

TRK-MPC5604P Fast Start kit Training





March 2014

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TRK-MPC5604P Fast Start Kit hardware contents

- StarterTRAK TRK-MPC5604P Evaluation Board
- USB cable
- Installation media
- Instruction pamphlet



TRK-MPC5604P Fast Start Kit software contents

- The TRK-MPC5604P Fast Start Kit contains Single installer that installs all software tools, documents and example projects:
- 1. RAppID init and RAppID pin wizard for MPC560xP with permanent license
- 2. Utility to add RAppID generated code to CodeWarrior 10.5 Project
- 3. CodeWarrior for MPC56xx 10.5 SE
- 4. Low Level Drivers (LLDs) for MPC5604P
- 5. High Level Drivers (HLDs) for StarterTRAK TRK-MPC5604P
- 6. RAppID Bootloader utility
- 7. FreeMASTER utility
- 8. Simple LED application examples that demonstrates the usage of software tools, LLDs and HLDs.



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Installing Software tools

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FastStartKit_for_TRK_MPC5604P - InstallShield Wizard

Ready to Install the Program

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This will launch FreeMASTER installer.



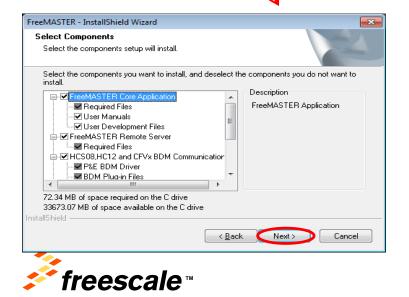
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Installing Software tools – FreeMASTER

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Installing Software tools – FreeMASTER

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Installing Software tools – RAppID Init

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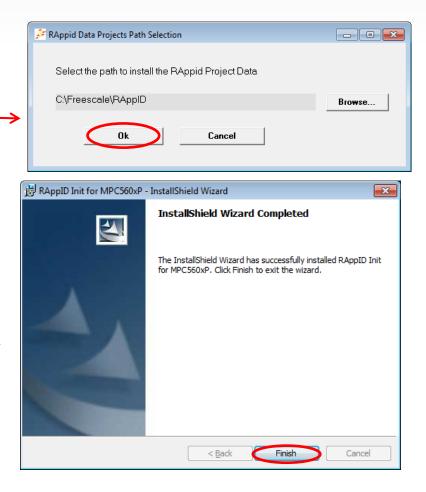
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Installing Software tools – RAppID Init

Accept default location for RAppID project data folder by clicking on *Ok*

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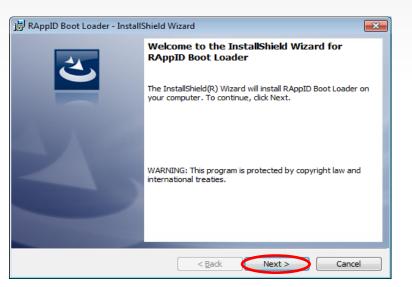




Installing Software tools – RAppID Boot loader

Click on *Next* to start RAppID boot loader installation.

Accept license agreement and click on Next



📸 RAppID Boot Loader - InstallShield Wizard 🛛 💦				
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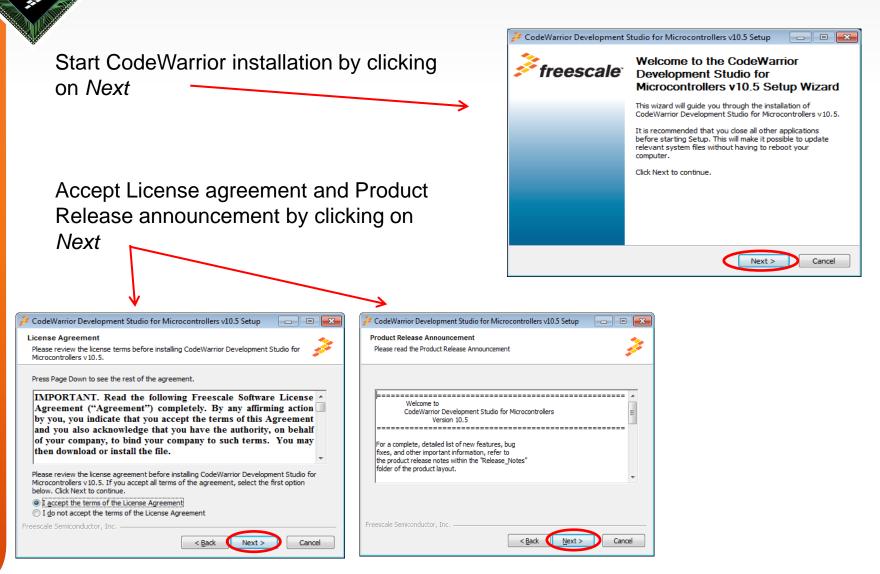


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Installing Software tools – RAppID Boot loader 🛃 RAppID Boot Loader - InstallShield Wizard Destination Folder Click Next to install to this folder, or click Change to install to a different folder Install RAppID Boot Loader to: C:\Freescale\RAppIDBL\ Change... Accept default destination folder by accepting by clicking on Next. installShield Next > Cancel < Back 🙀 RAppID Boot Loader - InstallShield Wizard Start installation by selecting Install. Ready to Install the Program The wizard is ready to begin installation If you want to review or change any of your installation settings, click Back. Click Cancel to Current Settings Setup Type: Typica Destination Folder C: \Freescale \RAppIDBL \ Jser Information: Name: Freescale Company: Freescale < Back Cancel After installation is complete, select 🙀 RAppID Boot Loader - InstallShield Wizard × Finish to complete installation. InstallShield Wizard Completed 2 The InstallShield Wizard has successfully installed RAppID Boot er. Click Finish to exit the wizard. This will start CodeWarrior installation. < <u>B</u>ack Cancel



Installing Software tools - CodeWarrior





Installing Software tools - CodeWarrior

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🝃 CodeWarrior Development Studio for Microcontrollers v10.5 Setup

Installing Software tools - CodeWarrior

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Finish

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RAppID Init Overview

- Intuitive, easy-to-use graphical user interface (GUI)
- Comprehensive initialization of the CPU, memory and peripherals
- Automatic DMA register setting from peripherals for basic modes
- Built-in consistency checks to minimize incorrect settings
- Automatic report generation of settings
- Efficient C and assembly code generation for compilers such as Wind River®, Green Hills® and CodeWarrior
- Online documentation and built-in tool tips
- Installation comes with many example projects
- Generates complete infrastructure code for MCU startup



RAppID Init Overview

- Provisions for revision management
- Automatic date and time stamps on generated code and reports
- Modular code generation—generate code for any or all peripherals
- Option to generate code for RAM or Flash
- Flexible Initialization sequence
- Project import/export capability for distributed development teams





RAppID Generates What?

Driver Utilities	Lov
Interrupt/Exception Infrastructure	Inter
Device Initialization	Dev
Main Function – System Init Function	Exa
Low Level Setup Code	Fro
Reset Vector Code	RC

Low Functionality Drivers

Interrupt Vector Table, Handler, ISR functions

Device and Peripheral Initialization Code

Example Main, Init Sequence Function...

From Reset to Main, crt0, Stack,...

RCHW, Section Map...



CodeWarrior project maker utility

- The Fast Start Kit provides a utility to assist in adding RAppID generated code to a CodeWarrior project
- After creating a empty CodeWarrior project for the required microcontroller, the user can invoke the utility *rsp2cw10.exe* which will add RAppID generated code and sets up the CodeWarrior project by adding all the CodeWarrior setup variables to enable clean build.





Low Level Driver code

- In the installation disk, the following low level driver code is provided
 - GPIO
 - ADC
 - UART
 - CAN



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GPIO Low Level Driver code

- uint8_t GPIO_GetState (uint16_t ch)
 - This function returns the state of requested GPIO pin
- void GPIO_SetState (uint16_t ch, uint8_t value)
 - This function sets the GPIO pin to the specified state



ADC Low Level Driver code

- uint16_t A2D_GetSingleCh_ADC0 (uint32_t ch)
 - This function sets up, starts, and returns a conversion for a single ADC0 channel
- uint16_t A2D_GetSingleCh_ADC1 (uint32_t ch)
 - This function Sets up, starts, and returns a conversion for a single ADC1 channel
- uint16_t A2D_GetChResult_ADC0(uint32_t ch)
 - This function returns the result for a single ADC0 channel

• uint16_t A2D_GetChResult_ADC1(uint32_t ch)

- This function returns the result for a single ADC1 channel
- void A2D_SetupCh_ADC0(uint32_t ch)
 - This function sets up channel for the ADC0 conversion
- void A2D_SetupCh_ADC1(uint32_t ch)
 - This function sets up channel for the ADC1 conversion



UART Low Level Driver code

- void UartTxMsg(uint8_t *u8TxData, uint32_t u32Size)
 - This function transmits a message in buffer *u8TxData* of size *u32Size*
- uint8_t UartRxDataByte(void)
 - This function returns data from UART buffer
- uint32_t UartRxNewDataSize(void)
 - This function checks how much new data there is in UART buffer

• uint8_t UartRxBufEmpty(void)

- This function checks if the UART buffer is empty
- void UartBufInit(void)
 - This function initializes UART Buffer

void UartRxFillBuf(void)

- This function fills the UART Buffer from the UART RX peripheral



CAN Low Level Driver code

- void SetCanRxFilter(uint32_t id, uint8_t mb, uint8_t ext)
 - This function sets up the mailboxes on the specified CAN channel and works for standard and extended IDs.
- void CanTxMsg (uint32_t id, uint8_t mb, uint8_t dlc, uint8_t data[], uint8_t ext)
 - This function transmits a CAN message.
- can_msg_struct CanRxMsg (uint8_t mb)
 - This function receives a CAN message.
- uint8_t CanRxMbFull (uint8_t mb)
 - This function checks if CAN Mail box is full.
- uint8_t CanTxMbEmpty (uint8_t mb)
 - This function checks if CAN Mail box is empty.





High Level Driver code

- In the installation disk, the following high level driver code is provided
 - Potentiometer
 - Photo Sensor
 - SBC



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Potentiometer High Level Driver code

- uint16_t Pot_Get_Value(void)
 - This function sets up, starts, and returns conversion value for Potentiometer channel (PE0, ADC1 Channel 5 of TRK-MPC5604P board).



Photo Sensor High Level Driver code

- uint16_t Photo_Sensor_Get_Value (void)
 - This function sets up, starts, and returns conversion value for Photo sensor channel (PE1, ADC0 Channel 4 of TRK-MPC5604P board).



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SBC High Level Driver code

- void SBC_Init_DBG(void)
 - Sets SBC in TRK-MPC5604P board to enable CAN. It is assumed that SBC is in Debug mode and watchdog refresh is required only on initialization.



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RAppID Bootloader utility

- The RAppID Boot Loader is a tool developed by Freescale to help with the development of software for Freescale MCUs by allowing the customer a method to update software of a MCU through a serial link using CCP.
- The RAppID Boot Loader works with the built in Boot Assist Module (BAM) included in the Freescale Qorivva & PX series family of parts.
- The Boot Loader provides a streamlined method for programming code into FLASH or RAM on either target EVBs or custom boards.
- The Boot Loader has two modes of operation, for use as a standalone PC desktop GUI utility, or for integration with different user required tools chains through a command line interface (i.e. Eclipse Plug-in, MatLab/SimuLink etc.).





FreeMASTER utility

- FreeMASTER allows users to debug applications in true realtime through its ability to watch and modify variables.
- Remote control capability allows it to be used as a diagnostic tool for debugging customer applications remotely across a network.
- It is an outstanding tool for demonstrating algorithm or application execution and variable outputs.
- It provides monitoring/visualization of application variables in the same manner as a classical oscilloscope with a CRT.
- Simple RS232 native connection and other options possible on selected platforms (BDM, JTAG, CAN,...)
- Built-in support for standard variable types (integer, floating point, bit fields)



LED Example Using RAppID Init

- The next few slides will demonstrate an example project that describes steps to configure MPC5604P, generate, build, flash and test the code using various tools provided with TRK-MPC5604P Fast Start Kit
- In this example we will use RAppID Init tool to configure and generate initialization code for MPC5604P
- We will use the GPIO, ADC and CAN driver code supplied with the installation
- We will use CodeWarrior 10.5 to build the code
- We will use RAppID Boot loader utility to flash the code to the target
- The example turns on/off LEDs based on Switch input, Potentiometer input and CAN commands.



LED Example overview

- LED1 turns on when switch S1 is in pressed state and turned off when S1 is in released state
- LED2 is turned On/Off based on potentiometer input
- LED3 is turned On/Off based on CAN command input
- PD10 is driven using FlexPWM signal and the duty signal can be increased by input switch S4 and decreased by input switch S3.
- PA0 is configured as eTimer input capture function which is used to calculate duty cycle of PWM output of PD4 by connecting output PD4 to input PA0.



Creating LED example using RAppID init tool

• The next few slides will demonstrate how to create RAppID project to configure all the pins and peripherals required for this example and generate code for CodeWarrior compiler.



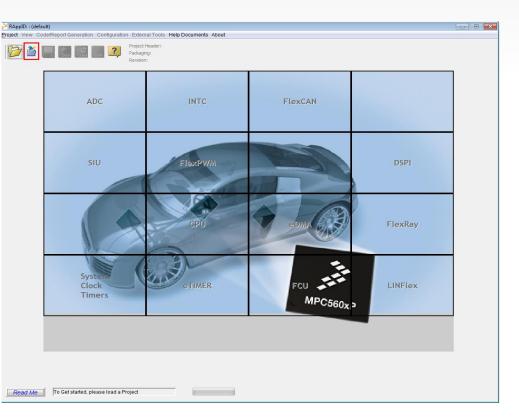
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Create a New RAppID Project



Launch RAppID init by double clicking on RAppID init desktop icon



Start a new project by clicking on "New Project Wizard" button

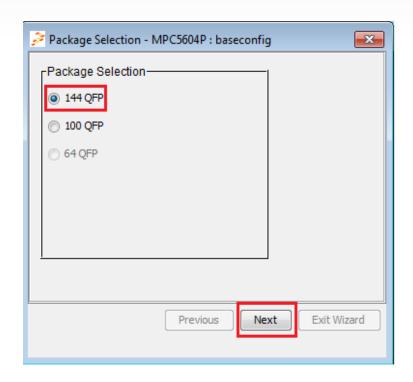


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Select Part and Package

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					Start Wizard	Cancel



Select a Part MPC5604P and select Start Wizard

Select a Package 144 QFP and select Next



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Configure ADC input

Pin Allocation - MPC5604P : baseconfig *				
rPin Allocation Wizard				
	HC16 12.3 P001 12.4 P000 12.6 VR01 12.6 P003 12.7 P004 12.8 P015 12.7 P026 12.7 P031 12.8 P041 12.9 P053 13.2 P070 13.3 P071 13.4 P071 13.4	PB0 B20 B20 <td>EST</td>	EST	
2 3 N H B G N H B G N H B G N H B N H B G N H B G N H B G N H B G N H B G N H B G N H B G N H B G N H B G N H B G N H B G N H B G N H B G N H B G N H B G N H B G N H B G N H B H				
ADC DSPI FCU FlexCAN Fin	EXPWM FlexRay GPIO LINFlex MISC Input	Output	User Assigned Signal Name	
ADC_1 AN 03	PC0		A	
ADC_1 AN 04	PD15			
ADC_1 AN 05	V PEO	ADO	C1_Ch5_Potentiometer_Input	
		 		
III Previous Next Evit Wizard View				

Potentiometer is connected to PE0. In ADC tab, configure PE0 as ADC input and add appropriate name in User Assigned Signal Name edit box.





