

Technical Manual

*Creating Media for the
Motorola C350 Handset*

Version 1.0.3



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Overview

Welcome to the *Creating Media for the Motorola C350 Handset* guide. This guide contains all the information you need to get started developing pictures, animation, and sounds for the Motorola C350 handset.

The Motorola C350 handset guide covers these areas:

- Display information like size, color depth, and more
- Graphic support information
- Sound support information

This document assumes you familiar with creating different media using the appropriate tools. This guide does not cover the tools required to create pictures, animations, sounds, or messages. Instead, it concentrates on the features and limitations of the device when working with media.

Document History

Version	Date	Author	Comments
Final (1.0)	9 Jan, 2003	MW MDP	Original release
Final (1.0.1)	23 Jan, 2003	MW MDP	Minor revisions
Final (1.0.2)	28 Jan, 2003	MW MDP	Added theme note
Final (1.0.3)	10 Feb, 2003	MW MDP	Modified theme limits

Glossary

Here are definitions of common terms used in this manual:

Term	Definition
AMR	Adaptive Multi Rate
EMS	Enhanced Messaging Service
GIF	Graphics Interchange Format
iMelody	Infrared Data Association (IrDA) standard for the textual representation of a ring tone.
MIDI	Musical Instrument Digital Interface
MIDI Patch	One of the channels in a MIDI device, defined by the general MIDI standard
Pixel	One picture element on the display
WAP	Wireless Application Protocol
WBMP	Wireless Bitmap

References

The following references provides information related to developing media for this device:

Organization	URL
3GPP	www.3gpp.org
Infrared Data Association	www.irda.org
MIDI Manufacturers Association	www.midi.org
Motorola Developer Program	www.motorola.com/developers/wireless
WAP Forum	www.wapforum.org
World Wide Web Consortium	www.w3.org

Display

This chapter describes the display characteristics for the Motorola C350 handset.

Display Info

The physical internal display characteristics of the Motorola C350 handset is:

Item	Description
Screen resolution	96 x 65
Screen dimensions	27 mm x 19 mm
Pixel pitch	0.285
Color depth	12-bit pixels
Maximum Colors	Capable of supporting up to 4096 colors

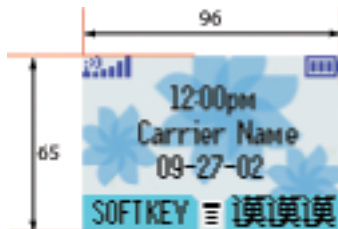


Figure 1. The Motorola C350 display.

Graphics

This chapter describes the graphic environment available in the Motorola C350 handsets. It includes information on picture and animation formats, size restrictions, pre-defined media, and more. Use it as a reference when creating pictures or animations that support your products.

Supported Picture Formats

The Motorola C350 handsets support these graphic formats:

Type	Description
EMS 5.0 Bitmaps	Enhanced Messaging Service bitmap
GIF 87a	Graphics Interchange Format, a standard file format for lossless compression of still images. It is used to display static images. This is the preferred format for pictures.
GIF 89a	The GIF 89a standard is a superset of the GIF 87a specification. It allows a sequence of GIF images to be displayed in succession that generates an animation.
WBMP	Wireless Bitmap format described in the WAP specifications. It is an optimized bitmap format intended for use in portable devices with smaller screens and limited display capabilities.

Picture Support

The Motorola C350 handsets support these picture sizes:

Type	Description
Small	Color, 16 x 16 pixels
Large	Color, 32 x 32 pixels
Variable	Color, 8, 16, 32, or 64 pixels
Maximum size	125 x 125

Color Values

The screen supports a 12-bit pixel size, which is capable of supporting up to 4096 colors.

The 12-bit colors are created from 24-bit color values by truncating the least significant bits for the color's R, G, and B components (red, green, blue). For example, a color of RGB (254 , 227 , 206) is drawn as RGB (240 , 224 , 192). You can simulate the color shift in some programs by converting colors to a 12-bit pixel size.


