

Sample Exam G		Blatt Nr.: 1 von 8
Studiengang: Kommunikationstechnik KTB Softwaretechnik SWB Technische Informatik TIB Ingenieurpädagogik IEP		Semester: IT4
Prüfungsfach: Computerarchitektur		Fachnummer: 4022, 1054003
Hilfsmittel: Vorlesungs- und Labormanuskript, Fachliteratur, Taschenrechner Lecture manuscript, books, pocket calculator		Dauer: 90 min Dozent: Zimmermann

Insert your name here:

Total: 90 Points

Given name (Vorname):	Last name (Nachname):	Student ID (Matrikelnummer):
-----------------------	-----------------------	------------------------------

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.

Bitte tragen Sie Ihre Lösungen in Deutsch oder English in die Aufgabenblätter ein. Sollte der vorgesehene Platz nicht ausreichen, verwenden Sie bitte die Rückseite bzw. Zusatzblätter. Kennzeichnen Sie eindeutig, auf welche Fragen sich die Zusatzblätter beziehen.

Viel Erfolg - Good luck!

Problem 1: Miscellaneous (Σ 10 points)

1.1

(4 points)

What is a "Programming Model"? What does the term "CPU family" imply?

1.2

(4 points)

What is the contents of variables `s1`, `s2`, `s3` and `s4`, after the following C code has been executed:

`char a = 0x7E, b = 0x81, c=0x7F, s1, s2, s3, s4;`

`s1 = !a =`

`s2 = b & c =`

`s3 = c + 1 =`

`s4 = a ^ a =`

1.3

(2 points)

In which memory area (memory type) does the HCS12 C-compiler place the initialization values of global C variables?

Sample Exam G		Blatt Nr.: 2 von 8
Studiengang:	Kommunikationstechnik KTB Softwaretechnik SWB Technische Informatik TIB Ingenieurpädagogik IEP	Semester: IT4
Prüfungsfach:	Computerarchitektur	Fachnummer: 4022, 1054003
Hilfsmittel:	Vorlesungs- und Labormanuskript, Fachliteratur, Taschenrechner Lecture manuscript, books, pocket calculator	Dauer: 90 min Dozent: Zimmermann

Problem 2: Addressing Modes (Σ 30 points)

2.1

(8 points)

Specify the addressing mode for all operands of the following HCS12 instructions:

Instruction	1st operand	2nd operand
EXG X, D		
LDY #var2		
STD 4, -X		
DEX		
MOVW var1,4,Y		

2.2

A HCS12 assembler program defines the following global variables and constants:

```
.const:      SECTION
              ORG      $D800

con1:        DC.W      $3210, $7654, $BA98, $FEDC
con2:        DC.B      $01, $23, $45, $67, $89, $AB, $CD, $EF
con3:        DC.L      $10203040, $50607080

.data:      SECTION
              ORG      $2800

v1:          DS.W      1
v2:          DS.B      2
```

For each row in the following table specify the contents of CPU registers D, X and Y and of variables v1 and v2, after the instructions in the left field of the row have been executed. Fields, which do not change values, may be left empty. Mark unknown values as “???” if necessary.

(22 points)

HOCHSCHULE ESSLINGEN FAKULTÄT INFORMATIONSTECHNIK

Sample Exam G		Blatt Nr.: 3 von 8
Studiengang: Kommunikationstechnik KTB Softwaretechnik SWB Technische Informatik TIB Ingenieurpädagogik IEP	Semester: IT4	
Prüfungsfach: Computerarchitektur	Fachnummer: 4022, 1054003	
Hilfsmittel: Vorlesungs- und Labormanuskript, Fachliteratur, Taschenrechner Lecture manuscript, books, pocket calculator	Dauer: 90 min	Dozent: Zimmermann

HCS12 instructions	D	X	Y	v1	v2[0]	v2[1]
Initial values	\$1122	\$3344	\$5566	\$7788	\$99	\$AA
LDD con1 LDX con2 LDY con3 MOVW #\$2456, v1 MOVW #v1, v2						
STX 2,-SP STY 2,-SP STAA 1,-SP STAB 1,-SP PULX PULD LDY 2,SP+						
LDX #con1 LDY #con2 LDAA 4,+X LDAB 1, Y-	.					
LDX #v2 LDD [0,X]						
LDD #\$789A TFR A, X TFR B, Y						
LDD #\$2800 LDX \$D800 LDY con3+2						
MOVB #0, v2 LDD #\$AABB STD v1+2						
LDX #\$2802 LDD #\$1122 STD 2, -X LDY 2, X+						

