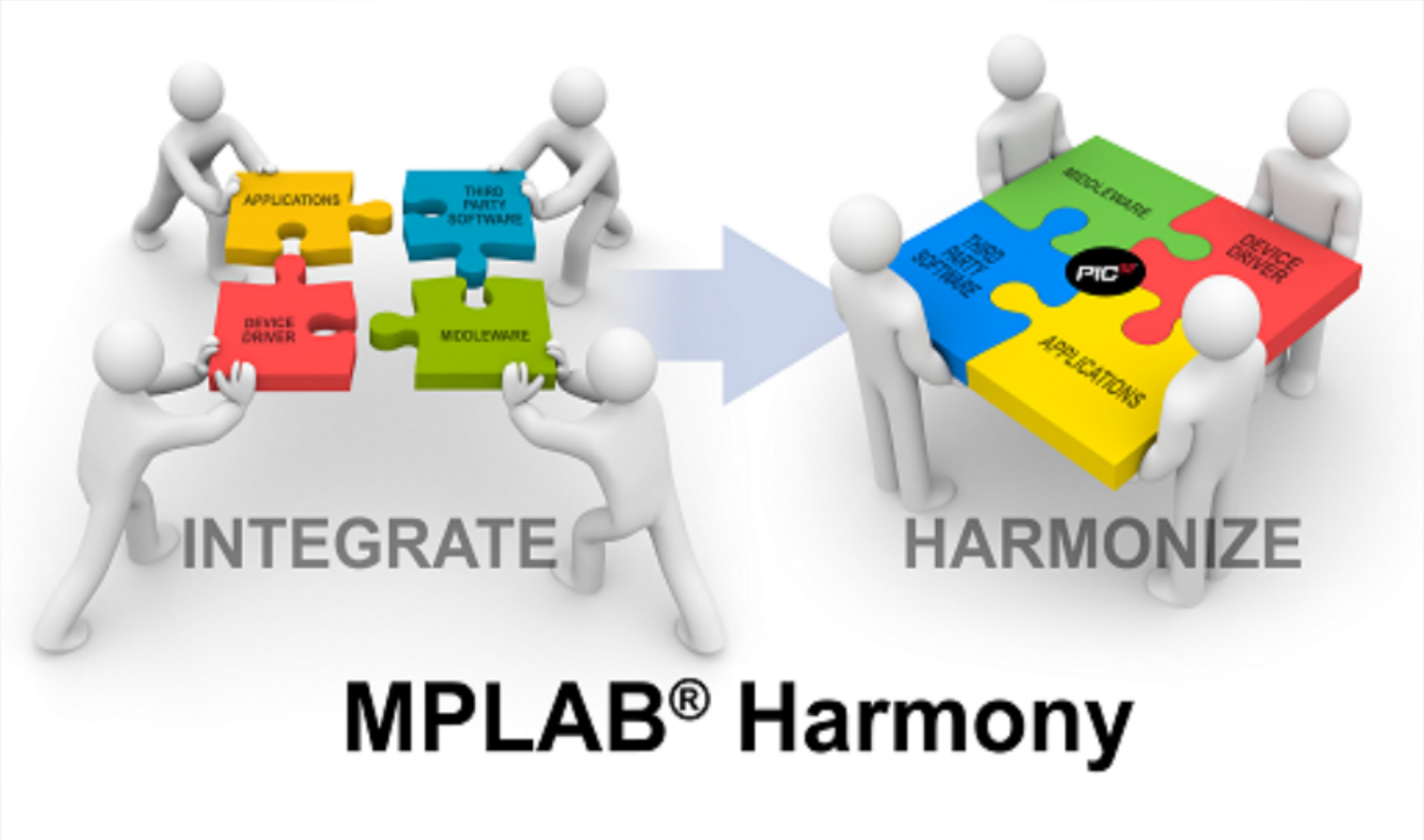
HarmonyでLチカ



果たして、HarmonyはPIC32MXの敷居を下げているのか？

前回(TQFPの半田付け)の課題

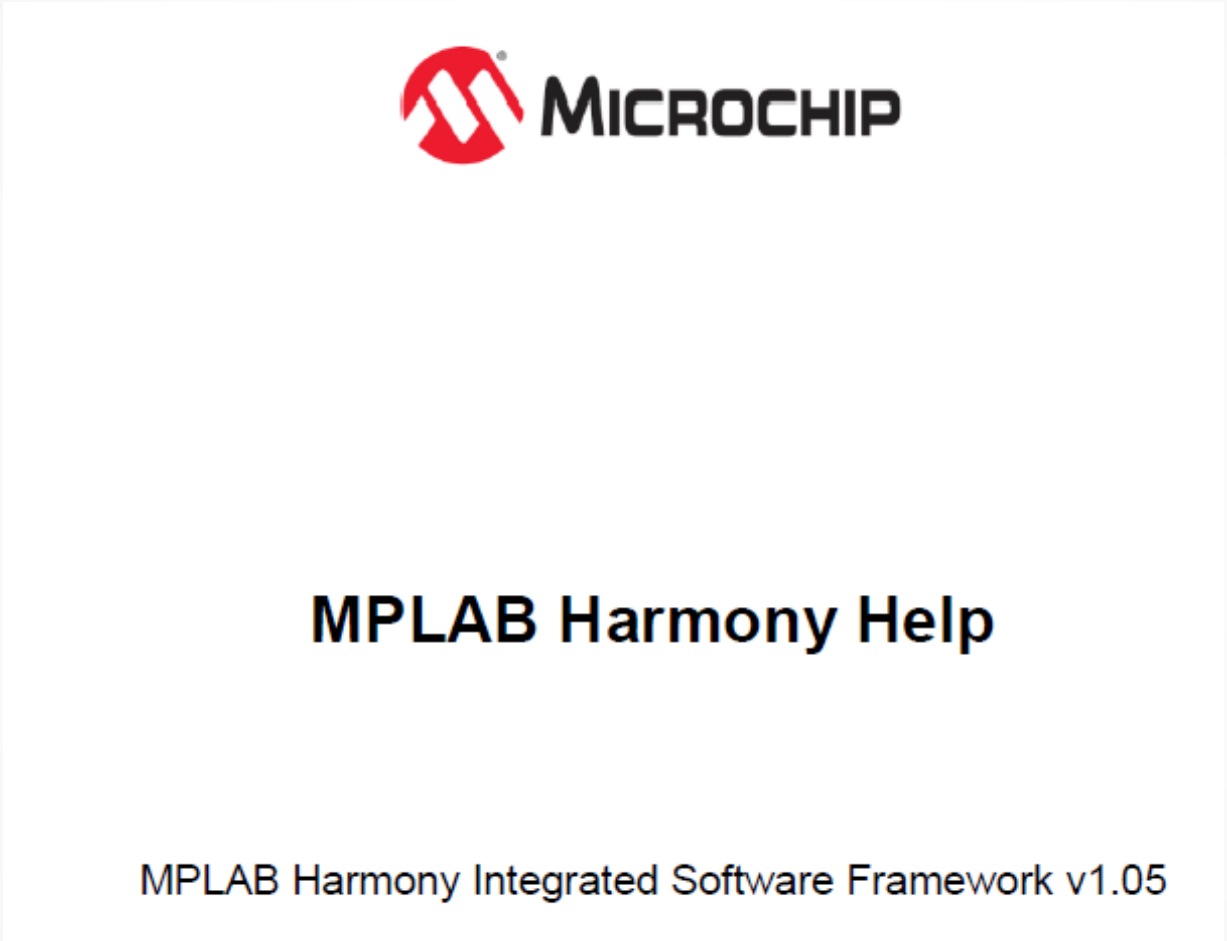
Oscilogi2のプログラムをHarmonyベースで書き換える。

==> 作業は順調に進んでいる。

Oscilogi2のコンソール・プログラムを書き換える。
（オシロ７CH、ロジアナ12CHへの対応）
==> 作業は難航（前進は）している。

Oscilogi2のHarmonize(?)の話より
Harmony導入時に行ったLチカの話の方が良いかも・・・

これがやる気を削いでしまう



Harmoyのドキュメントはこれ（8400ページもある）しか無い！（？）

どこから手をつけるか

Where to Begin

The help documentation provides a comprehensive source of information on how to use and understand MPLAB Harmony. However, you don't need to read the entire document before you start working with MPLAB Harmony. Where you should begin depends on your current objectives and level of familiarity with MPLAB Harmony.

Start here...	If you...
Release Contents	...want to know what is included in this release.
Release Notes	...want to know what is new in this release and to learn of any known issues.
Understanding MPLAB Harmony	...are new to MPLAB Harmony and need to understand the basic concepts.
Prerequisites	...want to make sure that you have everything you need to begin working with MPLAB Harmony.
Application and Library Development, Distribution, and Integration	...want to know how to develop MPLAB Harmony-compatible applications and libraries and how to best distribute and integrate them into an existing installation.
Tutorial	...are ready to start creating your own MPLAB Harmony applications.
Porting to MPLAB Harmony	...are a MLA user and you need to port your application to MPLAB Harmony.

