

**M4G Group (1)**  
**Application Note**  
**Trimming Circuit**  
**(TRM-A)**

**Outlines**

This application note is a reference material for developing products using Trimming Circuit (TRM) function of M4G group (1). This document helps the user check operation of the products and develop its programs.

Target sample program: TRMOSC\_M4G9

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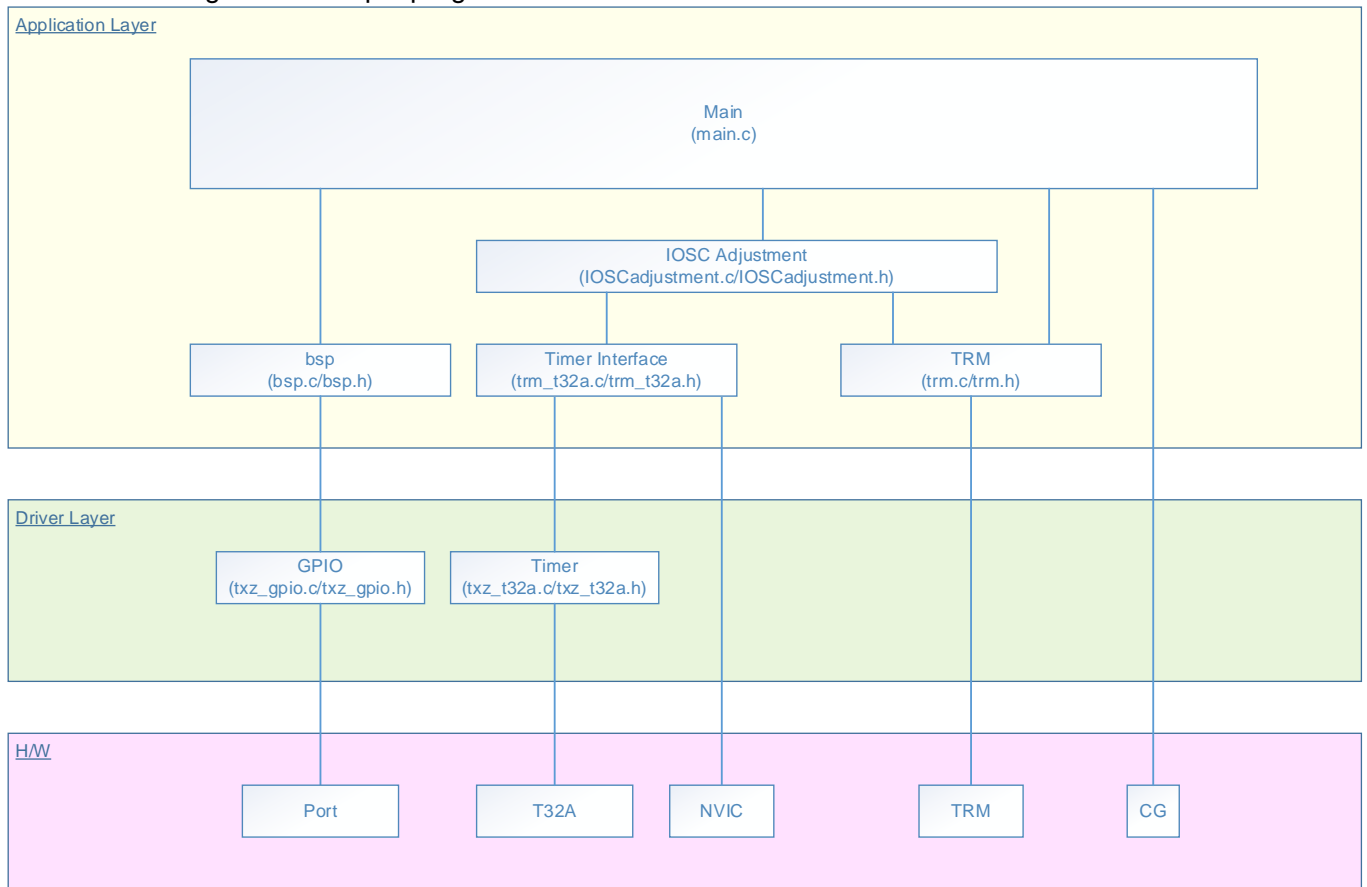
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### 1. Preface

This sample program should be used to check the operation of the Trimming circuit function. The internal high-speed oscillator is trimmed repeatedly until its frequency becomes a target one.

