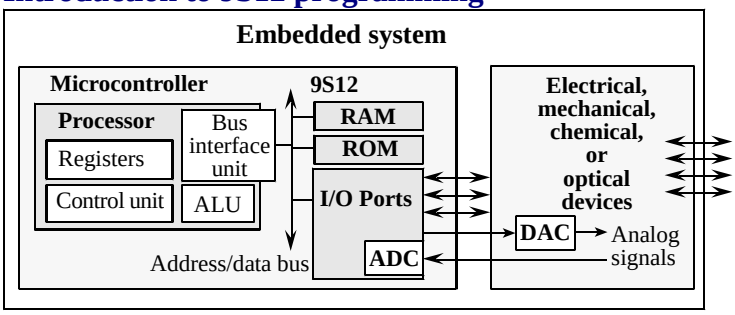
Recap

Embedded system
Microcontroller
Data Flow graph

Overview

9S12 programming
TExaS simulator
Top down design

Introduction to 9S12 programming



Register A, 8-bit number from 0 to 255
Z-bit, 0 means result not zero, 1 means result is zero
$0240 is Port T, input/output port
$0242 is the direction register for PortT (0=in, 1=out)
$2000 to $3FFF is RAM, volatile, variables (DG128)
$4000 to $FFFF is EEPROM, nonvolatile, program (DG128)

```
;template
   org  $4000
main

   stop
   org  $FFFE
   fdb  main
```

Short list of instructions to get started

```
   ldaa #10   ;make A=10
   ldaa $2000 ;A=contents of memory
   staa $2000 ;store contents of A into mem
   deca       ;A=A-1
   lsra       ;A=A/2 (shift right)
   lsla       ;A=A*2 (shift left)
   adda #10   ;A=A+10
   anda #$02  ;A=A&2 (logic and)
   eora #$08  ;A=A^8 (exclusive or)
   oraa #$03  ;A=A|3 (logic or)
   bra  loop  ;always jump to loop
   bne  loop  ;jump to loop if not zero
   beq  loop  ;jump to loop if zero
   stop
```

Appendix 1. Embedded system development using TExaS

A1.1. Introduction to TExaS

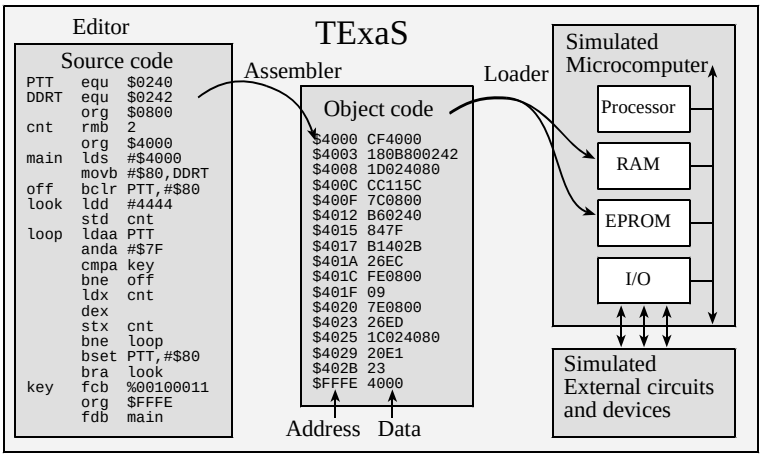


Figure 2.1. Assembly language development process in TExaS.

TExaS supports six phases of software development:

- Defining the microcomputer type and memory configuration,
- Writing the program source code using an editor,
- Assembling source code and loading object code into memory,
- Interfacing external components,
- Debugging the program by running it on the interactive simulator
- Debugging the program by running it on an actual board

Observation: *Hiding windows will improve the simulation speed.*

Checkpoint A1.1: *What is an assembly source code?*

Program file (`*.rtf`) source code.

`TheLog.rtf`	logs information, interactive debugger
`TheList.rtf`	the assembly listing
`TheCRT.rtf`	the input/output data of a CRT terminal

Microcomputer file (`*.uc`) internal microcomputer
I/O Device file (`*.io`) external I/O devices
switches, LEDs, LCDs, keyboard, the CRT, motors, IR and sensors.
Stack file (`*.stk`) holds temporary information
Scope file (`*.scp`) used for debugging
Plot file (`*.plt`) display graphical information

A1.2. Major components of TExaS

Editor
Assembler
    Source code to object code
Simulation Mode
    Instruction set simulator
        bus cycle activity and the extensive error checking
    I/O port simulator
    External device simulator
Real mode
    Debugger interface to real 9S12 board
Help system
    How TExaS works
    9S12 reference material
        Instructions
        I/O ports
    Lots of examples

Unique aspect of this simulator is the error checking.

- Execution of an illegal instruction,
- Read/write to an undefined address,
- Stack underflow (causing a read/write from unimplemented memory),
- Write to ROM, EPROM, EEPROM,
- Read from unprogrammed ROM, EPROM, EEPROM,
- Read from RAM that has not yet been written to,
- Read from an unimplemented I/O port.

1.5. Product development cycle

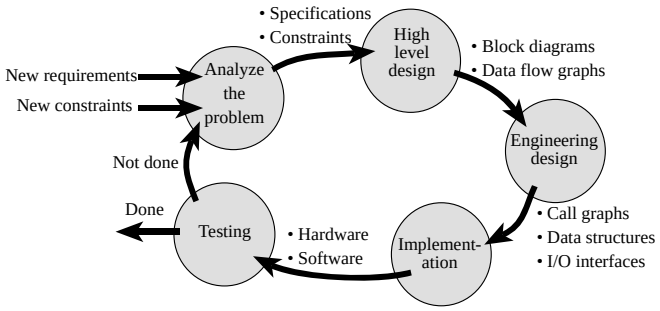
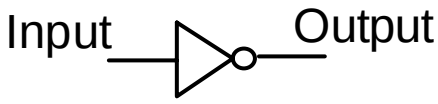


Figure 1.5. Product development cycle.

Top down embedded system design
    first draw a data flow graph
        choose inputs, outputs, data structures
        define major hardware/software modular blocks
    estimate calculations/sec, memory size

choose a processor family
next draw a call graph showing the control linkage
design at a very high level using pseudo code
design at a lower level using a high level language like C
convert the software by hand into assembly
simulate prototype
test and redesign algorithms
choose a specific microcontroller
build and test actual prototype

Design Problem – NOT gate



Steps

Market survey, customer focus group, cost/benefit analysis
Inputs, outputs (specifications, constraints)
Data flow graph
Design for test (add features to facilitate testing)
Flowchart – pseudo code
Edit source code
Build input/output mechanical/electrical devices in simulator
Interface to 9S12 in simulator
Debug system in simulator
Design for test (add features to facilitate testing)
Build real input/output devices
Interface real devices to 9S12
Debug real 9S12 prototype
Redesign for production
Design for test (add features to facilitate testing)
Manufacturability (can it be built?),
Maintainability (can it be repaired?),
Reliability (how long will it work?)
Power, packaging, safety, component availability
Test production units

The bottom line

You've learned assembly programming in EE306
Get the reference materials on 9S12 instructions
Bosses love top-down design
TExaS simulates hardware and software
TExaS will be also used to download onto real board
Metrowerks will allow projects and includes a C compiler