MetaWatch Remote Message Protocol

1   Contents

2 Introduction

This protocol provides the serial message format for the MetaWatch project.

3 Revision History

Revision	Details	Date
1.0	Original Release	October 3, 2011
1.0.1	Redefine Button Event Message (0x34) payload to include same set of info as that of Enable Button (0x46).	June 11, 2012
1.0.2	Add a nval identifier "language" to support local "day of week" format	June 18, 2012
1.0.3	Add two parameters: start row and number of rows to "Update LCD Display" (0x43).	June 28, 2012
1.1.0	Update "WriteBuffer" and "UpdateDisplay" supporting new Widget UI	September, 2012
1.1.1	Add "Set Widget List" message	September 25, 2012
1.1.2	Correct "UpdateDisplay" bits definition errors.	October 18, 2012
1.1.3	Update "UpdateDisplay" and "Get Information String Response"	5 November 2012
1.1.4	Update "SetWidgetList": List shall be in ascend sorting order	5 November 2012
1.1.5	Update "SetWidgetList": 0-15: home widget IDs	7 November 2012
1.1.6	Add "Music play state message"; update "WriteBuffer" and "UpdateDisplay"	November 16, 2012
1.1.7	Change typo "7:0" to "0:7"	January 15, 2013
1.1.8	Add new format for Nval operation message (0x30)	January 15, 2013
1.1.9	Deprecate Idle buffer configuration Nval key (0x30)	January 17, 2013
1.2.0	Update 0x30	February 28, 2013
1.2.1	Update 5.30 (0x57) Read Battery Voltage	February 28, 2013

4 Packet Format

Messages are sent using the Bluetooth Serial Port Profile. Most messages originate from the phone but the watch can also send messages. For this system the message size is limited to 32 bytes. The minimum message length is 6 bytes. Therefore 6 >= n <= 32.

Packet Format			
0	Start Byte	0x01	This is the ASCII start of frame.
1	Length Byte	6-32	Length of the packet including overhead bytes and CRC.
2	Message Type	-	The message types are defined in the following section
3	Options	-	Additional options for the message. Set to 0x00 when not used.
4:n	Data	-	Variable Length Payload
n+1:n+2	CRC	-	The CRC is a 16 bit value. The least significant byte is sent first.

4.1 CRC Generation

The phone must generate the CRC that matches the MSP430. It uses CRC-CCITT with a starting value of 0xFFFF with reverse input bit order. For example, the Get Device Type message is: 0x01, 0x06, 0x01, 0x00, 0x0B, 0xD9. The CRC is 0xD90B.

5 Message Definitions

Message Type	Code	Source
Get Device Type	0x01	Phone
Get Device Type Response	0x02	Watch
Get Information String	0x03	Both
Get Information String Response	0x04	Both
Diagnostic Loopback	0x05	Both
Write OLED Buffer	0x10	Phone
Change OLED Mode	0x12	Phone
Write OLED Scroll Buffer	0x13	Phone
Advance Watch Hands	0x20	Phone
Set Vibrate Mode	0x23	Phone
Set Real Time Clock	0x26	Phone
Get Real Time Clock	0x27	Both
Get Real Time Clock Response	0x28	Both
Nval Operation	0x30	Phone
Nval Operation Response	0x31	Phone
Status Change Event	0x33	Watch
Button Event Message	0x34	Watch
General Purpose Phone Message	0x35	Watch
General Purpose Watch Message	0x36	Phone
Write LCD Buffer	0x40	Phone
Configure LCD Idle Buffer Size	0x42	Phone
Update LCD Display	0x43	Phone
Load Template (LCD only)	0x44	Phone
Enable Button	0x46	Phone
Disable Button	0x47	Phone
Battery Configuration Message	0x53	Phone
Low Battery Warning Message	0x54	Watch
Low Battery Bluetooth off Message	0x55	Watch
Read Battery Voltage Message	0x56	Phone
Read Battery Voltage Response	0x57	Phone
Read Light Sense Message	0x58	Phone
Read Light Sensor Response Message	0x59	Phone

5.1 Get Device Type (0x01)

This command is used to query the type of watch that is connected.

