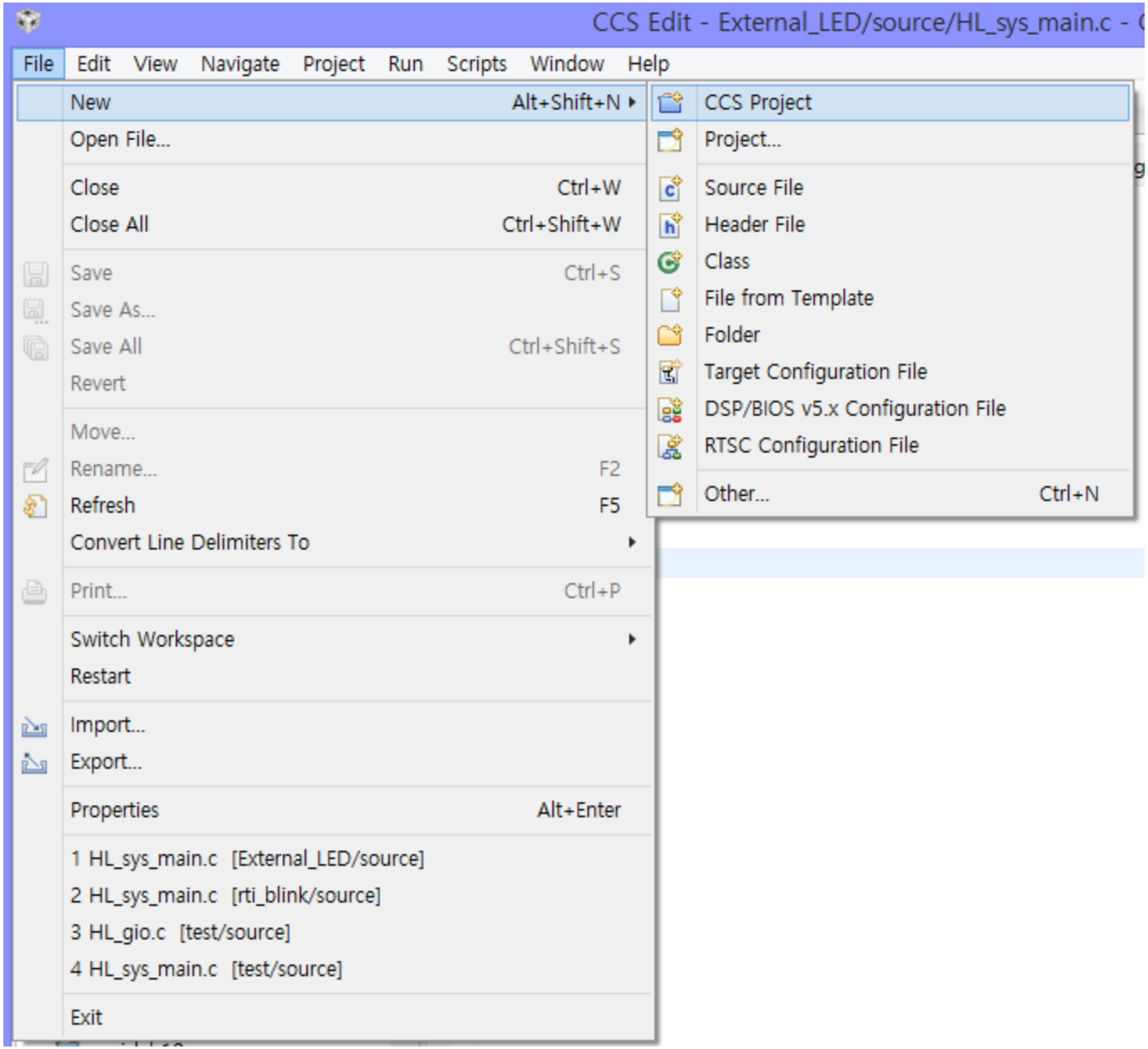
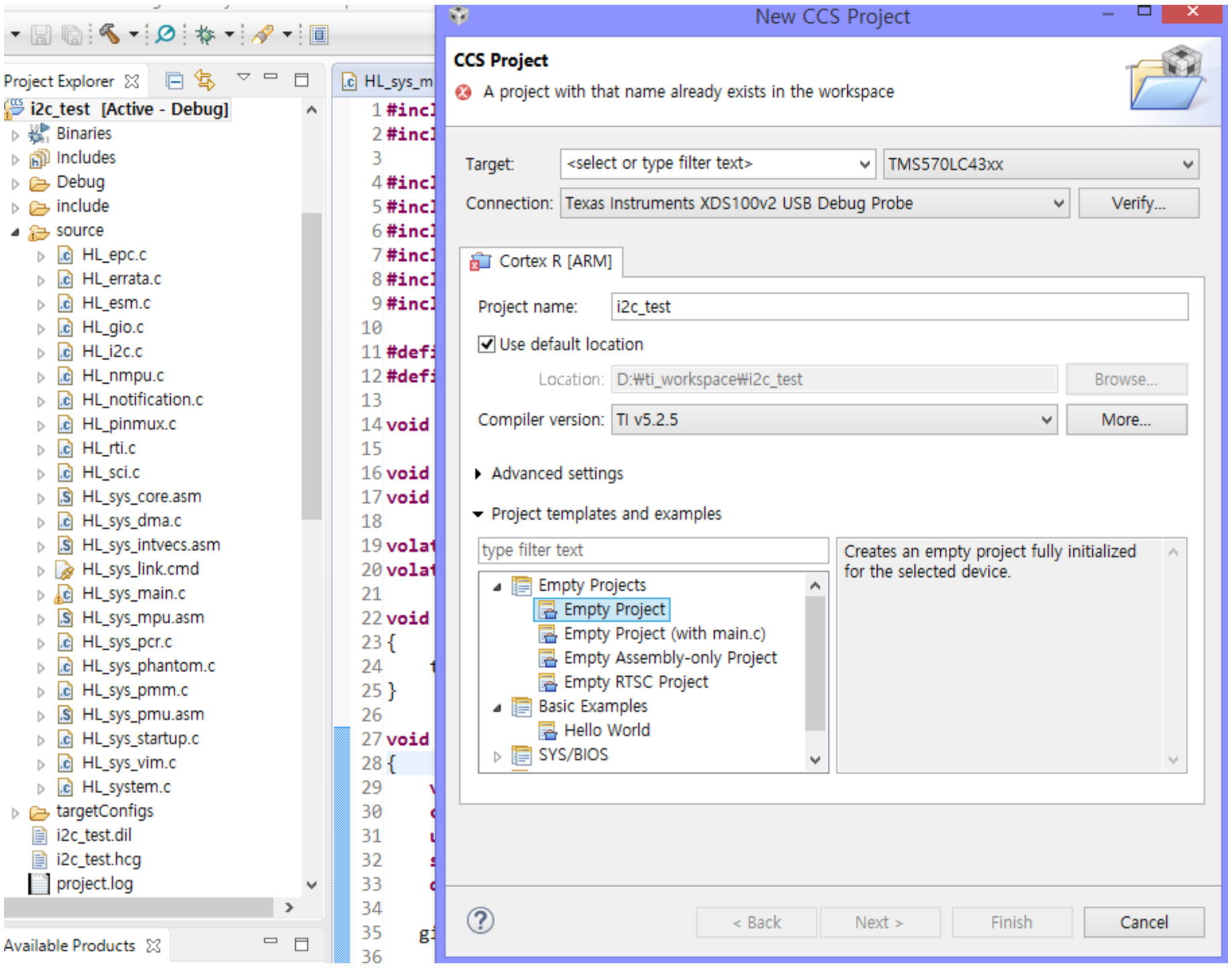
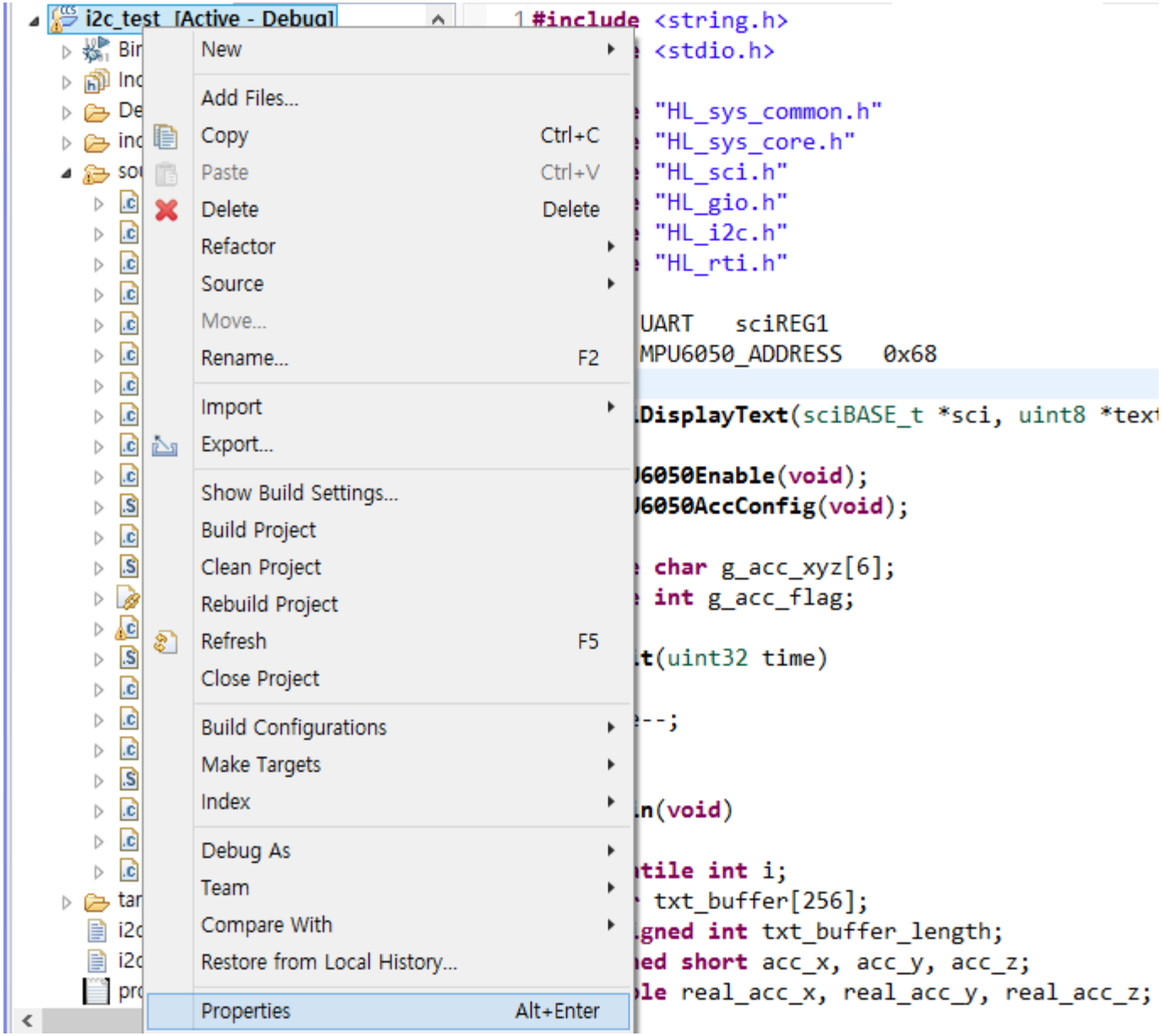
Xilinx Zynq FPGA, TI DSP, MCU 기반의 회로 설계 및 임베디드 전문가 과정

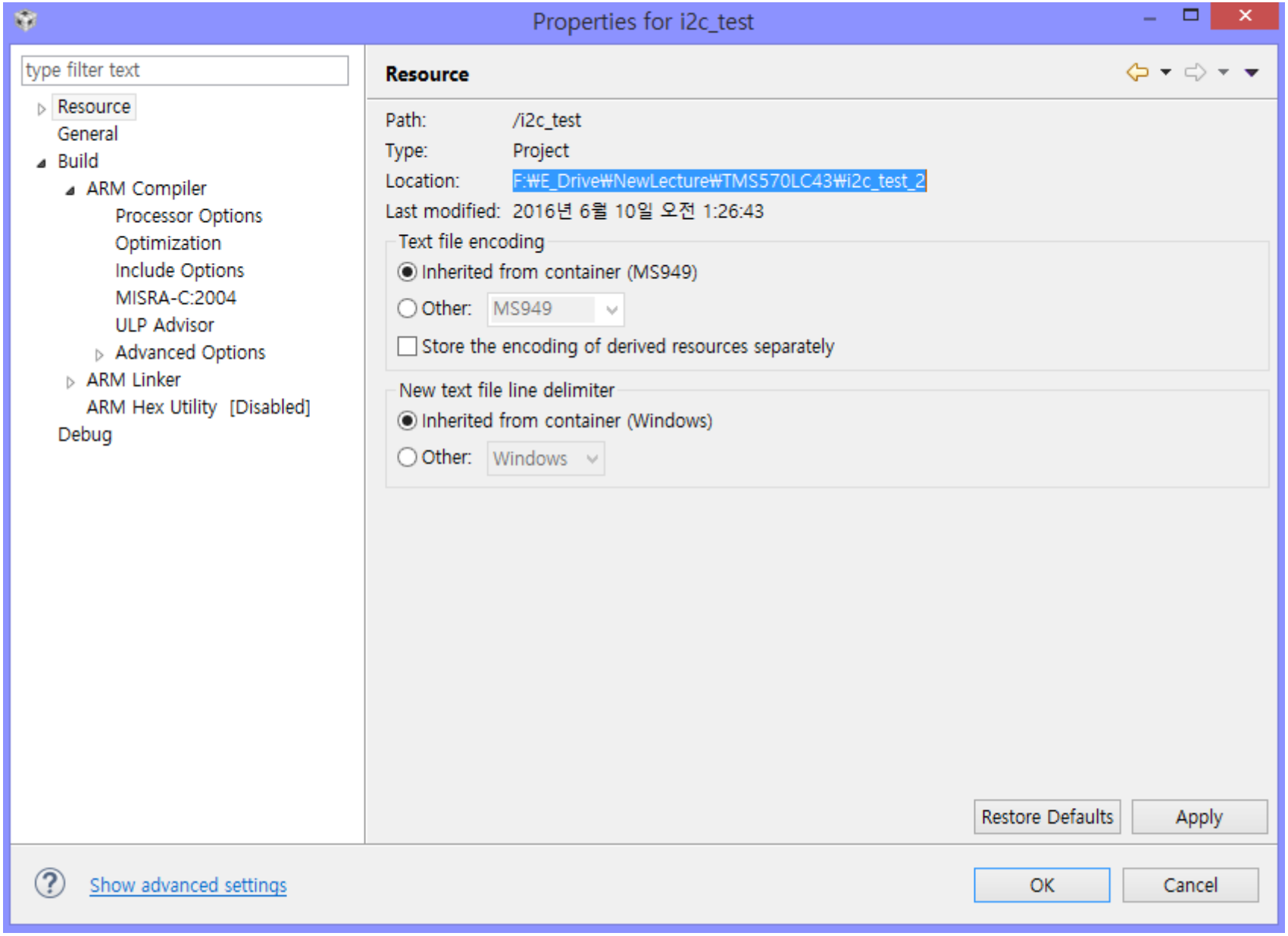
강사 – Innova Lee(이상훈)
gcccompil3r@gmail.com

