



EDDI

Electronic Design
Development Institute

에디로봇아카데미

임베디드 마스터 Lv2 과정

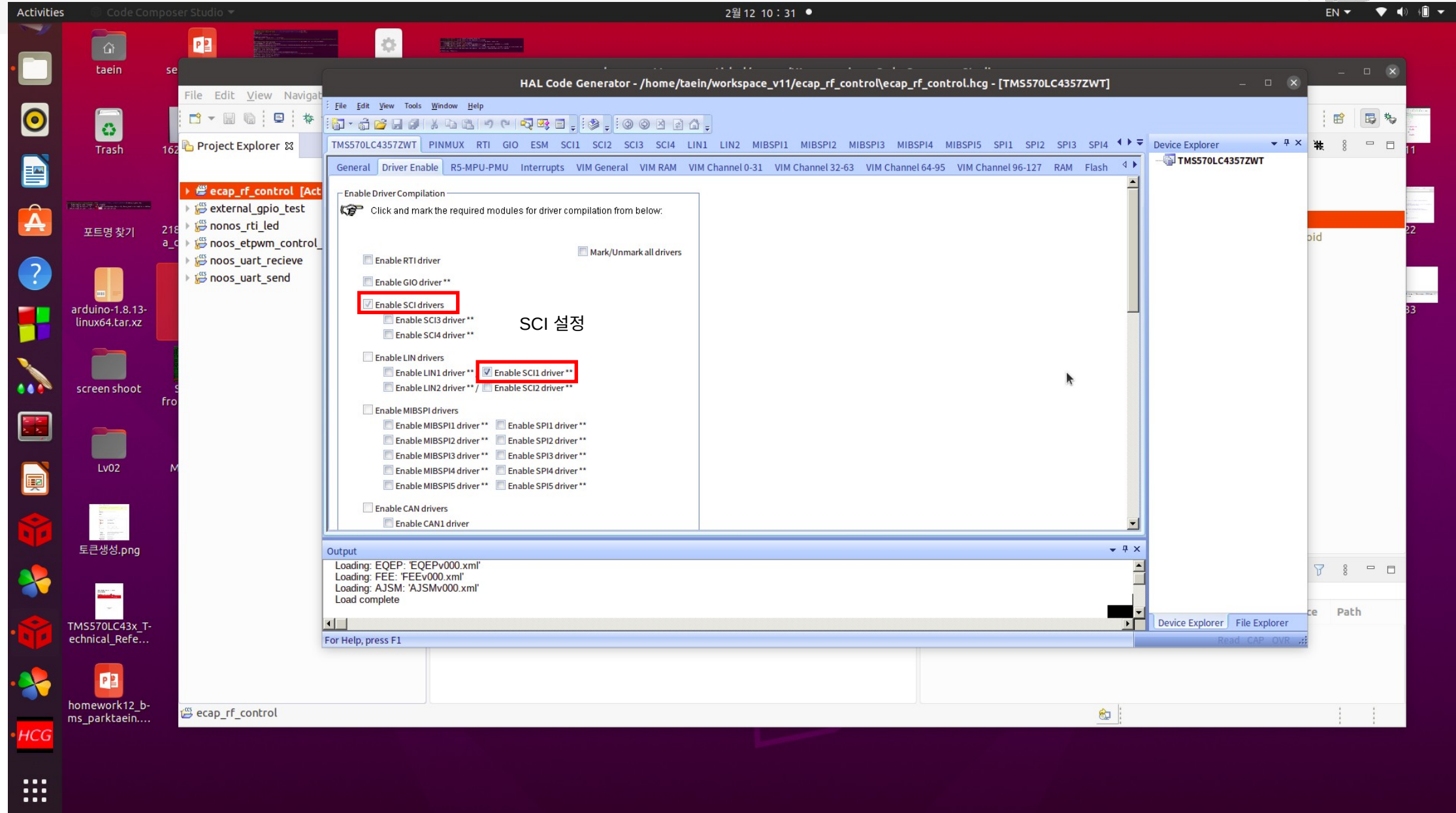
[TMS 570_eCAP(RF_Control)]

제 1기

2022. 03. 11

박태인

eCAP(RF_Control)



eCAP(RF_Control)