Configure DSPI pins

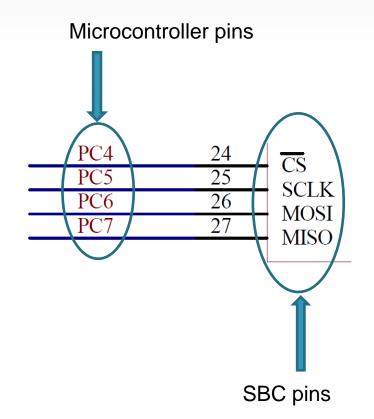
- TRK-MPC5604P contains MCZ3390S5EK system basis chip (SBC) with integrated CAN transceiver and LIN 2.0 interface.
- DSPI 0 is connected to SBC. We need to configure DSPI 0 as master and SBC as slave so that SBC can be configured to enable CAN by sending appropriate commands via DSPI 0.





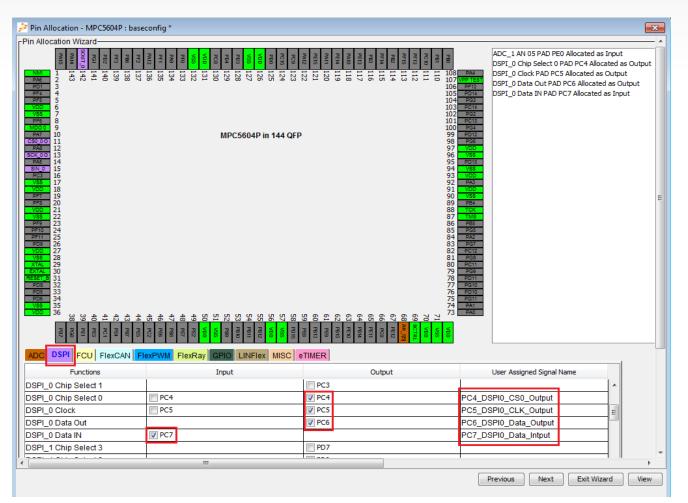
Configure DSPI pins

- The connection between DSPI 0 of microcontroller and SBC is shown in this picture
- Configure DSPI 0 pins as follows to enable communication with SBC.
 - PC4 is connected to CS pin of SBC.
 Configure PC4 as DSPI_0 Chip select 0 output
 - PC5 is connected to Clock input pin of SBC. Configure PC5 as DSPI_0 Clock output
 - PC6 is connected to MOSI pin of SBC.
 Configure PC6 as DSPI_0 Data output
 - PC7 is connected to MISO pin of SBC.
 Configure PC7 as DSPI_0 Data input





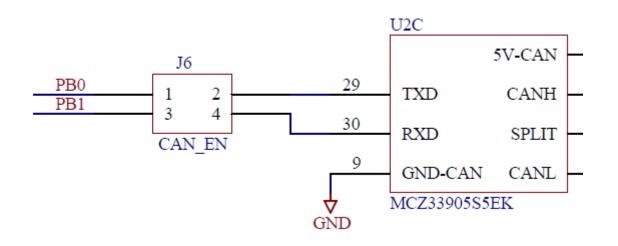
Configure DSPI pins





Configure FlexCAN pins

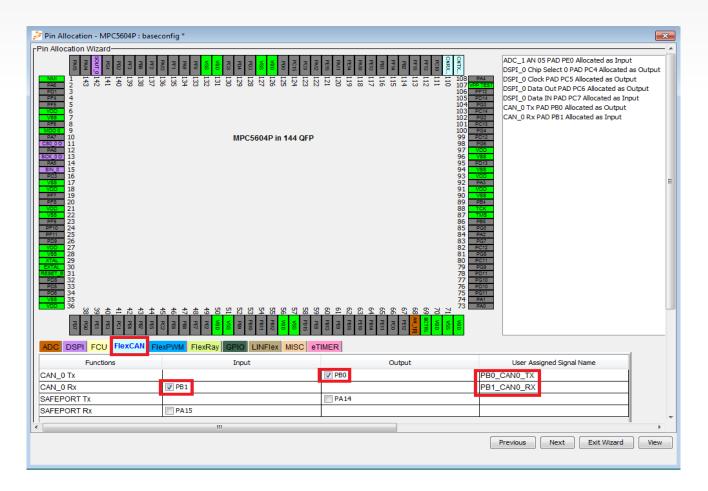
- The CAN TX and CAN RX pins of SBC are connected to the pins PB0 and PB1 of CAN 0 peripheral of the microcontroller.
- We need to configure PB0 as CAN 0 TX pin and PB1 as CAN 0 RX pin.







Configure FlexCAN pins



In FlexCAN tab, configure PB0 as CAN_0 Tx and PB01 as CAN_0 Rx pins and signal names.



Configure FlexPWM pin

Pin Allocation - MPC5604P : ba	seconfig *		
Pin Allocation Wizard			
MA 1 SOUTO 1 4 AA 2 43 1 30 30 PEI 1 4 1 30 30 PEI 1 5 5 1 30 PEF 6 7 7 8 7 PEF 8 7 7 8 7 PEF 8 7 7 8 7 PEF 8 7 7 8 7 SC (0) 11 1 5 7 7 8 SC (0) 13 16 5 7 7 7 PES 16 7 7 7 7 7	ин 10 10 10 10 10 10 10 10 10 10	QFP	08 FM DSPL_0 Clock PAD PC5 Allocated as Output 07 FP33 DSPL_0 Data Out PAD PC6 Allocated as output 06 FP31 DSPL_0 Data NI PAD PC7 Allocated as Output 04 F83 CAN_0 TX PAD P60 Allocated as Output 05 FP31 CAN_0 TX PAD P60 Allocated as Output 07 F83 CAN_0 TX PAD P61 Allocated as Output 07 F84 F80 07 F03 F84 19 F912 F84 15 F913 F84 14 F83 F86 15 F913 F84 14 F83 F86 17 F86 F86 18 F86 F86 19 F913 F913 19 F913 F914 19 F913 F915 19 F913 F86 19 F913 F86 19 F914 F80
PE3 PE3 PE1 PE3 PE1 PG30	V00 P812 P810 P810 P810 P810 P810 P810 P810 P810	71	10 95 19 784 18 TOX 17 TUS 18 TOX 18 TOX
ADC DSPI FCU FIexCAN	FlexPWM FlexRay GPIO LINFlex MIS		
Functions	Input	Output	User Assigned Signal Name
FlexPWM_A 0	PD10 PA11	PD10 PA11	PD10_FlexPWM_A0
FlexPWM_A 1	PC7 PD13 PC15	PC7 PD13 PC15	
FlexPWM_A 2	PA12 PA11 PG3	PA12 PA11 PG3	=
FlexPWM_A 3	PD3 PA2 PC10 PG6	PD3 PA2 PC10 PG6	
FlexPWM_B 0	PA10 PD11	PA10 PD11	
FlexPWM_B 1	PD14 PC6 PD0	PD14 PC6 PD0	
FlexPWM_B 2	PA13 PA12 PG4	PA13 PA12 PG4	
FlexPWM_B.3	PA3 PA9 PD4 PG7	PA3 PA9 PD4 PG7	
	m		

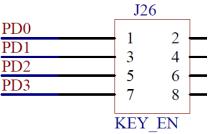
In this example, we are using PD10 as FlexPWM output. In FlexPWM tab, select PD10 as output and add user signal name.

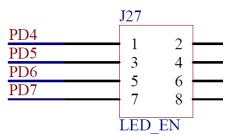




Configure GPIO pins

- In this example, we are using Switch S1, S3 and S4 as input and the LED1, LED2 and LED3 as outputs.
- Switch S1, S3 and S4 are connected to PD0, PD2 and PD3. Configure these 3 pins as inputs.
- LED1, LED2 and LED3 are connected to PD4 PD5 and PD6. Configure these 3 pins as outputs.



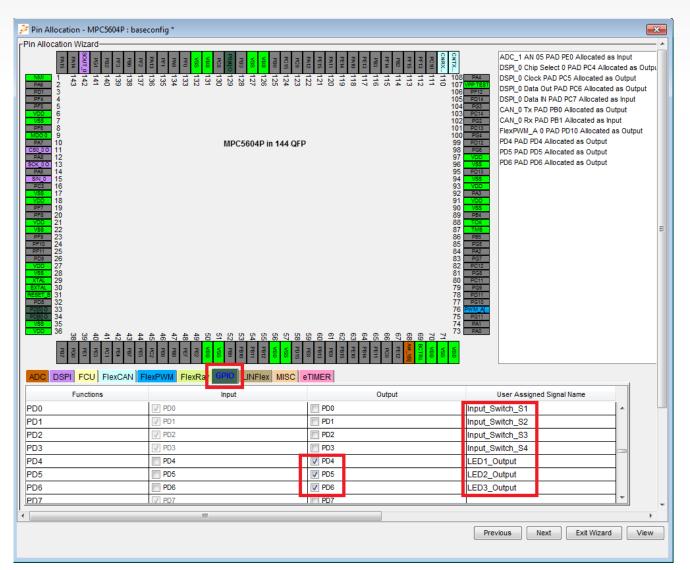




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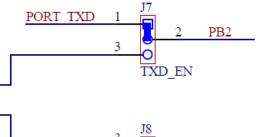
Configure GPIO pins

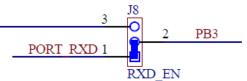




Configure LINFlex (UART) pins

- In this example, we will use Virtual serial port of TRK-MPC5604P board for serial communication.
- The PB2 and PB3 of microcontroller in TRK-MPC5604P board are connected to TX and RX pins of virtual serial port.
- We need to configure PB2 as LINFlex0 TX pin and PB3 as LINFlex0 RX pin.



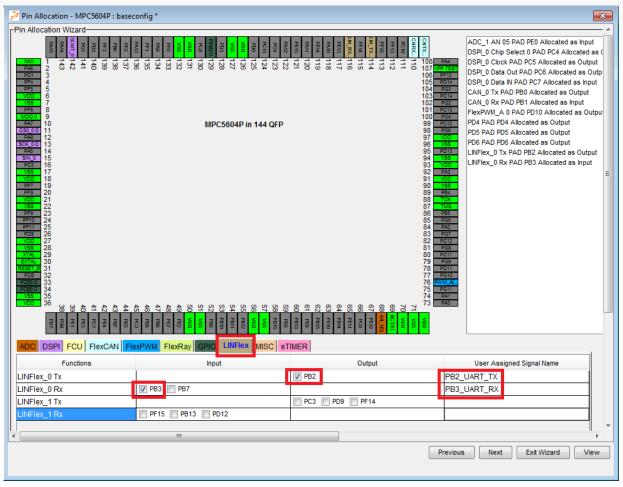


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RS232 CIRCUITRY
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Configure LINFlex (UART) pins



In LINFlex tab, configure PB2 as LINFlex_0 Tx and PB3 as LINFlex_0 Rx pins and add user signal names.





Configure eTimer pin

Pin Allocation - MPC5604P : bas	seconfig *		
Pin Allocation Wizard			
NU I SU III IIII IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	Negl 12.2 Sec Sec </th <th>106 105 104 103 100 100 100 99 99 99 96 95 95 94 95 95 94 95 95 94 95 95 94 95 95 94 95 95 94 95 95 94 95 95 94 97 96 97 96 97 97 97 96 97 97 96 97 97 96 97 97 97 97 96 97 97 97 97 97 97 97 97 97 97 97 97 97</th> <th>BD1 DSPL 0 Data N PAD PC7 Allocated as input PG2 CAN_0 T X PAD PB0 Allocated as output RG2 CAN_0 R X PAD PB1 Allocated as output FB03 FB04 PAD PD4 Allocated as output FB04 PAD PD4 Allocated as output FB07 PD4 PAD PD4 Allocated as Output FB03 EVAD PD5 Allocated as input FB03 EVAD PD5 Allocated as input</th>	106 105 104 103 100 100 100 99 99 99 96 95 95 94 95 95 94 95 95 94 95 95 94 95 95 94 95 95 94 95 95 94 95 95 94 97 96 97 96 97 97 97 96 97 97 96 97 97 96 97 97 97 97 96 97 97 97 97 97 97 97 97 97 97 97 97 97	BD1 DSPL 0 Data N PAD PC7 Allocated as input PG2 CAN_0 T X PAD PB0 Allocated as output RG2 CAN_0 R X PAD PB1 Allocated as output FB03 FB04 PAD PD4 Allocated as output FB04 PAD PD4 Allocated as output FB07 PD4 PAD PD4 Allocated as Output FB03 EVAD PD5 Allocated as input FB03 EVAD PD5 Allocated as input
ADC DSPI FCU FlexCAN	FlexPWM FlexRay GPIO LINFlex MISC	eTIMER	
Functions	Input	Output	User Assigned Signal Name
eTimer_0_CH0	PA0		PA0_eTimer_Input
eTimer_0_CH1	PA1	PA1	
eTimer_0_CH2	PA2	PA2	
eTimer_0_CH3	PA3	PA3	=
eTimer_0_CH4	PC11 PB14 PA4	PC11 PA4	
eTimer_0_CH5	PC12 PB8	PC12	
Times 4 0110			
			4
			Previous Next Exit Wizard View

In this example, we are using eTimer Channel 1 as input capture function to calculate duty signal of PWM signal. In eTimer tab, configure PA0 as eTimer input pin and add user signal names.