Option Bits			
0:7	Reserved		

Payload Bytes			
0:n	Reserved		

5.2 Get Device Type Response (0x02)

This message is a response from the watch to the phone.

Option Bits			
0:7	Reserved		

Payload Bytes

0	Device Type	0	Reserved
		1	Analog Watch
		2	Digital Watch
		3	Digital Development Board
		4	Analog Development Board
		5-255	Reserved

5.3 Get Information String (0x03)

This command is reserved for future use.

Option Bits

0:7	Reserved		

Payload Bytes

0	String Select	0-255	Reserved

5.4 Get Information String Response (0x04)

This command is reserved for future use.

Option Bits

0:7	Reserved		

Payload Bytes

0-5	Firmware build number	'0'-'9'	6 character bytes, one digit each.
6-8	Firmware version number	0-255	3 bytes of major, minor and patch version numbers.

5.5 Diagnostic Loopback (0x05)

The message from the phone is routed directly back to the phone by the watch.

5.6 Write OLED Buffer (0x10)

Option Bits

0:3	Mode Select	0	Idle
		1	Application
		2	Notification
		3-15	Reserved
4:6	Page Control	0	No Action
		1	Invalidate Page
		2	Invalidate and Clear Page
		3	Invalidate and Fill Page
		4	Activate page (validates page also)
		5-7	Reserved
7	Reserved		

Payload Bytes

0	Buffer Select	0	Top Page #1
		1	Bottom Page #1
		2	Top Page #2
		3	Bottom Page #2
1	Column Index	0-79	Top Row
		80-159	Bottom Row
2	Size	0-23	Size of the item in bytes
3:n	Data	0-255	Pixel Data

Only the idle mode contains buffers for the top and bottom page #2. When any byte in a page is written the page is validated. If a page is invalid then it will not be displayed when in idle mode and the middle button is pressed. When the phone wishes to display a page it should set the activate page control bits in the final command it sends.

Scroll control is only valid for the Bottom Page #1 in Notification mode.

If a page is activated and the current mode is not active then the current mode will be changed before displaying the page.

Each display consists of two rows of 80 characters.

Page	Page Address	Rows	Row Index
Top Page #1	0	Top Row	0-79
		Bottom Row	80-159
Bottom Page #1	1	Top Row	0-79
		Bottom Row	80-159
Top Page #2	2	Top Row	0-79
		Bottom Row	80-159
Bottom Page #2	3	Top Row	0-79
		Bottom Row	80-159

OLED pixel structure is as follows.

	Byte 0, Bit 7	Byte 1	Byte …	Byte 79
Row 0	Byte 0, Bit 6			
	Byte 0, Bit …			
	Byte 0, Bit 0			
Row 1	Byte 80, Bit 7			Byte 159, Bit 7
	Byte 80, Bit 0			Byte 159, Bit 0

5.7   Change Mode – OLED only (0x12)

Change the mode of the watch. This command does not cause an update of the top or bottom OLED. It does change how the buttons are handled. When a mode other than IDLE is selected its mode timer is started.

Option Bits			
0:3	Mode Select	0	Idle
		1	Application
		2	Notification
		3-15	Reserved
3:7	Reserved		

Payload Bytes			
0	Reserved		

5.8 Write OLED Scroll Buffer (0x13)

Option Bits			
0	Scroll Complete	0	This is not the last packet of scroll information
		1	This is the last packet of scroll information
1	Scroll Control	0	No action
		1	Scroll Start
2:7	Reserved		

Payload Bytes			
0	Size	1-25	Size in bytes
1:n	Data	0-255	Pixel Data

The scroll buffer contains 240 bytes that are used to display scroll information. This information is tied to the bottom row of the bottom OLED. This buffer can be written indefinitely.
If the scroll state machine runs out of data then the scroll will be terminated.
The scroll state machine will send a scroll request status message each time it scrolls 80 characters (OLED display columns). The phone is responsible for not writing too many characters to the scroll buffer.
When a scroll is started if the top OLED is on then it will remain on for the duration of the scroll.

5.9 Advance Watch Hands (0x20)

This command will advance the watch hands by the specified amount.