Applications Help	...want to build and use the demonstration and example applications included in the installation.
Framework Help	...want to look up details on how to use the MPLAB Harmony framework libraries.
Third-Party Products Help	...need help with one of the third-party products included in this installation.
Board Support Package Help	...want to look up details on how to use MPLAB Harmony Board Support Packages.
Utilities Help	...need help using the MPLAB Harmony Configurator (MHC) or one of the other utilities included in this installation.
MHC Developer's Guide	...want information on how to create your own MPLAB Harmony library and integrated help.
MPLAB Harmony Compatibility Guide	...want to ensure software libraries you create are compatible with MPLAB Harmony.
Testing Help	...want to know how to test your own MPLAB Harmony libraries.
Support	...need additional assistance.
Tips and Tricks	...want to learn more efficient and effective ways to use MPLAB Harmony.
Glossary	...need an explanation of the terms used in MPLAB Harmony.

The majority of the help content is located in the Framework Help section, which provides detailed reference information on the libraries that make up the MPLAB Harmony framework. Each library's help section also provides introductory information on how to build, configure, and use the library, along with the detailed interface reference. However, you do not need to read the Framework Help section from end-to-end to use MPLAB Harmony.

Tutorialは無視して良い。Framework Helpが8000ページある。

Harmonyを使う前の準備

MPLAB X IDE　（最新版は3.10）

MPLAC XC32C/C++Compiler　（最新版は1.40）

MPLAB Harmony　（最新版は1.06）

MPLAB Harmony Configurator（最新版は1.06）

ただし、MPLAB Harmony ConfiguratorはMPLABXのPlugin

Helpの斜め読み

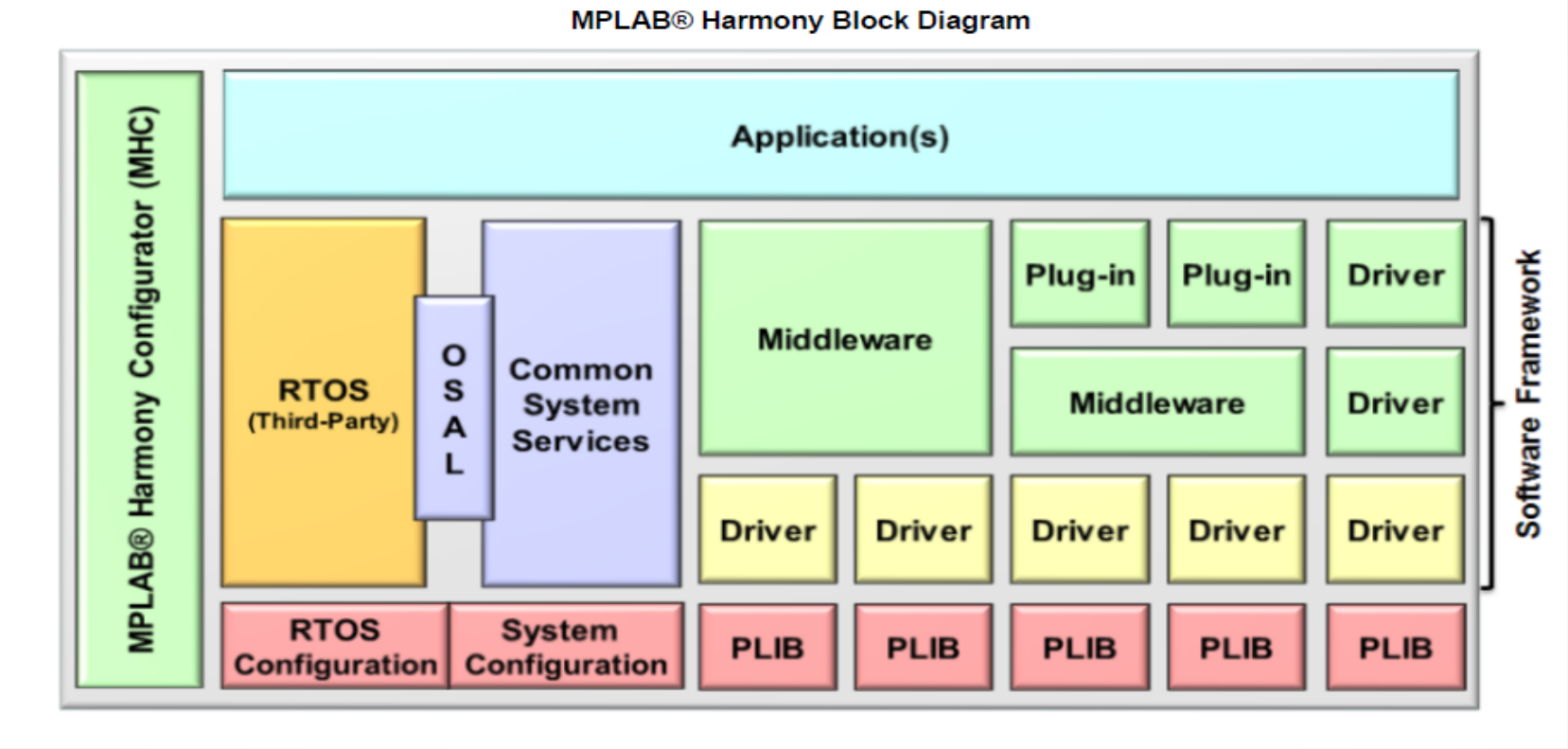
Applications Helpはサンプル・アプリケーションの説明

Framework Helpは各種ライブラリの説明

Utility HelpはMHCその他のUtilityの説明
MHC User's Guideに目を通しておけば
これから起きることの予習になる

v1_0x/apps以下のサンプル・プロジェクト
（特にexample/peripheral以下のサンプル）は
ライブラリを利用する上で大変参考になる

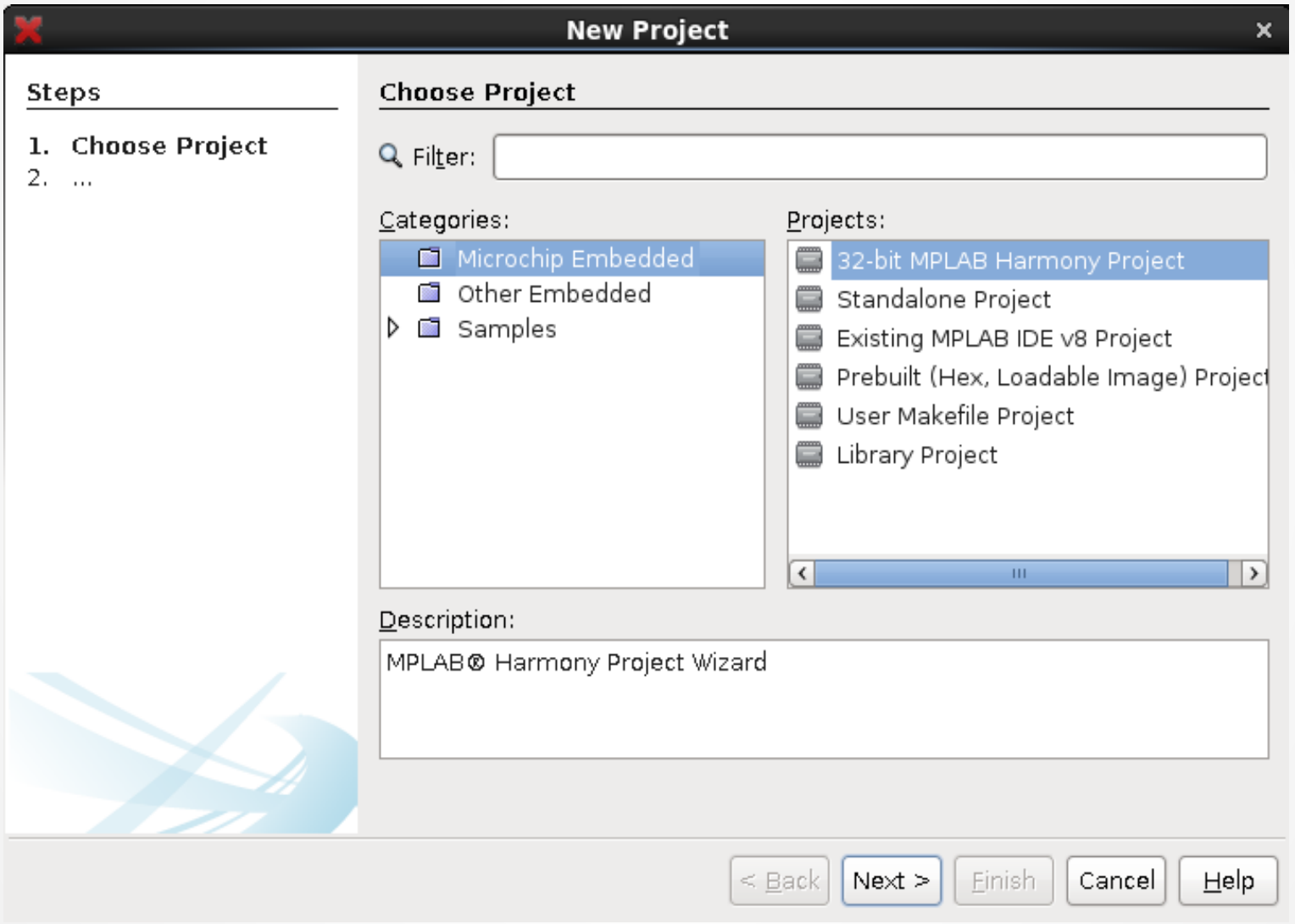
Harmonyの概要もざっと目を通しておく



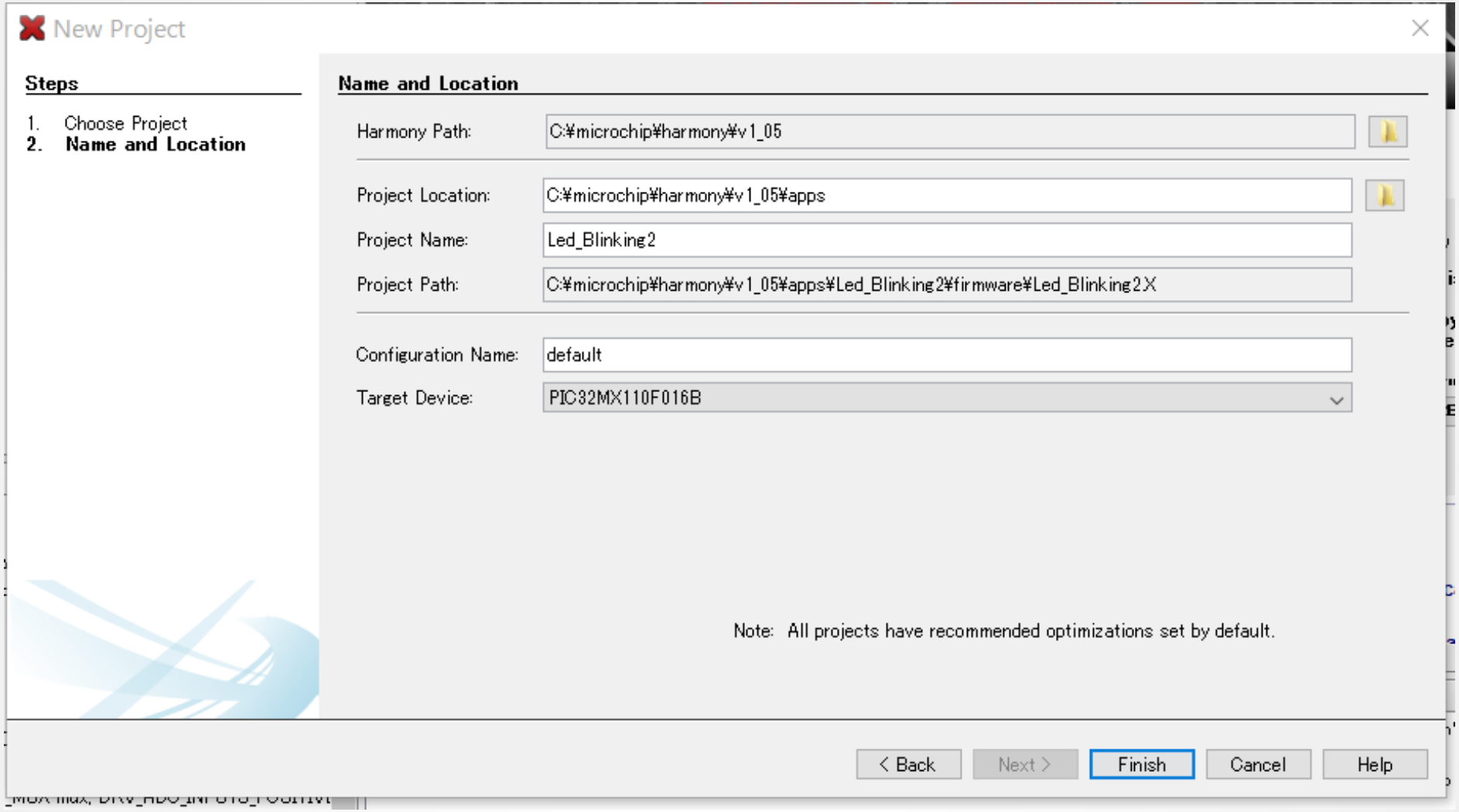
デバイス ドライバーは単純かつ高度に抽象化された
ペリフェラル インターフェース・・・