Select Next and skip next window by selecting Next to configure Mode Entry



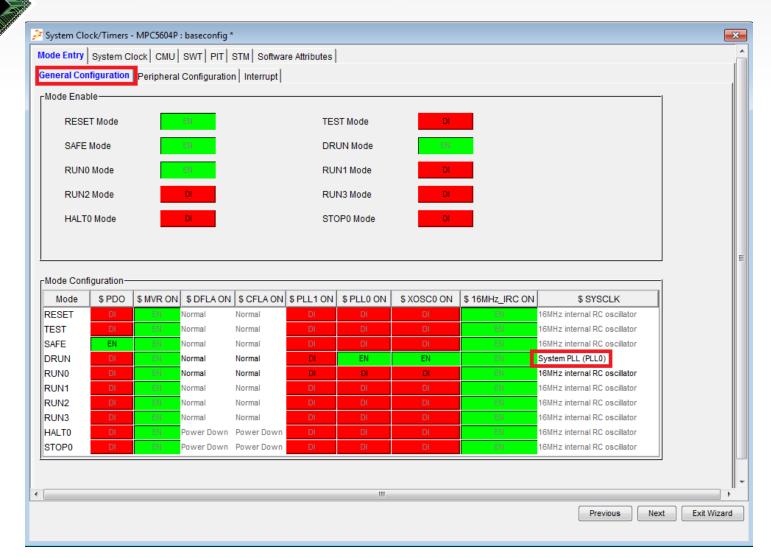


Configure Mode Entry

- RAppID tool generates code to set the microcontroller in DRUN mode at startup.
- In this example, we will use system PLL (PLL0) as system clock source. Select System PLL from the drop down under SYSTEM column in DRUN mode.



Configure Mode Entry







Configure Mode Entry

Configure the peripherals to be enabled during different operational modes.

Select "Normal" configuration

This will enable the "peripheral run configuration" and "low power configuration" across different operational modes

Then it will assign these two configurations across all peripherals

5 DSPL1 Di Low-Power Mode Configuration 0 RUN Mode Configuration 0 5 DSPL2 Di Low-Power Mode Configuration 0 RUN Mode Configuration 0 7 DSPL3 Di Low-Power Mode Configuration 0 RUN Mode Configuration 0 16 FlexCRN_0 Di Low-Power Mode Configuration 0 RUN Mode Configuration 0 24 FlexRay Di Low-Power Mode Configuration 0 RUN Mode Configuration 0 26 SafetyPort Di Low-Power Mode Configuration 0 RUN Mode Configuration 0 32 ADC_0 Di Low-Power Mode Configuration 0 RUN Mode Configuration 0 33 ADC_1 Di Low-Power Mode Configuration 0 RUN Mode Configuration 0 35 CTU_0 Di Low-Power Mode Configuration 0 RUN Mode Configuration 0 38 eTimer0 Di Low-Power Mode Configuration 0 RUN Mode Configuration 0			iration Ir								
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Bun Peripherals Config2 Active/Frozen Di											
Run Peripherals Config3 Active/Frozen Di											
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PiexRay Di Low-Power Mode Configuration 0 RUN Mode Configuration 0 26 SafetyPort Di Low-Power Mode Configuration 0 RUN Mode Configuration 0 28 ADC_0 Di Low-Power Mode Configuration 0 RUN Mode Configuration 0 33 ADC_1 Di Low-Power Mode Configuration 0 RUN Mode Configuration 0 35 CTU_0 Di Low-Power Mode Configuration 0 RUN Mode Configuration 0 38 eTimer0 Di Low-Power Mode Configuration 0 RUN Mode Configuration 0 30 CTU_0 Di Low-Power Mode Configuration 0 RUN Mode Configuration 0 39 eTimer0 Di Low-Power Mode Configuration 0 RUN Mode Configuration 0 30 eTimer0 Di Low-Power Mode Configuration 0 RUN Mode Configuration 0 30 eTimer0 Di Low-Power Mode Configuration 0 RUN Mode Configuration 0	Peripheral Control No. Peripheral Name 4 DSPI_0 5 DSPI_1 0 DSPI_2	Mode U DI	Low-Pow Low-Pow	er Mode (er Mode) er Mode (Configura Configura Configura	tion 0 F tion 0 F tion 0 F	RUN Mode RUN Mode RUN Mode	Configura Configura Configura	ation 0 ation 0 ation 0	n	
26 SafetyPort Di Low-Power Mode Configuration 0 RUN Mode Configuration 0 32 ADC_0 Di Low-Power Mode Configuration 0 RUN Mode Configuration 0 33 ADC_1 Di Low-Power Mode Configuration 0 RUN Mode Configuration 0 35 CTU_0 Di Low-Power Mode Configuration 0 RUN Mode Configuration 0 88 eTimer0 Di Low-Power Mode Configuration 0 RUN Mode Configuration 0	Peripheral Control No. Peripheral Name 4 DSPI_0 5 DSPI_1 5 DSPI_2 7 DSPI_3	Mode DI DI DI	Low-Pow Low-Pow Low-Pow Low-Pow	er Mode (er Mode) er Mode (er Mode)	Configura Configura Configura Configura	tion 0 F tion 0 F tion 0 F tion 0 F	RUN Mode RUN Mode RUN Mode RUN Mode	Configura Configura Configura Configura	ation 0 ation 0 ation 0 ation 0	n	
ADC_0 DI Low-Power Mode Configuration 0 RUN Mode Configuration 0 ADC_1 DI Low-Power Mode Configuration 0 RUN Mode Configuration 0 CTU_0 DI Low-Power Mode Configuration 0 RUN Mode Configuration 0 88 eTimer0 DI Low-Power Mode Configuration 0 RUN Mode Configuration 0 CTU_C DI Low-Power Mode Configuration 0 RUN Mode Configuration 0	Peripheral Control No. DSPL 0 5 DSPL 1 5 DSPL 2 7 DSPL 3 16 FlexcAN_0	Mode UI DI DI UI DI	Low-Pow Low-Pow Low-Pow Low-Pow Low-Pow	er Mode er Mode er Mode er Mode er Mode	Configura Configura Configura Configura Configura	tion 0 F tion 0 F tion 0 F tion 0 F tion 0 F	RUN Mode RUN Mode RUN Mode RUN Mode RUN Mode	Configura Configura Configura Configura Configura	ation 0 ation 0 ation 0 ation 0 ation 0	n	
ADC_1 Di Low-Power Mode Configuration 0 RUN Mode Configuration 0 CTU_0 Di Low-Power Mode Configuration 0 RUN Mode Configuration 0 88 eTimer0 Di Low-Power Mode Configuration 0 RUN Mode Configuration 0 CTU_0 Di Low-Power Mode Configuration 0 RUN Mode Configuration 0	Peripheral Control No. Peripheral A DSPI_0 5 DSPI_1 5 DSPI_2 7 DSPI_3 16 FlexRay 24 FlexRay	Mode UI DI UI UI DI DI DI	Low-Pow Low-Pow Low-Pow Low-Pow Low-Pow Low-Pow	rer Mode (rer Mode) rer Mode (rer Mode) rer Mode (rer Mode)	Configura Configura Configura Configura Configura Configura	tion 0 F tion 0 F tion 0 F tion 0 F tion 0 F tion 0 F	RUN Mode RUN Mode RUN Mode RUN Mode RUN Mode RUN Mode	Configura Configura Configura Configura Configura Configura	ation 0 ation 0 ation 0 ation 0 ation 0 ation 0	n	
35 CTU_0 Di Low-Power Mode Configuration 0 RUN Mode Configuration 0 38 eTimer0 Di Low-Power Mode Configuration 0 RUN Mode Configuration 0 38 eTimer0 Di Low-Power Mode Configuration 0 RUN Mode Configuration 0	Peripheral Control No. Peripheral Name 4 DSPL 0 5 DSPL 1 5 DSPL 2 7 DSPL 3 16 HoxCAN_0 24 FlexRay 26 SafetyPort	Mode DI DI DI DI DI DI DI DI	Low-Pow Low-Pow Low-Pow Low-Pow Low-Pow Low-Pow	rer Mode (rer Mode (rer Mode (rer Mode (rer Mode (rer Mode (rer Mode (Configura Configura Configura Configura Configura Configura Configura	tion 0 F tion 0 F tion 0 F tion 0 F tion 0 F tion 0 F tion 0 F	RUN Mode RUN Mode RUN Mode RUN Mode RUN Mode RUN Mode RUN Mode	Configura Configura Configura Configura Configura Configura Configura	ation 0 ation 0 ation 0 ation 0 ation 0 ation 0 ation 0 ation 0	E	
Building Configuration 0 Configuratio	Peripheral Control No. Peripheral Name 4 DSPL 0 5 DSPL 1 6 DSPL 2 7 DSPL 3 16 FlexRay FlexRay 26 SafetyPort 32	Mode DI DI DI DI DI DI DI DI	Low-Pow Low-Pow Low-Pow Low-Pow Low-Pow Low-Pow Low-Pow Low-Pow	rer Mode (rer Mode (rer Mode (rer Mode (rer Mode (rer Mode (rer Mode (Configura Configura Configura Configura Configura Configura Configura Configura	tion 0 F tion 0 F	RUN Mode RUN Mode RUN Mode RUN Mode RUN Mode RUN Mode RUN Mode	Configura Configura Configura Configura Configura Configura Configura	ation 0 ation 0 ation 0 ation 0 ation 0 ation 0 ation 0 ation 0 ation 0	E	
	Peripheral Control No. Peripheral Name 4 DSPL 0 5 DSPL 1 6 DSPL 2 7 DSPL 3 16 FlexRay 26 SafetyPort 32 ADC_0 33 ADC_1	Mode UI Di Di Di Di Di Di Di Di	Low-Pow Low-Pow Low-Pow Low-Pow Low-Pow Low-Pow Low-Pow Low-Pow	rer Mode (rer Mode (Configura Configura Configura Configura Configura Configura Configura Configura	tion 0 F tion 0 F	RUN Mode RUN Mode RUN Mode RUN Mode RUN Mode RUN Mode RUN Mode RUN Mode	Configura Configura Configura Configura Configura Configura Configura	ation 0 ation 0 ation 0 ation 0 ation 0 ation 0 ation 0 ation 0 ation 0	E	
	Peripheral Control No. Peripheral Name 4 DSPL 0 5 DSPL 1 5 DSPL 2 7 DSPL 3 16 FlexcAn_0 24 FlexcAn_0 25 SafetyPort 32 ADC_0 33 ADC_1 35 CTU_0 38 eTimer0	Mode DI DI DI DI DI DI DI DI DI DI	Low-Pow Low-Pow Low-Pow Low-Pow Low-Pow Low-Pow Low-Pow Low-Pow Low-Pow	er Mode (er Mode) er Mode (er Mode) er Mode (er Mode) er Mode (er Mode) er Mode (er Mode)	Configura Configura Configura Configura Configura Configura Configura Configura Configura	tion 0 F tion 0 F	RUN Mode RUN Mode RUN Mode RUN Mode RUN Mode RUN Mode RUN Mode RUN Mode RUN Mode	Configura Configura Configura Configura Configura Configura Configura Configura	ation 0 ation 0 ation 0 ation 0 ation 0 ation 0 ation 0 ation 0 ation 0 ation 0	E	
	Peripheral Control No. Peripheral Name 4 DSPL 0 5 DSPL 1 5 DSPL 2 7 DSPL 3 16 FlexcAN_0 24 FlexRay 26 SafetyPort 32 ADC_0 33 ADC_1 35 CTU_0	Mode DI DI DI DI DI DI DI DI DI DI	Low-Pow Low-Pow Low-Pow Low-Pow Low-Pow Low-Pow Low-Pow Low-Pow Low-Pow	er Mode (er Mode) er Mode (er Mode) er Mode (er Mode) er Mode (er Mode) er Mode (er Mode)	Configura Configura Configura Configura Configura Configura Configura Configura Configura	tion 0 F tion 0 F	RUN Mode RUN Mode RUN Mode RUN Mode RUN Mode RUN Mode RUN Mode RUN Mode RUN Mode	Configura Configura Configura Configura Configura Configura Configura Configura	ation 0 ation 0 ation 0 ation 0 ation 0 ation 0 ation 0 ation 0 ation 0 ation 0	E	





Configure Clock

System Clock/Timers - MPC5604P : baseconfig *	×.
Mode Entry System Clock CMU SWT PIT STM Software Attributes	
System Clock and Peripheral Clock Setup	
System Clock Setup	
DRUN Mode Clock System PLL XOSC Frequency 8.00 MHz	System Clock Frequency 32.000 MHz
Clock Source Configuration	System Clock Frequency Formula
Clock SBypass Divider SEnd of Count SInterrupt STRIM	
XOSC DI 0x80 DI	System Clock Frequency = XOSC Frequency * Final Reference Frequency Multiplier
16MHz IRC1 0x0	Final Relefence Frequency Multiplier
PLL 0 PLL 1	Clock Output Setup
PLL Setup	Clock Output DI
Progressive Clock Switching DI PLL Frequency Modulation Setup	Clock Output Select 16MHz Internal RC oscillator 💌
Input Division Factor 2 Frequency Modulation DI	Clock Divider
Output Division Factor 8	Clock Output Frequency 16.000 MHz
Modulation Period 0	
Loop Division Factor 64	Output Clock Pin 138 (PB6) - Not Assigned
Final Reference Frequency Multiplier	Auxiliary Clock Setup
Final Reference Frequency Multiplier = Loop Division Factor/ (Input Division Factor * Output Division Factor) PLL 0/P Frequency = XOSC Frequency * Final Reference Frequency Multiplier	Aux 0 Aux 1 Aux 2 Aux 3
VCO Frequency = XOSC * (Loop Division Factor / Input Division Factor)	Clock Source 16MHz Internal RC Oscillator
	Peripheral \$ Divider \$ Divider Final Clock Clock Set Status (MHz)
	FlexPWM Clock EN 1 16.000
↓	-
	Previous Next Exit Wizard

We will configure system clock to 32MHz. The default XOSC frequency in RAppID is 40MHz but TRK-MPC5604P uses 8 MHz crystal. Change XOSC value to 8 MHz. Change Input Division factor to 2 to set the system clock at 32 MHz.





Disable Watchdog

By default, watchdog is enabled in MPC5604P. In this example, we will not use Watchdog feature. Disable Watchdog Timer in SWT tab.

System Clock/Timers - MPC5604P : baseconfig * Mode Entry System Clock CMU SWT PIT STM Software	
rSWT-	Autoutes
rWatchdog Control	
Enable Watchdog Timer	Clock Source 16MHz IRC 💌
Reset on Invalid Access EN S	Service Sequence Fixed Service Sequence
Interrupt then Reset DI V	Window Mode DI
Soft Lock DI H	Hard Lock Di
Debug Mode Control EN S	Stop Mode Control DI
✓ Load Value In Hex	
Watchdog Timeout Value 0x500 V	Window Value 0x0
rWatchdog Timeout-	rWatchdog Window Start Period
Clock Source Frequency: 16 MHz	Service Sequence Window Time in Clock Cycles: 0
Watchdog Timeout Range: 16 µs to 268.44 sec	Service Sequence Window Time: 0 ms
Watchdog Resolution: 0.062 µs	Window Time as Percentage of Timeout Period: 0 %
Watchdog Timeout in Clock Cycles: 1280	
Watchdog Timeout: 0.08 ms	
	Previous Next Exit Wizard





Configure PIT

We will monitor switch inputs S3 and S4 every 250ms in PIT Channel 0 interrupt. Select PIT tab and

-Enable Timer module -Enable PIT Channel 0 timer

- Set load value to 8000000 to set the time out value to 250 ms

-Enable PIT Channel 0 interrupt

-Select Next to start peripheral configuration.