Activities Code Composer Studio 2월 12 10 : 32 EN

HAL Code Generator - /home/taein/workspace_v11/ecap_rf_control/ecap_rf_control.hcg - [TMS570LC4357ZWT]

File Edit View Tools Window Help

TMS570LC4357ZWT PINMUX RTI GIO ESM SCI1 SCI2 SCI3 SCI4 LIN1 LIN2 MIBSPI1 MIBSPI2 MIBSPI3 MIBSPI4 MIBSPI5 SPI1 SPI2 SPI3 SPI4

General Driver Enable R5-MPU-PMU Interrupts VIM General VIM RAM VIM Channel 0-31 VIM Channel 32-63 VIM Channel 64-95 VIM Channel 96-127 RAM Flash

☐ Enable DCC driver

☐ Enable EMIF driver**

☐ Enable POM driver

☐ Enable CRC driver

☐ Enable CRC1 driver

☐ Enable CRC2 driver

☐ Enable EQEP driver

☐ Enable EQEP1 driver**

☐ Enable EQEP2 driver**

☒ Enable ETPWM driver

☒ **Enable ECAP driver** ECAP enable

☐ Enable FEE driver

☐ Enable AJSM driver

Note :
** - Pins of these modules are muxed. Enable the corresponding pins in PINMUX

Output

Loading: EQEP: 'EQEPv000.xml'
Loading: FEE: 'FEEv000.xml'
Loading: AJSM: 'AJSMv000.xml'
Load complete

For Help, press F1

Device Explorer TMS570LC4357ZWT

Device Explorer File Explorer

ecap_rf_control

eCAP(RF_Control)

The screenshot displays the HAL Code Generator interface within Code Composer Studio. The main window shows the configuration for the TMS570LC4357ZWT device, specifically the VIM Channel 96-127 tab. The configuration table lists various interrupts and their corresponding VIM channels. The ECAP 1~4 interrupts (104, 105, 106, 107) are highlighted with a red box, indicating they are the focus of the configuration. The output window shows the loading of EQEP, FEE, and AJSM modules, and the completion of the load process.

Interrupt	Channel	IRQ	FIQ
102: eTPWM7 interrupt	102	IRQ	FIQ
103: eTPWM7 Trip Zone	103	IRQ	FIQ
104: eCAP1 interrupt	104	IRQ	FIQ
105: eCAP2 interrupt	105	IRQ	FIQ
106: eCAP3 interrupt	106	IRQ	FIQ
107: eCAP4 interrupt	107	IRQ	FIQ
108: eCAP5 interrupt	108	IRQ	FIQ
109: eCAP6 interrupt	109	IRQ	FIQ
110: eQEP1 interrupt	110	IRQ	FIQ
111: eQEP2 interrupt	111	IRQ	FIQ

ECAP 1~4 interrupt 설정

Output
Loading: EQEP: 'EQEPv000.xml'
Loading: FEE: 'FEEv000.xml'
Loading: AJSM: 'AJSMv000.xml'
Load complete

eCAP(RF_Control)

Activities Code Composer Studio 2월 12 10 : 34

HAL Code Generator - /home/taein/workspace_v11/ecap_rf_control/ecap_rf_control.hcg - [PINMUX]

File Edit View Tools Window Help

TMS570LC4357ZWT **PINMUX** RTI GIO ESM SCI1 SCI2 SCI3 SCI4 LIN1 LIN2 MIBSPI1 MIBSPI2 MIBSPI3 MIBSPI4 MIBSPI5 SPI1 SPI2 SPI3 SPI4

Pin Muxing Input Pin Muxing Special Pin Muxing

Enable / Disable Peripherals

<input type="checkbox"/> HET1	<input type="checkbox"/> GIOA	<input type="checkbox"/> MIBSPI2	<input type="checkbox"/> MIBSPI1	<input type="checkbox"/> SCI3	<input type="checkbox"/> RMI
<input type="checkbox"/> HET2	<input type="checkbox"/> GIOB	<input type="checkbox"/> MIBSPI4	<input type="checkbox"/> MIBSPI3	<input type="checkbox"/> SCI4	<input type="checkbox"/> MII
<input type="checkbox"/> EMIF	<input type="checkbox"/> EQEP	<input type="checkbox"/> AD1EVT	<input type="checkbox"/> MIBSPI5	<input type="checkbox"/> LIN2/SCI2	<input type="checkbox"/> CAN4
<input type="checkbox"/> ETPWM	<input checked="" type="checkbox"/> ECAP	<input type="checkbox"/> AD2EVT	<input type="checkbox"/> I2C1	<input type="checkbox"/> I2C2	