Option Bits			
0:7	Reserved		

Payload Bytes			
0	Hours	0-12	
1	Minutes	0-60	
2	Seconds	0-60	

5.10 Set Vibrate Mode (0x23)

This message causes the watch to vibrate.

Option Bits			
0:7	Reserved		

Payload Bytes			
0	Control	0	Disable (Cancel)
		1	Enable
1	On Duration LSB	0-255	LSB of on duration in milliseconds
2	On Duration MSB	0-255	MSB of on duration in milliseconds
3	Off Duration LSB	0-255	LSB of off duration in milliseconds
4	Off Duration MSB	0-255	MSB of off duration in milliseconds
5	Number of Cycles	0-255	Number of on/off cycles

5.11 Set Real Time Clock (0x26)

This message sets the real time clock in the MSP430.

Option Bits			
0:7	Reserved		

Payload Bytes			
0	MSB of Year		4 most significant bits of a 12 bit value
1	LSB of Year		8 least significant bits of a 12 bit value
2	Month	1-12	
3	Day of Month	1-31	
4	Day of Week	0-6	
5	Hour	0-23	
6	Minute	0-59	
7	Second	0-59	

5.12 Get Real Time Clock (0x27)

This message can be used by the phone or the watch to request the time from the other device.

Option Bits			
0:7	Reserved		

Payload Bytes			
0:n	Reserved		

5.13 Get Real Time Clock Response (0x28)

Option Bits			
0:7	Reserved		

Payload Bytes			
0	MSB of Year		4 most significant bits of a 12 bit value
1	LSB of Year		8 leas significant bits of a 12 bit value
2	Month	1-12	
3	Day of Month	1-31	
4	Day of Week	0-6	
5	Hour	0-23	
6	Minute	0-59	
7	Second	0-59	

5.14 Nval Operation (0x30)

The Nval (Non-volatile memory) operation message is used to read and write values to flash. These values will retain their values when the battery is depleted. The flash can be erased and written a limited number of times. There are two formats of the message: one with and one without payload.
The Option byte and the payload definitions for the message with payload are:

Option Bits			
		0x00	Reserved
0:7	Operation Select	0x01	Read Operation
		0x02	Write Operation

Payload Bytes			
0:1	Nval Identifier		Unique identifier for the object stored in Non-volatile memory. LSB is in byte 0.
2	Size		Size of the item in bytes
3:n	Data		

The Option byte definition for none-payload format is:

Option Bits	If the bit is set to 1
0	Show date in 24H format. Default is 12H (with AM and PM)
1	Show date in DDMM format. Default is MMDD.
2	Show seconds in the clock. Default is not-show.
3	Show separating dot lines between widgets in idle mode. It's the default.
7	Read operation. Default is Write (0).

5.15   Nval Operation Response (0x31)

Similar to the Nval Operation (0x30), there are two formats: with and without payload. The format of payload message is:

Option Bits			
		0x00	Success
		0x01	Failure
0:7	Status	0x09	Item Not initialized (Identifier Not found)
		0x0A	Operation failed
		0x0C	Bad Item length

Payload Bytes			
0:1	Nval Identifier		Unique identifier for the object stored in Non-volatile memory
2:n	Read Data		Value of Identifier

For non-payload message, in case of Write Nval Operation Response, the option byte has same meaning as that of the payload message. In case of Read Nval Operation Reponse, the bits 0 to 6 are the Nval values as defined in Option Bits of Nval Operation (0x30) and the bit 7 is the Read operation status: 0 if success; 1 if fail.

Table 1: Nval Identifiers

Identifier Name	Identifier	Size in bytes	Default Value	Description
Reserved	0x0000	-	-	
Link Key	0x0001	-	-	Not accessible by phone
Idle Buffer Configuration	0x0002	1	0	Deprecated
Idle Buffer Invert	0x0003	1	0	0 = no invert / 1 = invert display
Idle Mode Timeout	0x0004	2	-	Reserved
Application Mode Timeout	0x0005	2	600	Time in seconds before returning to Idle mode after an update display command is received. Set to 0 for no timeout.
Notification Mode Timeout	0x0006	2	30	Time in seconds before returning to Idle

