MOD-SIX
Nixie Clock System
Updating Instructions

February 2018

This manual provides instructions for updating the firmware of the MOD-SIX Nixie Clock System as well as a brief firmware revision history. Hardware upgrade procedures are also covered.

Revision/Update Information:	This is a revised manual
Clock Firmware:	V09-18
RPTR-OLED Firmware:	V47
Keyfob Firmware:	V32
TimeLink receiver Firmware:	V41

http://www.badnixie.com

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WARNING: The clock makes use of high voltages within the case. Use extreme care when operating the clock with the cover removed.

Preface

This manual provides instructions for performing firmware updates as well as a brief firmware version summary for the MOD-SIX Nixie Clock System. Hardware upgrade procedures are also covered.

Intended Audience

This manual is intended for all MOD-SIX Nixie Clock System owners.

Important Cautions

WARNING: Hazardous voltages are present at some locations on the circuit boards when the clock is operating. Avoid touching any components other than the updating dongle while power is applied.

The tubes are extremely fragile and expensive. Take care to avoid damaging them when removing and reinstalling the acrylic cover, when updating the clock firmware, and when moving the clock.

NEVER install or remove the updating dongle or the RF-Link mezzanine board while power is applied.

NEVER connect or disconnect any cables or change the position of any hardware jumpers without first removing power to the item(s) in question. Components such as the optional PIR sensor and the GPS antenna on the RPTR-OLED are not intended for "hot-plug" operation and can cause damage to themselves or other clock components if power is not disconnected first.

Like all electronic devices, the clock system components can be damaged by static electricity. When updating the firmware, always touch the aluminum base plate first to discharge any static.

Applicable hardware

This document covers all versions of the MOD-SIX clock CPU board and keyfob, but only the current-generation RPTR-OLED and TimeLink receiver hardware. For information on updating firmware on older-generation hardware, refer to the archived versions of this document at http://www.badnixie.com/MOD-SIX_Info_Page.html

1 Identifying the installed firmware

In order to determine if there is a newer version of firmware available for any of your clock components, you will need to first determine the current version. This chapter provides instructions for identifying the firmware version of each clock system component.

1.1 Identifying clock firmware

Unplug the power cable from the left rear of the clock. Wait a moment and then plug it back in. As part of the clock's startup messages, it will display the firmware version as "Vxx-xx" where xx-xx is the current firmware version.

1.2 Identifying RPTR-OLED firmware

Disconnect the power from the RPTR-OLED by unplugging the micro USB cable from the RPTR-OLED. Wait a few moments and reconnect the RPTR-OLED's power. The display on the RPTR-OLED will show a series of startup messages, one of which will be "RPTR Vx.x" where x.x indicates the RPTR-OLED's current firmware version.

Caution: The power connector on the RPTR-OLED is rather delicate (as are all micro USB connectors). Ensure you have the end of the cable in the correct orientation when plugging it into the RPTR-OLED.

Notes: The RPTR-OLED also sends this information to the MOD-SIX clock which displays it.

You can also use the RPTR-OLED's VERSION menu command to determine this information.

1.3 Identifying keyfob firmware

Press and hold both the up and down buttons on the keyfob simultaneously for approximately 5 seconds until the keyfob LED flashes orange, then release both buttons. The clock will then display a message of the form "F# x/x" where # indicates the keyfob's current address (0-7) and x/x indicates the keyfob's firmware version.

Note: The clock must be running firmware V08-01 or newer in order to display the keyfob version information.

The same up + down procedure will also display the keyfob version number on the keyfob LED. For example, three green blinks followed by two orange blinks would indicate version V32.

1.4 Identifying TimeLink receiver firmware

Disconnect power to the clock the TimeLink receiver is connected to, wait a few moments, then reconnect power. The LED on the TimeLink receiver will blink blue and then display its firmware version number. Red blinks indicate the major version, while green blinks indicate the minor version. For example, 4 red blinks followed by 1 green blink indicates firmware V4.1. Any subsequent red blinks are part of the TimeLink receiver data stream and not part of the version number.

Caution: NEVER disconnect the TimeLink receiver from a powered-on clock to power cycle the TimeLink receiver (or for any other purpose). Instead, remove power from the clock, which will power off both the clock and the TimeLink receiver.

2 Firmware updating procedures

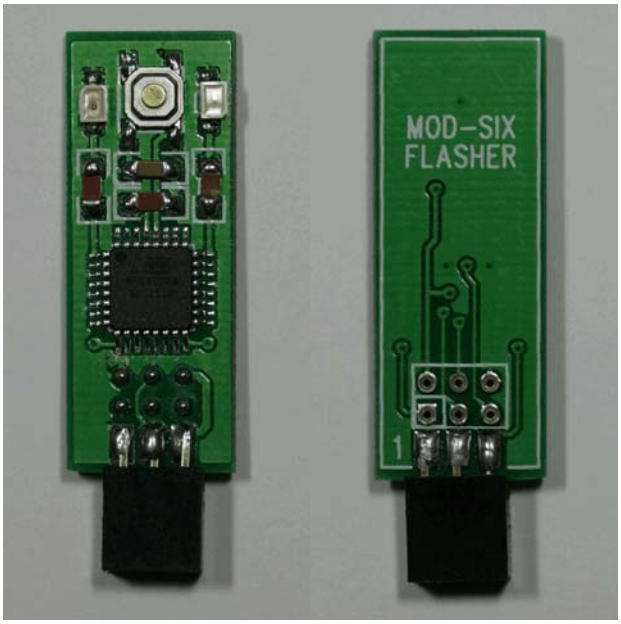
2.1 Clock updating procedure

Clock firmware updates are performed with a small updating dongle. The dongle installs the new firmware onto the clock CPU and is removed once the update is completed.

