

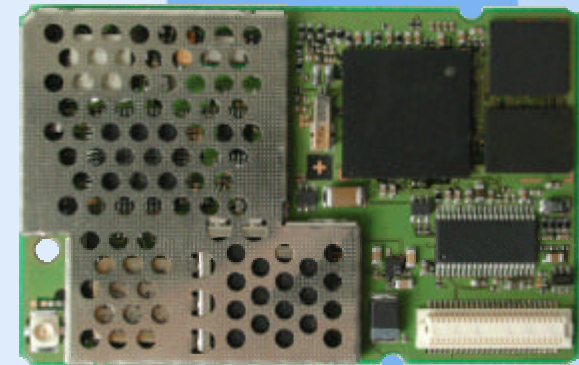
Siemens Cellular Engine MC45

Introduction to hardware architecture

WM AE SL

U.Peters

01/10/2002



- **Hardware concept**
- **RF concept**
- **Antenna connection**
- **Mechanical fixing**
- **Summary**

Hardware at a glance (1)

- **Power supply** **Single supply voltage 3.2V – 4.5V**
- **Frequency bands** **Triple Band EGSM900/
DCS1800/PCS1900
for voice, data, SMS, Fax**
- **Transmit power** **Class 4 (2W) for EGSM900
Class 1 (1W) for DCS1800/PCS1900**
- **GPRS connectivity** **GPRS multi-slot class 10
(max. 2 TX / 3 RX TS)
GPRS mobile station class B**

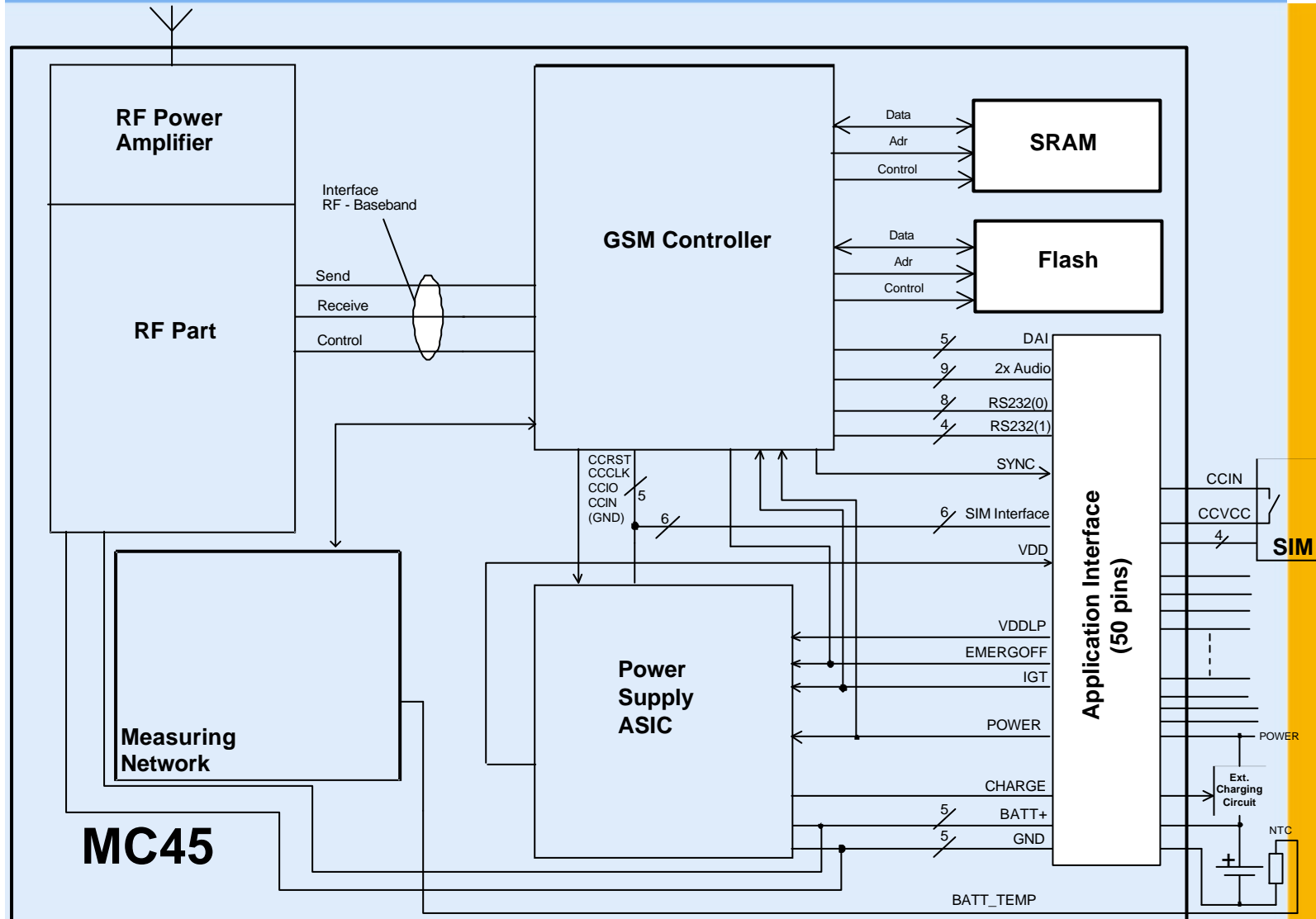
Hardware at a glance (2)

- **Temperature (Restricted) / normal operation**
 - (-25°)-20°C to +55°(+70°)C
- **Speech codec:**
 - Half Rate, Full Rate, Enhanced Full Rate
- **Data transmission rates**
 - CSD, GPRS data up-/downlink
2.4/4.8/9.6/14.4kbps, up to 42.8/85.6kbps
(calc. @CS4, 2TX/4RX)
 - GPRS coding schemes CS 1, 2, 3, 4
- **Two RS-232 serial at-interfaces with 2.65V level for commands/data**
 - Selectable baud rate 300 bps ... 230 kbps
 - Autobauding range 1.2 kbps ... 230 kbps
(not: 14.4, 28.8 kbps)

Hardware at a glance (3)

- Supported SIM card 3V
- Firmware upgrade via RS-232 interface or via SIM interface
- Real time clock (RTC) with programmable timer function
- Size / Weight 53mm x 34mm x 3.5mm / 10g

Hardware overview (4)



Hardware current consumption (5)

■ Current consumption (typical average values):

■ TALK mode

- During TX burst @ EGSM 900 / GSM 1800 2A
- EGSM 900 / DCS 1800/ PCS 1900 300mA / 270mA

■ DATA GPRS mode

- Class 8 (1TX) EGSM 900 / DCS 1800 360mA / 330mA
- Class 10 (2TX) EGSM 900 / DCS 1800 590mA / 560mA
- Class 10 (2TX) EGSM 900 max 840mA

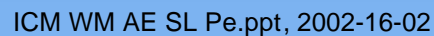
■ IDLE mode 25mA

■ SLEEP mode (@ DRX=6) 3mA

■ POWERDOWN mode 50µA

SIEMENS
mobile

- the MC45 will fall back to the power saving state from all events (AT-commands, call, data, etc); except at+cfun=1
- RS232 response time is dependent on the DRX value from GSM network (maximum 2.12s) - hardware flow control (RTS/CTS) is mandatory



Hardware new AT command (7)

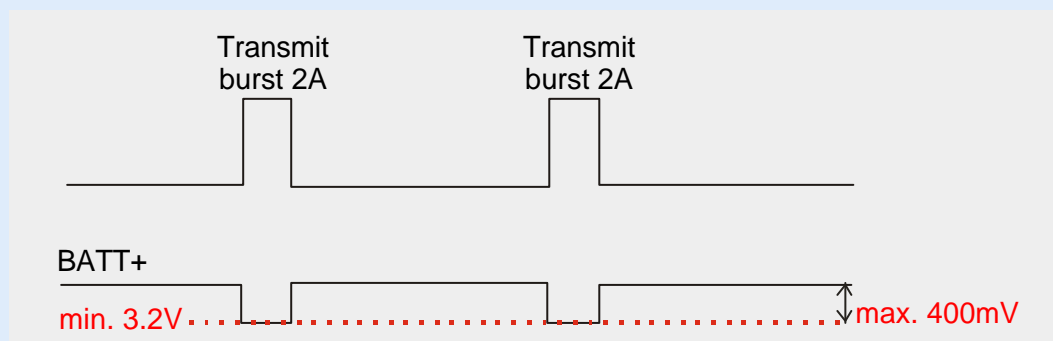
■ **AT ^SBV**

- The execute command allows to monitor the battery voltage of the module. The reference point for measuring the voltage is the test point BATT+ on the bottom of the module.



Hardware Supply Voltage (7)

- Ensure that the input voltage at BATT+ never drops below 3.2V on the MC45 board, not even during transmit bursts
- Voltage drops that may occur during transmit bursts must never exceed 400mV.
- MC45 will be switched off in the event of exceeding the under voltage limit

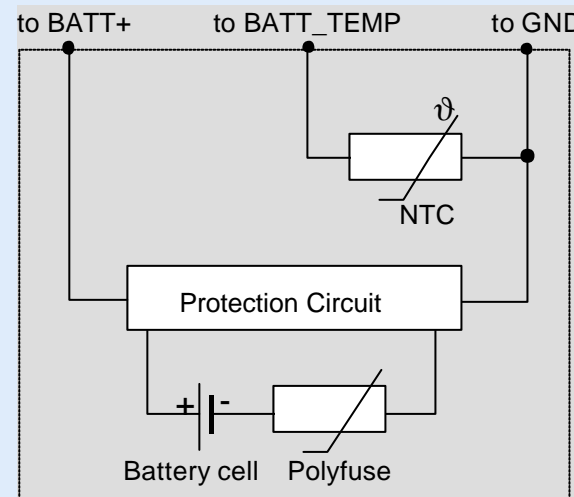


Hardware battery pack (8)

- MC45 can be powered from a Li-Ion battery pack, with 3.6V, 850mAh, final charge voltage 4.2V
- Ensure that the battery pack incorporates a protection circuit
- The battery pack should include an NTC resistor
- The NTC is indispensable for proper charging, i.e. the charging process will not start if no NTC is present

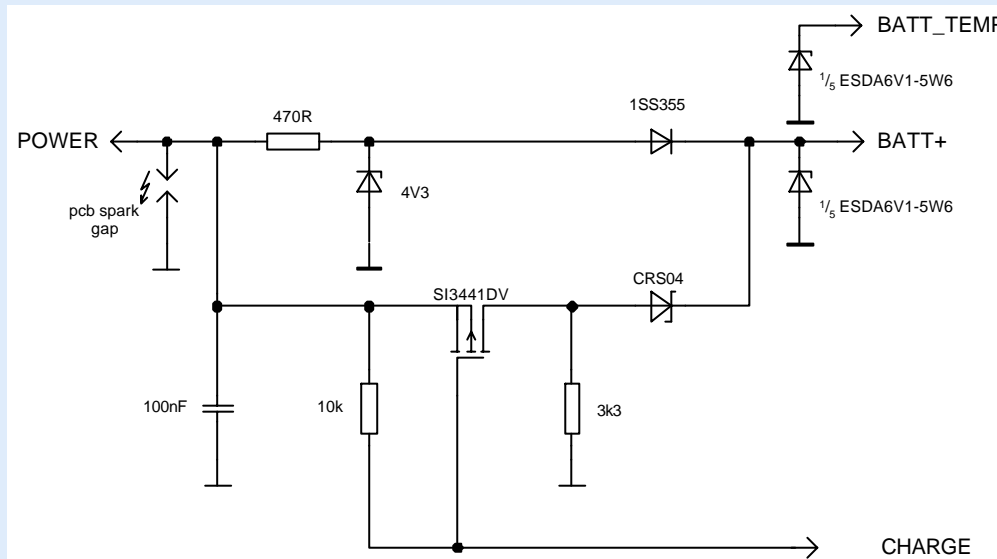
Hardware protection circuit (9)

- The protection circuit must be capable of detecting over voltage (protection against overcharging), under voltage (protection against deep discharging), and over current
- The battery cell must be insensitive to rupture, fire and gazing



Hardware external charging (10)

- External charging circuit is mandatory for charging!