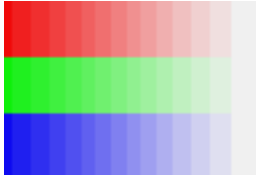




24 bit color	12 bit color
	
	
RGB (254 , 227 , 206), or 0xFEE3CE	RGB (240 , 224 , 192), or 0xF0E0C0
	











Figure 2. The effect of reducing color values from 24 bits to 12 bits.

To convert the color value 0xFEE3CE (which is red: 0xFE, green: 0xE3, blue: 0xCE) zero out the second value in each color. The color now becomes 0xF0E0C0 (red: 0xF0, green:0xE0, blue:0xC0).

The color shift from 24-bit to 12-bit values is most apparent in smooth gradients, where color banding can occur. Figure 2 illustrates of how the color conversion affects various color mages.

Pre-Loaded EMS Pictures

These Motorola C350 handsets include these pre-loaded pictures, which the user can include in EMS messages:

Name	Image	Size (pixels)
Balloons		32 x 32
Butterfly		32 x 32
Cake		32 x 32
Drink		32 x 32
Heart		32 x 32
Lips		32 x 32
Place Setting		32 x 32
Suitcase		32 x 32
Sun		32 x 32
Umbrella		32 x 32

Animation Support








The Motorola C350 handset supports use of these animation settings:

Type	Description
Small	Color, 8 x 8 pixels
Large	Color, 16 x 16 pixels
Frames	4 frames maximum (EMS animations only)
Rate	500 ms
Loop	Continuous

Pre-Defined EMS Animations

The Motorola C350 handsets include these pre-defined EMS animations, which the user can include in EMS messages:

Description	Animation Frame
I am angry	
I am confused	
Devil	
I am crying	
I am glad	
Wearing glasses	
I am indifferent	
I am ironic, flirty	

Description	Animation Frame
I am laughing	
In love / kissing	
I am sad	
I am skeptic	
Tongue hanging out	
I am winking	
Wow!	

Screensaver Support

The Motorola C350 handset supports screensavers. **Screensavers** are animated or static images selected by the user that are shown full screen when the phone has been inactive for a time.

The recommended format for a screen saver is animated GIF (GIF 89a). Other file types are also supported including: static GIF (GIF 87a), WBMP, and EMS 5.0 bitmaps. The maximum recommended size of a screensaver file is 30K.

Screen savers are displayed using the entire screen. In the event an image is larger or smaller than the display, the following rules are followed:

- **Image too small**—image is scaled up to fit the display, maintaining the same aspect ratio, and centered on the display.
- **Image too large**—image is scaled down to fit the display while maintaining the same aspect ratio.

If the screensaver is an animation, it plays for one minute and then halts at the first animation frame. This first frame, or key frame, then remains on the screen. When creating the animation, the first frame must be a key frame.




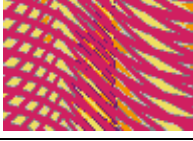
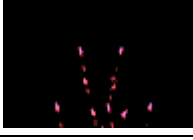



Graphics



This table describes the screensaver limitations:

Type	Description
Frames per Second	8
Recommended file size	30K

Pre-Loaded Screensavers

The Motorola C350 handset can include these pre-loaded screensavers images.

Name	Screensaver	Size (Pixels)
Alien		96 x 65
Bounce		96 x 65
Boxing		96 x 65
Cosmic		96 x 65
Fireworks		96 x 65
Frog		96 x 65
Jazzy		96 x 65
Party		96 x 65

Name	Screensaver	Size (Pixels)
Spaceship		96 x 65
Warped		96 x 65

Wallpaper Support

Wallpaper images are static images that are shown on both the idle screen and the main menu screen. Wallpaper images can be tiled or centered as selected by the user; centered is the default setting.

The recommended format for wallpaper graphics is static GIF (GIF87a). Other file types that can be used as wallpaper image are WBMP and EMS 5.0 bitmaps. The maximum recommended size of a wallpaper file is 5K.