Note: Depending on your current clock firmware version, you may or may not receive a clock updating dongle.

Note: The dongle checks to make sure it contains appropriate firmware for the device being updated and will not install the update if it is for the wrong device.

Figure 2–1 Updating Dongle (front and back views)

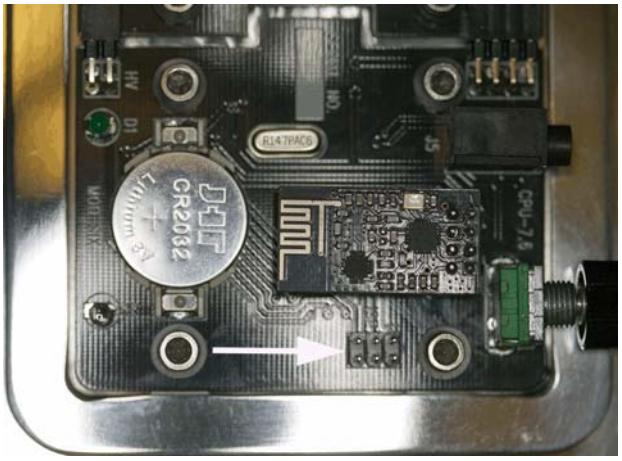


Note: You may want to write down your clock configuration settings before proceeding, as the update process resets the clock to default values.

To perform the update, disconnect the power cord from the clock. Remove the acrylic cover (you may want to use cotton gloves or some similar method to avoid getting fingerprints on the cover) and set it aside. Locate the programming connector on the CPU board, labeled "ISP J4". Note that if you have a GEN I CPU (labeled "CPU 1.0") with an RF-Link mezzanine

board installed, you will need to remove the mezzanine board in order to access the ISP connector.

Figure 2–2 Location of ISP connector on CPU

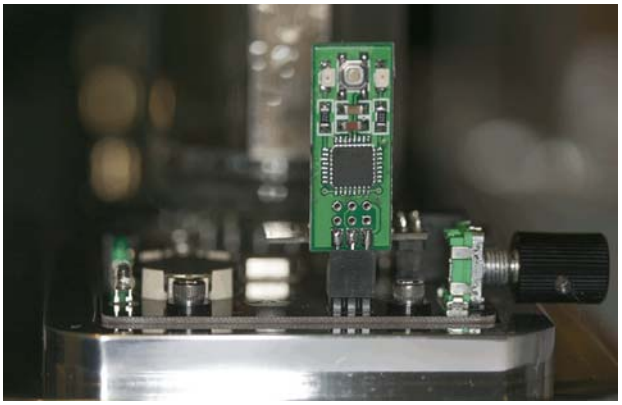


Note: The above picture shows a GEN V CPU. While the layout of the GEN I and GEN II CPU boards is somewhat different, the ISP connector is in the same general location and orientation.

Install the updating dongle on the CPU with the dongle components facing away from the tubes. Make sure that all 6 pins on the dongle are on the matching pins on the CPU, not offset by one pin.

WARNING: The clock generates and uses high voltages to operate the tubes. Use caution to not touch any clock components other than the updating dongle when performing the update procedure.

Figure 2–3 Dongle installed on CPU



Apply power to the clock and wait for it to proceed through its normal startup. If the clock does not power on and display the normal startup messages, immediately disconnect the power and check your installation of the updating dongle.

Press the button on the top center of the updating dongle. It is rather small, and you may have trouble pressing it if you have large fingers. There should be an obvious tactile "pop" when it is successfully pressed.

The red and green LEDs on the dongle will light while updating is in progress. This normally completes within a few seconds. After the update completes, the green LED will remain lit to show a successful update and the clock will reset and display the new firmware version. If the red LED is lit instead, the firmware update was unsuccessful and you should press the button again to repeat the update procedure.

Note: During the updating process, the tubes may go blank or freeze while displaying a message. This display may be brighter or dimmer than normal operation and does not indicate a problem with the update process.

Once updating is complete, disconnect power from the clock and remove the updating dongle. If you removed an RF-Link mezzanine board, reinstall it, being careful to align all the connectors properly. Place the dongle back into its antistatic bag and reinstall the acrylic cover on the clock.

Apply power to the clock and set your desired configuration options. You may wish to review the features in the latest *MOD-SIX Nixie Clock System User's Guide* to see if there are any new options you'd like to explore.