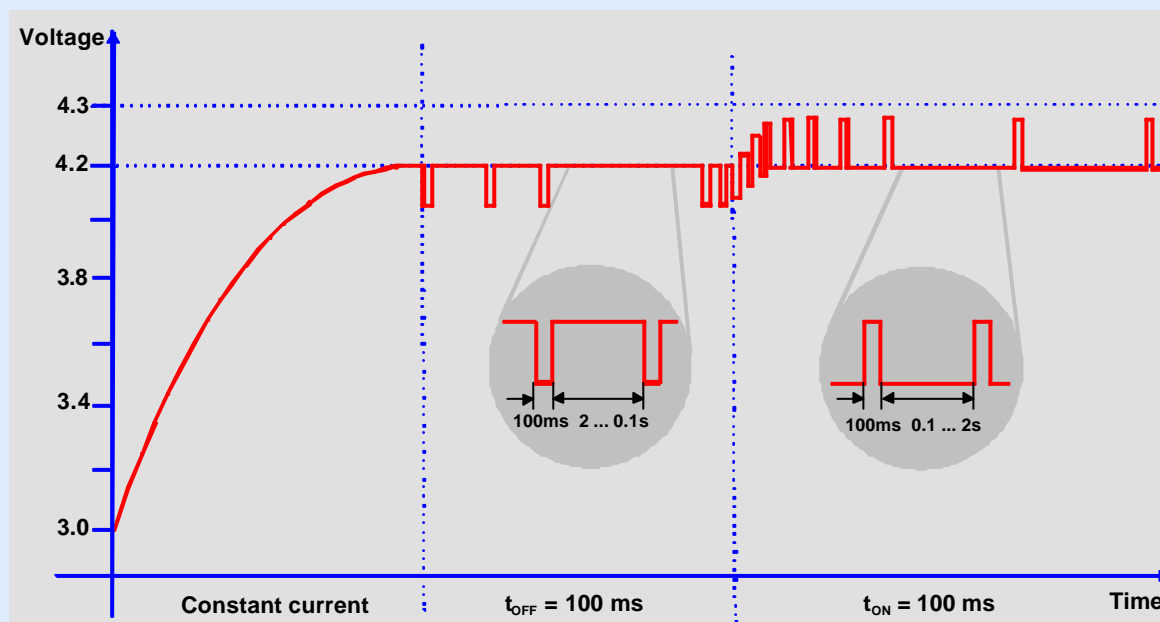
- Trickle charging allows charging a deeply discharged battery
- Not processor controlled, current is depending on battery voltage

Hardware external charging (11)

- To start charging connect the charger to the POWER pin of the B2B connector
- Trickle charging is performed with a charging current of less than 10mA and up to a battery voltage of 3.6V
- When the battery voltage reaches 3.2V within 60 minutes, fast charging will start in addition to trickle charging

Hardware external charging (13)

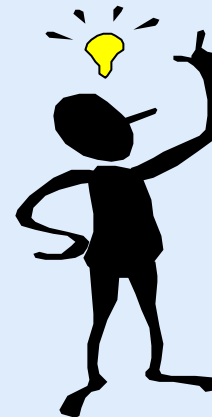
- Pulse duty cycle is reduced to adjust the charging procedure and prevent the voltage from overshooting beyond 4.2V
- Once the pulse width reaches the minimum of 100ms and the duty cycle does not change for 2 minutes, fast charging is completed



Hardware power on the module (14)

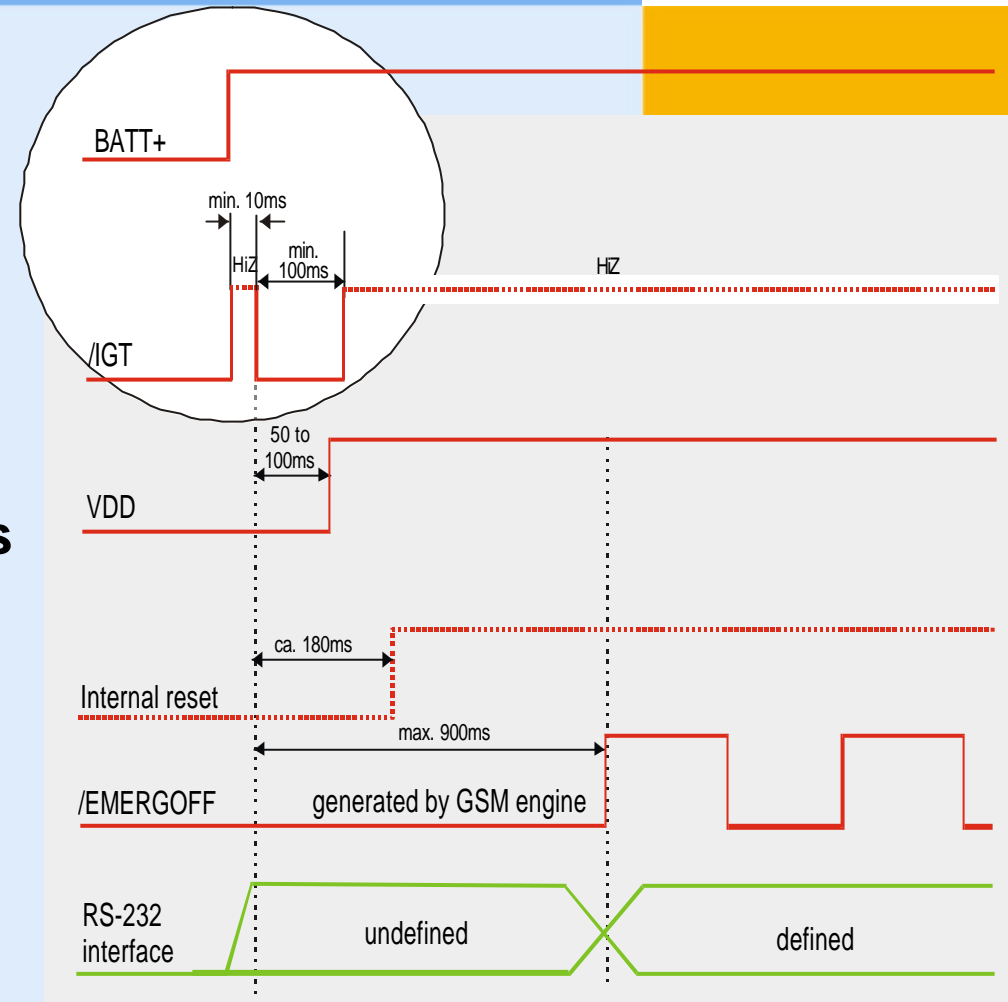
MC45 can be activated in a variety of ways:

- **Ignition line /IGT: Start of Normal mode**
- **POWER line:Start of Charge-Only mode**
- **RTC interrupt:Start of Alarm mode**



Hardware power on the module (15)

- The **/IGT (Ignition)** signal needs to be driven to ground level for at least 100ms
- The voltage **VDD** follows **/IGT** up to 100ms later and signalizes „ON“ of the module
- The **RS-232** interfaces are active less than 0.9s after the **/IGT** edge



Hardware charge modes (16)

- If the charger is connected to the POWER line while MC45 is in POWERDOWN mode, only the charging algorithm will be launched. MC45 runs in a restricted mode, referred to as Charge-Only mode (charging only works with additional external HW).
- During the Charge-Only mode MC45 is not logged on to the GSM network and only special AT commands are working
- When the minimum voltage of 3.2V is achieved within 60 minutes MC45 proceeds to fast charging

Hardware charge modes (17)

- To switch to normal operation and log on to the GSM network, the /IGT line needs to be activated
- In a battery operated MC45 application, the duration of the /IGT signal must be 1s minimum when the charger is connected

Hardware power on (18)

- Another power-on approach is to use the RTC, which is constantly supplied with power from a separate voltage regulator in the power supply ASIC
- The RTC provides an alert function which allows to wake up MC45 from POWERDOWN mode
- To prevent MC45 from unintentionally logging into the GSM network, this procedure only enables restricted operation, referred to as Alarm mode
- A programmable alert function during Normal mode, which reminds with an URC is also implemented

Hardware power off the module (19)

- To switch the module off the following procedures may be used:

- **Normal procedure:**

Software controlled by sending an AT^SMSO to the RS-232 interface

This procedure lets MC45 log off from the GSM network

The software enters into a secure state

Data are saved before disconnecting the power supply

- **Emergency shutdown:**

Hardware driven by switching the /EMERGOFF line of the B2B connector to ground = immediate shutdown of supply voltages, only applicable if the software controlled procedure fails!

Hardware power off the module (20)

- **Automatic shutdown:**
Takes effect if under voltage is detected or if the battery or on-board temperature exceeds critical limits. The automatic shutdown procedure can not prevent the module from damage!

Hardware Power Supply (21)

Power:

- **BATT+: Power Supply (5 pins)**

Vin = 3.2...4.5V, Vin nominal = 4.1V

Power supply pins are connected in parallel due to peak current up to 3A

Supplying the MC45 with a 3.3V standard supply is not supported ! (Drop!)

- **GND: Ground (5 pins)**

- **VDD: 2.9V/max. 10mA, available in Normal mode only. Supply voltage for digital logic, e. g. level shifter or LED. Avoid spikes and glitches!**

Hardware Charger (22)

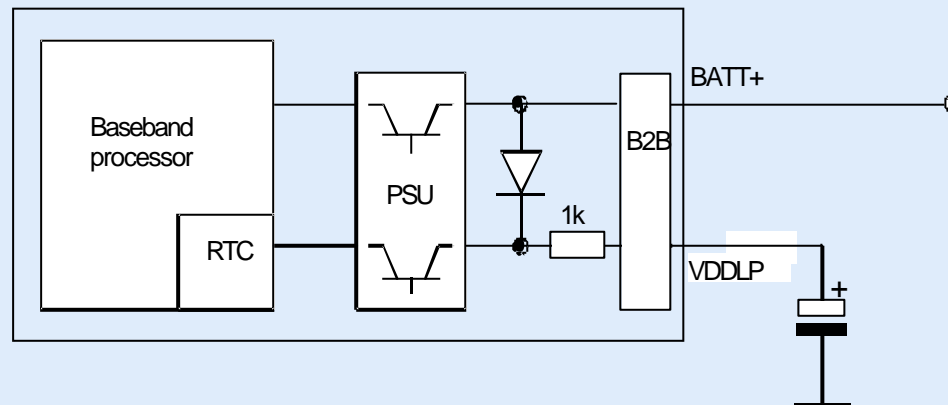
Charging control:

- **POWER:** Charger voltage $V_{in} = 3.0...15V$ (signalling for charging algorithm)
- **CHARGE:** Control signal for external charging transistor
- **BATT_TEMP:** Input for temperature measurement
 - connect external NTC to GND, inside or close to battery pack
 - NTC is mandatory for enabling the implemented charging facilities !

