Documentation to the EPC537 NIM Process CONTROLLER

Contents

I. stairs

1. Hardware

The EPC537N NIM Microcontroller module puts a multiplicity of universally applicable configuration features at the disposal, which can be used depending upon requirement totally or partly to the user. The compilation took place with the target to support both purely similar and digital applications. The configuration is limited mainly by the available workstation on the front plate of a 1/12-NIM-Einschubs with the use the common sockets of the series of NIM CAMAC S00.

1,1 configuration features

An outline of the available " features " of the hardware gives the following enumerating:

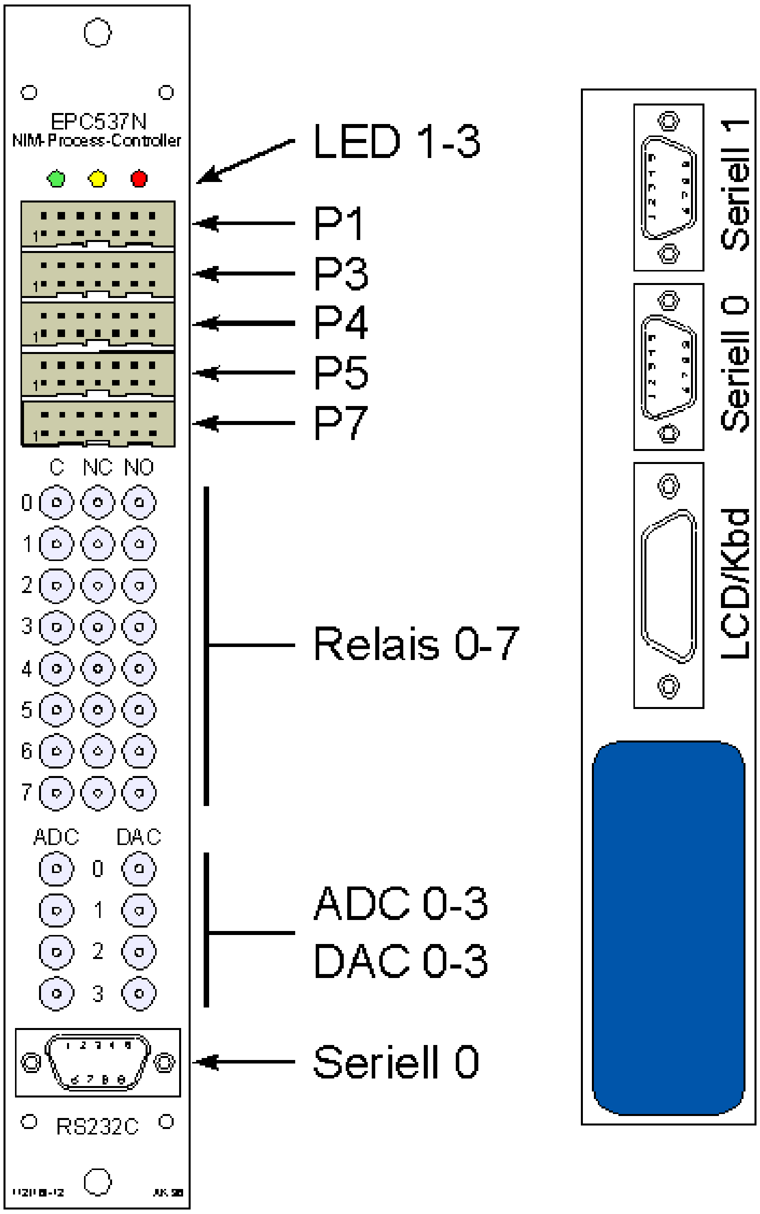
- 5 freely available of TTL port at the front plate:

Port NR.	Function
P1	8-bit-bi-directional I/O
P3	4-Bit-Bidirektionale I/O, INTERRUPT
P4	8-bit-bi-directional I/O
P5	8-bit-bi-directional I/O
P7	8-Bit-Inp/ADC

- 8 relays 1xUm with ACMcAcC EURONORM S00-Buchsen
- 4 ADC inputs with 12 bits dissolution
- 4 DAC outputs with 12 bits dissolution and 50 ohm drivers
- 2 serial RS232C interfaces
- Link for LCD/FUNCTION key module
- With back-up battery real-time clock with calendar
- EEPROM 64x16Bit
- Base for extension by 32kByte RAM and 32kByte EPROM

1,2 plug arrangement and steckerbelegung

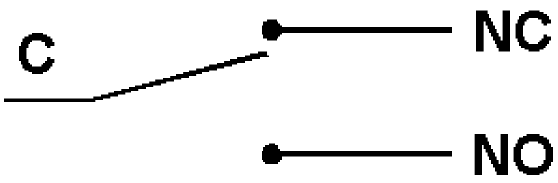
The following figures show the position of the plug connectors at the front plate and at the rear side of the NIM CONTROLLER. The defined links are continued to describe in the link.



The light emitting diodes LED1 - LED3 are freely programmable, however them use the inserted monitor often commodity in a determined way: After the start of the monitor program only LED1 lights up (green). If instruction are executed, then additionally LED3 (red) lights up, in order to display the Busy status of the CONTROLLER. The allocation the processor port P1, P3, P4, P5 and P7 is summarized in the following table. The port lines are directly connected with the links of the SAB80C537 Microcontrollers. Many of the lines can be connected apart from the use as simple of TTL I/O port with more complex functions in the Microcontroller (e.g. INTERRUPT, Capture/Compare, timer, Counter...). For more exact information over the respective meaning and mode of operation Siemens is referred to the appropriate data books of the company.

Pin	P1	P3	P4	P5	P7
1	P1.0	Vcc(+5V)	P4.0	P5.0	P7.0/ADC
2	Gnd	Gnd	Gnd	Gnd	Gnd
3	P1.1	Vcc(+5V)	P4.1	P5.1	P7.1/ADC
4	Gnd	Gnd	Gnd	Gnd	Gnd
5	P1.2	P3.2	P4.2	P5.2	P7.2/ADC
6	Gnd	Gnd	Gnd	Gnd	Gnd
7	P1.3	P3.3	P4.3	P5.3	P7.3/ADC
8	Gnd	Gnd	Gnd	Gnd	Gnd
9	P1.4	P3.4	P4.4	P5.4	P7.4/ADC
10	Gnd	Gnd	Gnd	Gnd	Gnd
11	P1.5	P3.5	P4.5	P5.5	P7.5/ADC
12	Gnd	Gnd	Gnd	Gnd	Gnd
13	P1.6	Vcc(+5V)	P4.6	P5.6	P7.6/ADC
14	Gnd	Gnd	Gnd	Gnd	Gnd
15	P1.7	Vcc(+5V)	P4.7	P5.7	P7.7/ADC
16	Gnd	Gnd	Gnd	Gnd	Gnd

Port the P1, P3, P4 and **P5** can be used as output input and output for TTL signals. If an input is to take place of port line, then the output register of the appropriate port at the bit position of the line must indicate a " 1 ". In this way it is possible to use output input and output on a port mixed.
Port P7 can be used for TTL signals only as entry port. Additionally the processor-internal ADC (8+2 bits dissolution) uses these lines for the measurement of voltages, why the lines of P7 are decoupled by an inserted input operation amplifier also. The voltage to all port must be situated within the operating voltage area of the Microcontrollers (Gnd - 5.0V), in order to avoid destruction of the CONTROLLER.
The wiring of the eight **relays** , which indicate a nominal contact rating of 1.0A/30V and a max. permanent current of 2.0A, can be inferred from the following sketch. It concerns eight independently adjustable two-way contacts with a resting (numerical control) and a make contact (NO).



