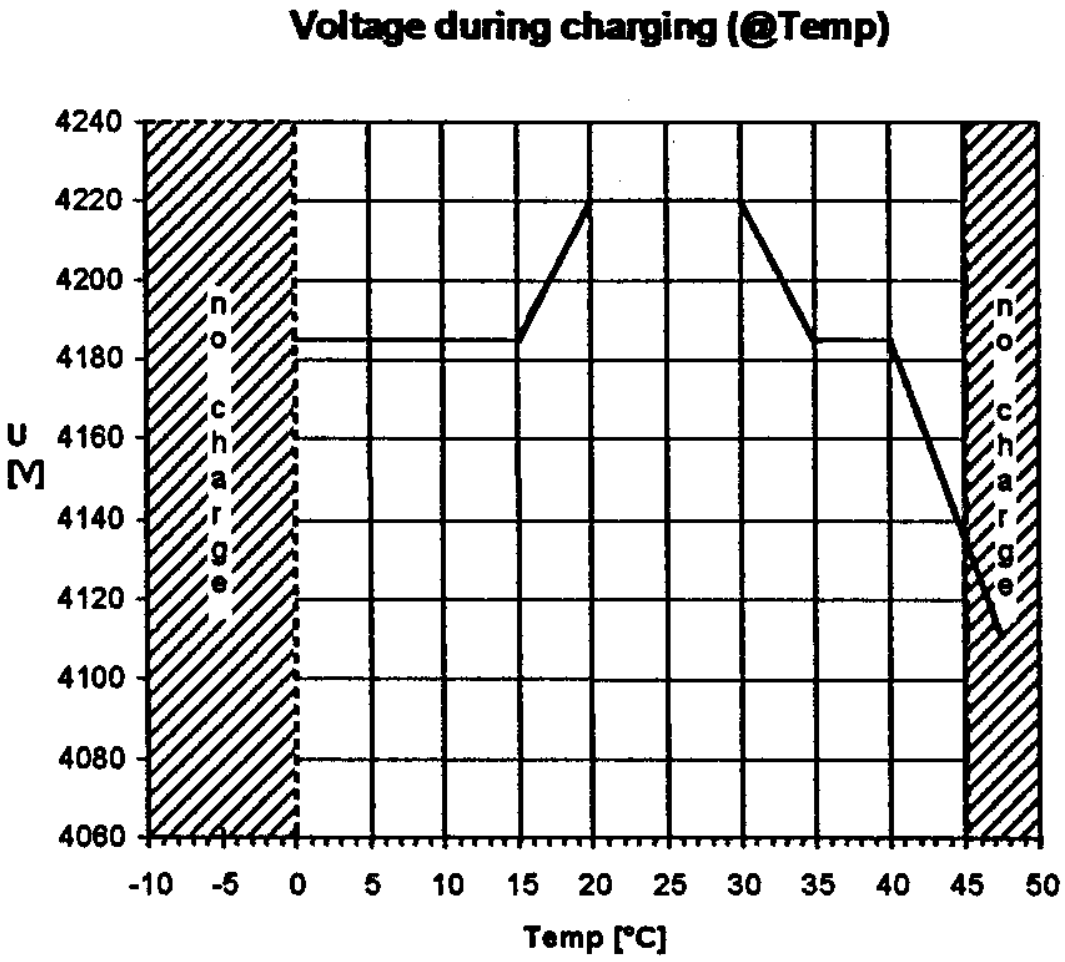

Figure 3: Final charge voltage vs temperature

5 Discharging process

To meet the GSM specifications the GSM engine should be powered down if voltage drops below the required operating voltage. For this purpose, the monitoring function of the discharging process causes the GSM engine to switch to Power Down in the event of undervoltage.

The absolute minimum operation voltage for the GSM engine is 3.3V measured on the GSM engine itself. The final discharge voltage of the battery pack is higher than 3.3V, due to the following factors:

1. The internal resistance of the battery pack (incl. protection circuit)
2. The resistance of the battery pack contacts and following printed circuits, etc.
3. The resistance of the power lines (FFC) and ZIF connectors (see TC35-AN-07)

To avoid these resistances take care that the ZIF connectors and the FFC cable are designed according to the TC35-AN-07 application note. Note that the GSM engine will switch from IDLE to Power Down mode even though the voltage at the battery contacts is still above the minimum operating voltage of the GSM engine (3.3V). Likewise, switching into Power Down may also occur in the transmission mode, due to high current that causes voltage drop down to 3.3V.

6 Charger

The charging process begins once the charger is connected to the POWER-pin at the GSM engine, no matter whether the GSM engine is in Power-Down, IDLE or TALK mode.

If the battery has been deeply discharged only trickle charging is used (see 4.1).

If the charger is connected while the GSM engine is in the Power Down mode, the GSM engine switches into the Charge-Only mode. Once charging is completed the GSM engine falls back into Power Down. Connecting the charger while the GSM engine is run in any other mode, however, will not affect the operating mode since charging can be performed in parallel. Charging will stop once the charger is disconnected.
If the GSM engine is in the Power Down mode and the charger will be connected the GSM engine starts in Charge-Only mode. After charging the GSM engine falls back to Power Down. Any other mode of the GSM engine will not be affected by connecting the charger but the charging starts additionally and stops with disconnecting the charger.

Be sure the charger meets the following electrical requirements:

Simple transformer power plug
- Output voltage: +5.5...+15V DC. ATTENTION: There must not be any capacitor placed on the secondary side of plug (to avoid current spikes at the beginning of charging)
- The charge current must be limited to 500mA ±20%
- At an output voltage of 2.8V the current must not exceed 1A at any time
- Voltage spikes that might occur during disconnecting or connecting the charger must be limited to a maximum of +25V and must not exceed 1ms.

Supplementary information pertaining to the regulated power supply mode:
- Output voltage: +5.5...+8V DC. ATTENTION: These values are only applicable while the GSM engine is battery operated.
- When switching off the current, a voltage peak of 12V maximum is allowed, the period the voltage is above 10V may not exceed 1ms
- When switching on the current, a spike of 1.6A for 1ms is allowed