Hardware RTC Back Up (23)

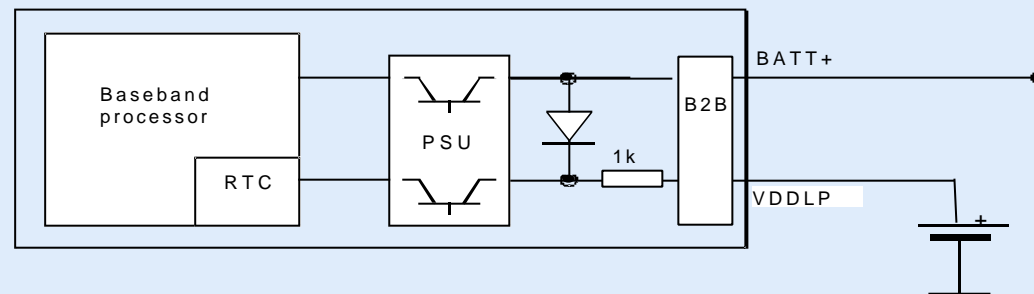
VDDL: RTC backup

- Use the VDDL pin on the B2B connector to backup the RTC from an external capacitor or a battery (rechargeable or non-chargeable)

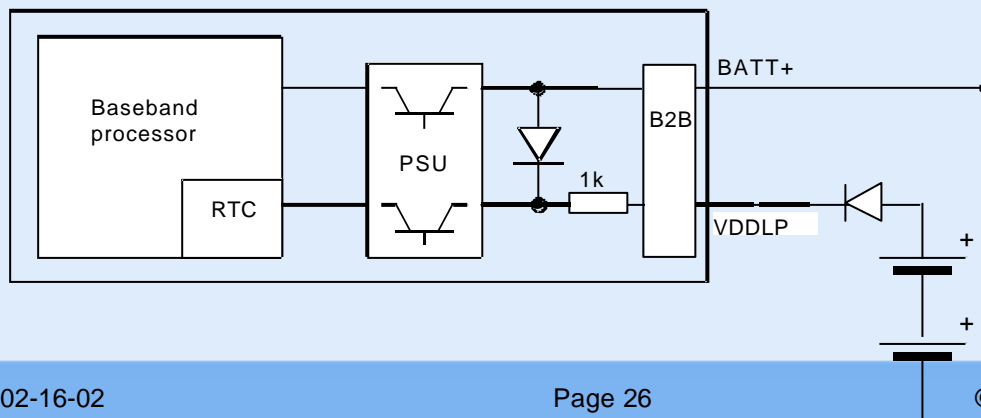


Hardware RTC Back Up (24)

- The capacitor is charged by the BATT+ line of MC45
- If the supply voltage at BATT+ is disconnected the RTC can be powered by the capacitor / battery



- Internal serial resistor $R_i = 1k\Omega$

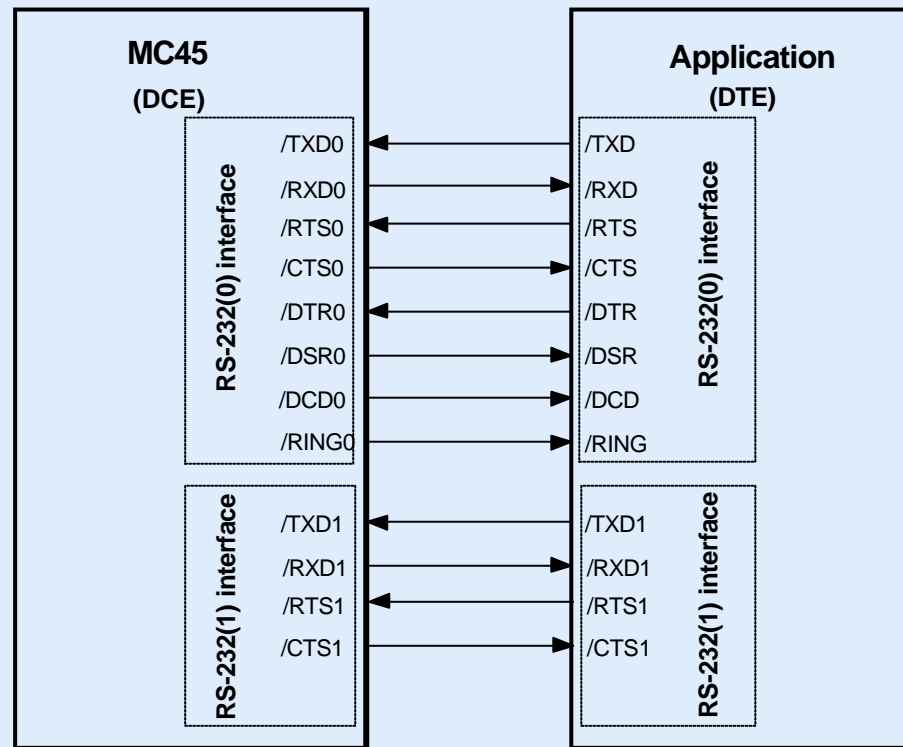


Hardware Interfaces (25)

- The data interface is implemented as a serial asynchronous transmitter and receiver conforming to ITU-T RS-232 interchange circuits DCE
- It operates at 2.65V level
- All RS-232 signals on the B2B connector are low active
- /TxD @ application sends data to /TxD0 of MC45
- /RxD @ application receives data from /RXD0 of MC45
- Bit rates from 300bps to 230kbps
- Autobauding supports bit rates from 1.2kbps to 230kbps
(not: 14.4 / 28.8kbps)

Hardware Interfaces (26)

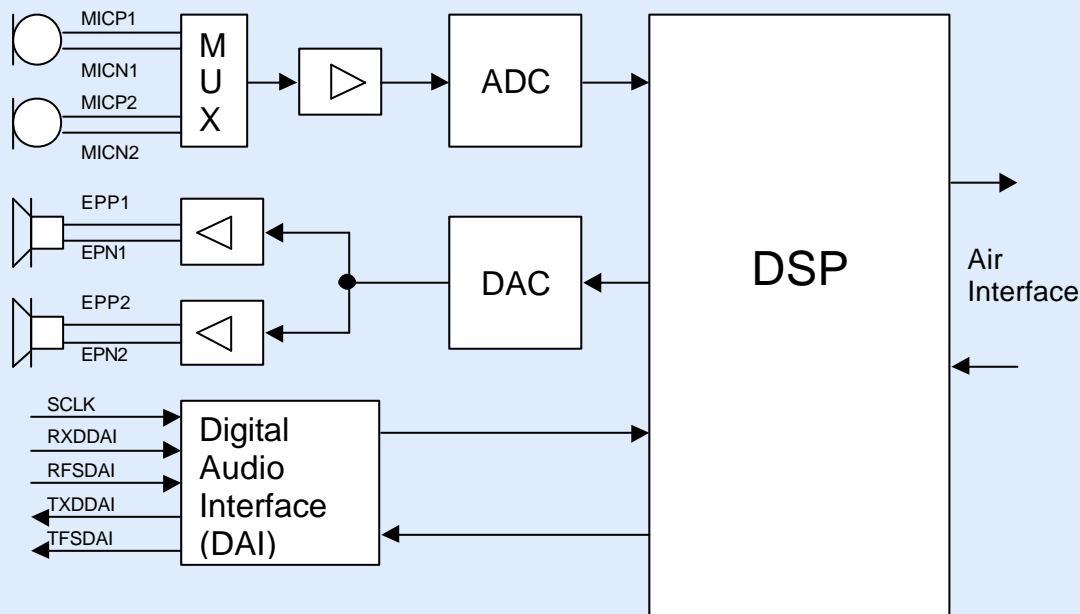
Interfaces: RS-232



Hardware Audio (27)

■ Audio Interfaces

- it is not possible to use more than one interface simultaneously

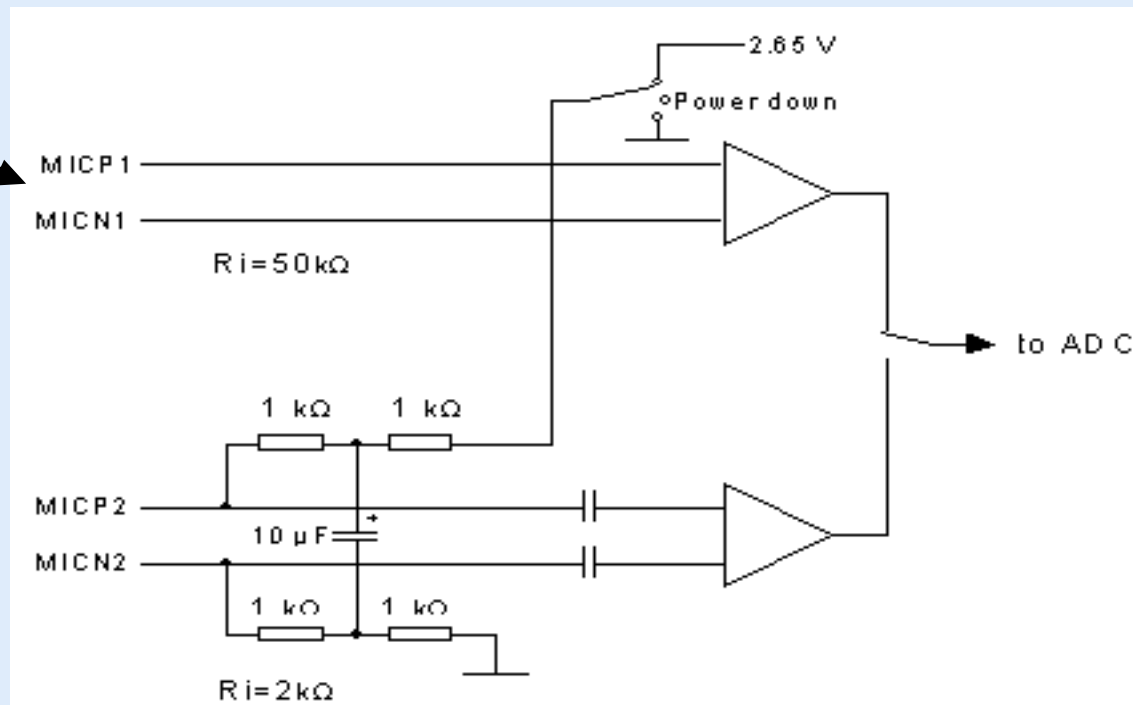


Hardware Audio (28)

Interface 1

- Has no microphone supply circuit and an impedance of 50k Ω .
connecting a microphone or another signal source to interface 1 you are required to add two 100 nF capacitors, one to each line

