Hardware - Documentation Proxi-ESCORTE

1 Functional description

1.1 Basic functionality

The basic function of the Standard ESCORTE is that of an intelligent data collector: Every time a GCS data strip is read in correctly, the Data Acquisition Unit (DAU) recognises the unique 8-digit number encoded in the strip and stores this number together with the time and date of the reading in its memory. Then you can either transfer the data to a computer for further processing using a Data Transfer Unit (DTU) or have the data evaluated in the DAU itself and check the results in the form of well structured printouts.
Proxi–ESCORTE in addition offers the possibility to read transponders (also called tags), too. Further processing is the same as reading a data strip.

1.2 How it works

Data strips consist of a carrier made of plastic and a ferromagnetic tape on the top of the carrier. During the production process the barcode is mechanically engraved into the tape. The code represents an 8 digit decimal number plus checksum.
In order to record a data strip the reading head of the Proxi–ESCORTE must be wiped over the strip without applying to much pressure. During scanning the strip a permanent magnet placed in the reading head magnetizes the ferromagnetic tape. At the same time a magnetic reading head system which is mounted in the reading head of the Proxi–ESCORTE with a cardanic suspension picks up the magnetic field emitted by the magnetic tape. A specially designed circuit amplifies the weak signal of the magnetic head and provides a digital signal for further processing. Processing of incoming data is done by a micro-controller. Correct readings will be acknowledged by the unit with an acoustic and an optical signal (the LEDs will flash).

Proxi–ESCORTE additionally offers the possibly to read and also write transponders (tags). Transponders contain an integrated circuit (chip) and an antenna – they are typically shaped as discs. The chip contains an 8 digit identification code. In order to read out data from the chip it is necessary to first position the head of the Proxi–ESCORTE in a maximum distance of about 1” above the tag and then shortly press the button placed at the top of the device. This will trigger the system and the transponder communication process will start. First a magnetic field is build up by the antenna coil which is placed in the fixed part of the reading head of the Proxi–ESCORTE. Then the transponder accumulates energy which it picks up with its antenna from the radiated field of the Proxi–ESCORTE and starts to send data by load modulation. Load modulation is detected by a special integrated circuit (reader ASIC) and a digital signal is output. Further signal processing is done by the micro-controller. Data sent to the transponder is ASK modulated.

An additional feature of the tags versus data strips is the write function. Read only transponders can only be read, read/write transponders store the unit’s serial number, time and date of the last reading in a nonvolatile memory. This information may later on be read locally by another unit, e.g. by a supervisor, no access to a database is needed. The mode of operation is set by a flag in the transponder memory and can be altered by GCS. The flag may be ignored if the Proxi-ESCORTE is set to do so. The transponder communication process for writing tags is quite similar to reading tags. The main difference is that during programming the nonvolatile memory

more energy is needed by the transponder than for reading it. Therefore the maximum communication distance for writing is less than for reading.

The user has to keep in mind that strong electromagnetic fields may have an adverse effect on the reading of data strips and tags, and that they shorten the lifetime of the power pack.

Communication between the DTU and the Proxi–ESCORTE is done wireless by inductive coupling. There are separate coils for transmitting and receiving data.

Proxi–ESCORTE is powered by three alkaline batteries put together in a battery pack. For normal use this pack usually lasts for one to two years.

1.3 Parts of the Proxi-ESCORTE

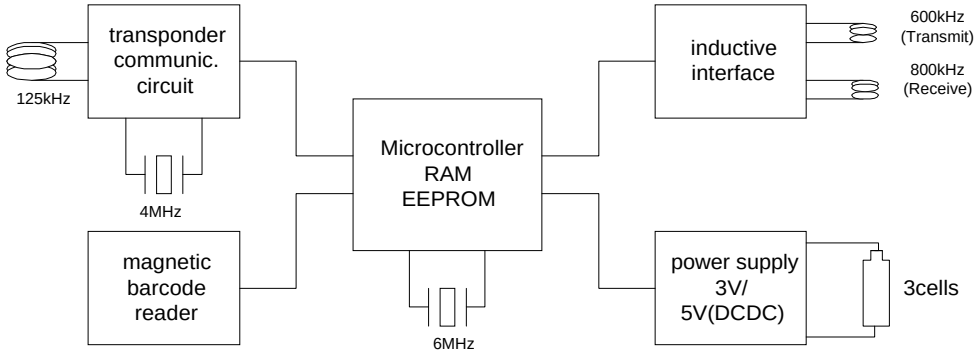
The device consists of three main parts

- electronic part
  The case/body consists of two plastic parts which are glued together. Inside there are 3 PCBs:
  - the reading head board with the magnetic head signal amplifier, the LEDs and the buzzer on it
  - the analog print with the circuitry for the wireless interface to the DTU, the circuits for transponder communication and other peripheral analog circuits on it
  - and the digital print with the micro-controller, memory and ‘glue logic’ on it.