The four 12-Bit **of ADC inputs ADC 0-3** indicate an input voltage section of 0.00V - 5.00V and an input impedance of 1kOhm. They are decoupled and against overvoltage protected by one operation amplifier each. The signal of all four channels can be transferred by the use of four separated ADCs parallel and thus at the same time to those the ADCs upstream T/H levels.
Likewise a voltage range of 0.00V - 5.00V take the four separated adjustable 12-Bit off **of DAC outputs DAC 0-3** . These outputs in a the position are by output buffer amplifiers to drive 50Ohm-Lasten.
The serial interface 0 , over which the monitor program of the NIM CONTROLLER is served, is accessible at the front plate and at the rear side of the module. Only the signals TxD and RxD are used, the lines DSR and DTR or RTS and CTS are connected in each case. The 9-polige plug points the generally usual allocation to (2=RxD, 3=TxD, 5=Gnd).
The serial interface 1 , which is available only at the rear side of the module, indicates the same pin allocation as the interface 0. The software does not make use of this interface, it in the standard version can however by user programs be used.
The link for the LCD/Kbd module is herausge at the rear side of the module leads and indicates the lines necessary for the control of an LCD with function keys.

2. Software

The inserted software of the NIM CONTROLLER is inevitably very generally held, since the CONTROLLER should be universally usable and the special task from application can be different to application.

2,1 configuration features

The following list of the " software features " gives a short overview of the characteristics of the inserted EPC monitor program, with whose assistance of the NIM CONTROLLER can be served:

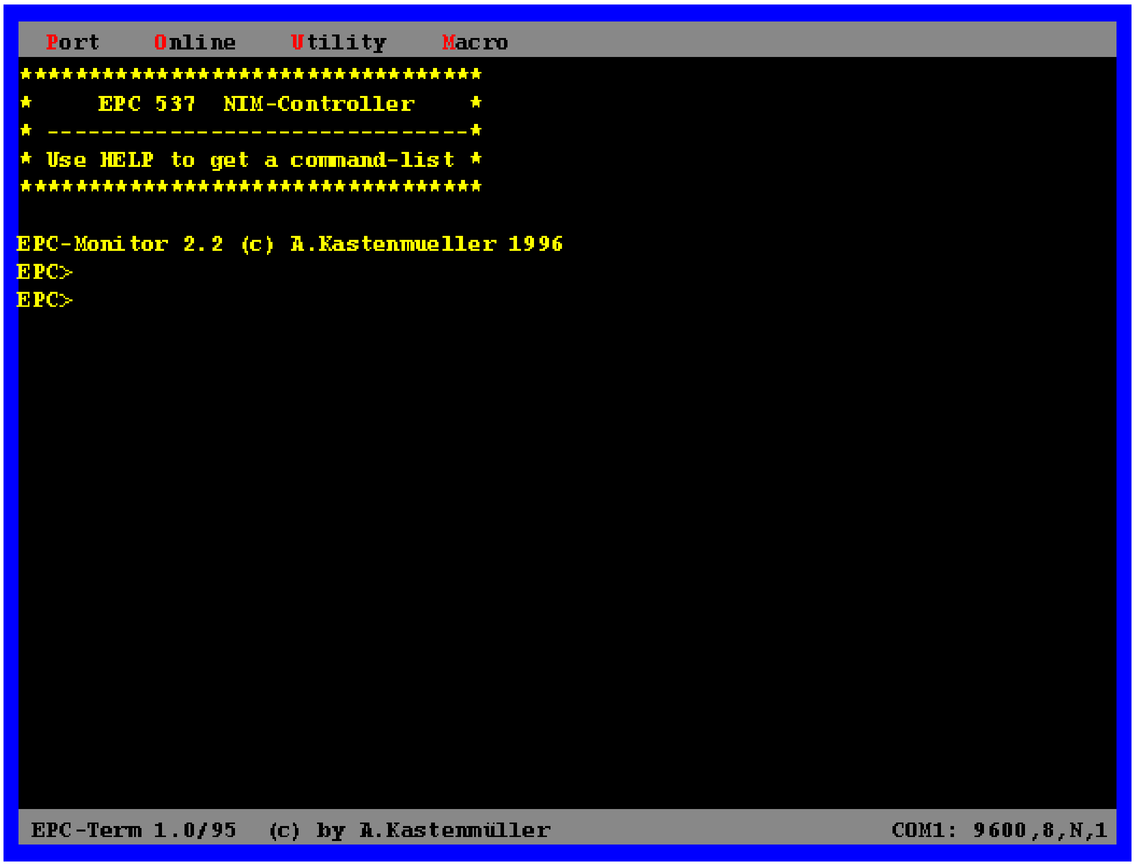
- Communication with each text terminal over the serial interface
- Operation with simple text commands
- Access to all processor port
- Access on the entire program and memories
- Command for the setting/resetting of the relays
- Simply reading from ADC values and setting of the DAC output voltage
- Access to the real-time clock and the EEPROM
- Possibility for the control of an LCD/FUNCTION key module
- Module concept for the extension of the inserted software
- Autostart possibility for software in the extension module
- UP/DOWN load functions for software development
- Revealed BIOS Einsprungadressen for the integration of BIOS routines into own programs

2,2 operation

The EPC monitor program is served by means of text commands, which are transmitted to the serial interface 0 of the CONTROLLER. The controlling computer needs only a serial interface with the signals TxD, RxD and Gnd. The link effected usually with one sucked. Modem eliminator cable, which exchanges the lines TxD and RxD. For transferring the commands and for the output of the return values of the EPC of monitor almost any terminal program can be used. The interface 0 of the NIM CONTROLLER is initialized with the RESET (= switching on on) by the EPC monitor on the following adjustment:

9600 Baud, 8, N, 1

Since the EPC monitor sends the received characters back to the interface, local echo **must** be stopped in the terminal program **to** off. When switching on on the monitor program announces itself with the following output, before it transmits and **for >** instruction inputs waits command-promptly the EPC:



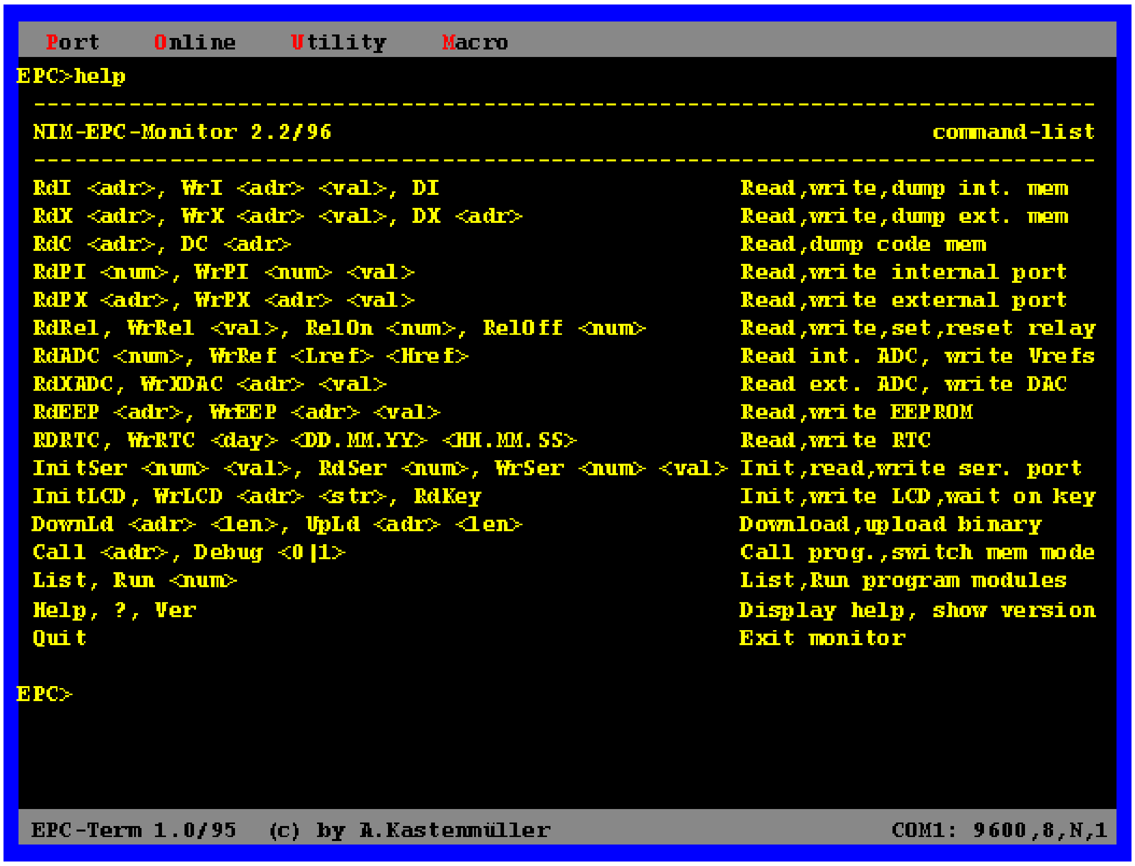
Now commands at the NIM CONTROLLERS can be transmitted, whereby independently of the respective command the following applies:

- The EPC monitor does not differentiate between small and capital letters.
- The max. length of the input buffer amounts to 32 characters. Longer command lines are not assumed or are not analysed.
- < RETURN > arranges the analysis and execution of the input command. < If RETURN > was not transmitted yet, then the Komman DO with backspace < can > be edited.