Cortex-R5 I2C Howto

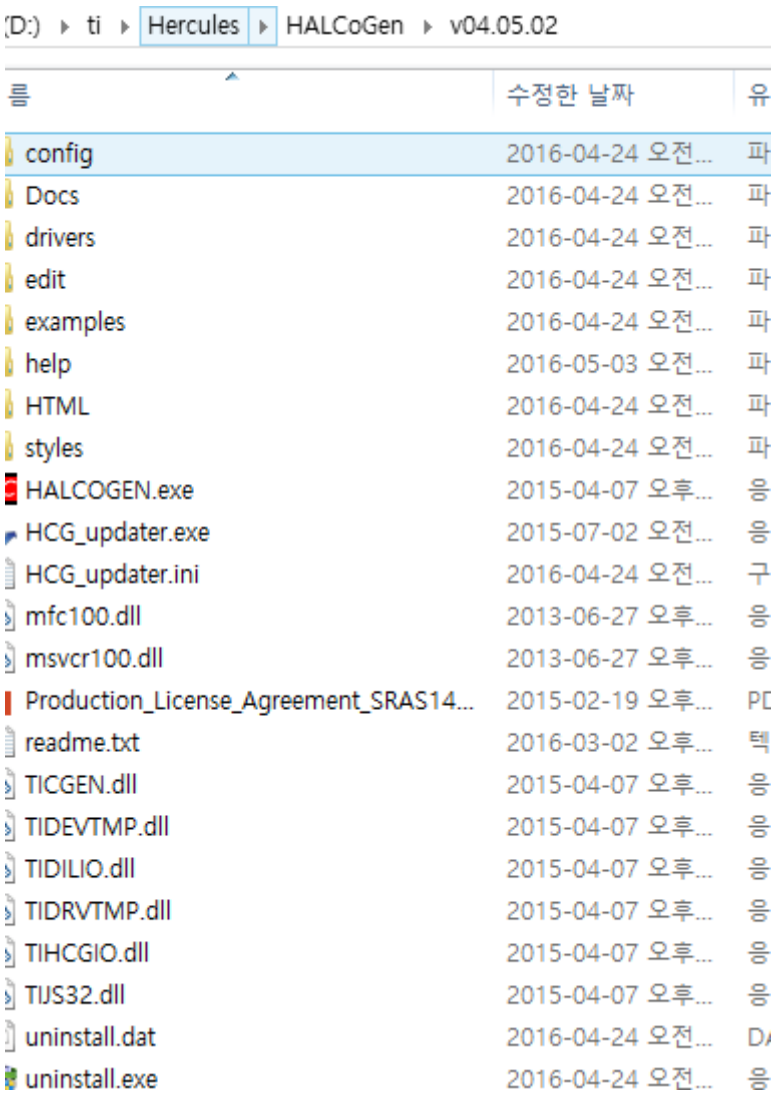

CCS Edit - External_LED/source/HL_sys_main.c -
File
Edit
View
Navigate
Project
Run
Scripts
Window
Help
New Alt+Shift+N
Open File...
Close Ctrl+W
Close All Ctrl+Shift+W
Save Ctrl+S
Save As...
Save All Ctrl+Shift+S
Revert
Move...
Rename... F2
Refresh F5
Convert Line Delimiters To
Print... Ctrl+P
Switch Workspace
Restart
Import...
Export...
Properties Alt+Enter
1 HL_sys_main.c [External_LED/source]
2 HL_sys_main.c [rti_blink/source]
3 HL_gio.c [test/source]
4 HL_sys_main.c [test/source]
Exit
CCS Project
Project...
Source File
Header File
Class
File from Template
Folder
Target Configuration File
DSP/BIOS v5.x Configuration File
RTSC Configuration File
Other... Ctrl+N

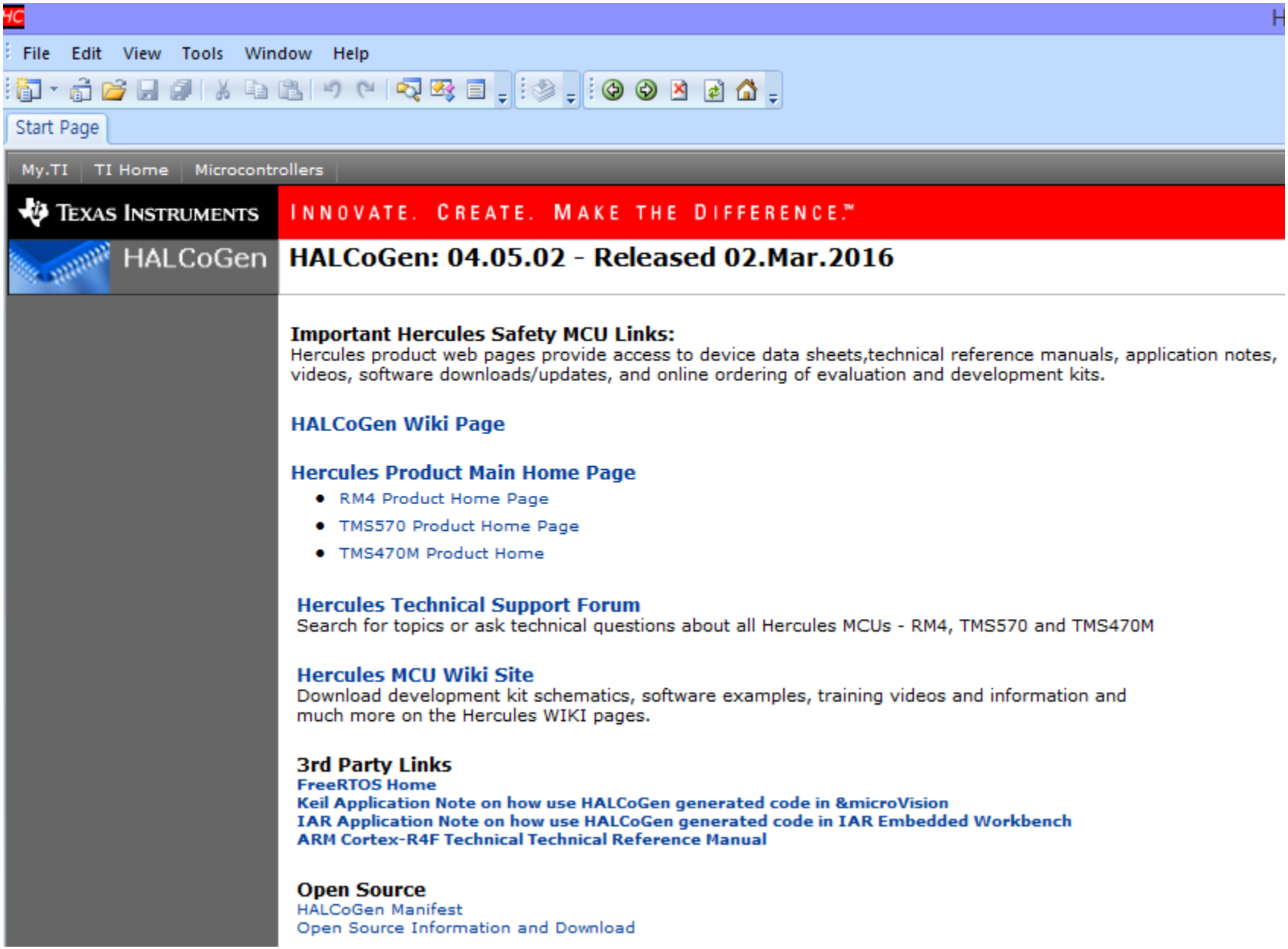

Project Explorer
i2c_test [Active - Debug]
Binaries
Includes
Debug
include
source
HL_epc.c
HL_errata.c
HL_esm.c
HL_gio.c
HL_i2c.c
HL_nmpu.c
HL_notification.c
HL_pinmux.c
HL_rti.c
HL_sci.c
HL_sys_core.asm
HL_sys_dma.c
HL_sys_intvecs.asm
HL_sys_link.cmd
HL_sys_main.c
HL_sys_mpu.asm
HL_sys_pcr.c
HL_sys_phantom.c
HL_sys_pmm.c
HL_sys_pmu.asm
HL_sys_startup.c
HL_sys_vim.c
HL_system.c
targetConfigs
i2c_test.dil
i2c_test.hcg
project.log
Available Products
HL_sys_m
#incl
#incl
#incl
#incl
#incl
#incl
#incl
#defi
#defi
void
void
void
volat
volat
void
{
}
void
{
New CCS Project
CCS Project
A project with that name already exists in the workspace
Target:
<select or type filter text>
TMS570LC43xx
Connection:
Texas Instruments XDS100v2 USB Debug Probe
Verify...
Cortex R [ARM]
Project name:
i2c_test
Use default location
Location:
D:₩ti_workspace₩i2c_test
Browse...
Compiler version:
TI v5.2.5
More...
Advanced settings
Project templates and examples
type filter text
Empty Projects
Empty Project
Empty Project (with main.c)
Empty Assembly-only Project
Empty RTSC Project
Basic Examples
Hello World
SYS/BIOS
Creates an empty project fully initialized for the selected device.
< Back
Next >
Finish
Cancel


i2c_test [Active - Debug]
New
Add Files...
Copy Ctrl+C
Paste Ctrl+V
Delete Delete
Refactor
Source
Move...
Rename... F2
Import
Export...
Show Build Settings...
Build Project
Clean Project
Rebuild Project
Refresh F5
Close Project
Build Configurations
Make Targets
Index
Debug As
Team
Compare With
Restore from Local History...
Properties Alt+Enter
#include <string.h>
<stdio.h>
"HL_sys_common.h"
"HL_sys_core.h"
"HL_sci.h"
"HL_gio.h"
"HL_i2c.h"
"HL_rti.h"
UART sciREG1
MPU6050_ADDRESS 0x68
DisplayText(sciBASE_t *sci, uint8 *text
6050Enable(void);
6050AccConfig(void);
char g_acc_xyz[6];
int g_acc_flag;
t(uint32 time)
--;
n(void)
tile int i;
txt_buffer[256];
gned int txt_buffer_length;
ed short acc_x, acc_y, acc_z;
le real_acc_x, real_acc_y, real_acc_z;


Properties for i2c_test
type filter text
Resource
General
Build
ARM Compiler
Processor Options
Optimization
Include Options
MISRA-C:2004
ULP Advisor
Advanced Options
ARM Linker
ARM Hex Utility [Disabled]
Debug
Resource
Path: /i2c_test
Type: Project
Location: F:₩E_Drive₩NewLecture₩TMS570LC43₩i2c_test_2
Last modified: 2016년 6월 10일 오전 1:26:43
Text file encoding
Inherited from container (MS949)
Other: MS949
Store the encoding of derived resources separately
New text file line delimiter
Inherited from container (Windows)
Other: Windows
Restore Defaults
Apply
Show advanced settings
OK
Cancel

복사한 상태로 HALCoGen을 동작시킨다.




