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Renesas Electronics Corporation

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M16C/26

C Compiler Startup Files

1.0 Abstract

The following article describes the startup files for the NC30 and KNC30 C compilers. A set of customized startup files is given for the M30262 version of the M16C/26 microcontroller.

2.0 Introduction

The Renesas M30262 is a 16-bit MCU based on the M16C/60 series CPU core. The MCU features include up to 64KB of Flash ROM, 2KB of RAM, and 4KB of virtual EEPROM. The peripheral set includes 10-bit A/D, UARTs, Timers, DMA, and GPIO. 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**, which is the startup file, and **sect30.inc**, which contains the section information.

3.0 NCRT0.A30

The NCRT0.A30 file is a generic startup, which was written for most of the M16C/60 series microcontrollers. After reset, program 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 initialize variables are copied from ROM into RAM.

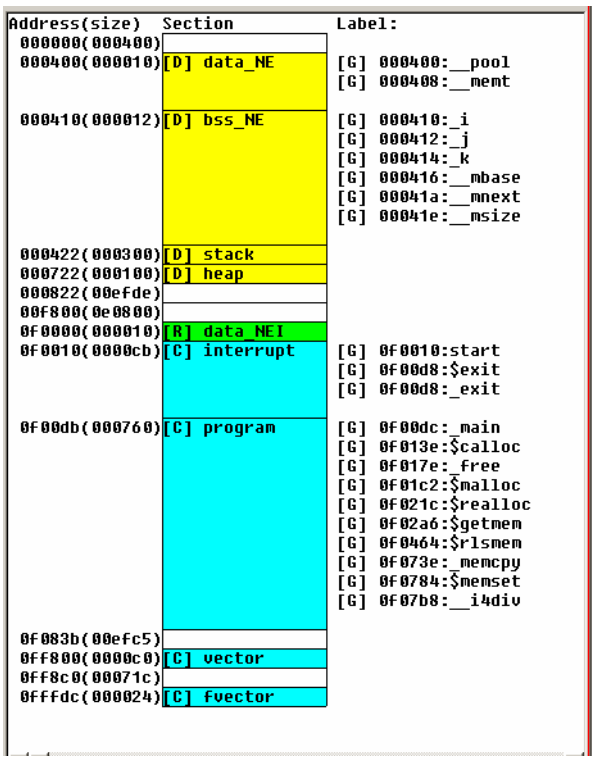
A customized startup file for the M16C/26 starter kits is described in section 7.1 and referred to as ncrt0_26.a30.

4.0 SECT30.INC

The sect30.inc file is a generic section file for the M16C series microcontrollers. The purpose of the section definition file is to set the location of C language sections in the microcontroller's physical memory map. This file contains information that the linker will used to determine where aligned variables (integers), non-aligned variables (characters), code (in ROM), interrupt vectors, and so forth, are to be placed.

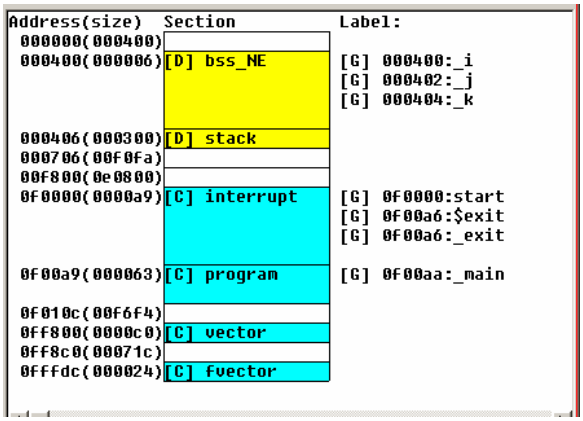
A customized section definition file for the M16C/26 starter kits is described in section 7.2 and referred to as sect30_26.inc.