Note
GIO pins are mapped to two terminals. The checkboxes enable both the default and alternate terminals. Remove the unwanted terminal to avoid conflicts.
MII have dedicated pins. Alternate terminals are enabled using the MII RMI and MII checkboxes does not set the functional mode. Enable them in Special Pinmuxing tab

List Conflicts
Total Conflicts 0

Ball	Default Mux	Mux Option 1	Mux Option 2	Mux Option 3	Mux Option 4	Mux Option 5	Conflict?
A4	N2HET1[16]	NONE	NONE	ETPWM1SYNCR	NONE	ETPWM1SYNCO	
A13	N2HET1[17]	EMIF_nOE	SCI4RX	NONE	NONE	NONE	
A14	N2HET1[26]	NONE	MII_RXD[1]	RMI_RXD[1]	NONE	NONE	
B2	MIBSPI3NCS[2]	I2C1_SDA	NONE	N2HET1[27]	NONE	nTZ1_2	
B3	N2HET1[22]	EMIF_nDQM[3]	NONE	NONE	NONE	NONE	

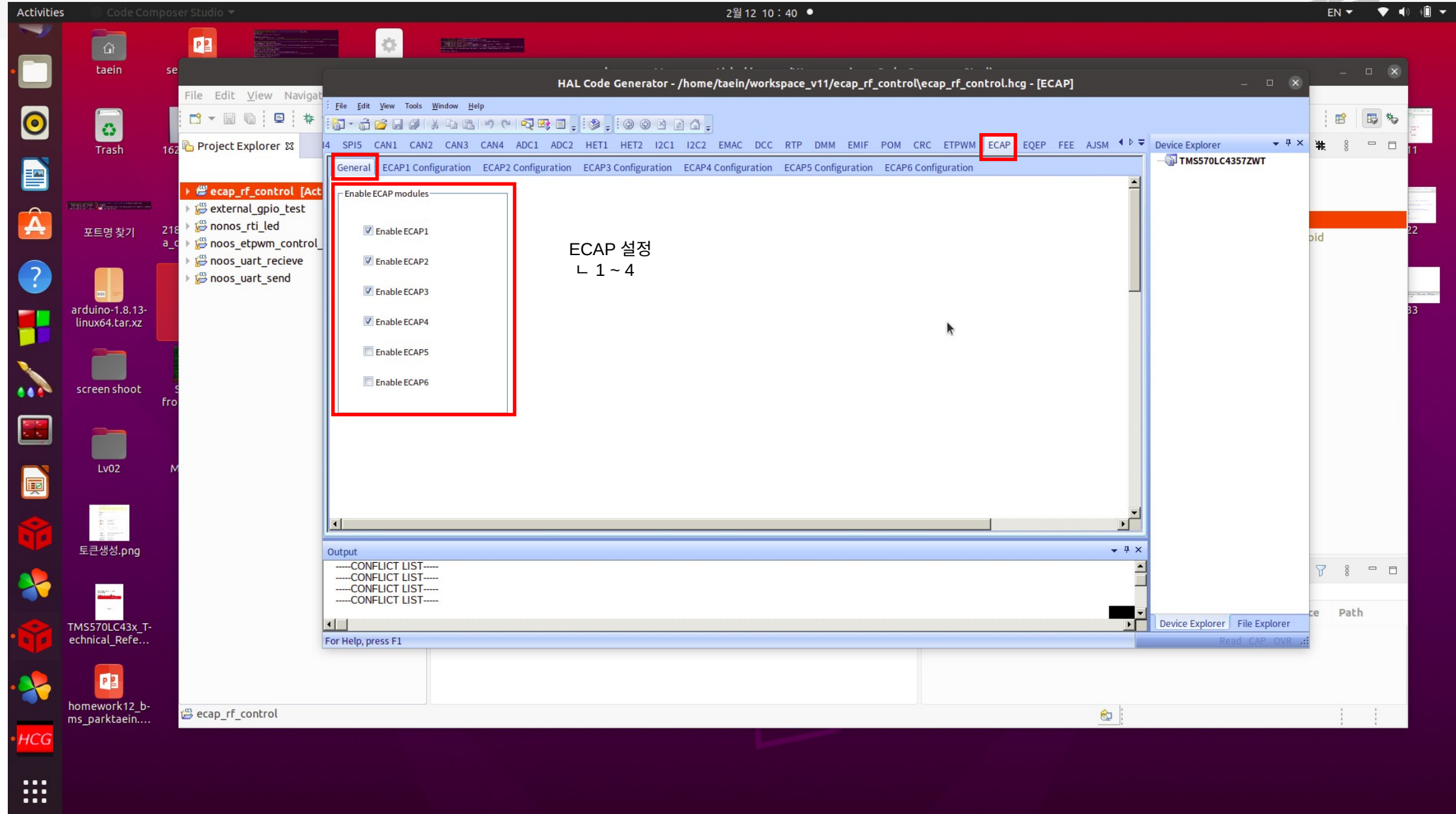
Output
Loading: FEE: 'FEEv000.xml'
Loading: AJSM: 'AJSMv000.xml'
Load complete
-----CONFLICT LIST-----