File Edit View Tools Window Help
Start Page
My.TI TI Home Microcontrollers
Texas Instruments
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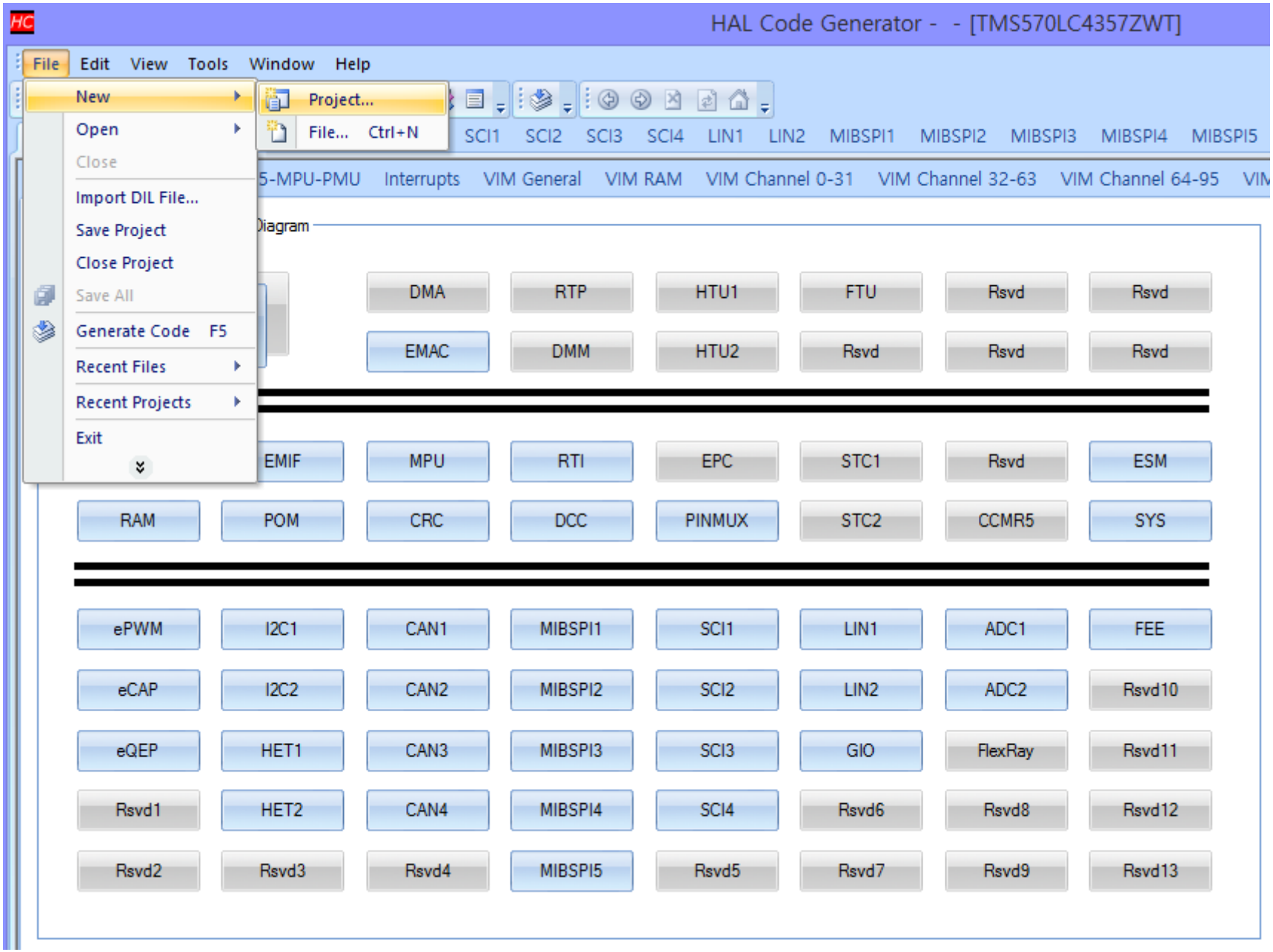
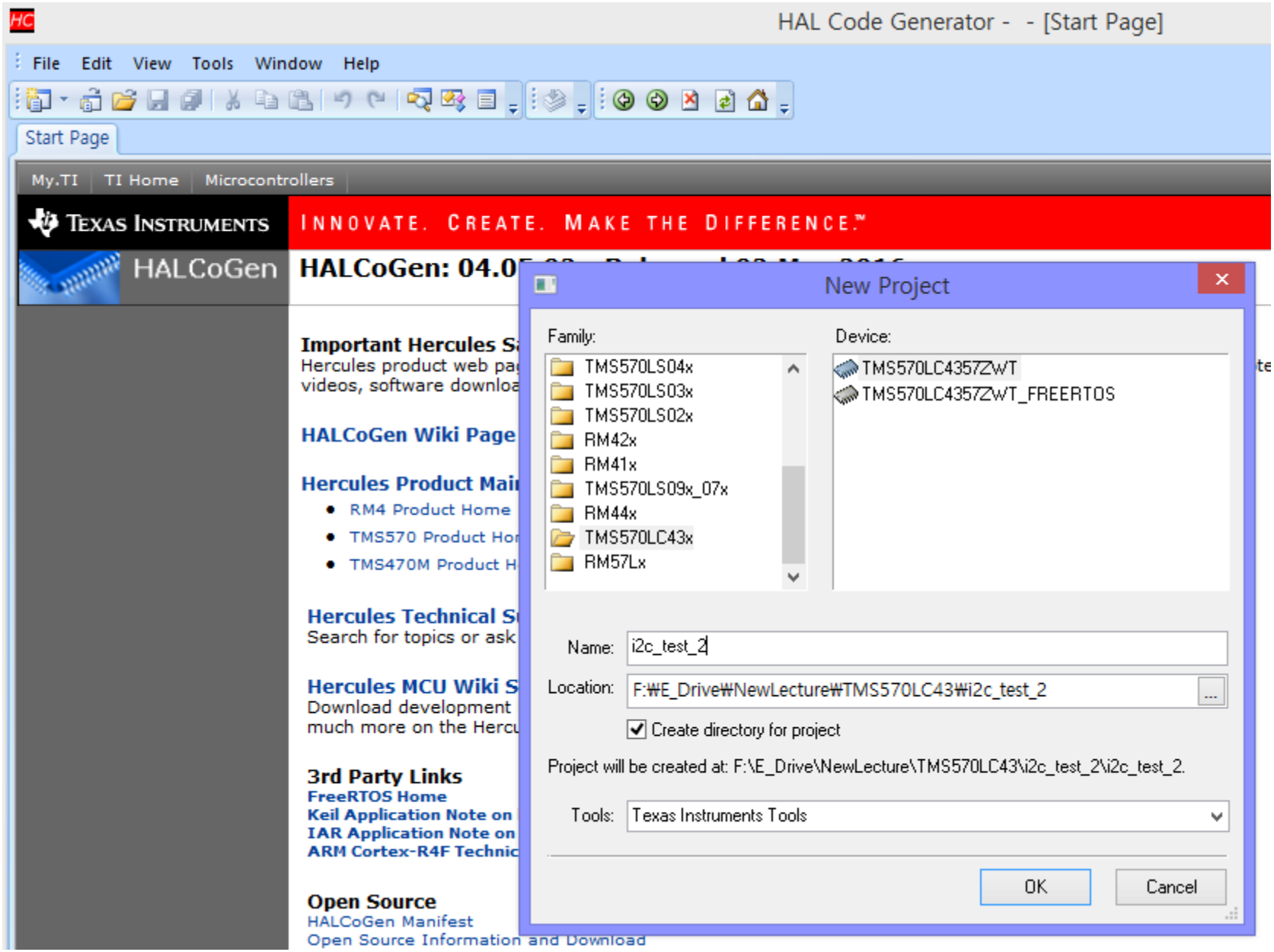
HALCoGen
HALCoGen: 04.05.02 - Released 02.Mar.2016
Important Hercules Safety MCU Links:
Hercules product web pages provide access to device data sheets,technical reference manuals, application notes, videos, software downloads/updates, and online ordering of evaluation and development kits.
HALCoGen Wiki Page
Hercules Product Main Home Page
RM4 Product Home Page
TMS570 Product Home Page
TMS470M Product Home
Hercules Technical Support Forum
Search for topics or ask technical questions about all Hercules MCUs - RM4, TMS570 and TMS470M
Hercules MCU Wiki Site
Download development kit schematics, software examples, training videos and information and much more on the Hercules WIKI pages.
3rd Party Links
FreeRTOS Home
Keil Application Note on how use HALCoGen generated code in &microVision
IAR Application Note on how use HALCoGen generated code in IAR Embedded Workbench
ARM Cortex-R4F Technical Technical Reference Manual
Open Source
HALCoGen Manifest
Open Source Information and Download


HAL Code Generator - - [TMS570LC4357ZWT]
File
Edit
View
Tools
Window
Help
New
Open
Close
Import DIL File...
Save Project
Close Project
Save All
Generate Code F5
Recent Files
Recent Projects
Exit
Project...
File... Ctrl+N
SCI1 SCI2 SCI3 SCI4 LIN1 LIN2 MIBSPI1 MIBSPI2 MIBSPI3 MIBSPI4 MIBSPI5
5-MPU-PMU Interrupts VIM General VIM RAM VIM Channel 0-31 VIM Channel 32-63 VIM Channel 64-95
Diagram
DMA RTP HTU1 FTU Rsvd Rsvd
EMAC DMM HTU2 Rsvd Rsvd Rsvd
EMIF MPU RTI EPC STC1 Rsvd ESM
RAM POM CRC DCC PINMUX STC2 CCMR5 SYS
ePWM I2C1 CAN1 MIBSPI1 SCI1 LIN1 ADC1 FEE
eCAP I2C2 CAN2 MIBSPI2 SCI2 LIN2 ADC2 Rsvd10
eQEP HET1 CAN3 MIBSPI3 SCI3 GIO FlexRay Rsvd11
Rsvd1 HET2 CAN4 MIBSPI4 SCI4 Rsvd6 Rsvd8 Rsvd12
Rsvd2 Rsvd3 Rsvd4 MIBSPI5 Rsvd5 Rsvd7 Rsvd9 Rsvd13


HAL Code Generator - - [Start Page]
File Edit View Tools Window Help
Start Page
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Texas Instruments
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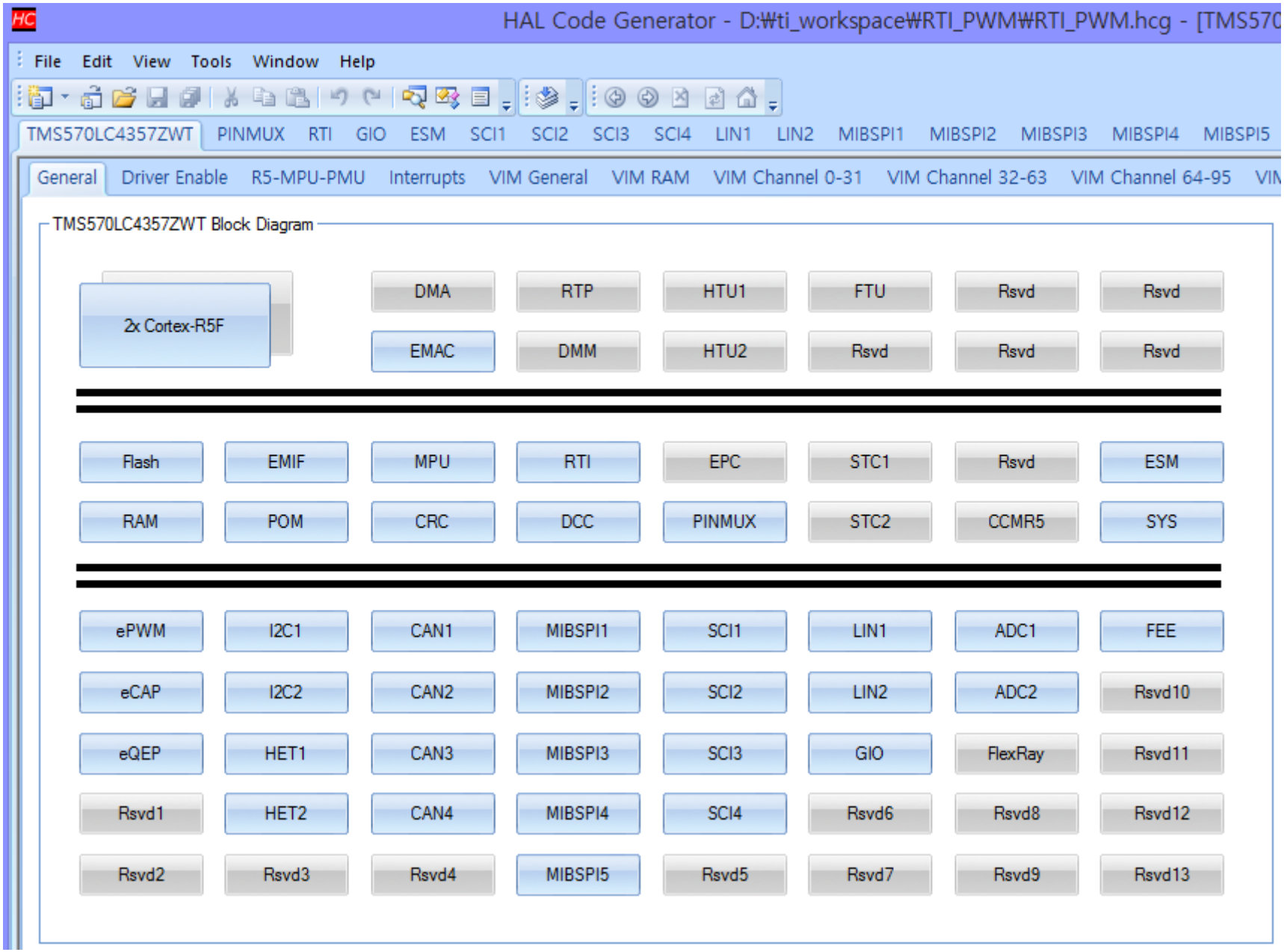
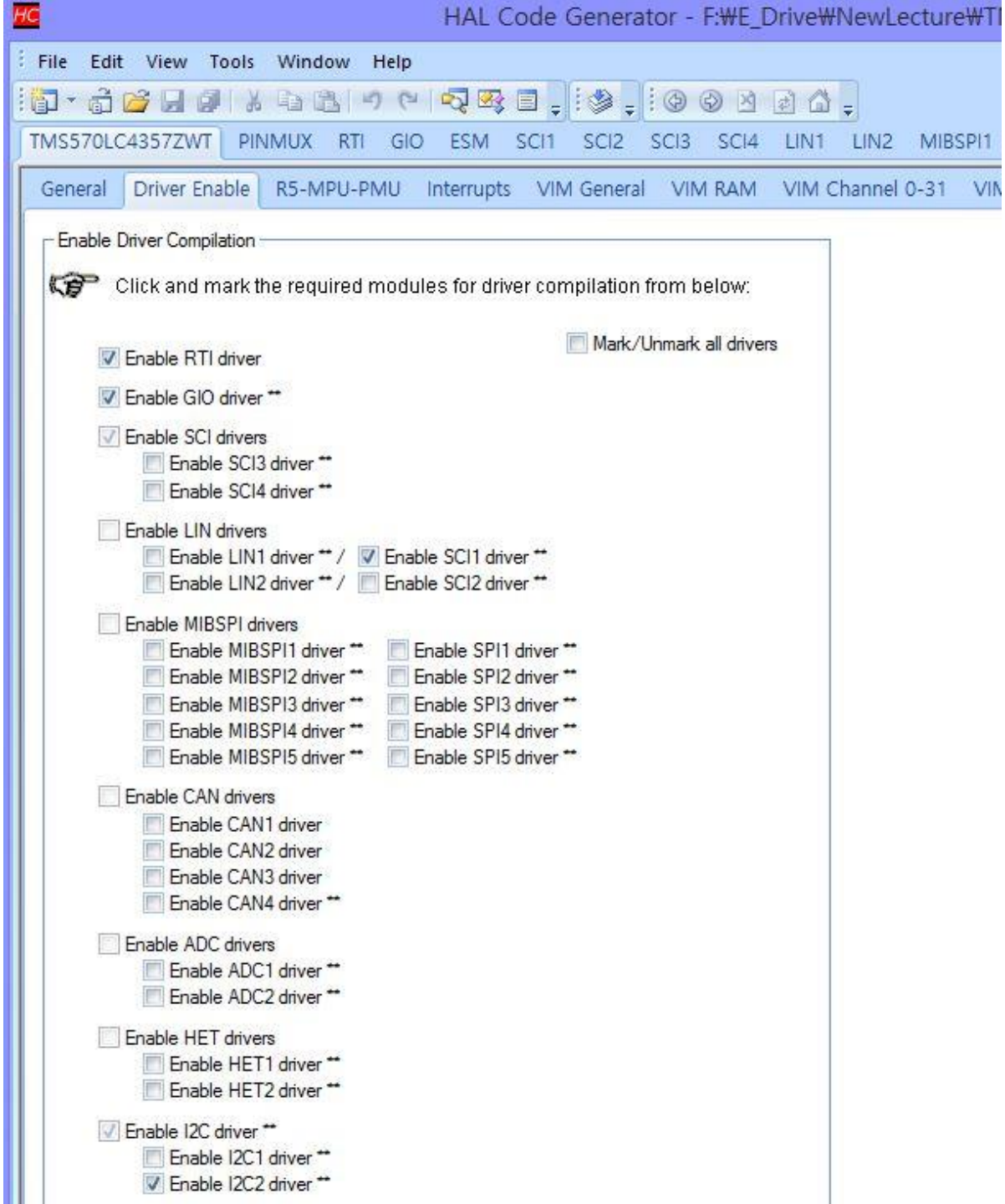
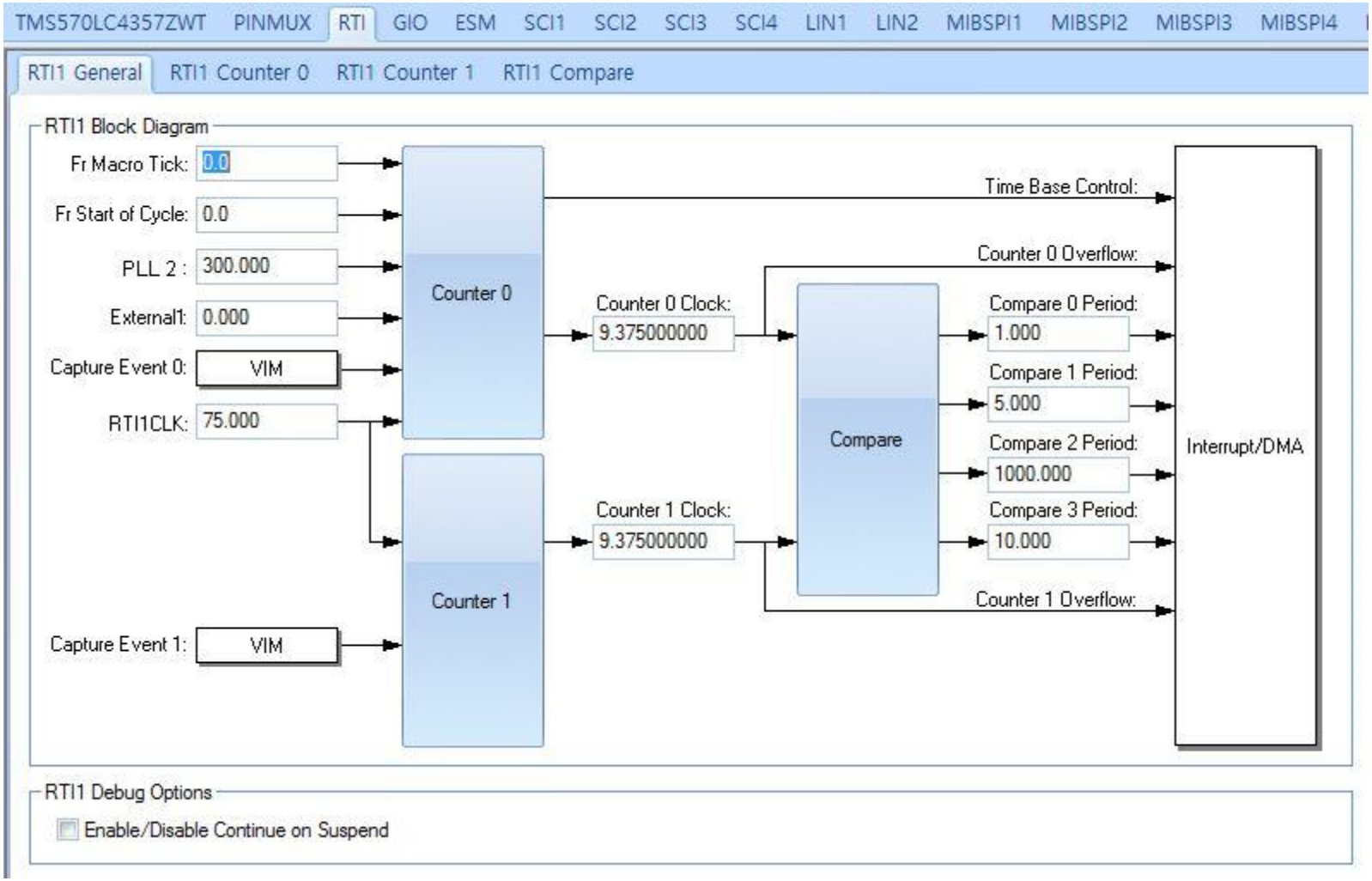
HALCoGen
HALCoGen: 04.0
Important Hercules S
Hercules product web pa
videos, software downloa
HALCoGen Wiki Page
Hercules Product Mai
RM4 Product Home
TMS570 Product Hor
TMS470M Product H
Hercules Technical S
Search for topics or ask
Hercules MCU Wiki S
Download development
much more on the Hercu
3rd Party Links
FreeRTOS Home
Keil Application Note on
IAR Application Note on
ARM Cortex-R4F Technic
Open Source
HALCoGen Manifest
Open Source Information and Download
New Project
Family:
TMS570LS04x
TMS570LS03x
TMS570LS02x
RM42x
RM41x
TMS570LS09x_07x
RM44x
TMS570LC43x
RM57Lx
Device:
TMS570LC4357ZWT
TMS570LC4357ZWT_FREERTOS
Name: i2c_test_2
Location: F:₩E_Drive₩NewLecture₩TMS570LC43₩i2c_test_2
Create directory for project
Project will be created at: F:\E_Drive\NewLecture\TMS570LC43\i2c_test_2\i2c_test_2.
Tools: Texas Instruments Tools
OK
Cancel