Interface 1

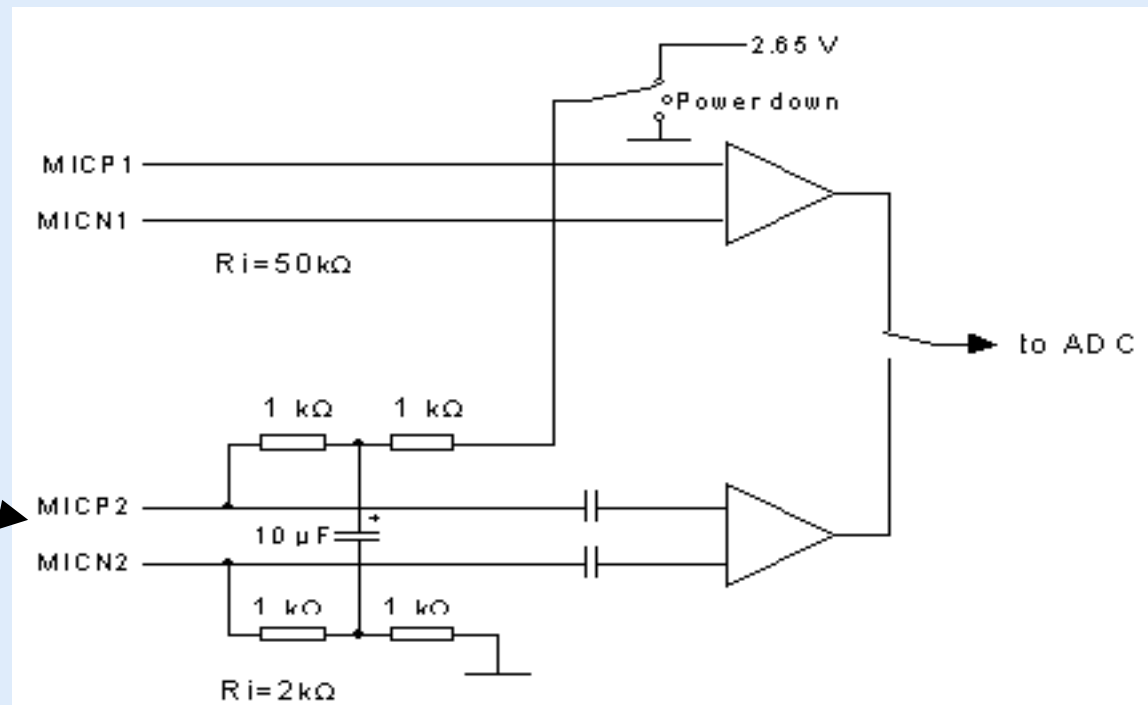


Hardware Audio (29)

Interface 2

- Has a microphone supply circuit and can feed an active microphone. It has an impedance of 2k Ω .
- connecting another type of signal source, it needs to be decoupled with capacitors

Interface 2



Hardware Audio (30)

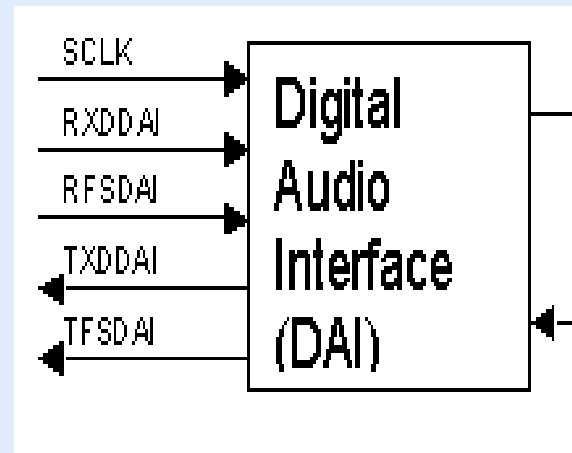
Interface 3 Digital Audio Interface

■ Input signals to DAI

- SCLK
- RXDDAI
- RFSDAI

■ Output signals from DAI

- TXDDAI
- TFSDAI



- **SCLK must be supplied from the application and can be in a frequency range between 0.2 and 10 MHz**

- **Serial interface is always active if the external input data clock SCLK is present**

Hardware Audio (31)

Interface 3 Digital Audio Interface

- Audio samples are transferred from the module to the application in an average of 125µs. This is determined by the 8kHz sampling rate, which is derived from and synchronized to the GSM network. As SLCK is independent of the GSM network, the distance between two succeeding sample transfers may vary about ± 1 SLCK period.
- The application is required to adapt its sampling rate to the TFSDAI rate. Failure to synchronize the timing between the module and the application may cause audible pops and clicks in a conversation

Hardware Audio (32)

- **AT^SAIC allows switching between the two analog and the digital interface**
- **To suit several types of equipment six audio modes are selectable with AT^SNFS**
- **Sending/receiving and sidetone path amplification depend on the audio mode but can also be adjusted with AT commands (except for audio mode 1)**

Hardware SIM (33)

- Base band processor has an integrated SIM interface compatible with the ISO 7816-3 IC Card standard
- This is wired to the host interface (B2B connector) in order to be adapted to an external SIM card holder



Hardware SIM (34)

- **CCRST: Chip card reset, provided by base band processor**
- CCCLK: Chip card clock**
- CCIO: Serial data line, input and output**
- CCIN: Input on the base band processor for detecting the SIM in the holder; if the SIM is removed during operation the interface is shut down immediately to prevent destruction of the SIM**
- CCVCC: SIM supply voltage 2.9V**
- CCGND: Separate ground connection on B2B connector for SIM card to improve EMC**

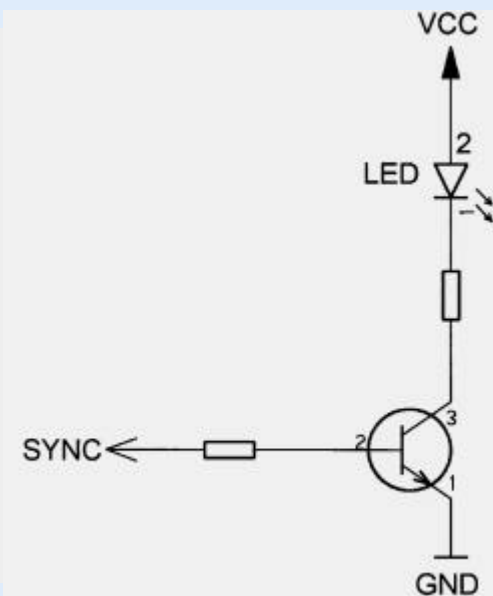
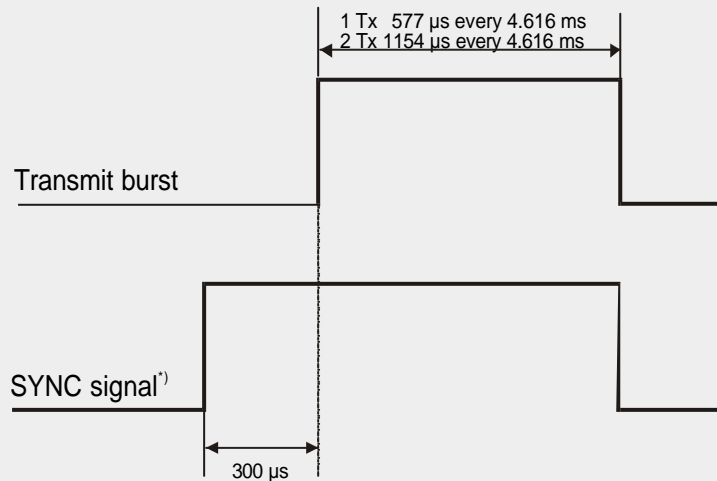
Hardware Control Pins (35)

- **/IGT (Ignition):** Falling edge is used to power up MC45
- **/EMERGOFF:** Deactivation of MC45 by switching to ground for $\geq 3.5\text{s}$ --> *Emergency shutdown only!*

Hardware Control Pins (36)

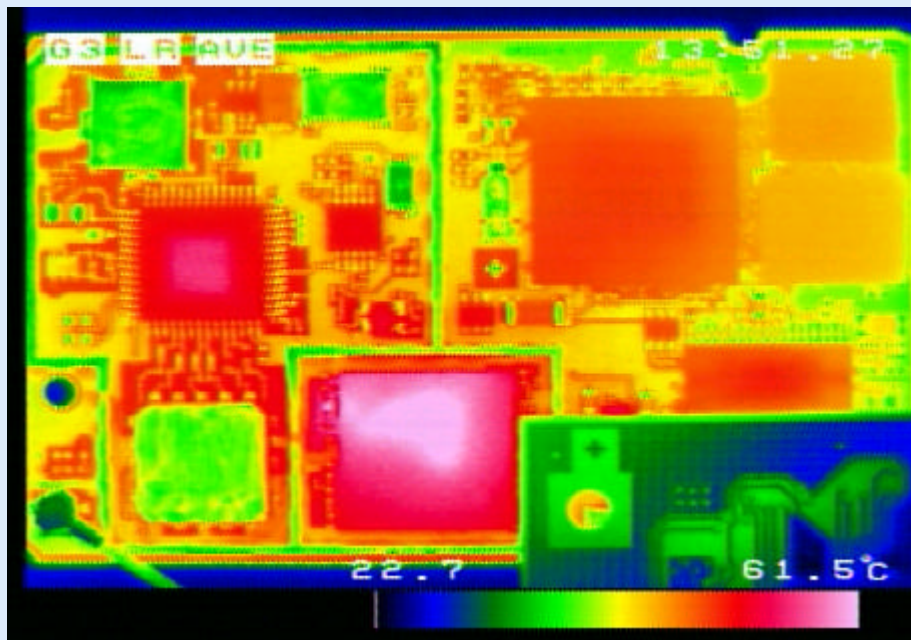
■ SYNC

- option A: serves to indicate growing power consumption during the transmit burst
- option B: controls a status LED (shows operating states; not available in SLEEP Mode)

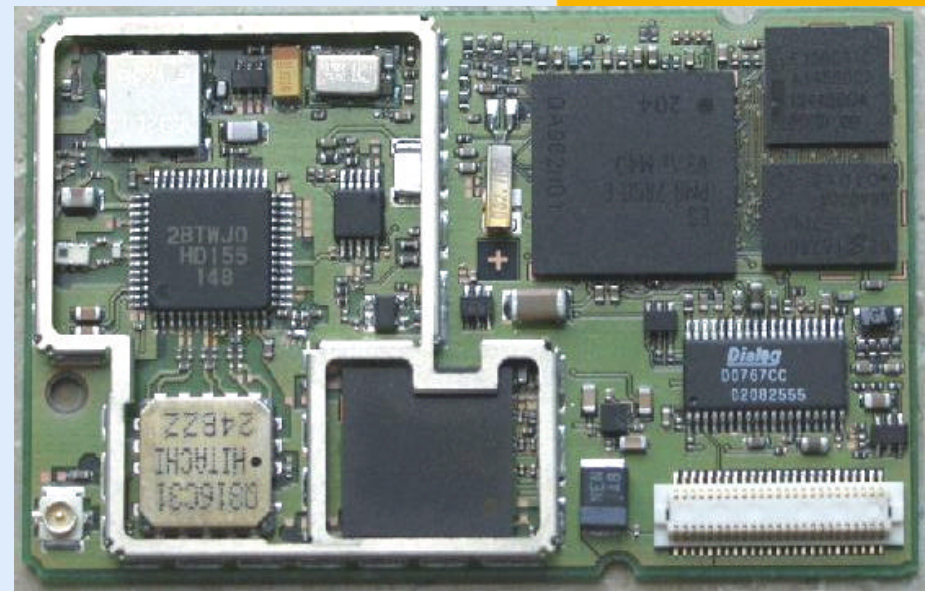


Hardware Temperature (37)

- Normal Conditions ($T_{amb}=25^{\circ}\text{C}$), max. RF power level (BB without GSM protocol)