- the reading head
  The reading head is attached to the electronic part/body and should only be removed by authorized persons. To remove the head first two plastic rivets have to be extracted using a special tool. The reading head consists of:
  - a fixed part which is attached to the electronic part/body (as described above) where the antenna for the transponder communication is integrated
  - a cardanic suspension for the reading head system
  - the reading head system to read the magnetized strips (also containing a small permanent magnet to first magnetize the strips)

- the power pack
  The power pack is attached to the electronic part/body and should only be removed by authorized persons. To remove the battery first two small round plastic parts have to be removed. Then access to two screws is possible, they have to be turn out. Lastly two plastic rivets have to be extracted using a special tool – similar to the reading head.

2 block diagram showing all relevant clock frequencies



Most functions are performed by the micro-controller (80C154) operating at a clock frequency of **6MHz**. It is only active if necessary – otherwise it is in standby mode (oscillator is off).

The transponder communication circuit (reader ASIC) uses a system clock at a clock frequency of **4MHz**. The carrier frequency for communication with transponders is **125kHz**.

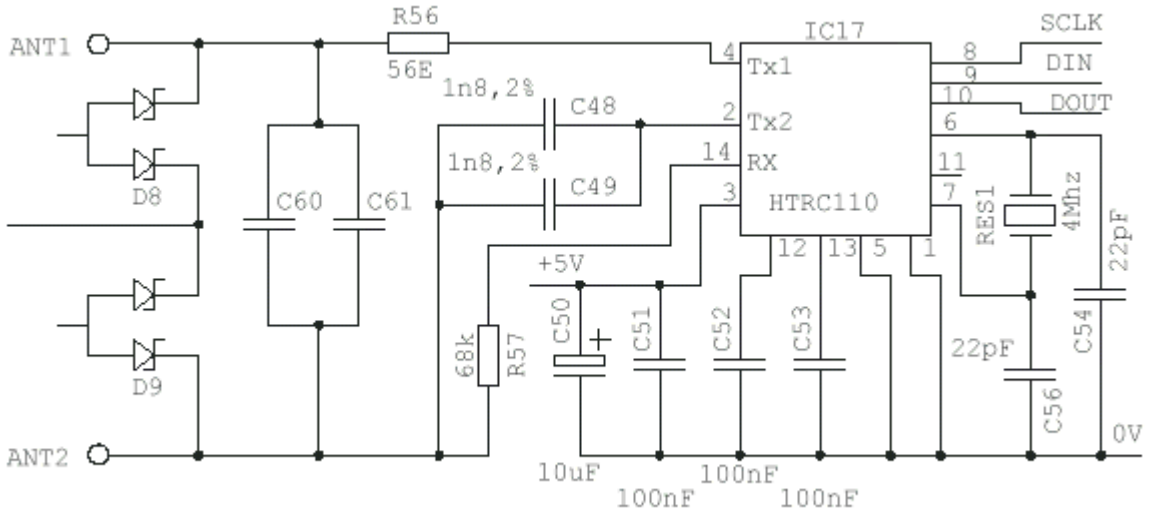
For communication from Proxi-ESCORTE to DTU a carrier frequency of **600kHz** is used and ASK modulated. For communication from DTU to Proxi-ESCORTE a carrier frequency of **800kHz** is used and ASK modulated. Communication distance is limited to approximately 0,5".

The battery pack consists of three cells in series which result in 4.5Volts. The internal operating voltage is 3Volts with the exception of the transponder communication circuit which operates at a voltage of 5Volts (DC/DC converter MAX857ESA; The switching frequency depends upon the load and the input voltage, and can range up to **500kHz**).

