M16C/62

C Compiler Startup Files for the M16C/62 MCU

1.0 Abstract

The following article describes the Startup files for the NC30 C compiler. A set of customized Startup files is given for the M30624 version of the M16C/62 microcontroller.

2.0 Introduction

The Renesas M16C/62 is a 16-bit MCU, based on the M16C CPU core, with features including 10-bit A/D, D/A, UARTS, timers, DMA, and up to 256k bytes of user flash. The M16C series is ideally suited for programming using the C language.

C compilers for microcontrollers typically require some sort of assembler ‘startup’ file to set processor modes, initialize variables, and so forth. For the NC30 compiler, the startup file also includes section information so the linker knows where, in physical memory, to put variables, constants, code, and so on. The default files included with the NC30 are “ncrt0.a30”, the startup file, and “sect30.inc”, which give section information.

3.0 NCRT0.A30 Description

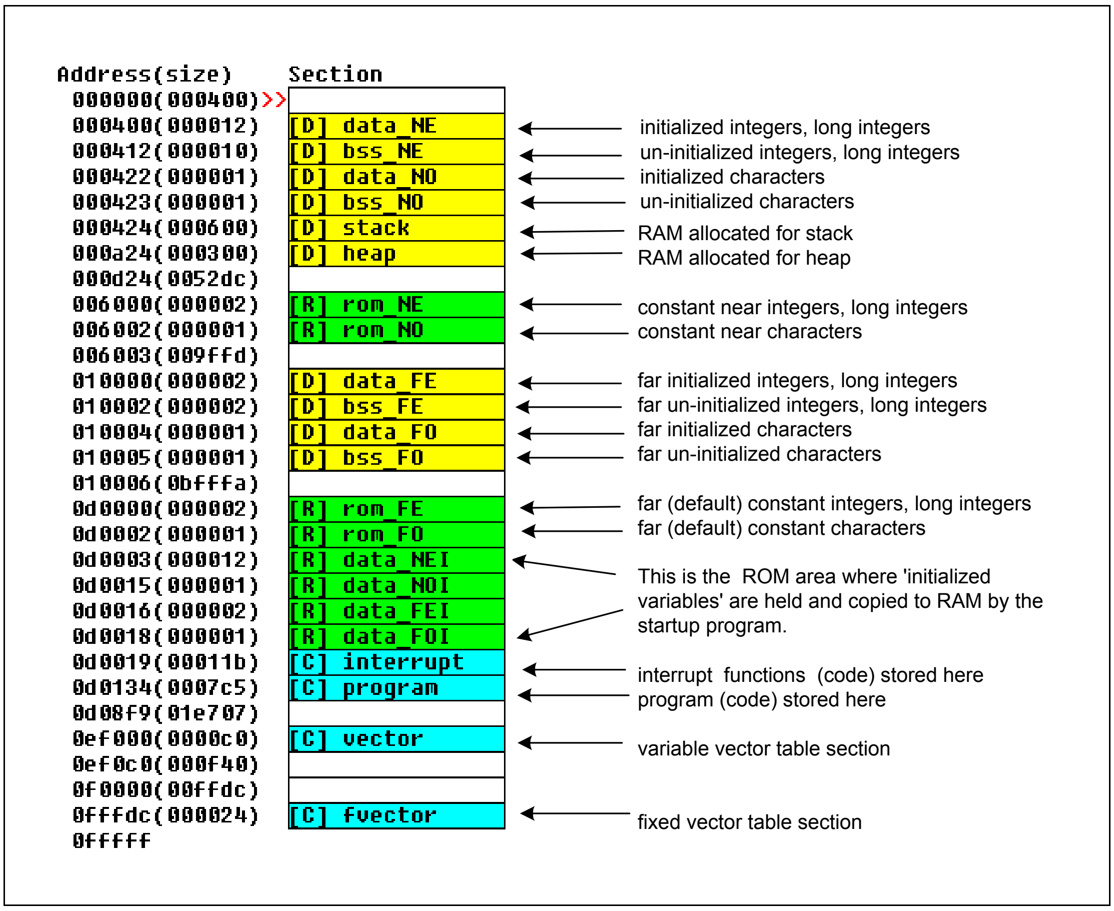
The NC30 compiler is shipped with a default startup file, “ncrt0.a30”. This file is a generic startup, which was written for most of the M16C/60 and M16C/20 series microcontrollers. A customized startup file for the M16C/62 starter kits is described in section 7.1 and referred to as ncrt0_62askp.a30.

