Card Games

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1. Introduction

1.1. Smart Cards Basics

Everybody owns at least one of those small plastic cards with its mysterious gold contacts, e.g. cash cards for the current account, insurance cards for the doctor or phone cards. This makes the electronics expert – and owners of BASIC-Tiger® – curious. The BASIC-Tiger® is very useful for experiments with those kinds of data carriers. If you, however, plan to charge your cash card bypassing your bank, we must disappoint you. But we will provide some useful and interesting information concerning smart cards. But first we will give you some details concerning the data carrier's structure:

Inside the inconspicuous flat smart cards there is real high-tech electronics. But only the sometimes different looking contact areas are visible from the outside (figure 1).

Fig. 1 A standard phone card

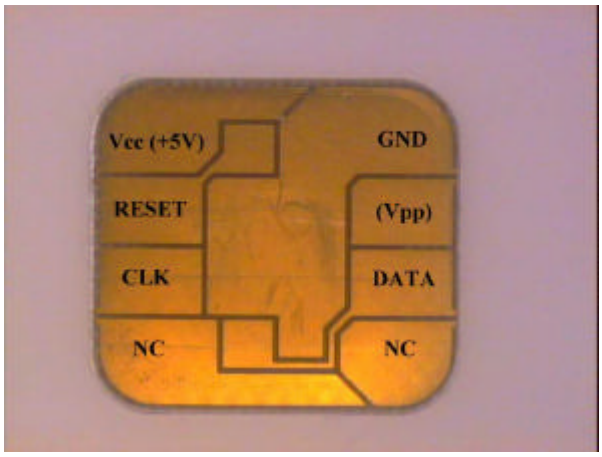

Fig. 2 Standard contact configuration

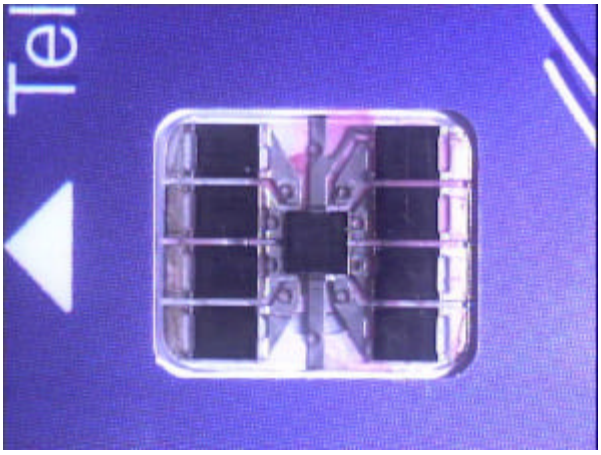

Fig. 3 The integrated chip

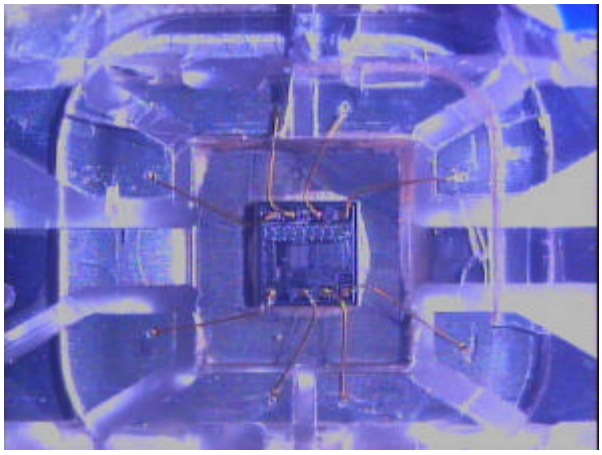

Fig. 4 The chip and its bond wires

Despite the different geometrics the smart cards' contact areas are always at the same place. Currently there are 8 contact areas, 2 of which are usually not connected and sometimes do not exist at all. The contact configuration is shown in figure 2.