Depending upon purpose of the command one or more parameters must be indicated after the command, whose general structure in paragraph II is described. In the following some simple instruction and their parameter are only pointed as " entrance ", without being received to all possibilities in the detail.

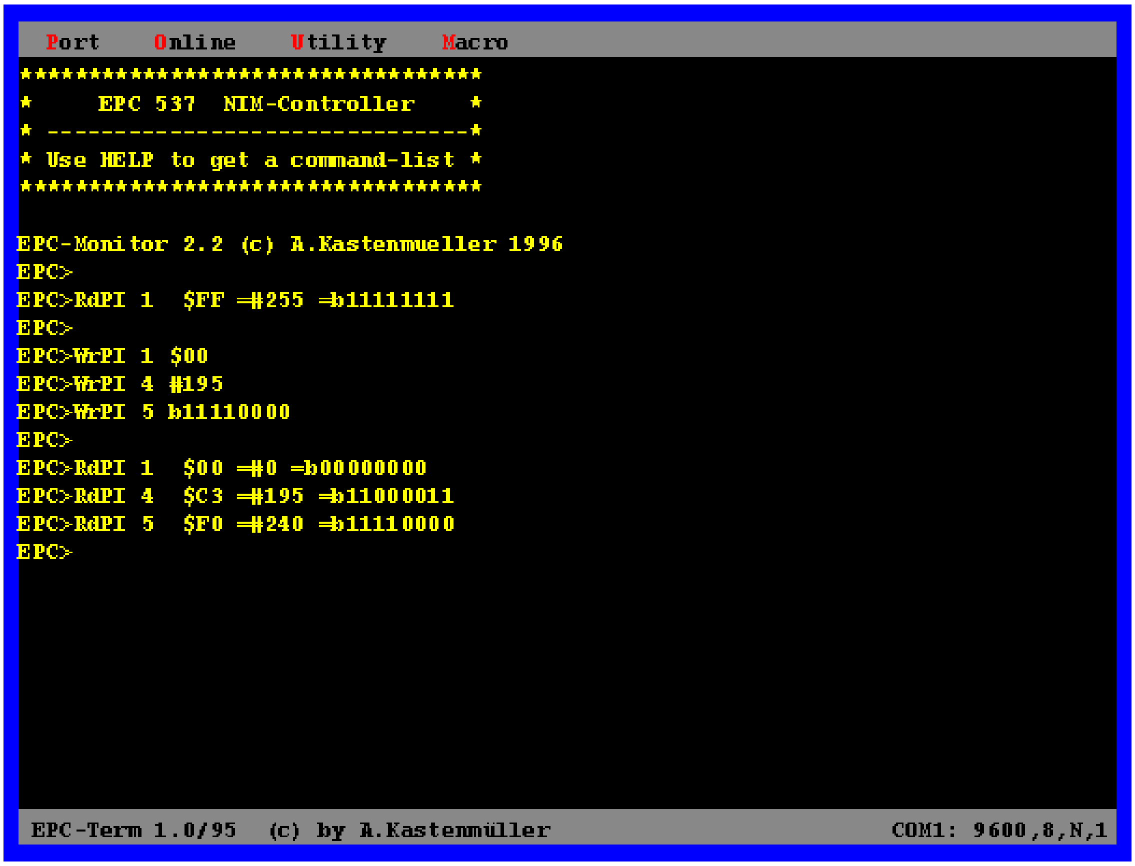
2,3 selection of fundamental commands

One of the simplest commands without additional parameters is the HELP - command, also by in ? to be abbreviated can. It arranges to output the monitor a short overview of all available commands:

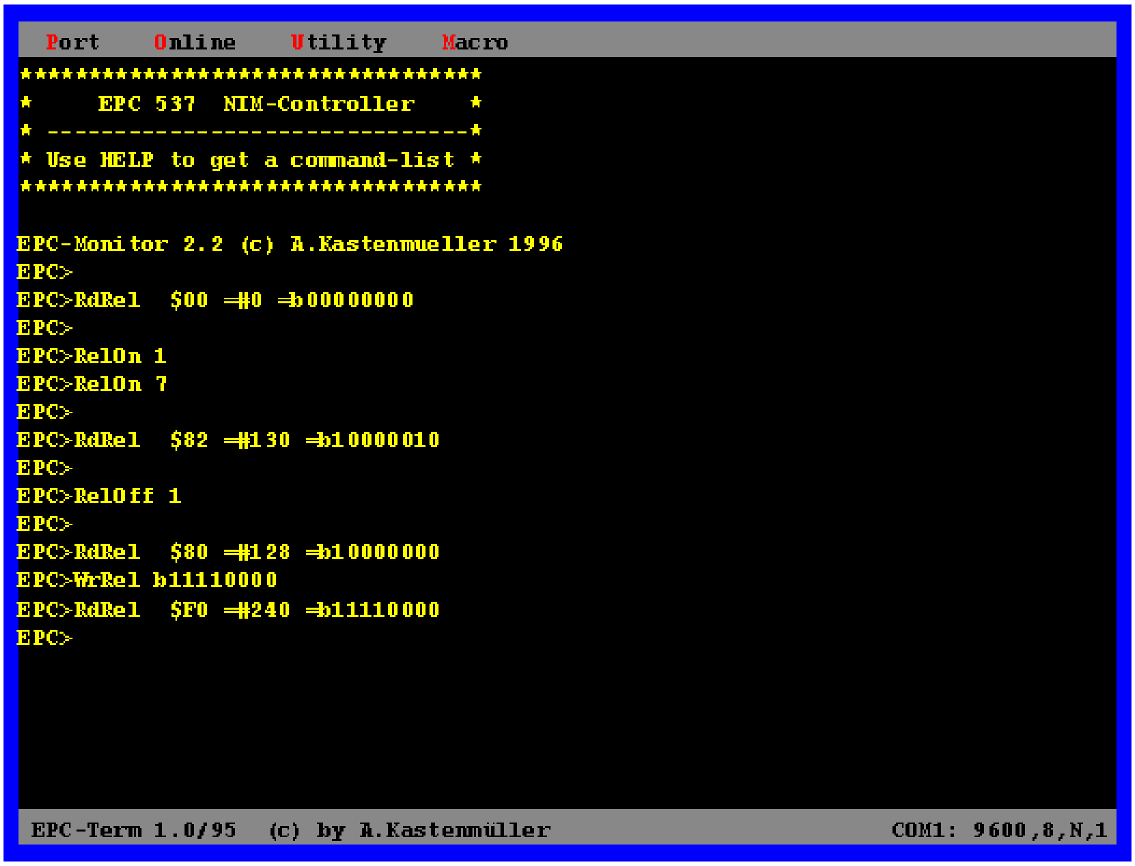


```
 Port    Online    Utility    Macro
EPC>help
 ------------------------------------------------------------------------
 NIM-EPC-Monitor 2.2/96                                      command-list
 ------------------------------------------------------------------------
 RdI <adr>, WrI <adr> <val>, DI                  Read,write,dump int. mem
 RdX <adr>, WrX <adr> <val>, DX <adr>            Read,write,dump ext. mem
 RdC <adr>, DC <adr>                             Read,dump code mem
 RdPI <num>, WrPI <num> <val>                    Read,write internal port
 RdPX <adr>, WrPX <adr> <val>                    Read,write external port
 RdRel, WrRel <val>, RelOn <num>, RelOff <num>   Read,write,set,reset relay
 RdADC <num>, WrRef <Lref> <Href>                Read int. ADC, write Vrefs
 RdXADC, WrXDAC <adr> <val>                      Read ext. ADC, write DAC
 RdEEP <adr>, WrEEP <adr> <val>                  Read,write EEPROM
 RDRTC, WrRTC <day> <DD.MM.YY> <HH.MM.SS>        Read,write RTC
 InitSer <num> <val>, RdSer <num>, WrSer <num> <val> Init,read,write ser. port
 InitLCD, WrLCD <adr> <str>, RdKey               Init,write LCD,wait on key
 DownLd <adr> <len>, UpLd <adr> <len>            Download,upload binary
 Call <adr>, Debug <0|1>                         Call prog.,switch mem mode
 List, Run <num>                                 List,Run program modules
 Help, ?, Ver                                    Display help, show version
 Quit                                            Exit monitor

EPC>

 EPC-Term 1.0/95  (c) by A.Kastenmüller                   COM1: 9600,8,N,1
```