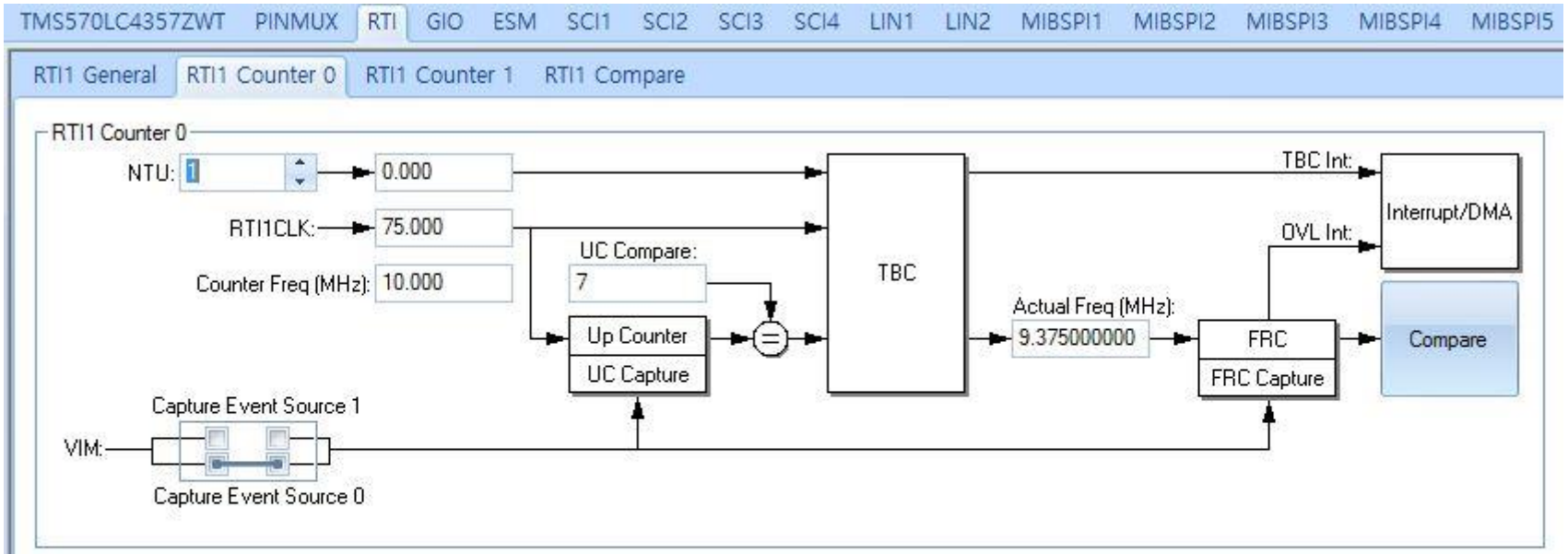
이번엔 PWM 을 활용하여 LED 를 제어해보도록 하자!

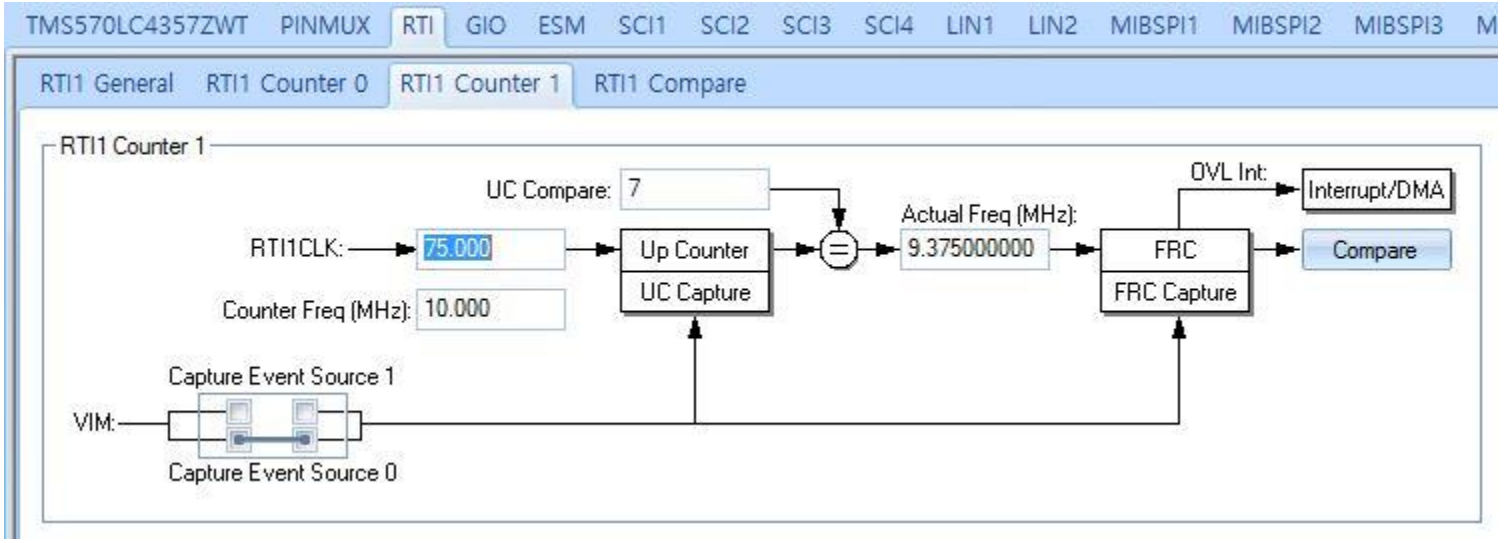


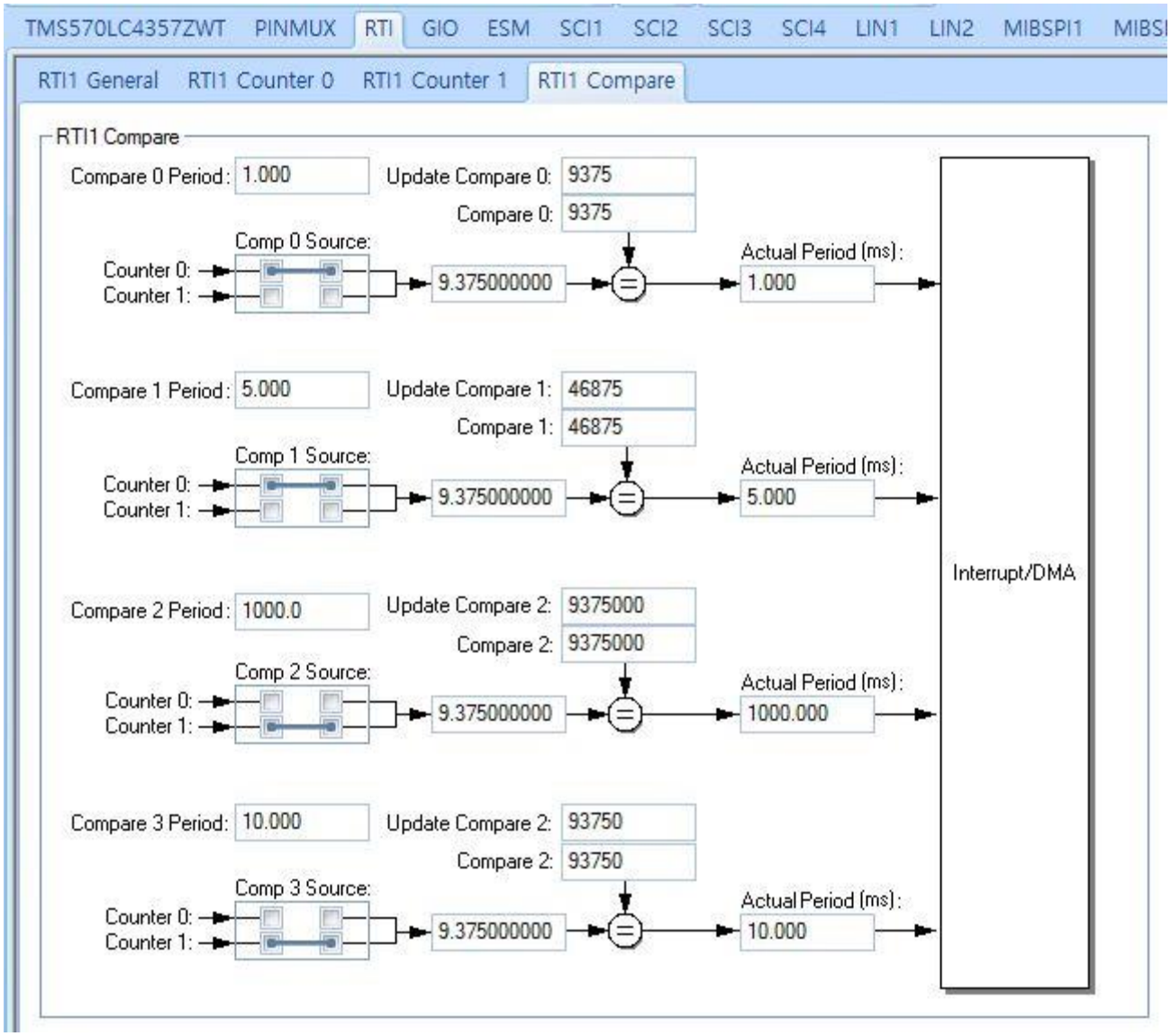

HAL Code Generator - F:₩E_Drive₩NewLecture₩TI
File Edit View Tools Window Help
TMS570LC4357ZWT PINMUX RTI GIO ESM SCI1 SCI2 SCI3 SCI4 LIN1 LIN2 MIBSPI1
General Driver Enable R5-MPU-PMU Interrupts VIM General VIM RAM VIM Channel 0-31 VIM
Enable Driver Compilation
Click and mark the required modules for driver compilation from below:
Mark/Unmark all drivers
Enable RTI driver
Enable GIO driver **
Enable SCI drivers
Enable SCI3 driver **
Enable SCI4 driver **
Enable LIN drivers
Enable LIN1 driver ** / Enable SCI1 driver **
Enable LIN2 driver ** / Enable SCI2 driver **
Enable MIBSPI drivers
Enable MIBSPI1 driver ** Enable SPI1 driver **
Enable MIBSPI2 driver ** Enable SPI2 driver **
Enable MIBSPI3 driver ** Enable SPI3 driver **
Enable MIBSPI4 driver ** Enable SPI4 driver **
Enable MIBSPI5 driver ** Enable SPI5 driver **
Enable CAN drivers
Enable CAN1 driver
Enable CAN2 driver
Enable CAN3 driver
Enable CAN4 driver **
Enable ADC drivers
Enable ADC1 driver **
Enable ADC2 driver **
Enable HET drivers
Enable HET1 driver **
Enable HET2 driver **
Enable I2C driver **
Enable I2C1 driver **
Enable I2C2 driver **