Right under the middle of the contact area there is a chip applied at the back, which is connected to the single contacts via bond wires. This is integrated in a card which is about 1 mm thick (figures 3 and 4). The integrated chip has several function groups, e.g. at least one serial interface for communication with the card reader, an EEPROM for non-volatile saving of data, modules for processing the supply voltage and protective facilities against electrostatic electricity. But there are also cards with whole micro computer systems, i.e. processor, RAM, ROM, EEPROM etc.

Depending on the task there are many versions of smart cards. Simple versions use some logic and an EEPROM for saving data; the more complex ones have a complete micro controller in addition. The phone card is one of the so-called synchronous cards; a cash card is an asynchronous smart card. Despite the differences in communication the principle always remains the same. After inserting the card, a card reader will confirm the contact, which applies the operating voltage of +5V to the card's VCC connection and starts the evaluation electronics. The external electronics and, if necessary, the software provides a reset impulse at the RST connection (this is where the differences in communication start). The smart card clock connection CLK is given a clock frequency, the smart card's chip provides one bit of the saved information with every clock impulse at data pin I/O.

1.2. Smart cards for "personal use"

All smart cards mentioned above are more or less externally controlled; most data are protected, which is evident in the case of cash or insurance cards. But there already are chip cards which can be accessed and even be written on freely. Those smart cards also have EEPROM's of different sizes and communicate with their environment via an ordinary I^2C interface.

Those chip cards a perfect for our purposes. Apart from a contacting facility and some simple discrete components not much more hardware is needed to work with the card. In the next chapter we will present, how it works. But before, we will make some considerations on using I^2C smart cards with the BASIC-Tiger®. What could we use such smart cards together with the BASIC-Tiger® for? Does it make sense to extend the sufficient memory (both RAM and ROM!) externally? Even the smallest Tiger has a huge ROM compared to smart cards. And the ROM can also be used for saving non-volatile data. So here are some suggestions how to use an external smart card memory in a useful way.

Parameter input for an existing program

When changing program parameters BASIC-Tiger® users are often confronted with the situation that they have to activate the BASIC-Tiger® software, to remove the Tiger from its circuitry (if necessary) and to load the new program. If you, for instance, constructed a function generator with self-made functions or a pattern generator with permanently changing bit patterns, the function or the bit pattern could be provided by the smart card, which you can exchange, if needed. This is probably interesting for many users.

Access control

Nowadays smart cards are also used for access control in the electronically secured world. What about designing such a system yourself with a BASIC-Tiger®? Write data of your choice onto your smart card, e.g. add a code word. A BASIC-Tiger® program reads the inserted smart card and checks the code word. This could open a door, start your PC or any other device. If you use several cards, different data of different card owners could be used for time registration (who used the phone/computer at what time?). Like this small companies can use this method to implement a professional time and presence registration system.

Capture data of a measurement system

Imagine you constructed a stand-alone measurement system that measures e.g. the temperature somewhere every hour. In this case it would be useful if the data could be saved on the smart card at the touch of a button. You could take the smart card and read it with another device.

2. Hardware

2.1. Components

First of all you need a smart card. Smart cards of different memory sizes are available e.g. at Conrad Electronic (www.conrad.de).

2Kbit	sufficient for small applications (order no. 96 78 15-11)
16Kbit	with our EEPROM 24LC16B (order no. 97 29 24-11)
64Kbit	for large projects (order no. 97 29 67-11)

You can also experiment with the discrete I^2C-EEPROM 24LC16B.

24C16 (order no. 16 09 97-11)

For details on the EEPROM 24LC16B in smart cards please see the data sheet which is also available at Conrad's:

http://www.produktinfo.conrad.de/datenblaetter/900000-999999/972924-da-01-en-I2C-Chipcard_16KBIT.pdf

A contacting facility for the smart cards is also required. It is the easiest way to buy a standard component, as provided by ELV Elektronik (figures 5 and 6 – with inserted phone card).