				or application mode
Reserved Mode Timeout	0x0007	2	-	Reserved
Idle Display Timeout	0x0008	2	7	Time in seconds before the display goes blank (OLED only)
Application Display Timeout	0x0009	2	5	Time in seconds before the display goes blank (OLED only)
Notification Display Timeout	0x000a	2	5	Time in seconds before the display goes blank (OLED only)
Reserved Display Timeout	0x000b	2	-	Reserved
Sniff Debug	0x1001	1	0	When 0 sniff information is not printed to the terminal.
Battery Debug	0x1002	1	0	When 0 battery debug information is not printed to the terminal
Connection Debug	0x1003	1	-	Reserved
RST/NMI Configuration	0x1004	1	0x01	0 = Reset pin is disabled 1 = Reset pin is enabled
Master Reset	0x1005	2	0x0000	When set to 0xDEAF the non-volatile values will return to their default values upon reset
Low Battery Warning Level	0x2001	2	3500	Value in millivolts that a warning message is sent to phone
Low Battery Bluetooth Off Level	0x2002	2	3300	Value in millivolts that warning message is sent to phone and Bluetooth radio is turned off
Battery Sense Interval	0x2003	2	8	Rate at which battery is monitored in seconds.
Light Sense Interval	0x2004	2	-	Reserved
Secure Simple Pairing Enable	0x2005	1	0	0 = Use pin code 0000 for pairing 1 = Allow secure simple pairing (Not designed for phone control. Only updated on watch reset)
Link Alarm Enable	0x2006	1	1	0 = link alarm disabled 1 = link alarm enabled (vibration will be generated when Bluetooth link is lost)
Link Alarm Duration	0x2007	-	-	Duration of vibration for link alarm
Pairing Mode Duration	0x2008	1	0	0 = Forever 1-255 Seconds allowed for pairing to complete before a connection timeout message is sent. Not intended for phone control. Only updated on watch reset.
Time Format	0x2009	1	0	0 = Twelve Hour 1 = 24 Hour
Date Format	0x200a	1	0	0 = Month First 1 = Day First
Display Seconds	0x200b	1	0	0 = Don't Display Seconds 1 = Display Seconds
Language	0x200c	1	0	0 = English 1 = Finnish 2 = German
Top OLED Contrast Index Day	0x3000	1	4	0 = Lowest, 9 = Highest
Bottom OLED Contrast Index Day	0x3001	1	4	0 = Lowest, 9 = Highest

Top OLED Contrast Index Night	0x3002	1	4	0 = Lowest, 9 = Highest
Bottom OLED Contrast Index Night	0x3003	1	4	0 = Lowest, 9 = Highest

5.16   Status Change Event (0x33)

This message is sent from the watch when it needs to notify the phone that a status change event has occurred.

Option Bits			
0:3	Mode Select		Event occurred for this mode
4:7	Reserved		

Payload Bytes			
0	Status Change Event Type	0x00	Reserved
		0x01	Mode Change
		0x02	Display Timeout
		0x03-0x0f	Reserved
		0x10	Scroll Complete
		0x11	Scroll Request

Additional Payload Bytes for Scroll Request			
1	Free Scroll Buffer Bytes	0-240	Number of bytes that are free in the scroll buffer

5.17   Button Event Message (0x34)

This message is sent from the watch when a button is pressed (and the button press has been configured to send a message to the phone).

Option Bits			
0:7			Option bits are configured in the enable button command

Payload Bytes			
0	Button Index	BIT 0	Button A
		BIT 1	Button B
		BIT 2	Button C
		BIT 3	Button D
		BIT 4	Reserved
		BIT 5	Button E
		BIT 6	Button F
		BIT 7	Pull Switch (Analog Only)
1	Display Mode	0	Idle mode
		1	Application Mode
		2	Notification Mode
2	Button Press Type	0	Immediate
		1	Press and Release
		2	Hold and Release

		3	Long Hold and Release
		4-255	Reserved
3	Callback Message Type		When a button is pressed this message will be sent. The phone should set this button to (0x34) to receive a message when a button is pressed
4	Callback Message Option		Options in callback message

5.18   General Purpose Phone Message (0x35)

This message is a general message that can be sent to the phone. The sub-type further defines the type of message.