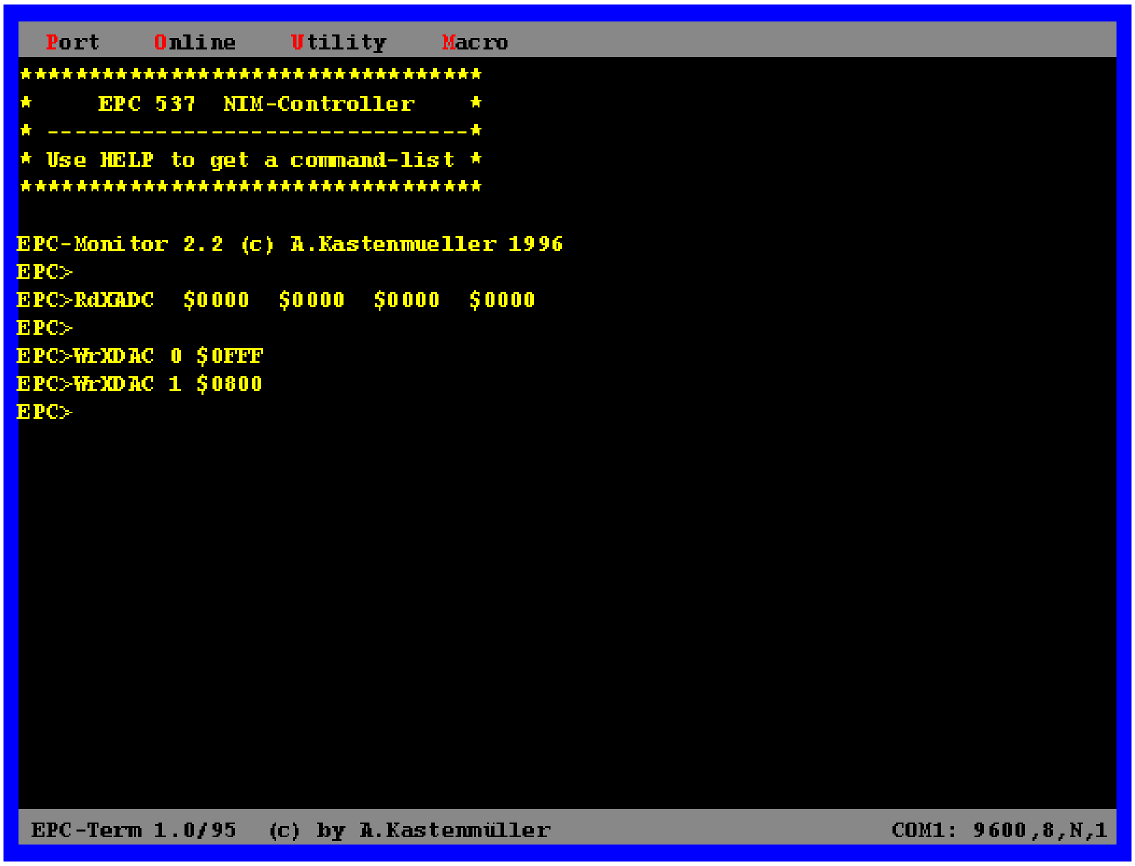
For the control the internal processor port available at the front plate **the instruction RdPI and WrPI serve P1** , **P3** , P4, P5 and P7 . With RdPI one can be read in the port, whereby the number of the desired port is indicated by a blank separately behind the command. The result of the reading operation is output directly behind the instruction. For the use of the port as entry port the appropriate output registers must be set however before to " 1 ". This occurs in similar way with the instruction WrPI , which is used also for the output by TTL signals. Beside the port number must here additionally the output value in decimally (Prefix #), hexadecimal (Prefix $) or binary (Prefix b) form to be indicated. The use of RdPI and WrPI shows the following example:



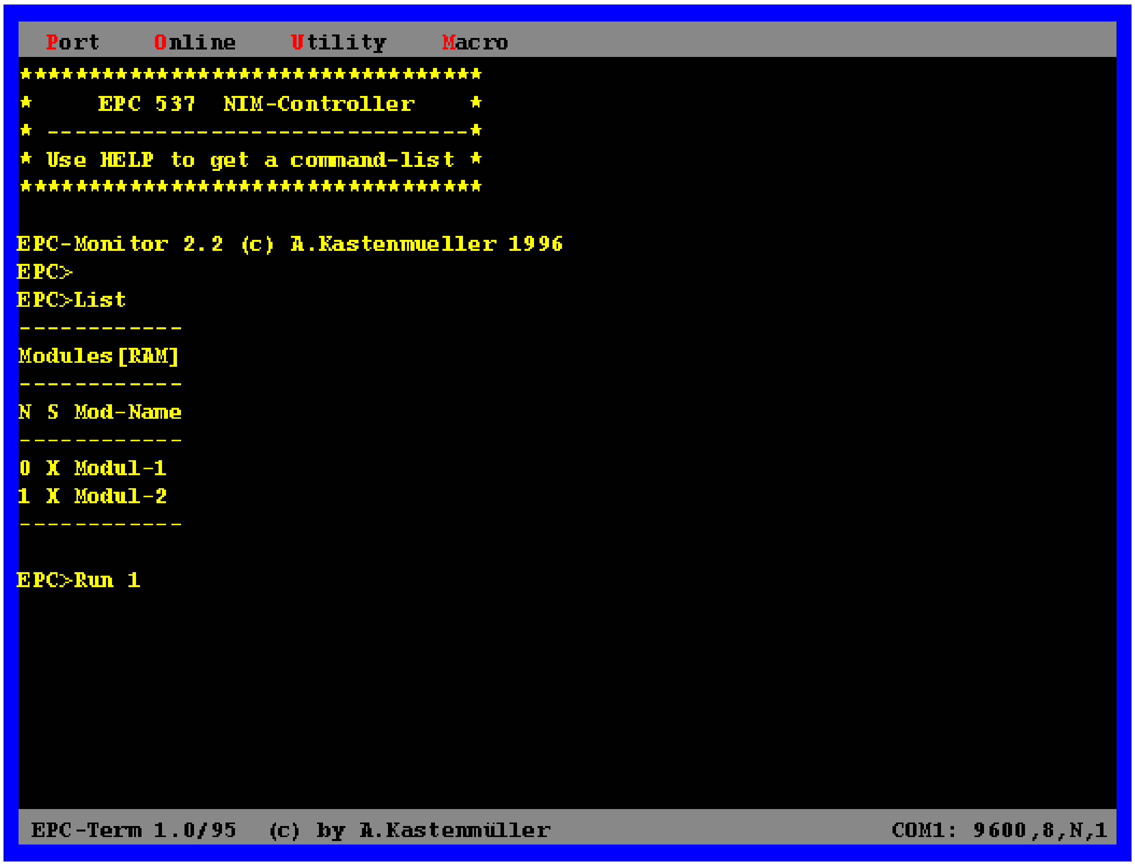
Likewise at the front plate accessible relays (0-7) can individually with RelOn or. RelOff or together with WrRel geschalten become. The status of the 8 relays can be queried at any time by the instruction RdRel. The commands RelOn and RelOff need the number of the desired relay, RdRel and WrRel as parameters in each case behave similarly as the instruction already described for heading for the internal port:



Beside the relays the NIM CONTROLLER offers also ever four 12-Bit of ADC inputs and 12-Bit of DAC outputs, which are served by the monitor instruction RdXADC and WrXDAC. By means of RdXADC at the ADC channels 0-3 a A/D transformation is executed and the transformation result immediately after it in hexadecimal notation is output on all four channels (0,1,2,3). There is thus no parameters necessarily. For setting an DAC output voltage with WrXDAC however the DAC number (0-3) must and the desired value as Word in hexadecimal notation to be indicated:



The use of completing program modules, which can be prepared by the user (see for this paragraph II 3.), by the monitor program by the instruction CUNNING and RUN are supported. CUNNING supplies an outline of the at present available program modules with number (N), status (s) and name of the module. A certain module can be started by input of RUN followed by the number of the desired module.



II. EPC monitor command reference

1. General remarks on the EPC monitor

The EPC monitor is served over the serial interface 0 the SAB80C537-Microcontrollers. For communication with PC or another controlling computer almost any terminal program can be used, be used there commands, parameters and outputs of the EPC monitor only ASCII character. The interface of the EPC80537 is initialized with the RESET by the EPC monitor on the following adjustment:

9600 Baud, 8, N, 1

Since the EPC monitor sends the received characters back to the interface, local echo **must** be stopped in the terminal program **to** off.

1,1 starting procedure of the EPC monitor

After the initialization the EPC monitor checks whether a program module is available starting from the address $8000 in the EPROM and this the status " autostart " has. In the EPROM if no program module is found, then the EPC monitor in the RAM looks $8000 up starting from address for an autostart module. If an autostart module was found, after a time delay of approx. 5s, which gives the possibility to the user to abort by an input over the serial interface the starting procedure that is started found module. Contained neither the EPROM nor RAM the valid autostart module, then directly command-promptly of the EPC monitor appears.

1,2 command line of the EPC monitor

- The EPC monitor announces itself with that command-promptly to EPC >
- The max. length of the input buffer amounts to 32 characters. Longer command lines are not assumed or are not analysed.
- The EPC monitor does not differentiate between small and capital letters.
- `< RETURN >` arranges the analysis and execution of the input command. `< If RETURN >` was not transmitted yet, then the command with backspace `< can >` be edited.

1,3 form of the command parameters

- Parameters are separated by blanks or comma. Directly behind the command (at least) a blank must be.

- **Num parameters** consist of an individual hexadecimal digit

  Scope: 0 - F

- **Byte parameters** can be input decimally, in hexadecimals or binary. Which base was used, by a prominent character one determines.

  Scope: 0 - 255 (decimally)

Format	Example
binary	b10100011
decimally	#237
in hexadecimals	$1f

- **Word parameters** are indicated basically only in hexadecimal notation.

  Scope: 0000 - FFFF (in hexadecimals)

  Example: $$F6C9

- **Other parameters** are described in each case with the appropriate instruction.

1,4 return values of the EPC monitor

- Individual memory contents are returned in each case in hexadecimal notation.
- Dump commands output in each case 256 bytes starting from the indicated start address, whereby in each case 16 byte per line in hexadecimals and as ASCII characters is represented. Bytes, whose value is smaller $20, are replaced by one point.
- Postage stops are returned in hexadecimal, decimal and binary notation.

2. Command of the EPC monitor

RdI

READ from internal RAM

Description: Reading from data from the internal RAM of the 80C537

Format: RdI < *address* > $_{\text{byte Par}}$

Parameter: Address $00-$ff

WrI

Write to internal RAM

Description: Writing of data in internal RAM of the 80C537

Format: WrI < *address* > $_{\text{byte Par}}$ < *value* > $_{\text{byte Par}}$

Parameter: Address $00-$ff
Worth $00-$ff

DI

Dump internal RAM

Description: Reading and representing of all contents internal RAM of the 80C537 in hexadecimal and ASCII form

Format: DI

RdX

READ from external RAM

Description: Reading from data from the external RAM of the 80C537

Format: RdX < *address* > $_{\text{Word Par}}$

Parameter: Address $0000-$ffff

WrX

Write to external RAM

Description: Writing of data in external RAM of the 80C537

Format: WrX < *address* > $_{\text{Word Par}}$ < *value* > $_{\text{byte Par}}$

Parameter: Address $0000-$ffff
Worth $00-$ff

DX	Dump external RAM

Description: Reading and representing from 256 bytes external RAM of the 80C537 in hexadecimal and ASCII form

Format: DX < *address* > $_{\text{Word Par}}$

Parameter: Address $0000-$ffff

RdC	READ from code MEMORY

Description: Reading from data from the program memory of the 80C537

Format: RdC < *address* > $_{\text{Word Par}}$

Parameter: Address $0000-$ffff

DC	Dump code MEMORY

Description: Reading and representing from 256 bytes of the program memory of the 80C537 in hexadecimal and ASCII form

Format: DC < *address* > $_{\text{Word Par}}$

Parameter: Address $0000-$ffff

RdPI	READ from internal port

Description: Reading from data of an internal processor port of the 80C537

Format: RdPI < *port NR* > $_{\text{Num Par}}$

Parameter: Port NR 0-8

WrPI	Write to internal port

Description: Writing of data into an internal processor port of the 80C537

Format: WrPI < *port NR* > $_{\text{byte Par}}$ < *value* > $_{\text{byte Par}}$

Parameter: Port NR 0-6
Worth $00-$ff

RdPX

READ from external port

Description: Reading from data of an external port of the EPC80537 with MEMORY mapped I/O within the range of $$FF00-$FFFF

Format: RdPX < *address* > $_{\text{byte Par}}$

Parameter: Address $00-$ff (accordingly $$FF00-$FFFF)

WrPX

Write to external port

Description: Writing of data into an external port of the EPC80537 with MEMORY mapped I/O within the range of $$FF00-$FFFF

Format: WrPX < *address* > $_{\text{byte Par}}$ < *value* > $_{\text{byte Par}}$

Parameter: Address $00-$ff (accordingly $$FF00-$FFFF)
Worth $00-$ff

RdEEP

READ from EEPROM

Description: Reading from data from the EEPROM

Format: RdEEP < *address* > $_{\text{byte Par}}$

Parameter: Address $00-$ff (dependent on the EEPROM type)

WrEEP

Write to EEPROM

Description: Writing of data into the EEPROM

Format: WrEEP < *address* > $_{\text{byte Par}}$ < *value* > $_{\text{Word Par}}$

Parameter: Address $00-$ff (dependent on the EEPROM type)
Worth $0000-$ffff

RdRTC

READ really time Clock

Description: Reading from date and time-of-day from the real-time clock

Format: RdRTC

WrRTC

Write to really time Clock

Description: Writing of date and time-of-day into the real-time clock

Format: WrRTC < *weekday* > $_{\text{Num Par}}$ < *date* > $_{\text{TT.MM.JJ}}$ < *time-of-day* > $_{\text{HH.MM.SS}}$

Parameter: Weekday 0-6 (0=So, 1=Mo... 6=Sa)
Date TT.MM.JJ (firmly given format)
Time-of-day HH.MM.SS (firmly given format)