After reset, execution begins with the code in this startup file. The stack pointer is set to point to a free area in RAM, and the processor mode is set. C requires that all (global) un-initialized variables be set to zero and initialized variables are copied from ROM into RAM.

4.0 SECT30.INC Description

The NC30 compiler is shipped with a default section definition file, “sect30.inc”. This file is a generic section file for the M16C series and typically requires editing for the specific processor. A customized section definition file for the M16C/62 starter kits is described in section 7.1 and referred to as sect30_62askp.inc.

The purpose of the section definition file is to set the location of the C language sections in the microcontroller’s physical memory map. The information here is used by the linker to determine where to put aligned variables (integers), nonaligned variables (characters), code (in ROM), interrupt vectors, and so forth. Figure 1 is an example of a memory map for an M16C/62 program that used the customized startup files. Note that the example map sets an external RAM section at address 10000h and an external ROM section at 6000h although the default configuration of the starter kit is in single-chip mode with no external memory.



Address(size)	Section	
000000(000400)>>		
000400(000012)	[D] data_NE	initialized integers, long integers
000412(000010)	[D] bss_NE	un-initialized integers, long integers
000422(000001)	[D] data_NO	initialized characters
000423(000001)	[D] bss_NO	un-initialized characters
000424(000600)	[D] stack	RAM allocated for stack
000a24(000300)	[D] heap	RAM allocated for heap
000d24(0052dc)		
006000(000002)	[R] rom_NE	constant near integers, long integers
006002(000001)	[R] rom_NO	constant near characters
006003(009ffd)		
010000(000002)	[D] data_FE	far initialized integers, long integers
010002(000002)	[D] bss_FE	far un-initialized integers, long integers
010004(000001)	[D] data_FO	far initialized characters
010005(000001)	[D] bss_FO	far un-initialized characters
010006(0bfffa)		
0d0000(000002)	[R] rom_FE	far (default) constant integers, long integers
0d0002(000001)	[R] rom_FO	far (default) constant characters
0d0003(000012)	[R] data_NEI	This is the ROM area where 'initialized variables' are held and copied to RAM by the startup program.
0d0015(000001)	[R] data_NOI	
0d0016(000002)	[R] data_FEI	
0d0018(000001)	[R] data_FOI	
0d0019(00011b)	[C] interrupt	interrupt functions (code) stored here
0d0134(0007c5)	[C] program	program (code) stored here
0d08f9(01e707)		
0ef000(0000c0)	[C] vector	variable vector table section
0ef0c0(000f40)		
0f0000(00ffdc)		
0fffdc(000024)	[C] fvector	fixed vector table section
0fffff		

Figure 1 M16C/62 Memory Map of Startup Files

5.0 Automatic Installation

When starting a new project using "TOOL MANAGER" (Renesas' development environment), the project wizard will ask if you wish to have the default startup files copied into the project's working directory. In order to have the project wizard copy the custom files instead, replace the default files with the custom startup files in the directory:

c:\MTOOL\SRC30\STARTUP

This assumes that when you installed the compiler, the default directory c:\MTOOL was specified. It is strongly recommended that you back up the default files first. Also, if you installed the development tools from a "Starter Kit" CD, the custom startup files included with the kit will automatically be used.

