HOCHSCHULE ESSLINGEN FAKULTÄT INFORMATIONSTECHNIK

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Studiengang:	**Kommunikationstechnik KTB** **Softwaretechnik SWB** **Technische Informatik TIB** **Ingenieurpädagogik IEP**	Semester:	IT4
Prüfungsfach:	**Computerarchitektur 3**	Exam ID:	**4022, 1054003**
Ressources:	**Lecture and Lab Manuscript** **Books, Pocket Calculator**	Duration: Prof:	**90 min** Zimmermann

Please enter your name here: **Total: 90 Points**

Given Name:	Family Name:	Student ID:

Please use the free space on these sheets for your solution. Solutions may be in English or German. If space is not sufficient, please use the backside or additional sheets.

(Note: This is a translated version, the original exam was in German).

Problem 1: Miscellaneous (20 Points)

1.1 List the various memory areas in the HCS12's memory map (name and purpose of the memory):

1.2 What is the purpose of the 5 lower bits in HCS12's Condition Code Register.

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1.3 HCS12 microcontrollers provide various addressing modes for operands. The following instructions use variables **`var1: ds.w`** and **`const: dc.w 1`**. For each operand specify the associated addressing mode. One of the combinations (instruction plus addressing mode) is invalid. Mark it with a cross X.

	1st Operand	2nd Operand
`TFR D,X`		
`LDD const`		
`STD #const`		
`MOVB 1,X,0,X`		
`LDD [var1,X]`		
`LDAA 1,Y+`		
`LDX const,Y`		

1.4 What is the purpose of HCS12 registers DDRH, PPSH und PERH?

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1.5 Which conditions are required for an interrupt service routine, e.g. for port H, to be called periodically?

1.6 Assume, that the HCS12 uses a crystal clock frequency of 8 MHz. Which value do you have to configure in RTICTL for the Real Time Interrupt Modul (RTI) to generate interrupts every 100 ms?
If an alarm clock is driven by this interrupt, which time error (in minutes) would this clock have after 24 hours?

RTICTL (binär oder hex): _____

Time error after 24 h: _____

Problem 2: Program Analysis (30 Points)

The following HCS12 assembler listing shows two functions which can be called from a C program. The associated C prototypes are

```
int f1(char *a1, char *a2);
void f2(void *a1, void *a2, int a3);
```

```
1    f1:  TFR   D,  X
2         LDY   +2, SP
3         CLRA
4         CLRB
5
6    la:  ADDD  #1
7         MOVB  1, X+, 1, Y+
8         TST   -1, X
9         BNE   la
10
11        RTS

12   ;-------------------------------------------------------

13   f2:  LDY   +2, SP
14        LDX   +4, SP
15
16        CPD   #0
17        BEQ   lc
18
19   lb:  MOVB  1, X+, 1, Y+
20        SUBD  #1
21        BNE   lb
22
23   lc:  RTS
```

2.1 The first function will be called as: `e = f1(0x1234, 0x2345)`. What is the contents of register X after execution of line 1?

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2.2 Function f1 now will be called as: `e = f1(0x1000, 0x2000).` The following table shows the memory content, before the function is called. Please fill out the column showing the values, when the function returns.

Memory address	Values before call	Values after call
`1000h`	`1`	
`1001h`	`2`	
`1002h`	`3`	
`1003h`	`4`	
…		
`2000h`	`20`	
`2001h`	`30`	
`2002h`	`0`	
`2003h`	`-4`	
`2004h`	`20`	

2.3 What is the contents of register D before line 11 is executed, if the function is called as in question 2.2?

2.4 The second function will be called as follows: `f2(0x1000, 0x2000, 4).` What is the contents of register X after line 14 was executed?

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2.5 Please fill out the following table, when function f2 returns after being called as in question 2.4.

Memory address	Values before call	Values after call
1000h	1	
1001h	2	
1002h	3	
1003h	4	
. . .		
2000h	20	
2001h	30	
2002h	0	
2003h	-4	
2004h	20	

2.6 Does function f2 work correctly, if a3 is null hat or negative? If not, what should be changed?

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Problem 3: Addressing Modes and Stack (25 Points):

3.1
An HCS12 assembler program defines the following global variables:

```
.const:    SECTION
           ORG   $D000
tabelle1:  DC.B  $11, $22, $33, $44, $55, $66, $77, $88
tabelle2:  DC.W  $D002, $D004
```

Please specify the contents of CPU registers D, X and Y after execution of the instruction for each row in the following table. Leave fields empty, if the register contents does not change.

Assemblerbefehle	**D**	**X**	**Y**
	$0000	$0000	$0000
LDX #2			
LDD tabelle1, X			
LDX tabelle1			
LDY #tabelle1			
LDAA 1, Y+			
LDAA 2, +Y			
LDAA 1, -Y			
LDX 3, Y			
LDX -1, Y			
LEAY 2, +Y			
LDX #tabelle2			
LDD [2, X]			

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3.2
A C-program defines the following global variables:

```
int valA, valB, valC;
int m;
```

These variables are used in the following C code, which you have to compile “manually” into the associated HCS12 assembler instructions.