3 Intentional Radiators

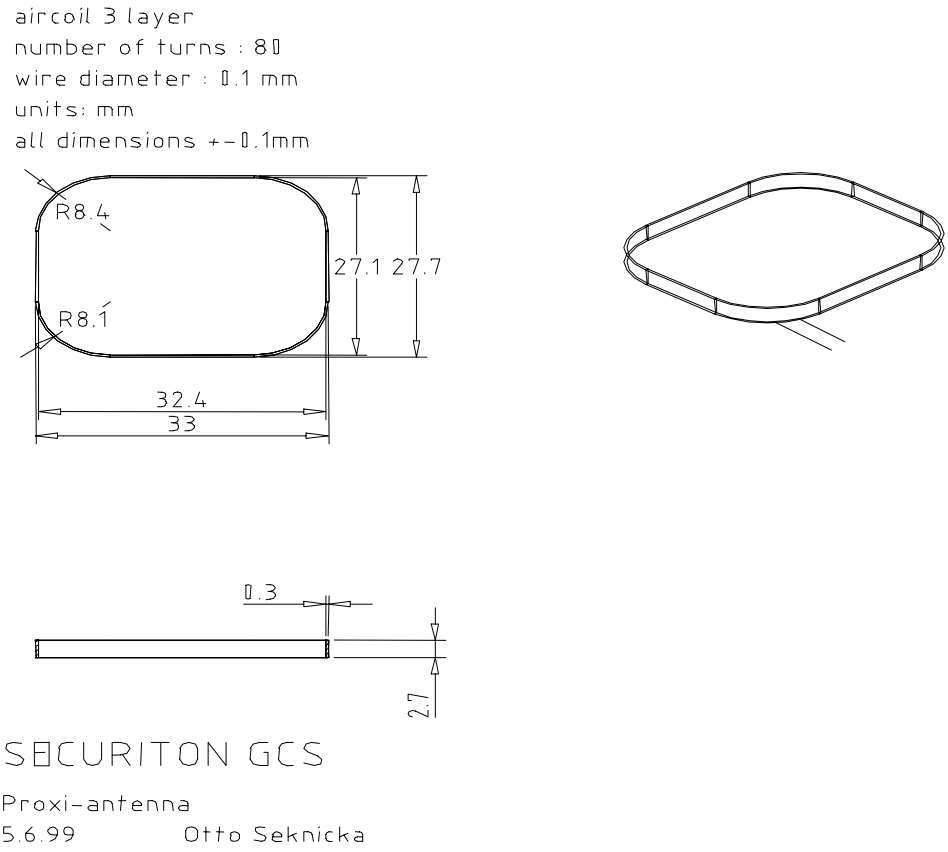
3.1 Transponder Communication Circuit

The transponder communication circuit consists mainly of the reader ASIC and the parts shown below and is responsible for the communication to the tags.



The antenna circuit is similar to the minimal required circuit of the application note of the HTRC110.
The internal oscillator of the Reader–ASIC is externally stabilized by a 4MHz resonator. C52,C53 are used for internal filtering and C50,C51 to absorb high frequency noise on the power supply. C48 and C49 are parts of the antenna resonance circuit which is tuned to 125kHz. C60 and C61 are not mounted they are for test purposes and future use.

A sketch of the used antenna is shown below.