ペリフェラル ライブラリは低レベルのペリフェラル インターフェースで、レジスタの詳細を隠すことによって、複数のコントローラ ファミリのサポートを容易にする・・・

新規プロジェクトを作る

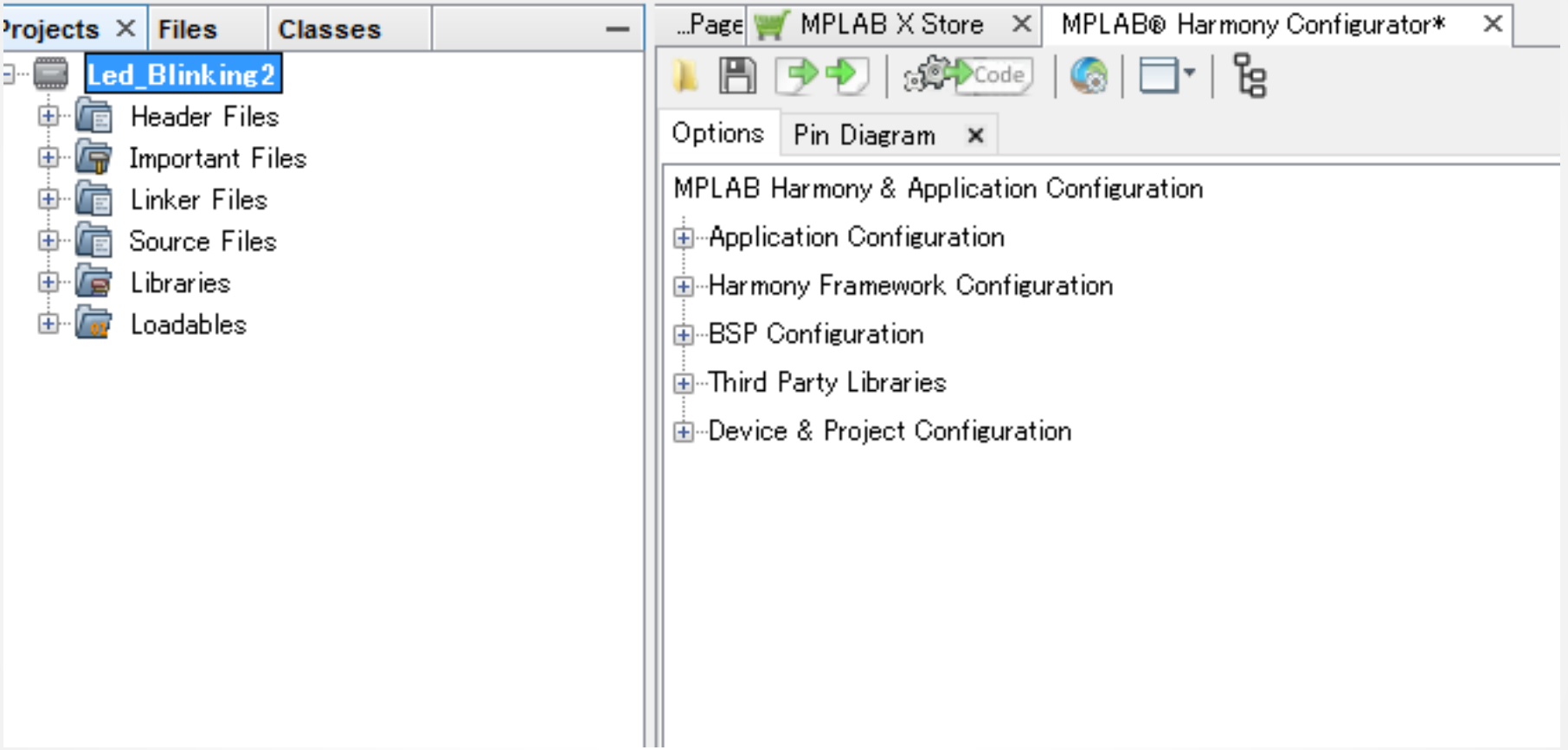


Project名を決める



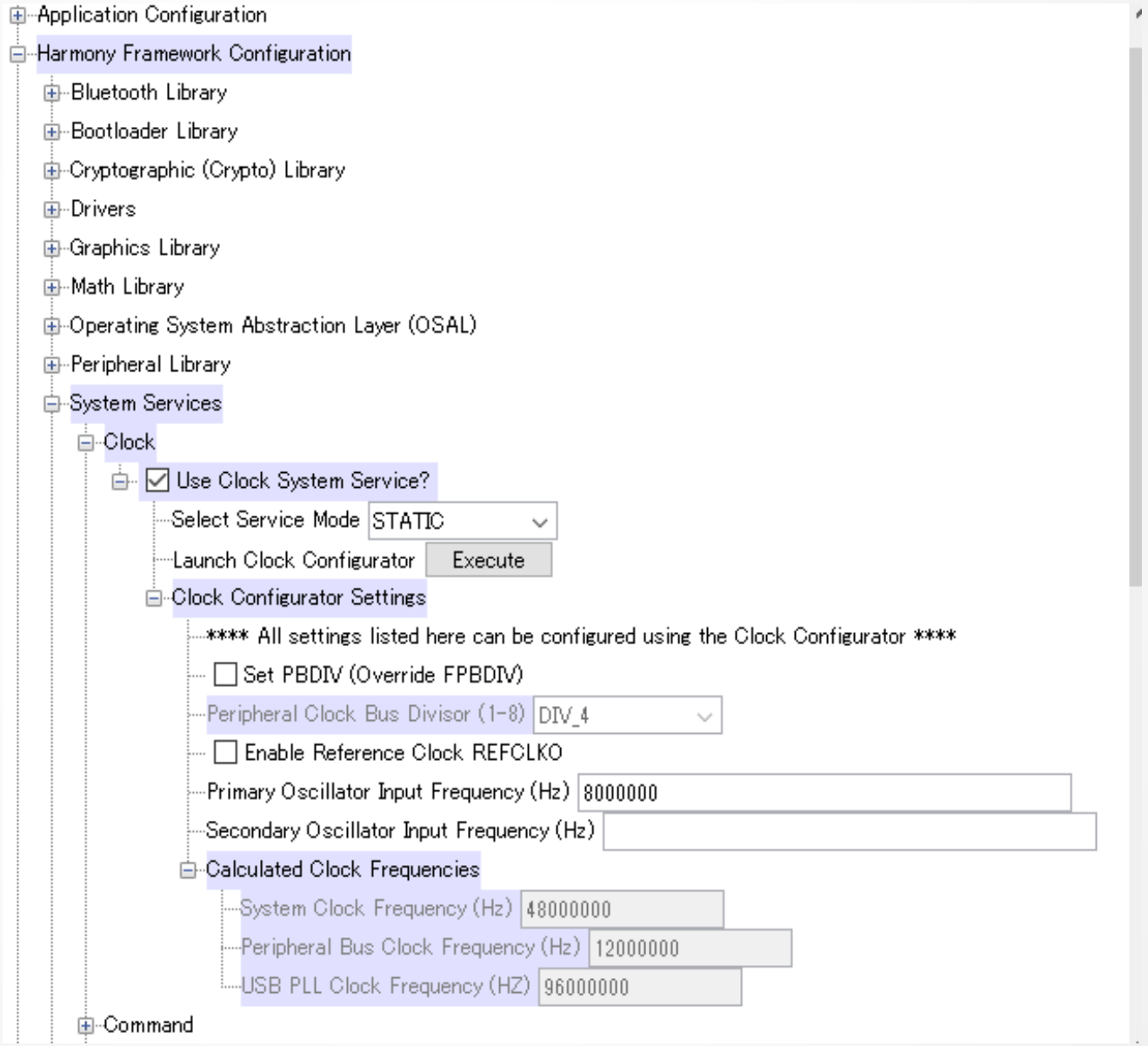
Target DeviceはProjectのPropertiesで設定しても良い