ELV Elektronik
Postfach
26787 Leer Tel.: 0491 600888 Internet: http://www.elv.de order no. 50-160-92

Fig. 5 Amphenol card adapter

Fig. 6 Soldering contacts on the back

2.2. Circuitry

Wiring the smart card adapter is simple. Basically you only need two lines apart from operating voltage and ground to control an EEPROM (and therefore a smart card) via the I^2C interface. In this case the I^2C interface of the BASIC-Tiger® (version 4) is not automatically derived from the pins L1-0/I2C data and L1-2/I2C clock, but from the 3 BASIC-Tiger® pins which are determined by the BASIC function I2C_SETUP (see I2C example program I2C_SETUP). In the underlying example we use lines L70, L71 and L72, which are connected to the EEPROM 24LC16B and structurally identical versions as follows: Both vertical lines

Clock and Data are the two standard lines of the I²C bus system. Here further I²C components can be connected, if necessary. Those have different addresses, depending on the version. Our EEPROM has the version address 1010XXXXb.

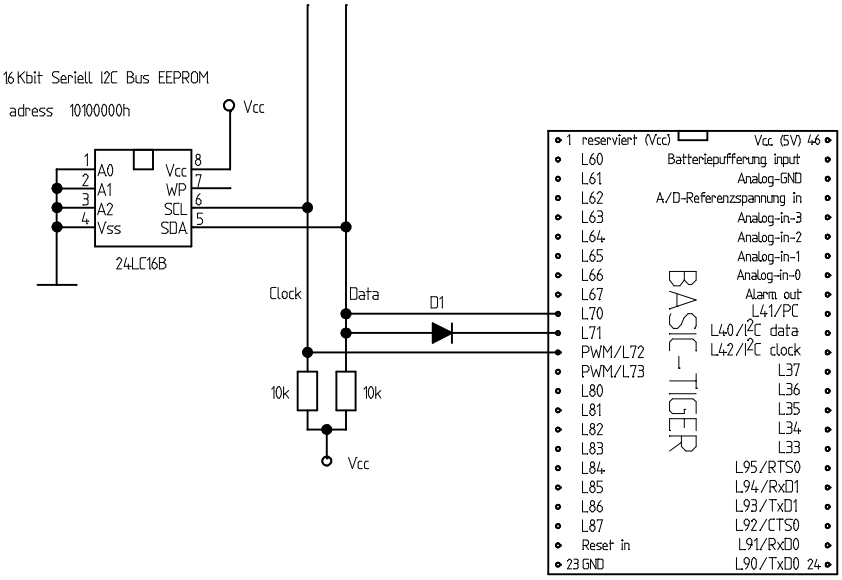

Fig. 7 Connection of the 16Kbit-EEPROMs and its I²C interface and a BASIC-Tiger®

But actually we plan to control a smart card. To achieve this simply apply Vcc, Vss, DATA and CLK (called Data and Clock in fig. 7) to the according contacts of the smart card adapter (see figure 2!). Connections Vpp and Reset can remain open in this application. The same applies to the connections which are supposed to switch the operating voltage when inserting the card into the adapter.

3. Using smart cards

3.1. Interaction with the PC

We cannot deal with all aspects concerning the interaction of smart cards and BASIC-Tiger® in detail in this application note. So we concentrate on the simple version: Writing on I²C smart cars and reading them. The software presented in chapter 3.2. consists of two BASIC-Tiger® programs which exactly do this. They are based on Wilke's example program I2C2416.TIG. If you want to read the 2048 bytes from the EEPROM 24LC16B or from the according smart card, the standard Plug-and-Play-Lab display will not be sufficient any more. Therefore we will use another method to display large amounts of data. The memory content is read page-by-page (256 bytes each) from the smart card to the BASIC-Tiger® and then transferred to the PC via the serial interface. This requires a terminal program. Both Windows 3.1 and Windows 95/98 provide such utilities. They are more or less convenient for reading data from the serial interface and display them. For the underlying application the author uses