Wallpaper images are displayed on screen as shown in Figure 3.



	
Wallpaper image.	Wallpaper images appear behind all screen elements on the idle screen.

Figure 3. How wallpaper is displayed on the idle screen.

If the user has selected to tile the wallpaper, the image is tiled starting from the upper left hand corner of the working area. The image is tiled horizontally and vertically equal to the display size, as shown in Figure 4.



	
<p>Original image</p>	<p>Tiled image used as wallpaper and appearing behind all screen elements on an idle screen.</p>

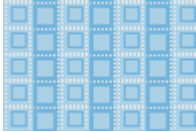




Figure 4. A GIF Image as tiled wallpaper.






If the user selects an animated GIF image, the first frame of the animated GIF becomes the wallpaper image. It's important that the colors of the wallpaper image allow the text displayed on the screen to remain legible.

If the wallpaper image is larger than the display in either the x or y-axis then it is resized to fit the display while maintaining the original aspect ratio.

Pre-Loaded Wallpaper

The Motorola C350 handset can include these pre-defined wallpaper images.

Name	Wallpaper	Size (Pixels)
Grid		96 x 65
Dots		96 x 65
Flowers		96 x 65
Fragment		96 x 65
Landscape		96 x 65

Name	Wallpaper	Size (Pixels)
Lines		96 x 65
Organic		96 x 65
Rays		96 x 65
Streaks		96 x 65
Waves		96 x 65

Theme Support

The Motorola C350 handset supports themes. A **theme** is a combination wallpaper, screensaver, and ring tone data set that enables users to customize their experience on the handset. Theme components are grouped together and downloaded to the handset as a bundle.

NOTE: The filenames used for screensavers, wallpapers, and ring tones used to create a theme files are limited to 32 characters each (excluding the dot and extension). Longer filenames are automatically truncated by the Media Manager (while retaining the extension) when it creates the theme file. Duplicate filenames are renamed by the phone to ensure they are unique. However, it is recommended you use unique filenames for each media element.





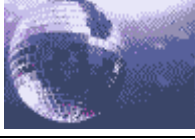



For more information on creating theme bundles, see the documentation that accompanies the Media Manager tools.

NOTE: Some wireless networks limit the maximum size of a Theme download to 100 KB. Developers are encouraged to keep their themes to this size or less. This size must also include header information, which can be up to 500 bytes in size.








Pre-Loaded Theme Images








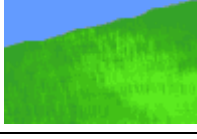
The Motorola C350 handset can include these pre-loaded theme images.

Theme Items	Image	Size (Pixels)
Biker Wallpaper		96 x 65
Biker Screensaver		96 x 65
Highway Man Ring Tone		
Boxing Monkey Wallpaper		96 x 65
Boxing Monkey Screensaver		96 x 65
Fight Night Ring Tone		
Cherry Blossom Wallpaper		96 x 65
Cherry Blossom Screensaver		96 x 65
Snowy Love Ring Tone		
Cocktail Wallpaper		96 x 65

Theme Items	Image	Size (Pixels)
Cocktail Screensaver		96 x 65
Bar Jazz Ring Tone		
Dancing Wallpaper		96 x 65
Dancing Screensaver		96 x 65
Clubland Ring Tone		
Discoball Wallpaper		96 x 65
Discoball Screensaver		96 x 65
Disco Dancing Ring Tone		
Dog Wallpaper		96 x 65
Dog Screensaver		96 x 65
Happy Dog Ring Tone		
Fashion Wallpaper		96 x 65

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Theme Items	Image	Size (Pixels)
Fashion Screensaver		96 x 65
Urban Style Ring Tone		
Graffiti Wallpaper		96 x 65
Graffiti Screensaver		96 x 65
Rock Time Ring Tone		
Leaves Wallpaper		96 x 65
Leaves Screensaver		96 x 65
Falling Leaves Ring Tone		
Potato Kid Wallpaper		96 x 65
Potato Kid Screensaver		96 x 65
Catch Me Ring Tone		