2.1.1 Return of the updating dongle

Once you have confirmed that the firmware has been updated and all components are operating normally, please email badnixie@badnixie.com for the address to return the dongle to.

Notes: A single dongle and its packaging can be mailed in a regular envelope and should be under 1 ounce.

Returning the dongle lets us send it to another clock owner and keep costs down.

2.2 RPTR-OLED updating procedure

The RPTR-OLED firmware and lexicon (random word dictionary) is updated wirelessly using Bluetooth® low energy via the nRF Toolbox utility. This free utility is available for Apple® iPhone® and iPad® devices as well as Android™ phones and tablets. Separate examples are provided here for Android devices and Apple devices; however, the nRF Toolbox operates similarly on both types of devices.

You will need the following in order to update the RPTR-OLED firmware:

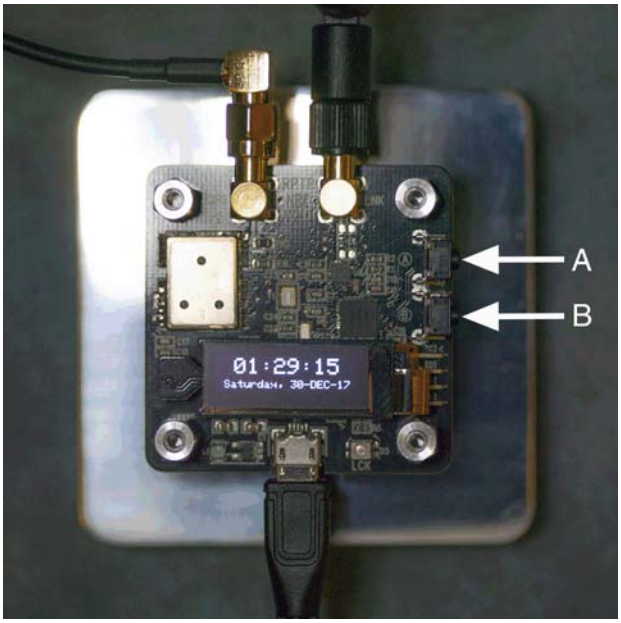
- RPTR-OLED with its power adapter and micro USB cable

- Apple iPhone or iPad, or Android phone or tablet with Bluetooth low energy support in both hardware and operating system
- nRF Toolbox for Apple devices, available free from the Apple App Store at https://www.apple.com/ios/app-store
- nRF Toolbox for Android devices, available free from Google Play at https://play.google.com/store/apps
- Updated RPTR-OLED firmware kit, downloaded from http://www.badnixie.com/MOD-SIX_Info_Page.html and copied to your phone or tablet

The firmware kit contains a number of firmware images with various lexicons; most users will want the *nrfXX-large.zip* which has the full set of four- and six-letter words. *XX* refers to the version of the RPTR-OLED firmware.

The following figure shows the top of the RPTR-OLED and buttons (clear acrylic cover removed for clarity):

Figure 2–4 RPTR-OLED top view showing button locations



Disconnect power from the RPTR-OLED by unplugging the micro USB power cable from the connector on the RPTR-OLED. While pressing and holding the B button on the RPTR-OLED, plug the micro USB power cable back into the RPTR-OLED. The RPTR-OLED LED will indicate the device is in update mode by illuminating solid purple.

Caution: The power connector on the RPTR-OLED is rather delicate (as are all micro USB connectors). Ensure you have the end of the cord in the correct orientation when plugging it into the RPTR-OLED.

Notes: **If the RPTR-OLED does not start to receive new firmware within 2 minutes after entering update mode, the update mode will time out and the unit will return to normal operation.**

If you download incorrect firmware to the RPTR-OLED, simply repeat the process from the beginning using the correct firmware.

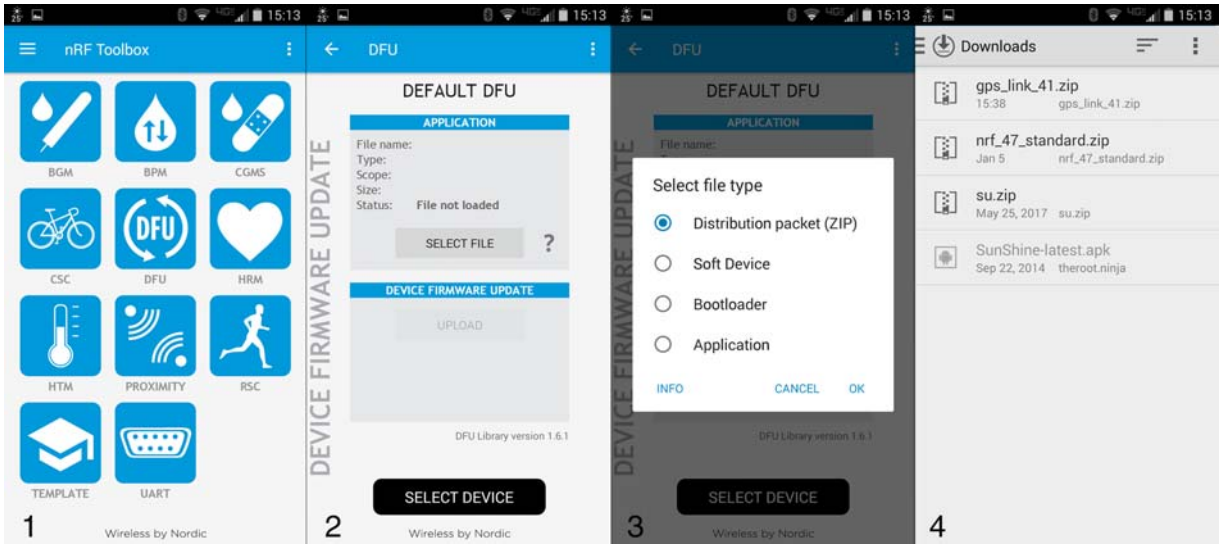
Ensure you have downloaded the correct RPTR-OLED firmware kit and not firmware for the older GPS repeater.