最初の状態

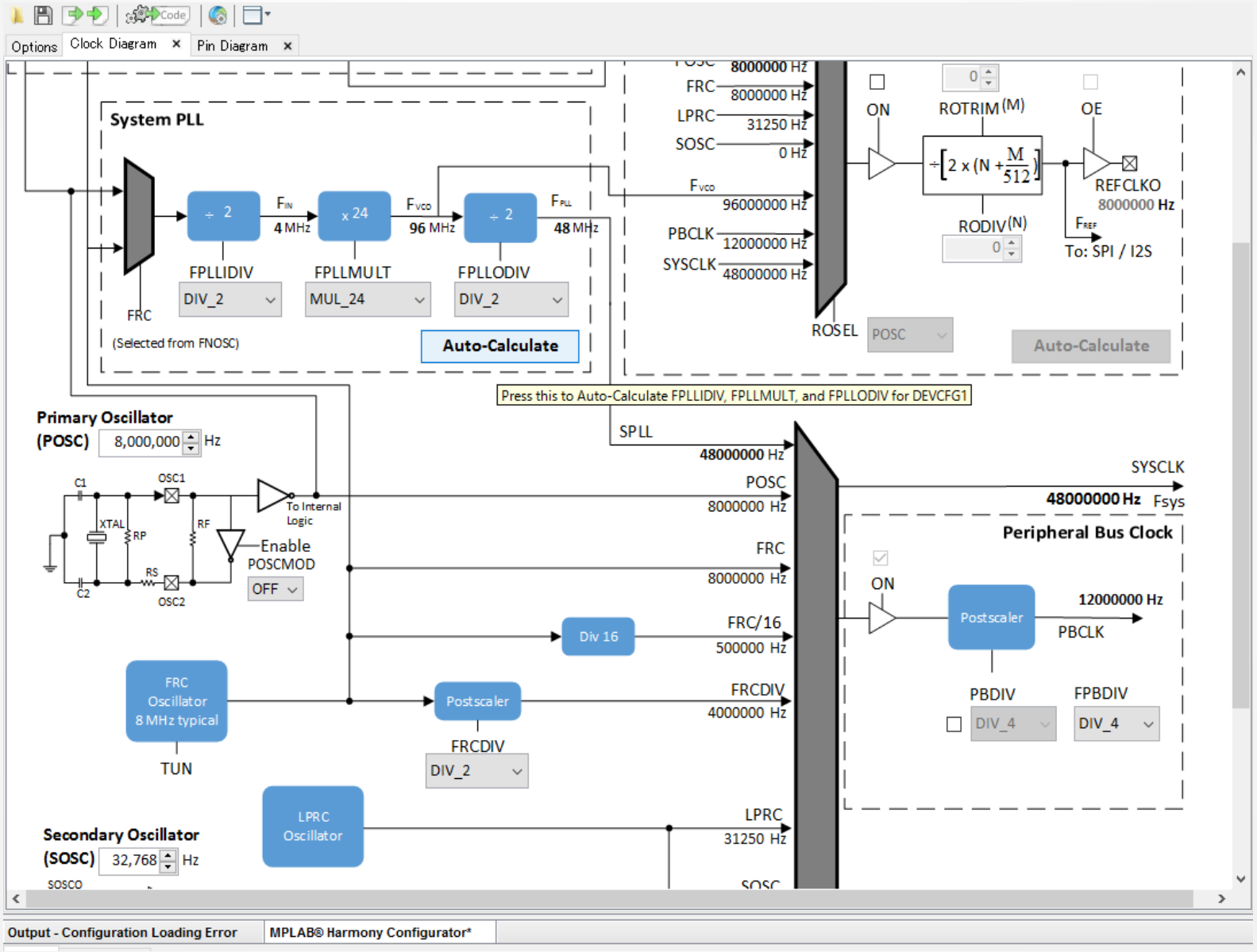


Projectフォルダは空っぽ

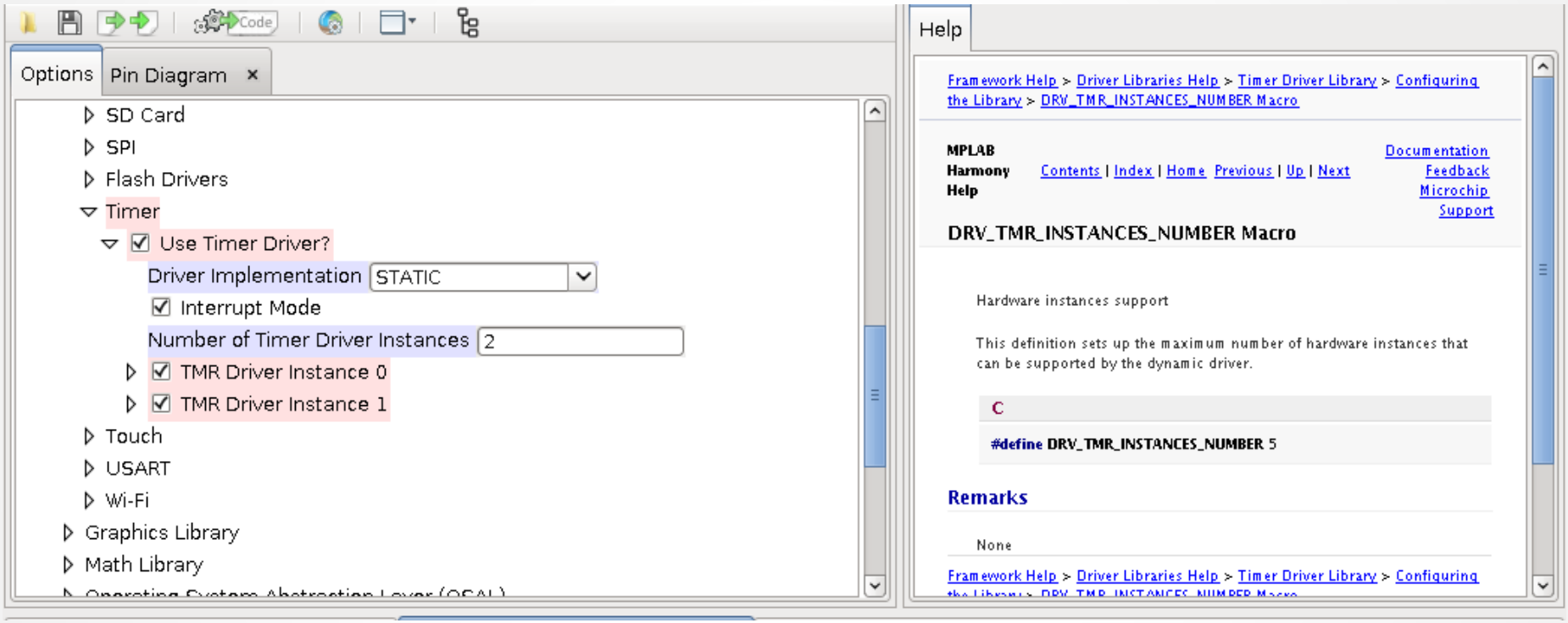
Clock設定


Application Configuration
Harmony Framework Configuration
Bluetooth Library
Bootloader Library
Cryptographic (Crypto) Library
Drivers
Graphics Library
Math Library
Operating System Abstraction Layer (OSAL)
Peripheral Library
System Services
Clock
Use Clock System Service?
Select Service Mode
STATIC
Launch Clock Configurator
Execute
Clock Configurator Settings
**** All settings listed here can be configured using the Clock Configurator ****
Set PBDIV (Override FPBDIV)