6.0 Reference

Renesas Technology Corporation Semiconductor Home Page

http://www.renesas.com

E-mail Support

support_apl@renesas.com

Data Sheets

- M16C/62 datasheets, 62aeds.pdf

User's Manual

- C Language Programming Manual: 6020EC.PDF

7.0 Software Code

7.1 Customized Startup Files for the M16C/62

The following is a set of customized startup files for the M30624 MCU. Except for adding entries into the interrupt vector tables, these files should suffice as-is for most applications. If using different versions of the M16C/62, the ROM starting address will need to be modified.

```
;***************************************************************************
;               NC30 C COMPILER for M16C/60 Starter Kits
;
;               Name:  ncrt0_62askp.a30
;       description: Customized startup program for the M16C/62 (M30624)
;                    microcontroller using the NC30 compiler. Programs
;                    complied with this ;startup file will run under the
;                    MSV1632 ROM Monitor or 'stand alone'.
;
;
;       Copyright 2003 RENESAS TECHNOLOGY CORPORATION
;       All Rights Reserved
;
;
;
;       $Id:
;
;***************************************************************************

;----------------------------------------------------------------------
; Section allocation and definitions
;----------------------------------------------------------------------

        .list OFF
        .include sect30_62askp.inc
        .list ON
;======================================================================
; Interrupt section start
;----------------------------------------------------------------------
        .insf   start,S,0   ; for stkviewer (see Tool Manager and NC30 manuals)
        .glb    start
        .section        interrupt

protect .equ    0ah
cm0             .equ    06h
cm1             .equ  07h
pm1             .equ  05h

;----------------------------------------------------------------------
; after reset, execution starts here
;----------------------------------------------------------------------

;Upon reset, the processor clock (bclk) is divided by 8 (f/8). The ROM Monitor
;on the Starter Kit sets bclk to f/1. For consistent stand alone operation,
;bclk is set to f/1 here.

start:
        ldc     #istack_top,isp   ;set istack pointer
        mov.b   #03h,protect      ;need to set protect register to operate on clock
        mov.b   #08h,cm0          ;mode and processor mode registers.
         mov.b   #08h,pm1        ;ROM Monitor sets this bit,set here for stand alone
                               ;operation (allows use of all internal RAM & ROM)
        mov.b   #00h,protect
        ldc         #0000h,     flg   ;ensure using register block 0 and use ISP if no RTOS
        ldc         #stack_top,sp    ;set if using an RTOS, has no effect otherwise
        ldc         #data_SE_top,sb  ;set sb register, for sb relative addressing
        ldintb      #VECTOR_ADR
        nop                                      ;Delay before
        fset       i                             ;enabling interrupts.

;======================================================================
; Variable area initialization. This code uses macro's (see sect30.inc)
; for initializing C variables. Clears global variables,
; sets initialized variables, etc.
;----------------------------------------------------------------------
; bss zero clear
;----------------------------------------------------------------------
        N_BZERO      bss_SE_top,bss_SE
        N_BZERO      bss_SO_top,bss_SO
        N_BZERO      bss_NE_top,bss_NE
        N_BZERO      bss_NO_top,bss_NO
;----------------------------------------------------------------------
; initialize data section
;----------------------------------------------------------------------
```

```
        N_BCOPY      data_SEI_top,data_SE_top,data_SE
        N_BCOPY      data_SOI_top,data_SO_top,data_SO
        N_BCOPY      data_NEI_top,data_NE_top,data_NE
        N_BCOPY      data_NOI_top,data_NO_top,data_NO

;======================================================================
; FAR area initialize.
;-----------------------------------------------------------------------
; bss zero clear
;-----------------------------------------------------------------------
        BZERO   bss_FE_top,bss_FE
        BZERO   bss_FO_top,bss_FO

;-----------------------------------------------------------------------
; Copy edata_E(O) section from edata_EI(OI) section
;-----------------------------------------------------------------------
        BCOPY   data_FEI_top,data_FE_top,data_FE
        BCOPY   data_FOI_top,data_FO_top,data_FO

;======================================================================
; heap area initialize. Can be removed if not using memory allocate
; functions
;-----------------------------------------------------------------------
        .glb    __mbase
        .glb    __mnext
        .glb    __msize
        mov.w   #(heap_top&0FFFFH), __mbase
        mov.w   #(heap_top>>16), __mbase+2