🌽 System Clock/Timers - N	/IPC5604P : basecon	ifig *				ĸ
Mode Entry System Cloc	k CMU SWT PI	T STM Software Att	ributes			^
🔽 Enable Timer M	lodule Time	er Clock: 32 MHz				
🔲 Load Value in H	lex PIT	Time Range: 0.031 µs	s to 134.218 sec			
Timer Source	\$ Timer	\$ Load Value	\$ Interrupt	Time Interval (ms)		
PIT Channel 0	EN	800000	EN	250		
PIT Channel 1	DI	0	DI	0		
PIT Channel 2	DI	0	DI	0		Ξ
PIT Channel 3	DI	0	DI	0		
•		III			,	+
				Previous	Next Exit Wizard	



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Configure Peripherals

🏂 Peripheral Configurat		econfig *			×.
Peripheral Configuration	on				
DSPI	LINFlex	FlexPWM	FlexCAN	ADC	
					E
		eTIMER			
	"		MPCSCO		
				Previous	ext Exit Wizard
				Previous	

In Peripheral Configuration window, select DSPI to configure DSPI peripheral





Configure DSPI 1

DSPI 0 should be set to master mode to send commands to SBC. Select Master mode

DSPI 0 Chip Select 0 is connected to SBC. Set Chip select 0 inactive state to High

Disable Halt mode

Select OK to finish DSPI 0 configuration.

In the Peripheral Configuration window, select LinFlex tile to start LinFlex configuration.

Deserial Serial Periph	eral Interface - MPC5604P : baseconfig *		×
DSPI_0 DSPI_1 DSI	PI_2 DSPI_3 Software Attributes		
General Configuration	Clock and Transfer Attributes SPI Commands DN	AVInterrupts	
-DSPI General Configu	iration		
	Master/Slave Mode:	Master	-
	SPI Mode :	SPI	T
	Freeze Mode:	Disable	v
	Modified Time Format:	Disable	v
	Peripheral Chip Select Strobe:	Disable	v
	Receive FIFO Overflow Overwrite Enable:	Disable	T
	Peripheral Chip Select Line 7 inactive state:	Low	v
	Peripheral Chip Select Line 6 inactive state:	Low	v
	Peripheral Chip Select Line 5 inactive state:	Low	v
	Peripheral Chip Select Line 4 inactive state:	Low	v
	Peripheral Chip Select Line 3 inactive state:	Low	v
	Peripheral Chip Select Line 2 inactive state:	Low	v
	Peripheral Chip Select Line 1 inactive state:	Low	T
	Peripheral Chip Select Line 0 inactive state:	High	T
	Transmit FIFO:	Enable	T
	Receive FIFO:	Enable	T
	Sample point:	0	T
	Continuous Serial Communication Clock:	Disable	v
	Halt Mode:	Disable	v
	Module:	Enable	T
	Transfer Count On Reset:	0	
Getting Started			Ok Cancel Apply





Configure LINFlex 0

- We will use UART of LINFlex 0 to communicate serially via virtual serial port of TRK-MPC5604P board
- We will use baud rate of 115,200
- When Baud Rate Factor and Fractional Baud Rate Factor values are selected, RAppID automatically calculates and displays the resulting baud rate.



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Configure LINFlex 0

Set Baud Rate Factor to 17

Set Fractional Baud Rate Factor to 6/16

This should set the Baud rate to approx. 115,200

泽 Local Interconnect Network - M	PC5604P : baseconfig *		×
LINFlex_0 LINFlex_1 Software	Attributes		
General Configuration Interrupt	s & Filters Timeout UART		
LIN Configuration			
Master Mode	DI	LINFlex System Clock (MHz)	32 MHz
Receiver Buffer Locked	DI	Loopback Mode	DI
LIN Master Break Length	10 bits	Self Test Mode	DI
Bypass Filter	EN	Slave Mode Break Detection Threshold	11 bits 💌
Auto Wakeup	DI	LIN Auto Sync	DI
Checksum Field	EN	Idle on Bit Error	EN
Programmed Checksum		Checksum Calculation	DI
Integer Baud Rate Factor	17	Idle on Identifier Parity Error	EN
Baudrate (Symbols/Sec) =	115107.91	Fractional Baud Rate Factor	6/16 💌
		∟Note	
		Baudrate (Symbols/Sec) = Fcpu / (16 * LFD	IV)
		LFDIV = Integer factor(Mantissa) + Fraction	al factor(fraction)
Getting Started		Ok	Cancel Apply





Configure LINFlex 0

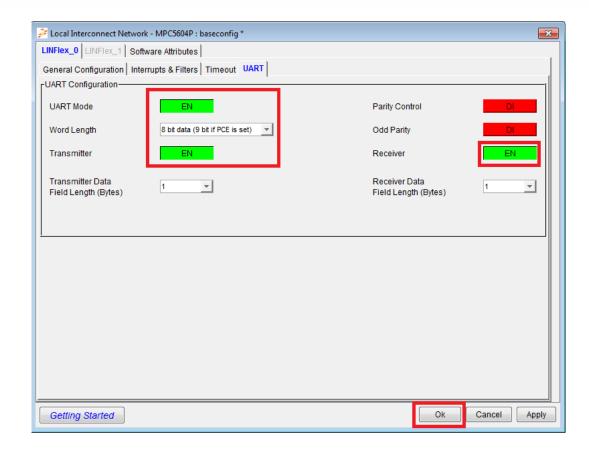
In UART tab, Enable UART

Set Word Length to 8 bit data

Enable Transmitter and Receiver

Select OK to finish LINFlex 0 configuration

In the Peripheral Configuration window, select FlexPWM tile to start FlexPWM configuration.







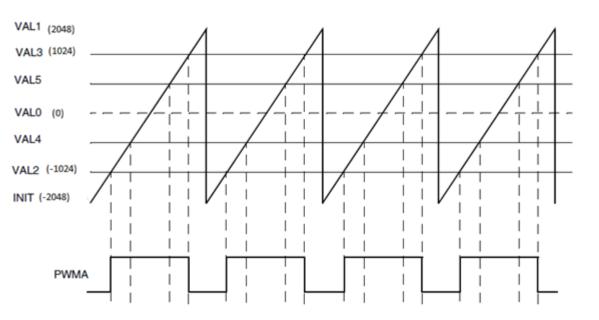
In this example, we will configure FlexPWM sub module 0, PWM A output to generate centeraligned PWM signals. The values of FlexPWM parameters are set as shown.

The PWM clock source is 16 MHz IRC clock.

The Period of PWM signal = (2048 + 2048) * 1/16 = 256 ms

The PWM signal high time = (1024+1024) * 1/16 = 128 ms.

Duty Cycle = 128/256 = 50%







We need to configure PD10 output (PWM A, sub module 0) for PWM signal

-Enable PWA 0 Output

- Enable PWM Generator for sub module 0
- -Set Load Okay bit

FlexPWM - MPC5604P : baseconfig *	×
FlexPWM_0 Software Attributes	
General Configuration Configuration 1 Configuration 2 Configur	ration 3 (Interrupt/DMA) Configuration 4
O/P Enable & Mask Configuration	Deadtime Source & S/W Ctrl O/P Configuration
SubModule 0 1 2 3	PWMxy_z Deadtime source S/W Controlled O/P
PWMAO/P EN DI DI	A_3 Generated PWM _ DI
PWM B O/P DI DI DI	B_3 Generated PWM DI
PWM X O/P DI DI DI DI	A_2 Generated PWM
PWM A Mask Di Di Di	B_2 Generated PWM V D
PWM B Mask DI DI DI	
PWMXMask DI DI DI	A_1 Generated PWM DI
Master Control Configuration	B_1 Generated PWM DI
Run (PWM Generator)	A_0 Generated PWM
Load to Buffer	B_0 Generated PWM D
Current Polarity (PWM)	xy=PWMxy z=Submodule number
Fault Control Configuration	
Fault Inputs	
0 1 2 3	Filter Control Configuration
Fault Interrupt DI DI DI DI	Filter Count (Samples) 3
Fault Safe Mode DI DI DI DI	Filter Period 0
Automatic Fault Clearing DI DI DI DI	
Fault Level 0 0 0	
•	T III III IIII IIII IIII IIII IIII III
Getting Started	Ok Cancel Apply





In Configuration 1 tab

-Set INIT counter value to -2048

-Set Pair Operation to Independent PWM

2	FlexP	WM - MP	C5604F	P : baseco	nfig *												_	۲.
F	lexPW	M_0 s	oftware	Attributes	s													
0	Genera	l Configu	ration	Configu	ration 1	Config	guration	2 Con	figuration	n 3 (Interru	pt/DMA) Co	nfiguration	4					
		odule Co						· ·										
	СН	INIT	DBL	PRSC	FULL	HALF	LDFQ	CLK	RLD	FORCE	FORCEN	INITSEL	PWMX	PWMB	PWMA	INDEP	WAIT	
	0	-2048	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0 0	
	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0 C	
	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0 0	
	3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0 0	
	[Confi	guration1-																
	Initi	alize Cou	unter (IN	VIT)	-3	2048					System Cloo	ck Frequen	cy(fclk)	16 MHz				
	Det	ubleSwite	bing (F	יוסר		DI					Force Initiali	ization (EOF		D				
				JOL)	_													E
	Pre	scalar (P	RSC)		fo	clk	▼ 16	6 MHz			Initialization	Control (IN	ITSEL)	Local sy	nc	–		
	Full	Cycle R	eload (I	FULL)		EN					PWMX Init(P	WMX)		LO	W			
	Hal	f Cycle R	eload ((HALF)		DI					PWMB Init (F	PWMB)		LO	W			
	Loa	d Freque	ency (Ll	DFQ)	E	very PWN	1	-			PWMA Init (F	PWMA)		LO	W			
	Clo	ck Sourc	e (CLK)	IP	Bus clock	k	-			Pair Operati	on (INDEP))	Independ	dent PWM	-		
	Rel	oad Sou	rce (RL	.D)	L	ocal reloa	d	-			Wait (WAIT)							
		ce Sourc				ocal force					Debug (DBC			D				
	FUI	Le Sourc	e(FOR	CE)			,				Debug (DBG	3)						
	_																	-
										11						0		
L	Gett	ng Star	ted												Ok	Cancel	Apply	





In Configuration 2 tab

-Set MAX counter value to 2048

-Set PWM A High to -1024

-Set PWM A Low to 1024

			504P : based are Attribut															
Gener	al Con	figurati			1 Configu	ration 2	Configurat	ion 3 (Inte	errupt/DI	MA) Confi	guration 4							
СН	MID	MAX	PWMAH	PWMA	L PWME	H PW	MBL POL	A POLB	POLX	PWMAFS	PWMBFS	PWMXFS	V0	V1	V2	V3	V4	V5
0	0	2048	-1024	1024	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PV	Mid Cycle Reload Point (MID) 0 Maximum Count (MAX) 2048 PWM A High (PWMAH) -1024 PWM A Low (PWMAL) 1024						PWM)	K O/P Po A O/P Fa	olarity (POL Iarity (POL) ult State (P ult State (F	X) WMAFS)	Not Inverte	_	*					
		ow (PV			0					ult State (P		Logic 0						
	AL: utput T	rigger	Control VA	V0 L DI	V1 Di	V2 Di	V3 DI	V4 DI	V5 DI									
0.4	ting S		_											Ok		Cano		App





In Configuration 4 tab

-Set PWM A Fault Mask to 0

-Set PWM A Dead Count to 0

-Select Ok to finish FlexPWM configuration.

-In the Peripheral Configuration window, select FlexCAN tile to start FlexCAN configuration.

FlexPWM - MPC5604P : baseconfig *														×				
	lexPW	M_0 s	oftware	e Attribu	tes							_				•		
	Genera	l Config	uration	Confi	guration 1	Configura	tion 2 Co	onfiguratio	on 3 (Inter	rupt/DMA)	Configuratio	on 4						
1	Sub Mo	dule C	onfigura	ation—														
	СН	DISA	DISB	DISX	DTCNTO	DTCNT1	CAPMD	EDGX0	EDGX1	INPSELX	EDGCNTX	CFX0WM	CFX1WM	EDGCMPX	ARMX			
	0 0 15 15 0 2047 0 0 0 0 0 0 0 0							-	0									
	1	15	15	15	2047	2047	0	0	0	0	0	0	0	0	0			
	2	15	15	15	2047	2047	0	0	0	0	0	0	0	0	0			
	3	15	15	15	2047	2047	0	0	0	0	0	0	0	0	0			
																·		
	Config	juration4														=		
	DW		Hlack	(DIOA)	00	00	-	1	lan	d EdgeV4 ((4)	Disabl	- d	T			
	PW	M A Fau	It Mask	(DISA)		00		1	inp	It Edgex 1 :	Select (EDG)	(1)	Disabi	ea	<u> </u>			
	PW	M B Fau	lt Mask	(DISB)	11	11	T		Inp	ut Select X ((INPSELX)		Raw P	Raw PWMX				
	PW	M X Fau	lt Mask	(DISX)	11	11	-		Edg	e Counter	X (EDGCNT)	K)		DI				
	DW	MADea	d Cour		NT0) 0				Cal	atura VO EIE	Os Water Ma	ork (CEX0M	/MD	DI				
		WADea	u cour		110)				Ca	Aure Auri	OS Water Ma		(111)					
	PW	M B Dea	ad Cour	nt (DTCI	NT1) 20	47			Ca	oture X1 FIF	Os Water Ma	ark (CFX1V	VM)	DI				
	Cap	ture Mo	de (CA	PMD)	Fr	ee Running	-		Edg	Edge CompareX (EDGCMPX) 0								
	Inpu	Input EdgeX0 Select (EDGX0)						Inp	Input Capture Mode(ARMX) DI									
	<u> </u>																	
																-		
4																4		
	Getti	ng Sta	rted											Ok	Cancel	Apply		





Configure FlexCAN

In TRK-MPC5604P board, the CAN 0 peripheral is connected to CAN transceiver in SBC. In this example, we will use CAN speed of 500 k bits/sec.