Updating the RPTR-OLED firmware does not change any previously configured settings on the unit.

2.2.1 Updating procedure using Android devices

Refer to the following illustrations for examples of each updating step.

Figure 2–5 Updating steps 1-4 (Android)



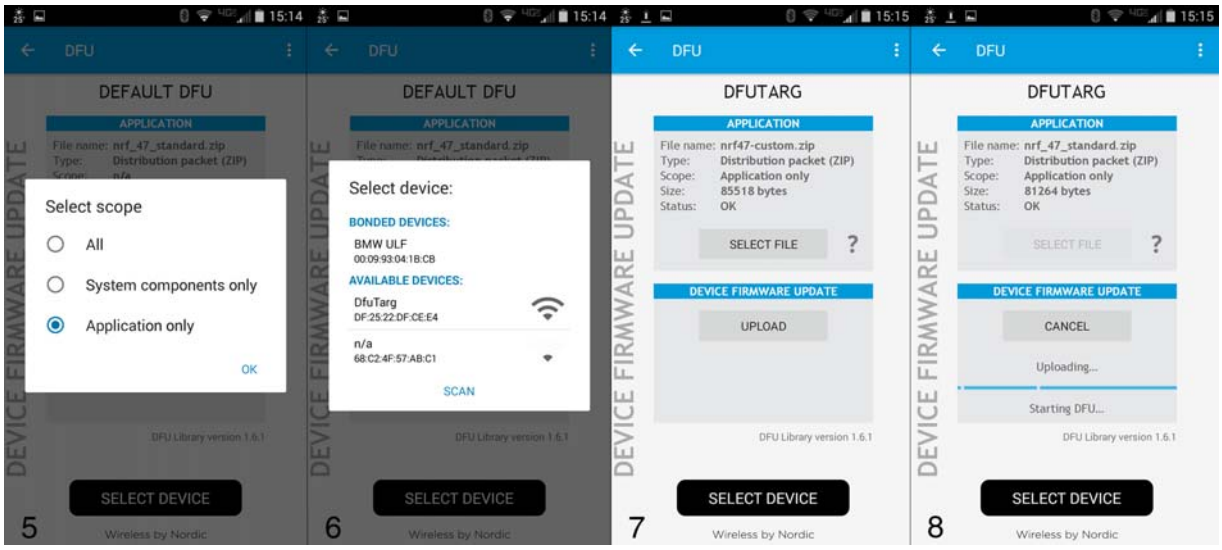
1 Launch the nRF Toolbox app on your phone or tablet and tap the "DFU" (device firmware upgrade) icon

2 Tap the "SELECT FILE" button

3 Select the "Distribution packet (ZIP)" file type and tap "OK"

4 Select the appropriate update file from the list of files shown by tapping on the file name

Figure 2–6 Updating steps 5-8 (Android)



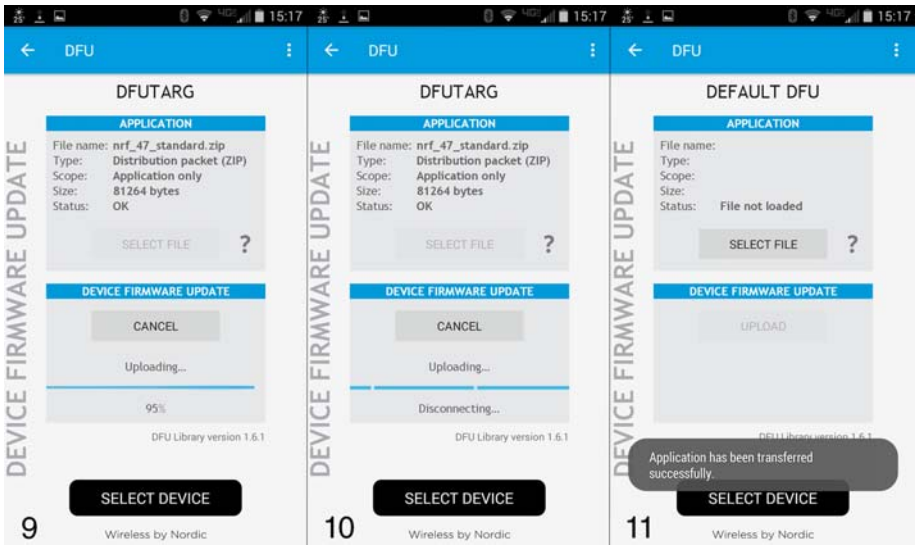
5 Select "Application only" scope and tap "OK"