At the beginning of the section file are several settings that allow users to customized memory allocations for HEAPSIZE and STACKSIZE. The HEAP memory is use by memory allocation functions. If memory allocation functions are not needed in your application, HEAPSIZE should be set to "00h". Figure 1 shows an example of the memory map when HEAPSIZE is set to "0100h". Figure 2 shows an example of the memory map when HEAPSIZE is set to "00h".



```
Address(size)  Section          Label:
 000000(000400)
 000400(000010)[D] data_NE      [G] 000400:__pool
                                [G] 000408:__memt
 000410(000012)[D] bss_NE       [G] 000410:_i
                                [G] 000412:_j
                                [G] 000414:_k
                                [G] 000416:__mbase
                                [G] 00041a:__mnext
                                [G] 00041e:__msize
 000422(000300)[D] stack
 000722(000100)[D] heap
 000822(00efde)
 00f800(0e0800)
 0f0000(000010)[R] data_NEI
 0f0010(0000cb)[C] interrupt    [G] 0f0010:start
                                [G] 0f00d8:$exit
                                [G] 0f00d8:_exit
 0f00db(000760)[C] program      [G] 0f00dc:_main
                                [G] 0f013e:$calloc
                                [G] 0f017e:_free
                                [G] 0f01c2:$malloc
                                [G] 0f021c:$realloc
                                [G] 0f02a6:$getmem
                                [G] 0f0464:$rlsmem
                                [G] 0f073e:_memcpy
                                [G] 0f0784:$memset
                                [G] 0f07b8:__i4div
 0f083b(00efc5)
 0ff800(0000c0)[C] vector
 0ff8c0(00071c)
 0fffdc(000024)[C] fvector
```

Figure 1 Memory Map with HEAP allocated



```
Address(size)  Section          Label:
 000000(000400)
 000400(000006)[D] bss_NE       [G] 000400:_i
                                [G] 000402:_j
                                [G] 000404:_k
 000406(000300)[D] stack
 000706(00f0fa)
 00f800(0e0800)
 0f0000(0000a9)[C] interrupt    [G] 0f0000:start
                                [G] 0f00a6:$exit
                                [G] 0f00a6:_exit
 0f00a9(000063)[C] program      [G] 0f00aa:_main
 0f010c(00f6f4)
 0ff800(0000c0)[C] vector
 0ff8c0(00071c)
 0fffdc(000024)[C] fvector
```

Figure 2 Memory Map with no HEAP allocated

5.0 Default or Custom Startup in Tool Manager

When starting a new project using Tool Manager (or TM) IDE, the project wizard will ask if a customized or a default startup file will be used. If a customized startup file will be used, you can specify the file that you intend to use. If the default startup file is used, the startup files installed under the **C:\MTOOL\SRC30\STARTUP** folder are copied to the new project's working directory. You can replace the startup files that were installed during compiler installation with customized ones as long as you keep the filenames. It is strongly recommended that you back up the default files first before replacing it.

Note: This assumes that the compiler was installed under the default directory, **C:\MTOOL**. If you have an M16C/26 SKP, the customized startup files for M16C/26 can be found under **C:\MTOOL\MSV30262-SKP\Sample_Code\Startup_files** folder.

6.0 Reference

Renesas Technology Corporation Semiconductor Home Page

http://www.renesas.com

E-mail Support

support_apl@renesas.com

Data Sheets

- M16C/26 datasheet, M30262eds.pdf

User's Manual

- C Language Programming Manual, 6020EC.PDF

7.0 Software Code

The following is a set of customized startup files for the M30262 MCU that is included with the M16C/26 SKP. 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/26, the ROM starting address will need to be modified.