Option Bits			
0:7			User Defined for each message sub-type

Payload Bytes			
0	General Purpose Type		Sub type for the general purpose message
1:n	Data		

5.19   General Purpose Watch Message (0x36)

This message is a general message that can be sent to the watch. A handler must be written for each sub type.

Option Bits			
0:7			

Payload Bytes			
0	General Purpose Type		Sub type for the general purpose message
1:n	Data		

5.20   Write LCD Buffer (0x40)

This message is used to draw image data into one of the 4 modes' buffers (Idle, Application, Notification and Music buffer) or one of the 16 widget-buffers of the Gen2 UI.

Option Bits			
0:1	Mode Select	0-3	Choose which one of 4 modes' buffer to write.
4	Number of Lines	0	Two lines of data in message
		1	One line of data in message
5:6	Reserved		
7	UI Select	0	Gen1 UI
		1	Gen2 4-Widgets and 4-idle-screen based Widget UI

Payload Bytes for Gen1 UI			
0	Row Select A	0-95	Index of first row to copy into the display buffer
1:12	Line A		First row of data to copy
13	Row Select B	0-95	Index of second row to copy into display buffer
14:25	Line B		Second for of data to copy into display buffer (optional)
Payload Bytes for Gen2 UI			

0	Widget ID	1-255	Widget ID of the widget to be written
1	Row Number	0 - 191	The first row number of two rows to be written. One widget can occupy at most 4 adjacent quard-screens. The row number counts quard by quard from left to right and up to bottom.
2:13	Two lines of data		

5.21 Configure LCD Idle Buffer Size (0x42)

This command is used to determine who draws the top 1/3 of the idle screen for Gen1 UI.

Option Bits			
0:7	Reserved		

Payload Bytes			
0	Watch Drawn Idle Buffer Size	0	Watch controls top 30 lines of the display in IDLE mode (This is where the time is drawn).
		1	Phone controls the entire screen in idle mode.

5.22 Update LCD Display (0x43)

This message is used to tell watch which buffer to draw to watch's LCD display.

Option Bits			
0:1	Mode Select		The selected mode buffer will become active.
2:3	Current idle page number	0 - 3	Current idle page number to be set
4	Reserved		
5	Set current idle page	1	Set current idle page to the page specified by bit 2 & 3
6	Grid setting	0-1	0: Show grid on idle screen; 1: No grid on idle screen
7	UI select	0-1	0: Gen1 UI mode buffer or Gen2 UI non-idle mode buffer; 1: Gen2 UI idle mode buffers.

Payload Bytes for Gen1			
0	Start Row	0 - 95	The starting row (of the selected buffer) to be drawn to the display.
1	Number of Rows	1 - 96	The number of rows (of the selected buffer) to be drawn to the display.

5.23 Load Template – LCD only (0x44)

Copy a template stored in flash memory into the display buffer. The clear and fill functions work, but otherwise this message is not implemented.

Option Bits			
0:3	Mode Select		Template will be loaded into selected mode's display buffer
4:7	Reserved		

Payload Bytes			
0	Template Select	0	Write '0' to each pixel in buffer
		1	Write '1' to each pixel in buffer
		2-255	Reserved

5.24 Enable Button (0x46)

Each button press type (immediate, press and release, hold and release, and long hold and release) can generate an event. In addition, each button press type can have a different event for each of the display modes (idle, application, and notification). For example, to cause button A to send a message to the phone when in notification mode the message payload would be 0x2, 0x0, 0x0, 0x34, 0x00. The message 0x34 will be sent to the phone once the button press has been detected (without waiting for the button to be released).

Option Bits			
0:7	Reserved		

Payload Bytes			
0	Display Mode	0	Idle mode
		1	Application Mode
		2	Notification Mode
1	Button Index	0	Button A
		1	Button B
		2	Button C
		3	Button D
		4	Reserved
		5	Button E
		6	Button F
		7	Pull Switch (Analog Only)
2	Button Press Type	0	Immediate
		1	Press and Release
		2	Hold and Release
		3	Long Hold and Release
		4-255	Reserved
3	Callback Message Type		When a button is pressed this message will be sent. The phone should set this button to (0x34) to receive a message when a button is pressed
4	Callback Message Option		Options in callback message

5.25 Disable Button (0x47)

The message is used to remove the association of a message with a button event.