Peripheral Clock Bus Divisor (1-8)
DIV_4
Enable Reference Clock REFCLKO
Primary Oscillator Input Frequency (Hz)
8000000
Secondary Oscillator Input Frequency (Hz)
Calculated Clock Frequencies
System Clock Frequency (Hz)
48000000
Peripheral Bus Clock Frequency (Hz)
12000000
USB PLL Clock Frequency (HZ)
96000000
Command

Clock Configrator

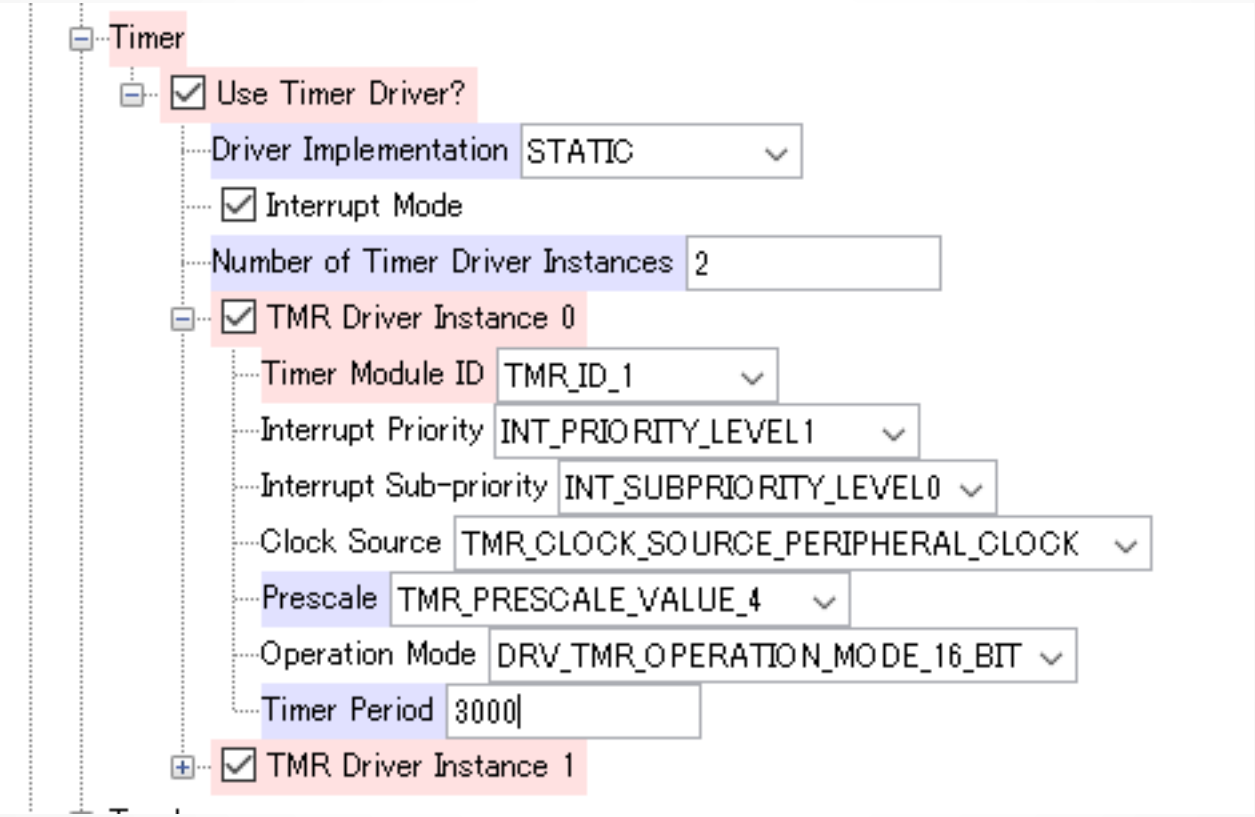


ProjectにTimer Driverを二つ組み込む



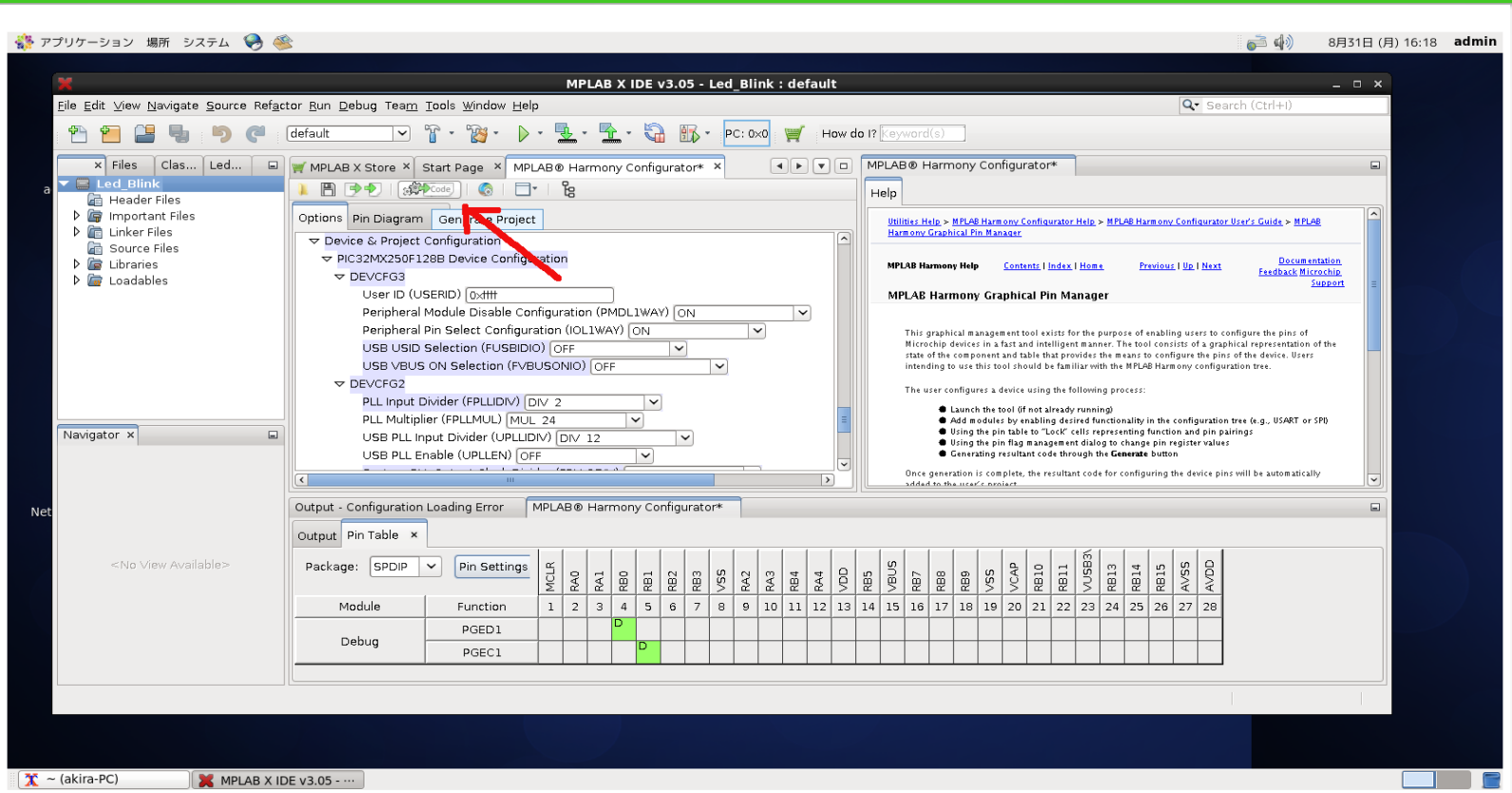
Harmony Framework Configuration
> Drivers
> Timer
Use Timer Driver?にチェックを入れ、Interrupt Modeにチェックを入れ、Driver Instanceを2にした