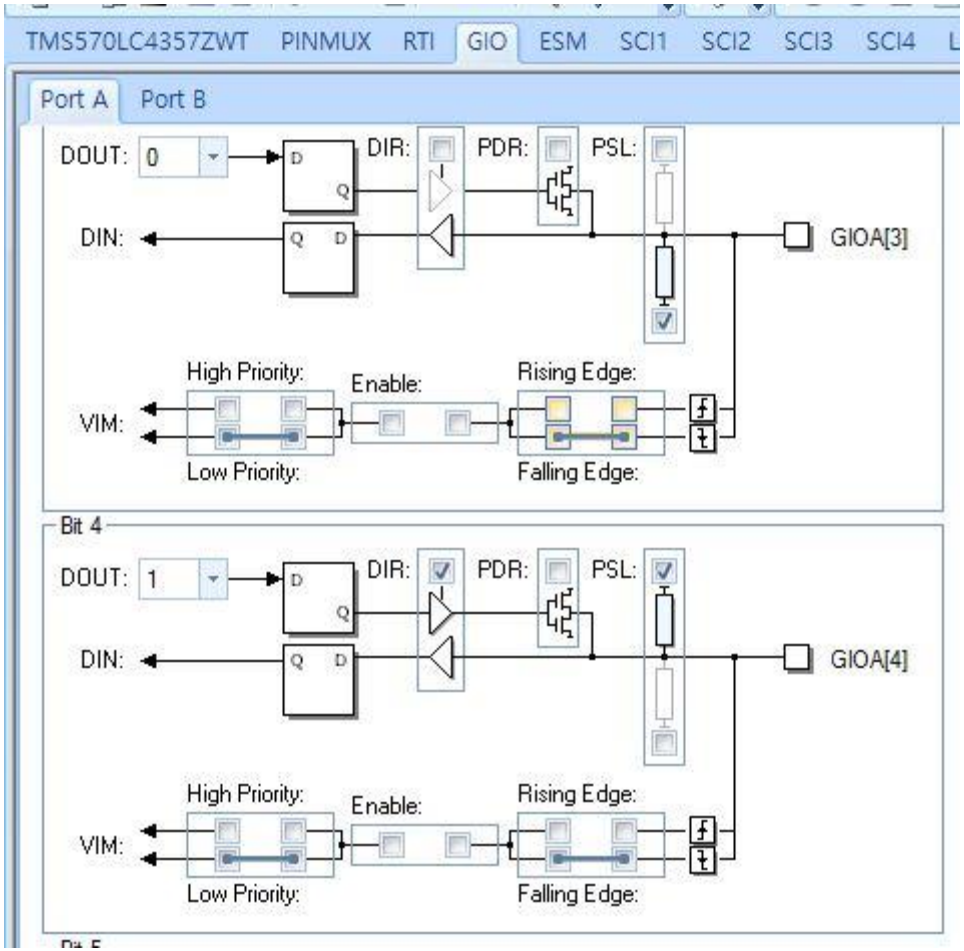

TMS570LC4357ZWT
PINMUX
RTI
GIO
ESM
SCI1
SCI2
SCI3
SCI4
LIN1
LIN2
MIBSPI1
MIBSPI2
MIBSPI3
MIBSP
Pin Muxing
Input Pin Muxing
Special Pin Muxing
F3 MIBSPI1NCS[1] NONE MII_COL N2HET1[17] NONE eQEP1S
F5 ETMDATA[21] EMIF_DATA[05] NONE NONE NONE NONE
G3 MIBSPI1NCS[2] NONE MDIO N2HET1[19] NONE NONE
G5 ETMDATA[22] EMIF_DATA[06] NONE NONE NONE NONE
G16 MIBSPI5SOMI[3] DMM_DATA[15] I2C2_SCL NONE EXT_ENA NONE
G17 MIBSPI5SIMO[3] DMM_DATA[11] I2C2_SDA NONE EXT_SEL[02] NONE
G19 MIBSPI1NENA NONE MII_RXD[2] N2HET1[23] NONE ECAP4
H3 GIOA[6] NONE N2HET2[04] NONE NONE eTPWM1B
H4 N2HET1[21] EMIF_nDQM[2] NONE NONE NONE NONE
H16 MIBSPI5SOMI[2] DMM_DATA[14] NONE NONE EXT_SEL[04] NONE
H17 MIBSPI5SIMO[2] DMM_DATA[10] NONE NONE EXT_SEL[01] NONE
H18 MIBSPI5NENA DMM_DATA[07] MII_RXD[3] NONE NONE ECAP5

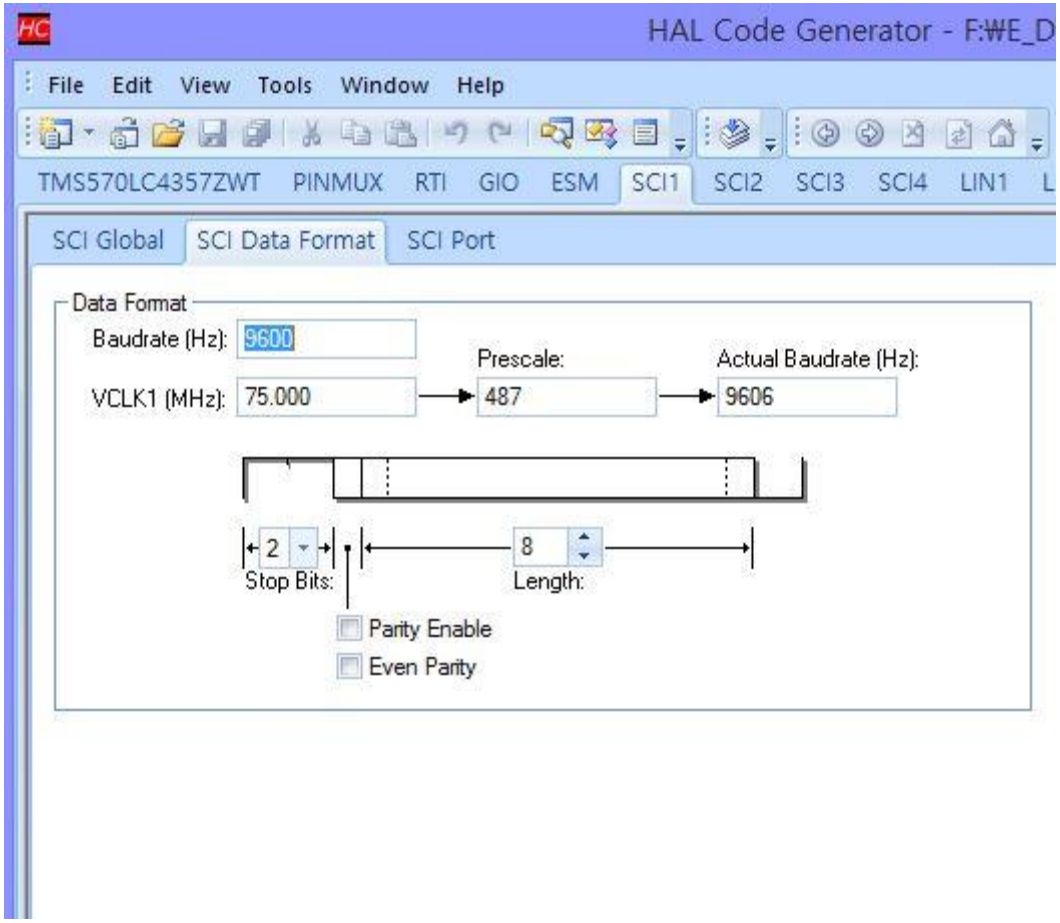

TMS570LC4357ZWT
PINMUX
RTI
GIO
ESM
SCI1
SCI2
SCI3
SCI4
LIN1
LIN2
MIBSPI1
MIBSPI2
MIBSPI3
MIBSPI4
RTI1 General
RTI1 Counter 0
RTI1 Counter 1
RTI1 Compare
RTI1 Block Diagram
Fr Macro Tick:
0.0
Fr Start of Cycle:
0.0
PLL 2 :
300.000
External1:
0.000
Capture Event 0:
VIM
RTI1CLK:
75.000
Capture Event 1:
VIM
Counter 0
Counter 1
Counter 0 Clock:
9.375000000
Counter 1 Clock:
9.375000000
Compare
Time Base Control:
Counter 0 Overflow:
Compare 0 Period:
1.000
Compare 1 Period:
5.000
Compare 2 Period:
1000.000
Compare 3 Period:
10.000
Counter 1 Overflow:
Interrupt/DMA
RTI1 Debug Options
Enable/Disable Continue on Suspend

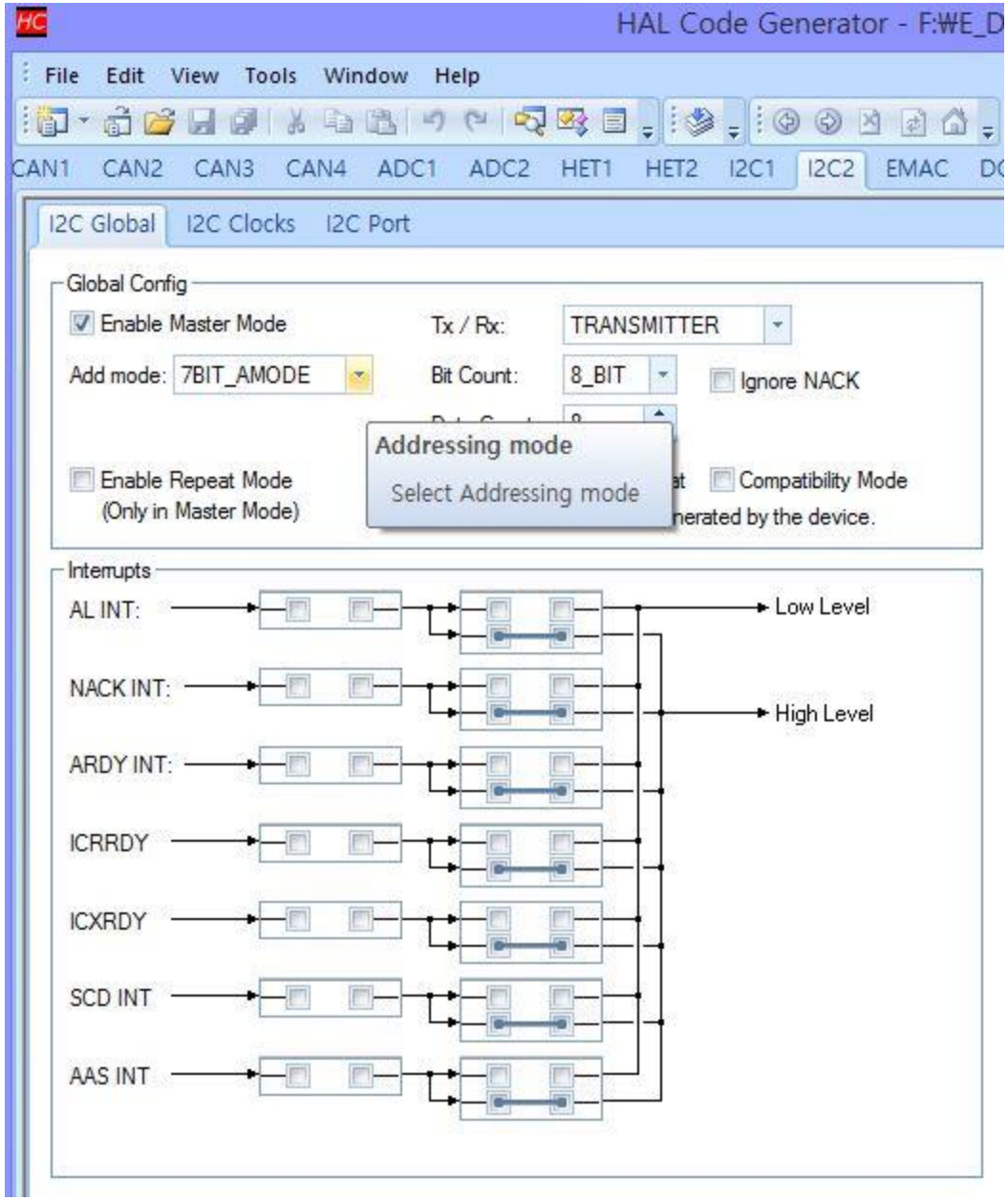

TMS570LC4357ZWT
PINMUX
RTI
GIO
ESM
SCI1
SCI2
SCI3
SCI4
LIN1
LIN2
MIBSPI1
MIBSPI2
MIBSPI3
MIBSPI4
MIBSPI5
RTI1 General
RTI1 Counter 0
RTI1 Counter 1
RTI1 Compare
RTI1 Counter 0
NTU:
1
0.000
RTI1CLK:
75.000
Counter Freq (MHz):
10.000
UC Compare:
7
Up Counter
UC Capture
TBC
TBC Int:
Interrupt/DMA
OVL Int:
Actual Freq (MHz):
9.375000000
FRC
FRC Capture
Compare
Capture Event Source 1
VIM:
Capture Event Source 0