Option Bits			
0:7	Reserved		

Payload Bytes		
0	Display Mode	
1	Button Index	See Enable Button Command for field descriptions.
2	Button Press Type	

5.26 Battery Configuration Message (0x53)

This determines at what voltage level a message is sent to the phone and user indicating a low battery event. This message also determines at what level the Bluetooth radio will be shut off to conserve battery power for watch only operation. The default warning level is 3.5 V and the default Bluetooth off level is 3.3V.

Option Bits	

0:7	Reserved		

Payload Bytes			
0	Warning Level	28-42	Value in 10ths of a volt
1	Bluetooth Off Level	28-42	Value in 10ths of a volt

5.27 Low Battery Warning Message (0x54)

This message is sent to the phone when the battery is low.

Option Bits			
0:7	Reserved		

Payload Bytes			
0:n	Reserved		

5.28 Low Battery Bluetooth off Message (0x55)

This message is sent to the phone when the battery is low and the Bluetooth radio is being shutdown to conserve power and allow the watch to function as a watch.

Option Bits			
0:7	Reserved		

Payload Bytes			
0:n	Reserved		

5.29 Read Battery Voltage Message (0x56)

This message will make the watch return the values for the most recent battery sense cycle. It will not cause a new cycle to be performed. The rate of battery sense cycles is determined by a setting stored in non-volatile memory.

Option Bits			
0:7	Reserved		

Payload Bytes			
0:n	Reserved		

5.30 Read Battery Voltage Response (0x57)

This message contains the results of the most recent battery sense cycle. Battery sense values are in 100ths of a volt. For example, a value of 3000 means 3.0 Volts. The average value is the average over the last 8 samples.

Option Bits			
0:7	Reserved		

Payload Bytes			
0	Clip attached		0: not attached; 1: attached
1	Battery Charging		0: not charging; 1: charging

2	Battery level (low byte)		
3	Battery level (high byte)		
4	Battery level in percentage		0 – 100

5.31   Read Light Sense Message (0x58)

This message will cause a light sensor cycle to be performed.

Option Bits			
0:7	Reserved		

Payload Bytes			
0:n	Reserved		

5.32   Read Light Sensor Response Message (0x59)

This message contains the results of the light sensor cycle. Light sensor readings are in 100ths of a volt. The average is of the last 10 samples.

Option Bits			
0:7	Reserved		

Payload Bytes			
0	Light Sense LSB		
1	Light Sense MSB		
2	Light Sense Average LSB		
3	Light Sense Average MSB		

5.33   Set Widget List Message (0xA1)

This message is used to set a list of widgets configuration including widget ID and widget layout settings. There could be 16 widgets for 4 idle screens at maximum. The payload of one message is 14 bytes which can contains 7 widgets' settings (2 bytes for each widget settings). So it requires at most 3 messages for all 16 widgets' settings. The list shall be in ascending order.

Option Bits			
0:1	Index of the messages	0 - 2	The index of total Set Widget List Messages.
2:3	Total number of the messages	1 - 3	Total number of Set Widget List Messages.

Payload Bytes			
Even byte	Widget ID of Widget n	0 - 254	0 - 15: Home widget drawn by watch; 16 - 254: normal widgets
Odd byte	Widget setting of Widget n	Bits 0:1	Starting quad of the idle screen; 0: upper-left quad; 1: upper-right quad; 2: bottom-left quad; 3: bottom-right quad.
		Bits: 2:3	Layout type: 0: one quad; 1: 2 horizontal quads; 2: 2 vertical quads; 3: 4 quads (full screen).
		Bits: 4:5	Idle screen number of the widget.
		Bit: 6	Inversion setting: 0: widget color is not inverted; 1:widget color is inverted (black -> white and white -> black).

5.34   Music Playing State Message (0x18)

This message is used to tell the watch about current music playing state: either "play" or "stop".

Option Bits			
0	Music playing state	0	Music play is stopped.
		1	Music starts playing.