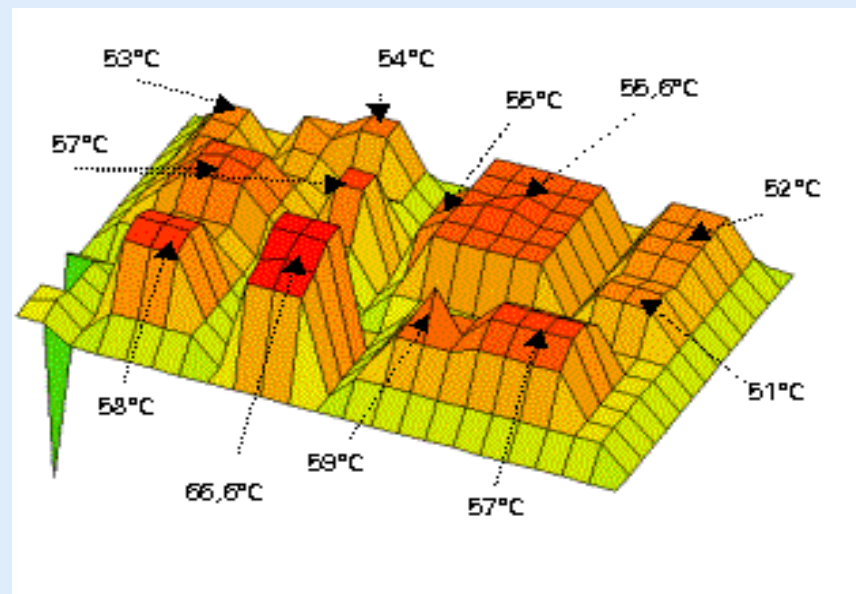


Thermal View of MC45



Hardware Temperature (38)

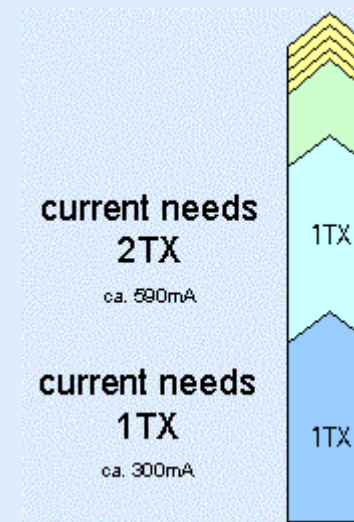
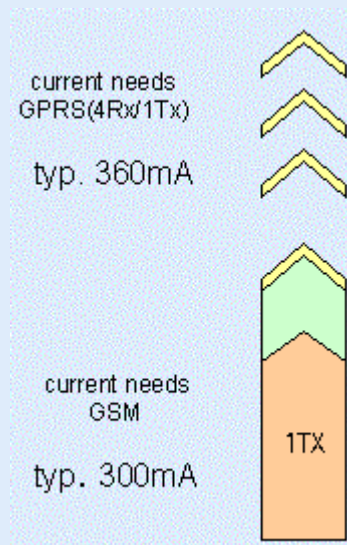
- Normal Conditions ($T_{amb}=25^{\circ}\text{C}$), max. RF power level (BB without GSM protocol)



Surface MC45

Hardware Current (39)

- Comparison of current needs for GSM and for GPRS and the temperature effect



Hardware EMC (40)

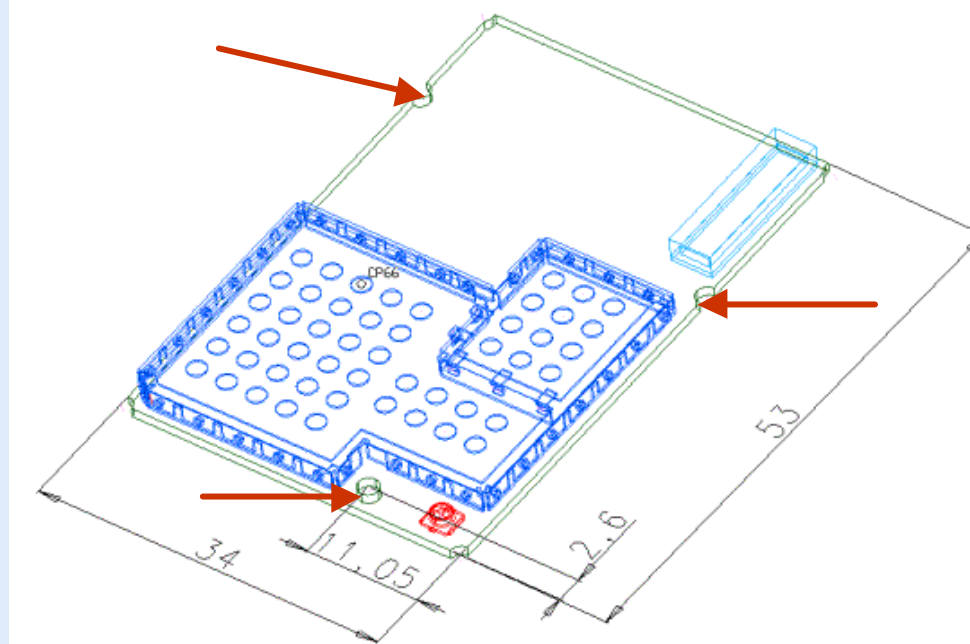
- Radiated spurious emissions measured according to EN55022 and GSM11.11
- Measured electrostatic values

Specification / Requirements	Contact discharge	Air discharge
ETSI EN 301 489-7		
ESD at SIM port	± 4kV	± 8kV
ESD at antenna port	± 4kV	± 8kV
Human Body Model (Test conditions: 1.5 kΩ, 100 pF)		
ESD at the module	± 1kV	

- Control lines of the module are protected according to the Human-Body-Model
- All measurements were accomplished with the reference equipment (DSB 45)

Hardware Physical dimensions (41)

- Only single-side mounted
- Smallest SMD parts (0201)
- Size: 53mm x 34mm x 3.5mm
- Weight: 10g
- Three fixing points

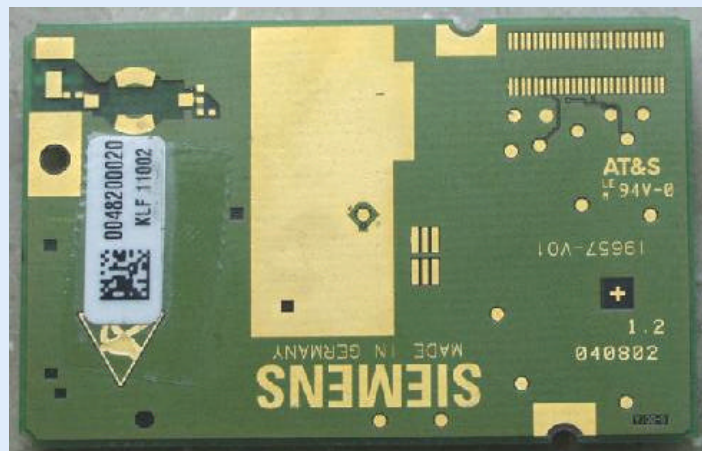
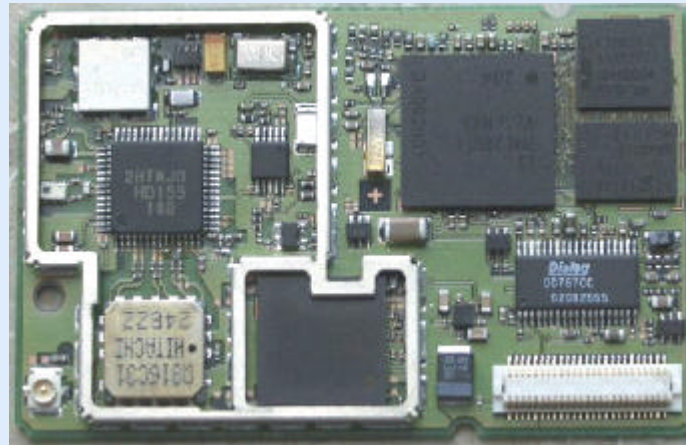


RF Architecture (1)

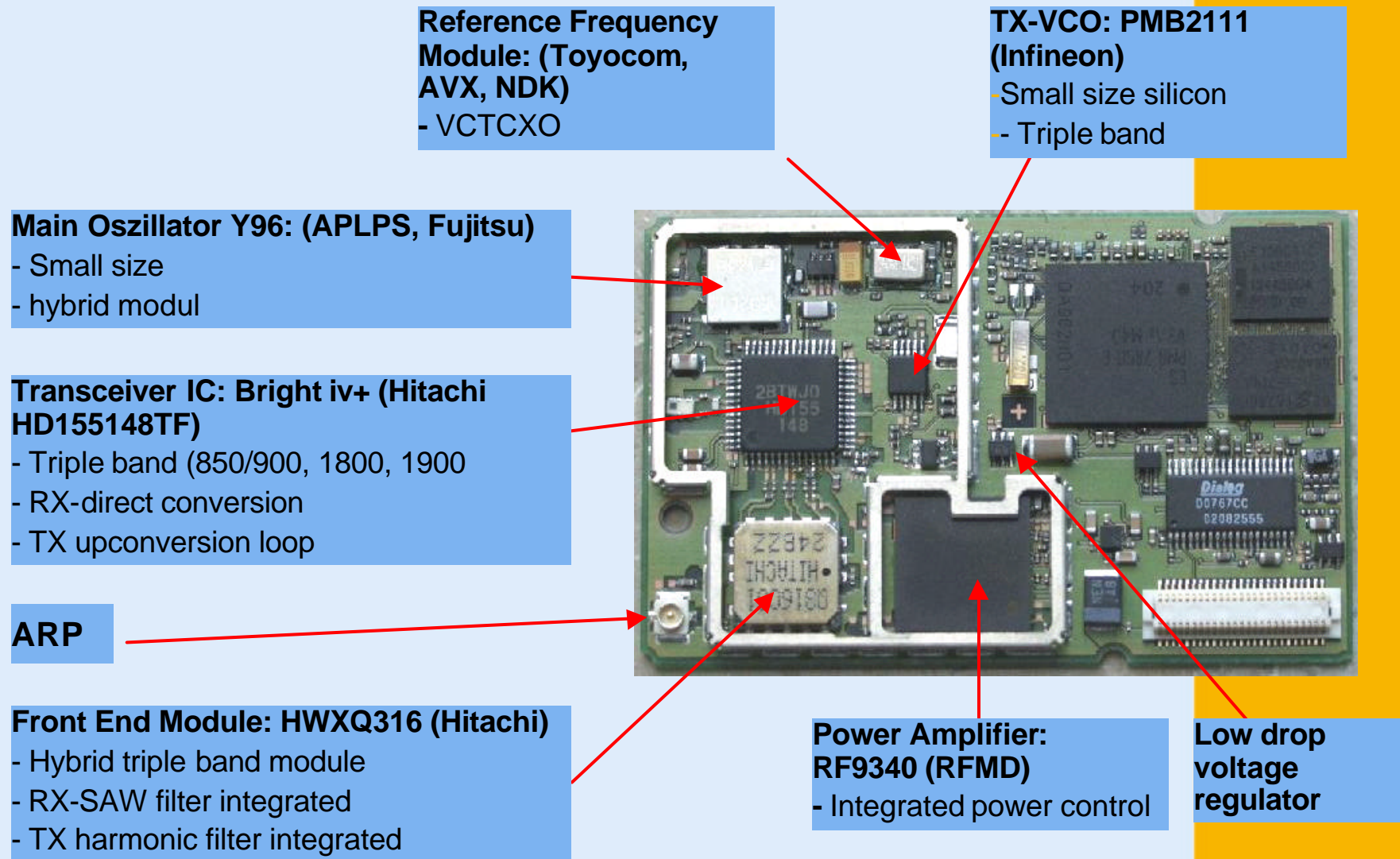
- **MC45/388**
- **Key components**

RF Architecture (2)