Structure diagram of Sample program



### 2. Reference Document

- Datasheet  
 TMPM4G Group (1) datasheet Rev1.0 (Japanese edition)
- Reference manual  
 Trimming Circuit (TRM-A) Rev2.0 (Japanese edition)  
 32-bit Timer Event Counter (T32A-B) Rev2.1 (Japanese edition)  
 Asynchronous Serial Communication Circuit (UART-C) Rev3.0 (Japanese edition)
- Application note  
 M4G Group (1) Application Note Startup (CMSIS System & Clock Configuration) Rev1.0
- Other reference document  
 TMPM4G (1) Group Peripheral Driver User Manual (Doxygen)

### 3. Function to Use

IP	Channel	Port	Function/Operation mode
Trimming Circuit	-	-	Adjustment of the frequency of the internal oscillator
Asynchronous Serial Communication Circuit	ch0	PE2 (UT0RXD) PE3 (UT0TXDA)	UART mode
32-bit Timer Event Counter	ch0	PA1 (T32A00OUTA)	Rectangular Wave Output
	ch8	-	Interval timer and Capture
	ch2	PB0 (T32A02INA0)	External clock input

### 4. Target Device

The target devices of this application note are as follows;

TMPM4G9F15FG	TMPM4G9F10FG	TMPM4G9FEFG	TMPM4G9FDFG
TMPM4G9F15XBG	TMPM4G9F10XBG	TMPM4G9FEXBG	TMPM4G9FDXBG
TMPM4G8F15FG	TMPM4G8F10FG	TMPM4G8FEFG	TMPM4G8FDFG
TMPM4G8F15XBG	TMPM4G8F10XBG	TMPM4G8FEXBG	TMPM4G8FDXBG
	TMPM4G7F10FG	TMPM4G7FEFG	TMPM4G7FDFG
	TMPM4G6F10FG	TMPM4G6FEFG	TMPM4G6FDFG

\* This sample program operates on the evaluation board of TMPM4G9F15FG.

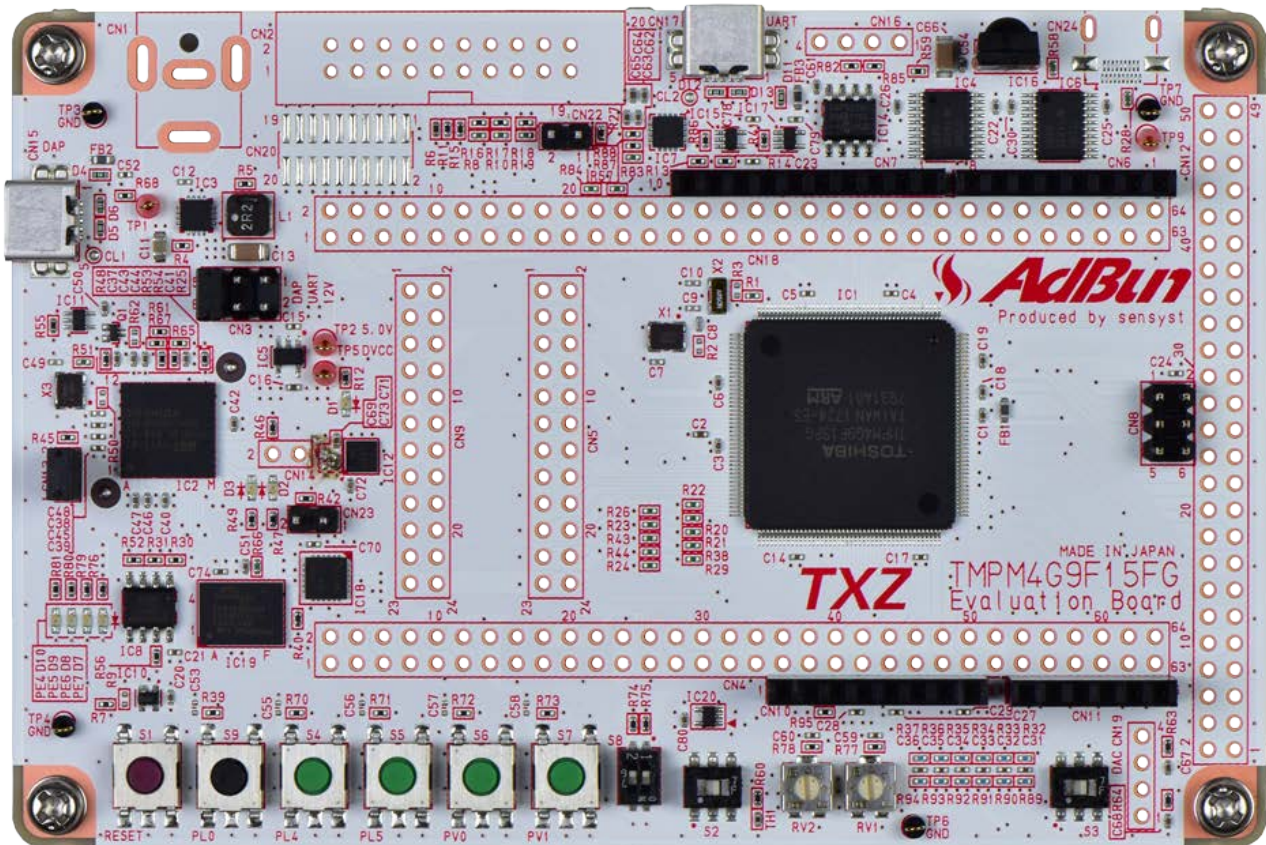
If other function than the TMPM4G9F15 one is checked, it is necessary that CMSIS Core related files (C startup file and I/O header file) should be changed properly.