For Help, press F1

Device Explorer
TMS570LC4357ZWT

Pin mux
ECAP 설정 후
List Conflicts 버튼
누르는데
버튼 눌렀을 때 사진 처럼
'0' 값이 떠야 좋다고 한다.

eCAP(RF_Control)



eCAP(RF_Control)

workspace_v11 - nonos_rti_led/source/HL_sys_main.c - Code Composer Studio

HAL Code Generator - /home/taein/workspace_v11/ecap_rf_control/ecap_rf_control.hcg - [ECAP]

Project Explorer

- external_gpio_test
- nonos_rti_led
- noos_etpwm_control_w
- noos_uart_recieve
- noos_uart_send

ECAP1 Configuration

Capture Configuration

ECAPx: → Prescale: → PSout

1

Enable Loading On Capture

Capture Mode: CONTINUOUS

Stop/Wrap Capture: CAPTURE_EVENT3

Capture 1 Polarity: RISING_EDGE

Capture 2 Polarity: FALLING_EDGE

Capture 3 Polarity: RISING_EDGE

Capture 4 Polarity: RISING_EDGE

Reset Counter After Capture 1

Reset Counter After Capture 2

Reset Counter After Capture 3

Reset Counter After Capture 4

Interrupt Selection

Enable CEVT1

Enable CEVT2

Enable CEVT3

Enable CEVT4

Enable CNTOVF

Enable PRD

Enable CMP

PWM Configuration

Enable PWM mode

PWM

Duty [%]: 50

Period [ns]: 200.000

50

1000.000

1000

tPeriod

tDuty

APWMx

Rising edge → falling edge → Rising edge 차례에서 eCAP Enable

Output

-----CONFLICT LIST-----

-----CONFLICT LIST-----

-----CONFLICT LIST-----

-----CONFLICT LIST-----

For Help, press F1

Device Explorer

TMS570LC4357ZWT

File Explorer

Path

ecap_rf_control

eCAP(RF_Control)

workspace_v11 - nonos_rti_led/source/HL_sys_main.c - Code Composer Studio

HAL Code Generator - /home/taein/workspace_v11/ecap_rf_control/ecap_rf_control.hcg - [ECAP]

Project Explorer

- ecap_rf_control [Active]
- external_gpio_test
- nonos_rti_led
- noos_etpwm_control_w
- noos_uart_recieve
- noos_uart_send