the Windows 3.1 terminal program TERMINAL.EXE, which also runs under Windows 95 without any restrictions and independently, i.e. you can copy and run TERMINAL.EXE, which is attached to this application note, anywhere. Before starting data transfer, the interface parameters have to be set. Via Einstellungen -> Datenübertragung (Settings -> Data transmission) you get to the menu shown in figure 8, which is used for setting the parameters valid for the BASIC-Tiger® software. Finally you have to set the buffer size under Einstellungen -> Terminal-Einstellungen (Settings -> Terminal settings) at bottom right to 300 lines (figure 9), so you can watch the whole smart card's content.

In the program EEPROM_L the serial interface SER1 is used, which is the same that is used for programming the BASIC-Tiger®. Therefore the interface cable can stay in the same place. However, you will have to close the terminal program before programming the BASIC-Tiger® and vice versa, because both access the same interface.

After those preparations the terminal program is ready to receive data from the BASIC-Tiger®. Before transmitting new data you can delete the terminal program's buffer (and therefore the display on the monitor) with Bearbeiten -> Puffer löschen (Edit -> Erase buffer).

The result will be a complete hex dump of the EEPROM content. The 8 EEPROM pages are outputted with space in between as both hexadecimal values (left) and the according ASCII characters (right).

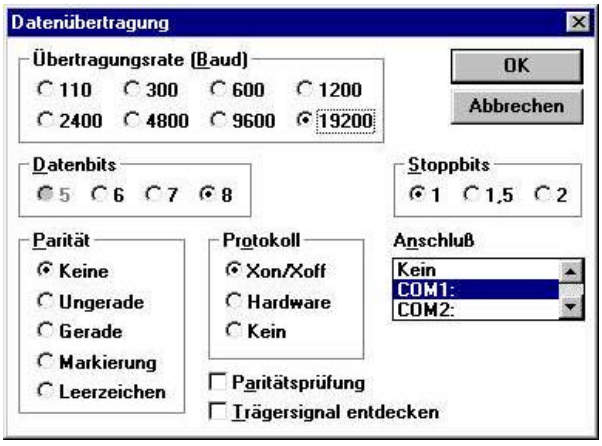

Fig. 8 Serial interface parameters

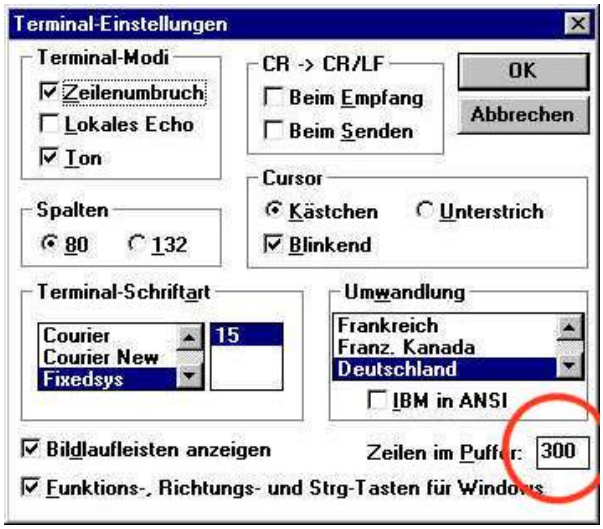

Fig. 9 Set buffer to 300 lines

3.2. BASIC-Tiger® Software

We present two simple programs, which are specialised to read from (EEPROM_L) and write to (EEPROM_S) an EEPROM 24LC16B. Visualisation is done, as mentioned above, via serial interface and terminal program TERMINAL.EXE on the PC.

Have fun experimenting with the I^2C smart cards. The hardware as well as the presented routines allow approaching the technology of other smart cards, too.