Cellular Engine TC35

The extra compact module for voice and data transmission

Application Note: **Battery Pack**

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Furthermore, all safety instructions regarding the use of mobile technical systems, including GSM products, which also apply to cellular phones must be followed.

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1 Introduction

Further to the "TC35 Hardware Interface Description", this document provides additional information on using special Li-Ion battery packs in conjunction with the Siemens TC35 GSM engine.

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1.1 References

TC35_HW_Interface_description

1.2 Terms and Abbreviations

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FFC</td>
<td>Flat Flexible Cable</td>
</tr>
<tr>
<td>PCB</td>
<td>Printed Circuit Board</td>
</tr>
<tr>
<td>ZIF</td>
<td>Zero Insertion Force</td>
</tr>
<tr>
<td>VSWR</td>
<td>Voltage Standing Wave Ratio</td>
</tr>
<tr>
<td>GSM</td>
<td>Global System for Mobile Communication</td>
</tr>
<tr>
<td>Li-Ion</td>
<td>Lithium Ion</td>
</tr>
</tbody>
</table>
2 Resistance considerations

2.1 General

If your TC35 application is powered from a Li-Ion battery pack, take into account the relatively high internal resistance of the Li-Ion battery and its protection elements.

![Graph showing discharging characteristics of a typical Li-Ion battery at power level 19](image)

Figure 1: Discharging at power level 19

The discharging characteristics of a typical Li-Ion battery are shown in Figure 1.

This application note explains the effects of parasitic resistance caused across the power supply lines and provides recommendations for achieving best performance.
2.2 Resistance of the power supply lines

In a standard TC35 application setup it is the \( V_{\text{Batt}} \) line of the FFC cable that connects the TC35 module to the power supply. The power supply may be an AC/DC adapter, a voltage regulator or a Li-Ion battery pack.

Due to the low voltage difference between a fully charged and an almost discharged battery, the series resistance of all connectors and lines should be as low as possible. As an advantage, the usable battery capacity would significantly grow.

The following figure explains our application setup.

![Schematic of a typical applications setup](image)

Figure 2: Schematic of a typical applications setup

The values of the components shown in the figure can be gathered from the following table:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>( R_{\text{ZIF}} )</td>
<td>max. 50</td>
<td>mOhm</td>
<td>Typical values are about 33 mOhm</td>
</tr>
<tr>
<td>( R_{\text{FFC}} )</td>
<td>typ. 146</td>
<td>mOhm</td>
<td>For a 200 mm cable</td>
</tr>
<tr>
<td>( R_{\text{ser}} = (R_{\text{ZIF}} \times 2 + R_{\text{FFC}}) / 5 )</td>
<td>typ. 49.2</td>
<td>mOhm</td>
<td></td>
</tr>
<tr>
<td>( R_{\text{intern}} )</td>
<td>typ. 120</td>
<td>mOhm</td>
<td>AC impedance of battery at time of delivery (including wire and contact resistor)</td>
</tr>
<tr>
<td>( R_{\text{intern}} )</td>
<td>max. 160</td>
<td>mOhm</td>
<td>AC impedance of battery after 500 discharge/charge cycles (including wire and contact resistor)</td>
</tr>
</tbody>
</table>

Since the FFC is inserted into the ZIF connector on both sides, the overall series resistance is 49.2 mOhm, each on the positive and the negative power line.
2.3 **Typical battery voltage at normal operation (discharging)**

To ensure that TC35 meets the requirements of GSM communications at high RF power levels, the battery discharge current is modulated at 1.8 A (approx.) pulses of 0.577 ms every 4.6 ms. During the low current period, current consumption is about 70 mA.

The current profile is illustrated in the following figures. The measured values refer to the GSM band at 900 MHz for maximum power level (PL 5) and minimum power level (PL 19).

![Figure 3: Current at Power Level 5](image)

![Figure 4: Current at Power Level 19](image)

The state of the battery can best be verified by monitoring the onboard voltage $U_{GSM}$ of the TC35 (see Figure 2). However, take into account that voltage may drop considerably between the battery contact and the PCB of the TC35, especially at high power levels. Therefore, it is essential that voltage drop across all cables and connectors is as low as possible. Also, the smaller the parasitic resistance the better the usable battery capacity.

Not all of the series resistors shown in Figure 2 can be shortened, but you can apply a short from the negative contact of the battery to the ground pad on the PCB of TC35 to reduce the sum of all resistors. Refer to Chapter 2.4 and Figure 5 for instructions.
2.4 Using a separate ground connection to reduce resistance

Generally, the FFC cable that connects the TC35 module to the customer application should be as short as possible.