Enable CAN module

Disable Freeze and Halt modes

Set Clock Source to System

Set CAN speed to 500. RAppID will configure Phase segments and Propagation segment values automatically.

Select OK to finish CAN configuration.

In the Peripheral Configuration window, select ADC tile to start ADC configuration.

FlexCAN - MPC5604P : baseconfig *											
CAN_0 SAFEPORT Software Attributes											
CAN Setting Interrupt Mask Receive Buffer Mask											
FlexCAN											
Module:	Enable	Max Message Buffer :	16								
Soft Reset:	Disable 💌	Bus Off Recovery:	Enable	-							
Freeze Enable:	Disable	Lowest Buffer Transfer First:	Disable	-							
Halt FlexCAN:	Disable	Loop Back Mode:	Disable	-							
Clock Source:	System 💌	Listen Only Mode:	Disable	-							
FlexCAN System Clock (MHz):	32	Timer Synch Mode:	Disable	-							
CAN Speed (k bits/s):	500	Supervisor Mode:	Supervisor mode	-							
CAN Bit Timing		Self Reception:	Enable	-							
Prescaler Division Factor:	4	Backwards Compatibility Configuration(BCC):	Enable	-							
Phase Segment 1:	3 💌	Abort Enable:	Disable	<u> </u>							
Phase Segment 2:	5 💌	Local Priority Enable:	Disable	-							
Propagation Segment:	7 💌	ID Acceptance Mode:	A	-							
Resynchronization Jump Width:	1	FIFO Enable:	Disable	-							
CAN Bit Sampling Mode:	1 Sample 💌	Warning Interrupt Enable:	Disable	-							
Sample Point (%):	68.8										
Serial Clock Frequency (MHz):	8										
Enable CAN2.0B Checks											
Note While setting Phase Segment 1, Phase	se Segment 2 and	CAN Speed =									
Propagation Segment following two c	ondition should be considered	I CAN Speed =									
 Phase Segment 2 >= Phase Segment Phase Segment 1 + Phase Segment 		1 FlexCAN System clock	FlexCAN System clock								
>= 8		(Prescaler*(Phase Segment1+Phas									
3)Propagation Segment + Phase seg	ment 1 >=4	2+Propagation Segment+	1))								
Getting Started		Ok	Cancel	\pply							





Configure ADC 1

In the Device Setup tab, Disable Power Down option to put ADC in normal mode

🏓 ADC	CTU - MPC5604P : baseconfig)*				×
ADC_0	ADC_1 ADC Cross Trigge	er Unit (CTU) Soft	vare Attributes			<u>^</u>
Device	Setup Sampling Control	Channel Setup Di	IA & Interrupt			
-Cone	ral Configuration					
	-	10.0.1				
ADC	System Clock (MHz)	16.0 MHz	ADC Resolution(bits): 10			
Num	ber of ADC Threshold Analog	g Watchdogs : 4	Conversion Mode	One Shot	-	
Over	write	DI	Alignment	Right	-	
Auto	Clock Off	DI	Decode Signal Delay (ADC Clock Cycles)	0		=
	er Down Delay	0	Power Down Enable	DI		
(ADC	Clock Cycles)	-				
ADC	Clock Select	System clock/2				
Trigg	er Mechanism					
	Cross Triggering CTU)	DI				
Exter	nal Trigger injection	DI	Trigger Injection edge	Falling	-	
* Note	: ADC can be triggered from	eTimer by enabling	Triggered Injection with appro	opriate Edge s	election.	
<u> </u>						
•			III			+
Gett	ing Started			Ok	Cancel	Apply



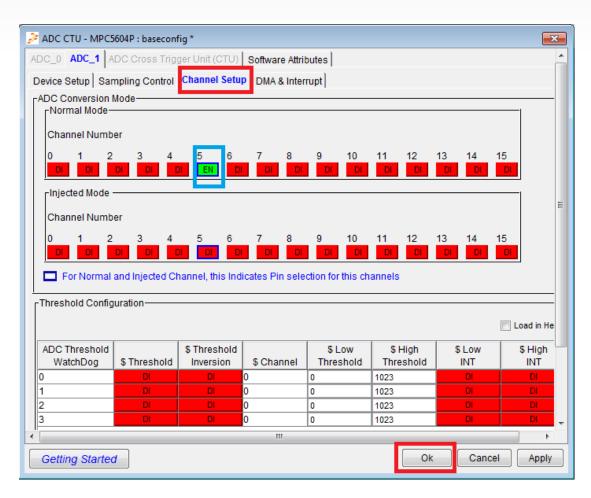


Configure ADC 1

The Potentiometer in TRK-MPC5604P board is connected to PE0 which is ADC 1 Channel 5. In this example we will use Normal conversion mode. Enable Channel 5 in Normal mode

Select OK to finish ADC peripheral configuration.

In the Peripheral Configuration window, select eTimer tile to start eTimer configuration.

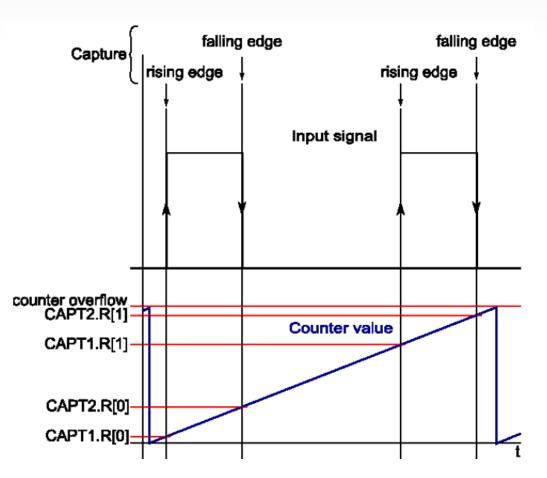






In this example, we will use channel 0 of the eTimer for measuring the frequency and duty cycle. The function uses the capture functionality of the eTimer.

The capture 1 register is set for capture the counter value on rising edge of signal and the capture 2 register is set for capture the counter value on falling edge of input signal. The capture registers have twodeep FIFO so they are able to capture two values.







The Motor Control clock is used as the primary source of clock and the input signal as secondary source. The counter is counting repeatedly the primary source and captures its values on edges produced by the secondary source or input.

To accomplish this, select values in eTimer Configuration 1 tab as shown in the picture.

eTimer Configuration 1 eTimer Configuration 2 eTimer Configuration 3 eTimer IRQ & DMA															
CHNL	ENBL	LOAD	DIR	SECSRC	SIPS	CNTMODE	ROC	PRISRC	PIPS	ONCE	DBGEN	LENGTH	STPEN	FILT_CNT	FILT_
	1	0x0	0	0	0	1	0	24	0	0	0	0	0	0	0
	1	0x0		0	0	0	0	0	0	0	0	0	0	0	0
	1 1	0x0 0x0	-	0	0	0	0	0	0	0	0	0	0	0	0
	1	0x0	-	0	0	0	0	0	0	0	0	0	0	0	0
	1	0x0	-	0	0	0	0	0	0	0	0	0	0	0	0
	ration 1			-		-	-	-			-	-	-	-	
Count (ENBL	er			EN			tialize Cou DAD)	inter	0x0			Direction (DIR)	Cou	unt Up	v
Secon (SECS	dary So RC)	urce	Counter () VP			Count Mode (CNTMODE)							•	
Secondary I/P Polarity (SIPS) True						load on C OC)	Do not reload						Ŧ		
Primary Source (PRISRC)						T	ntinuous / NCE)	ntinuous / One shot Continuous						Ŧ	
Primary I/P Polarity (PIPS)						Debug Actions (DBGEN) Continue with normal operation during debug mode							T		
Count Till Compare Di Stop Actions Di (LENGTH) (STPEN)															
-Input F	ilter Cor	nfiguratio	n						hdog Tir	ner Confi	guration (Only for eT	imer0)—		
Sample Count (FILT_CNT) Sample Period (FILT_PER)							0 Timeout High 0x0 Timeout Low 0x0								





The capture 1 register is set for capture the counter value on rising edge of signal and the capture 2 register is set for capture the counter value on falling edge of input signal. The capture registers have two-deep FIFO so they are able to capture two values.

To accomplish this, select values in eTimer Configuration 3 tab as shown in the picture.

CHNL	Configuration	CPT1MODE	CMPLD2	CPT2MODE	COMP1	COMP2	ONESHOT	ARM	CLC1	CFWM	CLC2	СМРМО
	0×0	2	0×0	1	0×0	0×0	0	0	0	2	0	0
	0×0	0	0x0	0	0×0	0x0	0	0	0	0	0	0
	0×0	0	0×0	0	0×0	0x0	0	0	0	0	0	0
	0×0	0	0x0	0	0×0	0x0	0	0	0	0	0	0
	0×0	0	0x0	0	0×0	0x0	0	0	0	0	0	0
	0×0	0	0x0	0	0×0	0x0	0	0	0	0	0	0
(CON		2 0×0	DI	(CLC: Comp). Load Cont 2) pare Mode MODE)	Never	preload CMP1 & CMP2 o	used when C	ounting Up		▼ ▼	
Arm Capture DI Capture FIFO Watermark 2 (CFWM)												





The frequency of the input PWM signal can be calculated as follows: f [kHz] = motc_clk [kHz]/(CAPT1.R[1] - CAPT1.R[0])

The duty cycle of the input PWM signal can be calculated as follows: duty cycle= ((CAPT2.R[0] - CAPT1.R[0])*100)/(CAPT1.R[1] - CAPT1.R[0])

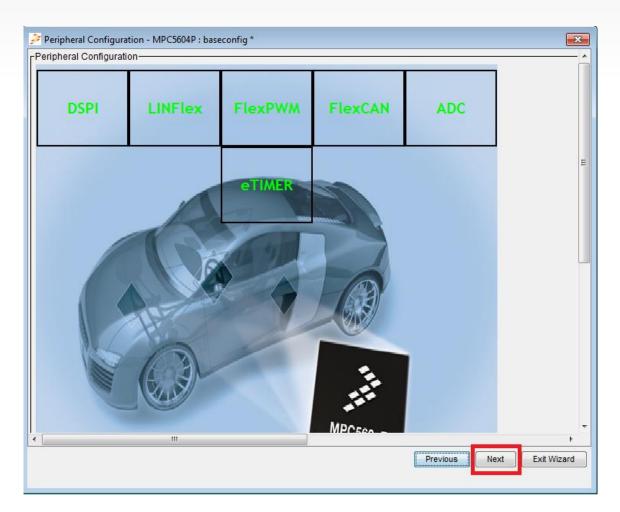


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Configure PIT Interrupt

This completes Peripheral configuration. Select *Next* to configure PIT interrupt.







Configure PIT Interrupt

In this example, PIT Channel 0 interrupt is used to monitor the state of input switches S3 and S4.

Configure PIT Ch0 interrupt as shown.

Click on PIT Channel 0 Edit button to add code to ISR function.

Interrupt Config	uration - MPC5604P : baseconf	ig *				x					
nterrupt Excepti	on Software Attributes					-					
Seneral System Configuration											
-Core											
Select Either Software or Hardware vector mode : Software											
Select the vec	tor Size :	4byte	s 💌								
Select the inte	errupt lower than priority level :	0	•								
elect the portion	of the INTC you wish to configu	ure below :									
nterrupt Source	Interrupt Vector	\$ Priority	Core(s)	\$ Function	\$ ISR Code	=					
	PIT Channel 0	1	e200z0	PIT_Ch0_ISR	Edit						
Software MCM	PIT Channel 1	0	e200z0	interrupt_handler	Edit						
	PIT Channel 2	0	e200z0	interrupt_handler	Edit						
	PIT Channel 3	0	e200z0	interrupt_handler	Edit						
MC_RGM FlexPWM (OSC GWT											
PIT											
DMA DSPI LINFIex STM ADC MC_ME											
				Previous	Next Exit Wizard	d _					





Configure PIT Interrupt

Add the following code to ISR to decrease Flex PWM duty cycle when S3 is pressed and increase the duty cycle when S4 is pressed.

```
/* Enter user code here */
#define MAX_PWM_COUNT 2048

if (!GPI0_GetState(50) && GPI0_GetState(51))
{
    if ((FLEXPWM_0.SUB[0].VAL[3].R - 0x80) > 0)
    {
        FLEXPWM_0.SUB[0].VAL[2].R = FLEXPWM_0.SUB[0].VAL[2].R + 0x80;
        FLEXPWM_0.SUB[0].VAL[3].R = FLEXPWM_0.SUB[0].VAL[3].R - 0x80;
        FLEXPWM_0.MCTRL.B.LDOK = 1;
    }
}
if (GPI0_GetState(50) && !GPI0_GetState(51))
{
    if ((FLEXPWM_0.SUB[0].VAL[3].R + 0x80) < MAX_PWM_COUNT)
    {
        FLEXPWM_0.SUB[0].VAL[2].R = FLEXPWM_0.SUB[0].VAL[2].R - 0x80;
        FLEXPWM_0.SUB[0].VAL[3].R + 0x80) < MAX_PWM_COUNT)
    {
        FLEXPWM_0.SUB[0].VAL[3].R = FLEXPWM_0.SUB[0].VAL[2].R - 0x80;
        FLEXPWM_0.SUB[0].VAL[3].R = FLEXPWM_0.SUB[0].VAL[3].R + 0x80;
        FLEXPWM_0.SUB[0].VAL[3].R = FLEXPWM_0.SUB[0].VAL[3].R + 0x80;
        FLEXPWM_0.MCTRL.B.LDOK = 1;
    }
}</pre>
```

Select OK to exit from Edit Code window.

Edit ISR Code		x							
Header File	gpio_drv.h								
	PIT.CH[0].TFLG.R = 0x00000001;	^							
	/* Enter user code here */ #define MAX_PWM_COUNT 2048	=							
ISR Code	if (!GPIO_GetState(50) && GPIO_GetState(51)) { if ((FLEXPWM_0.SUB[0].VAL[3].R - 0x80) > 0) { FLEXPWM_0.SUB[0].VAL[2].R = FLEXPWM_0.SUB[0].VA	Ŧ							
	sibility to write error free code in the edit box provided. Im 50 lines of code in this edit box.								
Default-Reset	OK Cance	1							



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Configure PIT Interrupt

Select Exit Wizard to exit to main RAppID window

Interrupt Excep	tion Software Attributes						
-Core-	Comgaration						
	Software or Hardware ved	tor mode :	Software 💌				
Select the ve	ctor Size :		4bytes 💌				
Select the inf	terrupt lower than priority le	vel :	0 💌				
Select the portion	of the INTC you wish to co	nfigure below :					
Interrupt Source	Interrupt Vector	\$ Prior	rity	Core(s)	\$ Function	\$ ISR Code	
SIU	PIT Channel 0	1	e	200z0	PIT_Ch0_ISR	Edit	
Software MCM	PIT Channel 1	0	e	200z0	interrupt_handler	Edit	
FlexCAN	PIT Channel 2	0	e	200z0	interrupt_handler	Edit	
MC_RGM	PIT Channel 3	0	e	200z0	interrupt_handler	Edit	
XOSC SWT							
PIT							
DMA DSPI							
LINFlex							
STM							
ADC							
MC_ME							
	1						



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- We have completed all pin and peripheral configurations required for this example project.
- Now we are ready to generate code. By default, RAppID generates code for RAM. In this example we will generate code for Flash.
- By default, RAppID generates code for all peripherals. In this example, we will select only the peripherals that are used in the example for code generation.