ECAP2 Configuration

Capture Configuration

ECAPx: \rightarrow Prescale: \rightarrow PSout

ECAPx: 1

Capture Mode: CONTINUOUS

☒ Enable Loading On Capture

Stop/Wrap Capture: CAPTURE_EVENT3

Capture 1 Polarity: RISING_EDGE

Capture 2 Polarity: FALLING_EDGE

Capture 3 Polarity: RISING_EDGE

Capture 4 Polarity: RISING_EDGE

☐ Reset Counter After Capture 1

☐ Reset Counter After Capture 2

☒ Reset Counter After Capture 3

☐ Reset Counter After Capture 4

Interrupt Selection

☐ Enable CEVT1 ☐ Enable CEVT2 ☒ Enable CEVT3 ☐ Enable CEVT4

☐ Enable CNTOVF ☐ Enable PRD ☐ Enable CMP

PWM Configuration

☒ Enable PWM mode

Duty [%]: 50

Period [ns]: 200.000

100.000

500

1000.000

1000

tPeriod

tDuty

PWM

APWMx

앞 선 setting 을
4번 까지 똑같이 한다.

Output

-----CONFLICT LIST-----
-----CONFLICT LIST-----
-----CONFLICT LIST-----
-----CONFLICT LIST-----

For Help, press F1

Device Explorer

TMS570LC4357ZWT

Device Explorer File Explorer

Read CAP_OVR

ecap_rf_control

eCAP(RF_Control)

Activities Code Composer Studio 2월 12 16 : 12 workspace_v11 - ecap_rf_control/source/HL_sys_main.c - Code Composer Studio

File Edit View Navigate Project Run Scripts Window Help

Project Explorer ecap_rf_control [Active - Debug]

- Binaries
- Includes
- Debug
- include
- source
 - HL_ecap.c
 - HL_epc.c
 - HL_errata_SSWF021_45.c
 - HL_errata.c
 - HL_esm.c
 - HL_nmpu.c
 - HL_notification.c
 - HL_pinmux.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
 - ecap_rf_control.dil
 - ecap_rf_control.hcg
- external_gpio_test
- nonos_rti_led
- noos_etpwm_control_with_uart
 - Binaries
 - Includes
 - Debug
 - include
 - source

HL_sys_main.c

```
87 }
88 }
89 }
90
91 void wait
92 {
93     int i
94     for(i=0; i<100; i++)
95     {
96         ;
97     }
98 /* USER CODE HERE */
99
100 int main(void)
101 {
102     /* USER CODE HERE */
103
104     sciIn
105
106     sprintf
107     buf_len
108     sci_d
109
110     ecap
111
112     sprintf
113     buf_
114     sci_
115
116     _ena
117
118 }
```

Import Projects from File System or Archive

This wizard analyzes the content of your folder or archive file to find projects and import them in the IDE.

Import source: /home/taein/eddi_embedded_mster/EmbeddedMasterLv2/LSH/RC_control Directory... Archive...

type filter text

Select All

Deselect All

1 of 2 selected

Hide already open projects

Folder Import as

- ☒ RC_controller_ecap Eclipse project
- ☐ RC_controller_ecap/RemoteSystemsTempFiles Project with same name

☐ Close newly imported projects upon completion

Use installed project configurators to:

- ☒ Search for nested projects
- ☒ Detect and configure project natures

Working sets

☒ Add project to working sets

Working sets: New... Select...

Show other specialized import wizards

< Back Next > Cancel Finish

이건 무슨 setting 인지 잘 모르겠다.

Outline

- HL_sys_common.h
- HL_system.h
- HL_sci.h
- HL_ecap.h
- string.h
- stdio.h
- sci_display_text(sciBASE_t*, uint8*, uint32): void
- wait(uint32): void
- UART
- txt_buf: char[]
- buf_len: unsigned int
- sci_display_text(sciBASE_t*, uint8*, uint32): void
- wait(uint32): void
- main(void): int**
- ecapNotification(ecapBASE_t*, uint16): void

Console

ecap_rf_control

CortexR5: GEL Output: Memory Map Setup for Flash @ Address 0x0CortexR5: GEL Output: Memory Map Setup for Flash @ Address 0x0 due to System Reset

Problems Advice Memory Allocation Stack Usage

3 items

Description	Resource	Path	Location
Optimization Advice (3 items)			

Writable Smart Insert 103 : 1 : 2985

eCAP(RF_Control)


ECAP 파트 부터는 선생님이 따로 정리 해주는 문서가 있어서 그 문서 내용을 이해하면서 더 조사가 필요한 부분은 추가하는 방향으로 복습 하도록 한다.