The BSP related file is dedicated to the evaluation board (TMPM4G9F15). If other function than the TMPM4G9F15 one is checked, the BSP related file should be changed properly.

### 5. Operation Confirmation Condition

Used microcontroller	TMPM4G9F15FG
Used board	TMPM4G9F15FG Evaluation Board by Sensyst
Unified development environment	IAR Embedded Workbench for ARM 8.11.2.13606
Unified development environment	µVision MDK Version 5.24.2.0
Terminal software	Tera Term V4.96
Sample program	V1000

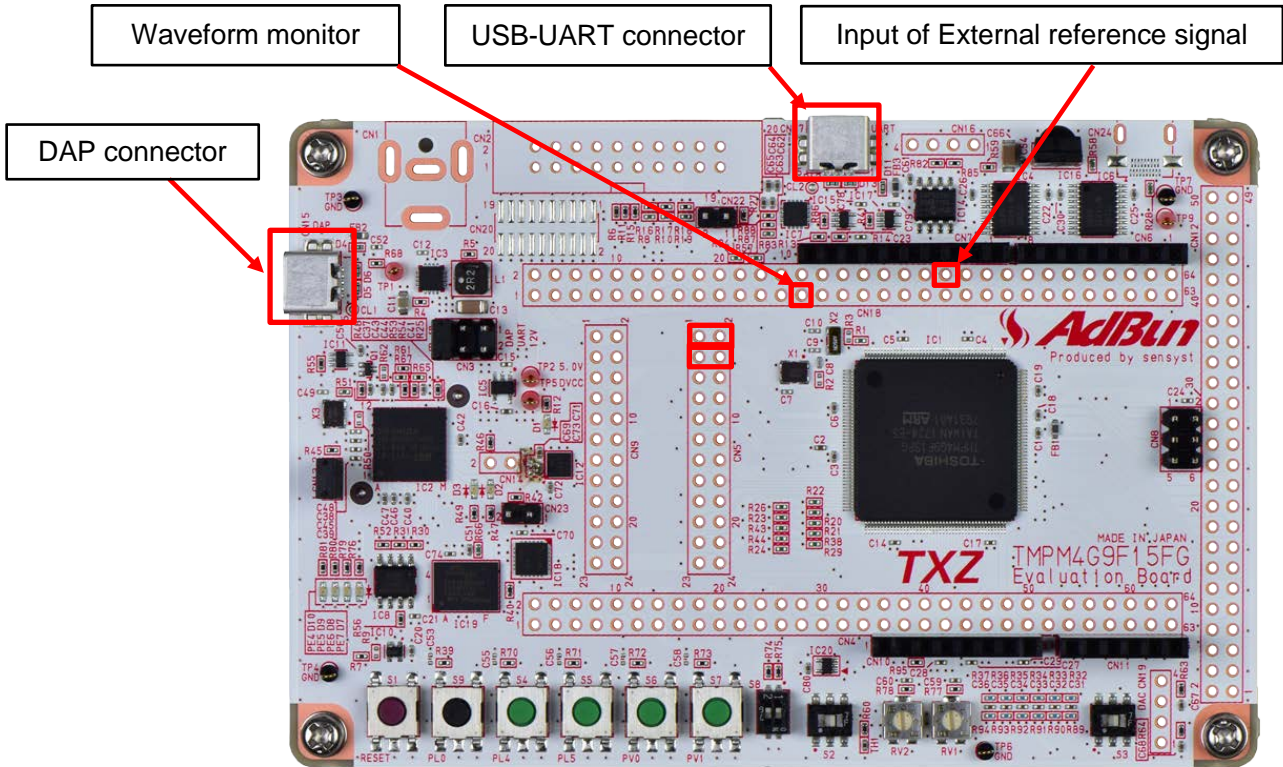
Evaluation board (TMPM4G9F15FG Evaluation Board) Top view