        mov.w   #(heap_top&0FFFFH), __mnext
        mov.w   #(heap_top>>16), __mnext+2
        mov.w   #(HEAPSIZE&0FFFFH), __msize
        mov.w   #(HEAPSIZE>>16), __msize+2

;======================================================================
; Initialize standard I/O
;-----------------------------------------------------------------------
; do not use default _init routine with SKP debugger since it uses UART1
        ;.glb   _init
        ;jsr.a  _init     ;required if using I/O stream serial port driver

;======================================================================
; Call main() function
;-----------------------------------------------------------------------
        ldc     #0h,fb  ; for debugger on starter kit

        .glb    _main
        jsr.a   _main


;======================================================================
; exit() function. This function is used in case of accidental return
; from main() or debugging code could be placed here.
;-----------------------------------------------------------------------
        .glb    _exit
        .glb    $exit
```

```
_exit:                    ; End program
$exit:
        jmp     _exit

;======================================================================
; dummy interrupt function. Used for all unassigned interrupts(see end
; of sect30.inc.
;----------------------------------------------------------------------
dummy_int:
        reit

        .end


;********************************************************************************
;
;  sect30_62askp.inc :    Customized section and macro definitions for the M30624
;                    (M16C/62) microcontroller using the NC30 compiler.
;
;  Description :  This file is specific to the M30624 microcontroller and adapted
;                 for use with the MSV1632 Starter Kit. UART1 interrupt
;                 vectors are used for the Starter Kit debugger.
;
;
;                   Copyright 2003 RENESAS TECHNOLOGY CORPORATION
;                   All Rights Reserved.
;
;
;
;       $Id:
;
;*******************************************************************************

;----------------------------------------------------------------------
; HEAP SIZE definition. Only used for memory allocate functions
;  (malloc, realloc, etc). If not required and need this RAM for other
;  usage, reduce the value of HEAPSIZE.
;----------------------------------------------------------------------
HEAPSIZE        .equ    300h

;----------------------------------------------------------------------
; STACK SIZE definition. Unless the system is running an RTOS, both
; interrupts and function calls should use the istack only (default startup
; configuration). If not required and need this RAM for other
; usage, reduce the value of USTACKSIZE.
;----------------------------------------------------------------------
STACKSIZE       .equ    300h

;----------------------------------------------------------------------
; INTERRUPT STACK SIZE definition
;----------------------------------------------------------------------
ISTACKSIZE      .equ    300h

;----------------------------------------------------------------------
; INTERRUPT VECTOR ADDRESS. do not set within a flash memory block used by
; the ROM Monitor.
;----------------------------------------------------------------------
VECTOR_ADR      .equ    0ef000h

;=====================================================================
; Initialize Macro declarations. These macro's are used in the startup
; file (ncrto.a30)for initializing C variables. Clears global variables,
; sets intialized variables, etc.
;----------------------------------------------------------------------
N_BZERO .       macro   TOP_ ,SECT_
        mov.b   #00H, R0L
        mov.w   #(TOP_ & 0FFFFH), A1
        mov.w   #sizeof SECT_ , R3
        sstr.b
        .endm

N_BCOPY .macro          FROM_,TO_,SECT_
        mov.w   #(FROM_ & 0FFFFH),A0
        mov.b   #(FROM_ >>16),R1H
        mov.w   #TO_ ,A1
        mov.w   #sizeof SECT_ , R3
        smovf.b
        .endm

BZERO   .macro  TOP_,SECT_
        push.w  #sizeof SECT_ >> 16
        push.w  #sizeof SECT_  & 0ffffh
        pusha   TOP_ >>16
        pusha   TOP_ & 0ffffh

        .glb    _bzero
        jsr.a   _bzero
        .endm
BCOPY   .macro  FROM_ ,TO_ ,SECT_
        push.w  #sizeof SECT_  >> 16
        push.w  #sizeof SECT_  & 0ffffh
        pusha   TO_ >>16
        pusha   TO_  & 0ffffh
        pusha   FROM_ >>16
        pusha   FROM_  & 0ffffh

        .glb    _bcopy
        jsr.a   _bcopy
        .endm
;----------------------------------------------------------------
; Special page definition. For defining routines or functions as
; special page.
;----------------------------------------------------------------
;macro define for special page
;
;Format:
;       SPECIAL number
;

SPECIAL         .macro  NUM
```

```
        .org    0FFFFEH-(NUM*2)
        .glb    __SPECIAL_@NUM
        .word   __SPECIAL_@NUM  & 0FFFFH
.endm


;---------------------------------------------------------------