7.1 Customized NCRT0 (ncrt0_26.a30)

```
;****************************************************************************** ;
;       C COMPILER for M16C/60, M16C/20
;       Copyright 1995-2003 Renesas Technology America, Inc.
;       All Rights Reserved.
;
;       ncrt0_26.a30 : NC30 startup program
;
;       Content:   Startup assembly file for M16C/26.
;                  This program is applicable when using the basic I/O library.
;
;===============================================================================
;       $Log:$
;       $Id: ncrt0.a30,v 1.12 2000/05/18 06:44:37 simomura Exp $
;                        ncrt0_26.a30, v 1.1 2003/05/15 11:36    R. Seville
;===============================================================================
;*******************************************************************************

;------------------------------------------------------------------------
; Section allocation and definitions
;------------------------------------------------------------------------
        .list OFF
        .include sect30_26.inc
        .list ON

;=====================================================================
; Interrupt section start
;---------------------------------------------------------------------
;       .insf   start,S,0       ; for stkviewer (see TM and NC30 manuals)
        .glb    start
        .section        interrupt

start:
;---------------------------------------------------------------------
; After reset, program execution starts here.
; Upon reset, the processor clock (BLCK) defaults to divided by 8 (f/8).
;---------------------------------------------------------------------
        ldc     #istack_top, isp        ; set istack pointer
```

```
;-----------------------------------------------------------------------
; two higher bits (b7 & b6) must be set to be able to use INT4 & INT5
;-----------------------------------------------------------------------
        mov.b   #0c0h,035Fh             ; set b7 & b6 if application will use INT4 & INT5
        ldc     #data_SE_top, sb        ; set sb register
        ldintb  #VECTOR_ADR

;=======================================================================
; NEAR area initialize.
;-----------------------------------------------------------------------
; 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

;=======================================================================
; heap area initialization - can be remove if not using memory allocate
; functions
;-----------------------------------------------------------------------
.IF      HEAPSIZE!=00h
        HEAPINIT
.ENDIF

;=======================================================================
; Initialize standard I/O
;-----------------------------------------------------------------------
; SKP sample codes/programs does NOT use this routine but instead call
; an mcu_init() routine from main().
;       .glb    _init
;       .call   _init,G
;       jsr.a   _init

;=======================================================================
; Call main() function
;-----------------------------------------------------------------------
        .glb    _main
        jsr.a   _main

;=======================================================================
; exit() function
;-----------------------------------------------------------------------
        .glb    _exit
        .glb    $exit
_exit:                  ; End program
```

```
$exit:
        jmp             _exit
        .einsf
;=====================================================================
; dummy interrupt function
;---------------------------------------------------------------------
dummy_int:
        reit
        .end

;*********************************************************************
;       C COMPILER for M16C/60, M16C/20
;       Copyright 1995-2003 Renesas Technology America, Inc.
;       All Rights Reserved.
;*********************************************************************
```