## 6. Evaluation Board Setting

The following pin connections should be done on the evaluation board.

CN5		
Board function	Through-hole No.	Through-hole No.
USB UART conversion	1: USB_UT_RX	2: PE2
USB UART conversion	3: USB_UT_TX	4: PE3



## 7. Operation of Evaluation Board

- PC and the USB\_UART are connected for communication with the terminal software.
- The sample program should be started up.
- The message which shows the start of the sample program is output to the terminal software.
- The frequency is adjusted by the Trimming circuit.
- The adjusted frequency can be monitored at PA1.
- After the trimming completes or the adjustment is done 10 times, "TRMOSC\_DONE" is displayed.

## 8. Outline of TRM Function

The trimming circuit (TRM) can adjust the frequency of an internal oscillator.  
The list of the functions is shown below.

Function Classification	Function	Operation
Frequency adjustment of the internal oscillator	Target oscillator	Internal High-Speed Oscillator 1 (IHOSC1)
	Adjustment range	Coarse trimming: -18.8 to +30.4 % (Average 0.8 % step) Fine trimming: -0.8 to +0.7 % (0.1% step)
	Monitor function	The reading of the internal trimming level is possible.
Protection	Protection function	Incorrect writing is prevented.

## **9. Sample Program**

The frequency of the internal high-speed oscillator is adjusted using an external reference signal or the frequency of the clock which is provided by an external low-speed oscillator. The adjustment repeats until the adjusted frequency becomes a target one.

### **9.1. Initialization**

The following initialization is done after power is supplied.  
The initialization of each clock setting and the setting of the watchdog timer are done.

### **9.2. Sample Program Main Operation**

The BSP (Board Support Package) is initialized.  
As initialization of the application software, the UART initialization and the UART interrupt enable are done.  
The timer clock output is initialized.  
The external input setting is initialized.  
The TRM circuit is initialized.

The start message is displayed on the terminal software.

The frequency adjustment is done as follows;