Timer Driver Instance 0の設定



Timer Module IDに1（Timer 1）を設定し、PrescaleにVALUE_4
Timer Periodに3000を設定した。ペリフェラル・クロックが12MHz
なら1msインターバルのタイマー割り込みになる

Generate Project



Harmony Framework Configuration

> System Services

> Clock

> Ports

Device ＆ Project Configurationなどを設定し、
最後にGenerate Projectをクリックする

自動生成されるmain関数

```
67  // *****************************************************************************
68  // *****************************************************************************
69
70  int main ( void )
71  {
72      /* Initialize all MPLAB Harmony modules, including application(s). */
73      SYS_Initialize ( NULL );
74
75
76      while ( true )
77      {
78          /* Maintain state machines of all polled MPLAB Harmony modules. */
79          SYS_Tasks ( );
80
81      }
82
83      /* Execution should not come here during normal operation */
84
85      return ( EXIT_FAILURE );
86  }
87
88
89  /*******************************************************************************
90   End of File
91  */
92
93
```

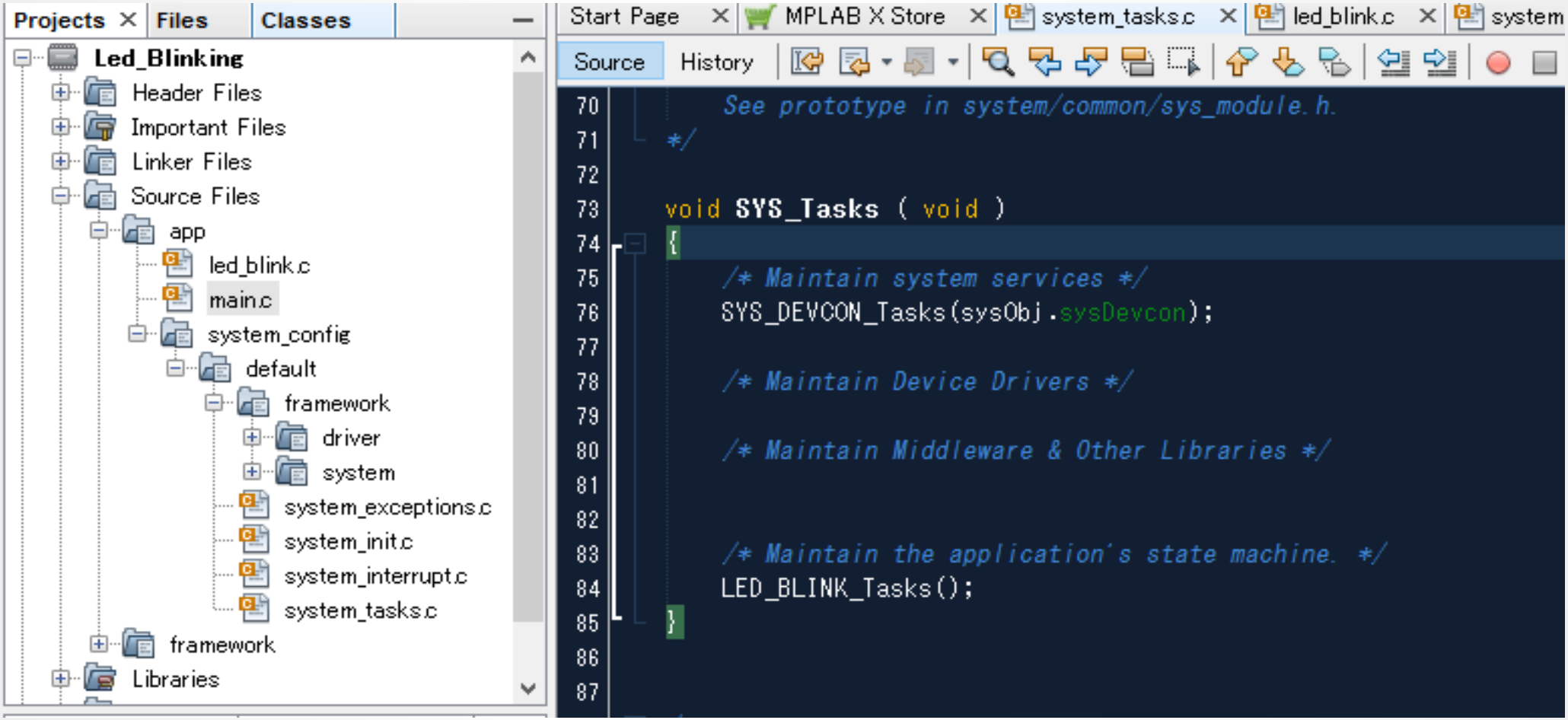
呼び出しているのは、SYS_Initialize()とSYS_Tasks()だけ

SYS_Initialize関数

```
174
175 void SYS_Initialize ( void* data )
176 {
177     /* Core Processor Initialization */
178     SYS_CLK_Initialize( NULL );
179     sysObj.sysDevcon = SYS_DEVCON_Initialize(SYS_DEVCON_INDEX_0, (SYS_MODULE_INIT*)&
180     SYS_DEVCON_PerformanceConfig(SYS_CLK_SystemFrequencyGet());
181     SYS_PORTS_Initialize();
182
183     /* Initialize Drivers */
184     /*Initialize TMR0 */
185     DRV_TMR0_Initialize();
186     /*Initialize TMR1 */
187     DRV_TMR1_Initialize();
188
189
190     /* Initialize System Services */
191     SYS_INT_Initialize();
192
193     /* Initialize Middleware */
194     /* Enable Global Interrupts */
195     SYS_INT_Enable();
196
197     /* Initialize the Application */
198     LED_BLINK_Initialize();
199 }
200
```

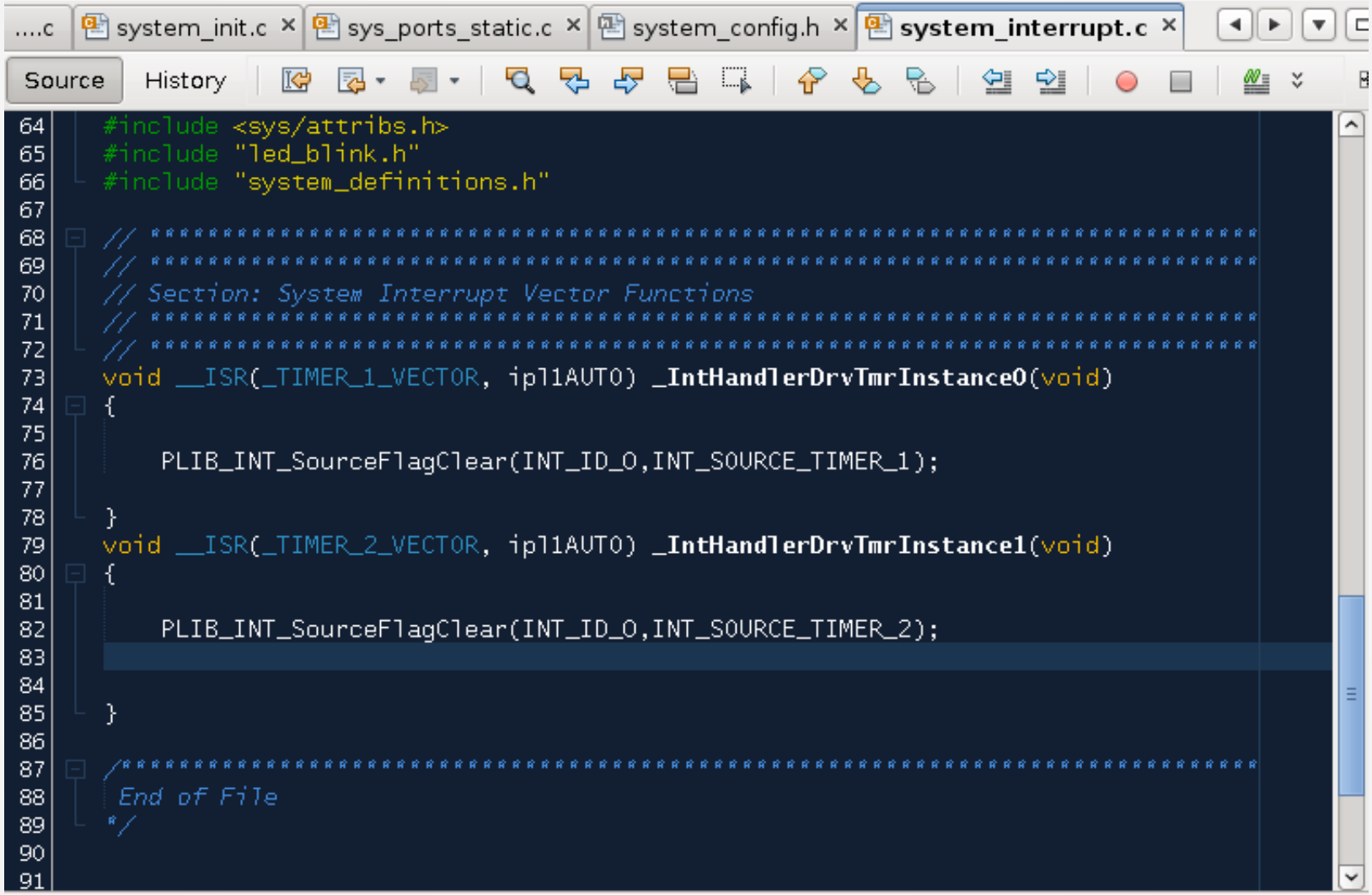
MHCで設定したSystem_serviceやDriverの初期化関数を呼び出している