6 Tap the "SELECT DEVICE" button and select the "DfuTarg" device from this list of available devices by tapping on it

7 Tap "UPLOAD" to begin the upload process

8 The app will display "Starting DFU"

Figure 2–7 Updating steps 9-11 (Android)



9 The app will show the progress of the update (this will take several minutes to complete) and the LED on the RPTR-OLED will change to solid yellow to indicate that the download is in progress

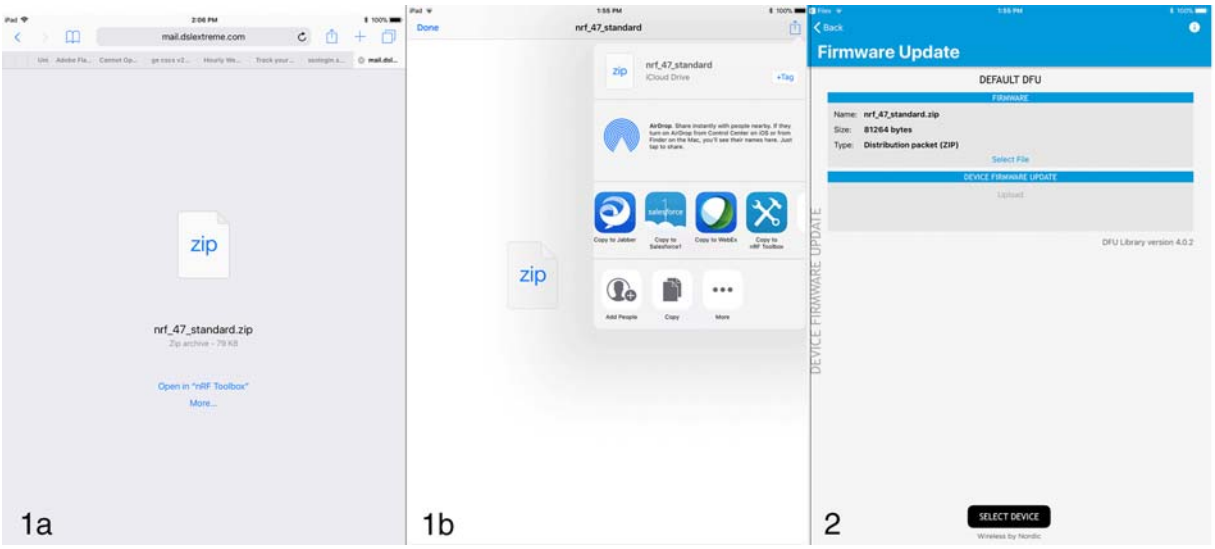
10 The app will disconnect from the device

11 The app will display "Application has been transferred successfully"

2.2.2 Updating procedure using Apple devices

The procedure on Apple iPhone and iPad devices is somewhat less complex as the nRF Toolbox registers itself as a type handler for ZIP archives. You can simply email the update file to your Apple device or save it in iCloud® and click on it to perform the update procedure. Refer to the following illustrations for examples of each updating step.

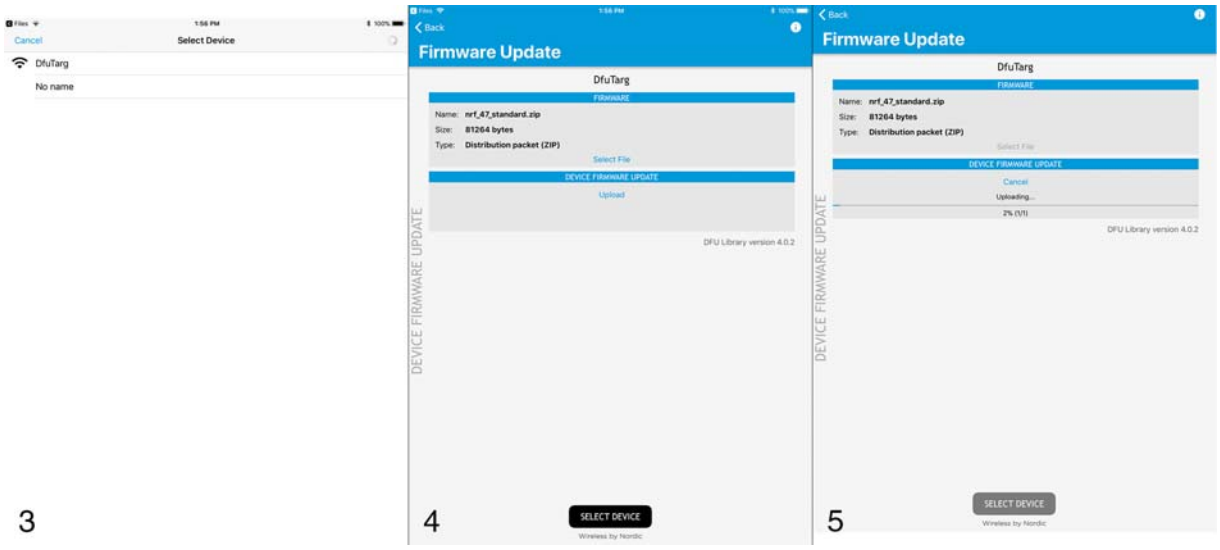
Figure 2–8 Updating steps 1-2 (Apple)