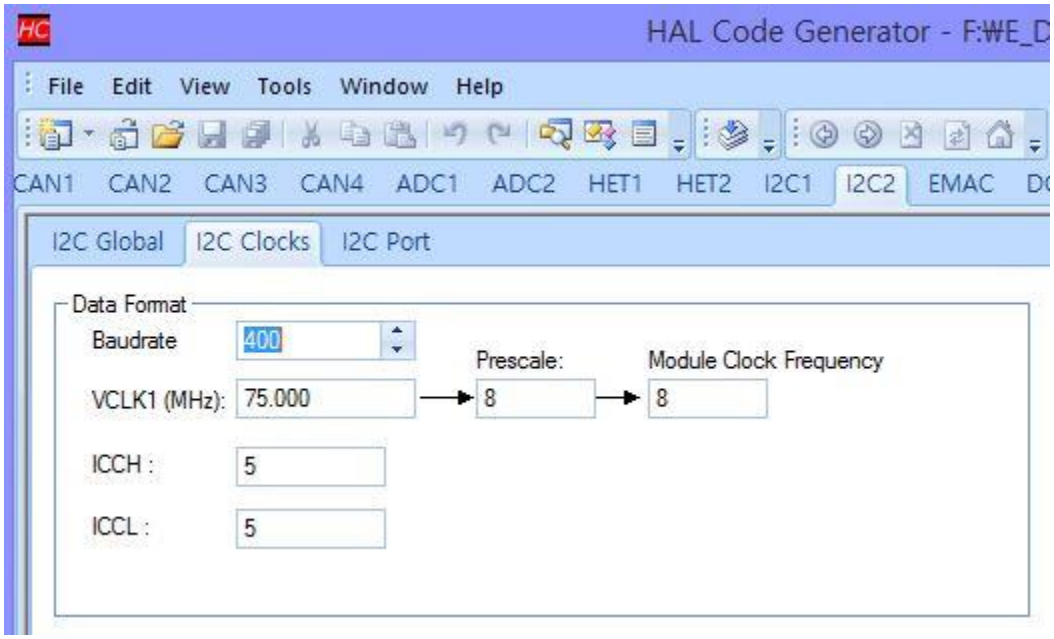

TMS570LC4357ZWT
PINMUX
RTI
GIO
ESM
SCI1
SCI2
SCI3
SCI4
LIN1
LIN2
MIBSPI1
MIBSPI2
MIBSPI3
M
RTI1 General
RTI1 Counter 0
RTI1 Counter 1
RTI1 Compare
RTI1 Counter 1
UC Compare:
7
RTI1CLK:
75.000
Counter Freq (MHz):
10.000
Up Counter
UC Capture
Actual Freq (MHz):
9.375000000
OVL Int:
Interrupt/DMA
FRC
FRC Capture
Compare
Capture Event Source 1
VIM:
Capture Event Source 0

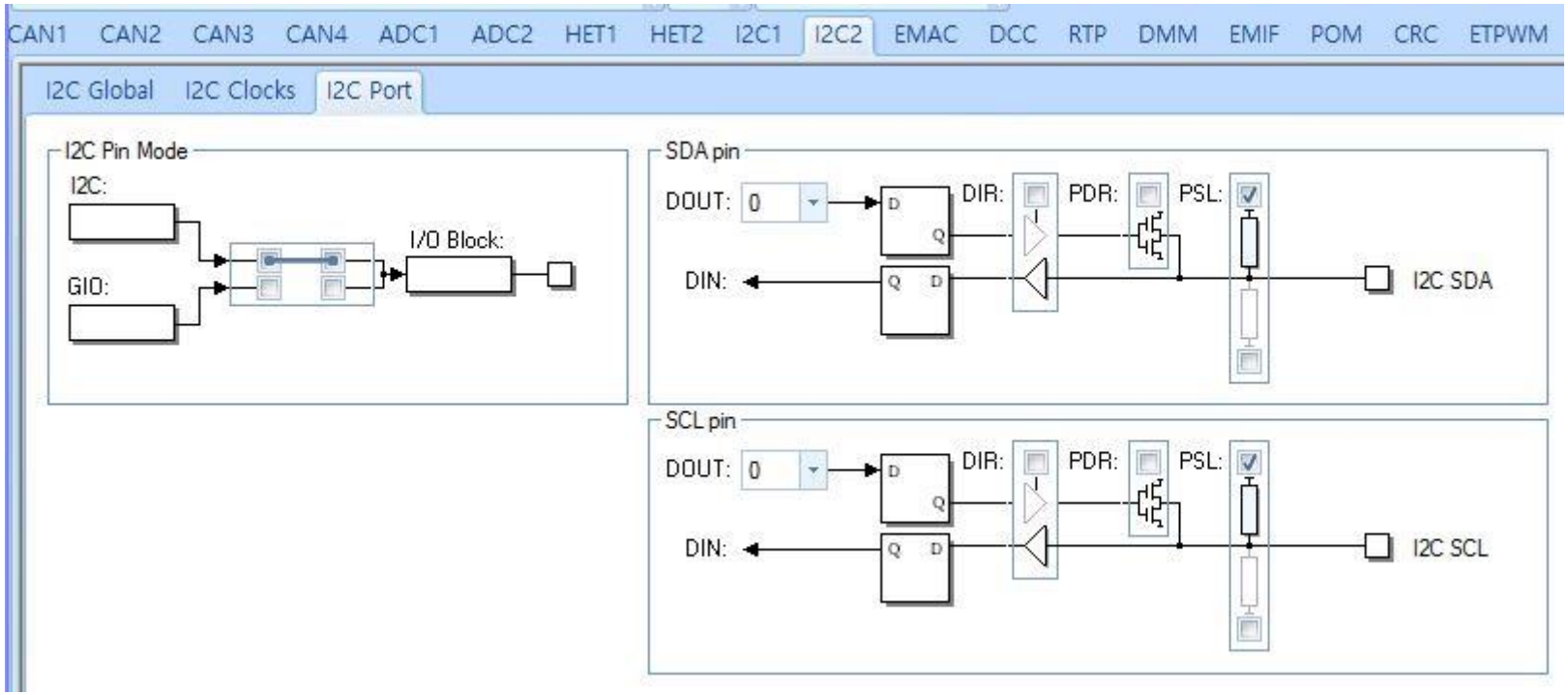

TMS570LC4357ZWT
PINMUX
RTI
GIO
ESM
SCI1
SCI2
SCI3
SCI4
LIN1
LIN2
MIBSPI1
RTI1 General
RTI1 Counter 0
RTI1 Counter 1
RTI1 Compare
RTI1 Compare
Compare 0 Period: 1.000
Update Compare 0: 9375
Compare 0: 9375
Comp 0 Source:
Counter 0:
Counter 1:
9.375000000
Actual Period (ms): 1.000
Compare 1 Period: 5.000
Update Compare 1: 46875
Compare 1: 46875
Comp 1 Source:
Counter 0:
Counter 1:
9.375000000
Actual Period (ms): 5.000
Compare 2 Period: 1000.0
Update Compare 2: 9375000
Compare 2: 9375000
Comp 2 Source:
Counter 0:
Counter 1:
9.375000000
Actual Period (ms): 1000.000
Compare 3 Period: 10.000
Update Compare 2: 93750
Compare 2: 93750
Comp 3 Source:
Counter 0:
Counter 1:
9.375000000
Actual Period (ms): 10.000
Interrupt/DMA

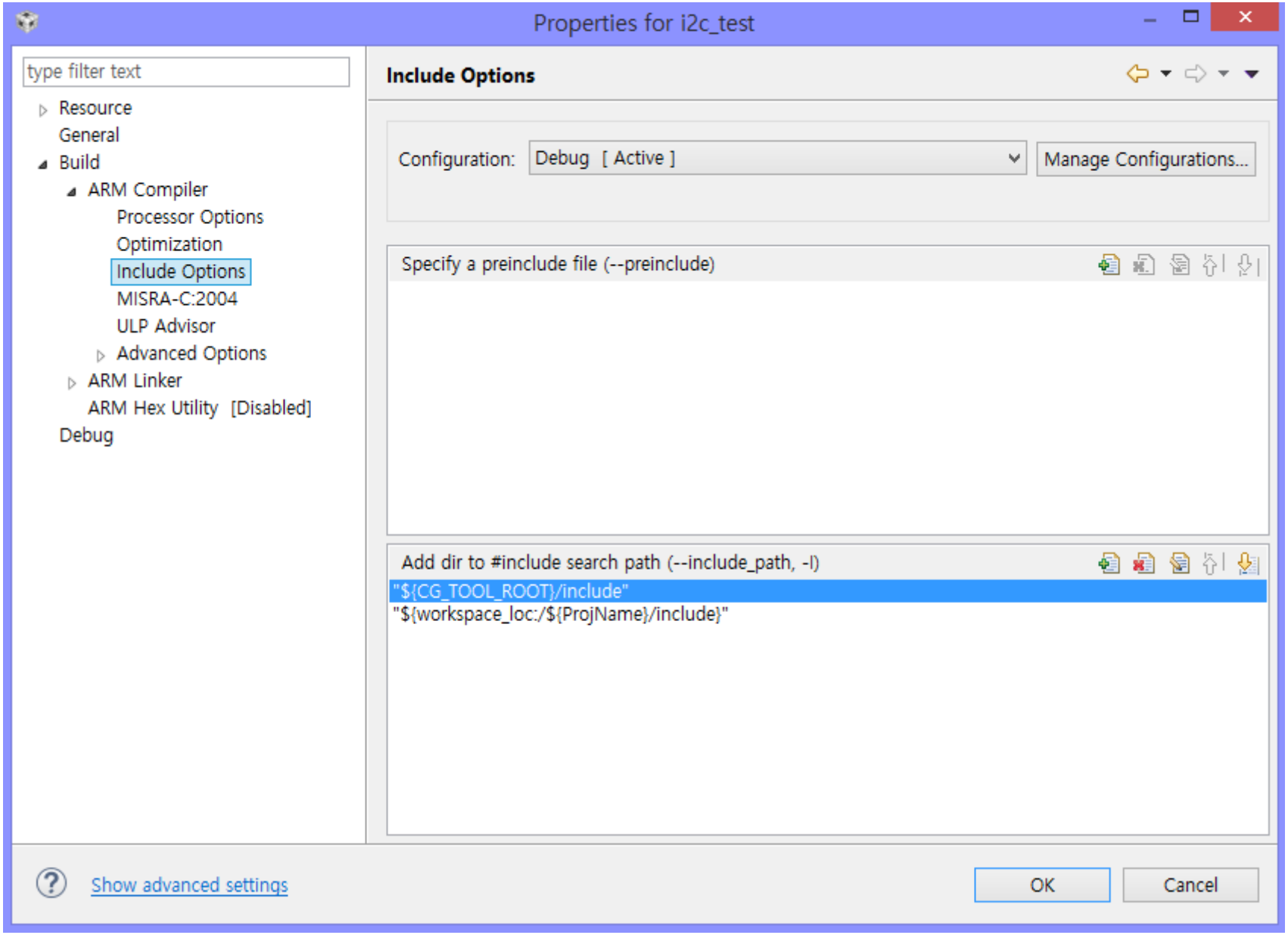

TMS570LC4357ZWT
PINMUX
RTI
GIO
ESM
SCI1
SCI2
SCI3
SCI4
Port A
Port B
DOUT:
0
DIR:
PDR:
PSL:
DIN:
GIOA[3]
High Priority:
Enable:
Rising Edge:
VIM:
Low Priority:
Falling Edge:
Bit 4
DOUT:
1
DIR:
PDR:
PSL:
DIN:
GIOA[4]
High Priority:
Enable:
Rising Edge:
VIM:
Low Priority:
Falling Edge:


HAL Code Generator - F:₩E_D
File
Edit
View
Tools
Window
Help
TMS570LC4357ZWT
PINMUX
RTI
GIO
ESM
SCI1
SCI2
SCI3
SCI4
LIN1
SCI Global
SCI Data Format
SCI Port
Data Format
Baudrate (Hz):
9600
Prescale:
Actual Baudrate (Hz):
VCLK1 (MHz):
75.000
487
9606
2
Stop Bits:
8
Length:
Parity Enable
Even Parity


HAL Code Generator - F:₩E_D
File Edit View Tools Window Help
CAN1 CAN2 CAN3 CAN4 ADC1 ADC2 HET1 HET2 I2C1 I2C2 EMAC
I2C Global I2C Clocks I2C Port
Global Config
Enable Master Mode
Tx / Rx:
TRANSMITTER
Add mode:
7BIT_AMODE
Bit Count:
8_BIT
Ignore NACK
Addressing mode
Select Addressing mode
Enable Repeat Mode
(Only in Master Mode)
Compatibility Mode
Interrupts
AL INT:
NACK INT:
ARDY INT:
ICRRDY
ICXRDY
SCD INT
AAS INT
Low Level
High Level