SYS_Tasks関数



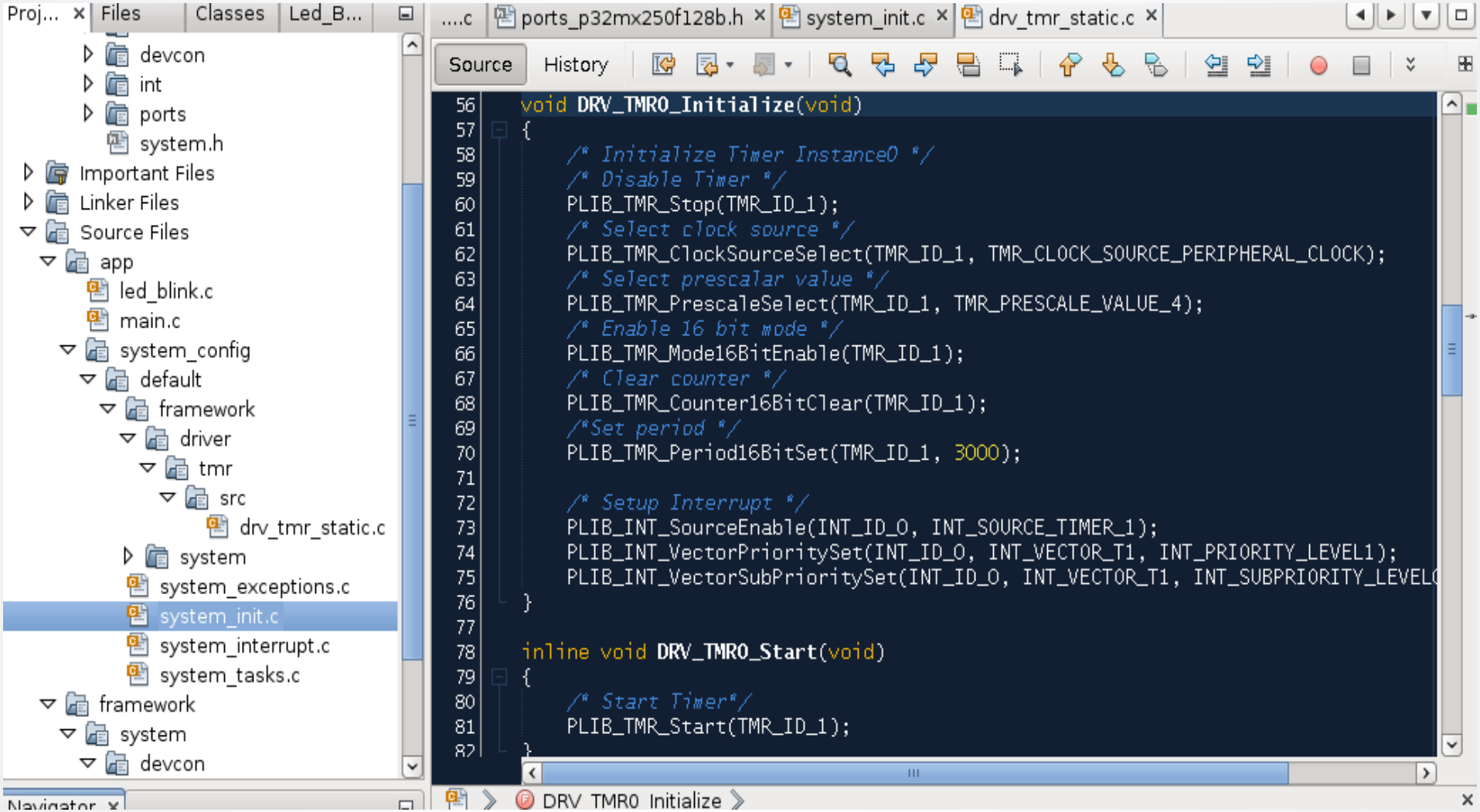
SYS_DEVCON_Tasks（システム・レベルのステートマシン）は機能していない。