Sample Exam G		Blatt Nr.: 4 von 8
Studiengang:	Kommunikationstechnik KTB Softwaretechnik SWB Technische Informatik TIB Ingenieurpädagogik IEP	Semester: IT4
Prüfungsfach:	Computerarchitektur	Fachnummer: 4022, 1054003
Hilfsmittel:	Vorlesungs- und Labormanuskript, Fachliteratur, Taschenrechner Lecture manuscript, books, pocket calculator	Dauer: 90 min Dozent: Zimmermann

Problem 3: Code Analysis (Σ 30 points)

The following C program deals with strings:

```
int  subA(char *pString);
char* subB(char *pString, char c);

char *text = "LittleString";
char *pP;
int  n = 0;

void main(void)
{
    EnableInterrupts;

    n  = subA(text);           // Line 1
    pP = subB(text, 'e');     // Line 2
}
```

Subroutines `subA()` and `subB()` are coded in HCS12 assembler:

```
subA:    TFR      D, X
         LDD      #0
L0:      TST      1,X+
         BEQ      L1
         ADDD     #1
         BRA      L0
L1:      RTS

subB:    PSHX
         LDX      4, SP
L3:      LDAA     0,X      ; // Line 3
         CBA
         BEQ      L4
         TST      1,+X
         BNE      L3
         LDX      #0
L4:      TFR      X, D
         PULX
         RTS
```

3.1

What is the value of variable `n` after line 1 in `main()` has been executed?

What is the purpose of subroutine `subA()`?

`n =`

Purpose of `subA()` :

(6 points)

Sample Exam G		Blatt Nr.: 5 von 8
Studiengang: Kommunikationstechnik KTB Softwaretechnik SWB Technische Informatik TIB Ingenieurpädagogik IEP		Semester: IT4
Prüfungsfach: Computerarchitektur		Fachnummer: 4022, 1054003
Hilfsmittel: Vorlesungs- und Labormanuskript, Fachliteratur, Taschenrechner Lecture manuscript, books, pocket calculator		Dauer: 90 min Dozent: Zimmermann

3.2

Into which HCS12 assembler instructions does the C compiler translate the subroutine call

```
pP = subB(text, 'e');           // Line 2
```

(6 points)

3.3

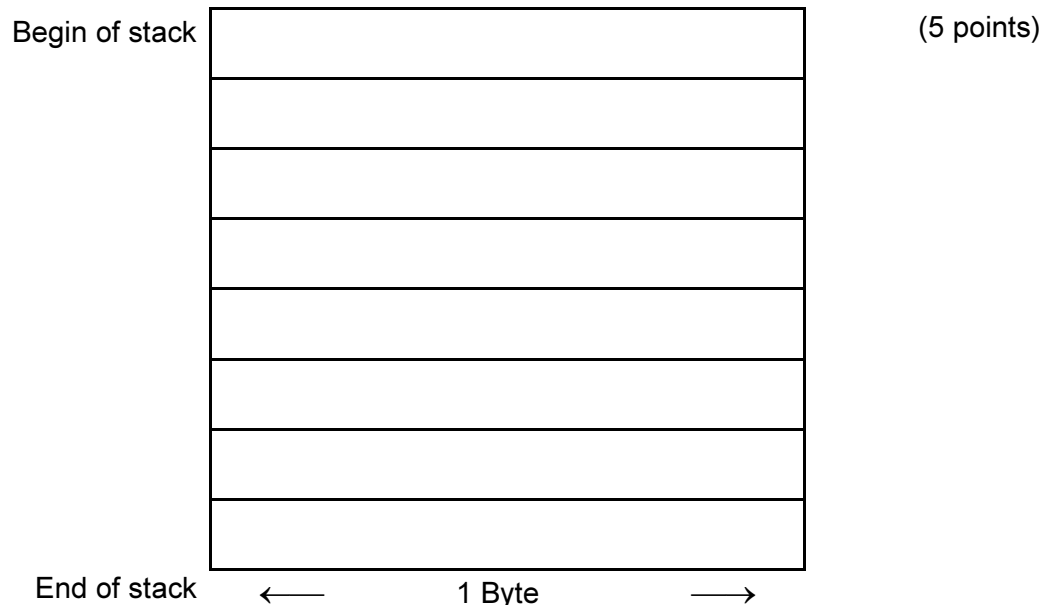
What is the contents of registers A and B, when the program completes executing line 3 in **subB ()** for the first time?