1 Tap on the email attachment containing the update file and then tap on "Open in nRF Toolbox" (if this is not the default choice, tap on "More" to select nRF Toolbox) **or** select the update file in iCloud and tap on "Copy to nRF Toolbox"

2 nRF Toolbox opens and displays information about the firmware file, tap on "SELECT DEVICE"

Figure 2–9 Updating steps 3-5 (Apple)



3 Select the "DfuTarg" device from this list of available devices by tapping on it

4 Tap on "Upload" (it is not obvious that this is a button, it is approximately 1/3 of the way down the image)

5 The app will show the progress of the update (this will take several minutes to complete) and the LED on the RPTR-OLED will change to solid yellow to indicate that the download is in progress

Figure 2–10 Updating step 6 (Apple)

6 The app will display "DFU Upload complete"

2.3 Keyfob updating procedure

Due to the small size of the keyfob circuit board and enclosure, it is not practical for most users to upgrade the keyfob firmware. Firmware updates will be handled by a "return for update" procedure if it becomes necessary to update the keyfob firmware.

2.4 TimeLink receiver updating procedure

The procedure for updating the TimeLink receiver is exactly the same as for the RPTR-OLED, except as follows:

- The firmware package will be named *gps_link_XX.zip* instead of *nrfXX-lexname.zip* (where *XX* indicates the version number).
- Firmware update mode is entered by pressing and holding the single button on the TimeLink receiver while applying power to the clock connected to the TimeLink receiver instead of pressing and holding the B button on the RPTR-OLED.
- The TimeLink receiver firmware download is indicated by a blue LED instead of a yellow LED as on the RPTR-OLED.

Caution: NEVER disconnect the TimeLink receiver from a powered-on clock to power cycle the TimeLink receiver (or for any other purpose). Instead, remove power from the clock, which will power off both the clock and the TimeLink receiver.

3 Version history

Note: Gaps in version numbers indicate unreleased development versions.

3.1 Clock version history

- V06-06 - Version shipped with original GEN I clocks †
- V07-07 - Version shipped with GEN II clock kits ‡
- V07-09 - Version shipped with assembled GEN II clocks ‡
- V07-53 - Version shipped with GEN IIv7 clocks ‡
- V08-08 - Version shipped with GEN IIv8 (SLW) clocks ‡
- V09-15 - Version shipped with GEN V PIR clocks, hard-wired PS/2 GPS support removed
- V09-18 - Version fixing internal day-of-week calculation for non-GPS / non-RPTR-OLED clocks, latest version

Notes: † Indicates 1st-generation CPU hardware (labeled "CPU 1.0" on the board, possibly with "MOD-SIX RF-LINK" radio daughterboard).

‡ Indicates 2nd-generation CPU hardware (labeled "CPU 1.8" on the board).

3.2 GPS repeater / RPTR-OLED version history

- V10 - Version shipped with GEN II clocks and GEN I upgrade kits †
- V26 - Version shipped with GEN IIv7 clocks †
- V27 - Version shipped as an update for GEN IIv7 clocks †
- V36 - Version shipped with GEN IIv8 (SLW) clocks with word dictionary ‡
- V41 - Version fixing New Year 2016 date bug ‡
- V46 - Version shipped with RPTR-OLED for GEN V PIR clocks
- V47 - Version adding LNK and GPS diagnostic menus to RPTR-OLED, latest version

Notes: † Indicates 1st-generation GPS repeater (labeled "MOD-SIX GPS-RPTR" on the board, not otherwise covered in this manual).

‡ Indicates 2nd-generation GPS repeater (labeled "RPTR-NEX VER 2.8" on the board, not otherwise covered in this manual).

3.3 Keyfob version history

- V12 - Version for prototype (Sparkfun) hardware †
- V14 - Version shipped with GEN IIv8 (SLW) clocks ‡
- V32 - Version shipped with GEN V PIR clocks, latest version

Notes: † **Indicates prototype keyfob.**

‡ **Indicates 1st-generation keyfob.**

Other than hardware changes for manufacturing, including a different set of LED colors and a black case instead of translucent, there are no user-visible hardware or software changes between the 2 different non-prototype keyfobs.

3.4 TimeLink receiver version history

- V41 - Version shipped with GEN V clocks, latest version

A Building custom lexicons

A.1 Lexicon build procedure

A pre-built version of the *lex_make* utility for Windows® systems is provided (as *lex_make.exe*) in the root directory of the kit. Pre-built versions of *lex_make* for various other operating systems are provided in the *arch_bin* directory in the kit. Refer to the *0-README.txt* file in that directory for information on its contents.