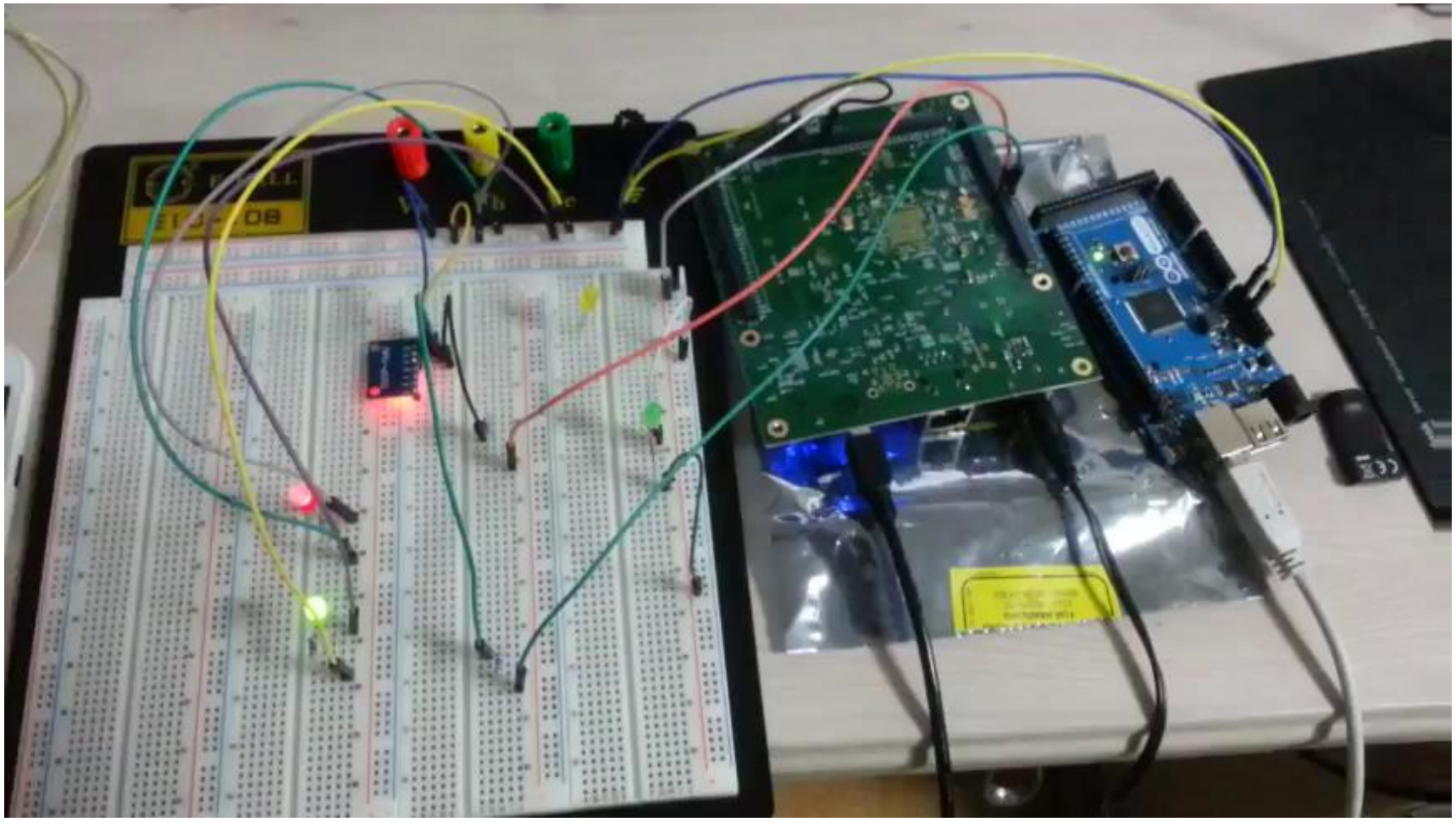

HAL Code Generator - F:₩E_D
File Edit View Tools Window Help
CAN1 CAN2 CAN3 CAN4 ADC1 ADC2 HET1 HET2 I2C1 I2C2 EMAC
I2C Global I2C Clocks I2C Port
Data Format
Baudrate 400
VCLK1 (MHz): 75.000
Prescale: 8
Module Clock Frequency 8
ICCH : 5
ICCL : 5

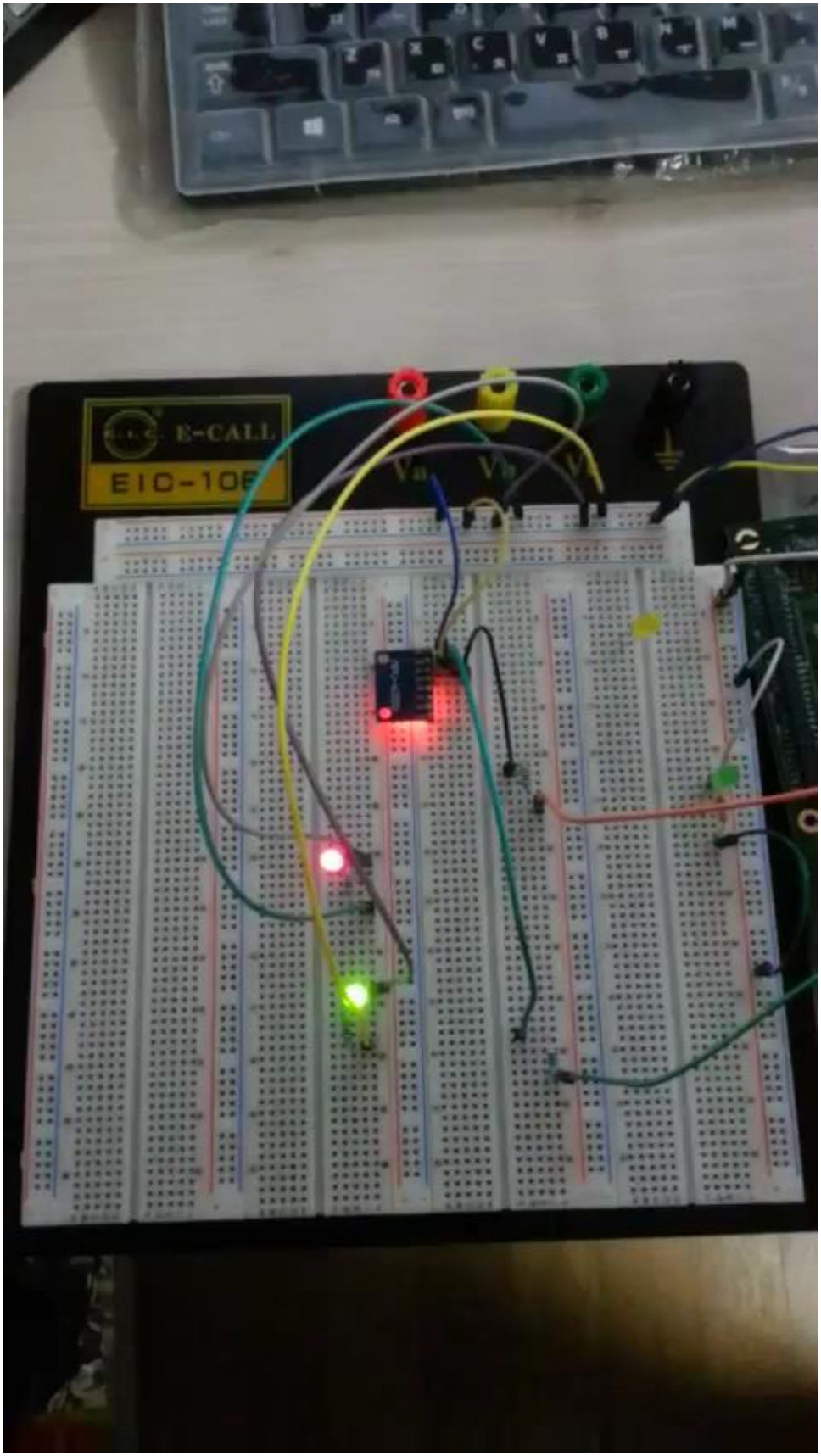

CAN1 CAN2 CAN3 CAN4 ADC1 ADC2 HET1 HET2 I2C1 I2C2 EMAC DCC RTP DMM EMIF POM CRC ETPWM
I2C Global I2C Clocks I2C Port
I2C Pin Mode
I2C:
GIO:
I/O Block:
SDA pin
DOUT: 0
DIN:
DIR:
PDR:
PSL:
I2C SDA
SCL pin
DOUT: 0
DIN:
DIR:
PDR:
PSL:
I2C SCL


Properties for i2c_test
type filter text
Resource
General
Build
ARM Compiler
Processor Options
Optimization
Include Options
MISRA-C:2004
ULP Advisor
Advanced Options
ARM Linker
ARM Hex Utility [Disabled]
Debug
Include Options
Configuration: Debug [Active]
Manage Configurations...
Specify a preinclude file (--preinclude)
Add dir to #include search path (--include_path, -I)
"${CG_TOOL_ROOT}/include"
"${workspace_loc:/${ProjName}/include}"
Show advanced settings
OK
Cancel

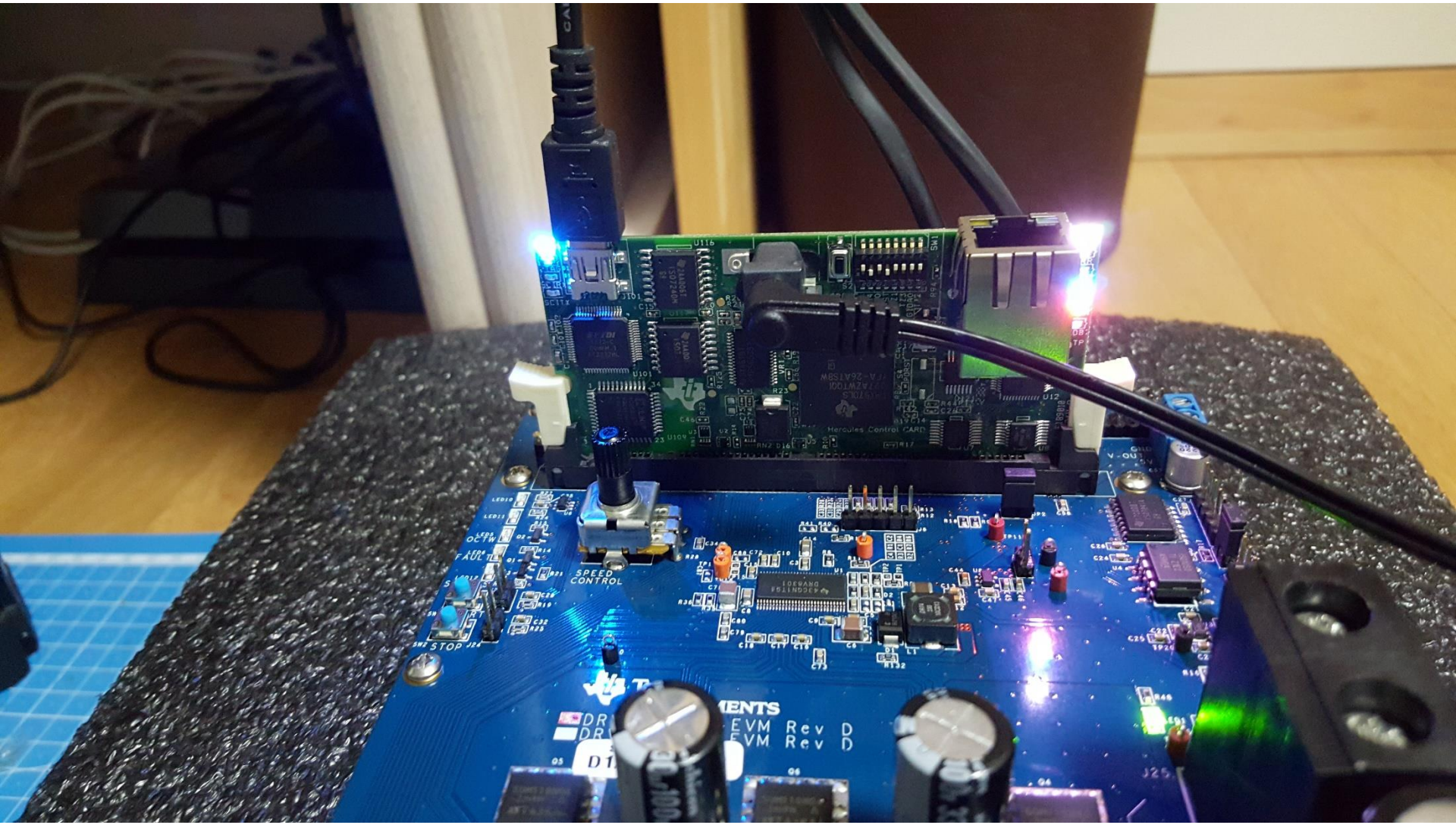
이후의 코드 부분은 github 에 올려놓은
main 코드와 각종 Device 초기화 코드를 살펴보면 된다.

추가적으로 우리는 이제 5V 전원을 공급할 수 있는 회로를 설계해서 가지고 있다.
기존에 5V 전원 회로가 없어 아두이노등의 보드를 통해 공급받던 전원을
Open Collector 혹은 Open Drain 방식을 통해 공급받아 사용하도록 한다.