먼저 스코프상에 잡히는 파형을 통해 이를 분석하도록 합니다.

<https://cafe.naver.com/eddicorp/392>

링크샘 칼럼 >

[링크샘 칼럼] TMS570 eCAP 분석

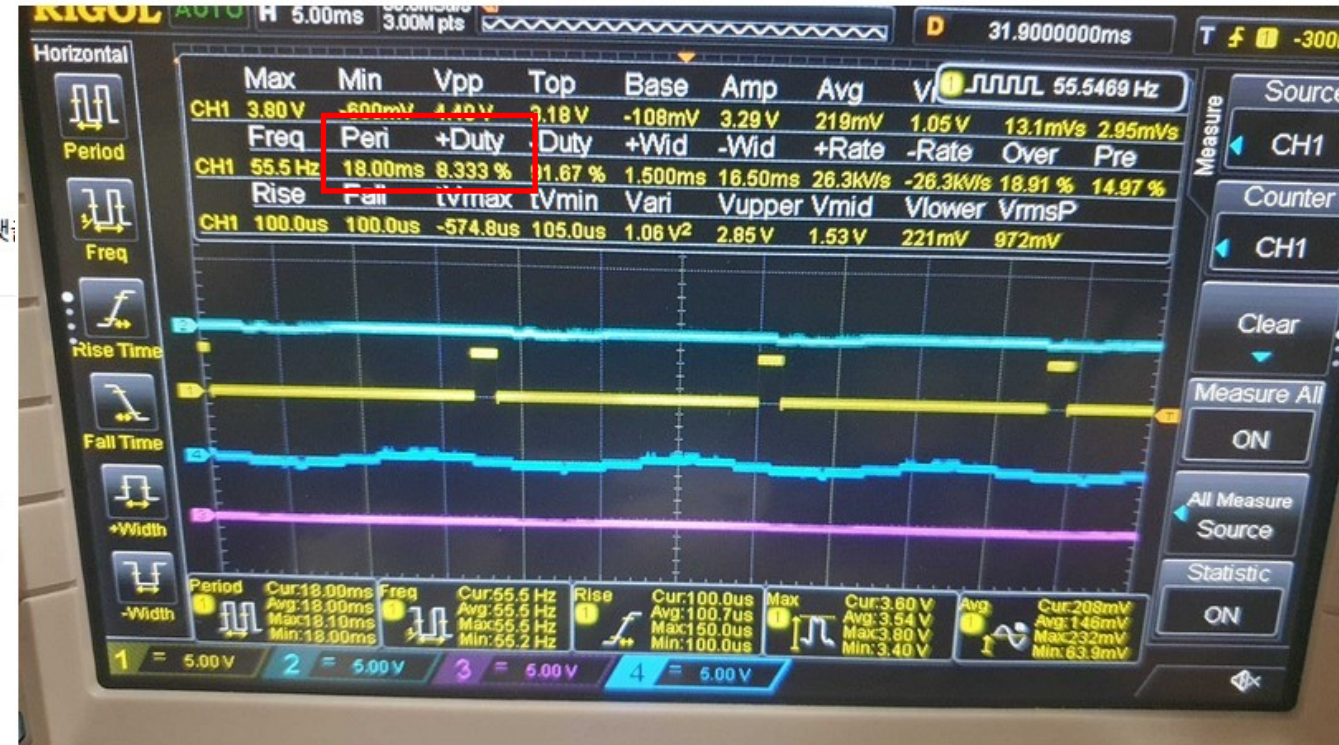
링크샘 카페매니저  1:1 채팅
2022.02.18. 13:49 조회 21

안녕하세요

에디로봇아카데미의 링크샘입니다.

이번에 RF 수신기의 신호를 감지하기 위해 활용했던 eCAP을 파악하기 위해 봐야하는 코드는 아래와 같습니다.
ecapInit(), ecapStartCounter(), ecapEnableCapture(), ecapGetCAP1(), ecapGetCAP2()에 해당합니다.

먼저 스코프상에 잡히는 파형을 통해 이를 분석하도록 합니다.