Note: Pre-built *lex_make* files (other than the official Windows executable) are provided as an unsupported convenience and may not be up-to-date with the source files in the *src* directory. The source files should compile and run on any system with a modern C compiler and runtime library. Instructions for compiling the *lex_make* utility are outside the scope of this document; refer to your operating system or compiler documentation for more information.

The *lex_make* utility reads a configuration file and creates a custom firmware image based on the supplied configuration. Here is a sample config file named *lex_large.cfg*:

```
nrf-47.bin
nrf47-large
LARGE
words/flw_dirty.txt
words/slw_dirty.txt
words/flw_large.txt
words/slw_large.txt
```

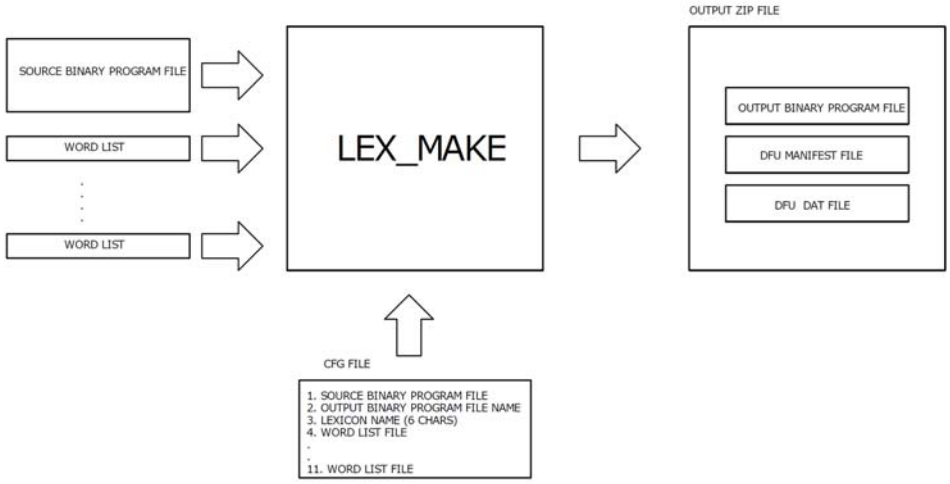
The first line contains the filename of the actual RPTR-OLED executable code file. The second line is the name of the firmware file to create (the utility will create the firmware update ZIP file using this file name). The third line is the display name of the lexicon which will be shown by the clock and RPTR-OLED when the RPTR-OLED powers on or is paired with the clock. The following lines, which can be as few as 1 or as many as 8, list the filenames of lexicons to be incorporated into the firmware. This example includes both the 4- and 6-letter "dirty" lexicons as well as the 4- and 6-letter large lexicons. Additional lexicons can be found in the "words" subdirectory and example config files which use them are also provided.

Notes: The RPTR-OLED firmware file referenced on the first line of the config file can be either "naked" firmware with no lexicon, or firmware with an embedded lexicon, such as the .bin file from the ZIP produced by the *lex_make* utility. Any pre-existing lexicon is removed by the *lex_make* utility.

If you specify more than 8 lexicon filenames, you will receive a warning for the 9th (and any additional) lexicon filename: *WARNING: Config line # discarded.*

The following graphic illustrates the *lex_make* process:

Figure A–1 *lex_make* process



The lexicons are stored in a special compressed format in order to increase the number of words which will fit in the RPTR-OLED. The *lex_make* utility attempts to verify that the created firmware image will be small enough to fit in the RPTR-OLED, however, it does not guarantee that this is the case. If you add a very large number of words, you may exceed the storage capacity of the RPTR-OLED.