Theme Items	Image	Size (Pixels)
Romance Wallpaper		96 x 65
Romance Screensaver		96 x 65
Love Theme Ring Tone		
Secret Agent Wallpaper		96 x 65
Secret Agent Screensaver		96 x 65
Space Thriller Ring Tone		
Tropical Wallpaper		96 x 65
Tropical Screensaver		96 x 65
Tropical Ring Tone		
Soccer Wallpaper		96 x 65
Soccer Screensaver		96 x 65
Team Winner Ring Tone		

Graphics

Theme Items	Image	Size (Pixels)
UFO Crossing Wallpaper		96 x 65
UFO Crossing Screensaver		96 x 65
Flying Saucer Ring Tone		
Zombie Wallpaper		96 x 65
Zombie Screensaver		96 x 65
Zambo Ring Tone		

Sound

This chapter describes the sound environment available in the Motorola C350 handset. It includes information on sound formats, pre-defined melodies and ring tones, and more. Use it as a reference when creating sounds for your products.

Supported Sound Formats

The Motorola C350 handsets support these sound formats:

Type	Description
MIDI	The Motorola C350 product is fully MIDI 1.0 compliant, and supports any data format described in <i>The Complete MIDI 1.0 Detailed Specification</i> , including: <ul style="list-style-type: none">– MIDI, Type 0– MIDI, Type 1– Scalable Polyphonic MIDI (SP-MIDI)
iMelody	iMelody is the Infrared Data Association (IrDA) standard for the textual representation of a ring tone that can be used to transfer melodies between devices.

Sound Support

The Motorola C350 handsets support use of these sound settings:

Type	Description
Recommended Size	9Kb
Duration	20 ms (minimum duration for a single note)

Ring Tone Support

Ring tones should not exceed 30 seconds because most voice mail systems pick up after four rings (16-25 seconds depending on the system).

Due to this length suggestion and the fact that Motorola C350's synthesizer has a maximum polyphony of 16 notes, ring tone length should never exceed 9Kb.

Pre-Defined EMS Ring Tones

The Motorola C350 handsets support these standard pre-defined EMS ring tones, which the user can enclose in an EMS text message or set as a ring indicator.

Number	Sound
0	Chimes high
1	Chimes low
2	Ding
3	TaDa
4	Notify
5	Drum
6	Claps
7	Fanfare
8	Chord high
9	Chord low

Pre-Loaded Ring Tones

The Motorola C350 handsets also support these pre-loaded ring tones, which the user can choose for one of the many ring tones in the phone's ring profiles, including specific callers in the phone book.

Pre-Loaded Ring Tones	Pre-Loaded Ring Tones
1812th Overture	Magic Flute
Alert (Alert 1)	Malaguena
Alert 1	Military March
Alert 2	Minuet
Alert 3	Mobile Merengue
Alert 4	Mountain Rave
Alert 5	Nessun Dorma

Pre-Loaded Ring Tones	Pre-Loaded Ring Tones
Anitra's Dance	Notification 1
Badineri	Notification 2
Battle Hymn of the Republic	Notification 3
Bells (Alert 3)	Notification 4
Bits & Bytes (Notification 3)	Notification 5
Blues	notify
Canon in D	Pacifica
Celtic Dance	Paganini Etudes
chimes_high	Pase El Agua
chimes_low	Plink
Chinese Folk Tune	Polyphonic Alert 1
chord_high	Polyphonic Alert 2
chord_low	Polyphonic Alert 3
Cinematica	Polyphonic Alert 4
claps	Polyphonic Alert 5
Cosmic (Polyphonic Alert 5)	Provincial (Polyphonic Alert 1)
custgoodbye	Puffy Clouds
custwakeup	Purple Euro
Dance Beat	Random (Notification 2)
Dance Macabre	Re-invention 13
ding	Retro
Ding (Notification 5)	Rock Me
Door Bell (Notification 4)	Russian Dance
drum	Scarboro Fair
Electro	Snaggle (Polyphonic Alert 4)
Emperor Concerto	Soaring High
fanfare	Solfeggio
Funkadellic	Sonata in C
FunkyDo	Standard (Alert 2)
Glow Stick	tada
Goldberg Variation	Techno
Harmonics (Polyphonic Alert 2)	The Eighties