(4 points)

A =

B =

Specify the state of the stack, when the CPU reaches line 3 in **subB ()** :



Sample Exam G		Blatt Nr.: 6 von 8
Studiengang:	Kommunikationstechnik KTB Softwaretechnik SWB Technische Informatik TIB Ingenieurpädagogik IEP	Semester: IT4
Prüfungsfach:	Computerarchitektur	Fachnummer: 4022, 1054003
Hilfsmittel:	Vorlesungs- und Labormanuskript, Fachliteratur, Taschenrechner Lecture manuscript, books, pocket calculator	Dauer: 90 min Dozent: Zimmermann

3.4

Where does pointer `pP` point to, when `subB()` returns in line 2?

(3 points)

3.5

What is the value of pointer `pP` after execution of line 2, when the subroutine was called as follows:

```
pP = subB(text, 'Z'); // Line 2 modified
```

(2 points)

3.6

What is the purpose of subroutine `subB()`?

(2 points)

3.7

Why did subroutine `subB()` not save and restore register D?

(2 points)

Sample Exam G		Blatt Nr.: 7 von 8
Studiengang:	Kommunikationstechnik KTB Softwaretechnik SWB Technische Informatik TIB Ingenieurpädagogik IEP	Semester: IT4
Prüfungsfach:	Computerarchitektur	Fachnummer: 4022, 1054003
Hilfsmittel:	Vorlesungs- und Labormanuskript, Fachliteratur, Taschenrechner Lecture manuscript, books, pocket calculator	Dauer: 90 min Dozent: Zimmermann

Problem 4: Dragon12 Electronic Music (Σ 20 points)

The C-program on page 8 generates sound with the Dragon12's beeper, which is connected to timer channel 5. The sound frequency can be modified via the potentiometer on the board, which is connected to the analog to digital converter ATD0's channel 7.

4.1

With which frequency will the interrupt service routine `timerHandler()` be called, when the timer is initialized via `timerInit()`? You may assume `deltaTicks = 0` here.

(4 points)

4.2

Add the required C-code for functions `adcInit()` and `adcGet()`. The ADC shall be initialized in `adcInit()`, but no conversion started. `adcGet()` shall start the conversion, wait till the conversion completes and return the conversion result. Detailed requirements are:

- Single measurement on channel 7
- 10 bit resolution, result right-adjusted
- Fastest conversion time possible.

(10 points)

4.3

When the program is running, what does the user have to do, to actually hear the beeper sound playing?

(3 points)

4.4

Assume the analog voltage to vary between 0 and 5 V. What influence does the potentiometer setting have?

(3 points)

Sample Exam G		Blatt Nr.: 8 von 8
Studiengang: Kommunikationstechnik KTB Softwaretechnik SWB Technische Informatik TIB Ingenieurpädagogik IEP	Semester: IT4	
Prüfungsfach: Computerarchitektur	Fachnummer: 4022, 1054003	
Hilfsmittel: Vorlesungs- und Labormanuskript, Fachliteratur, Taschenrechner Lecture manuscript, books, pocket calculator	Dauer: 90 min	Dozent: Zimmermann

```
// Dragon12 Electronic Music

unsigned int deltaTicks = 0;
unsigned int baseSound  = 1704;

void timerInit(void)
{
    TSCR1 = 0x80;
    TSCR2 = 4;
    TIOS  = 0x20;
    TCTL1 = 0b00000100;
    TC5   = TCNT + baseSound;
    TIE   = 0x20;
}

void interrupt 13 timerHandler(void)
{
    TC5   = TC5 + baseSound - deltaTicks;
    TFLG1 = 0x20;
}

void adcInit(void)
{
    . . .

}

unsigned int adcGet(void)
{
    . . .

}

void main(void)
{
    EnableInterrupts;

    adcInit();
    timerInit();

    for (;;)
    {
        if ((PTH & 0x01) == 0)
        {
            TCTL1 = 0b00000100;
            deltaTicks = adcGet();
        } else
        {
            TCTL1 = 0b00000000;
        }
    }
}
```