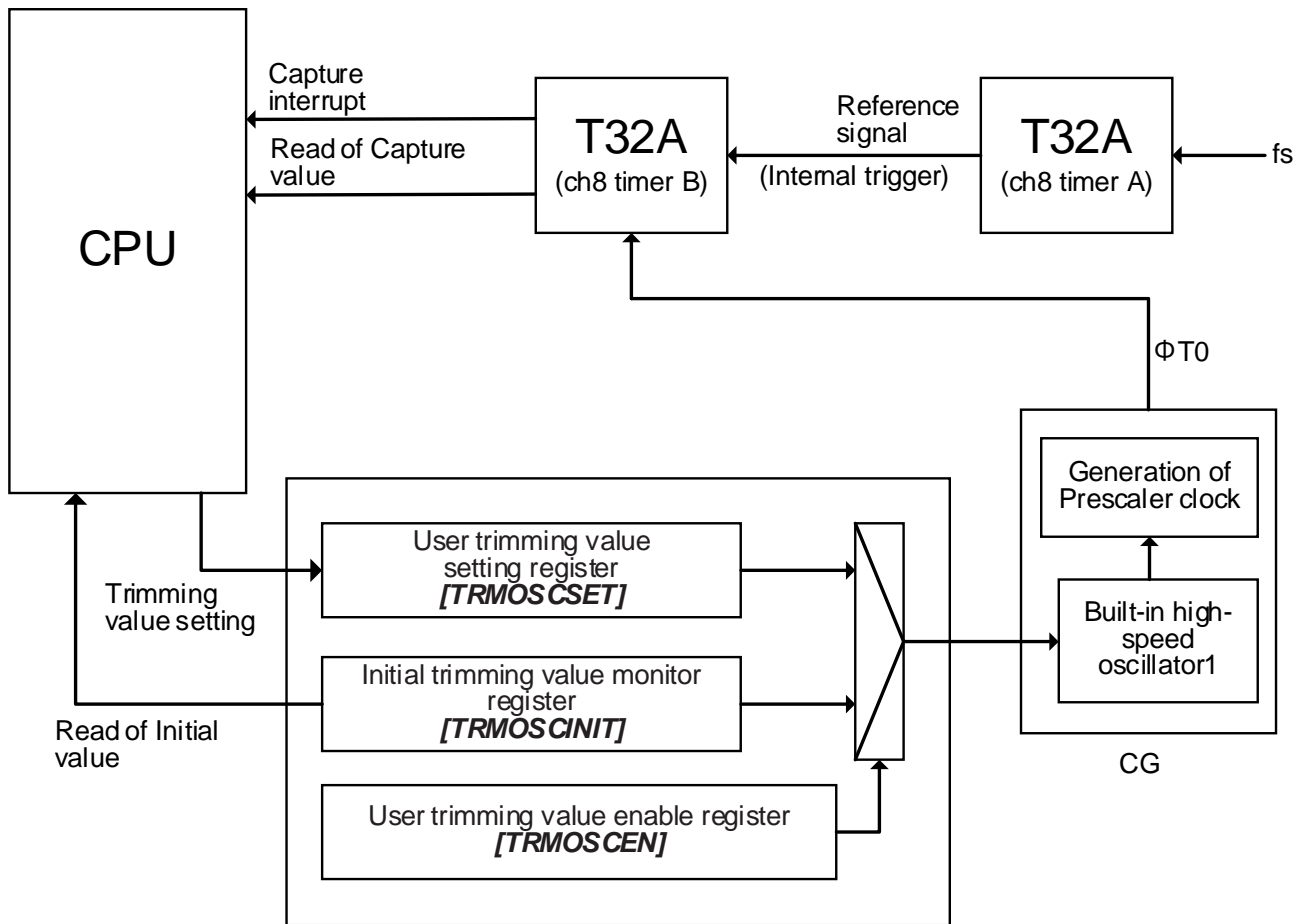
1. The frequency is measured, and the difference from the target frequency is calculated.
2. Using the difference value, a coarse trimming value and a fine trimming value are calculated.
3. Using the calculated values, the coarse trimming and the fine trimming are done.

The trimming procedure 1-3 repeats.

After the adjusted frequency becomes the value within the minimum adjustment range or the trimming procedure repeats 10 times, the trimming procedure finishes.



The following is the case that T32A and fs are used to generate a reference signal. The fs is connected to the internal trigger input of T32A ch8 timer A. And the output of the timer A is connected to the internal trigger input of the timer B.