Pre-Loaded Ring Tones	Pre-Loaded Ring Tones
Heart Ache	The Islands
Hungarian Dance	Timbale Taps
Interlude (Polyphonic Alert 3)	Triads (Alert 4)
Latin Loops	Twirl
Little Boy Blues	Up and Down (Alert 5)
Love Theme	Violin Conerto
Low Down Disco	Wind Chimes Notification 1

MIDI Support

The Musical Instrument Digital Interface (MIDI) enables people to use multimedia computers and electronic musical instruments to create, enjoy and learn about music.

The MIDI protocol is a music description language in which every word describes an action of musical performance. Each action is stored as a binary word and when combined, stored as MIDI files. These files can then be replayed by any electronic device that can read the MIDI file and recreate the performance using its available sound system. Unlike recorded sound files like MP3, WAV, or AIFF, MIDI files are extremely compact and completely editable, making them ideal for small mobile devices.

MIDI Key Mapping

The Motorola C350 supports all 128 general MIDI instruments and the standard drum kit, but due to frequency limitations, not all MIDI notes are supported for all patches. The following table describes what the valid key ranges are for the Motorola C350 handset.

Patch Number	Patch Names	Valid MIDI Note Numbers
0	Acoustic Grand Piano	21-96
1	Bright Acoustic Piano	21-96
2	Electric Grand Piano	21-96
3	Honky-tonk Piano	21-96
4	Electric Piano 1	28-96
5	Electric Piano 2	28-96
6	Harpsichord	24-89
7	Clavinet	24-84
8	Celesta	48-96
9	Glockenspiel	65-96

Patch Number	Patch Names	Valid MIDI Note Numbers
10	Music Box	48-84
11	Vibraphone	53-89
12	Marimba	48-96
13	Xylophone	60-96
14	Tubular Bells	48-96
15	Dulcimer	48-84
16	Drawbar Organ	36-96
17	Percussive Organ	36-96
18	Rock Organ	36-96
19	Church Organ	21-96
20	Reed Organ	36-96
21	Accordion	53-89
22	Harmonica	60-84
23	Tango Accordion	53-89
24	Acoustic Guitar (nylon)	40-86
25	Acoustic Guitar (steel)	40-86
26	Electric Guitar (jazz)	40-86
27	Electric Guitar (clean)	40-86
28	Electric Guitar (muted)	40-86
29	Overdriven Guitar	36-86
30	Distortion Guitar	36-91
31	Guitar Harmonics	36-86
32	Acoustic Bass	28-72
33	Electric Bass (finger)	28-60
34	Electric Bass (pick)	28-60
35	Fretless Bass	24-72
36	Slap Bass 1	28-60
37	Slap Bass 2	28-60
38	Synth Bass 1	28-60
39	Synth Bass 2	28-60
40	Violin	48-96
41	Viola	48-84

Sound

Patch Number	Patch Names	Valid MIDI Note Numbers
42	Cello	36-72
43	Contrabass	28-55
44	Tremolo Strings	28-91
45	Pizzicato Strings	28-96
46	Orchestral Harp	21-96
47	Timpani	36-84
48	String Ensemble 1	28-91
49	String Ensemble 2	28-96
50	Synth Strings 1	36-91
51	Synth Strings 2	36-91
52	Choir Aahs	48-84
53	Voice Oohs	48-84
54	Synth Voice	48-96
55	Orchestra Hit	36-84
56	Trumpet	58-94
57	Trombone	34-75
58	Tuba	29-55
59	Muted Trumpet	58-82
60	French Horn	41-77
61	Brass Section	36-91
62	Synth Brass 1	36-91
63	Synth Brass 2	36-91
64	Soprano Sax	54-87
65	Alto Sax	47-80
66	Tenor Sax	42-76
67	Baritone Sax	36-68
68	Oboe	58-91
69	English Horn	52-81
70	Bassoon	34-72
71	Clarinet	50-91
72	Piccolo	74-96
73	Flute	60-96