;   Section allocation. The following declarations sets the location of the
;   sections in the physical memory map. DO not change these settings
;   without referring to the NC30 manual on startup files.
;
;---------------------------------------------------------------
; Near RAM data area
;---------------------------------------------------------------
; SBDATA area
        .section        data_SE,DATA
        .org    400H
data_SE_top:
        .glb    __SB__
__SB__:                      ; declare sb 'section' here
        .section        bss_SE,DATA,ALIGN
bss_SE_top:

        .section        data_SO,DATA
data_SO_top:

        .section        bss_SO,DATA
bss_SO_top:

; near RAM area
        .section        data_NE,DATA,ALIGN
data_NE_top:

        .section        bss_NE,DATA,ALIGN
bss_NE_top:

        .section        data_NO,DATA
data_NO_top:

        .section        bss_NO,DATA
bss_NO_top:


;---------------------------------------------------------------
; Stack area. If the USP is not required, and the RAM
; allocated to the USP is needed, do not modify the declarations
; below, Simply set the USTACKSIZE (above) to zero.
;---------------------------------------------------------------
        .section        stack,DATA
        .blkb   STACKSIZE
```

```
stack_top:

        .blkb   ISTACKSIZE
istack_top:


;-----------------------------------------------------------------
;   Heap section. If the heap is not required, and the RAM
;   allocated to the heap is needed, do not modify the declarations
;   below, Simply set the HEAPSIZE (above) to zero.
;---------------------.-------------------------------------------
        .section        heap,DATA
heap_top:
        .blkb   HEAPSIZE

;-----------------------------------------------------------------
; Near ROM data area. For "near const".
; By definition, Near ROM is all ROM below address 10000h
;-----------------------------------------------------------------
;       .org            06000H  ; Example. External ROM located at 6000h
        .section        rom_NE,ROMDATA  ;rom_NE,ROMDATA,ALIGN

        .org            06000H  ; Example. External ROM located at 6000h
rom_NE_top:

        .section        rom_NO,ROMDATA
rom_NO_top:

;-----------------------------------------------------------------
; Far RAM data area. For "far" int's char's, etc
; By definition, Far RAM is all RAM above address FFFFh
;-----------------------------------------------------------------
        .section        data_FE,DATA
        .org            10000H ; Example. External RAM located at 10000h
data_FE_top:

        .section        bss_FE,DATA,ALIGN
bss_FE_top:

        .section        data_FO,DATA
data_FO_top:

        .section        bss_FO,DATA
bss_FO_top:


;-----------------------------------------------------------------
; Far ROM data area
;-----------------------------------------------------------------
        .section        rom_FE,ROMDATA
;Out of reset, the C0000h flash block (block6) is not visible until
;the pm13 bit is set(see M30624 spec's, Processor Mode Register 1)
;The ROM Monitor sets this bit, but for consistent stand alone
;operation, do not allow the reset vector to point to an address
;below D0000h.
```

```
        .org            0d0000H
rom_FE_top:

        .section        rom_FO,ROMDATA
rom_FO_top:

;----------------------------------------------------------------
; Initial data of 'data' section
;----------------------------------------------------------------
        .section        data_SEI,ROMDATA
data_SEI_top:

        .section        data_SOI,ROMDATA
data_SOI_top:

        .section        data_NEI,ROMDATA
data_NEI_top:

        .section        data_NOI,ROMDATA
data_NOI_top:

        .section        data_FEI,ROMDATA
data_FEI_top:

        .section        data_FOI,ROMDATA
data_FOI_top:


;----------------------------------------------------------------
; Switch Table Section
;----------------------------------------------------------------
        .section         switch_table,ROMDATA
switch_table_top:


;----------------------------------------------------------------
; code area
;----------------------------------------------------------------
        .section        interrupt

        .section        program

        .section        program_S      ; special page code must be in the
        .org            0f0000h        ; address range of F0000h to FFFDCh

;----------------------------------------------------------------
; variable vector section
; For proper interrupt operation, replace "dummy_int" with the assembler
; label or absolute address of the interrupt service routine
;----------------------------------------------------------------
        .section        vector          ; variable vector table
        .org    VECTOR_ADR


        .lword  dummy_int               ; BRK   (vector 0)
        .org    (VECTOR_ADR+16)
        .lword  dummy_int               ; int3(for user)(vector 4)
        .lword  dummy_int               ; timerB5(for user)(vector 5)