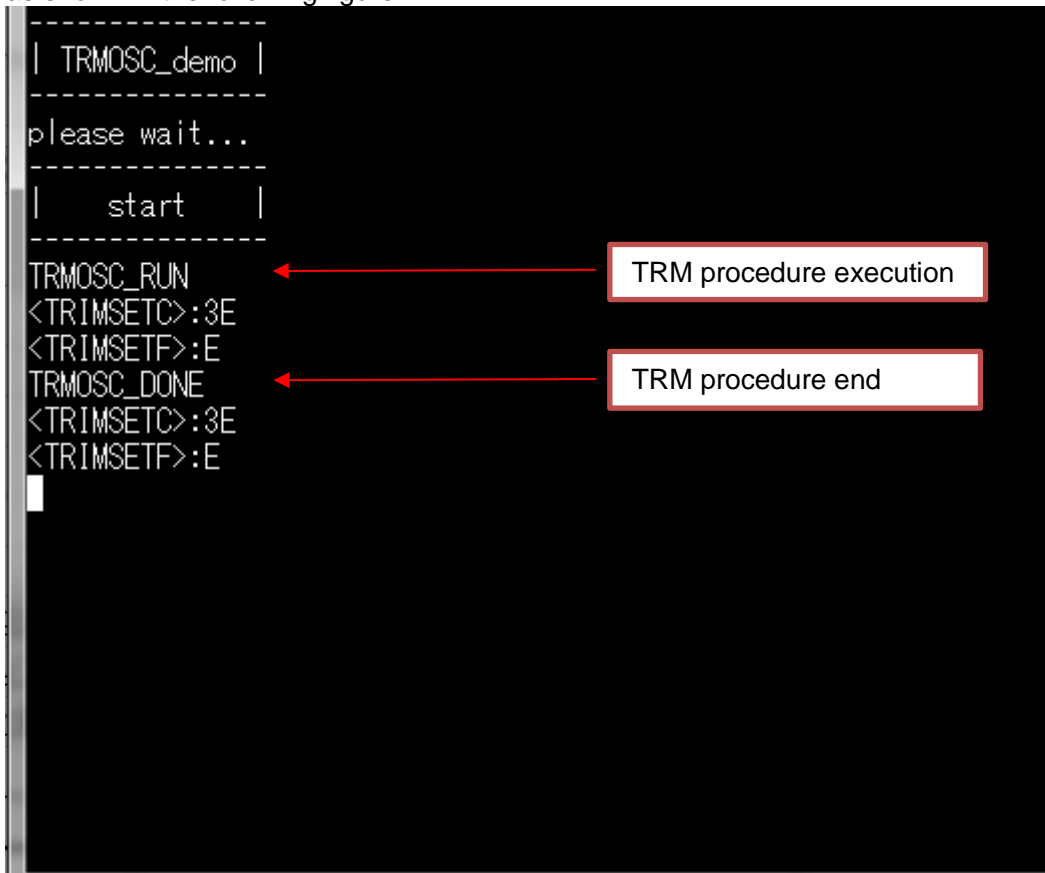


### 9.3. Change of Frequency Measurement Setting

The external reference signal or the fs can be used to measure the frequency of the Internal high-speed oscillator1. To select the external reference signal, "#define TRMOSC\_LOSC" which is in the 19-th line in "txz\_sample\_def.h" should be commented out. If it is not commented out, the fs is used.

## 9.4. Output Example of Sample Program

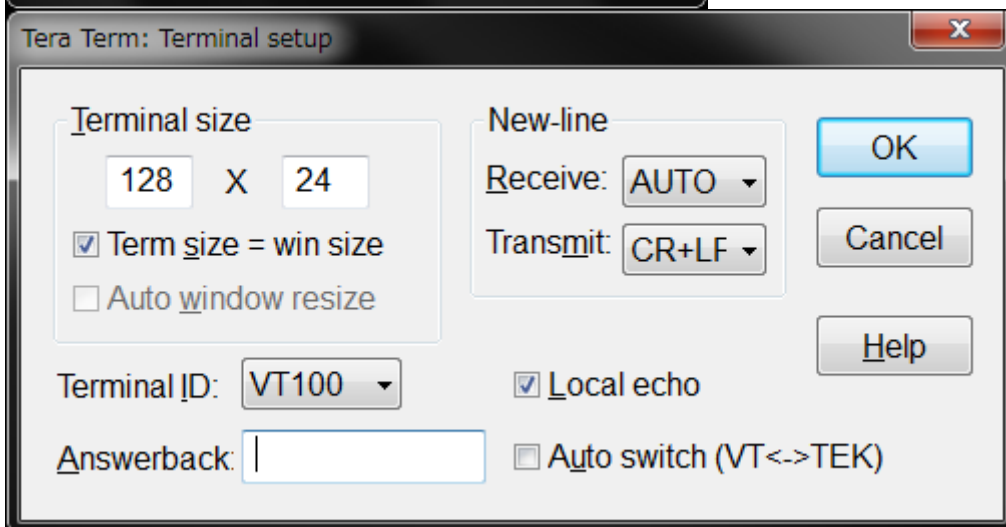
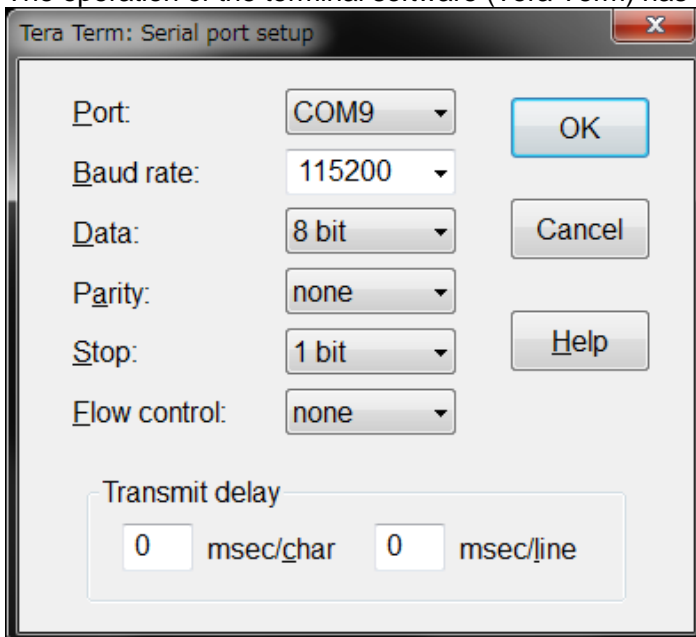
When the sample program executes, the adjustment status, the adjustment end, and others are displayed as shown in the following figure.



```
-----  
| TRMOSC_demo |  
-----  
please wait...  
-----  
|   start   |  
-----  
TRMOSC_RUN      ← TRM procedure execution  
<TRIMSETC>:3E  
<TRIMSETF>:E  
TRMOSC_DONE     ← TRM procedure end  
<TRIMSETC>:3E  
<TRIMSETF>:E  
█
```