Patch Number	Patch Names	Valid MIDI Note Numbers
74	Recorder	60-96
75	Pan Flute	60-96
76	Blown Bottle	60-96
77	Shakuhachi	55-84
78	Whistle	60-96
79	Ocarina	60-96
80	Lead 1 (square)	24-96
81	Lead 2 (sawtooth)	24-96
82	Lead 3 (calliope)	36-96
83	Lead 4 (chiff)	36-96
84	Lead 5 (charang)	24-96
85	Lead 6 (voice)	36-96
86	Lead 7 (fifths)	36-96
87	Lead 8 (bass+lead)	24-59
88	Pad 1 (new age)	36-91
89	Pad 2 (warm)	36-96
90	Pad 3 (polysynth)	36-96
91	Pad 4 (choir)	36-96
92	Pad 5 (bowed)	36-96
93	Pad 6 (metallic)	36-96
94	Pad 7 (halo)	36-96
95	Pad 8 (sweep)	36-96
96	FX 1 (train)	36-96
97	FX 2 (soundtrack)	36-96
98	FX 3 (crystal)	36-96
99	FX 4 (atmosphere)	24-96
100	FX 5 (brightness)	24-96
101	FX 6 (goblins)	36-96
102	FX 7 (echoes)	36-96
103	FX 8 (sci-fi)	36-96
104	Sitar	48-77
105	Banjo	48-84

Patch Number	Patch Names	Valid MIDI Note Numbers
106	Shamisen	50-79
107	Koto	55-84
108	Kalimba	48-79
109	Bagpipe	36-77
110	Fiddle	48-96
111	Shanai	48-72
112	Tinkle Bell	72-91
113	Agogo	60-72
114	Steel Drums	52-84
115	Woodblock	60-72
116	Tailo Drum	60-72
117	Melodic Drum	48-84
118	Synth Drum	48-84
119	Reverse Cymbal	60-72
120	Guitar Fret Noise	60-72
121	Breath Noise	60-72
122	Seashore	60-72
123	Bird Tweet	60-72
124	Telephone Ring	60-72
125	Helicopter	60-72
126	Applause	60-72
127	Gunshot	60-72
none	Drums	35-81

MIDI Audio Guidelines

The following are suggested guidelines to maximize sound quality while reducing the overall file size of a MIDI Ring Tone file for use with the Motorola C350 handset.

Tip 1: Use MIDI's running status feature

In the MIDI standard, a key-on or a key-off event will use at most three bytes each. However, when several key events occur on the same MIDI-channel, the running status feature can be used. In principle, running status means that the first byte of, say, a key-on event is omitted. In addition, the key-on event having a velocity of zero is equivalent to the

key-off event. Thus, combining running status with key-on events that have zero velocity reduces the number of bytes needed to encode all key events.

EXAMPLE:

Without using the running status, features, the sequence

```
91 2E 23 8E, 91 2B 50 8E, 81 2E 64 00, 81 2B 64 00
```

represents "Key 2E ON" Velocity 23 MIDI Ch 1", "Key 2B ON Velocity 50 MIDI Ch 1", "Key 2E OFF Velocity 64 MIDI Ch 1", "Key 2B OFF Velocity 64 MIDI Ch 1". Using the running status feature reduces the sequence to:

```
91 2E 23 8E, 2B 50 8E, 2E 00 00, 2B 00 00,
```

That is, the command byte is omitted and velocity zero is used for key off.

Tip 2: Use Standard MIDI File (SMF) type 1

The MIDI content can be stored in a Standard MIDI File (SMF) of type 0 or type 1. In a type 0 SMF, the file format uses one header chunk with one-track chunk. In a type 1 SMF, the format uses one header chunk with several track chunks. SMF type 2 should not be used.