7.2 Customized SECT30 (sect30_26.inc)

```
;*********************************************************************************
;       C Compiler for M16C/60, M16C/20
;       Copyright 1995-2003 Renesas Technology America, Inc,
;       All Rights Reserved.
;
;       Written by T.Aoyama
;
;       sect30_26.inc     : section definition
;       This program is applicable when using the basic I/O library
;
;=================================================================================
;       $Log:$
;       $Id: sect30.inc,v 1.9 2000/06/20 09:07:11 simomura Exp $
;                        sect30_26, v 1.1 2003/05/15 11:36    R. Seville
;=================================================================================
;*********************************************************************************

;---------------------------------------------------------------------
; HEAP SIZE definition. Only used for memory allocate functions
;  (malloc, realloc, etc). If not, set to 0h.
;---------------------------------------------------------------------
HEAPSIZE        .equ    0h              ; Heap memory not needed.

;---------------------------------------------------------------------
; 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, set to 0h.
;---------------------------------------------------------------------
STACKSIZE       .equ    0h              ;

;---------------------------------------------------------------------
; INTERRUPT STACK SIZE definition
;---------------------------------------------------------------------
ISTACKSIZE      .equ    100h    ;
```

```
;-----------------------------------------------------------------------
; INTERRUPT VECTOR ADDRESS.
; Do NOT set within a flash memory block used by the ROM Monitor which
; starts at 0FF900h. Size of vector table is 256 bytes.
;-----------------------------------------------------------------------
VECTOR_ADR      .equ    0ff800h

;=======================================================================
; Initialize Macro declarations. These macro's are used in the startup
; file (ncrto_26.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

HEAPINIT .macro
        .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
        .endm

;-----------------------------------------------------------------
; Special page vectors. This macro puts the jump address of
; functions defined as special page into the special page vector table.
; See example calls below. See the M16C Software Manual and the NC30
; manual for more information on special page vectors.
;-----------------------------------------------------------------
;       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 refering to the NC30 manual on startup files.
;------------------------------------------------------------------
; Near RAM data area
;------------------------------------------------------------------
; SBDATA area
        .section        data_SE,DATA
        .org    400H

data_SE_top:

        .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
; Virtual EEPROM can be found in 0F000h to 0FFFFh. However,
; the user program must enable access (set pm10 to 1) to it
; before using it.
;-----------------------------------------------------------------
        .section        rom_NE,ROMDATA
        .org            0F000H          ; Virtual EEPROM - 2KB x 2
rom_NE_top:

        .section        rom_NO,ROMDATA
rom_NO_top:

;-----------------------------------------------------------------
; Far ROM data area
;-----------------------------------------------------------------
        .section        rom_FE,ROMDATA
        .org            0F0000H
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        program

        .section        interrupt

        .section        program_S       ; special page code must be in
                                                ; address range from F0000H to FFFDCh
                                                ; Start of M30262F8 ROM address will
                                                ; vary depending on M30262 used.

;-----------------------------------------------------------------
; 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               ; vector 0 (BRK)
        .org    (VECTOR_ADR +16)
        .lword  dummy_int               ; INT3
        .lword  dummy_int               ; Reserved
        .lword  dummy_int               ; Reserved
        .lword  dummy_int               ; Reserved
        .lword  dummy_int               ; INT5 - bits b7 & b6 of the IFSR (035Fh) must be set
when using INT4 &
        .lword  dummy_int               ; INT4 - INT5 (bits are set in ncrt0_26.a30 before
main() is called).
        .lword  dummy_int               ; UART2 Bus collision detection iic
        .lword  dummy_int               ; DMA0 (for user)
        .lword  dummy_int               ; DMA1 (for user)
        .lword  dummy_int               ; Key-on wakeup (for user)
        .lword  dummy_int               ; AD Converter (for user)
        .lword  dummy_int               ; UART2 transmit/NACK, with iic mode NACK is selected.
        .lword  dummy_int               ; UART2 receive/ACK, with iic mode ACK is selected.
        .lword  dummy_int               ; UART0 transmit (for user)
        .lword  dummy_int               ; UART0 receive: use for UART0 recieve interrupt.
        .lword  dummy_int               ; UART1 transmit (for user)
        .lword  dummy_int               ; UART1 receive:  Not needed for M16C/26, USB-ICD uses
DBC irq.
        .lword  dummy_int               ; TIMER A0 (for user)
        .lword  dummy_int               ; TIMER A1 (for user)
        .lword  dummy_int               ; TIMER A2 (for user)
        .lword  dummy_int               ; TIMER A3 (for user)
        .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               ; Reserved
        .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)
        ; to vector 63 from vector 32 is used by 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
;          :
;          :
;       (omitted)
;          :
;          :
;       SPECIAL 24
;       SPECIAL 23
;       SPECIAL 22
;       SPECIAL 21
;       SPECIAL 20
;       SPECIAL 19
;       SPECIAL 18
;
;=================================================================
; fixed vector section.
;-----------------------------------------------------------------
        .org    0fffdch
```

```
UDI:
        .lword  dummy_int
OVER_FLOW:
        .lword  dummy_int
BRKI:
        .lword  dummy_int
ADDRESS_MATCH:
        .lword  dummy_int
SINGLE_STEP:
        .lword  dummy_int
WDT:
        .lword  dummy_int
DBC:
        .lword  dummy_int
NMI:
        .lword  dummy_int
RESET:
        .lword  start
;
;******************************************************************************
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;******************************************************************************
```

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