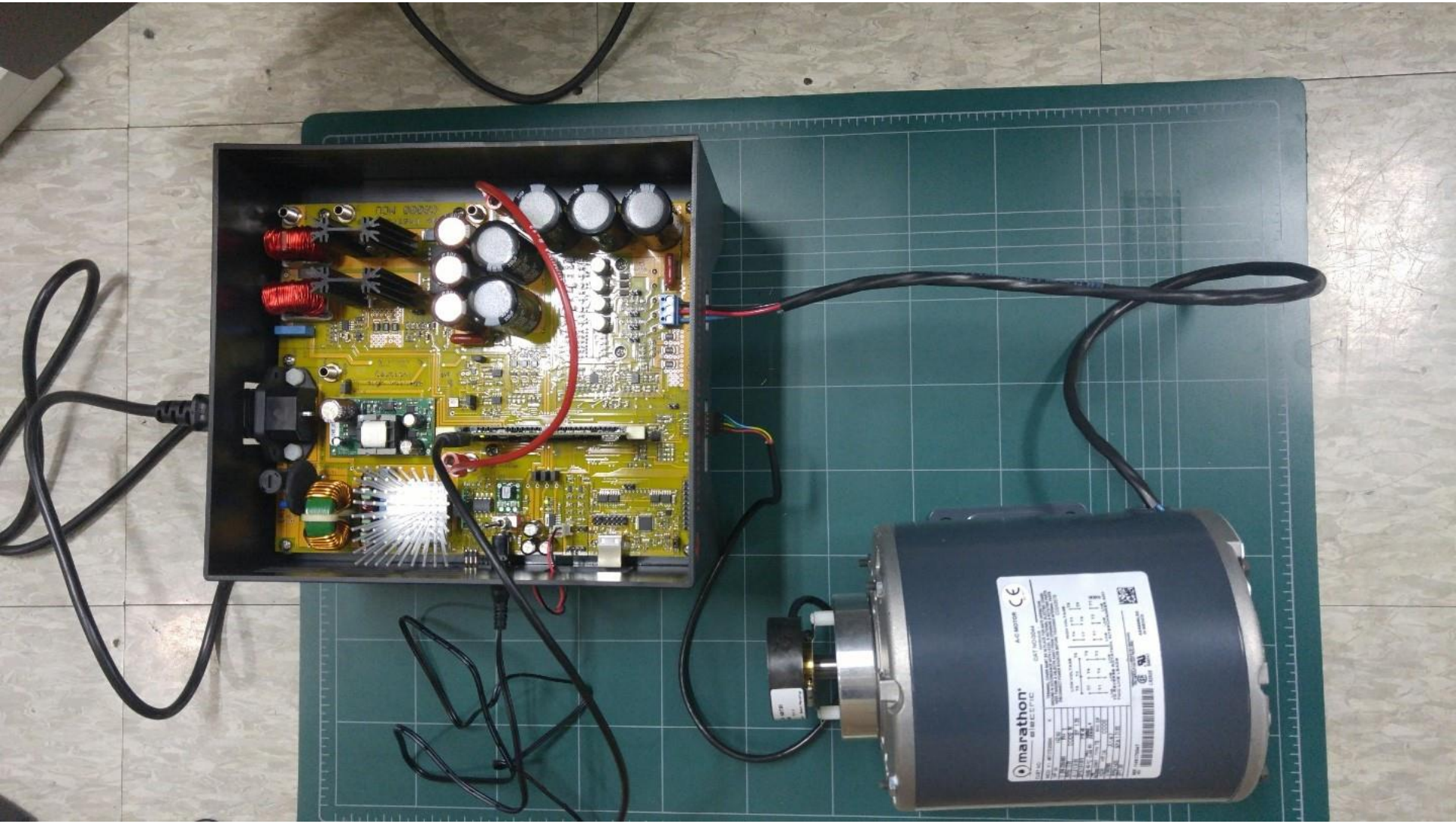

E-CALL
EIC-10

Inverter Control

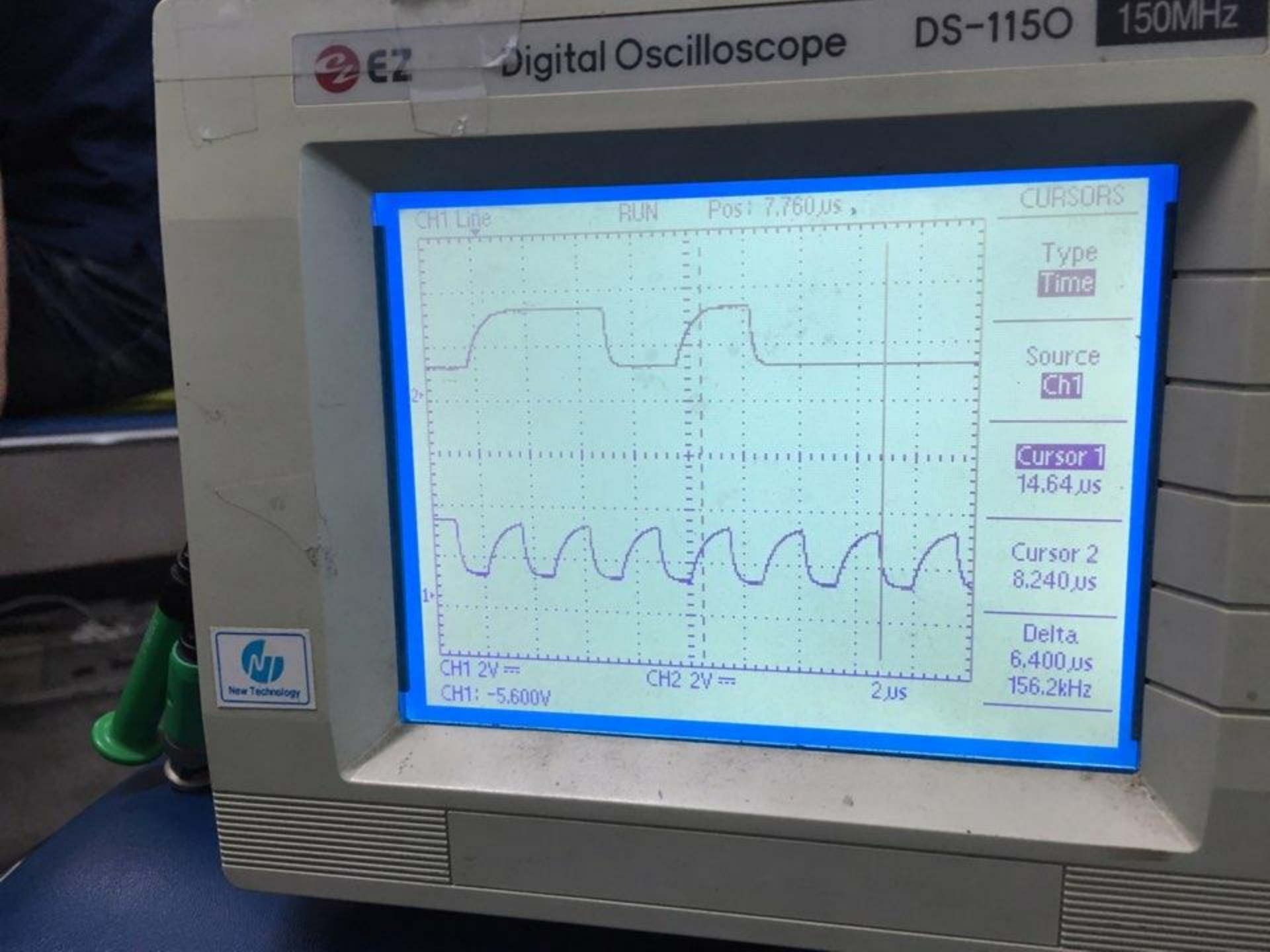


PMSM Motor Control

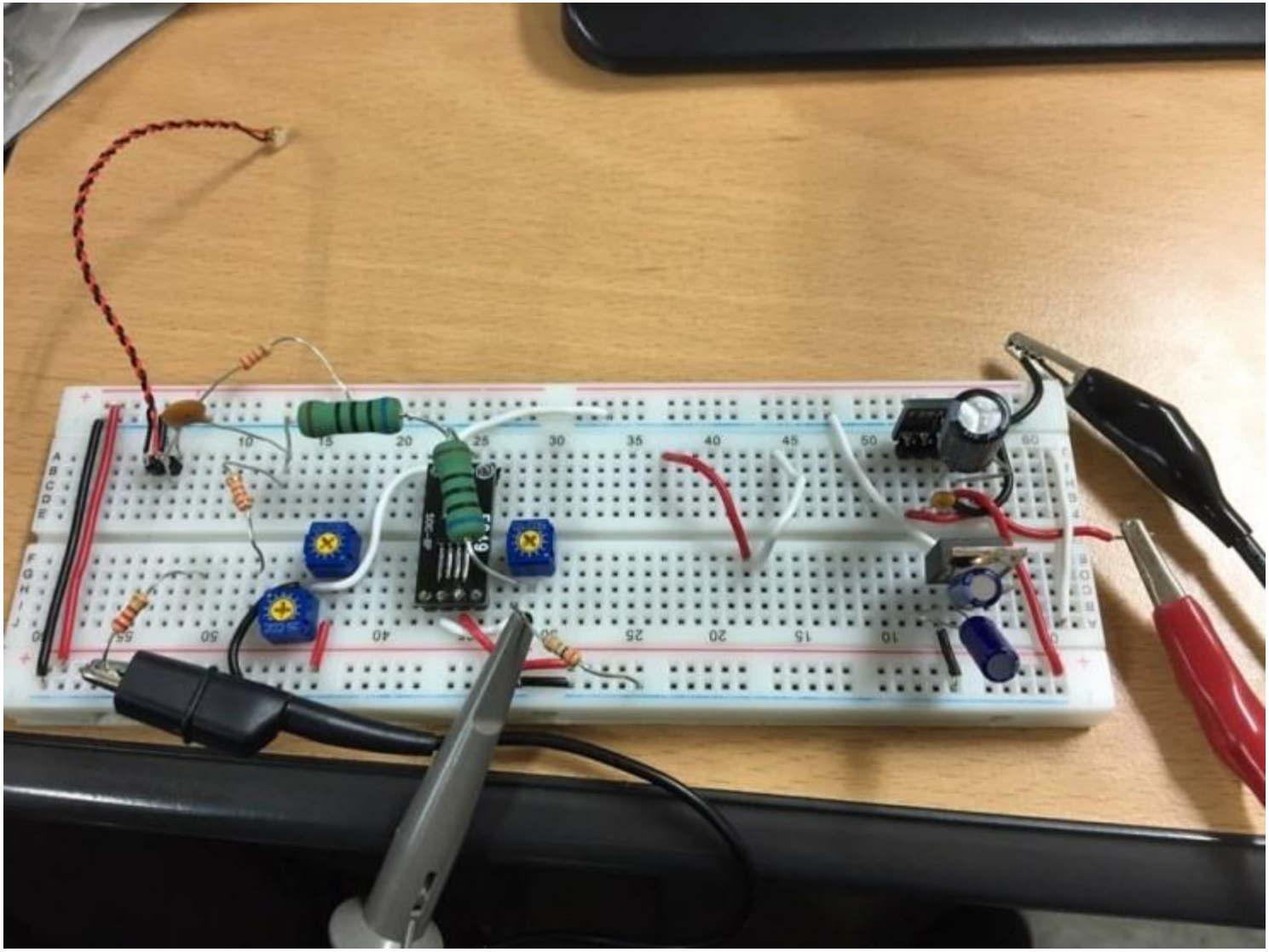
DSP Based High Voltage Inverter Control



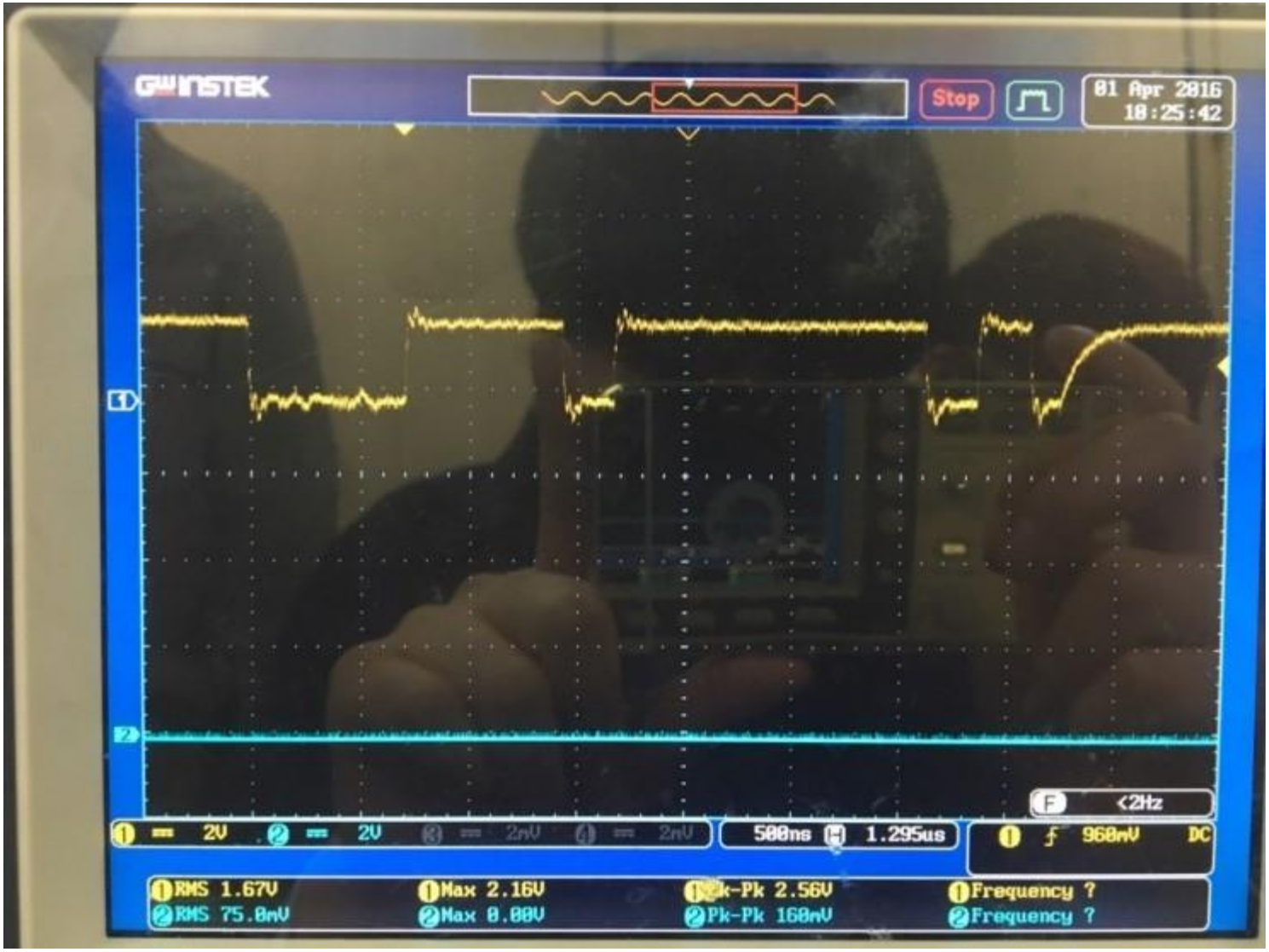
ACIM Motor Control


EZ
Digital Oscilloscope
DS-1150
150MHz
CH1 Line
RUN
Pos: 7.760µs
CURSORS
Type
Time
Source
Ch1
Cursor 1
14.64µs
Cursor 2
8.240µs
Delta
6.400µs
156.2kHz
CH1 2V ⎓
CH1: -5.600V
CH2 2V ⎓
2µs
New Technology


freescale™
OCTAL KITVALVECNTLEVM
© 2014 FREESCALE
QUAD
1R0




34.512MHz
RMS 1.27V
RMS Ch Off
Max 1.68V
Max Ch Off
Pk-Pk 1.72V
Pk Ch Off
Frequency ?
Frequency Ch Off


GW INSTEK
Stop
01 Apr 2016
18:25:42
2V
2V
500ns
1.295us
968mV
DC
<2Hz
RMS 1.67V
Max 2.16V
Pk-Pk 2.56V
Frequency ?
RMS 75.8mV
Max 0.00V
Pk-Pk 160mV
Frequency ?


EVM v1.0.3.0