실제 출력 결과를 보면 18ms의 주기가 잡히고 있으며 파형에서 잡히는 Duty는 8.333%임이 확인됩니다.
이와 같은 정보를 토대로 결과를 계산해 볼 수 있습니다.

eCAP(RF_Control)

실제로 화면상에 출력되는 결과에서도 이를 확인할 수 있습니다.

(18 * 10^-3) * 8.333 / 100

×

전체

쇼핑

이미지

지도

뉴스

더보기

도구

검색결과 약 0개 (0.81초)

18ms * 8.333 %

((18 * (10^(-3)))) * 8.33300) / 100 =

18ms의 8.333 % 는 약 1.5 ms

0.00149994

문서 저장하기

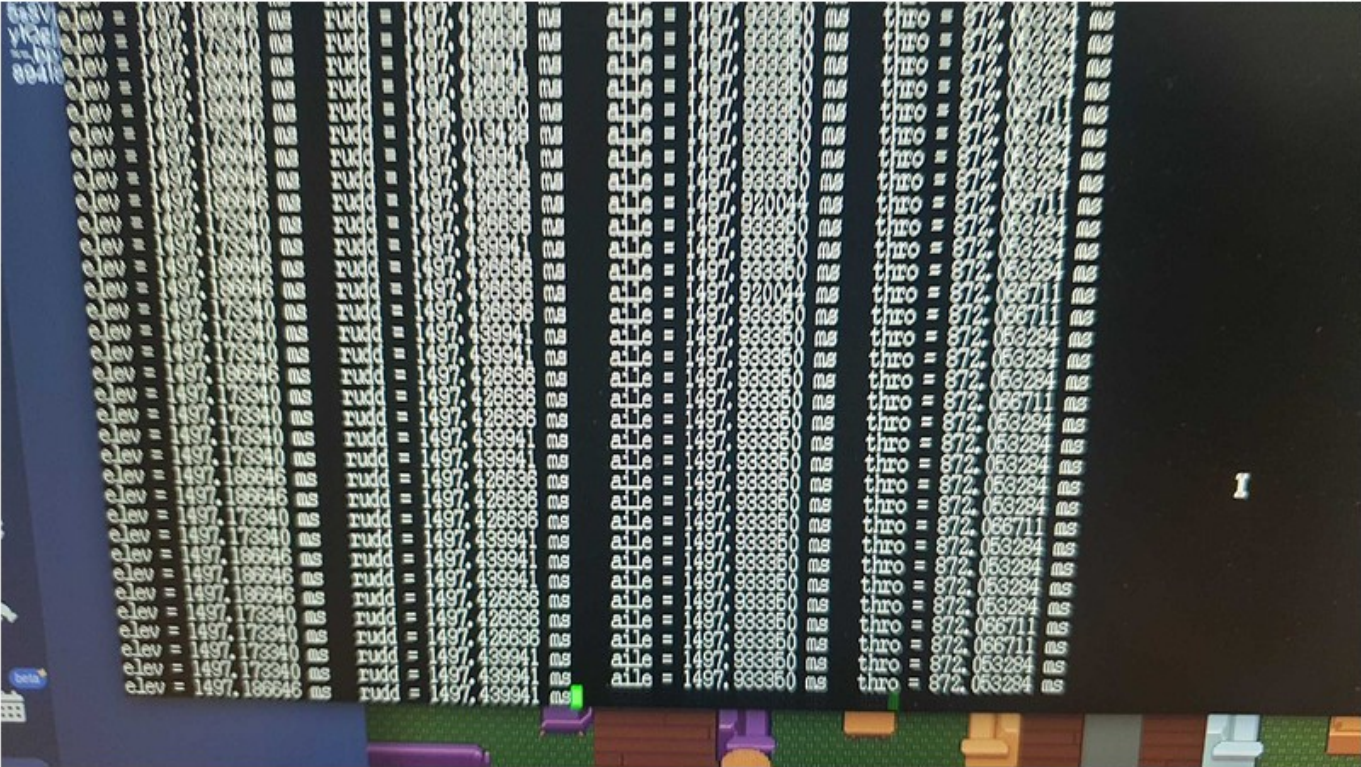
이것은 1.5 ms 에 해당하는 내용입니다.

그리고 아래 사이트에서 나오는 조종기 스펙을 보면 1.0 ~ 2.0 ms 를 가진다고 나타납니다.