In general, it is more efficient to store the MIDI data as a type 1 file. The increased efficiency is achieved because each track contains only one MIDI channel and one instrument (This is often the case). The running status feature can be applied on each individual track, thereby reducing the track size. To further reduce the size of the file, use one track per used MIDI channel. That is, if a temple/conductor track exists, merge it with the first instrument track. Remove all unnecessary meta-events such as the "track name" and "lyric" meta-events.

To summarize, the following measures can be taken in order to reduce the SMF:

1. Use SMF type 1 (Or verify that a type 1 file is smaller than a type 0 file and use the smallest file).
2. Use running status.
3. One and only one instrument per track. Try not to change channels.
4. Do not change tempo in the middle of the music. That is, set the tempo once.
5. Use beat, instead of SMPTE, to set the tempo.
6. Do not use Copyright Text Fields.
7. Limit the use of continuous controller information such as pitch-bend and volume.
8. Turn off the options below:
 - Sequence Number - MIDI sequence ids
 - Text - embedded text for any optional fields
 - Sequence / Track Name
 - Instrument Name
 - Lyric
 - Marker - for synchronization purposes
 - Cue Point

- Midi Channel Presix - associate channels with all events following
- Sequencer-Specific settings

Items one through three above optimize the encoding of the notes, while items four to eight optimize the overall melody. The above measures provide an SMF file that is ready-made for compression. However, prior to compression, the composer/content author can add a few values for key velocity, thereby increasing the redundancy of the file.

Tip 3: Consider the Frequency Response

Because the Motorola C350 MIDI Synthesizer uses data sampled at 8Khz, frequencies above 4Khz cannot be achieved. In addition, the polyphonic speaker’s volume decreases at approximately 20dB/octave below 800Hz.

Therefore, the recommended note range for a ring tone is between G5 and C8, assuming that the lowest MIDI note is C0. Please see the “Midi Key Mapping” table for all valid notes for each patch.

NOTE: The use of MIDI notes below 800Hz may cause a decrease in volume when playing the note. Always test your audio on an actual device to ensure the accuracy of the sound you want to produce.

Motorola Groovetunes Specification

The Motorola Groovetunes feature allows users to mix a repeating “base track” directly on the Motorola C350 using the MotoMixer application. The base track consists of four parts: three content-specified instruments and a drum part. Four variations are provided for each part in the base track file. Selecting one of the four variations for each of the parts at a specific point in time creates the mix. The mix created by the user can be saved in a file referred to as the “mix file” and can then be recalled later, used as a ring tone, or sent to another mobile phone using a messaging service (e.g., SMS or email). The initial release of Motorola C350 will **not** support mobile originated messages containing MIDI files.

The four variations defined for each part are referred to as “Variation A,” “Variation B,” “Variation A with effect,” and “Variation B with effect.” The user interface for the Groovetunes editor allows the user to modify three settings for each part: instrument on/off, which is used to enable or disable the part entirely; variation A/B, which is used to select the variation played; and effect on/off, which enables and disables the effect. There are five valid combinations of these three settings: part turned off (muted) and the four variations listed at the beginning of this paragraph. The Groovetunes editor starts with all four parts muted as shown in Figure 5.



Figure 5. MotoMixer editor with all four parts muted.

Changes made to the mix by the user will take effect only on 16th note boundaries. That is, if a base track was written in 4/4 time (four quarter notes per measure), there would be 16 equally-spaced “sequence points” in the measure where changes by the user would take effect.

When played, the base track file is looped. Initial revisions of the Groovetunes feature will loop the base track four times. Future revisions may allow the number of loops to be configurable (with a default value of four) by the user on a per-mix file basis.

Base Track File Format

Groovetunes base tracks are required to be standard MIDI files stored in format 0 (i.e., data for all channels is stored in a single track). Base track files can be any length and be written in any time and key signature. Groovetune base tracks should be saved with a `.bas` file extension.