        .lword  dummy_int               ; timerB4(for user)(vector 6)
        .lword  dummy_int               ; timerB3(for user)(vector 7)
        .lword  dummy_int               ; si/o4 /int5(for user)(vector 8)
        .lword  dummy_int               ; si/o3 /int4(for user)(vector 9)
        .lword  dummy_int               ; Bus collision detection(for user)(v10)
        .lword  dummy_int               ; DMA0(for user)(vector 11)
        .lword  dummy_int               ; DMA1(for user)(vector 12)
        .lword  dummy_int               ; Key input interrupt(for user)(vect 14)
        .lword  dummy_int               ; A-D(for user)(vector 14)
        .lword  dummy_int               ; uart2 transmit(for user)(vector 15)
        .lword  dummy_int               ; uart2 receive(for user)(vector 16)
        .lword  dummy_int               ; uart0 transmit(for user)(vector 17)
        .lword  dummy_int               ; uart0 receive(for user)(vector 18)
        .lword  0FF900h                 ; uart1 transmit-used by ROM Monitor(vector 19)
        .lword  0FF900h                 ; uart1 receive-used by ROM Monitor(vector 20)

        .lword  dummy_int               ; timer A0(for user)(vector 21)
        .lword  dummy_int               ; timer A1(for user)(vector 22)
        .lword  dummy_int               ; timer A2(for user)(vector 23)
        .lword  dummy_int               ; timer A3(for user)(vector 24)
        .lword  dummy_int               ; timer A4(for user)(vector 25)

        .lword  dummy_int               ; timer B0(for user)(vector 26)
        .lword  dummy_int               ; timer B1(for user)(vector 27)
        .lword  dummy_int               ; timer B2(for user)(vector 28)
        .lword  dummy_int               ; int0 (for user)(vector 29)
        .lword  dummy_int               ; int1 (for user)(vector 30)
        .lword  dummy_int               ; int2 (for user)(vector 31)

        .lword  dummy_int               ; vector 32 (for user or MR30)
        .lword  dummy_int               ; vector 33 (for user or MR30)
        .lword  dummy_int               ; vector 34 (for user or MR30)
        .lword  dummy_int               ; vector 35 (for user or MR30)
        .lword  dummy_int               ; vector 36 (for user or MR30)
        .lword  dummy_int               ; vector 37 (for user or MR30)
        .lword  dummy_int               ; vector 38 (for user or MR30)
        .lword  dummy_int               ; vector 39 (for user or MR30)
        .lword  dummy_int               ; vector 40 (for user or MR30)
        .lword  dummy_int               ; vector 41 (for user or MR30)
        .lword  dummy_int               ; vector 42 (for user or MR30)
        .lword  dummy_int               ; vector 43 (for user or MR30)
        .lword  dummy_int               ; vector 44 (for user or MR30)
        .lword  dummy_int               ; vector 45 (for user or MR30)
        .lword  dummy_int               ; vector 46 (for user or MR30)
        .lword  dummy_int               ; vector 47 (for user or MR30)
        ;
;=================================================================
; fixed vector section
;-----------------------------------------------------------------
        .section        fvector                 ; fixed vector table
;=================================================================
; special page definition
```

```
;---------------------------------------------------------------
; Special page functions can be specified      using
; "#pragma SPECIAL" directive and the macro defined above.
; Uncomment the proper line below to call the macro.
; See NC30 manual for more information.
;---------------------------------------------------------------
;       SPECIAL 255
;       SPECIAL 254
;       SPECIAL 253
;          :
;          :
;         etc
;          :
;          :
;       SPECIAL 24
;       SPECIAL 23
;       SPECIAL 22
;       SPECIAL 21
;       SPECIAL 20
;       SPECIAL 19
;       SPECIAL 18
;
;===============================================================
; fixed vector section. The 7 or'ed values below (commented out) are for
; specifying the ID codes for serial I/O flash programming
; (highest 8 bits of the vectors). See data sheets for
; more information. Current setting = all zeros by default.
; The highest 8 bits of the reset vector is the parallel protection
; 'register'. Caution! Setting these codes could result in loss of
; all flash programming. See M30624 data sheets before operating
; on these values.
;---------------------------------------------------------------
        .org    0fffdch
UDI:
        .lword  dummy_int ;   | 0ff000000h
OVER_FLOW:
        .lword  dummy_int ;   | 0ff000000h
BRKI:
        .lword  dummy_int
ADDRESS_MATCH:
        .lword  dummy_int ;   | 0ff000000h
SINGLE_STEP:
        .lword  dummy_int ;   | 0ff000000h
WDT:
        .lword  dummy_int ;   | 0ff000000h
DBC:
        .lword  dummy_int ;   | 0ff000000h
NMI:
        .lword  dummy_int ;   | 0ff000000h
RESET:
        .lword  start ;       | 0ff000000h
;
```