좀 더 구체적으로 아래와 같이 명시되어 있습니다.

Channel Pacing:	1200KHz
Spread Spectrum:	FHSS, 67 channels pseudo-random frequency hopping
Adjacent Channel Rejection:	>36dBm
Transmitter Power:	<100mW (20dBm)
Reception Sensitivity:	-104dBm
Transmission Rate :	38kbps
PWM Output Range:	1.0ms~2.0ms
Section precision:	4096, 0.5us per section
Cycle:	15ms/per frame
T8FB(BT) operating voltage:	4.8V~18V
T8FB(BT) operating current:	<80mA
R8EF operating voltage:	4.6~10V
R8EF operating current:	<30mA
Compatible receivers:	R8EF (Std), R8FM, R8SM, R8F, R7FG, R6FG, R6F, R4FGM, R4F

즉 계산된 결과인 1.5 ms 는 조종기 스펙상 존재할 수 있는 수치이며
중간값에 배치한 결과임을 알 수 있습니다.



뒤쪽의 ms 는 잘못 표현된 수치에 해당합니다.

아마 이 부분 때문에 혼선을 유발했을 것 같다는 생각이 드는군요.

결론에 해당하는 부분은 확인을 하였으니 각 동작에 대해 살펴보도록 하겠습니다.

eCAP(RF_Control)

먼저 ecapInit() 부분에서 반복되는 패턴들부터 살펴보도록 하겠습니다.

```
71  /** - Setup control register 1
72  *    - Set polarity and reset enable for Capture Events ]
73  *    - Enable/Disable loading on a capture event
74  *    - Setup Event Filter prescale
75  */
76  ecapREG1->ECCTL1 = ((uint16)((uint16)RISING_EDGE << 0U)
77                      | (uint16)((uint16)RESET_DISABLE << 1U)
78                      | (uint16)((uint16)FALLING_EDGE << 2U)
79                      | (uint16)((uint16)RESET_DISABLE << 3U)
80                      | (uint16)((uint16)RISING_EDGE << 4U)
81                      | (uint16)((uint16)RESET_ENABLE << 5U)
82                      | (uint16)((uint16)RISING_EDGE << 6U)
83                      | (uint16)((uint16)RESET_DISABLE << 7U)
84                      | (uint16)((uint16)1U << 8U)
85                      | (uint16)((uint16)0U << 9U));    /* 9
```

실제 RISING_EDGE, RESET_DISABLE 은 첫 번째 상승 엣지 이후 리셋하지 않음을 의미합니다.

FALLING_EDGE, RESET_DISABLE 을 통해 두 번째 하강 엣지 이후 역시 리셋을 의미합니다.

다음 RISING_EDGE, RESET_ENABLE 을 통해 세 번째 상승 엣지에서 리셋을 수행합니다. 3번째 Rising Edge에서

캡처 이벤트 발생시 CAP1-4 레지스터를 활성화 합니다.

Enable

Prescaler 는 별도의 지정이 없습니다.

33.5.8 ECAP Control Register 1 (ECCTL1)

Figure 33-21. ECAP Control Register 1 (ECCTL1) [offset = 2Ah]

15	14	13	9	8
FREE	SOFT	PRESCALE		CAPLDEN
R/W-0	R/W-0	R/W-0		R/W-0
7	6	5	4	3
CTRRST4	CAP4POL	CTRRST3	CAP3POL	CTRRST2
R/W-0	R/W-0	R/W-0	R/W-0	R/W-0

LEGEND: R/W = Read/Write; -n = value after reset

5	CTRRST3	0	Counter Reset on Capture Event 3.
		1	Do not reset counter on Capture Event 3 (absolute time stamp).
			Reset counter after Event 3 time-stamp has been captured (used in difference mode operation).
8	CAPLDEN	0	Enable Loading of CAP1-4 registers on a capture event.
		1	Disable CAP1-4 register loads at capture event time.
			Enable CAP1-4 register loads at capture event time.

CAP1-4 라는게
1다시 4가 아니라
CAP 1~4 전부라는
소리구나... 一.一;

eCAP(RF_Control)

ETTCL2 레지스터 부터
복습 진행..