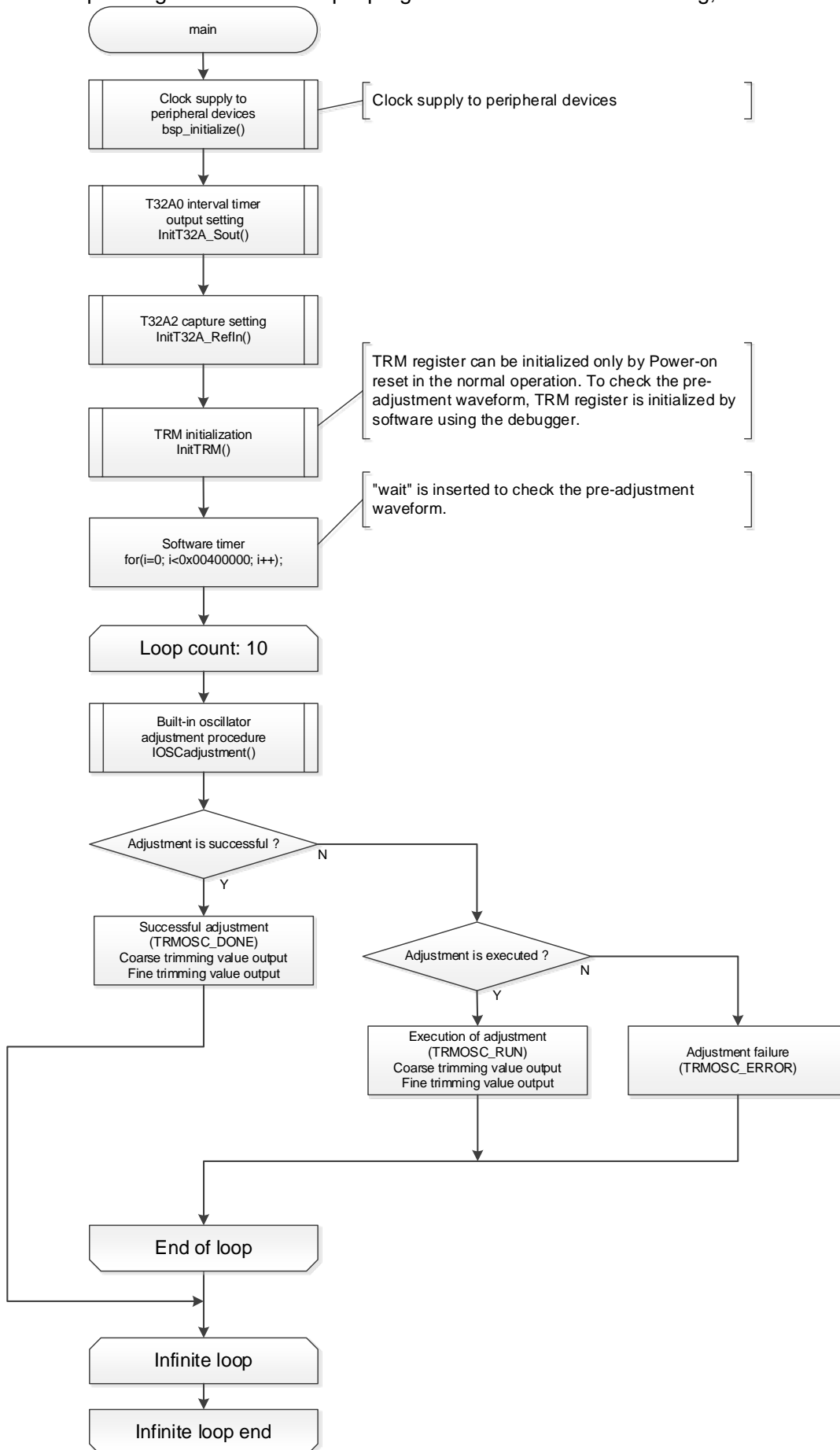
### 9.4.1. Setting Example of Terminal Software

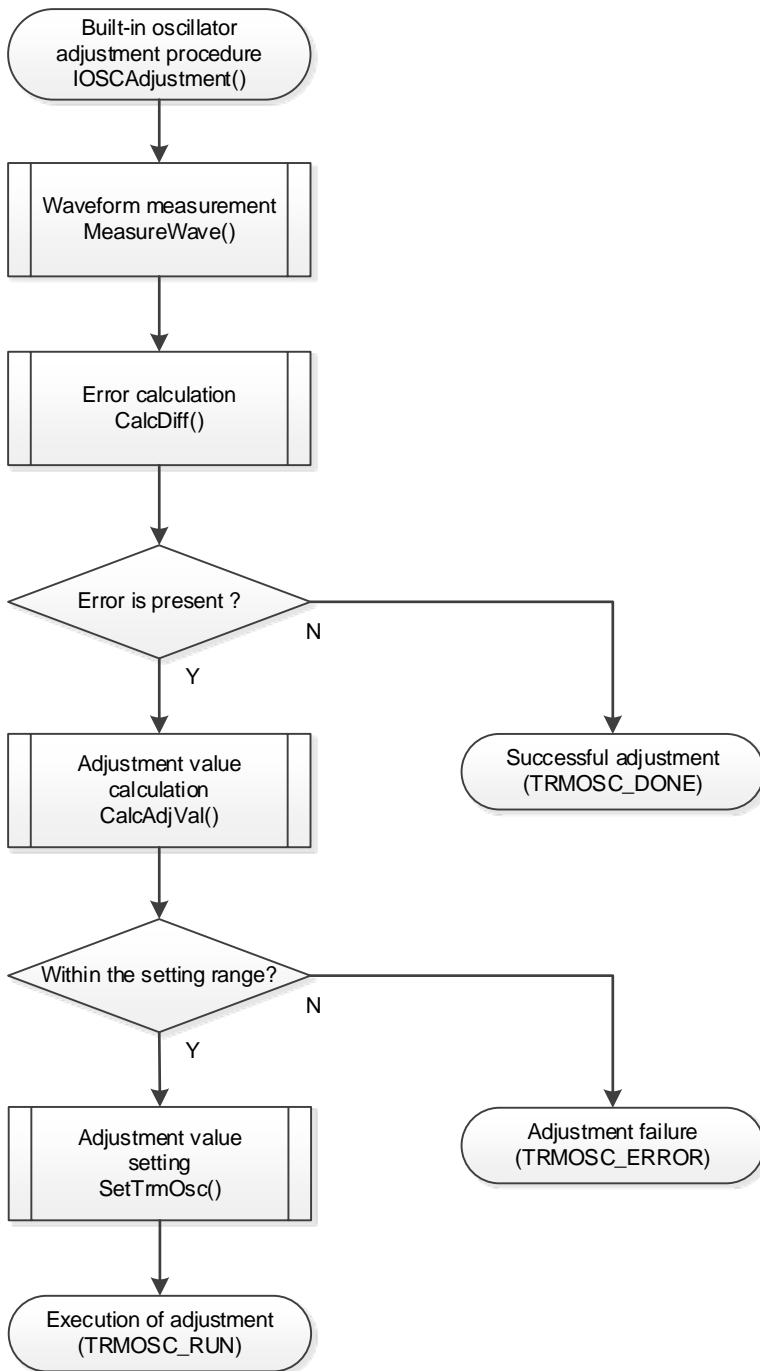
The operation of the terminal software (Tera Term) has been checked with the following settings.



### 9.5. Operating Flow of Sample Program

The basic operating flows of the sample program are shown in the following;





**10. Precaution**

When using the sample program with CPU other than TPM4G9F15, please check operation sufficiently.

**11. Revision History**

Rev	Date	Page	Description
1.0	2018-12-14	-	First release

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