MC45 and MC388



RF Architecture Key components (3)



Antenna Air Reference Point (1)

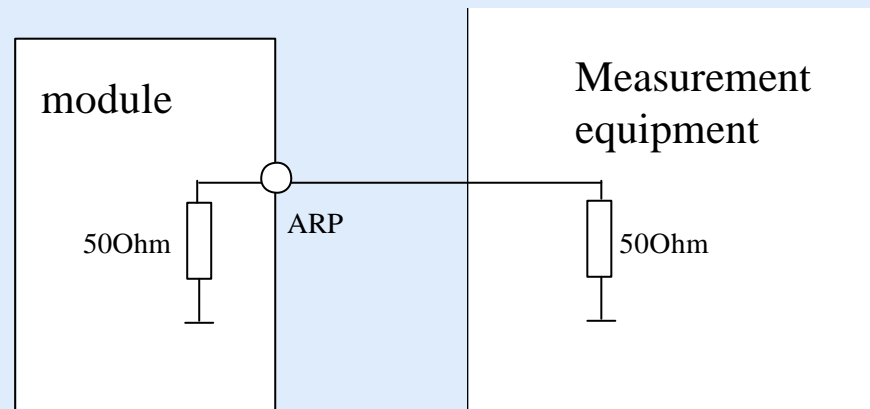
- ARP – Antenna reference point
- What is the reason for 50 Ohm matching?
- Permanent Connector, Temporary Connector
- What happens with miss matching?
- Example of DC power consumption
- WM Modules: Examples

Antenna Air Reference Point (2)

- **ARP – Antenna reference point**
 - **Defined interface for type approval and factory adjustments**
 - **All measurements like sensitivity, output power, are related to that interface**
 - **50Ohm U.FL (Hi Rose)**
 - **SMA / U.FL (Hi Rose)**

Antenna 50 Ohm (3)

- Standard impedance for all RF equipment
 - Out put Power is defined at 50 Ohms
- power matching between module and measurement equipment is necessary



Antenna Connectors (4)

■ RF Connector types for different modules

TC35, MC35

→GCS/SMA

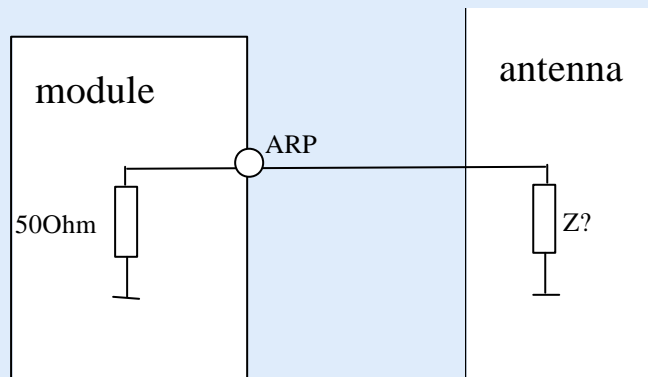
MC45/388

→U.FL/SMA

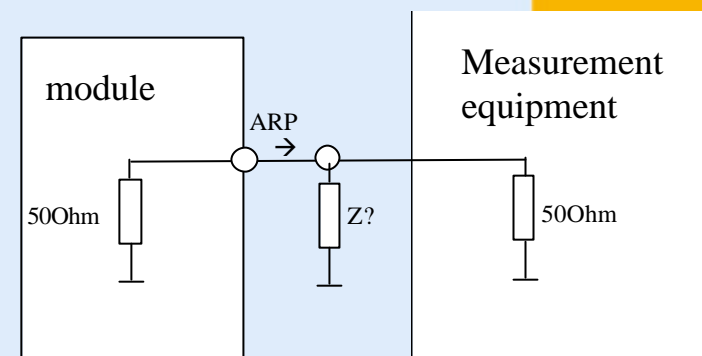
Antenna 50 Ohm Matching (5)

- DC power consumption #
- RF harmonic's #
- RF spurious, noise #
- RF switching spectrum #

Antenna miss match



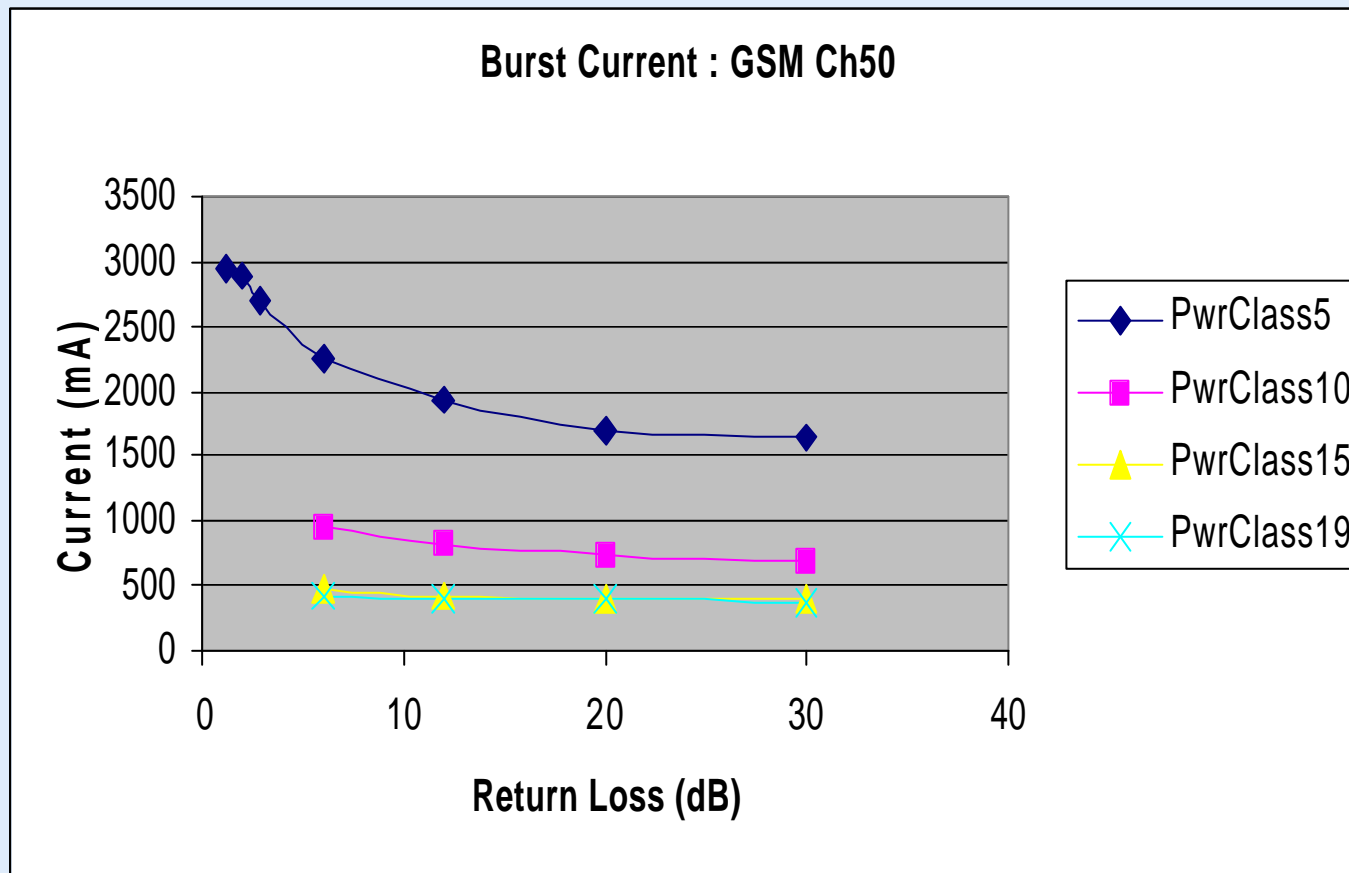
miss match through not suitable connections



Antenna 50 Ohm Miss Matching (6)

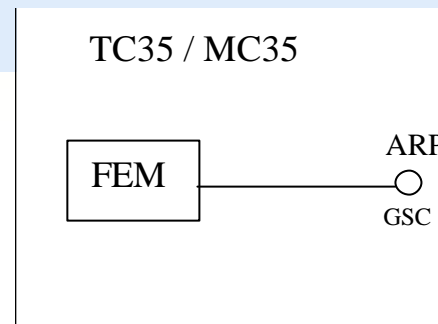
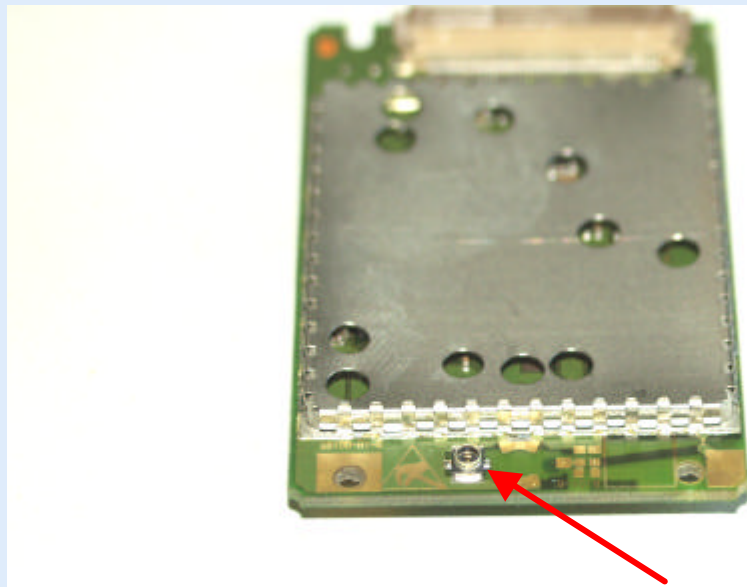
- DC power consumption vs. return loss

Refer to HID chapter: "Current consumption during transmit burst"



Antenna Connecting a Module (7)