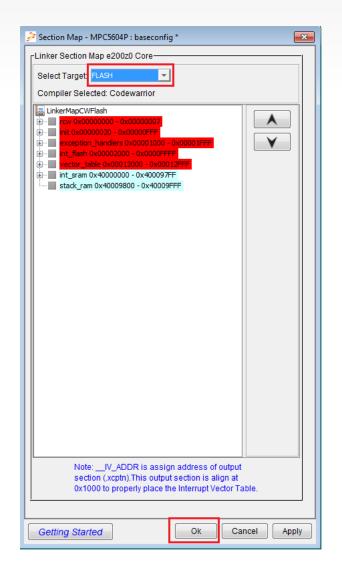
Configure Section Map

By Default, RAppID is configured to generate code for RAM. For this example, we will change the configuration to generate code for Flash.

From main RAppID window, select menu *View->View Section Map*.

Change Target to FLASH

Select Ok







Configure Code Generation

From main RAppID window, select menu *Configuration->Code Generation*.

Unselect code generation option for unused peripherals as shown.

Check ECC for code generation. This is required to generate initialization code for SRAM and ECC register.

Select CodeWarrior compiler

Select Code for Flash option

Select the directory where code should be generated

Select Ok

Code generation Setur	p			
Flash BIU	MSR	Peripheral	LINFlex	
 Startup Code ECC 	 System Clock Main 	ADC eDMA	■ FlexRay ✓ DSPI	
✓ System Init	RGM	FCU	 ✓ Timers ✓ FlexPWM ✓ eTIMER 	
Compiler Config	Codewarrior	T	Select All	Clear All
Source Compliance	ANSI C		View Code on completi	
			Autorun Consistency C	heck
			Generate LCF with Cod	le
			🔽 Generate Code For Fla	sh
Source Path ⁻ reescal	e\RAppID\RAppID Proje	ects\560xP\TRK56	04P\LED_Training_Example	



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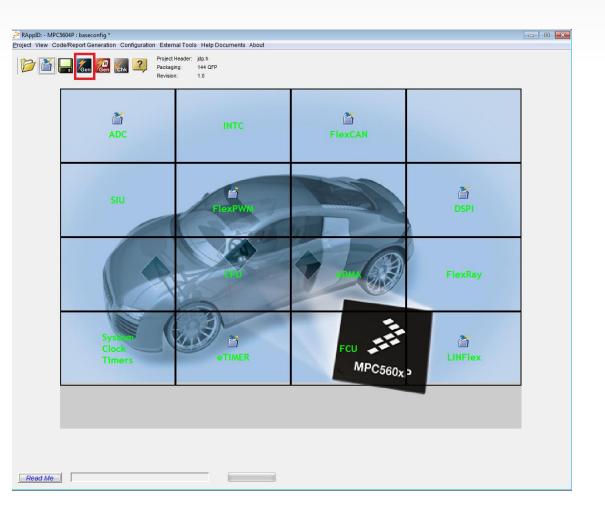


Generate code

Select Code Generation icon to generate code

Save the project when prompted

Now we are ready to build and run the project.







Report Generation

- RAppID init tool can generate a comprehensive report on the project
- Since we have finished with configuration for this example, we are ready to generate a report for this project.



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Configure Report Generation

From main RAppID window, select menu Configuration->Report Generation.

Unselect report generation option for unused peripherals

Select the directory where report should be generated

Select Ok

Project Configuration: LED_Training_Example *				x
Project Settings Code Generation Report Gen	eration External Tools	nitialization Se	quence	
Report Generation Setup				
- Core	Desighased			
	Peripheral			
Flash BIU	FlexCAN ADC	LINFlex		
System Clock	eDMA	DSPI	, ,	
V ECC	INTC	Timers		
RGM	FCU	FlexPW		
	SIU	V eTIMEF	R	
		Select Al	I Clear All	
		Select Al		
		📝 View Rep	port on completion	
Report Patt C:\Freescale\RAppID\RAppID Pro	jects\560xP\TRK5604P\Re	port		
1		_		
		Ok	Cancel App	ly

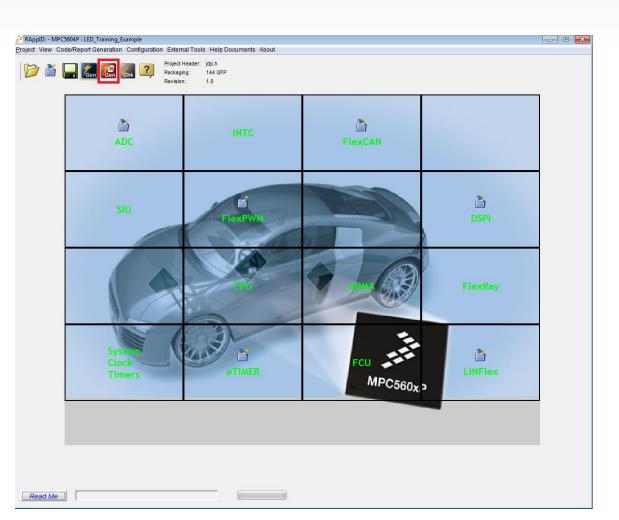




Generate Report

Select Report Generation icon to generate report

Save the project when prompted





RAppID Init Project Report

- RAppID tool generates a detailed report of the project that covers
 - Initialization Technique, both system and peripheral
 - Detailed Pin Allocation report
 - Section Map report
 - A detailed report of configuration of each peripheral





Project Report – Initialization Technique

Overview Initialization Technique	Configuration Report for MPC56 Package: 144 QFP	604P	
<u>Pin Allocation-l</u> Pin Allocation- <u>ll</u>	Project Name: baseconfig (Revision :1.0) Compiler Compliancy: Codewarrior, ANSI C Note: RAppID bit description is in Motorola (Big Endian) format.	Last Save Date: Fri, 04 May 2012 02:50:28 Tool Version: 1.4.0.4	
Section Map ADC_0 Configuration Device Setup Sampling Setup Channel Setup DMA & Interrupt Setup ADC_1 Configuration		for: Initialization Technique	
Device Setup Sampling Setup Channel Setup DMA & Interrupt Setup CTU Configuration CTU Trigger Generation Configuration CTU Configuration CTU Control & Interrupt FIFO Configuration Software Attributes Registers DSPI DSPI0 Configuration General Clock Attribute SPI Commands DMA/Interrupts DSPI1 Configuration General Clock Attribute SPI Commands DMA/Interrupts DSPI1 Configuration General	C startup ECC Initialization Main System Initialization Optional Function calls While (1) Application code	System Initialization (e20020 Core) - INTC Initialization - RGM Initialization - SWT Initialization - MSR Initialization - MSR Initialization - MSR Initialization - Mystem Clock Initialization - OHU Initialization - System Clock Initialization - STM Initialization - STM Initialization - FLASH BIU Initialization - FlexCAN Initialization - FlexCAN Initialization - FITHER Initialization - TIMER Initialization - FITHER Initialization - FITHER Initialization - FITHER Initialization - TIMER Initialization - UNFlex Initialization - FULP Initialization - SULP Initialization - SULP	
Clock Attribute SPI Commands DMAInternuots DSPI2 Configuration General Clock Attribute SPI Commands DMAInternuots	Perip	oheral Initialization	



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Project Report – Pin Allocation

<u>Overview</u>

Initialization Technique

Pin Allocation-I

Pin Allocation-II

Section Map

ADC

ADC_0 Configuration <u>Device Setue</u> <u>Sampling Setue</u> <u>Channel Setue</u> <u>DMA & Interrupt Setue</u> ADC_1 Configuration <u>Device Setue</u> <u>Sampling Setue</u> <u>Channel Setue</u> <u>DMA & Interrupt Setue</u>

CTU Configuration <u>CTU Trigger Generation Configuration</u> <u>Scheduling Unit</u> <u>CTU Command List</u> <u>CTU Control & Interrupt</u> <u>FIFO Configuration</u> <u>Software Attributes</u> <u>Registers</u>

DSPI

DSPI0 Configuration <u>General</u> <u>Clock Attribute</u> <u>SPI Commands</u> <u>DMA/Interrupts</u> DSPI1 Configuration <u>General</u> <u>Clock Attribute</u> <u>SPI2 Configuration</u> <u>General</u> <u>Clock Attribute</u> <u>SPI2 Commands</u> <u>DMA/Interrupts</u>

Configuration Report for MPC5604P Package: 144 QFP

Project Name: baseconfig (Revision :1.0) Compiler Compliancy: Codewarrior, ANSI C Note: RAppID bit description is in Motorola (Big Endian) format. Last Save Date: Fri, 04 May 2012 02:50:28 Tool Version: 1.4.0.4 Freescale"

Function Assignment for MPC5604P 144 QFP package

			Primary Function		Alternate Function 1		Alternate Function 2		Alternate Function 3		Input Functio	n 0	Input Function	m	Analog Pad Conrol	l	Assigned Fun	ctio	n
SIU PCR#	Package Pin #		GPIO (PA=3'b000)		ALT 1 (PA=3'b001)	dir	ALT 2 (PA=3'b010)		ALT 3 (PA=3'b011)	dir	IN 0	dir	IN 1	dir	APC	dir	Assigned Function	dir	User Assigned Signal Name
0	73	PA[0]	GPIO	IO	ETC_0[0]	IO	SCK_2	ю	FCU[0]	0							GPIO	Ι	
1	74	PA[1]	GPIO	IO	ETC_0[1]	IO	SOUT_2	0	FCU[1]	0							ETC_0[1] I	I	PA1_eTimer_In
2	84	PA[2]	GPIO	IO	ETC_0[2]	IO			PWM_A[3]	IO	SIN_2	I					GPIO	I	
3	92	PA[3]	GPIO	IO	ETC_0[3]	IO	CS0_2	IO	PWM_B[3]	IO							GPIO	Ι	
4	108	PA[4]	GPIO	IO	ETC_1[0]	IO	CS1_2	0	ETC_0[4]	IO							GPIO	I	
5	14	PA[5]	GPIO	IO	CS0_1	IO	ETC_1[5]	IO	CS7_0	0							GPIO	I	
6	2	PA[6]	GPIO	IO	SCK_1	IO											GPIO	I	
7	10	PA[7]	GPIO	IO	SOUT_1	0											GPIO	I	
8	12	PA[8]	GPIO	IO							SIN_1	I					GPIO	I	
9	134	PA[9]	GPIO	IO	C\$1_2	0			PWM_B[3]	IO	FAULT[0]	Ι					GPIO	I	
10	118	PA[10]	GPIO	IO	CS0_2	IO	PWM_B[0]	IO	PWM_X[2]	IO							GPIO	I	
11	120	PA[11]	GPIO	IO	SCK_2	IO	PWM_A[0]	IO	PWM_A[2]	IO							GPIO	I	
12	122	PA[12]	GPIO	IO	SOUT_2	0	PWM_A[2]	IO	PWM_B[2]	IO							GPIO	Ι	
13	136	PA[13]	GPIO	IO			PWM_B[2]	IO			SIN_2	I	FAULT[0]	Ι			GPIO	I	
14	143	PA[14]	GPIO	IO	SP_TXD	0	ETC_1[4]	IO									GPIO	Ι	
15	144	PA[15]	GPIO	IO			ETC_1[4]	IO			SP_RXD	Ι					GPIO	I	
16	109	PB[0]	GPIO	IO	CNTXD_0	0	ETC_1[2]	IO	DEBUG[0]	0							CNTXD_0	0	PB0_CAN0_TX
17	110	PB[1]	GPIO	IO			ETC_1[3]	IO	DEBUG[1]	0	CNRXD_0	Ι					CNRXD_0	Ι	PB1_CAN0_RX



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Project Report – Section Map

Overview Initialization Technique		Report for MPC5604P age: 144 QFP			
<u>Pin Allocation-I</u> <u>Pin Allocation-II</u>	Project Name: baseconfig (Revision :1.0) Compiler Compliancy: Codewarrior, ANSI C Note: RApp/D bit description is in Motorola (Big Endian) format.		Last Save Date: Fri, 0 Tool Version: 1.4.0.4	4 May 2012 02:50:28	
Section Map ADC ADC_0 Configuration Device Setup Sampling Setup Channel Setup DMA & Interrupt Setup ADC_1 Configuration Device Setup Sampling Setup	Selected Compiler: Codewarrior Selected Target: FLASH	Section Map			
Channel Setue DMA & Intervuot Setue CTU Configuration CTU Troper Generation Configuration Scheduling Unit CTU Command List CTU Commond List CTU Configuration Software Attributes Replaters	LinkerMapCWFlash Srew 0x00000000 - 0x0000007 Sini 0x00000000 - 0x00000FFF Sexception handlars 0x0001000 - 0x00001FFF Sint_fash 0x00002000 - 0x0000FFF Sint_fash 0x0000000 - 0x40009FFF -Sint_sram 0x40000000 - 0x40009FFF Stack_ram 0x40009800 - 0x40009FFF	Linker Section Map	e20010 Core		
DSPI DSPI0 Configuration General Clock Attribute	Croup		P Section F	ile	
SPI Commands DMAInternuts DSPI1 Configuration Glock Attribute SPI Commands DMAInternuts DSPI2 Configuration General	Eroop: 1 Groop: 1	init init via	tit	le	
Clock Attribute SPI Commands DM/Interrupts DSPI3 Configuration General Clock Attribute	Gross	exception_ba		la	
SPI Commands		exect vect	1		



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Project Report – Peripheral Configuration