Channels

The four variations for each part in the base track file are stored as separate channels. The mapping between part and variation and channel number is shown in table 3.

Part	Variation	MIDI Channel
Instrument 1	Variation A	1
	Variation B	2
	Variation A with effect	3
	Variation B with effect	4
Instrument 2	Variation A	5
	Variation B	6
	Variation A with effect	7
	Variation B with effect	8
Drums	Variation A	9
	Variation B	10
	Variation A with effect	11
	Variation B with effect	12
Instrument 3	Variation A	13
	Variation B	14
	Variation A with effect	15
	Variation B with effect	16

Table 3. Mapping between part, variation and channel number.

Instruments

The Groovetunes feature supports the use of all 128 General MIDI instruments. Note that not all phones are able to distinctly represent all of these instruments (e.g., all General MIDI piano-like instruments may be represented by a single piano sound (e.g., “Acoustic Grand Piano” may sound identical to “Electric Piano 2”). The Motorola C350 supports the full instruments set with very limited re-mapping. The General MIDI Percussion Map will be used for the drum part, so no instrument should be specified for the variations of the drum part.

In the Groovetunes editor, the parts are named by the General MIDI instrument used by the first note of the “Variation A” variation of the part. That is, if the first note in “Variation A” for a part is played with the “Whistle” instrument, the part is labeled in the user interface as “Whistle.” The different variations for a part can be implemented using different General MIDI instruments, but the part name displayed to the user will never change. The drum part will always be named “Drums” regardless of the drum sounds used in the part.

The results of changing instrument mapping for a variation in the middle of the variation are unpredictable and should be avoided.

Base tracks may use up to four different drum instruments from the General MIDI Percussion Map. For example, a base track may decide to use drum instruments 36, 40, 42, and 45 (Bass Drum 1, Electric Snare, Closed Hi Hat, and Low Tom). No additional drum instruments can be used. If other drum instruments are used, only the first four that are specified in the base track will be heard. This applies across all four variations of the drum part – only the four selected drum instruments can be used in the entire base track.

Tempo

The tempo of the base track must be specified at time 0 of the base track file. Tempo is specified in microseconds per quarter note in a standard MIDI “Set Tempo” meta-event. If the tempo is not set in the MIDI file or is not set at time 0, the tempo will default to 500,000 microseconds per quarter note (120 beats per minute). Tempo changes in the middle of the base track file will be ignored.

The Groovetunes user interface provides the user with an option to adjust the tempo of the base track. This user-specified tempo is saved as part of the mix file. The user is allowed to adjust the tempo on a scale of 0 to 7. Setting 3 is the default value and will be equal to the tempo specified in the base track file. Setting 0 is approximately equal to half of the default tempo. Setting 7 is more than double the default tempo.

Restrictions

The implementation of the Groovetunes feature uses a MIDI Text Event containing the text “\!” (Backslash exclamation mark) in the form:

```
FF 01 02 5C 21
```

Base tracks should NOT contain text events matching this format. Text events that contain other text can be included at any point in the base track file.

In addition, files should be created to allow for a maximum polyphony of 16 simultaneous notes when all tracks and effects are active.

Design Recommendations

Individual instruments' variations should be varied greatly to allow for an easily discernable difference between variation 1 and 2. This can be accomplished by using different rhythmic, harmonic and melodic structures. One possible recommendation is to use a more basic structure for variation 1 and a more complex one for variation two (steady rhythm vs. syncopation). The key point here is there must be an easily recognizable differentiation between each of the variations.

With regards to variations with effect, these tracks can be used in a multitude of different ways. One possibility is to use the effect track to add harmony to a melody of an associated track. Additionally, the effect track can be used to add musical substance such as arpeggiations or figured basses. Lastly, the effect track can be used to add delay effects such as echo by copying all musical events and pasting them at a short (1/32) offset. Overall, the effect track should be used to add rhythmic, harmonic or acoustical depth the associated variation track.

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