

M851 Periodic Task Design



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1 Introduction

The M851 Kernel is a platform that is geared for developing a variety of applications that can be incorporated into the operating system during power up or downloaded to EEPROM through USB Datalink communications.

This document serves as a guide for developing one type of application referred to as a Periodic Task. The periodic task is executed only if the TOD is the foreground application. It is sub-divided into tasks that are executed based on the the events occurring in the primary time zone. These events are the following:

- Minute updates
- Hour updates
- Day updates

The periodic task can be used to do the following features:

- Automatic forward/backward update at specified daylight-savings-time
- Visual effects during any of the periodic task events (minute, hour or daily)
- Screen savers
- Etc.

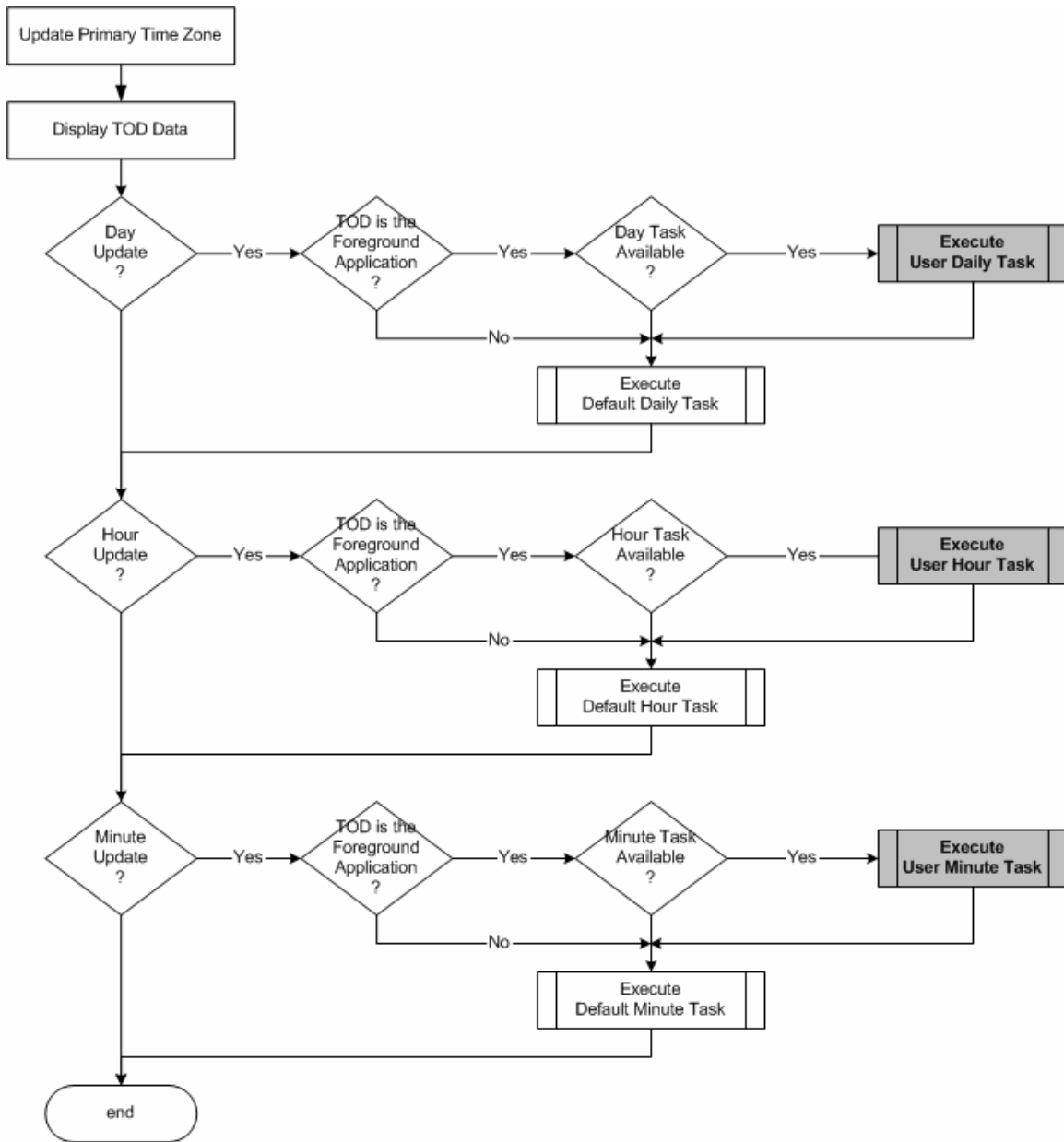
1.1 *Applicable Documents*

The following documents serves as references in the creation of this document.

- M851 Application Design Guide
- M851 WristApp API Reference Guide
- S1C88349 Core CPU Manual

2 Overview

The periodic task are executed when specific update events from the primary time zone are detected. The flowchart shown below shows when a specific periodic task is executed. The periodic tasks are highlighted in gray. Take note that the TOD update and display occurs first prior to the execution of the periodic task.



3 Bus Clock Speed Notes

By default, the bus clock is at 32768Hz. The following conditions below indicates when the MCU switches to a 2Mhz bus clock.

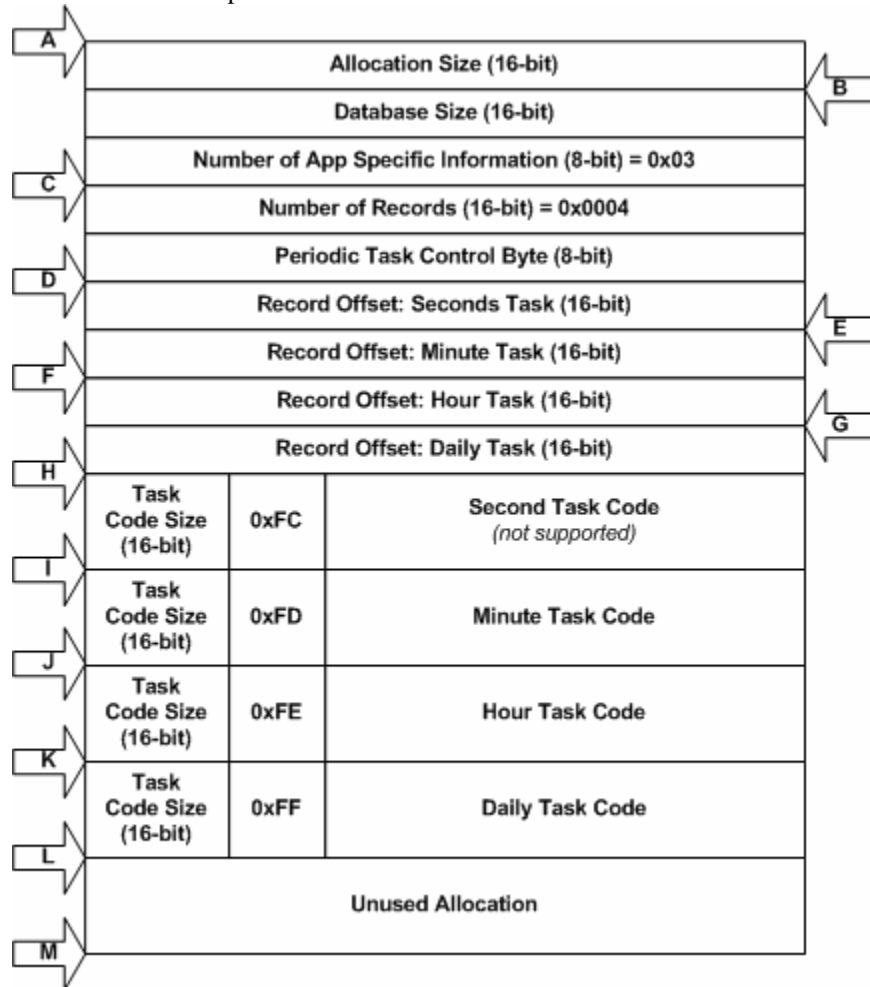
- When the system detects that a periodic task is to be executed, it will check if the correct periodic task code is loaded into the overlay memory area. If the task is already loaded, it will execute it immediately and not change the bus clock setting. If not, the system will increase the MCU bus clock to speed up loading the code from EEPROM.
- When an hour or day update is detected, the system will increase the MCU bus clock to speed up processing of all the system tasks that needs to be processed during these conditions.
- When a switch or ring event is to be processed by the application, the system will increase the MCU bus clock speed. It will automatically go back to the lower bus clock setting after 5 seconds.

4 Resetting the WatchDog

It is recommended that the periodic task complete its processing in the shortest possible time. When processing of the periodic task takes longer than 2 seconds, then the reset watchdog API must be included at certain location in the code to prevent the MCU from resetting.

5 Code File Structure

The code file uses the variable-size random access structure having 4 records. The task for seconds update is not supported in the M851, but it should still have its own record structure. The following diagram shows the code file structure of a periodic task.



Section	Description
Allocation Size	A 16-bit quantity that specifies the number of bytes that is allocated in the EEPROM for the periodic task code. This value is a multiple of 64 bytes. This optimizes the download speed during communications.

```

NumberOfPages = DatabaseSize / 64
If (DatabaseSize mod 64) > 0 then
    NumberOfPages = NumberOfPages+1
Endif
    
```

$$\text{AllocationSize} = \text{NumberOfPages} * 64$$

Database Size	<p>A 16-bit quantity that specifies the number of bytes of the actual code file.</p> $\text{DatabaseSize} = \text{Offset(L)} - \text{Offset(A)}$										
Number of App Specific Information	<p>An 8-bit quantity that specifies the number of bytes stored in the application specific header.</p> $\text{NumAppInfor} = \text{Offset(D)} - \text{Offset(C)}$										
Number of Records	<p>A 16-bit quantity that indicates the number of records in the code file. This field is always 0x0004.</p>										
Periodic Task Control Byte	<p>An 8-bit quantity that specifies the available tasks stored in the code file. This will be used by the M851 OS to check if a particular task is available in the code file prior to loading it into the overlay memory. If a bit is set, the task code must be</p> <table border="1" style="margin-left: auto; margin-right: auto; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Bit</th> <th style="text-align: left;">Description</th> </tr> </thead> <tbody> <tr> <td>10000000B</td> <td>Day task available</td> </tr> <tr> <td>01000000B</td> <td>Hour task available</td> </tr> <tr> <td>00100000B</td> <td>Minute task available</td> </tr> <tr> <td>00010000B</td> <td>Second task available (<i>not supported</i>)</td> </tr> </tbody> </table>	Bit	Description	10000000B	Day task available	01000000B	Hour task available	00100000B	Minute task available	00010000B	Second task available (<i>not supported</i>)
Bit	Description										
10000000B	Day task available										
01000000B	Hour task available										
00100000B	Minute task available										
00010000B	Second task available (<i>not supported</i>)										
Second Task Offset	<p>A 16-bit quantity specifying the base offset of the record where the second task code is stored.</p> $\text{SecondTaskOffset} = \text{Offset(H)} - \text{Offset(D)}$										
Minute Task Offset	<p>A 16-bit quantity specifying the base offset of the record where the minute task code is stored.</p> $\text{MinuteTaskOffset} = \text{Offset(I)} - \text{Offset(D)}$										
Hour Task Offset	<p>A 16-bit quantity specifying the base offset of the record where the hour task code is stored.</p> $\text{HourTaskOffset} = \text{Offset(J)} - \text{Offset(D)}$										
Day Task Offset	<p>A 16-bit quantity specifying the base offset of the record where the day task code is stored.</p> $\text{DayTaskOffset} = \text{Offset(K)} - \text{Offset(D)}$										
Second Task Code Record	<p>The record contains three fields:</p> <table border="1" style="margin-left: auto; margin-right: auto; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Field</th> <th style="text-align: left;">Description</th> </tr> </thead> <tbody> <tr> <td>Code Size</td> <td>Number of bytes of entire record. $\text{RecordSize} = \text{Offset(I)} - \text{Offset(H)}$</td> </tr> <tr> <td>0xFC</td> <td>Indicates the task type.</td> </tr> </tbody> </table>	Field	Description	Code Size	Number of bytes of entire record. $\text{RecordSize} = \text{Offset(I)} - \text{Offset(H)}$	0xFC	Indicates the task type.				
Field	Description										
Code Size	Number of bytes of entire record. $\text{RecordSize} = \text{Offset(I)} - \text{Offset(H)}$										
0xFC	Indicates the task type.										
Minute Task Code Record	<p>The record contains three fields:</p> <table border="1" style="margin-left: auto; margin-right: auto; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Field</th> <th style="text-align: left;">Description</th> </tr> </thead> <tbody> <tr> <td>Code Size</td> <td>Number of bytes of entire record.</td> </tr> </tbody> </table>	Field	Description	Code Size	Number of bytes of entire record.						
Field	Description										
Code Size	Number of bytes of entire record.										

		$RecordSize = Offset(J) - Offset(I)$
	0xFD	Indicates the task type.
Hour Task Code Record	The record contains three fields:	
	Field	Description
	Code	Size
	Number of bytes of entire record. $RecordSize = Offset(K) - Offset(J)$	
	0xFE	Indicates the task type.
Day Task Code Record	The record contains three fields:	
	Field	Description
	Code	Size
	Number of bytes of entire record. $RecordSize = Offset(L) - Offset(K)$	
	0xFF	Indicates the task type.

6 Screen Saver: Putting it all together.

This section will go through the process of building a periodic task that will implement a simple screen saver. During a minute rollover, it will clear the display and prevent the TOD application from refreshing the time. The display will be restored when user switch inputs are detected.



WARNING: *There is no debugging capability once the periodic task is downloaded into the watch. You will either have a fully operational periodic task or the watch resets during periodic task execution.*

6.1 Files

The minute periodic task will be coded into one file while the rest will be created by the periodic task utility (which are RET by default).

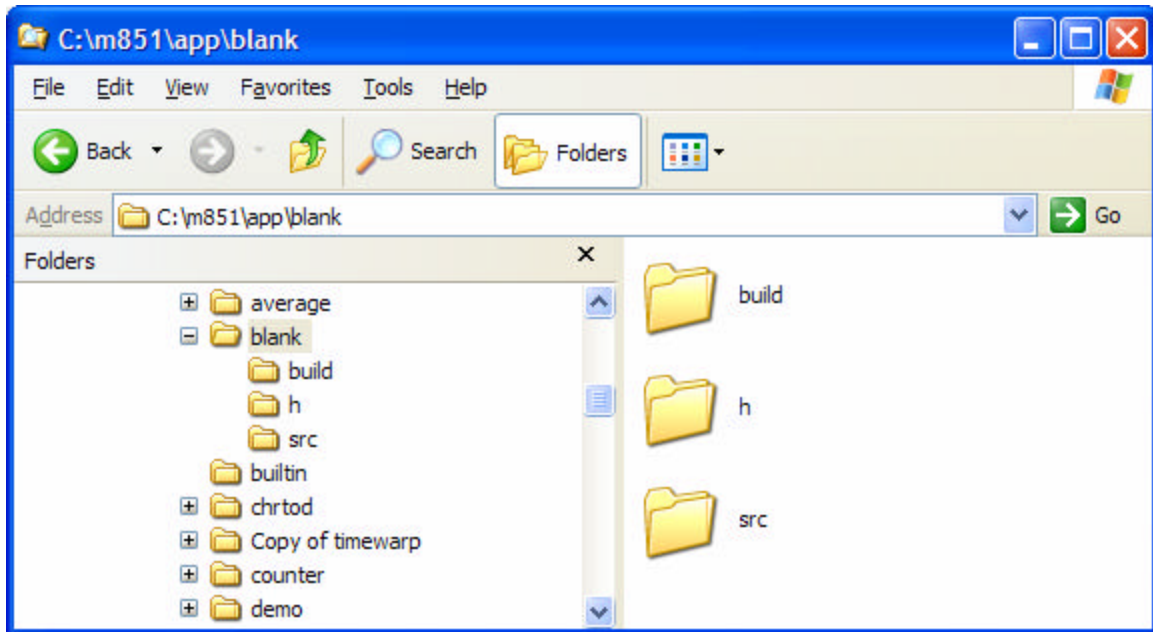
File	Description
blank.asm	Minute task to blank out the display.

6.2 Directory Structure

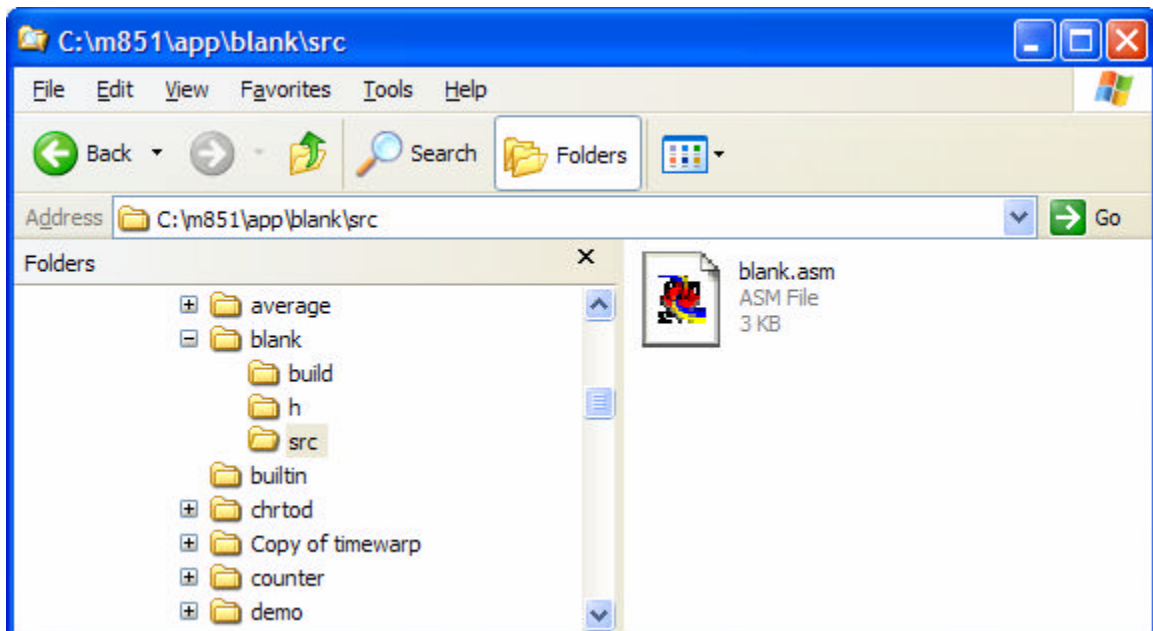
The build scripts requires a specific directory structure to facilitate location of required files. Create the required directories for the application prior to using the build utilities.

- All source files are to be stored under the C:\M851\APP\appname\SRC directory.
- All header files are to be stored under the C:\M851\APP\appname\H directory.
- All build scripts will be created under the C:\M851\APP\appname\BUILD directory.
- Output files during periodic task creation will be in the C:\M851\APP\appname\BUILD directory.
- All executable files will be located in the C:\M851\BIN directory.
- All the M851 header and macro files will be in the C:\M851\INCLUDE directory.
- The assembler, linker and locator executable will be located in the C:\C88 directory.

The figure below shows a snapshot of the blank directory structure:



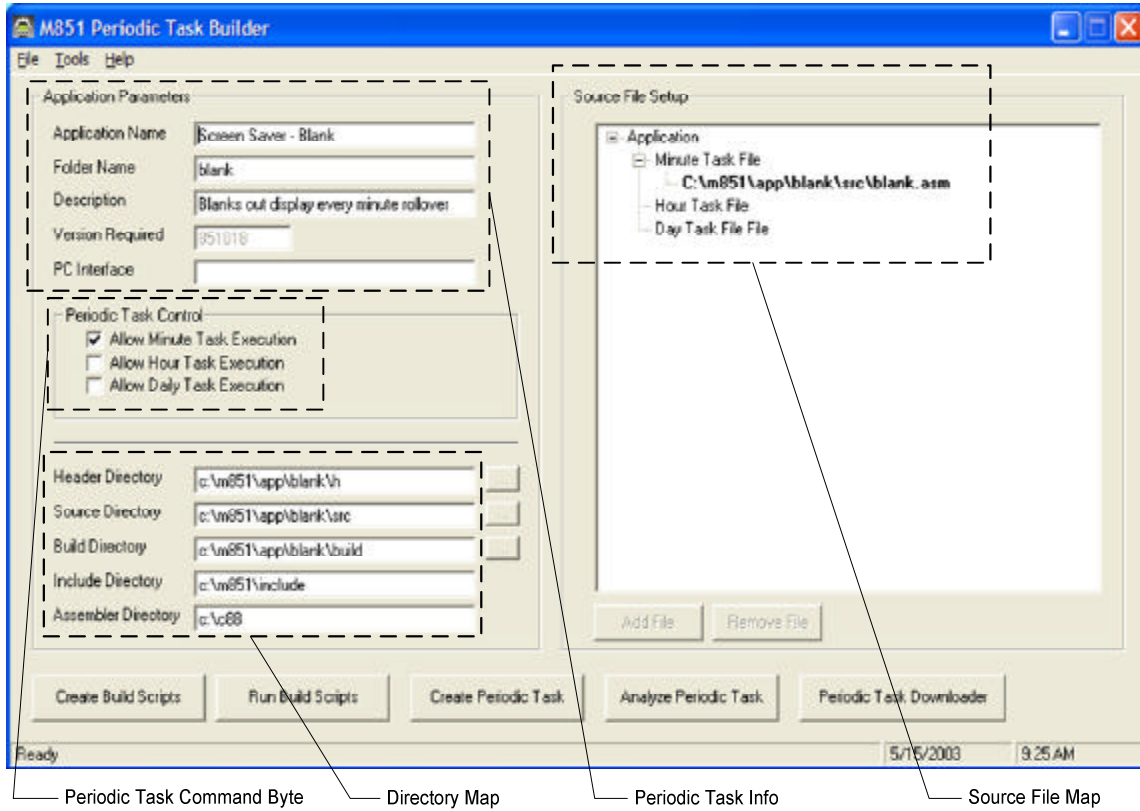
The figure below shows the file list for the blank periodic task source files:



6.3 Coding the Periodic Task

6.3.1 Definitions

There are no definitions required for this periodic task.



Section	Description
Periodic Task Control Byte	Indicates the available task when this periodic task code is loaded into the watch.
Directory Map	Shows the locations of source files, executables, include files, and assembler files.
Periodic Task Info	Data source to fill out the *.TSK file used by the PIM to download a periodic task to a watch.
Source File Map	A hierarchal view of the files associations to the actual periodic task function.



NOTE: The information displayed in the utility is stored in a file *APPNAME.PSC*. The file is created when the build scripts are generated or it was saved through the **File\Save** menu. The file is stored in the build directory of the application.

6.4.1 Periodic Task Control Byte

This control byte will be used by the M851 OS to determine the availability of the specific periodic task code in EEPROM. If the box is unchecked, even if the code is available in the code file, it will not be executed by the M851 OS.

6.4.2 Directory Map

Specifies the directories that will be used in the creation of the build scripts.

6.4.3 Periodic Task Info

Fill up all the required information in periodic task info section.

Field	Description
Application Name	<i>Descriptive name of the application.</i>
Folder Name	<i>Indicates the application folder name. Entering data in the Folder Name text box will automatically fill up the required entries in the Directory Map section.</i>
Description	<i>A brief description of the application.</i>
Version Required	<i>Indicates the M851 firmware version that the periodic task is referencing.</i>

6.4.4 Source File Map

Add the files associated with the different application sections.

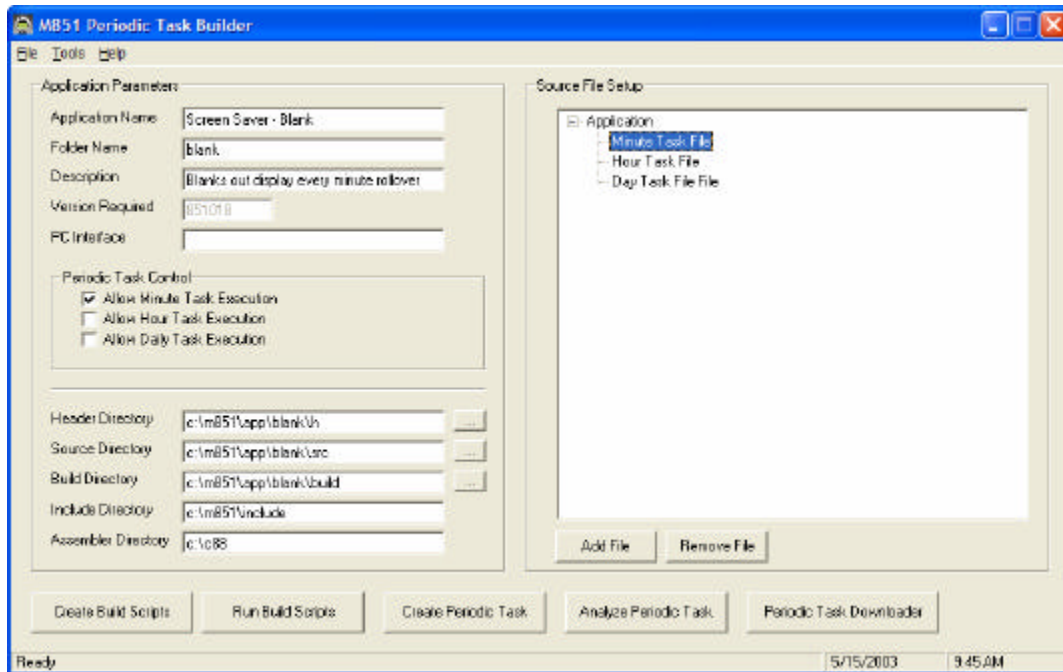
Section	Description
Second Task File	<i>The source code to be located in the second task record. Second Task is not supported by the M851 OS version 018.</i>
Minute Task File	<i>The source code to be located in the minute task record.</i>
Hour Task File	<i>The source code to be located in the hour task record.</i>
Daily Task File	<i>The source code to be located in the daily task record.</i>

There are two procedures in adding files into each section of the Source File Map.

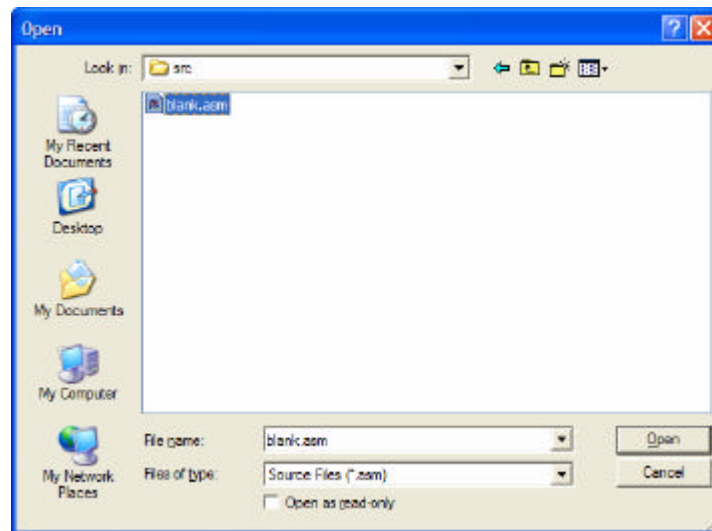
- Using the Add File button;
- Using Drag & Drop method from File Explorer.

Adding a File using the Add File button.

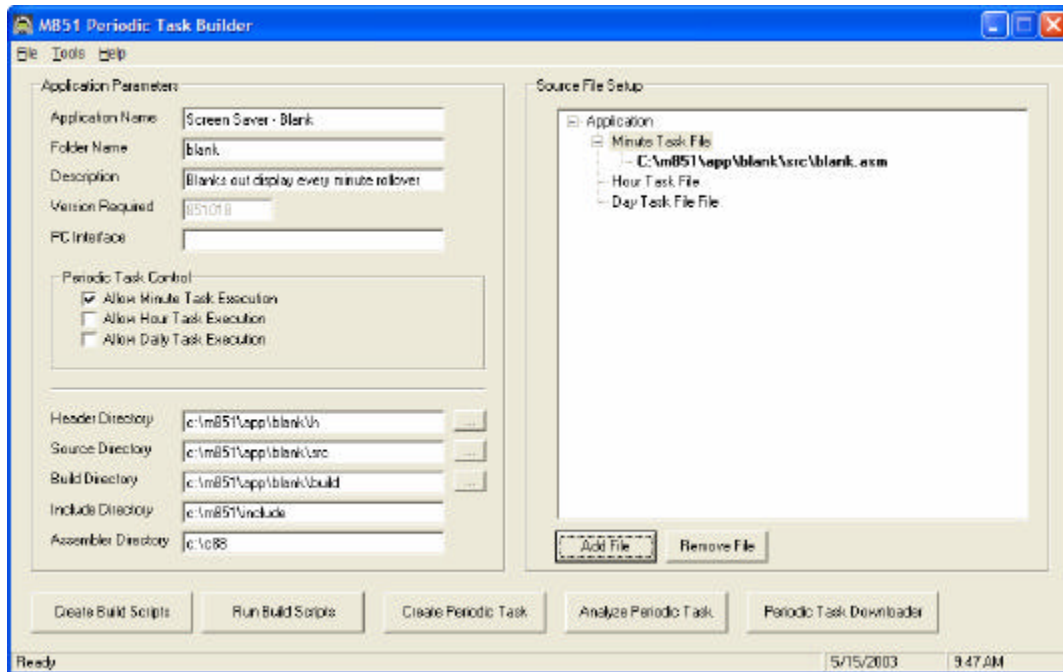
Click on a section where the new file is to be added (the figure shows the “Minute Task File” being selected. Then click on the “**Add File**” button to open up the Open dialog window.



Select the file to be added in the section and click **Open**. The figure below shows the file “BLANK.ASM” selected.

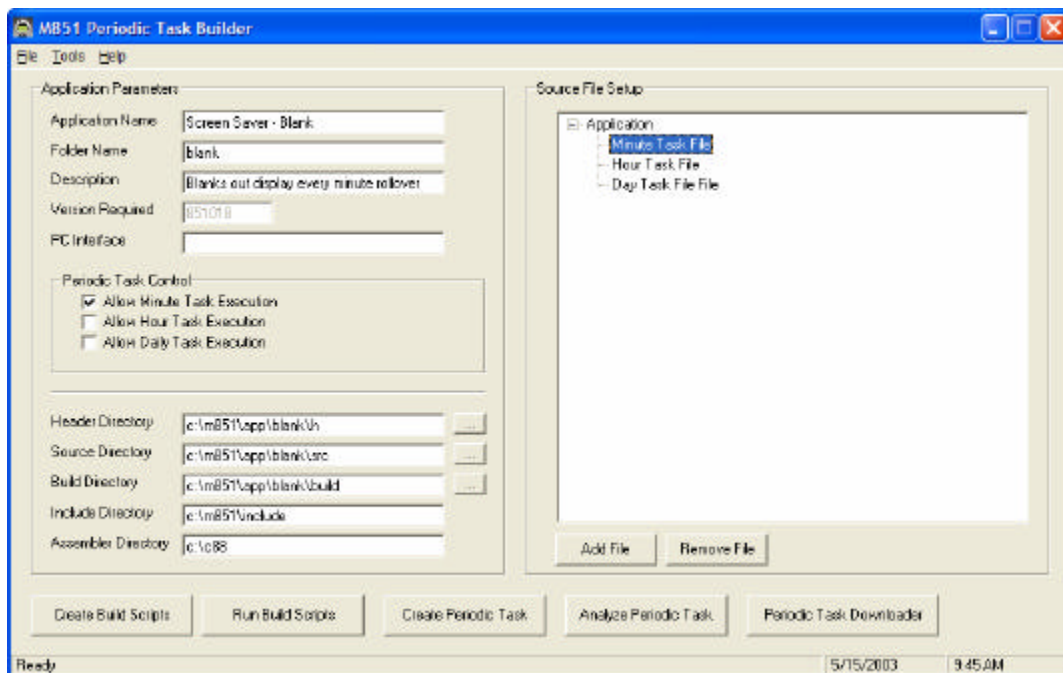


After this operation, the file BLANK.ASM will be added under the “Minute Task File” section. See figure below.

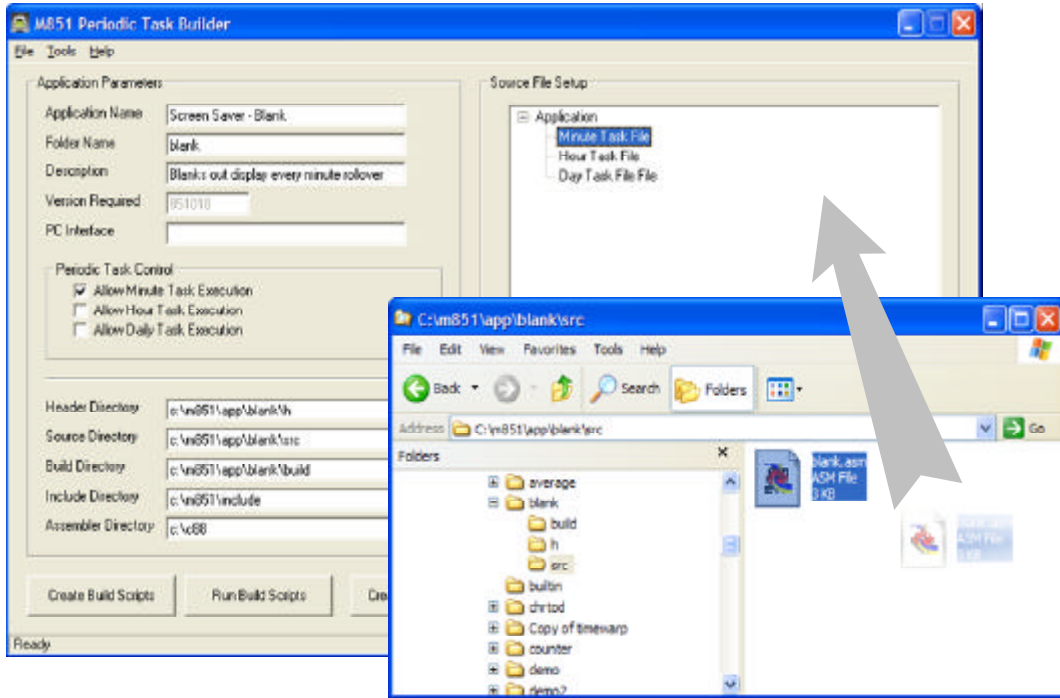


Adding a file using File Explorer.

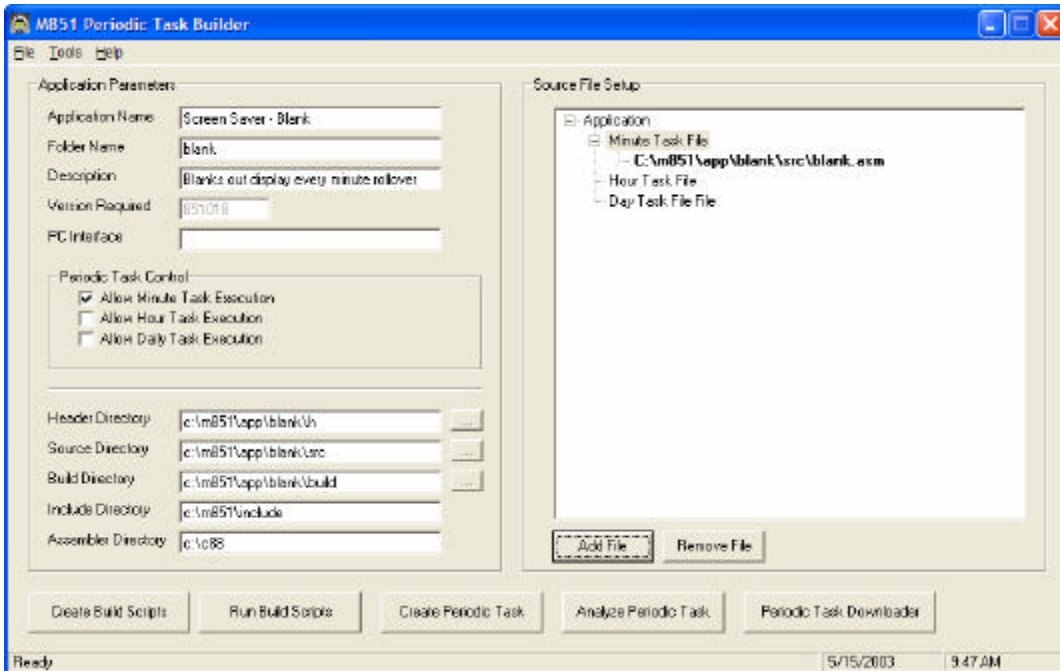
Click on a section where the new file is to be added (the figure shows the “Header File” being selected).



Open File Explorer and select the files to be added. Then click on the highlighted files and drag them over the Source File Setup List window.



After this operation, the file BLANK.ASM will be added under the “Minute Task File” section. See figure below.

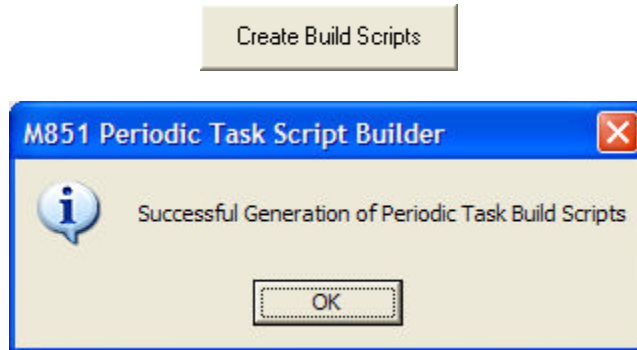


6.4.5 Saving the Current Workspace

Selecting **File\Save** menu option will store the current workspace under the filename `C:\M851\APP\appname\build\appname.psc`. It can be loaded again by using the **File\Open** menu option.

6.4.6 Creating the Build Scripts

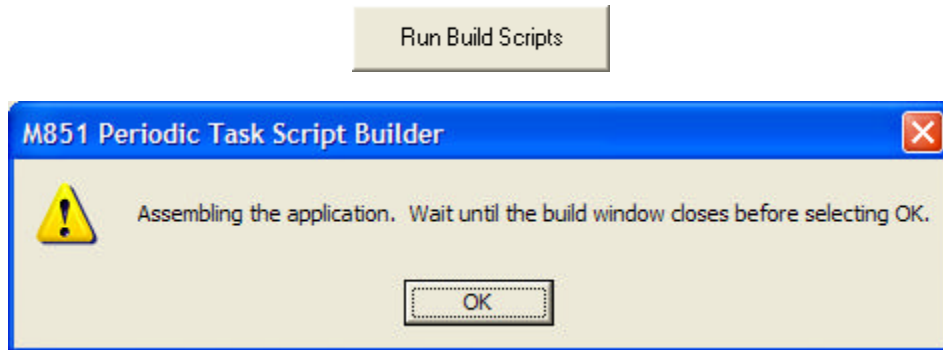
Clicking on the “Create Build Scripts” button will create all the required scripts that automates the assembly and linking of the source files. All script files will be created under the `C:\M851\APP\appname\BUILD` directory. This process will also save the current workspace under the filename `C:\m851\app\appname\build\appname.psc`.



Once the build scripts are created, it is not required to create them again during the debugging process.

6.4.7 Executing the Build Scripts

Clicking on the “Run Build Scripts” button will execute all the scripts generated in the previous section. This process will open up a command window where all the required scripts are executed. The build process will take some time to complete.



```

C:\WINDOWS\System32\cmd.exe
Could Not Find C:\m851\app\blank\build\*.err
Could Not Find C:\m851\app\blank\build\*.lnl
Could Not Find C:\m851\app\blank\build\*.cal
Could Not Find C:\m851\app\blank\build\*.bak
Could Not Find C:\m851\app\blank\build\*.ers
E0C88 assembler v1.2 r2          SN00088242-048 (c) 1999 TASKING, Inc.

Section summary:
  NR ADDR  SIZE CYCLE NAME
  1 00F310 0003    3 .text
E0C88 object linker v1.2 r2     SN00088242-018 (c) 1999 TASKING, Inc.
E0C88 locator v1.2 r2         SN00088242-027 (c) 1999 TASKING, Inc.

E0C88 assembler v1.2 r2          SN00088242-048 (c) 1999 TASKING, Inc.

Section summary:
  NR ADDR  SIZE CYCLE NAME
  1 00F310 000f   20 .text
E0C88 object linker v1.2 r2     SN00088242-018 (c) 1999 TASKING, Inc.
E0C88 locator v1.2 r2         SN00088242-027 (c) 1999 TASKING, Inc.

E0C88 assembler v1.2 r2          SN00088242-048 (c) 1999 TASKING, Inc.

```

Build Window

A successful build of the code sections for the periodic task will generate the following SRE files:

- DAILY.SRE
- HOUR.SRE
- MINUTE.SRE
- SECOND.SRE



NOTE: Wait until the build process is complete. Do not click on the “Create Periodic Task” button until the command window is closed.



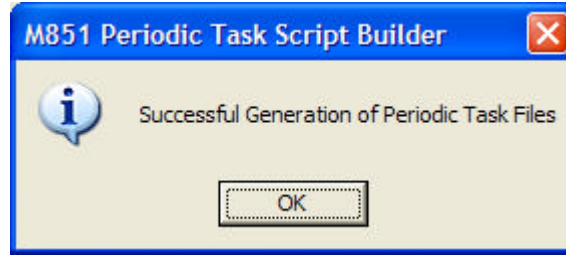
WARNING: Executing the build scripts does not necessarily mean that all the code sections has been compiled properly.

6.4.8 Creating the Periodic Task Downloadable File

Clicking on the “Create Periodic Task” button will create the files that are downloaded to the watch.

Create Periodic Task

If all the code sections has been compiled properly with no compile and build errors, the distribution files are generated for download and testing.



The distribution files are described below:

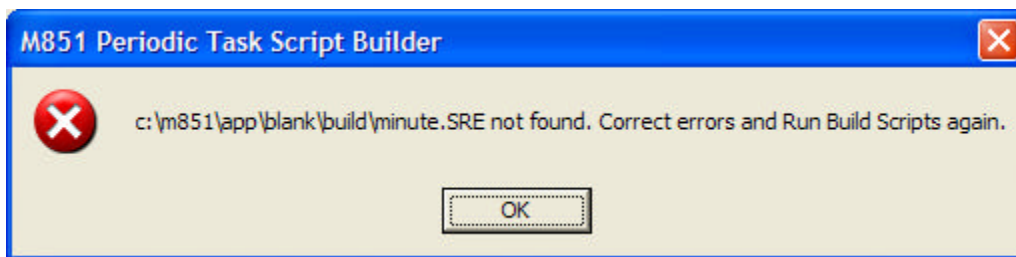
File	Description
<i>appname.tsk</i>	<i>This file is required by the PIM. This contains information about the periodic task such as: the code file, firmware version requirements and descriptive comments.</i> <i>The appname is the name of periodic task.</i>
<i>appname.txt</i>	<i>Description file for the PIM. This is a template only. Modify this template and save it under another directory for distribution</i>
<i>appname_code_nnn.bin</i>	<i>This is the Periodic Task code stored in a format that the watch can readily grab the correct section to be loaded into the overlay area for execution.</i> <i>The appname is the name of the periodic task. nnn is the version number of the required M851 firmware.</i>

For the blank periodic task, these are the following files generated:

- blank.tsk
- blank.txt
- blank_code_018.bin

If there are no errors in the source files, all the required files to build the downloadable file will be available and executing the Create Periodic Task Downloadable Files would be completed.

If the Create Periodic Task button displays a message indicating that a ???????.SRE is not found (as shown in the screen snapshots below), this indicates that the build script was unable to complete compiling the section due to errors in the source files attached to a section.



Source files attached to the MINUTE section have errors.

If an error exists then you can view the source of the errors by opening the following files:

File	Description
<i>sourcename.ers</i>	<i>This error file is generated by the assembler (AS88.EXE). If</i>

successful, the output of the assembler is an OBJ file.

*The **sourcename** could be the section that generated the error.*

`sourcename.elk`

This error file is generated by the linker (LK88.EXE). If successful, the output of the linker is an OUT file.

*The **sourcename** could be the section that generated the error.*

`sourcename.elc`

This error file is generated by the locator (LC88.EXE). If successful, the output of the locator is an SRE file.

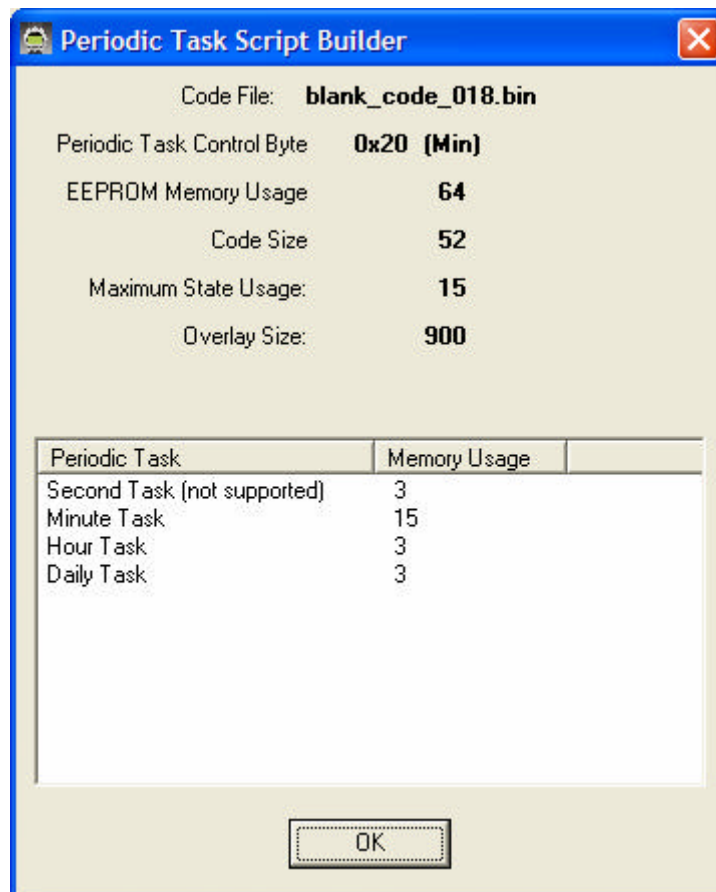
*The **sourcename** could be the section that generated the error.*

To incorporate this periodic task into the PIM, copy the above files into the APP directory of the PIM.

6.4.9 Periodic Task Memory Usage Analysis

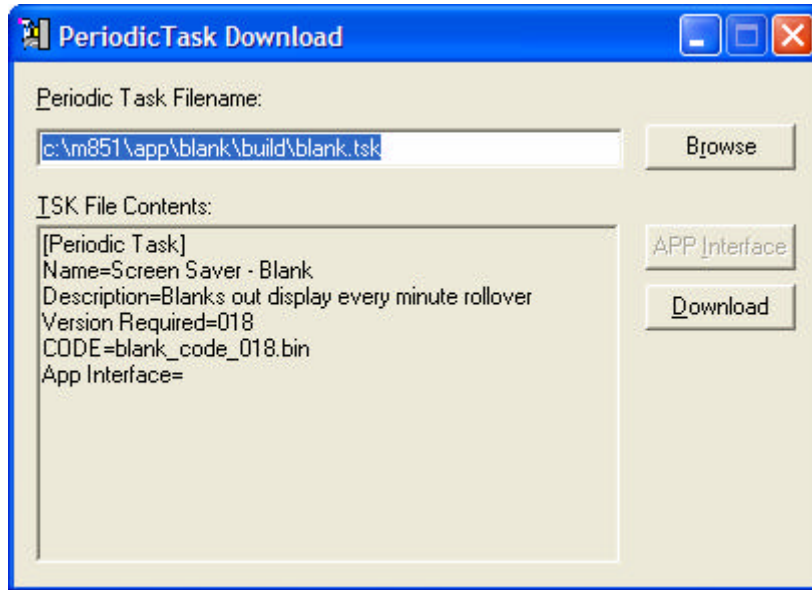
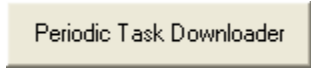
Clicking on the “Analyze Periodic Task” button will open up a window that shows the memory usage of the periodic task and determines if it can fit in the overlay memory area of the M851. A sample display is shown below. The maximum state usage must not exceed the 900 byte limit of the overlay area.

Analyze Periodic Task

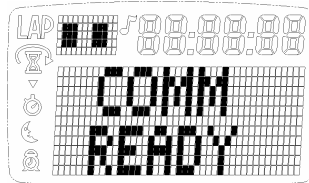


6.4.10 Downloading and Testing the Periodic Task

Clicking on the “Periodic Task Downloader” button will execute the “M851 Periodic Task Download Utility”. Once open, click on the “Browse” button and select the *appname.tsk* indicated in the previous section.



Connect the watch to the PC using the USB cable. Once the watch displays “COMM READY”, click on the “Download” button of the utility.



NOTE: The M851 Periodic Task Download Utility can be executed directly. It is located in the C:\M851\BIN directory.

6.4.11 Creating a Description File

Prepare a description file that will be used by the PIM to describe the periodic task. The filename is the same as the task file name. In this example, the description file is: BLANK.TXT. The text below shows a sample entry for the description file.

PERIODIC TASK: SCREEN SAVER - BLANK OUT

Description:

A "screen saver" for the TOD application. Once activated during a minute rollover, it will clear the display and prevent the TOD application from refreshing the display during updates.

The display will be restored during user switch inputs.

Usage:

NONE

Files:

blank.tsk - application info
 blank.txt - application description (this file)
 blank_code_018.bin - application code

6.4.12 Distributing the Periodic Task

The following files generated by the system and one manually created by the user will be used for distribution of the periodic task.

Filename	Description
<i>application_name.TSK</i>	<i>Information file required by PIM.</i>
<i>application_name.TXT</i>	<i>Description of the periodic task and its operation.</i>
<i>application_name_CODE_018.BIN</i>	<i>Periodic task code.</i>
<i>application_name_DBASE_018.BIN</i>	<i>Periodic task database file.</i>
<i>application_name.DLL</i>	<i>Periodic Task PC interface</i>

The blank periodic task distribution files:

Filename	Description
BLANK.TSK	<i>Information file required by PIM.</i>
BLANK.TXT	<i>Description of the periodic task and its operation.</i>
BLANK_CODE_018.BIN	<i>Screen Saver - Blank code.</i>

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