*	
<u>Overview</u>	Configuration Report for MPC5604P Package: 144 QFP
Initialization Technique	Package. 144 QFP
Pin Allocation-I	Project Name: baseconfig (Revision :1.0) Last Save Date: Fri, 04 May 2012 02:50:28 Compiler Compliancy: Codewarrior, ANSI C Tool Version: 1.4.0.4
Pin Allocation-II	Note: RAppID bit description is in Motorola (Big Endian) format.
Section Map	
ADC ADC_0 Configuration <u>Device Setup</u> <u>Sampling Setup</u> <u>Channel Setup</u>	Device Settings for: ADC_0
DMA & Interrupt Setup ADC_1 Configuration	
Device Setup Sampling Setup	ADC General Setup Information
Channel Setup DMA & Interrupt Setup	General Device Settings
OTH Or of successory	Normal Conversion will not start when external Start Signal is detected. Clock will not automatically switch off when ADC is idle.
CTU Configuration <u>CTU Trigger Generation Configuration</u> Scheduling Unit CTU Command List	Conversion of ADC command shall be one channel chain at a time. After conversion data is right allign also old conversion data will be not overwritten by newer result, hence newer result will be discarded.
CTU Control & Interrupt FIFO Configuration	Delay between extrenal decode signal and start of sampling pulse is set to 0 clock cycles. Delay between extrenal power signal and start of sampling pulse is set to 0 clock cycles.
Software Attributes Registers	ADC Clock selected as System Clock/2.
DSPI DSPI0 Configuration	Cross Triggering unit <u>Disabled.</u>
General Clock Attribute SPI Commands DMA/Interrupts	Triggered Injection is <u>Disabled</u> , with Trigger Injection edge selected as <u>Falling</u> , Register
DSPI1 Configuration General	
Clock Attribute SPI Commands DMA/Interrupts	ADC_0_MCR
DSPI2 Configuration	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
General Clock Attribute SPI Commands DMA/Interrupts	OWR WOLE EDGE LEV TROLEN EDGE LEV Res. JTROL Busserword CTUEN Res. FW FW
DSPI3 Configuration General Clock Attribute	16 17 18 19 20 21 22 23 24 25 28 27 28 29 30 31
SPI Commands	Reserved ADCRX ABORT ACCO ABORT ACCO OFF OFF FREM CANC



Adding Low and high level Driver code

 We will use driver code supplied with the installation media to perform low level functions. Copy the driver code to the directory where RAppID code was generated



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Adding FreeMASTER code

- We will use FreeMASTER utility to monitor global variables. To add this ability, we have to add FreeMASTER code which is provided with the installation media.
- Copy all the code from sub-folders src_common and src_platforms\MPC56xx to the location where RAppID code is generated.
- FreeMASTER can be used in polling or interrupt mode via CAN or SCI. In this example, you will use FreeMASTER in poll mode via SCI.
- To use FreeMASTER in polling or interrupt mode you will have to make changes to FreeMASTER configuration header file.

- Rename *freemaster_cfg.h.example* file to *freemaster_cfg.h*. This file contains all the macro definitions available for the FreeMASTER configuration.

- Select poll driven SCI communication and disable TSA by making following changes to *freemaster_cfg.h*:

#define FMSTR_SHORT_INTR 0
#define FMSTR_POLL_DRIVEN 1
#define FMSTR_USE_TSA 0



Edit main.c

- The main.c generated by RAppID initializes peripherals and includes an empty while loop. We have to add code to main.c to:
 - Turn on LED1 when Switch S1 is pressed and turn off when S1 is not pressed
 - Turn on LED2 when potentiometer input value is <=512 otherwise turn off LED2
 - Turn on LED3 when command '1' is sent via CAN and turn off LED3 when '0' is sent
 - Add FreeMASTER supporting code
 - Add code to calculate frequency and duty cycle of eTimer channel 0 PWM input signal





Edit main.c – Global variables

Add following global variables to main.c:

/* CAN messages to transmit */
unsigned char msgOKCAN[8] = {1,1,0,0,0,0,0,0};
unsigned char msgErrorCAN[8] = {1,0xFF,0,0,0,0,0,0};
vuint16_t potValue;/* Potentiometer input value */
vuint16_t switchState; /* State of input switch S1 */
vuint32_t PWMDutyCycle; /* Duty cycle of input PWM signal */
vuint32_t PWMFreq; /* Frequency of input PWM signal */

Note: This example CodeWarrior project along with source code is provided with the installation disk. You can use Import project option to create this example project within CodeWarrior.





Edit main function

Add following include files:

#include "freemaster.h"
#include "pot_hld.h"
#include "sbc_hld.h"
#include "CANapi.h"
#include "gpio_drv.h"

Add following code to *main* function:

Add a call to driver to initialize SBC to enable CAN communication: SBC_Init_DBG();

The 4 LEDs are active low and they turn on at start up. Turn them off:

GPIO_SetState(52, 1); GPIO_SetState(53, 1); GPIO_SetState(54, 1); GPIO_SetState(55, 1);





Edit main function (Continued)

We will receive CAN messages with CAN ID = 1. Add a call to CAN driver to setup mailbox 0 with Id = 1:

SetCanRxFilter(1, 0, 0);

Call FreeMASTER internal variables initialization function: *FMSTR_Init();*



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Edit main function (Continued)

Within while loop, add function calls to process FreeMASTER, GPIO, ADC, CAN and duty cycle calculation.

```
while(1)
          FMSTR_Poll();
          ProcessGPIO();
          ProcessADC();
          ProcessCAN();
          CalcDC();
```



{

}

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Add ProcessCAN function

We will add function *ProcessCAN* to process messages received via CAN. This function will call the CAN driver functions to check if any CAN message is received. If a CAN message is received with first data byte value of 1, it will turn On LED3 and if the first data byte value is 0, it will turn Off LED3.

If the first data byte is either 0 or 1, it will transmit CAN message *msgOKCAN*, other wise it will transmit CAN message *msgErrorCAN*. The code is shown below:



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Add ProcessCAN function (Continued)

```
void ProcessCAN(void)
```

```
can_msg_struct msgCanRX;
if (CanRxMbFull(0) == 1)
                                   /* Check if CAN message received */
  msgCanRX = CanRxMsg(0);
  if (msgCanRX.data[0] == 0)
                                   /* If received data byte is 0, turn off LED3 and send positive response */
         GPIO_SetState(54, 1);
         CanTxMsg (2, 1, 8, (uint8_t *)msgOKCAN, 0);
  }
  else if (msgCanRX.data[0] == 1) /* If received data byte is 1, turn on LED3 and send positive response */
  {
         GPIO_SetState(54, 0);
         CanTxMsg (2, 1, 8, (uint8_t *)msgOKCAN, 0);
  }
```





Add ProcessCAN function (Continued)

/* If received data byte is not 0 or 1, send a negative response */

CanTxMsg (2, 1, 8, (uint8_t *)msgErrorCAN, 0);



else

{

}

}

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Add ProcessADC function

We will add function *ProcessADC* to process potentiometer input. If potentiometer value is <=512, it will turn on LED2, otherwise turn off LED2. The code is shown below:

```
void ProcessADC(void)
{
    potValue = Pot_Get_Value();
    if(potValue <= 512) /* If Potentiometer input is <= 512 turn on LED2, other wise turn off LED2 */
    {
        GPIO_SetState(53, 0);
    }
    else
    {
        GPIO_SetState(53, 1);
    }
}</pre>
```



Add ProcessGPIO function

We will add function *ProcessGPIO* to process input switch S1. If switch S1 is pressed, it will turn On LED1, otherwise turn Off LED1. The code is shown below:

```
void ProcessGPIO(void)
{
    switchState = GPIO_GetState(48); /* Check switch S1 state */
    if (!switchState) /* If Switch S1 is pressed, turn on LED1, other wise turn off LED1*/
    {
        GPIO_SetState(52, 0);
    }
    else
    {
        GPIO_SetState(52, 1);
    }
}
```





Add CalcDC function

We will add function *CalcDC* to calculate duty cycle and frequency of the PWM signal captured by eTimer channel 0. The code is shown below:

```
void CalcDC(void)
```

```
{
```

vuint32_t PWMPeriod;

```
vuint16_t measure[4];
```

```
ETIMER_0.CHANNEL[0].CCCTRL.B.ARM = 1;

if (ETIMER_0.CHANNEL[0].STS.B.ICF1 == 0 || ETIMER_0.CHANNEL[0].STS.B.ICF2 == 0)

{

return;

}

ETIMER_0.CHANNEL[0].CCCTRL.B.ARM = 0;

ETIMER_0.CHANNEL[0].STS.B.ICF1 = 0x1; //clear capture 1 flag

ETIMER_0.CHANNEL[0].STS.B.ICF2 = 0x1; //clear capture 2 flag

measure[0] = ETIMER_0.CHANNEL[0].CAPT1.R; //read first capture1 value

measure[1] = ETIMER_0.CHANNEL[0].CAPT1.R; //read second capture 1 value
```

measure[2] = ETIMER_0.CHANNEL[0].CAPT2.R; //read first capture2 value

measure[3] = ETIMER_0.CHANNEL[0].CAPT2.R; //read second capture2 value





Add CalcDC function (Continued)

PWMPeriod = (vuint32_t) (measure[1] - measure[0]);

if (PWMPeriod != 0)

{

}

PWMDutyCycle = (vuint32_t)((measure[2] - measure[0]))*100/ (vuint32_t) (measure[1] - measure[0]); //PWMOnTime/PWMPeriod;

PWMFreq = 1600000/PWMPeriod;



}

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- Now we are ready to compile and build the code. To do this,
 - create an empty CodeWarrior project
 - add RAppID generated code and driver code to the CodeWarrior project using CodeWarrior script utility – rsp2cw10.exe
 - -Build the code using Codewarrior
- The next few slides explains these steps





Launch CodeWarrior 10.5 from Windows Start menu

Provide a workspace name

Select OK

🥬 Workspace Launcher	X
Select a workspace CodeWarrior Development Studio stores your projects in a folder Choose a workspace folder to use for this session.	called a workspace.
Workspace: C:\workspace\TRK_MPC5604P_Example	▼ Browse
Use this as the default and do not ask again	
	OK Cancel





 ∇ - -🚖 Commander 🔀 123 Project Creation Settings 🔤 Import project Project settings Build settings Import example project Manual Import MCU executable file 🍇 Debug settings New MCU project Miscellaneous New MQX-Lite project Welcome screen Build/Debug Quick access 🐔 Build (All) 22 Flash programmer 🛒 Clean (All) 🔯 Debug .€ 111

We will first create a Bareboard project for MPC5604P

To create a new Bareboard project, Select "New MCU project" from Commander window.



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Provide a name for the project – Training_LED_Example select Next

🥦 New Bareboard Project	
Devices	
Select the derivative or board you would like to use	
Device or board to be used:	_
5604P	a l
 Qorivva MPC56xxP Family MPC5604P 	
Project Type / Output:	E
Application	
© Library	
Creates project for MPC5604P derivative	~
Creates application project that runs on board or simulator	
	-
< Back Next > Finish	Cancel
•	

'eescale™

New Bareboard Project	
Create an MCU Bareboard Project	
Choose the location for the new project	
Project name: Training_LED_Example	
✓ Use <u>d</u> efault location	
Location: C:\workspace\TRK_MPC5604P_Example\Training_LE Brow	vse
< Back Next > Einish Ca	ancel

Select Qorivva->MPC560xP->MPC5604P device from the list

Select Next

104

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Accept the default connection option and select Next

🏁 New Bareboard Project	
Language and Build Tools Options	
Language:	
@ C	
© C++	
Instruction Set Options:	
Output Set Instruction Set	
\bigcirc Use the BookE instruction set	
Floating Point:	
None	
Software	
SPFP	
SPFP_Only	
C language support will be included in the project. This w application with an ANSI-C compliant startup code (doin global variables). When enabled, the compiler VLE options will be enabled a selected.	g initialization of
? < Back Next > Einish	Cancel

🥬 New Bareboard Project	
Connections	
Choose the connection to use for this project	
	<u> </u>
Connection to be used:	
P&E USB MultiLink Universal [FX] / USB MultiLink	E
P&E Cyclone MAX Open Source JTAG	
Connect to P&F USB-MI -PPCNEXUS	
connect to Face obdime FF energies.	
	Ŧ
? < <u>Back</u> <u>Next</u> <u>Finish</u>	Cancel

We will be using C code and VLE instructions for this example project. Accept the default options and select Finish



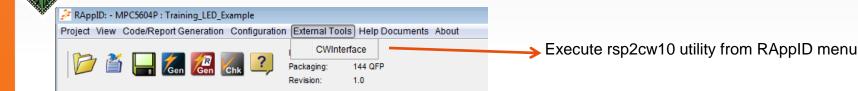
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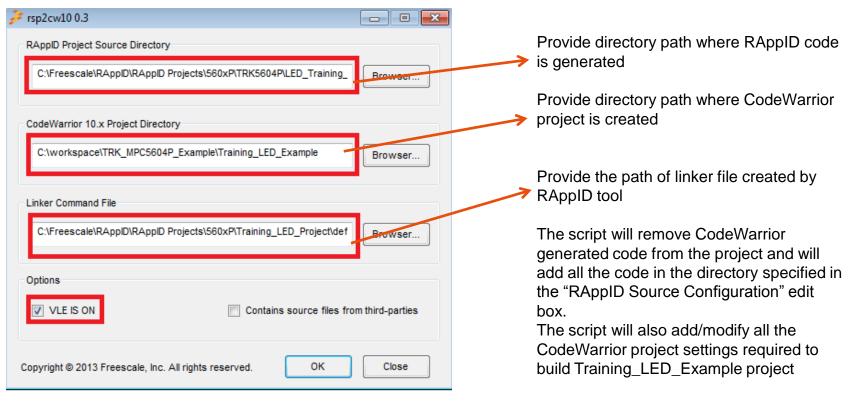
- When Finish is selected, CodeWarrior creates a new bareboard project with CodeWarrior generated code and linker file included in the project.
- Since we have generated code using RAppID for Training_LED_Example project, we want to remove all the CodeWarrior generated code and add RAppID generated code and linker file along with the driver code to be included in the CodeWarrior project.
- This can be done using CodeWarrior project maker utility rsp2cw10.exe
- First close the Training_LED_Example project by selecting menu Project->Close Project
- Run *rsp2cw10* utility which is provided with the installation disk: This can be done by selecting the file from the installed directory or by using the menu in RAppID - *External Tools->CWInterface*

106



Run cwpjmaker utility









🗄 CodeWarrior Projects 🛛		
	⊑ 🔄 🔎 🛛 🗸 🗸	
File Name	Build	
▲ 😤 Training_LED_Example : FLASH		
 FLASH MPC5604P_readme.txt Prefix 	RAM FLASH	

Now re-open the Training_LED_Example project by selecting menu Project->Open Project

Since we generated code for Flash, we need to change the build configuration to Flash. Change the build option to Flash as shown.