Note: Assembler directives XDEF, XREF, INCLUDE, SECTION etc. may be omitted.

a) Compile the C program into HCS12 assembler instructions

C-Program

```
//***** Main Program *****
void main(void)
{   . . .
    m = add3(valA, valB, valC);
    . . .
}









//***** Subroutine *****
int add3(int a, int b, int c)
{
    return a + b + c;
}
```

HCS12-Assembler-Program

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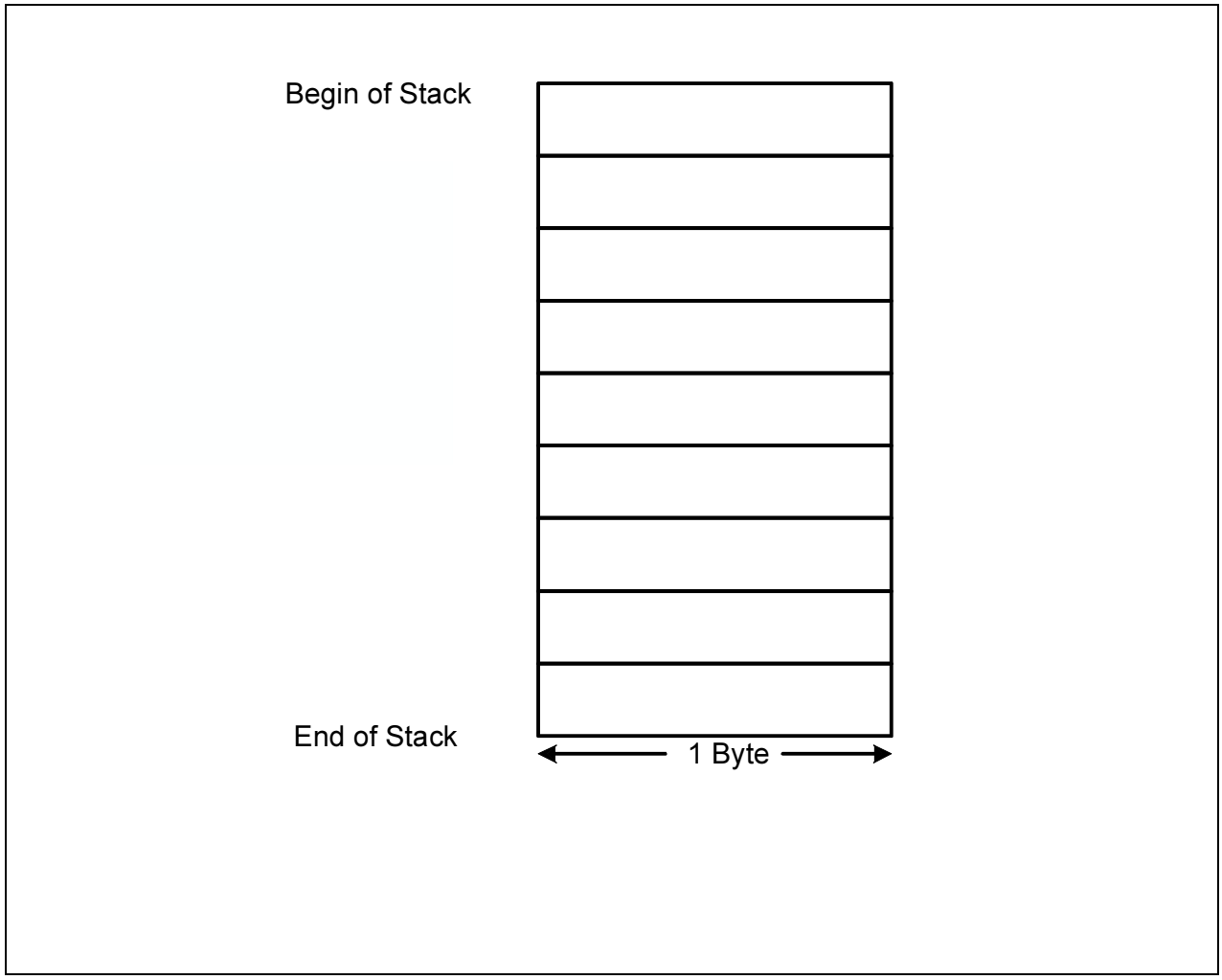
b) Specify the state of the stack at the begin of subroutine **`add3()`**:



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Problem 4: HCS12 Signal Generator (25 Points):

4.1 Write an HCS12 assembler subroutine **`initSCI1`**, which shall configure the HCS12's serial interface SCI1 in such a way, that periodically sending hex character "0x55" generates a square wave signal with 440 Hz. The serial interface shall use transmit interrupts. The function does not have parameters or return values.

Note: A square wave signal consists of sequence of 1-0- and a 0-1 transitions. For each signal period the serial interface has to output two bits (bits, not bytes!).

4.2 Write the HCS12 assembler interrupt service routine **`isrSCI1`** to be used with the code in question 4.1. On each transmit interrupt event, the ISR shall send hex character "0x55".

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4.3 Write the HCS12 assembler main program, which shall initialize the serial interface and start generating the 440 Hz square wave signal. Don't forget the required assembler directives like SECTIONS etc including the entry of the ISR in the interrupt vector table.