RdRel

READ Relay status

Description: Reading of the relay status

Format: RdRel

WrRel

Write Relay status

Description: Writing of the relay status as 8-bit word

Format: WrRel < *value* > $_{\textit{byte Par}}$

Parameter: Worth $00-$ff bit pattern for relay status

RelOn

Relay on

Description: Switch on a relay

Format: RelOn < *relay NR* > $_{\text{Num Par}}$

Parameter: Relay NR 0-7

RelOff

Relay off

Description: Switch off a relay

Format: RelOff < *relay NR* > $_{\text{Num Par}}$

Parameter: Relay NR 0-7

WrRef

Write ADC Reference volume daily

Description: Adjust that reference reference now genereference now gene of the internal ADC of the EPC80537

Format: WrRef < *VGnd* > $_{\text{Num Par}}$ < *VRef* > $_{\text{Num Par}}$

Parameter: VGnd 0-C (according to the following table)
VRef 0,4-F (according to the following table)

VGnd/VRefMode	lower reference	upper reference
0	0.0000	5.0000
1	0.3125	-
2	0.6250	-
3	0.9375	-
4	1.2500	1.2500
5	1.5625	1.5625
6	1.8750	1.8750
7	2.1875	2.1875
8	2.5000	2.5000
9	2.8125	2.8125
A	3.1250	3.1250
B	3.4375	3.4375
C	3.7500	3.7500
D	-	4.0625
E	-	4.3750
F	-	4.6875

RdADC

READ ADC Channel

Description: Execute a AD transformation at a ADC channel of the 80C537

Format: RdADC < *channel* > $_{\text{Num Par}}$

Parameter: Channel 0-B (according to P7.0 - P7.7, P8.0 - P8.3)

RdXADC

READ external ADC

Description: Execute a simultaneous AD transformation at the 4 external 12-Bit ADCs

Format: RdXADC

# WrXDAC	**Write to external DAC**

Description: Output of an analog value on one of the 4 external 12-Bit SINCE transducer

Format: WrXDAC < *DAC NR* > $_{\text{Num Par}}$ < *value* > $_{\text{Word Par}}$

Parameter: DAC NR 0-3
Worth \$0000-\$0fff (12-bit value)

# Init LCD	**Initialize LCD**

Description: Initializing and deletion LCD

Format: Init LCD

# WrLCD	**Write to LCD**

Description: Output from text on the LCD

Format: WrLCD < *address* > $_{\text{byte Par}}$ < *text* > $_{\text{stringer}}$

Parameter: Address: \$00-\$ff (address in the memory LCD)
Text: ASCII character (output only in uppercase letters)

# RdKey	**READ key board**

Description: Control rooms on a depressing the key at the LCD/KEY board or a character at Ser0

Format: RdKey

Output: Bit pattern of the pressed keys (bit 0-4)

# InitSer	**Init Serial port**

Description: Adjust the transfer parameter of the serial interfaces of the EPC80537

Format: InitSer < *port NR* > $_{\text{Num Par}}$ < *mode* > $_{\text{Num Par}}$

Parameter: Port NR 0-1
Mode 0-9 (according to the following table)

Mode	Baud rate serial 0	Baud rate serial 1
0	150	-
1	300	-
2	600	-
3	1200	-
4	2400	-
5	4800	4800
6	9600	9600
7	19200	19200
8	-	38400
9	-	57600

WrSer

Write to of Serial port

Description: Transmit a byte at a serial interface of the 80C537

Format: WrSer < *port NR* > $_{\text{Num Par}}$ < *value* > $_{\text{byte Par}}$

Parameter: Port NR 0-1
Worth $00-$ff

RdSer

READ from Serial port

Description: Read a byte of serial Schnittstelledes a 80C537

Format: RdSer < *port NR* > $_{\text{Num Par}}$

Parameter: Port NR 0-1

Downld

Download to external RAM

Description: Load a number of bytes in the binary format to an address in the external RAM of the EPC80537

Format: Downld < *address* > $_{\text{Word Par}}$ < *length* > $_{\text{Word Par}}$

Parameter: Address \$0000-\$ffff
\$0000-\$ffff (number of the bytes) lengthens

Flow: Start of the Downloads after the message " Download active.... "
End after the message " finished Checksum \$\$xx "
The check total is calculated as total of all received bytes without Carry and in hexadecimals output.

Upld	**Upload from external RAM**

Description: Read a number of bytes in the binary format of an address in the external RAM of the EPC80537

Format: Upld < *address* > $_{\text{Word Par}}$ < *length* > $_{\text{Word Par}}$

Parameter: Address \$0000-\$ffff
\$0000-\$ffff (number of the bytes) lengthens

Flow: Start of the Uploads after the message "< CR > for start... "
and transmitting a character without echo.
End after the message " finished Checksum \$\$xx "
The check total is calculated as total of all transmitted bytes without Carry and in hexadecimals output.

Call	**Call to of Program**

Description: Call of a program in the code MEMORY

Format: Call < *address* > $_{\text{Word Par}}$

Parameter: Address \$0000-\$ffff (branch address)

Debug	**SWITCH MEMORY configuration**

Description: Switch the memory configuration between Debug mode (program partly in the RAM) and normal mode (program completely in the ROM/CEprom)

Format: Debug < *mode* > $_{\text{Num Par}}$

Parameter: Mode 0 = normal mode (ROM)
Mode 1 = Debug mode (RAM)

Cunning	**Cunning Modules**

Description: Display the available program modules in the ROM or RAM with number, status and name

Format: Cunning

## Run	**Run Program of modules**

Description: Start a program Modules in the ROM or RAM

Format: Run < *module NR* > $_{\text{Num Par}}$

Parameter: Module NR 0-F

	Version

Description: Output of the program version number of the EPC monitor over the serial interface

Format:

## Help	**Help**

Description: Output of a command outline of all available commands of the EPC monitor

Format: Help or?

## Quit	**Quit EPC monitor**

Description: Terminate the EPC monitor

Format: Quit

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3. Creation of completing program modules

3,1 bases

The EPC monitor supports the supplement of the function range with the commands CUNNING and RUN by user specific modules, which can be produced with different development tools. It must be available only the possibility, when result to assemble or compile a file with object code for a certain address. These max. 16 program modules, which itself in the EPROM (Debug 0) or in (Nonvolatile)RAM (Debug 1) to rule can, begin in each case with a header, which contains information apart from the name and the status of the module also for the concatenation of the modules. The header of the first program module always is at the address $8000 in the EPROM or

RAM. The addresses of the following modules result then in each case from the length of the preceding modules.
In this description with the programming of Microcontrollern one does not deal, which is represented in detail in various drawer books. In particular the CONTROLLERS of the so-called 8051-Serie and their Siemens derivatives (e.g. the used SAB80C537) are topic of a multiplicity of publications.
Only the necessary information is given here, in order to develop successfully with appropriate development tools modules, which can be inserted into the concept of the EPC monitor.

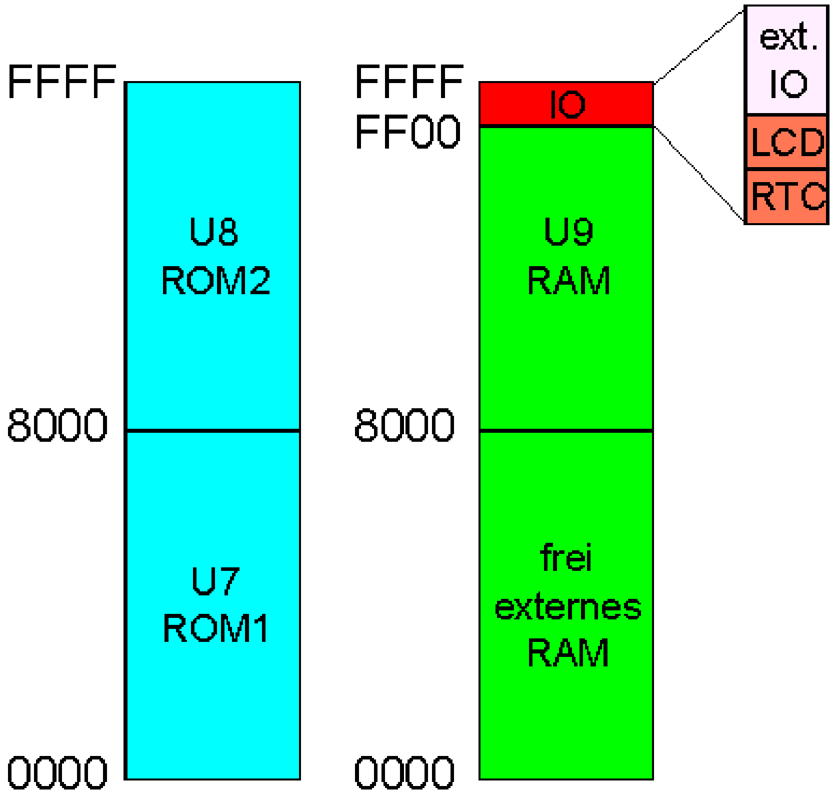
3,2 paging

The memory of the 80C537-Controllers covers 64kByte for program code and 64kByte for data. The address decoding of the CONTROLLER hardware permits a partial over-dazzles these areas, in order to be able to execute programs, which were loaded first in the data area, afterwards. The program memory range from $0000-$7fff is not to the user at the disposal, since this is reserved for the BIOS and the EPC monitor. Within the range of $8000-$ff00 both the program memory knows (EPROM) and the memory (RAM) for program modules to be used. Switching between both areas concerning the position of the program code takes place with the Debug instruction of the monitor.

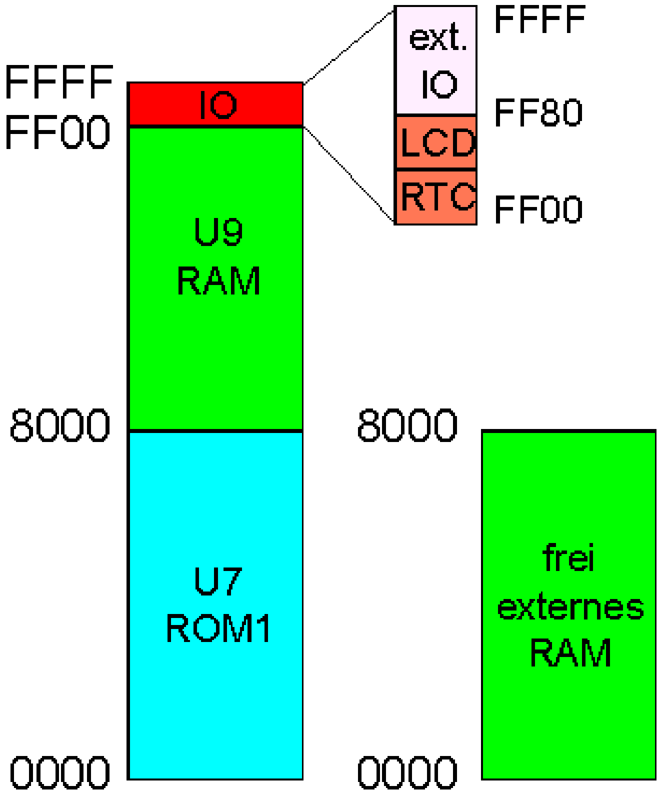
The range from $$FF00-$FFFF the memory is used as port area for the control of hardware components and can be read nor described neither, since any accesses in addresses within this area to I/O accesses are rerouted.

The allocation of the storage areas is shown in the following diagrams:

Image mode (Debug 0): Separate program and memory too for each 64KByte



Debug mode (Debug 1): Insertion RAM ($8000-$ff00) into the program memory



3,3 structure of modules

The program modules are stored as chained list starting from the address $8000 in the memory of the CONTROLLER. Each module receives a special header, which contains a pointer apart from additional information about the module also on the beginning of the following module. The header of a module is 16 byte long and has the following determined structure:

Address	Use	Assertion
00h-01h	Identifier	' AK '
02h	Status	' A ' = autostart ' X ' = Executable
03h	Check total	Check total over the program code, which follows after the header and is calculated up to the value of the pointer after the next module as simple byte total without transfer.
04-05h	Pointer	Pointer on the beginning of the next module header or behind the end of the present module (format: LSB:MSB)
06h	unused	-
07h-0Eh	Text	Text, which is displayed of CUNNING as module name.
0Fh	End label	00h

If the first module (at address $8000) has the status A (autostart), then it is started by the EPC

monitor directly after switching on of the NIM CONTROLLER on, if within 5s a character at the serial interface will not receive. This offers the possibility of using the NIM CONTROLLER with a fixed program without a controlling terminal for determined functions.
The program code must begin directly after the module header, since the call takes place via an LCALL instruction to the offset address $0010 from the beginning of the module header. A return to command-promptly the EPC monitor is possible by an RET instruction in the program code, whereby it must be guaranteed that the stack of the system is again in the initial state. Since the program code is branched to directly, it must be for the respective address assembled or reloziert (e.g. the code for module 0 begins with $8010). This is to be considered in particular with successive modules, whereby for each module also the necessary header must be considered. The simplest possibility of ensuring this is the linkage of all headers and Object files to a file, which afterwards to the address $8000 into RAM of the EPC is loaded or into a 32k-EPROM burned.

An example of a simple module is the following assembler program:

```
;*******************************************************************************
Demo program for a program module, which can be assembled with
TASM;**************************************************************************
last modification:  08.04.1996;    Function:  The middle light
emitting diode is to flash 10x;    # INCLUDE " SFR80537.DEF ";
Mnemonics for SFRs

# INCLUDE " NIMCTRL.EQU ";  Label definitions for BIOS routines

ModStart equ $8000;  Start address of the first module HeaderLen equ
$0010;  Length of the module header

org ModStart + HeaderLen

-------------------------- start module code
-------------------------------  Code start push ACC;  Registers on
stack protect push lcall LEDÃ²ff to B;  LED2 switch mov B off, #10;
Mov A, #250 set counter initial value on 10;  Delay 250ms loop lcall
LEDÃ²n;  LED2 switch lcall Delms on;  Delay lcall LEDÃ²ff;  LED2
switch lcall Delms off;  Delay djnz B, loop;  Pop B pass through loop;
Registers of the stack get pop ACC ret;  --------------------------
end module code --------------------------------- end
```

The composition of modules to a file and the automatic production of the necessary headers are possible with the program COMPMOD. As input serves a simple text file, which contains the necessary information for the concatenation of the individual Object files:

```
;    Name[max.8], Status[1], Adresse[hex], file name;
Modul-1, X, 8000, OCMcPcMcOcD1.cOcBcJ Modul-2, X, 8100,
OCMcPcMcOcD2.cOcBcJ
```

COMPMOD.EXE the name of this file transferred as command line parameters (e.g. COMPMOD.MDL) and the specified Object files to be situated in the same directory. After the execution of COMPMOD there is a new file with the Extension MOD (e.g. COMPMOD.MOD), which can be loaded directly to the address $8000 and all modules contains. Loading of the file takes place with the help of the instruction Downld of the EPC monitor and a terminal program. Particularly comfortably this is possible with the program EPCTERM, since this takes over also the examination of the check total. After switching into the Debug mode it can be checked with CUNNING whether the modules are as desired available.

3,4 use of BIOS routines

The control of the hardware of the NIM CONTROLLER requires usually special knowledge of the circuit and the internal mode of operation of the assigned components. In order to simplify programming, there are already BIOS routines, which are contained in the EPROM for all important functions. These can be used, as the list of the re-entry point addresses is merged NIMCTRL.EQU into the source text of the module and the respective routine with a simple LCALL is branched to. Almost all parameters of the following routines are transferred as register contents.

```
;*****************************************************************************
*  General routines of the EPC BIOS
*;*****************************************************************************

----------------------------------------------------------------------------;
Delms;  Produces a time delay around n ms (n in A);
----------------------------------------------------------------------------;
********************* external port area FF00-FFFF
***********************;
----------------------------------------------------------------------------;
RdExtPort;  External port (addr in B 00-FF) read;  Worth in A;
----------------------------------------------------------------------------;
WrExtPort;  External port (addr in B 00-FF) write;  Worth in A;
----------------------------------------------------------------------------;
************************* serial interface 0
*************************;
----------------------------------------------------------------------------;
InitSer0;  Initialization Ser0 (A=xxxxx000 < 150Baud to
A=xxxxx111 > 19200 Baud);
----------------------------------------------------------------------------;
WaitTI0;  Control rooms, to interface 0 transmit ready;
----------------------------------------------------------------------------;
SendStr0;  Transmit a stringer from the code at Ser0 (addr in DPTR,
end of the Strings=00h);
----------------------------------------------------------------------------;
************************* serial interface 1
*************************;
----------------------------------------------------------------------------;
InitSer1;  Initialization Ser1 (A=xxxx0100 < 2400 Baud to
A=xxxx1001 > 57600 Baud);
----------------------------------------------------------------------------;
WaitTI1;  Control rooms, to interface 1 transmit ready;
----------------------------------------------------------------------------;
S
*** TRANSLATION ENDS HERE ***endStr1
; Senden eines Strings aus dem Code an Ser1 (Adr in DPTR, Ende des Strings=00h)
; ----------------------------------------------------------------------------
; ***************************** EEPROM NS93C46 ******************************
; ----------------------------------------------------------------------------
; WrEEPW
; Schreiben eines Words (R1,R0) an die Adr. A in das EEPROM
; ----------------------------------------------------------------------------
; RdEEPW
; Lesen eines Words (R1,R0) an die Adr. A aus dem EEPROM
; ----------------------------------------------------------------------------
; *************************** Echtzeituhr 72421 *****************************
; ----------------------------------------------------------------------------
; InitRTC
; RÃ¼
cksetzen der RTC: So 01.01.95 00:00:00, keine Interrupts
; ----------------------------------------------------------------------------
; GetDate
```

```
; Lesen des Datums (BCD): R2=Tag,R3=Monat,R4=Jahr,R5=Wochentag (So=0)
; -----------------------------------------------------------------------------
; SetDate
; Schreiben des Datums (BCD): R2=Tag,R3=Monat,R4=Jahr,R5=Wochentag (So=0)
; -----------------------------------------------------------------------------
; GetTime
; Lesen der Uhrzeit (BCD): R2=Sek,R3=Min.,R4=Std
; -----------------------------------------------------------------------------
; SetTime
; Schreiben der Uhrzeit (BCD): R2=Sek,R3=Min.,R4=Std
; -----------------------------------------------------------------------------
; ************************* LCD-Anzeige mit HD44780 ***************************
; -----------------------------------------------------------------------------
; InitLCD
; Initialisieren der LCD (8-Bit Interface, Cursor Off, Clear Display)
; -----------------------------------------------------------------------------
; WrLCDz1
; WrLCDz2
; Ausgabe eines Textes (Code-Adr. in DPTR) in Zeile 1 oder 2 (Txt-Ende = 00h)
; -----------------------------------------------------------------------------
; GetKey
; Einlesen der LCD-Keys (Bit-Muster in A, LSB=Taste1)
; -----------------------------------------------------------------------------


; *****************************************************************************
; *  Routinen zur Ansteuerung der zus
Ã¤
tzlichen Hardware des NIM-Controllers   *
; *****************************************************************************
;******************************* LED - Routinen *******************************
; -----------------------------------------------------------------------------
; LED1On
; LED2On
; LED3On
; LEDxOn schaltet eine Leuchtdiode (x=1-3) ein
; -----------------------------------------------------------------------------
; LED1Off
; LED2Off
; LED3Off
; LEDxOff schaltet eine Leuchtdiode (x=1-3) aus
; -----------------------------------------------------------------------------
;*************************** Relais - Routinen ********************************
; -----------------------------------------------------------------------------
; ReadRel
; ReadRel liest den Zustand der Relais ein (Wert in A)
; -----------------------------------------------------------------------------
; WriteRel
; WriteRel schreibt einen Zustand in die Relais (Wert in A)
; -----------------------------------------------------------------------------
; SetRel
; SetRel schaltet ein Relais ein (Nummmer 0-7 in A)
; -----------------------------------------------------------------------------
; ResetRel
; ResetRel schaltet ein Relais aus (Nummmer 0-7 in A)
; -----------------------------------------------------------------------------
;************************* externe DAC-Routinen *******************************
; -----------------------------------------------------------------------------
; ShiftDAC
; ShiftDAC gibt ein 12-Bit-Wort (R1,R0) an die DACs aus (ohne LOAD-Impuls)
; -----------------------------------------------------------------------------
; LoadAllDAC
; LoadAllDAC gibt einen LOAD-Impuls an alle DACS parallel
; -----------------------------------------------------------------------------
; LoadDAC
```

```
; LoadDAC gibt einen LOAD-Impuls an einen DAC (Nr. 0-3 in A)
; ----------------------------------------------------------------------------
;*********************** externe ADC-Routinen *****************************
; ----------------------------------------------------------------------------
; ReadExtADC
; Gleichzeitiges Einlesen der Werte der externen 12-Bit ADCs (0-3);
; Ergebnisse in (R1:R0, R3:R2, R5:R4, R7:R6)
; ----------------------------------------------------------------------------


; **************************************************************************
; *          Routinen des EPC-Monitors f
Ã¼
r Schnittstelle seriell 0            *
; **************************************************************************
; ----------------------------------------------------------------------------
; GetNumPar
; Wertet Ziffern-Param. (0-F) im Kommandopuffer aus (Wert-
>A; C=1:Fehler)
; ----------------------------------------------------------------------------
; GetBytePar
; Wertet Byte-Param.(bin,dez,hex) im Kommandopuffer aus (Wert->A; C=1:Fehler)
; ----------------------------------------------------------------------------
; GetWordPar
; Wertet Word-Param. (hex) im Kommandopuffer aus (Wert-
>DPTR; C=1:Fehler)
; ----------------------------------------------------------------------------
; SendZi
; Senden einer ASCII-Ziffer (bin
Ã¤
rer Wert in A)
; ----------------------------------------------------------------------------
; SBinByte
; Senden des Akkus in bin
Ã¤
rer Form
; ----------------------------------------------------------------------------
; SDezByte
; Senden des Akkus in dezimaler Form
; ----------------------------------------------------------------------------
; SHexByte
; Senden des Akkus in hexadezimaler Form
; ----------------------------------------------------------------------------
; SendPortByte
; Sendet ein Byte (Akku) in Hexadezimaler,dezimaler und bin
Ã¤
rer Form
; ----------------------------------------------------------------------------
```

3.5 Verwendung von Interrupts

Das Interrupt-Konzept des SAB80C537-Controllers kann den bereits erw Ã¤ hnten Fachb Ã¼ chern oder den Datenbl Ã¤ ttern zum SAB80C537 entnommen werden. Um den Benutzer in die Lage zu versetzen, auf Interrupts zu reagieren, werden alle Interrupts auf Adressen im Bereich $FEC0-$FF00 umgeleitet, wobei f Ã¼ r jeden Interrupt ein Bereich von 4 Bytes reserviert ist. Dies reicht aus, um durch einen erneuten JMP-Befehl die gew Ã¼ nschte Interrupt-Service-Routine anzuspringen.

Die Zuordnung der Adressen zu den Interrupt-Quellen ist wie folgt:

Einsprungadresse	**Interrupt-Quelle**
FEC0h	IE0
FEC4h	TF0
FEC8h	IE1
FECCh	TF1
FED0h	RI0 & TI0
FED4h	TF2 & EXF2
FED8h	IADC
FEDCh	IEX2
FEE0h	EX3
FEE4h	IEX4
FEE8h	IEX5
FEECh	IEX6
FEF0h	RI1 & TI1
FEF4h	CTF

Last modified: 1996-07-21 A. Kastenm Ã¼ ller