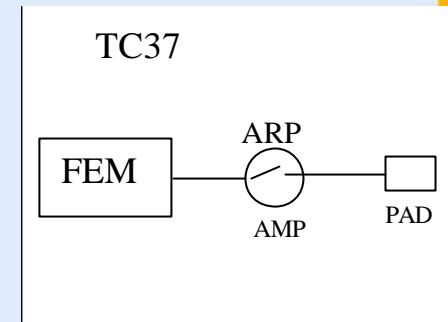
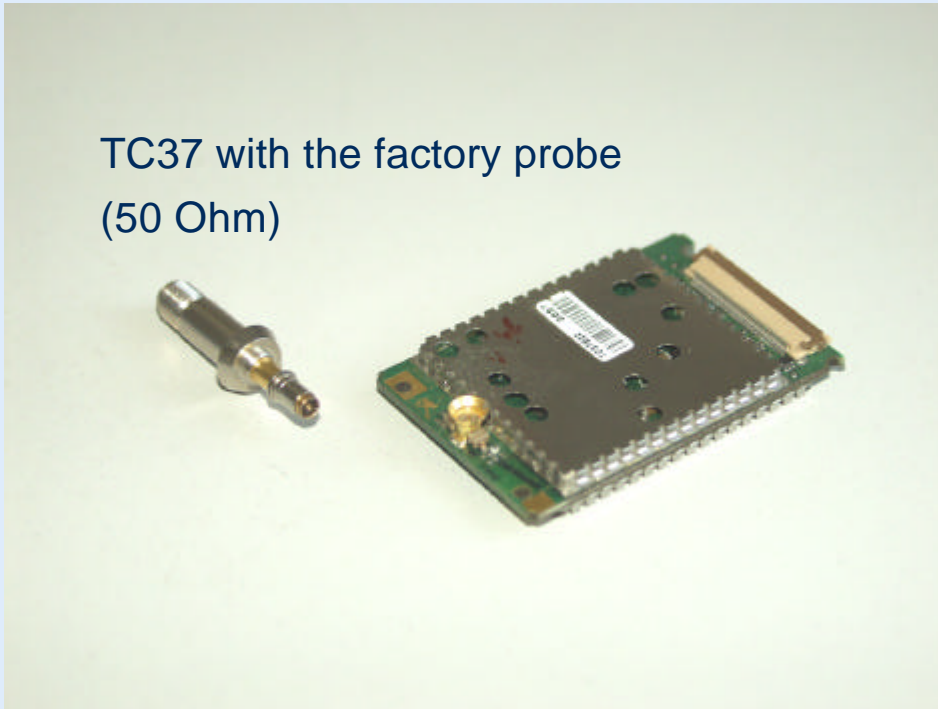
- ARP – 50 Ohm GSC connector for factory adjustments and type approval



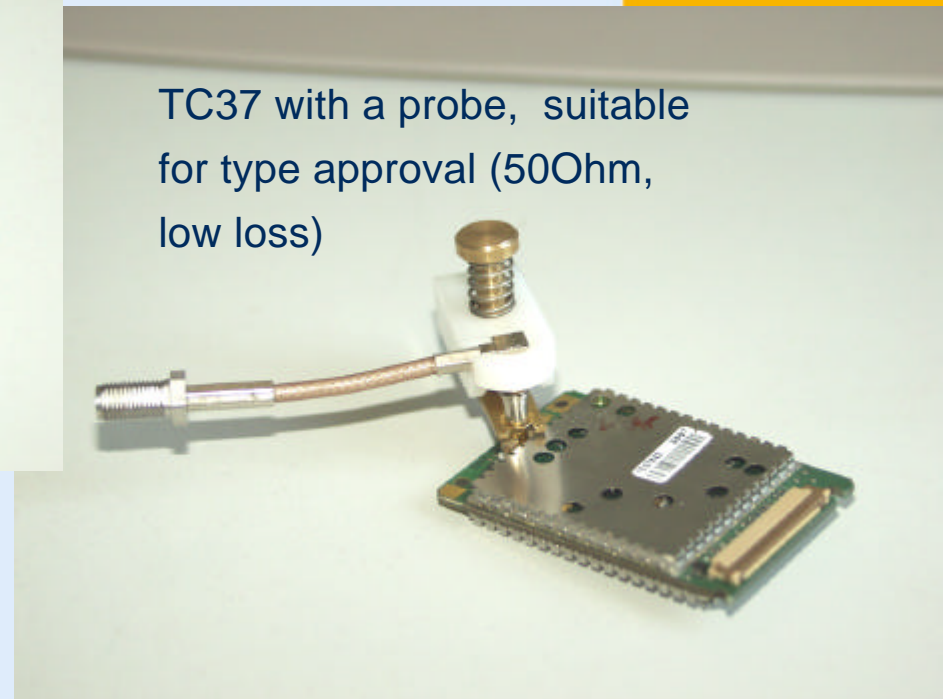
Antenna Connecting a Module (8)

■ AMP switching connector + PAD

TC37 with the factory probe
(50 Ohm)

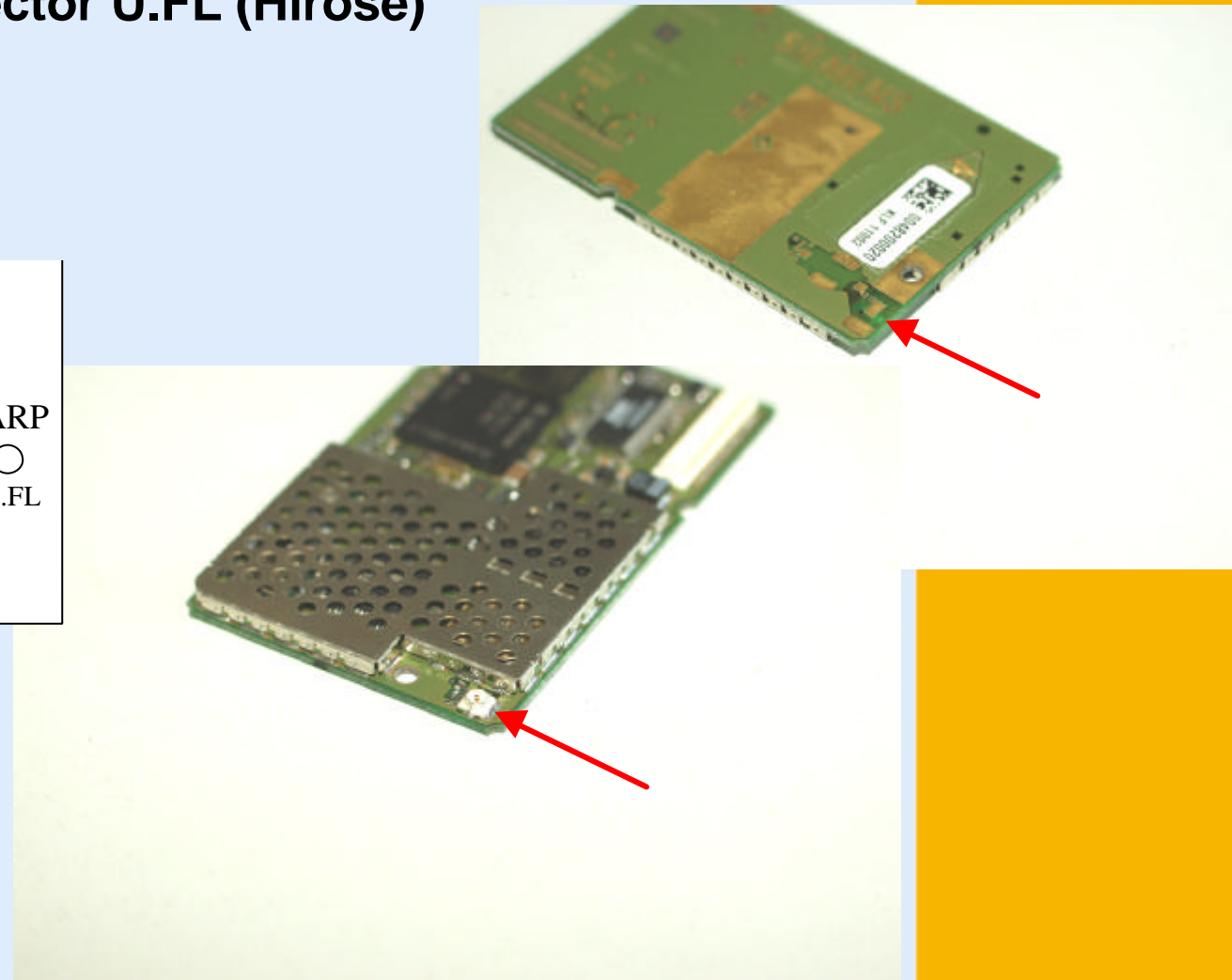
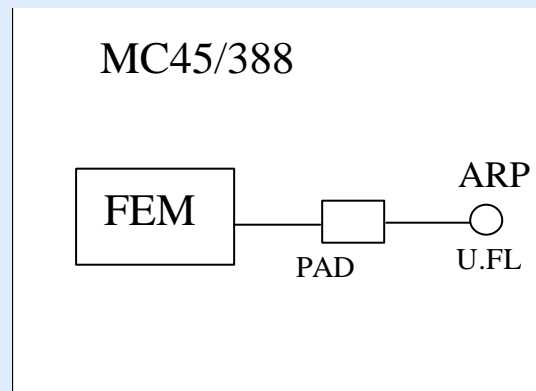


TC37 with a probe, suitable
for type approval (50Ohm,
low loss)



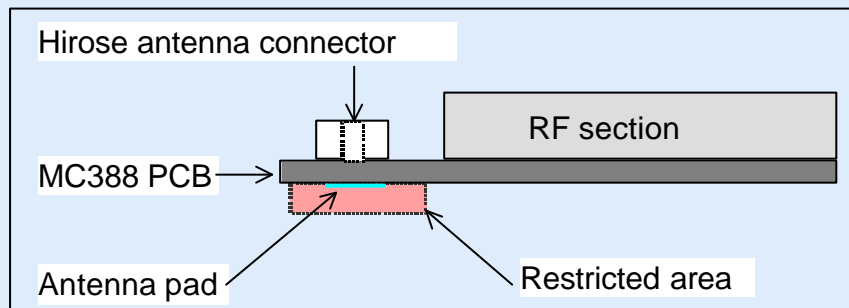
Antenna Connecting MC45/388 (9)

- 50Ohm coax connector U.FL (Hirose)
- 50Ohm PAD

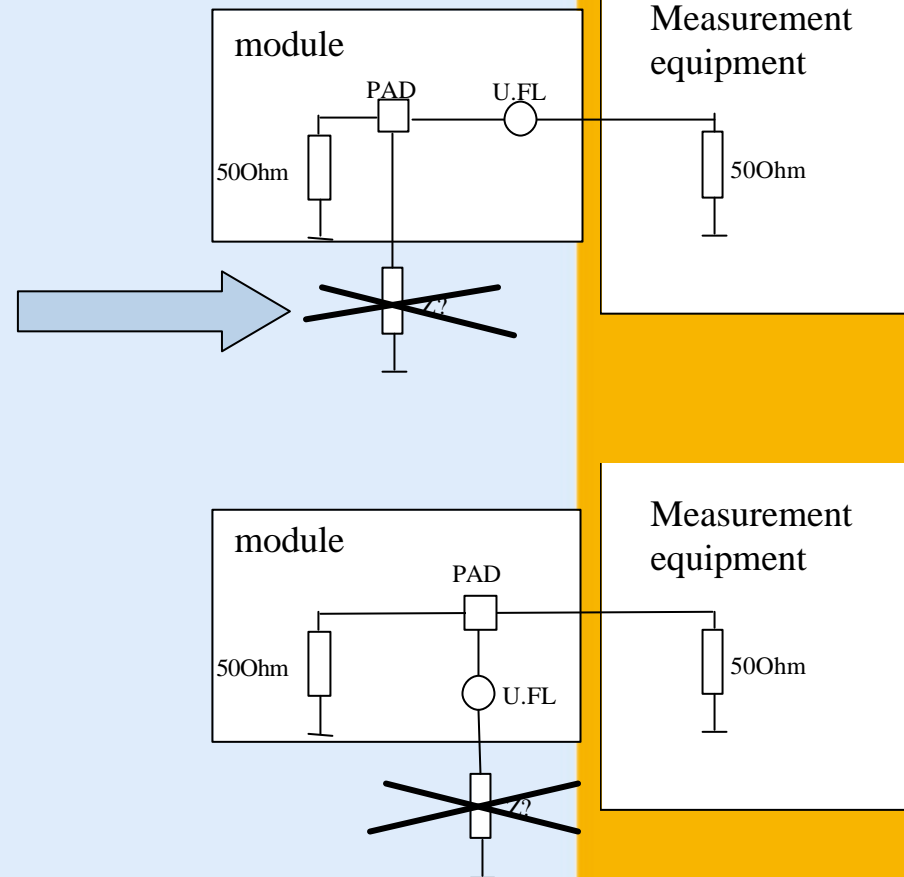


Antenna Connecting MC45/388 (10)