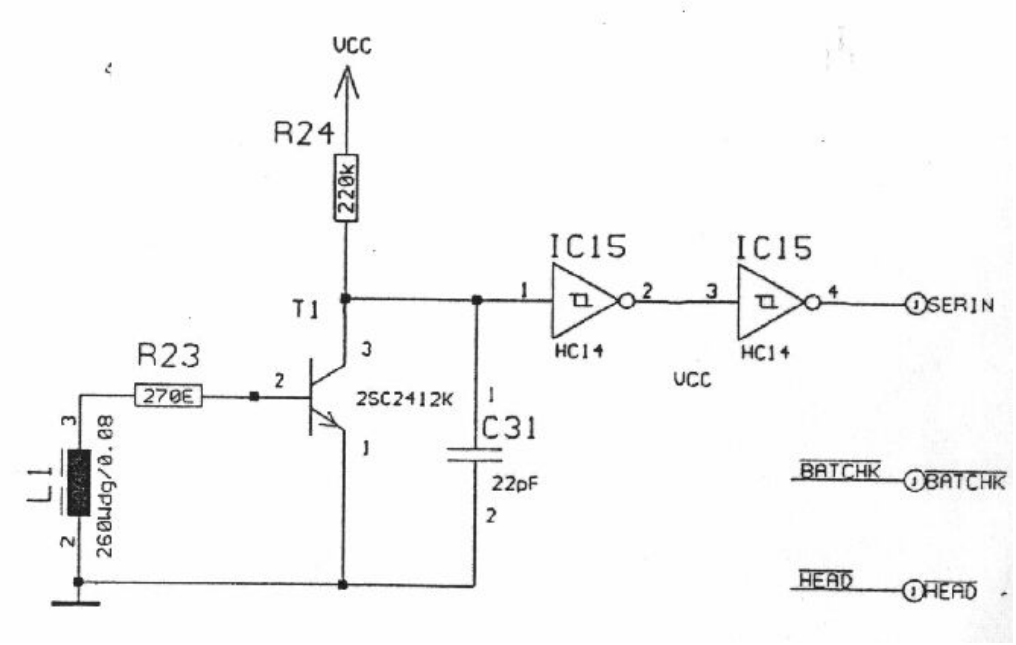


The antenna circuit (inductor $L_{a\ (antenna)}$, capacitor C_a) is calculated for a resonance frequency of 125kHz. The maximum current through the antenna (80 windings of lacquer isolated copper wire, ∅ 0.1 mm) is about 50 to 60 mA.

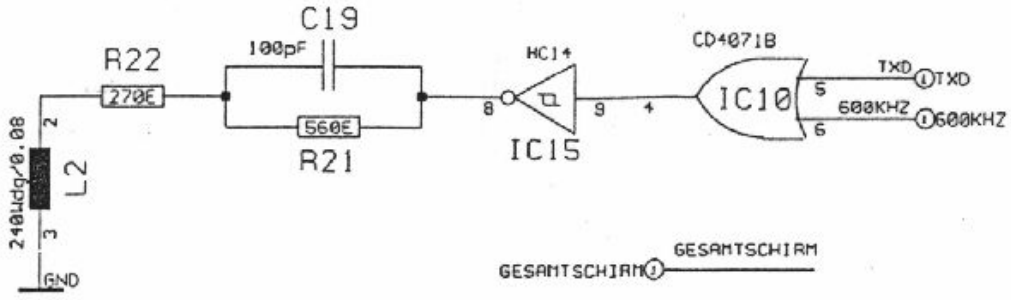
3.2 DTU interface

The DTU interface provides communication to (carrier frequency 600 kHz) and from the DTU (carrier frequency 800 kHz).

3.2.1 Receiving circuitry



3.2.2 Transmitting circuitry

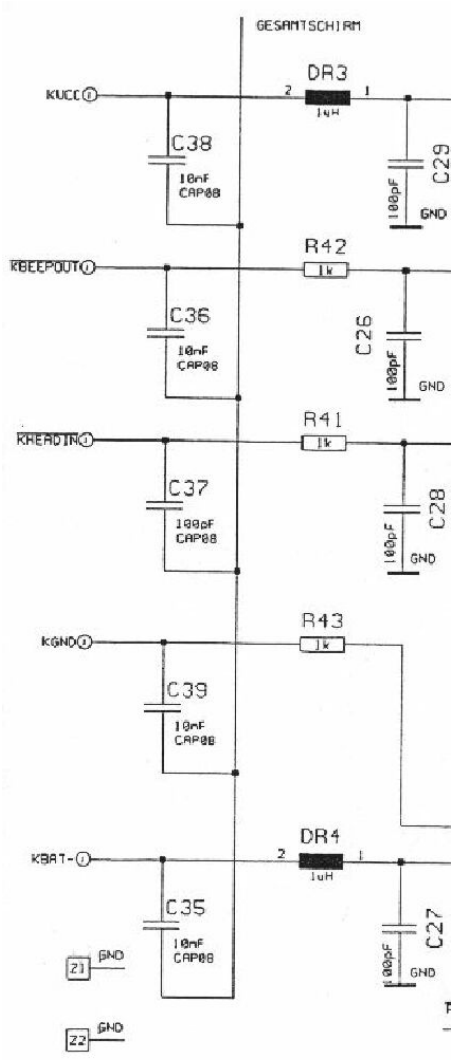


A similar circuit is used in the DTU (800 kHz carrier frequency).

4 Ground system

Following measures were taken to ensure sufficient susceptibility to electrostatic discharge and strong electromagnetic fields as well as low radiation of the device:

- a copper plated foil which is placed flat above the digital board (with the micro-processor and its 6MHz oscillator on it) and which has electrical contact to the board
- a copper plated foil which is wrapped around both digital and analog board being a good screen against electromagnetic fields. All signals and power supplies connected to these boards have coupling capacitors to the screen (see following picture). Resistors or small inductors are used as a barrier for high frequency signals and noise from and to the electronics.



Cross section of Proxi-ESCORTE showing internal screening of the electronics: