Technical Manual

Motorola T720 Handset Developer Guide

Version 1.0

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Table of Contents

Introduction

Welcome to the *Motorola T720 Handset Developer's Guide*. This manual contains all the information you need to get started developing software that operates on the Motorola T720 handset.

The Motorola T720 handset information covers the following areas:

- Hardware specifications like displays, processors, memory, and more
- Software specifications like languages, fonts, audio, and more
- Development tools information
- Software development references, guidelines, and instructions

This document assumes that the developer is familiar with the basic principles of programming, the wireless infrastructure, and wireless specifications.

Document History

Version	Date	Author	Comments
Draft (1.0)	9 Dec, 2002	MW MDP	First draft
Draft (1.0)	29 Jan, 2003	MW MDP	Second draft
Final (1.0)	10 Feb, 2003	MW MDP	FC-1
Final (1.0)	27 Feb, 2003	MW MDP	Final release

Overview

The chapters in this manual cover all aspects of developing programs that operate on the Motorola T720 handset. These include:

- *Hardware Environment*–learn the hardware that is available and the capabilities of the processor, memory, networks, and more
- *Software Environment*–learn the software environment in which your programs will operate on the device
- *Development Tools*–learn which development tools are available to make your program happen
- *Developing for the Motorola T720 Handset* –provides the information you need in order to create, debug, download, and package programs
- *Coding Example*–learn how to customize the LWT Button class on the Motorola T720 in this extended code example.

Glossary

Here are definitions of common terms used in this manual:

Term	**Definition**
AMR	Adaptive Multi Rate
API	Application Programming Interface
BREW	Binary Runtime Environment for Wireless
CDMA	Code Division Multiple Access
EMS	Enhanced Messaging Service
GPRS	General Packet Radio Services
GSM	Global System for Mobile Communications
MMS	Multimedia Messaging Service
SMIL	Synchronized Multimedia Integration Language
WAP	Wireless Application Protocol

References

The following references provide information related to developing software for wireless devices in general.

Organization	URL
3GPP	www.3gpp.org
Brew Development	www.qualcomm.com/brew
Infrared Data Association	www.irda.org
JPEG Organization	www.jpeg.org
Motorola Developer Program	www.motocoder.com
Open Mobile Alliance	www.openmobilealliance.org
Qualcomm	www.qualcomm.com
Sun Microsystems	wireless.java.sun.com
WAP Forum	www.wapforum.org
World Wide Web Consortium	www.w3.org

Hardware Environment

This chapter describes the hardware characteristics of the Motorola T720 handset. Use it to understand the hardware environment in which your software will operate.

Hardware Overview

The Motorola T720 mobile phone represents the latest generation of 2.5G capable mobile phones from Motorola. For domestic USA and European markets, the Motorola T720 uses GSM/GPRS wireless communications. The Motorola T720's built-in J2ME™ environment executes the Java™ applications that you write and customers download to the phone. For Asian and South American markets, a version using CDMA is available that uses BREW to write and support applications.

Supported Networks

The Motorola T720 handset supports these networks:

- GSM 900/1800 (EMEA)
- GSM 850/1900 (Americas)
- GPRS (General Packet Radio Service) packet data
- CDMA 800/1900 and 800 AMPS TriMode (Asia, S. America)
- CDMA 1XRTT

GSM Networks

The Motorola T720 uses GPRS wireless technology (in the US and European Union versions) to manage voice calls and transfer data. Four channels are allocated for downstream data, and one channel is dedicated to upstream data. This gives the Motorola T720 a theoretical download rate of 54 Kbps and a theoretical upload rate of 13.4 Kbps. These rates will vary according to the network operator's channel allocation and the signal quality.

CDMA Networks

The Motorola T720 uses CDMA wireless technology (in the Asian and S. American versions) to manage voice calls and transfer data. Two channels are allocated for downstream data, and one channel is dedicated to upstream data. This gives the Motorola T720 a theoretical download rate of 153 Kbps. This rate will vary according to the network operator's channel allocation and the signal quality.

Connectivity

The Motorola T720 handset contains the following connectors:

- USB 1.0
- RS232 serial connection (P2K connector)

The consumer can use these ports to perform synchronization of the phone's contact lists and other personal information to a database on a desktop PC.

Display Info

The physical display characteristics of this Motorola T720 handset are:

Item	**External**	**Internal**
Screen resolution	96 x 32 pixels	120 x 160 pixels
Screen dimensions		28 mm x 38 mm
Pixel pitch		0.237 mm
Color depth	Black and White	12-bit pixels
Maximum Colors	2	4096

The resolution of the interior color screen on the Motorola T720 is 120 by 160 pixels. The interior color screen displays nine lines of text, plus one line of color icons. A “zoom mode” has the screen present 7 lines of enlarged text for easy reading. The Motorola T720 has a second, 96- by 32-pixel black-and-white screen on the outer case. This external screen displays a line of text and status icons, as shown in Figure 1. It allows the user to check on call information without opening the phone.

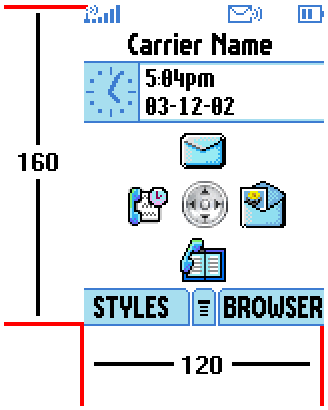


Figure 1. The Motorola T720 internal display.

The Motorola T720's display hardware supports a 12-bit pixel depth, with a screen capable of producing up to 4096 colors. With the larger color range, images on the Motorola T720 appear at a much higher quality than on devices whose display hardware limits the palette to 256 colors.

The Motorola T720 generates a 12-bit color by taking a 24-bit RGB color value and truncating the four least significant bits in the byte that represents each color component. That is, if a 24-bit RGB color has a value of 0xFEE3CE (red: 0xFE, green; 0xE3, blue: 0xCE), the conversion process zeros the bits in each component so that the value becomes 0xF0E0C0 (red: 0xF0, green; 0xE0, blue: 0xC0).

Battery Life

The battery characteristics of the Motorola T720 handset include:

Item	Description
Type	Li Ion battery
Size (slim battery)	80cc, 106g
Slim battery	Type: 550 mAhr Talk Time: up to 156-270 minutes Standby Time: up to 90-170 hours
Standard battery	Type: 750 mAhr Talk Time: up to 210-390 minutes Standby Time: up to 120-230 hours
Extended battery	Type: 1100 mAhr Talk Time: up to 318-540 minutes Standby Time: up to 180-340 hours

Software Environment

This chapter describes the environment of the Motorola T720 handset. Use it to understand the operating system and software environment in which your software will operate.

Java™ Support

This device supports the following Java™ technologies and their respective APIs:

- Java 2 Standard, Micro Edition
- MIDP™ 1.0
- CLDC™ 1.0

Devices that support J2ME development are available for the GSM and GPRS networks.

Java™ 2 Standard, Micro Edition

The Java™ 2 Standard, Micro Edition (J2ME™) is a highly optimized runtime environment targeting a wide range of consumer products, including pagers, cellular phones, screenphones, digital set-top boxes and car navigation systems.

For information and documentation, visit: `wireless.java.sun.com/j2me/`

CLDC 1.0

The J2ME Connected Limited Device Configuration (CLDC) specification consists of the K virtual machine and a core set of class libraries appropriate for use within an industry-defined profile. This configuration is intended for small wireless devices with simplified user interfaces, minimum memory budgets starting at about 128 kilobytes, and intermittent network connections with lower bandwidth.

For information and documentation, visit: `wireless.java.sun.com/configurations/`

MIDP 1.0

The J2ME™ Mobile Information Device Profile (MIDP) lets you write downloadable applications and services for network-connectable, battery-operated mobile handheld devices.

For information and documentation, visit: `wireless.java.sun.com/midp/`

BREW Support

The Binary Runtime Environment for Wireless (BREW) is an open-source on-line application development platform for wireless CDMA devices. BREW is designed to allow developers to write in whatever language they choose. Most native BREW applications are written using C or C++, but BREW supports other programming languages too, such as Java. Using BREW, developers can create portable applications that will work on CDMA devices.

For information and documentation, visit: `www.qualcomm.com/brew/`

WAP Support

The Wireless Application Protocol (WAP) is an open industry standard technology that allows mobile users to access and to interact with information and services easily. WAP makes it possible to link wireless devices (such as mobile phones) to the Internet by translating Internet information so it can be displayed on the display screen of a mobile telephone or other portable device.

The Motorola T720 handset supports:

- WAP specification–WAP 1.2.1
- WML 1.3, xHTML, WTLS Class 2

For information on WAP, visit: `www.wapforum.org`

Display Language Support

The following languages bundles are supported by the Motorola T720 handset:

Bundle ID	Language Bundle
0001	US English
0002	UK English
0003	US English, French Canadian, Spanish Col. Port. Brazil
0004	UK English, French, German, Italian

Bundle ID	Language Bundle
0005	UK English, French, German, Dutch
0006	n/a
0007	n/a
0008	n/a
000A	UK English, Spanish, Portuguese, Greek
000B	UK English, Norwegian, Danish, Swedish
000C	UK English, Swedish, Finnish, Estonian
000D	UK English, Lithuanian, Latvian, Russian
000E	UK English, Polish, Czech, Slovak
000F	UK English, Hungarian, Turkish, Bulgarian
0010	UK English, Serbian, Slovenian, Croatian
0011	UK English, Russian, Ukranian, Romanian
0012	UK English, Arabic, Hebrew, Russian
0014	UK English, Complex Chinese (lite)
0015	US English, Simplified Chinese
0016	US English, Complex Chinese (lite)
0017	US English, French Canadian
0018	US English, Spanish Columbian
0019	US English, Portuguese Brazil
001A	US English, Spanish Columbian, Portuguese Brazil
001B	US English, French Canadian, Spanish Columbian
0020	UK English, French, Arabic, Turkish
0021	UK English, Thai, Vietnamese
0022	n/a
0023	n/a
0024	UK English, Simplified Chinese

Application Language Checking

The Motorola T720 supports the ISO-639A language standard. When writing programs that use a specific language, use these guidelines.

Upon startup, a MIDlet that supports multiple languages should query the handset to determine which display language is supported by that model. If the language is supported, the MIDlet can then use the language; otherwise, it should use the default language (normally English).

NOTE: Due to the ISO language assignments, a query for Traditional Chinese will only return Chinese as a supported language, not the subgroups of Traditional or Simplified Chinese. The program itself must then determine which version of Chinese to use.

Media Support

See the *Creating Media for the Motorola T720 Handset* manual for information on supported media types, which include:

- Messaging support (SMS, EMS 5.0, POP)
- Graphic support (JPEG, GIF, WBMP)
- Ring Tone support (iMelody, MIDI)

If you are creating programs that use any of these media, download the *Creating Media for the Motorola T720 Handset* manual from: `www.motorola.com/developers/wireless.`

Development Tools

This chapter describes the development tools and associated software development kits, and application program interfaces required to create programs that operate on the Motorola T720 handset.

NOTE: There are two different development paths for the Motorola T720 depending upon which network the phone is deployed on. For GSM and GPRS networks, the path to use is J2ME. For CDMA networks, the required path is BREW. This manualonly covers the creation of J2ME applications and the development tools available on the MOTOCODER web site.

Development Tools

Use these development tools and software development kits to write programs for the Motorola T720 handset used on GSM or GPRS networks:

- Motorola SDK for J2ME™
- Metrowerks' CodeWarrior™ Wireless Studio, 7.0
- Lightweight Windowing Toolkit
- Sun One Studio, Mobile Edition
- Java™ 2 Standard, Micro Edition Wireless Toolkit

For more information on all of these tools, visit: `www.motorola.com/developers/wireless`

Motorola SDK for J2ME™

The Motorola Software Development Kit (SDK) for the J2ME platform is the tool used for developing and testing programs written in the Java programming language. The SDK includes applications that make it easy to launch MIDlets (J2ME programs) using the Motorola J2ME device emulator. Together these tools allow you to develop and debug your J2ME programs in emulation before downloading them to a target device. The Motorola SDK can be integrated into Metrowerks' CodeWarrior Wireless Studio 7.0 as well as other development environments

Licensee Open Class APIs

The Motorola Software Development Kit includes several Licensee Open Class (LOC) API packages that make programming specific functionality easier. Just because an LOC is included does not mean it will work on all devices. Always refer to the documentation to find out which mobile devices are supported by a particular LOC.

The table below lists each LOC API and provides a brief description.

Package	Description
com.mot.tcc.media	The Media package provides classes to control a phone's backlight, media player, and vibration.
com.motorola.game	The Gaming package provides classes essential for writing exciting games that run on mobile devices and includes classes for working with screens, sprites, music, sound effects, and much more.
com.motorola.lwt	LWT provides basic interface components that make writing smaller and more powerful user interface easier.
com.motorola.messaging	The Messaging package provides the base interfaces containing functionality common to all messages for implementing derived messaging interfaces.

NOTE: The Motorola T720 only supports the com.motorola.lwt API package.

For more information on the various LOCs; see the JavaDoc documentation that accompanies the Motorola SDK for J2ME.

CodeWarrior Wireless Studio 7.0

Use CodeWarrior Wireless Studio as the development tool for creating world-class applications targeting the J2ME™ and Personal Java™ platforms for smartphones, PDAs, set-top boxes and other Java technology enabled devices.

CodeWarrior Wireless Studio provides an open and customizable Integrated Development Environment (IDE), a state-of-the art project manager and build system, class browser and code navigation system, text editor with code completion, debugger, emulators, support for team collaboration and WYSIWYG -drag and drop application development.

Registered developers can download a copy of CodeWarrior Wireless Studio from `www.motorola.com/developers/wireless/`.

Lightweight Windowing Toolkit (LWT)

The Lightweight Windowing Toolkit (LWT) is a J2ME™ Licensee Open Class (LOC) designed by Motorola to enhance the capabilities of the Mobile Information Device Profile (MIDP). It defines new J2ME classes to implement Buttons, Checkboxes, Sliders, and other user interface widgets. These widgets let application programmers produce applications that are more powerful and more intuitive user interfaces while still keeping the size of the application as small as possible. They also reduce the amount of time needed to write these applications by providing a powerful set of extensible classes ready for use.

Registered developers can download a copy of LWT from `www.motorola.com/developers/wireless/`.

Java™ 2 Standard, Micro Edition Wireless Toolkit

The Java™2 Platform Micro Edition, (J2ME™) Wireless Toolkit is a set of tools that provides application developers with the emulation environment, documentation and examples needed to develop Java technology applications targeted at CLDC/MIDP compliant mobile phones and entry level PDAs.

The J2ME Wireless Toolkit is normally bundled with development toolsets like CodeWarrior Wirelss Studio and Sun One Mobile, but if not, you can download it from: `java.sun.com/products/j2mewtoolkit/`.

Sun One Studio, Mobile Edition

Sun One Studio, Mobile Edition is Sun's integrated development environment (IDE), which provides support for developing mobile applications and comes bundled with the J2ME Wireless Toolkit.

For more info on Sun One Studio, Mobile Edition, visit: `java.sun.com/products/j2mewtoolkit/`.

Developer Training

Online, instructor led courses are available at the Motorola Developer Learning Center for members of the Motorola Developer Program. These courses provide a faster and easier way for you to get up to speed in developing applications that operate on Motorola Java technology enabled devices.

Some of the courses currently available cover the CodeWarrior Wireless Studio development tools as well as Programming the Motorola T720. These courses are available at `www.motocoder.com`.

Developing for the Motorola T720 Handset

This chapter provides the information you need in order to create, debug, download, and packaging of programs written for the Motorola T720 handset.

Developing Programs

This section provides the basic resources available and key mapping information needed to develop applications for the Motorola T720 handset.

Resources Available

This section provides information on the availability of resources for the Motorola T720 handset.

Internal Display	
Resolution	160 x 120
Color Depth	12 bit color (up to 4096 colors)
External Display	
Resolution	96 x 32
Color Depth	Black & white (2 colors)
Networking	
Max HTTP Socket connections*	3
UDP Max Socket connections*	10
UDP Max Buffer Size	1500 bytes
UDP Packet Size	1300 bytes
TCP Max Socket connections*	10
File & RMS	

<table>
<tr><td>Max number of Files/RMS*</td><td colspan="2">~500</td></tr>
<tr><td colspan="3"><b>Java VM</b></td></tr>
<tr><td>Heap Space</td><td colspan="2">512 KB</td></tr>
<tr><td rowspan="2">Program Space</td><td><b>Motorola T720</b></td><td><b>Motorola T720i</b></td></tr>
<tr><td>640K</td><td>512K</td></tr>
<tr><td rowspan="2">Data Space*</td><td><b>Motorola T720</b></td><td><b>Motorola T720i</b></td></tr>
<tr><td>384K</td><td>512K</td></tr>
<tr><td>Recommended JAR Size</td><td colspan="2">50-100 KB</td></tr>
<tr><td>Maximum JAR Size</td><td colspan="2">200 KB</td></tr>
</table>

* These resources are shared with the rest of the phone and there could be less available to Java at any given time.

Zoom In and Zoom Out Modes

The Motorola T720 supports zoom in and zoom out modes on the display. When zoom in mode is selected, the display area is enlarged, reducing the number of visible pixels on the display. The zoom mode is controlled by a user selectable option but is often preset by region distributors. For example, in Asia, zoom in mode is the default setting, whereas in the US, zoom out is the default setting.

Developers should note which region they are writing the program for and adjust the program's UI accordingly to fit. Just as important, you should test the program under both zoom conditions to ensure no clipping of the visible portions of the program occur.

If your program requires the use of one zoom mode over another, it should read and store the current zoom setting, change it as required during execution, and always restore the original zoom zetting upon exit.

Softkey Character Limits

The softkey area at the bottom of the display is divided into three equal sections of approximately 40 pixels each. Any text that appears as a softkey selection must fit within that 40-pixel limit. This limits the number of characters you can use in a softkey to a maximum of six characters per softkey. Failure to follow this guideline can result in clipped softkey text displays.

Key Mapping Information

The key map information for the Motorola T720 handset is as follows:

Key Number (KN)	Key Code (KC)	Game Action (GA)
# (pound)	35	0
* (asterisk)	42	0
0	48	0
1	49	GAME_A
2	50	0
3	51	GAME_B
4	52	0
5	53	0
6	54	0
7	55	GAME_C
8	56	0
9	57	GAME_D
Down Arrow	-11	DOWN
Left Arrow	-12	LEFT
Left Soft Key	-20	0
Right Arrow	-13	RIGHT
Right Soft Key	-21	7
Send (Enter)	-14	FIRE
Up Arrow	-10	UP
- (minus)	-22	0

NOTE: Game Action column shows J2ME-defined constants for game actions.

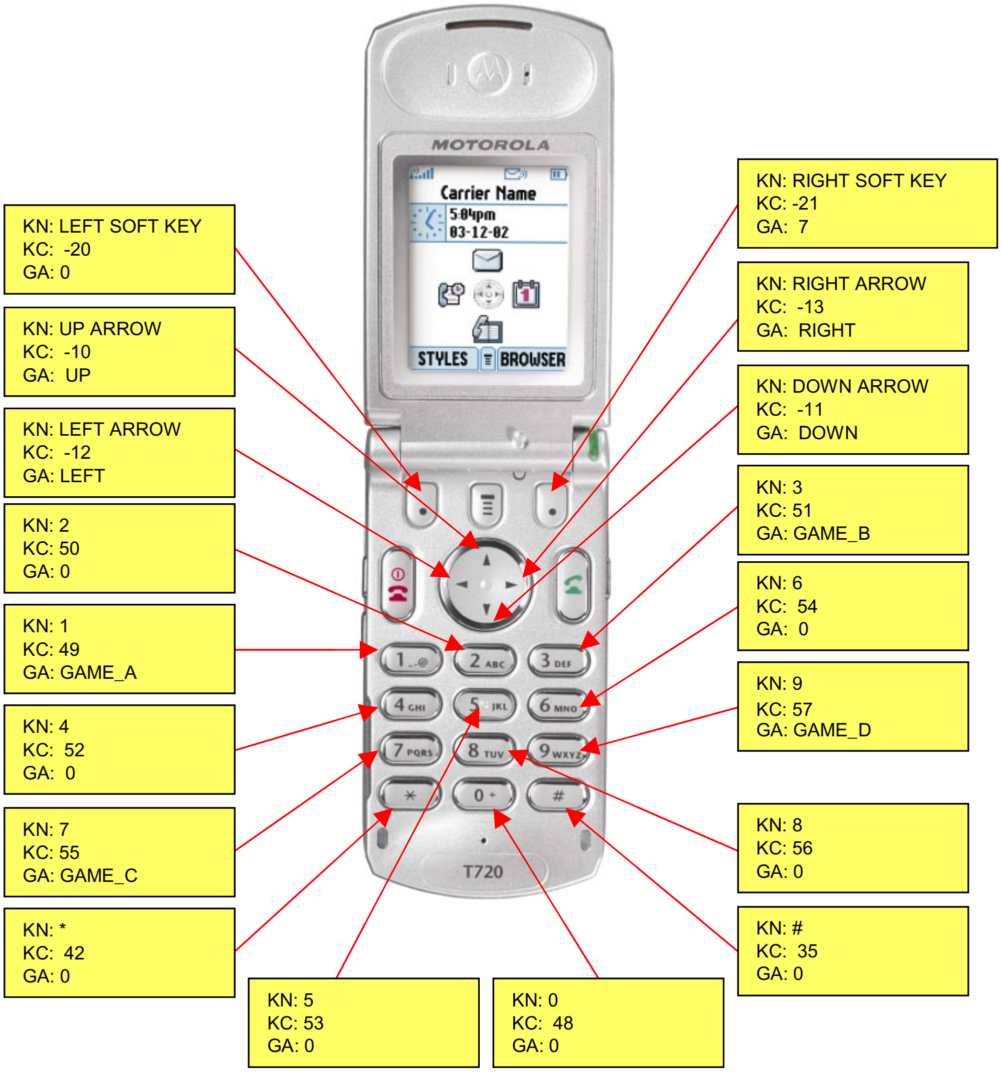


Figure 2. Key Mapping information for the Motorola T720 handset.

Creating Programs

This section explains how to use the CodeWarrior™ IDE to create MIDlets. A MIDlet is a Java™ application that conforms to two specifications defined by Sun® Microsystems:

- the Connected, Limited Device Configuration (CLDC) and
- the Mobile Information Device Profile (MIDP)

These specifications define requirements that Java applications must adhere to in order to run on a mobile device. Mobile devices that can run MIDlets have several common attributes:

- some level of network connectivity
- limited screen size
- relatively low memory
- relatively low processing power

Cellular phones and pagers are good examples of devices that have these characteristics. The CLDC and MIDP specifications address the limitations of these devices.

CodeWarrior Wireless Studio provides two ways to create a MIDlet project. You can create a MIDlet project based on stationery, or you can create a project by using a CodeWarrior wizard. Both of these methods create a project that is configured to use the CLDC and the MIDP.

For more information, see the *CodeWarrior IDE User Guide*.

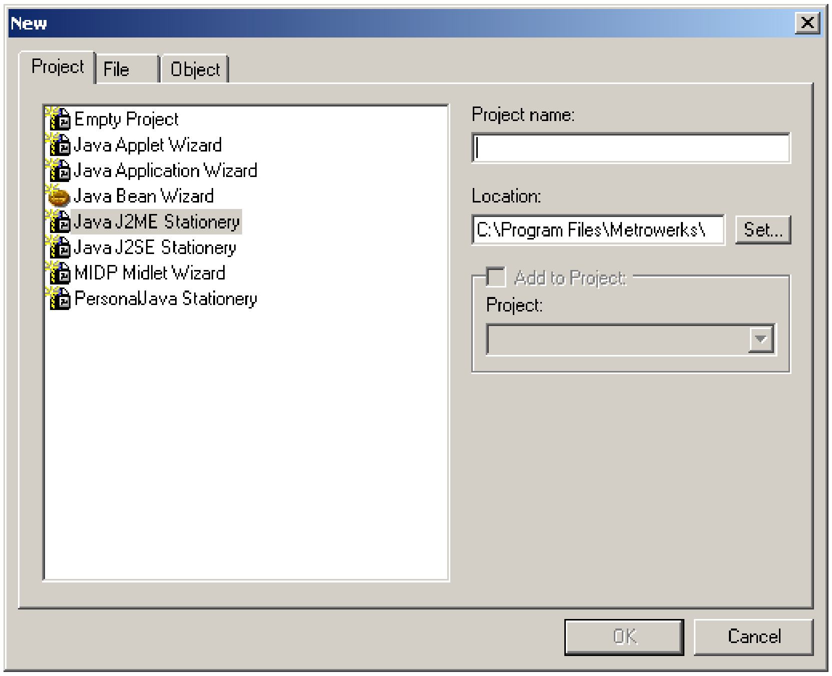
Using MIDlet Stationery to Create a Project

The CodeWarrior IDE includes Java J2ME stationery that contains the base files and default settings required to build a MIDlet project. You can create a new project based on this stationery and then modify project settings and files to suit your needs.

To create a new MIDlet project from stationery:

1 Select File > New from the main menu bar.

The CodeWarrior IDE displays the New window (Figure 3).



Project name:

Location: C:\Program Files\Metrowerks\

Project:

Figure 3. New window

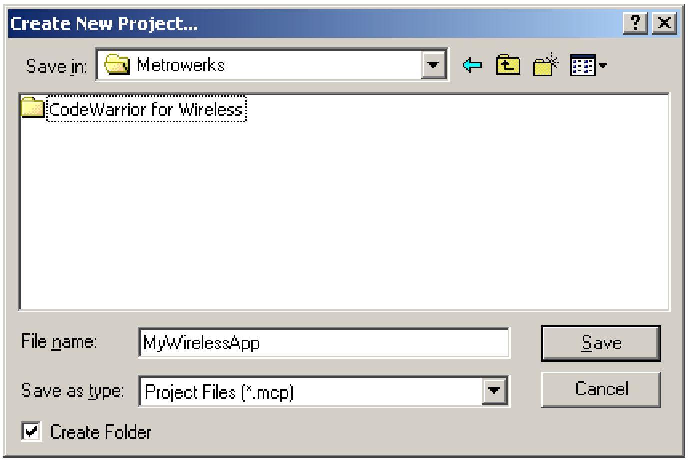
2 Select Java J2ME Stationery.

3 Name the project.

Type a name for the project in the text field labeled Project Name. If you want your project to be recognized by all versions of CodeWarrior tools on all host platforms, the filename extension must be .mcp. If you do not type a filename extension, the IDE automatically adds the .mcp extension to the filename.

4 Specify the project directory

Click the Set... button. The Create New Project... window appears (Figure 4). Browse to the directory where you want the project to be saved.



Save in: Metrowerks

File name: MyWirelessApp

Save as type: Project Files (*.mcp)

☑ Create Folder

Figure 4. Create New Project... window

5 Create a new folder.

Check the Create Folder check box to indicate that you want to create a new folder that will contain all of the project files. The new folder has the same name as the project file without the file extension.

6 Click the Save button to create the new project directory, and return to the New dialog box.

7 Click the OK button.

The IDE displays the New Project window.

8 Click on the tree control (+) to expand the list of Generic stationery.

The New Project window (0) lists the available J2ME stationery. The list varies, depending on which SDKs are installed on your computer and whether you have created your own stationery.

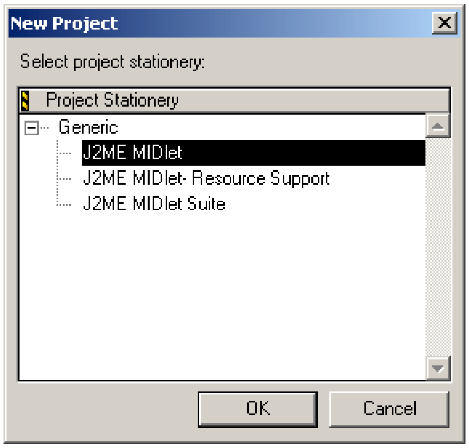


Figure 5. New Project Window Displaying Available J2ME Stationery

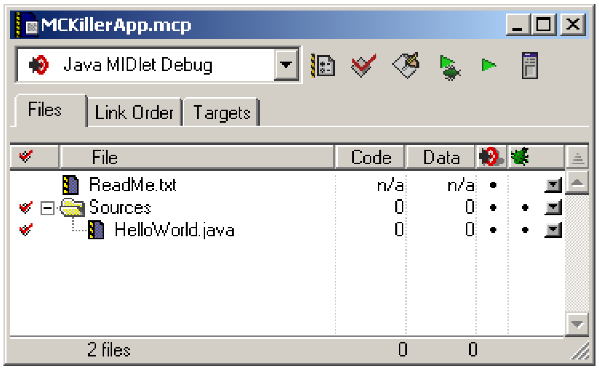
9 Select J2ME MIDlet.

You can select from three different J2ME stationeries. The J2ME MIDlet stationery contains an example of a Hello World MIDlet. The J2ME MIDlet-Resource Support stationery contains an example of a MIDlet that uses resource files. The J2ME MIDlet Suite stationery contains an example of a MIDlet suite that contains multiple MIDlets.

If you want to create a MIDlet that uses graphical user interface (GUI) components, you should create the MIDlet by using the CodeWarrior MIDlet Wizard. For more information about the CodeWarrior MIDlet Wizard, see "*Using the MIDlet Wizard to Create a Project*".

10 Click the OK button.

The CodeWarrior IDE creates project files and a project folder based on the stationery that you selected. The CodeWarrior IDE displays a new Project window (Figure 6).



✓	File	Code	Data		
	ReadMe.txt	n/a	n/a	•	
✓	Sources	0	0	•	•
✓	HelloWorld.java	0	0	•	•
	2 files	0	0		

Figure 6. Project Window displaying project created from J2ME Stationery

The CodeWarrior project manager also creates a directory named *ProjectName* Data, where *ProjectName* is the name of your project. The CodeWarrior IDE uses this directory to store internal data. Do not modify or move any files in this directory.

A project that is created from stationery contains example source files, and other files that provide you with a starting point for your project. You can modify these files and save them with a new name, or replace them with your own files.

Using the MIDlet Wizard to Create a Project

The following procedure shows you how to use the MIDlet Wizard to create a new MIDlet project. The MIDlet Wizard creates a project that is configured for a MIDlet that uses graphical user interface (GUI) components. The project takes advantage of the CodeWarrior RAD tools, which help you create GUI components.

This procedure consists of the following sections:

- The New Window
- MIDlet Wizard - Page 1 of 3
- MIDlet Wizard - Page 2 of 3
- MIDlet Wizard - Page 3 of 3
- MIDlet Wizard - Summary

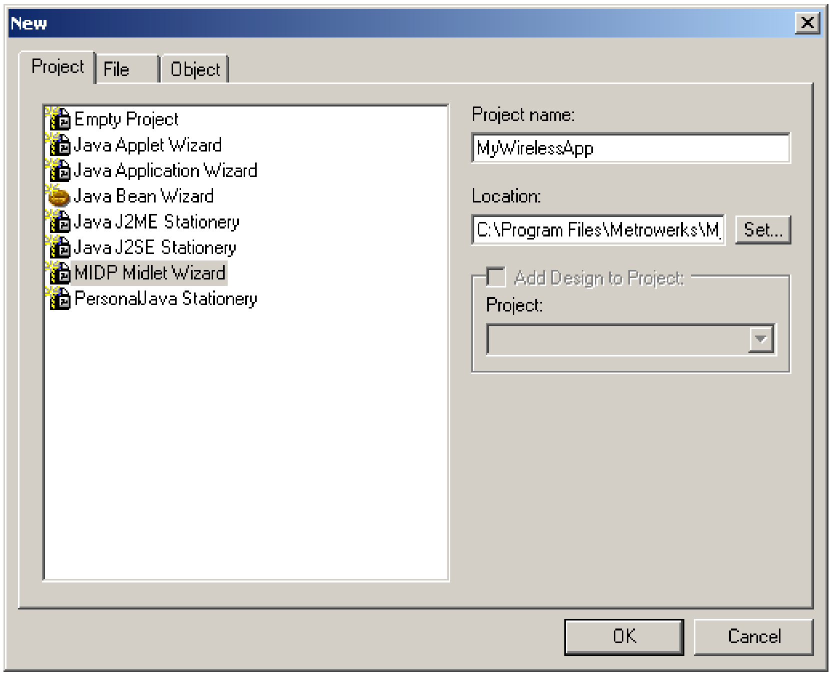
The New Window

The New window (Figure 7) is where you specify the name and location of the new CodeWarrior project. You also specify the wizard to use to create the new project.

To start the MIDlet Wizard:

1 Open the New window.

Select File > New from the main menu bar. The IDE displays the New window (Figure 7).



Project name: MyWirelessApp

Location: C:\Program Files\Metrowerks\M

□ Add Design to Project:

Figure 7. New Window

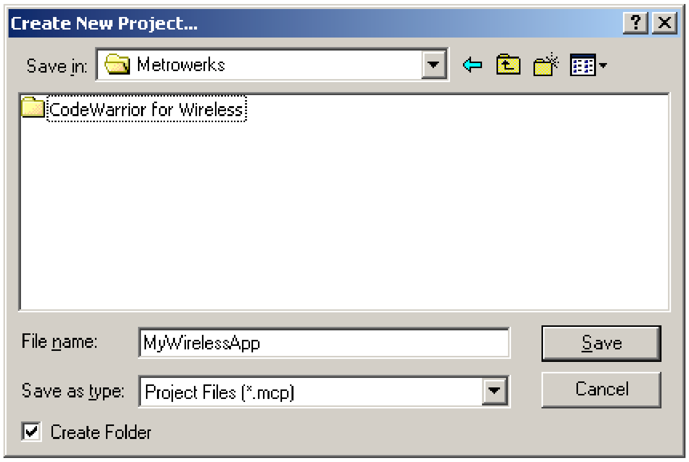
2 Select MIDP Midlet Wizard.

3 Name the project.

Type a name for the project in the text field labeled Project Name. If you want your project to be recognized by all versions of CodeWarrior tools on all host platforms, the filename extension must be .mcp. If you do not type a filename extension, the IDE automatically adds the .mcp extension to the filename.

4 Specify the project directory.

Click the Set... button. The Create New Project... dialog box appears (Figure 8). Browse to the directory where you want the project to be saved.



Save in: Metrowerks

File name: MyWirelessApp

Save as type: Project Files (*.mcp)

☑ Create Folder

Figure 8. Create New Project Dialog Box

5 Click the Save button.

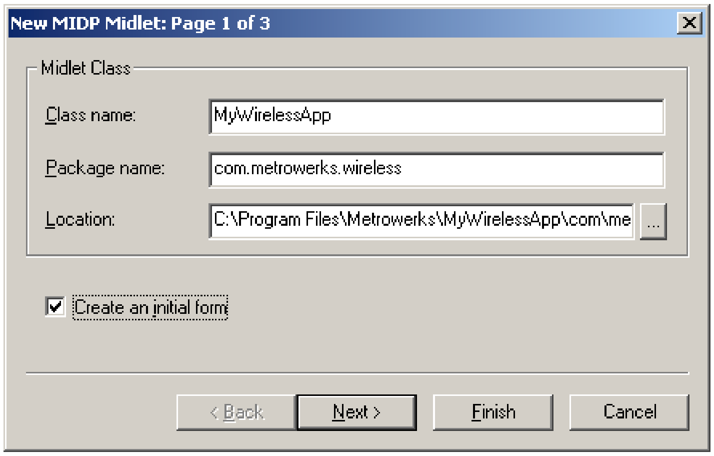
The IDE saves the location and returns to the New window.

6 Click the OK button.

The IDE displays the New MIDP MIDlet: Page 1 of 3 window (Figure 9).

MIDlet Wizard - Page 1 of 3

The first page of the wizard (Figure 9) lets you define basic properties of the MIDlet, such as the class and package name. Fill in the appropriate fields and click Next button to show the next page of the wizard.



New MIDP Midlet: Page 1 of 3

Midlet Class

Class name: MyWirelessApp

Package name: com.metrowerks.wireless

Location: C:\Program Files\Metrowerks\MyWirelessApp\com\me

☑ Create an initial form

Figure 9. New MIDP MIDlet: Page 1 of 3 Window

The components found in Page 1 of 3 include:

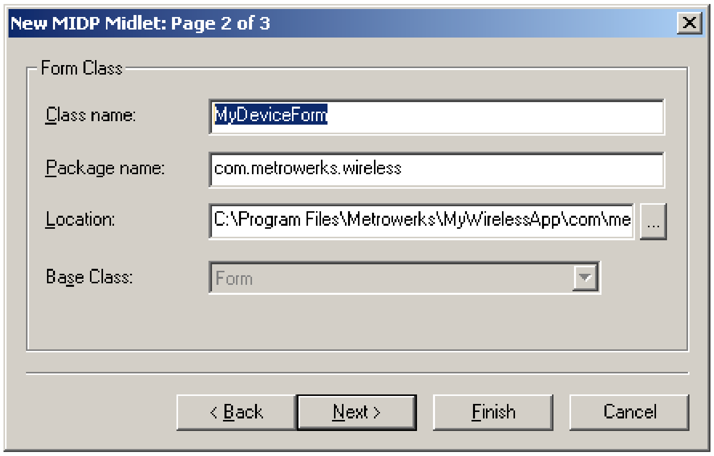
Component	Description
Class name	Type the name of the main class for the new MIDlet.
Package name	Type the name of the package for the new MIDlet.
Location	Type in a new location or click the … button to the right of the text field to choose a new location.
Create an initial form	Check this box to have the wizard create a form for the application. The form inherits from the following class: `javax.microedition.lcdui.form`

NOTE: If you did not check the Create an initial form check box, the IDE does not show you the Wizard’s Frame Class configuration page. In this case, skip to “MIDlet Wizard - Page 3 of 3” on page 84 for the next step of this procedure.

MIDlet Wizard - Page 2 of 3

Page 2 of 3 (Figure 10) of the wizard lets you specify information about the form class for the MIDlet. Fill in the appropriate fields and click Next button to show the next page of the wizard.

NOTE: Skip this section if you did not check the Create an initial form check box in the MIDlet Wizard - Page 1 of 3.



New MIDP Midlet: Page 2 of 3

Form Class

Class name: MyDeviceForm

Package name: com.metrowerks.wireless

Location: C:\Program Files\Metrowerks\MyWirelessApp\com\me

Base Class: Form

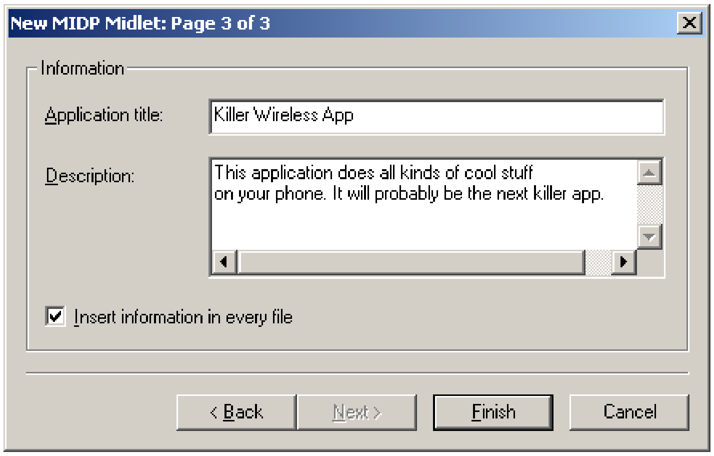
Figure 10. New MIDP MIDlet: Page 2 of 3

The components found in Page 2 of 3 include:

Component	Description
Class name	Type the name you want to use for the form class.
Package name	Type the name of the package for the new form class.
Location	To change this location, either type in a new location or click the button to the right of the text field to choose a new location.
Base Class	The base class for the form class can only be the Form class. You do not need to set the Base Class.

MIDlet Wizard - Page 3 of 3

This page of the wizard (Figure 11) contains information that the IDE can insert into each of the source code files it generates. Fill in the appropriate fields and click Finish button to show the Summary page of the wizard.



Application title: Killer Wireless App

Description: This application does all kinds of cool stuff
on your phone. It will probably be the next killer app.

☑ Insert information in every file

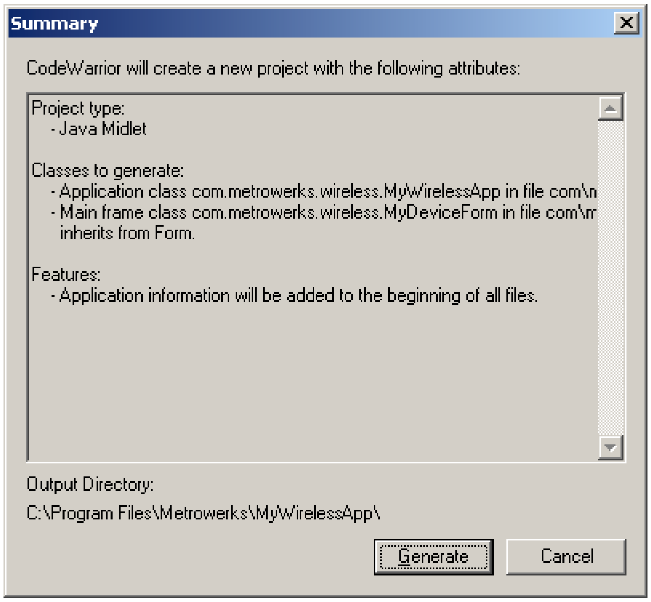
Figure 11. New MIDlet MIDlet: Page 3 of 3

The components found in Page 3 of 3 include:

Component	Description
Application	Type the title for the MIDlet. The IDE inserts this text into the Title comment at the start of the generated source code files for the application. The target device uses this title as the name of your MIDlet.
Description	Type a description of the application. The IDE inserts this text into the Description comment at the start of the generated source code files for the application.

MIDlet Wizard - Summary

To complete the wizard and generate the project just review the attributes that you have specified, then click the Generate button. The CodeWarrior IDE creates the project files and a project folder for a new MIDlet project. The CodeWarrior IDE displays a new Project window (Figure 4.11).



CodeWarrior will create a new project with the following attributes:

Project type:
- Java Midlet

Classes to generate:
- Application class com.metrowerks.wireless.MyWirelessApp in file com\n
- Main frame class com.metrowerks.wireless.MyDeviceForm in file com\m
  inherits from Form.

Features:
- Application information will be added to the beginning of all files.

Output Directory:
C:\Program Files\Metrowerks\MyWirelessApp\

Figure 12. Project Window for MIDlet Project Created by the MIDP MIDlet Wizard

The IDE also opens three other windows: the Component Palette window, the Object Inspector window, and the RAD canvas window. For more information about using these windows, see “Java MIDP Components” on page 145 and the IDE User Guide.

Preverifying a MIDlet

Due to memory and processing power available on a device, the verification process of classes are split into two processes. The first process is the preverification which is off-device and done using the preverify tool. The second process is verification, which is done on-device.

The byte code preverifier tool rearranges byte codes in the classes to simplify the final stage of byte code verification on the CLDC virtual machine. The preverifier tool also checks for the use of virtual machine features that are not supported by the CLDC.

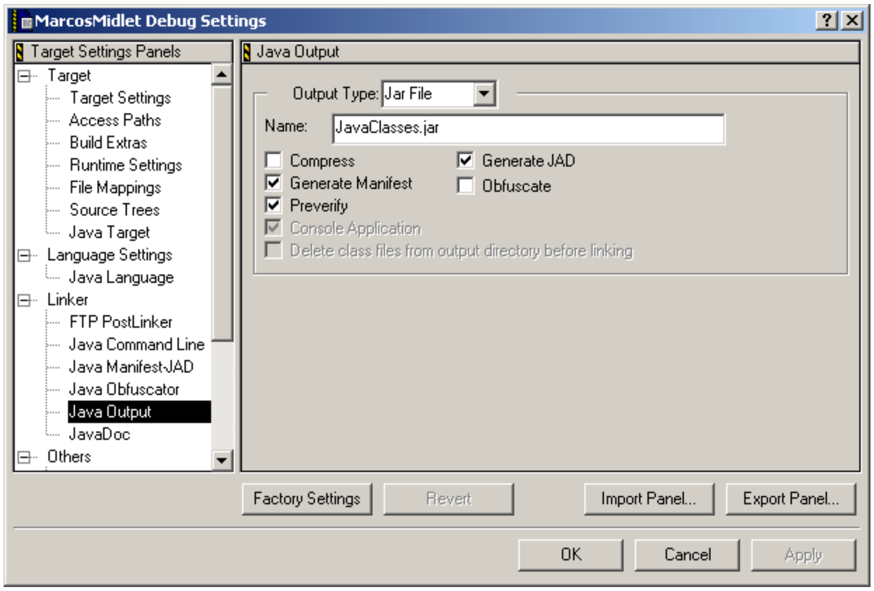
To preverify a MIDlet:

1 Open the Target Settings window.

Select Edit > *TargetName* Settings from the main menu bar (where *TargetName* is the name of the current build target). The IDE displays the Target Settings window.

2 Access the Java Output settings panel (Figure 13).

Select Java Output in the Target Settings Panels list on the left side of the window. The IDE displays the Java Output settings panel.



Output Type: Jar File

Name: JavaClasses.jar

☐ Compress ☑ Generate JAD

☑ Generate Manifest ☐ Obfuscate

☑ Preverify

☑ Console Application

☐ Delete class files from output directory before linking

Figure 13. Java Output Settings Panel with Preverification Enabled

3 Check the Preverify check box.

4 Click on the Apply button.

The IDE saves the change to the target settings for this build target. The next time that you build the build target, the IDE will run the preverification tool against the MIDlet.

Selecting a VM and Simulator

Before you can run a MIDlet, you need to specify the virtual machine (VM) and simulator the IDE uses to run the MIDlet.

To select a VM and simulator:

1 Open the Target Settings window.

Select Edit > *TargetName* Settings from the main menu bar (where *TargetName* is the name of the current build target). The IDE displays the Target Settings window.

2 Access the Java Target settings panel (Figure 14).

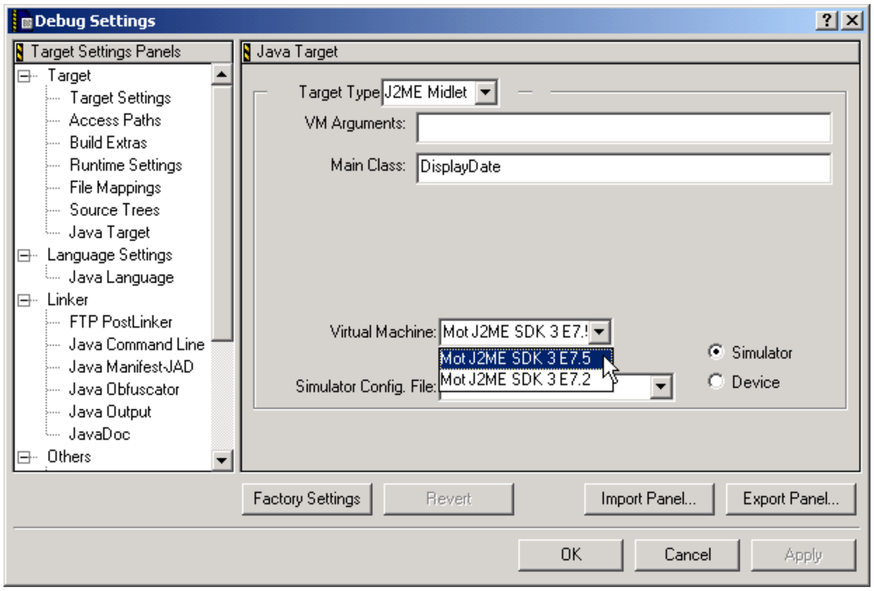
3 Select a VM from the Virtual Machine drop list.

The virtual machine listing lets you select from any installed VM.

4 Select a simulator from the Simulator Config. File drop list.

The Simulator Config. File listing lets you select any simulator that operates with the selected VM.

5 Click the Apply button.



Target Type: J2ME Midlet

VM Arguments:

Main Class: DisplayDate

Virtual Machine: Mot J2ME SDK 3 E7.5

Simulator Config. File:

● Simulator

○ Device

Figure 14. Java Target settings panel with Virtual Machine list

Running a MIDlet

To run a MIDlet:

1 Make sure the MIDlet project is open in the Project window.

2 Make sure the current build target is the one you want to run.

3 Select Project > Run from the main menu bar.

The CodeWarrior IDE starts the VM you specified in Java Target settings panel, and runs the MIDlet in that VM.

Debugging Programs

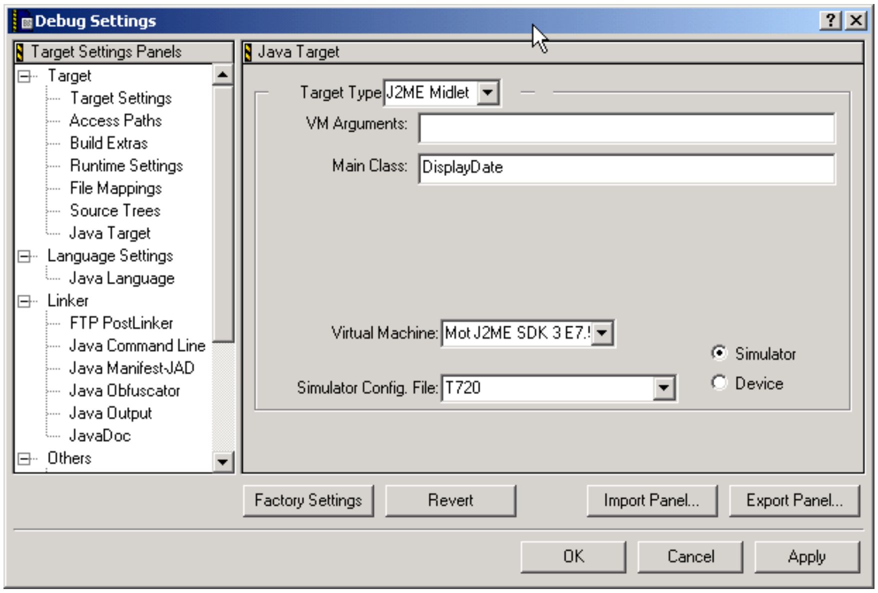
CodeWarrior Wireless Studio supports the low-level debugging of Java projects, however, direct on-device debugging is not supported. Instead, you must use the Motorola T720 Simulator available in the Motorola SDK for J2ME to debug your Java programs.

For information on the CodeWarrior Debugger, see the *CodeWarrior IDE User Guide*. For information on debugging Java projects, see the *CodeWarrior Wireless Studio* manual. Both are available in PDF format on the CodeWarrior Wireless Studio CD.

MIDlet Debugging Setup

In CodeWarrior Wireless Studio, use the Java Target settings panel (Figure 15) in the Target Settings window to specify:

- **Virtual Machine:** Mot J2ME SDK 3 E7.5
- **Target device:** Simulator
- **Simulator Config. File:** Motorola T720



Debug Settings

Java Target

Target Type J2ME Midlet

VM Arguments:

Main Class: DisplayDate

Virtual Machine: Mot J2ME SDK 3 E7.!

Simulator Config. File: T720

● Simulator

○ Device

Figure 15. Java Target settings panel showing debug setting for Motorola T720

Debugging a MIDlet

To debug a MIDlet using the CodeWarrior IDE:

1 Make sure the MIDlet project is open in the Project window.

2 Make sure the current build target is the one you want to debug.

3 Makes sure the Java Target setting panel options for Virtual Machine, Simulator, and Simulator Config. File are set correctly.

4 Select Project > Debug from the main menu bar.

The CodeWarrior IDE starts the VM you specified in Java Target settings panel, runs the MIDlet in that VM, then halts execution in the CodeWarrior Debugger.

Downloading Programs

This section explains how to download a MIDlet program to the Motorola T720 handset.

Serial Downloading

By default, the serial downloading of programs is disabled on Motorola T720 handsets. It is recommended that you use OTA instead to load programs on the device for testing.

Over the Air (OTA) Downloading

You can download Java™ MIDlets from any web server as long as that server understands the Java Archive (JAR™) and Java Descriptor (JAD™) file MIME types. The MIME type descriptors to use are:

- JAD files: `text/vnd.sun.j2me.app`
- JAR files: `application/java-archive`

For more information, check your web server documentation.

CodeWarrior Wireless Studio produces both the JAR and JAD output files when compiling a Java project. The JAD file contains a `MIDlet-Jar-URL` line, which automatically points to the program's location while under development. This is the wrong location once you move the JAR file (e.g. by loading it onto a server for download).

For example, if the program `mytest.jar` is uploaded to the test directory of `www.testserv.com`, then the JAD file's `MIDlet-Jar-URL` line needs modification. Where it once said:

```
MIDlet-Jar-URL: C:\Program Files\MyTest\mytest.jar
```

You modify it to read:

```
MIDlet-Jar-URL: http://www.testserv.com/test/mytest.jar
```

Once the JAD is correctly modified, both files can be uploaded to the web server. After that, the MIDlet is available for downloading from the web server just as any other file stored there. At this point, you can just key in the URL to the JAD file on the handset to download it.

Continuing with the above example, you would type this URL into your WAP browser to access the MIDlet:

```
http://www.testserv.com/test/mytest.jad
```

NOTE: JAR files cannot be downloaded directly onto phones. The only way to properly install MIDlets is to download the JAD files, which then download the JAR for you. If you set up an index page to allow MIDlet downloading, be sure your links point to the JAD files and not the JAR files.

For more information on downloading files using a WAP Browser, see the *WAP SDK Browser User Guide*.

Installing Programs

This section provides a program checklist, and information on the running and exiting programs on the Motorola T720 handset.

Installation Checklist

Here is a checklist of items to review before attempting to download a program to the Motorola T720 handset for testing. Following this checklist will ensure that you don't waste testing time.

Application checklist:

- JAD file was created
- JAD file's `MIDlet-Jar-URL` attribute correctly modified (See Over the Air (OTA) Downloading for a description of this process.)
- JAR file contains `META-INF/MANIFEST.MF`
- Verify `MIDlet-Name`, `MIDlet-Version,` and `MIDlet-Vendor` attributes are duplicated in both `MANIFEST.MF` and the JAD file
- Both JAD and JAR files have identical names (except for extensions)
- Names for JAD and JAR files are less than 32 characters (including extension)
- Less than 20 MIDlet suites are currently installed
- Maximum length of class path name inside JAR file is less than 64 characters
- Maximum length of URL path is less than 256 characters
- No more than ~500 files are used by the installed MIDlet suites
- JAR size listed in JAD matches actual JAR file size
- MIDlet suite version must be higher than an already installed version

Installation Troubleshooting

You may encounter one or more of the following errors while attempting to install an application:

- **Insufficient Memory**–There is not enough data space (file system space) to store the JAR file. Try removing other applications to free up data space so you can upload the new JAR file.
- **Memory Full**–There is not enough heap space to uncompress and run the JAR file. The JAR size should be predefined as a portion of heap space, typically no more than 100K. If larger than 100K, the MIDlet normally cannot be installed and run.

Note, there are exceptions to this size limitation, typically related to the number of class files versus resource files in the JAR file.

- **Memory Full**–There is not enough data space to both install the JAR file and store MIDlet resources. There must be enough room to both uncompress the JAR file in heap space and store the resources associated with it in data space. Once uncompressed into a MIDlet, the JAR file is deleted. Note that the total size of the uncompressed resources may differ from the data space required by the MIDlet once it is installed.
- **Not enough Program Space**– There is not enough program space to store the MIDlet. A MIDlet requires more storage space than a JAR file because it is stored on the device in uncompressed form, normally as a DAV Object. DAV reserved additional space for the MIDlet equal to the largest DAV Object. This reserved space cannot be used to store other MIDlets. Instead, it provides power loss protection during a DAV reclaim of flash memory.

Starting Applications

Many times a MIDlet suite contains one MIDlet. If so, the MIDlet can be launched from the Games & Apps menu by highlighting the MIDlet suite and pressing the SELECT soft key.

If there are multiple MIDlets in the suite, then a suite content menu is displayed. Choose one of the individual MIDlets, and then press the RUN soft key to launch the selected MIDlet.

Exiting Applications

During the development process, chances are a MIDlet may not exit properly. If a program becomes unstable or fails to respond during the development process, you can end the program by pressing the END soft key.

Removing Applications

Use the standard menu commands on the Motorola T720 to remove a program once you are finished using it.

Packaging Programs

When developing applications, there are two situations to be aware of when packaging your applications for loading on the device.

- **Accessing external libraries or resources**–in this situation, make sure that all the necessary libraries and resources are placed in the JAR file so that the application has access to them on the device.
- **Duplicate external class libraries**–when packaging your application, be sure that any external class libraries already available on the device's KVM are not duplicated in the JAR file. This prevents your application from using scarce program space to duplicate already available functionality.

Troubleshooting

This section describes some common troubleshooting issues and their solutions.

Title	Applications consume more space on the Motorola T720 than other devices.
Problem	The application consumes much more size when downloaded to Motorola T720 devices or use Motorola T720 emulator. The Motorola i95cl (actual device as well as emulator) uses approx 340KB of heap. Motorola's Motorola T720 emulator, the exact same MIDlet uses over 900KB of heap!
Solution	Image files take up twice as much space in the emulator as they should. Image files will be substantially larger under the emulator since they are stored as 24-bit true color images instead of the 12-bit images that would be stored on the phone. We recommend increasing the heap size of the emulator as a workaround. The heap size can be changed in the Motorola T720.props file in the 7.5 emulator installation. Although image files take up the correct amount on space on the “real” phone, you will encounter other problems there. On the real Motorola T720 phone an installed MIDlet requests twice as much memory as it needs so you might run into more problems.

Title	An application installed on the device takes permanent space for existing on the device.
Problem	When an application is installed to a device, it consumes the device's space. Does this application take that program space permanently in order to exist on the handset, or just temporally in order to install on the handset?
Solution	After the application has been installed on the phone, it exists there. Normally, the installation of an application to the phone takes 3 steps: 1. Decompression if your JAR file is compressed; 2. Verificaton: the class files are verified to ensure that the class files come from a trusted source; 3. Transformation: After the application has been verified, it is transformed from the application class files into a device specific internal representation. This allows the application to be launched and executed faster than loading the raw class files. The transformed file (and associated resources) is stored in the FLASH file system on the device.

Title	OTA installation failed on Motorola T720.
Problem	While downloading an application to the Motorola T720, an OTA failed message comes up:"File corrupt". Does this mean the JAD/manifest files are incorrect, class files are not correctly preverified…etc.?
Solution	In the event you experience problems, check the following: 1. Make sure ALL the fields in JAD file are EXACTLY IDENTICAL to the fields in the manifest inside the JAR. And I mean *EXACTLY*. If you have a white space after the Vendor name, for example, it wouldn't work... 2. Make sure the size is ok If it still doesn't work, try to upgrade the firmware. For firmware V8, sometimes it has problem to download some MIDlets but these MIDlets are installed fine on V11.

Title	Phone issues a “file corrupt” error when installing program.
Problem	MIDlet operates fine in simulator but the phone issues a “file corrupt” error when attempting to install the program
Solution	The PNG files in the MIDlet may contain meta-data, which the VM on the phone cannot handle. This meta-data is attached to the PNG by some graphic programs and is most often seen with images from digital cameras. The image meta-data can include data like F-stop settings, flash setting, resolution, and a host of other information. To determine if image meta-data is the problem, try removing the PNG images from the MIDlet and re-installing on the phone. If the error does not appear, the PNG images will need replacing with versions that do not contain meta-data.

Title	Determining the font size used in the Motorola T720 in various regions.
Problem	Different regions use different font sizes in the device. A program needs to consider the font size when it comes to drawing to the screen to avoid display errors.
Solution	You can use the Java method `Font.getHeight()` to determine the size of the visible font for all regions. The method returns the standard height of a line of text in the current font. The returned value represents the sum of two different values: font height plus leading. Font height is the actual height of the characters in the font and leading is the separation, or distance between two different lines of text as intended by the font designer and the device. The leading always occurs below the text. The returned font height value also takes into account the "zoom in" or "zoom out" mode setting of the device. The zoom mode is set by the user and independent of the Java environment. For example, a font that is returned as 14-points in "zoom out" mode may be returned as 18-points in "zoom in" mode.

Coding Example

This chapter explores how you can extend the capabilities of the Lightweight Windowing Toolkit's (LWT) Button class to enhance a program with unique components. It is not meant to be a tutorial on LWT or using the Button class, but to demonstrate how easy it is to expand LWT for special purposes.

Button Overview

The program displays several LWT Buttons and two custom RoundButtons on the device's screen. You use the navigation keys to select the different Buttons. Note how the button's appearance changes as it gains focus. Press the Enter key to actuate the Buttons or RoundButtons. You will see how to customize this class to make a unique button design, while inheriting many of the features of the Button class. Finally, you will see that there are many ways to arrange LWT components on a mobile information device's (MID) screen.

The objectives for this code example include:

- To build an example program that displays several Button objects
- To examine example code that extends the Button class to make a round button
- To change the various characteristics of buttons, such as whether they are enabled or visible
- To change the offset fields of particular buttons and observe how their arrangement changes on-screen
- To see how to implement both an LCDUI command listener and LWT component listener in the same application

Download the complete LWT Button source code (called `button.zip`) from the MOTOCODER web site: `www.motorola.com/wireless/developers`.

Characteristics of LWT Buttons

One of the most valuable capabilities of the Motorola LWT is that it provides a toolbox of ready-made user interface (UI) components. You use these components to implement the interface to your mobile application.

This lesson demonstrates the capabilities of one LWT UI component, the Button class. The Button class provides a simple and effective way to add interactive buttons to your application's interface. LWT buttons have the following features:

- They can have different, descriptive labels. Within limits, a button automatically resizes itself to accommodate the text string that makes up the label.
- They can be placed on the screen using a variety of offset schemes. Such offsets schemes are relative to the screen, or from other LWT components. If the UI is carefully designed, these offset schemes allow the buttons to adapt to a screen of a different size automatically.
- They can be enabled or disabled under program control. A disabled button does not respond to user events. Its appearance will also be slightly different to indicate that it is disabled.
- They can be made visible or invisible under program control. Because the user can't interact with it, an invisible button is disabled.
- They have two interactive states: normal and pressed. Each state has a different appearance to provide visual feedback to the user. A pressed button changes appearance and sends an actuate event to the application. The actuate event signals the application that the operation that the button represents must be carried out.
- They can be customized. Unlike most LCDUI objects, LWT component classes can be extended to customize their appearance, or to add a unique behavior in response to user events.

The MIDlet used for this lesson shows how to use the LWT Button class. It also shows how to customize a button. For this lesson an example class, RoundButton, extends the Button class to display a round button. Normally, LWT buttons are rectangular.

Let's start by seeing how LWT buttons function within a mobile application.

NOTE: If you haven't already done so, download the Button sample program from the MOTOCODER site, then launch CodeWarrior Wireless Studio and open the Button.mcp file.

Step 1: Build the Button project

Go to the Button directory and double-click on the project file Button.mcp. This opens the Project window. Ensure that the Java MIDlet Debug build target is selected in the pull-down menu. Issue the Debug command (Project | Debug) to compile and link the program and launch the debugger. If there are no errors, the phone simulator window appears, followed by the debugger's Thread window.

Step 2: Run the MIDlet

Issue a Run command (Project | Run) to start the program under debugger control. The phone simulator's screen should display an array of buttons, and resemble Figure 16. There should be three rectangular buttons, and two round buttons. One of the round buttons should be partially off-screen.

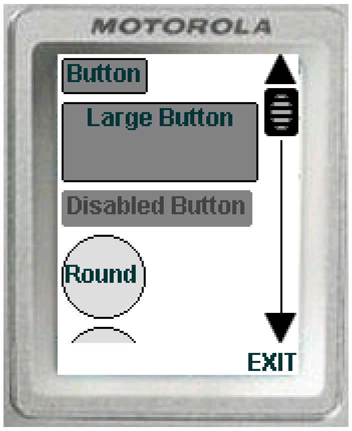


Figure 16. The simulator displaying LWT buttons.

You'll notice that where LWT objects can't fit entirely on the screen, the LWT displays a scrollbar at the right of the screen. You can't interact with the scrollbar; it's used to indicate that some of the application's UI is off-screen. You use the navigation button to see these hidden UI elements.

Step 3: Observe the button's behavior

Click on the Motorola T720's navigation button or use the keyboard's arrow keys to navigate down the screen. The first click on the navigation button's down arrow causes the small button at the top of the screen to display a small border (Figure 17). This border indicates that the button has focus, or focus ownership.

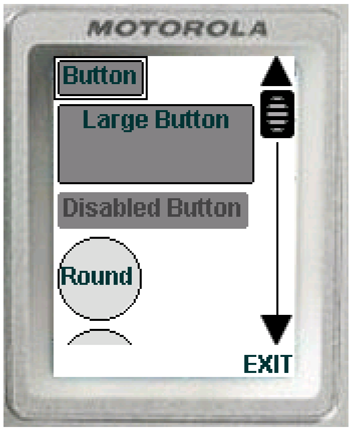


Figure 17. The first button has focus ownership, as indicated by the border.

Focus defines where an LWT component receives key events from the device. In the case of a button, there's not much in the way of key events to process, but it's important for, say, an LWT TextArea component where the user must rely on the phone's keypad to enter text.

NOTE: An LWT component receives focus only if it is visible, enabled, and its acceptKeyFocus field is set to true. You might set this field to false to use the button as an ornament in a screen design, rather than as a functional control.

Press on the phone simulator's End key (which represents the LWT's Enter key) and hold it down. Watch what happens to the button (Figure 18). Release the key, and the button reverts to its normal state.

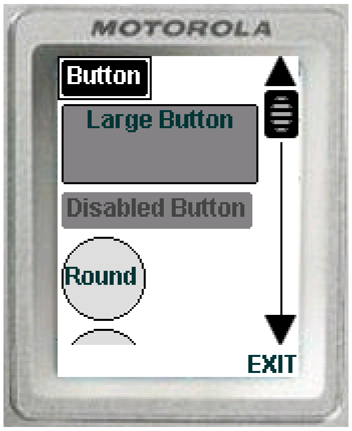


Figure 18. The LWT button when the Enter key (the End button) is pressed.

The highlighting that occurs indicates that the button has received and accepted an Enter key press. This different appearance represents the button's pressed state. Clicking the button itself will demonstrate the same behavior. The button is providing feedback that helps the user operate the program. When pressed, the button sends an actuate event to its listener.

Step 4: Observe the change of focus ownership

Press on the navigation button's down arrow two more times. With each key press, the focus ownership moves to the next enabled button. You'll notice that the focus skips the disabled button (the button third from the top) to select the first round button (Figure 19).

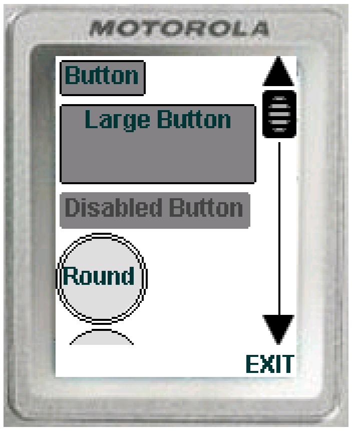


Figure 19. The focus ownership has moved to the round button.

Now press the down arrow on the navigation button once more, so that the second round button receives focus ownership, as shown in Figure 20.

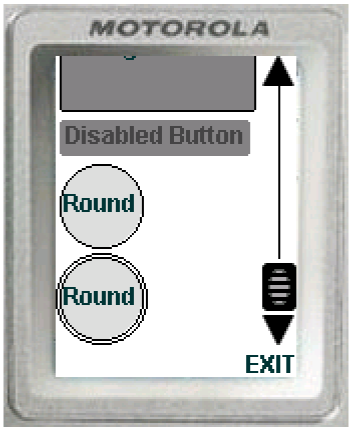


Figure 20. **The second round button has focus ownership. Note that the screen has scrolled.**

Observe how the screen has automatically scrolled to fully display the second button. This vertical scrolling is a feature provided by the LWT. If you press the down arrow on the navigation button again, the focus jumps back to the topmost button on the screen. The screen also scrolls back up to the top, so that you're looking at a screen that resembles Figure 17. Try using both the up and down arrows to move the focus ownership among the various buttons.

NOTE: The LWT reserves the vertical scrollbar to maneuver through the visible screen components. You use horizontal scrollbars to implement sliders. However, you can extend the LWT's components to process up, down, left, and right key events. You would do this to implement a game or a special-purpose vertical market application.

Press the Exit soft key to quit the MIDlet and terminate the debugger session.

RoundButton Class Code Tour

Now that you understand how LWT components handle focus ownership and provide desktop-quality visual feedback in response to events, let's take a tour of the code that makes use of the Button class to implement the RoundButton class. The RoundButton code shows you how easy it is to extend an LWT component. Start by double-clicking on the file Buttons.java in the Project window to open the file in the editor.

```
import java.io.*;
import javax.microedition.midlet.*;
import javax.microedition.lcdui.*;
import com.motorola.lwt.*;

// The RoundButton class. Draws a round LWT button.
// Inherits the rest of its capabilities (such as
// key events) from the Button class.
```

```
public class RoundButton extends Button {

  String label;                  // The Button's text

  /**
   * Constructs a RoundButton with no label.
   */
  public RoundButton() {
      this("");
  }

/**
   * Constructs a RoundButton with the specified label.
   * @param label the label of the button
   */
  public RoundButton(String label) {
  int x, y;

      this.label = label;
      x = getPreferredWidth();
      y = getPreferredHeight();
      setBottomEdge(HEIGHT, x);  // note use of width
      setRightEdge(WIDTH, x);
      preferredWidthChanged();
      preferredHeightChanged();
      repaint();
  }
```

Thus far, this code looks very standard. It defines a RoundButton class that extends the Button. If you look at the LWT JavaDoc documentation for the Button class, you can see that this section of code defines and implements the methods `RoundButton()` and RoundButton(String label), similar to those in the Button class. The empty label version of the RoundButton is trivial, while the labeled implementation does nothing out of the ordinary.

The method `RoundButton(String label)` uses the LWT Component methods `getPreferredWidth()` and `getPreferredHeight()` to obtain the this button's dimensions in pixels. These two methods take into account the size of the string that comprises the RoundButton's label.

The LWT Component methods `setBottomEdge()` and `setRightEdge()` adjust RoundButton's height and width, respectively. Because the label string's width is typically larger than the its height, the width value x is plugged into the `setBottomEdge()` method as well as `setRightEdge()`. This ensures that RoundButton's `paint()` methods draws a circle—and not an oval. The code then signals the LWT that the button's dimensions have changed with the `preferredWidthChanged()` and `preferredHeightChanged()` methods. Finally, the method invokes `repaint()` to force a screen update so that the top-level container object, ComponentScreen, draws the new RoundButton. Moving through the file with the editor, we see:

```
  /**
   * gets the label
   * @see setLabel
   */
  public String getLabel() {
      return label;
  }

  /**
   * sets the label
   * @see getLabel
   */
  public void setLabel(String label) {

      this.label = label;
      repaint();
  }
```

These methods, `getLabel()` and `setLabel()`, fetch the string that represents the RoundButton’s label or sets it, respectively.

The next method, `paint()`, contains the code that draws a round button:

```
/**
   * paints the RoundButton
   */
       public void paint(Graphics g) {

// Ensure that the button doesn't draw into
// the clipping area
       int s = Math.max(getWidth() - 5, getHeight() - 5);

       if (hasFocus()) {
              g.drawArc(0,0, s+4,s+4,0,360);
       } //end if

// Set the color, depending upon if button is depressed
       if (isPressed()){   // black, pressed state
              g.setColor(0, 0, 0);
       } // end if

       else {              // gray, normal state
              g.setColor(220, 220, 220);
       } // end else
```

The first section of code derives a value s that becomes the size of a rectangle within which the LWT draws the round button. It takes the values that `getWidth()` and `getHeight()` obtain for this component’s dimensions, and uses the largest value.

One thing to note is that we reduce the drawing rectangle's size by five pixels. This is so that the button and its focus border (which must be slightly larger than the button) can be drawn safely within the rectangle that comprises the actual component. If you draw outside of the component's rectangle, a portion of the image is clipped.

The next section of code tests to see if the round button component has focus ownership (`isPressed()` returns true). If so, the focus border circle i drawn using the drawing rectangle's dimensions plus four pixels.

The code next tests to see if the button is in its pressed state. If so (`isPressed()` returns true), then the button's fill color is set to black. Otherwise, the button is in its normal state, and the fill color is set to gray.

```
// Paint the interior of the button with the chosen color
       g.fillArc(2, 2, s, s, 0, 360);

// Draw the perimeter of the button
if (isEnabled()){
       g.setColor(0, 0, 0);
       g.drawArc(2, 2, s, s, 0, 360);
} // end if

// Draw the label centered in the button
// Set color depending upon if button is depressed

       if (isPressed()){   // white label (pressed)
              g.setColor(255, 255, 255);
       } // end if

       else {           // black label (normal)
              g.setColor(0, 0, 0);
       } // end else

       Font f = getFont();        // Get typeface info
       g.drawString(label,        // Draw the text
              (s/2 - f.stringWidth(label)/2)+2,
              (s/2 - f.getHeight()/2)+2,
              Graphics.TOP|Graphics.LEFT);
} // end paint
```

This section of code draws the button's body. The `fillArc()` method paints an area using the current color. Because the drawing rectangle that `fillArc()` works with is actually a square in this case, which results in painting a circular area with the current color.

The code tests to see if the button is enabled (`isEnabled()` returns true). If it is, a black perimeter is drawn. Otherwise, the perimeter isn't drawn, so that the button appears disabled.

Finally, the code draws the button's label. It first sets the color that's used to draw the string, based upon the buttons's state. That is, for the normal state, the text is set to black, otherwise, it is set to white to represent the pressed state.

The `getFont()` method fetches the string's typeface information. The typeface's dimension information is used to center the text string within the button. The `drawString()` method draws the button's label

Scrolling to the end of the RoundButton class code, you see:

```
/**
   * The preferred width of the button.
   */
       public int getPreferredWidth() {
              Font f = getFont();
              int x = f.stringWidth(label) + 10;
              return x;
       } // end getPreferredWidth

  /**
   * The preferred height of the button.
   */
       public int getPreferredHeight() {
              Font f = getFont();
              int y = f.getHeight() + 10;
              return y;
       } // end getPreferredHeight

   /**
    * Send an action event to the listener.
    */
   public void componentActuated() {
       dispatchComponentEvent(BUTTON_ACTION_EVENT);
   } // end componentActuated

} // end RoundButton
```

The methods `getPreferredWidth()` and `getPreferredHeight()` use the dimensions of the label string to set the button's width and height dimensions. The code adds 10 pixels to the values returned for two reasons. First, it provides a 10-pixel buffer zone between the round button's perimeter and the label string. Second, if the label string is null, a button10 pixels in diameter gets drawn.

The last method, `componentActuated()`, is called by the LWT when the user presses the button. This method simply sends an action event to the button's listener.

As you can see, this code is very basic, other than employing one or two tricks to implement drawing a circle. The RoundButton class inherits Button's other features, such as its response to key events and positioning on screen. In addition, you don't have to worry about managing the button's states (normal, pressed, and focus ownership). The

LWT manages this for you, and as the RoundButton code shows, you merely query these state values as you paint the component. The LWT will issue a repaint request every time a component's state changes.

Because of how `getPreferredWidth()` and `getPreferredHeight()` are implemented, the button automatically sizes itself to accommodate the label's width. Feel free to try this by editing the label in the statements that make the round buttons. These statements can be found in the ButtonScreen's constructor.

LWT components use Component listeners to manage UI events, while LCDUI classes use Command listeners. Can both be used in the same MIDlet? Yes, they can. The sample MIDlet you just ran demonstrates this by using a CommandListener interface (implemented in the DemoScreen class) to handle the Exit soft key. Meanwhile, the ButtonScreen class implements a ComponentListerner interface, which manages the interaction of the LWT buttons. If you look in the ButtonScreen's code, you'll see:

```
public void processComponentEvent(Object source, int eventType) {

       // Button #1 pressed
       if (source == b1)
              statusLabel= "Button #1 pressed";

       // Button #2 pressed
       else if (source == b2)
              statusLabel= "Button #2 pressed";

       // Button #3 pressed
       else if (source == b3)
              statusLabel= "Button #3 pressed";

       // Button #4 pressed
       else if (source == b4)
              statusLabel= "Button #4 clicked";

       // Button #5 pressed
       else if (source == b5)
              statusLabel= "Button #5 clicked";

  } // end processComponenEvent
```

This is the listener for LWT component events. This method is simple in that it only examines the source object of the event, and not the event's type. More complex LWT classes might require you to examine the event's type. The statements that set the string statusLabel are just code stubs that can be populated with code that actually accomplishes something.

Now, let's see what we can do with LWT components in regards to their being visible, and the effects of their offset schemes.

Modify a Button’s Characteristics

Let’s examine ButtonDemo’s constructor in more detail to see how LWT buttons are made, and how their visibility and screen location can be changed. Scroll through the Buttons.java file with the editor to find:

```
// The constructor for our screen
public ButtonScreen() {

// First button
       b1 = new Button("Button");
       add(b1);

// Second button, set to fill the screen
       b2 = new Button("Large Button");
       b2.setRightEdge(Component.SCREEN_RIGHT, 0);
       b2.setBottomEdge(Component.HEIGHT,
           b2.getPreferredHeight() * 2);
//     b2.setVisible(false);
       add(b2);

// Third button, disabled
       b3 = new Button("Disabled Button");
       b3.setEnabled(false);
       add(b3);

// Fourth button, using the custom RoundButton class
       b4 = new RoundButton("Round");
//     b4.setEnabled(false);
//     b4.setVisible(false);
       add(b4);

// Fifth button, RoundButton class, located to right and
// level with the top of the previous button
       b5 = new RoundButton("Round");
//     b5.setLeftEdge(Component.PREVIOUS_COMPONENT_RIGHT,
              0);
//     b5.setTopEdge(Component.PREVIOUS_COMPONENT_TOP, 0);
//     b5.setVisible(false);
       add(b5);

// Assign each button a listener
       b1.setComponentListener(this);
       b2.setComponentListener(this);
       b3.setComponentListener(this);
       b4.setComponentListener(this);
       b5.setComponentListener(this);
} // end constructor
```

As the code shows, using an LWT button is straightforward. You use the new constructor and then the `add()` method to add the button to a LWT ComponentScreen. (The instance of a ComponentScreen is made in the class DemoScreen.) Making a RoundButton is no different: you use its new constructor and add it to the ComponentScreen. Finally, you assign each button a listener, even if it is disabled.

For the second button, note how the button's right edge field can be set to reach to the right edge of the screen. (`Component.SCREEN_RIGHT`).

For the third button, observe that by using the method `setEnabled()` with an argument of false, it disables the button.

Now, let's change things and see what happens.

Step 1: Modify a button's visibility.

For the second button, b2, uncomment the statement:

```
//     b2.setVisible(false);
```

This makes the second button invisible.

Step 2: Disable a button.

For the fourth button, b4, uncomment the statement

```
//     b4.setEnabled(false);
```

This disables the fourth button.

Step 3: Run the program and observe the results.

Build the project (Project | Make) and run it under debugger control (Project | Debug). Start the debugger, (Project | Run) and notice that changes. The phone simulator's screen should resemble Figure 21.

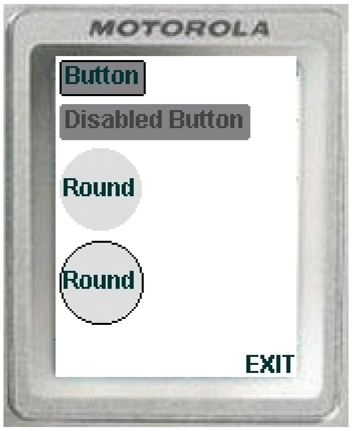


Figure 21. The screen after the second button was made invisible and the fourth button is disabled.

Step 4: Watch the change of focus ownership.

Use the navigation button to traverse the focus among the enabled buttons. You'll see that only two of the buttons receive focus ownership: the first button b1, and the second round button, b5.

There are several other statements in the ButtonDemo constructor that you can uncomment to disable other buttons or make them invisible. Feel free to experiment with those and see what happens.

Now let's see what effect an LWT component's offset scheme can have on the MIDlet's UI layout.

Modify a Button's Location

You can specify the screen location of an LWT component using one of several schemes. You can position the component using offsets from a screen location (top, left, right, or center). For example, the second button's right edge was set to coincide with the right of the screen by supplying the `setRightEdge()` method with arguments of a `SCREEN_RIGHT` constant and an offset of zero.

Alternatively, components can be located offset relative to other components. The LWT provides an extensive suite of relative offset schemes, where a component can be offset from another component's right edge, left edge, horizontal center, top edge, bottom edge, or vertical center. Consult the *Lightweight Window Toolkit Programmer's Guide* for further information on these offset schemes.

By default, the LWT aligns a component adjacent to the left edge of the screen and under the previous component. This is what the MIDlet's current layout shows. Let's change an offset scheme or two and see what happens.

Step 1: Change a button's offset scheme

Locate the code for the fifth button, b5, in the ButtonScreen's constructor. Uncomment the statement:

```
// b5.setLeftEdge(Component.PREVIOUS_COMPONENT_RIGHT, 0);
```

What this statement does is offsets b5's left edge to the right edge of the previous component, which is the round button b4.

Step 2: Build and start the program under debugger control

Issue the Debug command (Project | Debug) to have CodeWarrior's IDE make the program and start the debugger.

Step 3: Observe the effect of the new offset scheme

Issue a Run command (Project | Run) to have the MIDlet execute in the debugger. Note that the location of the second round button, b5, has changed

Use the navigation button to move the focus ownership so that the second round button has focus (Figure 22).

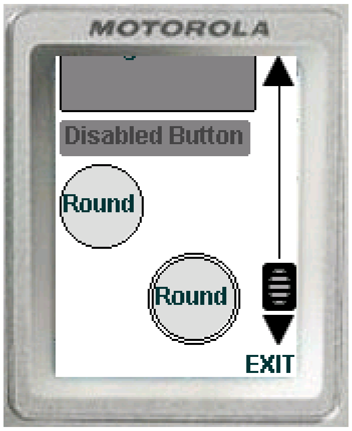


Figure 22. The second round button, using an offset where the button's left edge is relative to the first round button's right edge.

The second round button appears relative to the first round button's right edge. However, the vertical offset scheme is still in effect: this button's top edge is located relative to the first round button's bottom edge.

Use the Exit soft key to terminate the MIDlet and end the debugger session.

Step 4: Change another offset scheme for this button

Use the editor to uncomment the statement:

```
//     b5.setTopEdge(Component.PREVIOUS_COMPONENT_TOP, 0);
```

This statement has the b5 button’s top edge offset from the top edge of the preceding component, not from its bottom. The second argument can supply a pixel value to add to this offset. Since it’s zero for this example, the b5 button’s top will be aligned to the top of the button b4.

Step 5: Run the program and observe the effect of the offset scheme

Issue the Debug command (Project | Debug) to have CodeWarrior’s IDE make the program and start the debugger. Now issue the Run command (Project | Run). The second round button now appears to the right of the first round button, and aligned with its top (Figure 23).

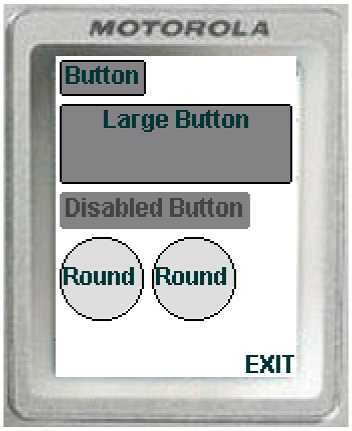


Figure 23. The second round button, positioned relative to the top and right edge of the first round button.

Feel free to experiment with the offset schemes for the buttons in this program.

What this demonstration shows you is how the LWT provides you with a powerful set of UI classes with which to build a desktop-quality UI for your mobile application. The LWT components provide visual feedback when actuated, and can be hidden or disabled under program control. The behavior and capabilities of LWT buttons can be applied to the all of LWT UI classes that implement interactive components.

Index