- Never use both interface at the same time
- Consider the PAD is „hot“

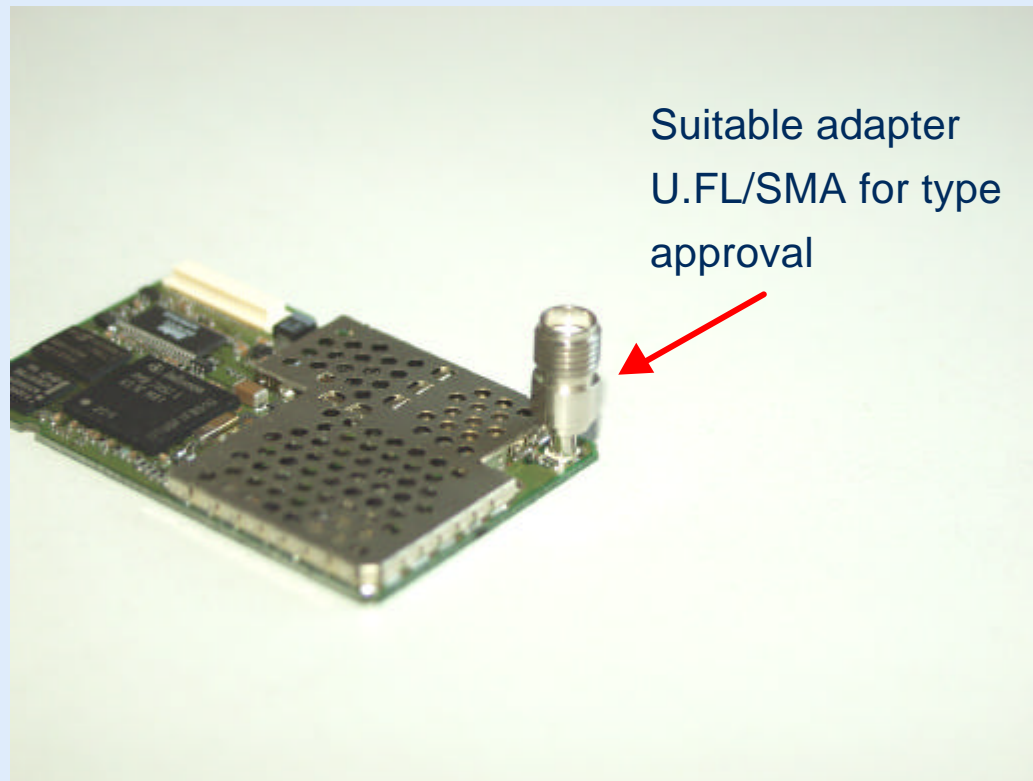


Equivalent circuits



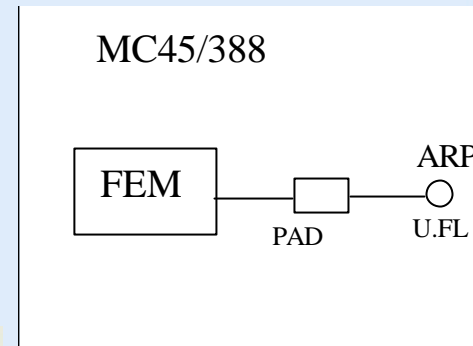
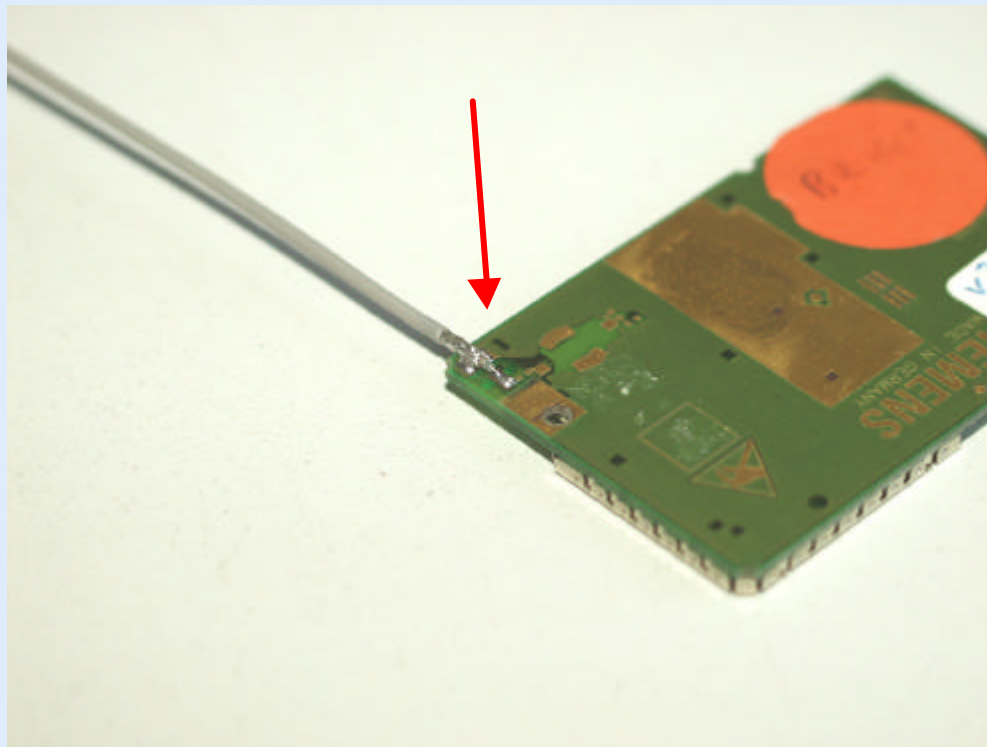
RF Architecture Connecting MC45/388 (11)

- Only the coax connector is the ARP
- Never use the PAD for type approval

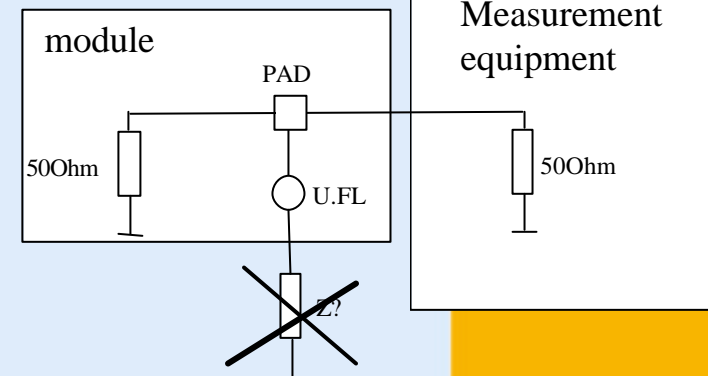


RF Architecture Connecting MC45/388 (12)

■ Soldered coax cable



Equivalent circuit



Summary (1)

■ Comparison between MC 45 MC 388

	MC45	MC388
Maße	53 x 34; 3.5mm dick = 1802mm ²	53 x 34; 3.5mm dick = 1802mm ²
chipset	Bright 4 + RFMD PA	Bright 4 + RFMD PA
GSM	tri band	dual band
power	3.2V...4.5V	3.2V...4.5V
Temp.	-20°C to +55°C	-20°C to +55°C
connctor	B2B 50pol.	B2B 50pol.
RF conn.	pad, Hirose	pad, Hirose
RS232	1x full, 1x half	1x full, 1x half
GPRS	GPRS 10	GPRS 8
charging option	external	external
Antenna recogn.	no	no
audio	2x anlg, DAI	2x anlg, DAI

MC 45

SIEMENS
mobile

CETECOM ICT Services GmbH

EC Identification number 0682

authorized by the German Government



with decree Vfg 28/2000, issued in the Official Journal 6/2000
of the Regulierungsbehörde für Telekommunikation und Post,
to act as Notified Body in accordance with the R&TTE Directive 1999/5/EC of 9. March 1999.

CERTIFICATE EXPERT OPINION

Registration-No.: M3504500-EO
Certificate Holder: Siemens AG
Siemensdamm 50
D-13623 Berlin
Germany

Product Designation: Cellular Engine MC45
Product Description: E-GSM 900 / GSM 1800 / GSM 1900 GPRS Terminal Equipment
Product Manufacturer: See Certificate Holder

essential requirement (corresponding R&TTE article)	Applied Specifications / Standards	Evidence Documentation	Result
RF spectrum efficiency (Art. 3.2)	3GPP TS 51.010-1:v.4.9.0, selection acc. to GCF-CC:v.3.5.0 resp. NAPRD.03:v.2.6.0, covering essential radio test suites of EN 301 511:v.7.0.1	Test Report	conform
EMC (Art. 3.1b)	EN 301 489-1:v.1.2.1 EN 301 489-7:v.1.1.1	Test Report & Certificate of Confor- mity (EMC)	conform
Safety (Art. 3.1a)	EN 60950:2000	Test Report	conform

Marking: The products shall be marked with CE and our notified
body number as shown right hand.

CE 0682

The scope of evaluation relates to the submitted documents only.
The certificate is only valid in conjunction with the following annex.

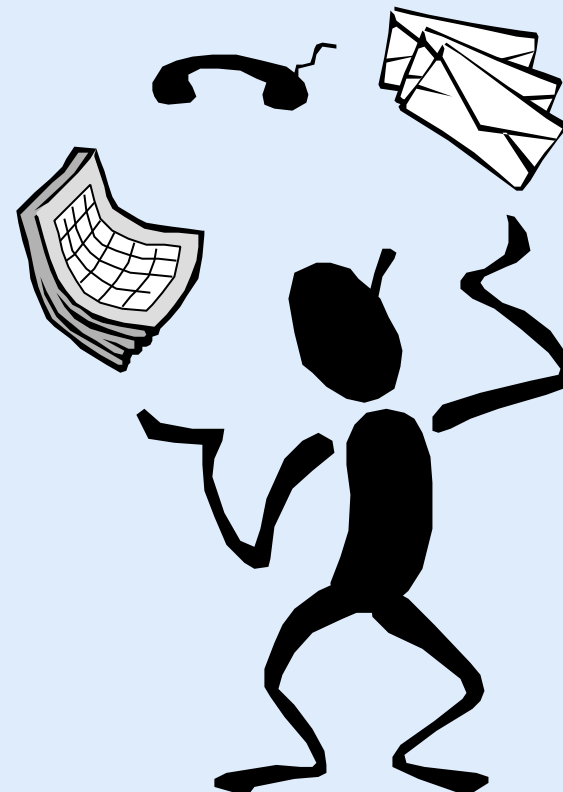
Saarbrücken, September 25, 2002

Place, Date of Issue

Signed by Nikolaus Wahl
Notified Body



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**Thank`s for your
attention**