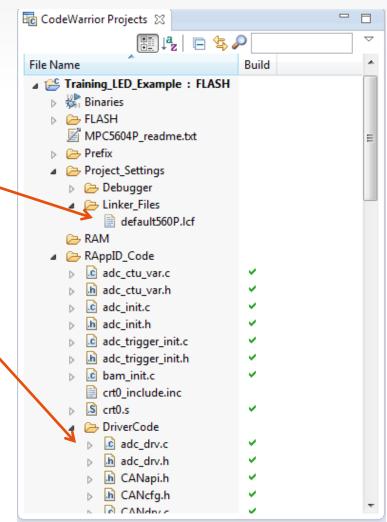


Create CodeWarrior project

Now the project should contain:

RAppID generated linker file

RAppID generated source files and driver code copied from the installation disk



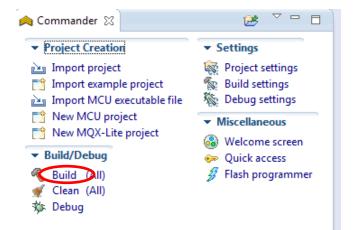


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Build project

To build Training_LED_Example project , select Build from Commander window





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Build project

The build command will produce 2 executable files:

Training_LED_Example.elf (executable with debug symbols)

Training_LED_Example.mot (S-record)

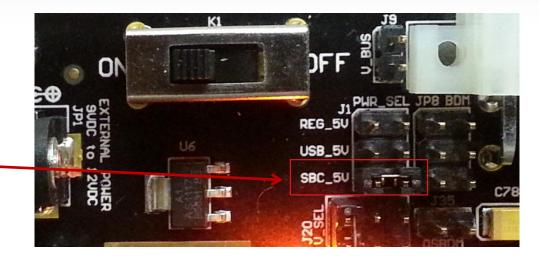
📅 CodeWarrior Projects 🔀 🗧	
📰 🖧 🖻 🚖 🔎	
File Name Build	*
▲ Straining_LED_Example : FLASH > Straining_LED_Example : FLASH	
a 🗁 FLASH	
makefile makefile.local objects.mk	
RAppID_Code	
sources.mk	
Training LED Example args	
🁈 🕸 Training_LED_Example.elf 🖌	
Training_LED_Example.MA	
MPC5604P_readme.txt	
Prefix	
Project_Settings	
🗁 RAM	
A B RAppID_Code	
▷ adc_ctu_var.c	
▷ In adc_ctu_var.h	
▷ 🖸 adc_init.c	
▶ 🛅 adc_init.h	-
adc trigger init.c	Ψ.

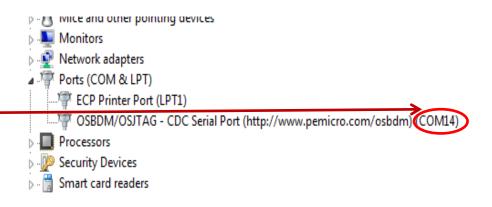


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Jumper settings and Power connections

- Since we are using CAN in this example, we need to enable CAN.
- To enable CAN, the board needs to power SBC using external 12V supply.
- Connect jumpers across SBC_5V of J1
- Connect External power to JP1
- Connect your computer to JP2 via USB cable. This connection provides virtual serial port. Confirm this by checking available COM ports in Windows Device manager. In the example shown, the COM port assigned is COM14



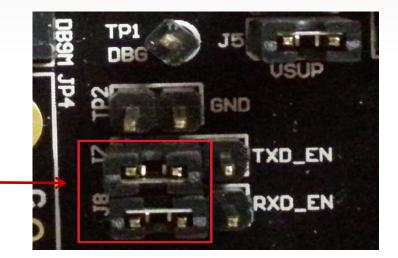




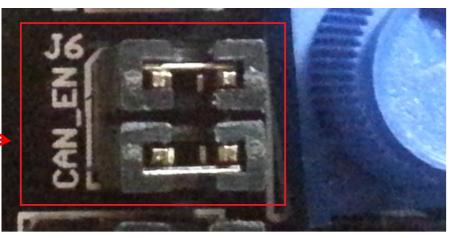
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Jumper settings and Power connections

 In this example, we will use Virtual serial port for UART communication.
 To enable this, connect jumper J7 (TXD_EN) and J8 (RXD_EN) to position 1-2



 To enable CAN communication, connect J6 as shown.

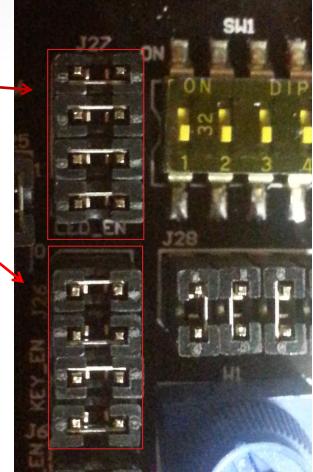




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Jumper settings and Power connections

- To enable LEDs, connect all 4 jumpers in J27
- To enable input switches, connect all 4 jumpers in J26





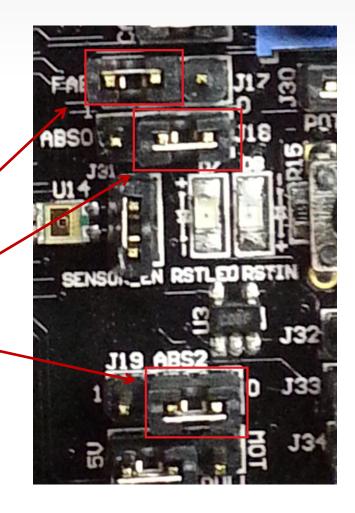
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Flash code to target

- Before Flashing the code, make sure the TRK-MPC5604P board is connected to external power and to your computer via USB cable
- Set the jumper of J17 to position 1-2 which pulls FAB high and jumper J18 and J19 to position 2-3 to set ABS0 and ABS2 low
- We will use RAppID Bootloader utility to flash S-record file Training_LED_Example.mot using serial port







Flash code to target

- Launch RAppID bootloader utility from Windows Start menu
- Select Serial Port as Comm Mode
- Select the correct COM channel
- Select 9600 baud
- Select MPC5604/3P as MCU part number
- Set BAM status as Enabled
- Select default password
- Enter the path for the file to be flashed: Training_LED_Example.mot
- Select Start Boot Loader button to start the flash process

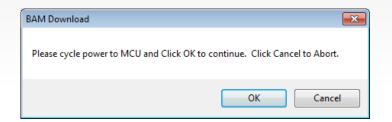
AppID BL Tool	
File Help	
Communication Setup: Comm Mode Serial Port Channel	OM12 - Baud Rate: 9600 -
MCU Setup: BAM Setup:	
MCU Part No MPC5604/3P +	EEDFACECAFEBEEF
App Setup: Application File: C1workspace1TRK_MPC5604P_Example1FSI	K LED Example/FLASH/FSK LED Browse
Auto Read File Start Address: 0x0	Code Size Range: 0x12376
Operation Setup: Read MCU Memory Erase Flash Only	Erase and Program Start Boot Loader Enable Trace
Status: [Serial Port COM12 (9600Baud)] [MPC5604P.rba]	[No rbl File Loaded]

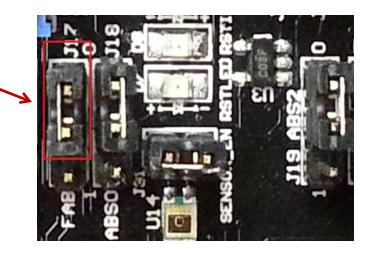




Flash code to target

- When asked to cycle power to MCU, press the reset button on the board. Flashing process should start.
- After Flash is complete, Move the jumper J17 to position 2-3 to pull FAB low.
- Turn the power off to the module and re-apply the power
- The code should be running now.







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Testing code

- Press switch S1 to turn on LED1 and release S1 to turn off LED1
- Turn the potentiometer halfway to observe LED2 turning On/Off.
- Send CAN command with first byte = 1 to turn on LED3 and first byte = 0 to turn off LED3
- Connect pin PD10 to a scope and check the duty cycle of PWM signal is 50%. Press switch S3 to decrease the duty cycle and S4 to increase the duty cycle.
- Connect PD10 to PA0 and using FreeMASTER, check the value of duty cycle calculated by eTimer input channel 0 (PA0).





CAN command to turn On/Off LED3

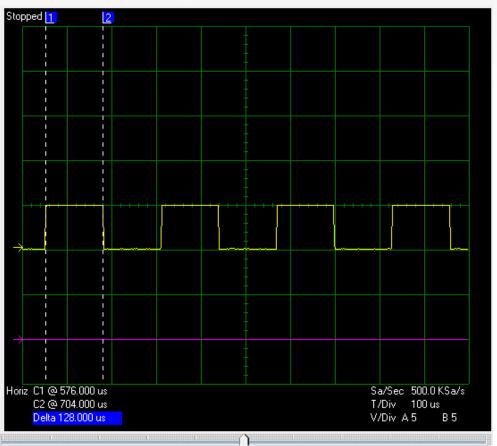
🔛 MiniMon V3 by IXXAT								
<u>F</u> ile <u>V</u> iew Functions Options <u>H</u> elp								
IXXAT Interfaces	Time / 10 mSec Id	dentifier Format	Flags	Data				
🖃 🖤 USB-to-CAN compact	00:00:06.77	1 Std	Self	01 00	00 00 00 00 00 00			
CAN 1: SJA 1000	00:00:06.77	2 Std			00 00 00 00 00 00			
	00:00:10.01	1 Std	Self		00 00 00 00 00 00			
	00:00:10.01	2 Std			00 00 00 00 00 00			
	00:00:11.88	1 Std	Self		00 00 00 00 00 00			
	00:00:11.88	2 Std		01 FF	00 00 00 00 00 00			
Controller initialized	Tx	Identifier	Ext.	Rtr		Data		
Controller initialized		Identifier 1	Ext.	Rtr	12 00 00 00 00 00			
 Controller initialized Low speed transceiver 	Tx	Identifier 1	Ext.	Rtr	12 00 00 00 00 00 00 00 00 00 00 00 00 00	00 00		
		1		Rtr		00 00 00 00 00 00 00 00 00 00 00 00 00		
Low speed transceiver Transmit pending	Tx	1			00 00 00 00 00 00	00 00 00 00 00 00 00 00 00 00 00 00 00		
 Low speed transceiver Transmit pending Data overrun 		1			00 00 00 00 00 00	00 00		
 Low speed transceiver Transmit pending Data overrun Error warning level 		1			00 00 00 00 00 00	00 00		
 Low speed transceiver Transmit pending Data overrun 		1			00 00 00 00 00 00	00 00		

Using a CAN communication tool like CANalyzer or IXXAT MiniMon, Send CAN command ID = 1 and first data byte = 1 to turn on LED3 Send CAN command ID = 1 and first data byte = 0 to turn off LED3





PWM output signal from PD10



Connect PD10 to a scope and check the PWM output signal





Launch FreeMASTER utility from Windows Start menu.

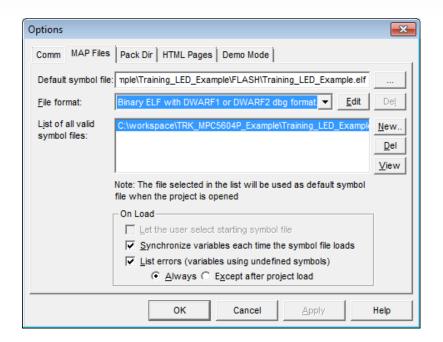
Select *Project* > *Options* >*Communication* from menu and set the communication port number and baud rate of 115200.

Project - FreeMASTER File Edit View Explorer Item F	Project Tools Help	
Image: Second		
_	<u>R</u> eload Symbol File Ctrl+M Select Symbol File	Options
-	Resource Files Options Ctrl+T	Comm MAP Files Pack Dir HTML Pages Demo Mode
	Welcome to • What's New in Vel See description of the most im application version. The latest JTAG and CAN connection for vs	Connect string: drv=bxat.port=1;btrate=500000;cmdid=0; → Configure Sort erer Save settings to project file Save settings to registry, use it as default.
	Name Value	Communication state on startup and on project load C Open port at startup C Do not open port at startup C Store port state on exit, apply it on startup Store state to project file, apply upon its load Advanced
		OK Cancel Apply Help
dit project options		Not connected



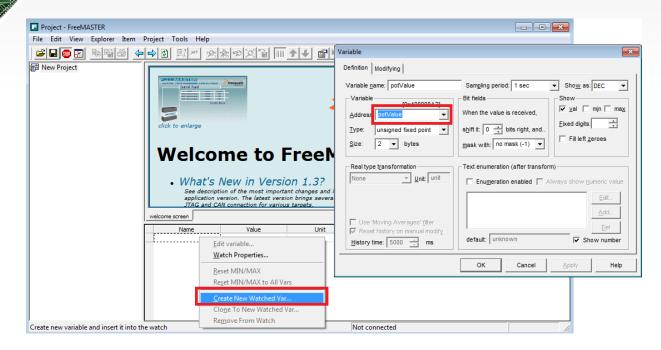
Select the example application MAP file. In this example, the MAP file is the *.elf* file generated during the build process. FreeMASTER uses the information about the variables, their names, types, and addresses contained in the *.elf* file.

From the MAP tab, select the MAP file (.elf file) as shown.





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Add the 2 global variables in this example project to monitor in the watch window – potValue and PWMDutyCycle as follows:

- Right-click on the variable grid
- Select Create New Watched Var... from the menu. This will pop up a variable selection window.
- Select potValue from the drop down and and select OK.
- Using similar steps, add PWMDutyCycle to watch window.



Project - FreeMASTER						- • •	
<u>File Edit Vi</u> ew Explorer Item <u>P</u> roject Tools <u>H</u> elp							
2 2 0 1 0 1 6 4 6 4		<u>素 ゆ 2 🔒 🖩</u>	<u>↑</u> ↓ <u>₽</u> №]	Tahoma	• 8 • B / <u>U</u>		
詞 New Project	project tree. • Show me If you don't w tree, you can Page".	y the URL of the document describing the item currently selected in the re where can I do it want to specify the description document for each item in the project hide the "tab" with this message by setting up the single "Control			∎ roject trol		
	Name	Value	Unit		Period		
	potValue	567	DEC	1000			
	PWMDutyCyde	49	IDEC.	1000			
Done				RS232;COM18;speed=11	5200		

Select the icon *Start/Stop communication* to start communication and observe the 2 watch variables getting updated.

- When you rotate the potentiometer, the watch window should get updated.

- When switch S3 is pressed, the duty cycle value should decrease and when switch S4 is pressed, the duty cycle value should increase.



Training Summary

- Overview of tools provided with Fast Start Kit for TRK-MPC5604P
- Utilized RAppID Init Tools for fast easy infrastructure configuration and code generation
- Generated comprehensive report on the project using RAppID Init tool
- Utilized supporting tools provided with the kit to help build and flash code on to the target
- Described setting up and using the TRK-MPC5604P evaluation board