system_interrupt.c



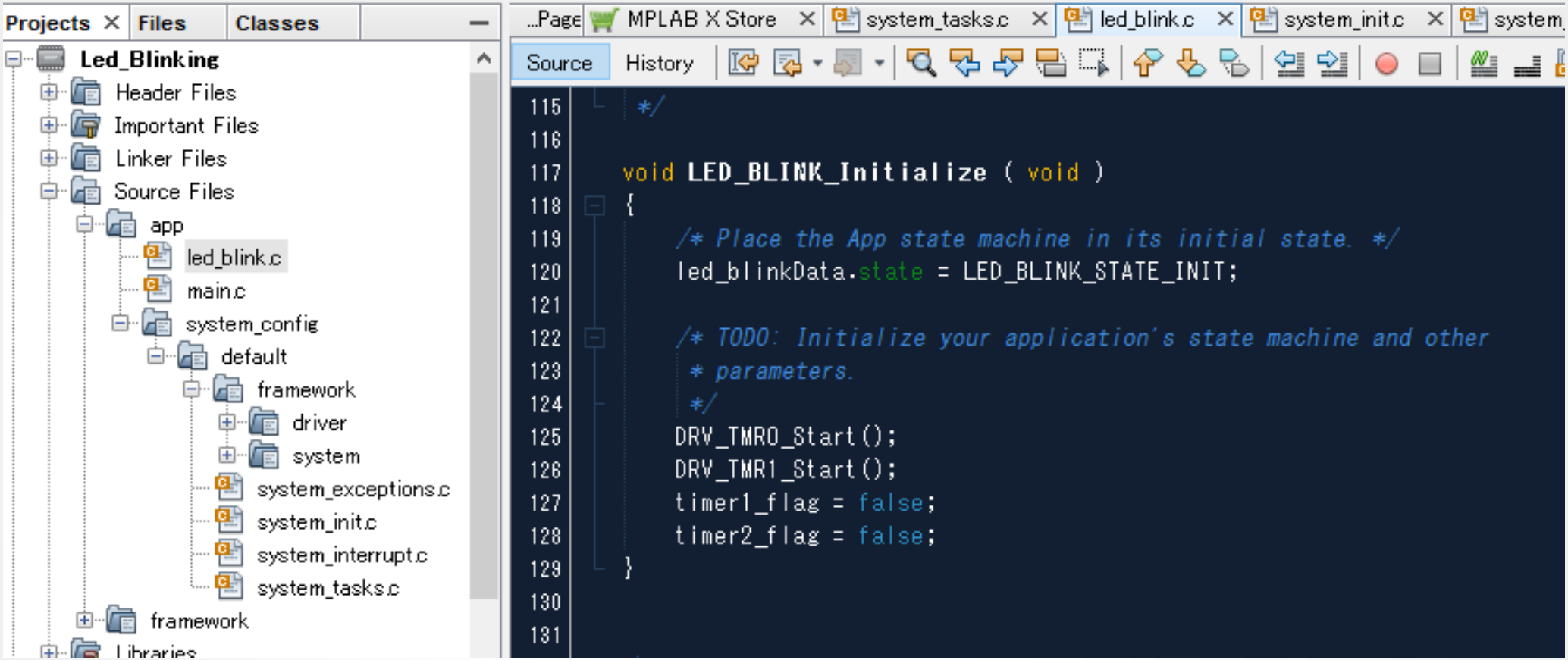
Timer割り込みハンドラが自動生成される

DRV_TMR0_Initialize関数



Timer Driver の設定に基づき初期化関数が生成される

LED_BLINK_Initialize関数



Timer起動とFlagの初期化コードを追加する
（FlagはTimer割り込みハンドラでセットする）

LED_BLINK_Tasks関数

```
void LED_BLINK_Tasks ( void )
{
    switch ( led_blinkData.state )
    {
        case LED_BLINK_STATE_INIT:
            led_blinkData.state = LED_BLINK_STATE_RUN;
            loop_count = 0;
            break;
        case LED_BLINK_STATE_RUN:
            if( timer1_flag )
            {
                timer1_flag = false;
                if( ++loop_count >= 1000 )
                {
                  SYS_PORTS_PinToggle( PORTS_ID_0, PORT_CHANNEL_B, PORTS_BIT_POS_2);
                  loop_count = 0;
                }
            }
            if( timer2_flag )
            {
                timer2_flag = false;
                SYS_PORTS_PinToggle( PORTS_ID_0, PORT_CHANNEL_B, PORTS_BIT_POS_3);
            }
            break;
```

これでLチカのプログラムが完成した

おまけ

```
124  void _general_exception_handler ( void )
125  {
126      /* Mask off Mask of the ExcCode Field from the Cause Register
127      Refer to the MIPs Software User's manual */
128      _exce                                                    >> 2;
129      _excep_addr = _CP0_GET_EPC();
130      _cause_str  = cause[_excep_code];
131
132      SYS_DEBUG_PRINT(SYS_ERROR_ERROR, "¥nGeneral Exception %s (cause=%d, addr=%x).¥n",
133                      _cause_str, _excep_code, _excep_addr);
134
135      while (1)
136      {
137          SYS_DEBUG_BreakPoint();
138      }
139  }
140
```

Address = 0xA0000204, _excep_addr = 0x9D0008D4

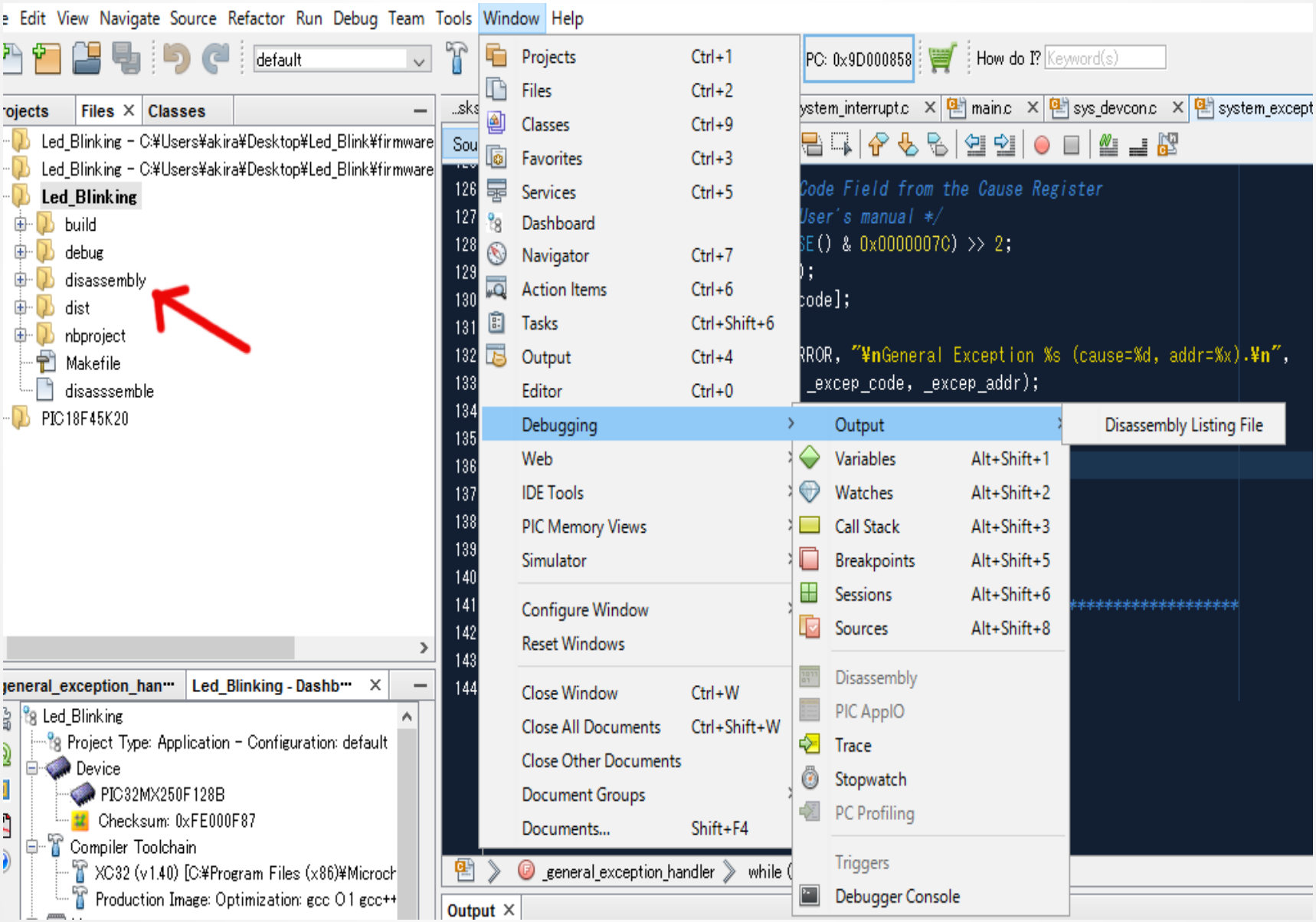
シミュレータで実行したらData bus errorを起こした

逆Asemmble List

```
10820  71:                    */
10821  72:
10822  73:                    void SYS_Tasks ( void )
10823  74:                    {
10824  9D0008D0  27BDFFE8    ADDIU SP, SP, -24
10825  9D0008D4  AFBF0014    SW RA, 20(SP)
10826  75:                        /* Maintain system services */
10827  76:                        SYS_DEVCON_Tasks(sysObj.sysDevcon);
10828  9D0008D8  3C02A000    LUI V0, -24576
10829  9D0008DC  0F400269    JAL SYS_DEVCON_Tasks
10830  9D0008E0  8C440220    LW A0, 544(V0)
10831  77:
10832  78:                        /* Maintain Device Drivers */
10833  79:
```

SyS_tasks関数のレジスタ待避でスタック・オーバーフローを起こしている。実機では起きなかったので、シミュレータのバグではないか（？）と思われる

おまけのおまけ


Edit View Navigate Source Refactor Run Debug Team Tools Window Help
default
Projects Files Classes
Led_Blinking - C:¥Users¥akira¥Desktop¥Led_Blink¥firmware
Led_Blinking - C:¥Users¥akira¥Desktop¥Led_Blink¥firmware
Led_Blinking
build
debug
disassembly
dist
nbproject
Makefile
disasssemble
PIC18F45K20
Led_Blinking - Dashb
Led_Blinking
Project Type: Application - Configuration: default
Device
PIC32MX250F128B
Checksum: 0xFE000F87
Compiler Toolchain
XC32 (v1.40) [C:¥Program Files (x86)¥Microch
Production Image: Optimization: gcc O1 gcc++
Projects Ctrl+1
Files Ctrl+2
Classes Ctrl+9
Favorites Ctrl+3
Services Ctrl+5
Dashboard
Navigator Ctrl+7
Action Items Ctrl+6
Tasks Ctrl+Shift+6
Output Ctrl+4
Editor Ctrl+0
Debugging
Web
IDE Tools
PIC Memory Views
Simulator
Configure Window
Reset Windows
Close Window Ctrl+W
Close All Documents Ctrl+Shift+W
Close Other Documents
Document Groups
Documents... Shift+F4
Output
Variables Alt+Shift+1
Watches Alt+Shift+2
Call Stack Alt+Shift+3
Breakpoints Alt+Shift+5
Sessions Alt+Shift+6
Sources Alt+Shift+8
Disassembly
PIC AppIO
Trace
Stopwatch
PC Profiling
Triggers
Debugger Console
Disassembly Listing File
PC: 0x9D000858
How do I? Keyword(s)
system_interrupt.c
main.c
sys_devcon.c
system_except
Code Field from the Cause Register
User's manual */
SE() & 0x0000007C) >> 2;
code];
RROR, "¥nGeneral Exception %s (cause=%d, addr=%x).¥n",
_excep_code, _excep_addr);
_general_exception_handler
while
Output