However, if the used FFC cable reaches the max. length of 200 mm you may be required to follow additional precautions for preventing excessive supply voltage drop during a GSM burst. This is necessary since undervoltage might cause the TC35 module to shut down.

To avoid this effect, minimise the resistance by using a separate ground connection that goes from the TC35 module to the customer application. To do so, simply fasten an additional cable to the module's ground pad and solder the other end to the battery ground in the customer application. The ground pad is located around the top right mounting hole that also allows to fasten a screw or a spacer (see top view of the TC35 module in Figure 5).

![Top view of TC35 module](image)

Figure 5: Top view of TC35 module

You can check the voltage in the same way as you do for monitoring the battery state, e.g. by using the test point marked TP301 in the figure. The signals available on the test point are equivalent to the supply voltage $V_{\text{Batt+}}$ of the TC35 module and can be measured with a voltage probe.

See Table 4 for the $V_{\text{Batt+}}$ values or refer to the "TC35 Hardware Interface Description" for more detailed information.
3  Peak current depending on antenna load

The following figures show the typical peak current depending on load mismatch during a transmit burst with the power control level for maximum RF power (PL5). The current is almost independent of the supply voltage and the temperature. For good performance, the return loss of an antenna should be better than 10dB (within the concerning frequency range).

![Typical current consumption GSM900 vs. load impedance](image1)

![Typical current consumption GSM 1800 vs. load impedance](image2)

Figure 6: Typical current consumption for GSM 900, power level 5

Figure 7: Typical current consumption for GSM1800, power level 0
3.1 Typical peak current values for antenna load matching

Peak current during transmit burst at max. power level. Values for current and return loss refer to Figure 6 and Figure 7.

Table 2 : GSM 900, power level 5

<table>
<thead>
<tr>
<th>Typ</th>
<th>Return loss</th>
<th>VSWR (approx.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1600 mA</td>
<td>20 dB</td>
<td>1.20</td>
</tr>
<tr>
<td>1800 mA</td>
<td>11 dB</td>
<td>1.75</td>
</tr>
<tr>
<td>2000 mA</td>
<td>6 dB *)</td>
<td>3.00</td>
</tr>
<tr>
<td>2300 mA</td>
<td>2.5 dB **)</td>
<td>9.00</td>
</tr>
</tbody>
</table>

Table 3 : GSM 1800, power level 0

<table>
<thead>
<tr>
<th>Typ</th>
<th>Return loss</th>
<th>VSWR (approx.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1200 mA</td>
<td>20 dB</td>
<td>1.20</td>
</tr>
<tr>
<td>1300 mA</td>
<td>11 dB</td>
<td>1.75</td>
</tr>
<tr>
<td>1400 mA</td>
<td>6 dB *)</td>
<td>3.00</td>
</tr>
<tr>
<td>1500 mA</td>
<td>2.5 dB **)</td>
<td>9.00</td>
</tr>
</tbody>
</table>

Note: Typical value of a dual band antenna is in the range of VSWR <2
*) mismatched antenna, e.g. caused by bad dielectric or a mistuned antenna
**) caused by a short circuit at the GSC connector or a damaged antenna.
## 4 Power supply

Table 4: Power supply

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{BATT+}$</td>
<td>Supply voltage</td>
<td>Reference point on the module (TP301). Voltage must be in the range of the min/max values, including voltage drop, ripple, spikes</td>
<td>3.3</td>
<td>4.2</td>
<td>5.5</td>
<td>V</td>
</tr>
<tr>
<td>$I_{BATT+}$</td>
<td>Voltage drop during transmit burst</td>
<td>Normal condition, power control level for $P_{out \text{ max}}$</td>
<td></td>
<td></td>
<td>400</td>
<td>mV</td>
</tr>
<tr>
<td>$I_{BATT+}$</td>
<td>Average supply current</td>
<td>Power Down mode</td>
<td>50</td>
<td>100</td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SLEEP mode</td>
<td>3</td>
<td>3.5</td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IDLE mode</td>
<td>20</td>
<td></td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TALK mode</td>
<td>300</td>
<td>400</td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td>Peak supply current (for 577μs transmission slot every 4.6ms)</td>
<td>Power control level for $P_{out \text{ max}}$</td>
<td></td>
<td></td>
<td>see Table 2 and Table 3</td>
<td>mA</td>
</tr>
<tr>
<td>$I_{CHARGE}$</td>
<td>Charging current</td>
<td>Li-Ion battery pack</td>
<td>500</td>
<td></td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td>Trickle charging</td>
<td></td>
<td>9.0</td>
<td></td>
<td></td>
<td>mA</td>
</tr>
</tbody>
</table>