The following example shows the the contents of the firmware kit, a sample config file, and the procedure to create firmware with the LARGE lexicon:

```
S:\lex_make>dir/o:n/s
 Volume in drive S is terry
 Volume Serial Number is 422E-E3AA

 Directory of S:\lex_make

01/26/2018  08:49 PM    <DIR>          .
12/18/2017  10:35 AM    <DIR>          ..
01/26/2018  08:47 PM    <DIR>          arch_bin
01/21/2018  06:00 AM               109 lex_basic.cfg
01/21/2018  06:00 AM                69 lex_clean_only.cfg
01/21/2018  06:00 AM                69 lex_dirty_only.cfg
01/21/2018  06:00 AM               109 lex_large.cfg
01/26/2018  08:34 PM           149,006 lex_make.exe
01/05/2018  11:15 AM           129,852 nrf-47.bin
01/26/2018  08:48 PM            75,685 nrf47-basic.zip
01/26/2018  08:48 PM            75,541 nrf47-clean.zip
01/26/2018  08:48 PM            18,310 nrf47-dirty.zip
01/26/2018  08:48 PM            85,441 nrf47-large.zip
01/26/2018  08:26 PM    <DIR>          src
01/23/2018  08:08 PM    <DIR>          words
              10 File(s)        534,191 bytes
```

```
 Directory of S:\lex_make\words

01/23/2018  08:08 PM    <DIR>          .
01/26/2018  08:49 PM    <DIR>          ..
11/10/2017  08:53 AM            20,395 flw_basic.txt
11/10/2017  08:53 AM               145 flw_dirty.txt
11/10/2017  08:53 AM            27,051 flw_large.txt
11/10/2017  08:53 AM           112,058 slw_basic.txt
11/10/2017  08:53 AM               138 slw_dirty.txt
11/10/2017  08:53 AM           126,164 slw_large.txt
               6 File(s)        285,951 bytes

 Directory of S:\lex_make\src

01/26/2018  08:26 PM    <DIR>          .
01/26/2018  08:49 PM    <DIR>          ..
01/26/2018  08:24 PM            18,608 lex_make.c
01/23/2018  05:56 PM               281 Makefile
01/23/2018  05:27 PM               293 Makefile.win32
01/19/2018  04:21 PM            23,041 miniz.c
01/19/2018  07:25 PM            22,865 miniz.h
01/19/2018  04:21 PM             2,516 miniz_common.h
01/19/2018  04:21 PM            69,428 miniz_tdef.c
01/19/2018  04:21 PM             9,836 miniz_tdef.h
01/19/2018  04:21 PM            37,468 miniz_tinfl.c
01/19/2018  04:21 PM             7,996 miniz_tinfl.h
01/19/2018  04:21 PM           183,605 miniz_zip.c
01/19/2018  04:21 PM            23,862 miniz_zip.h
              12 File(s)        399,799 bytes

 Directory of S:\lex_make\arch_bin

01/26/2018  08:47 PM    <DIR>          .
01/26/2018  08:49 PM    <DIR>          ..
01/22/2018  02:03 AM               803 0-README.txt
01/26/2018  08:43 PM            91,992 lex_make.el6_8.amd64
01/26/2018  08:39 PM            90,812 lex_make.el6_8.i686
01/26/2018  08:34 PM            92,328 lex_make.fbsd8_4.i386
01/26/2018  08:46 PM            99,492 lex_make.osx10_8.amd64
01/26/2018  08:34 PM           149,006 lex_make.win32.exe
               6 File(s)        524,433 bytes

     Total Files Listed:
              34 File(s)      1,744,374 bytes
              11 Dir(s)  55,860,920,320 bytes free

S:\lex_make>type lex_large.cfg
nrf-47.bin
nrf47-large
LARGE
words/flw_dirty.txt
words/slw_dirty.txt
words/flw_large.txt
words/slw_large.txt
```

```
S:\lex_make>lex_make lex_large.cfg
LEXICON MAKE UTIL VER NRF1.2e,  Jan 2018 HCO
Processing config file:"lex_large.cfg"
Processed "words/flw_dirty.txt", 25 total words were processed from text file.
Processed "words/slw_dirty.txt", 16 total words were processed from text file.
Processed "words/flw_large.txt", 5274 total words were processed from text file.
Processed "words/slw_large.txt", 17704 total words were processed from text file.
Total lines processed = 2882
Total regular four letter words = 5274
Total regular six letter words = 17704
Total dirty four letter words = 25
Total dirty six letter words = 16
Total words = 23019
Now generating output app data.
43008 bytes were read from input bin file into app buffer.
Lexicon "LARGE " output to app buffer "nrf47-large.app".
129852 (0x1FB3C) bytes were written to output app buffer with a generated crc16 ...
Creating final zip output from temp data.
Deleting existing "nrf47-large.zip" file.
Created "nrf47-large.zip" OTA DFU package.
```

Notes: File sizes and timestamps may be different than shown in this example.

The above example shows the Windows command-line environment. Operation will be similar under other operating systems. Refer to the following section for general guidance.

A.1.1 *lex_make* on non-Windows systems

As there are a large number of non-Windows systems, it is not practical to provided detailed instructions for every possible system users might have. This section provides general guidance. This section assumes that you have a UNIX®-like operating system. This includes FreeBSD®, Linux® and Mac® OS X® among others. It is expected that users will be familiar with the system they are using and have access to their system documentation and / or help files if needed.

lex_make is a command line (CLI) utility and not a menu-based application. Therefore, you will need to open a window that exposes the command line. On many systems, this is an application named "Terminal". It might also be referred to as a "shell". The following procedure refers to this as "Terminal". Substitute your application's name if it is different.

1 Download the combined firmware and *lex_make* kit from http://www.badnixie.com/MOD-SIX_Info_Page.html to your computer.

2 Open a Terminal window.

3 Unpack the distribution kit with the command *unzip filename* where *filename* is the directory (often "Downloads"), a slash, and the name of the firmware kit. For example: *unzip Downloads/lex_make_47.zip*

4 Type the command *cd lex_make*

5 Use the *cp* command to copy the appropriate binary for your system from the *arch_bin* subdirectory. For example, if you are using Mac OS X: *cp -p arch_bin/lex_make.osx10_8.amd64 ./lex_make*. Refer to the *arch_bin/0-README.txt* file for information on the various files in that directory.

6 Mark the *lex_make* binary you copied in the previous step as executable by typing the command *chmod 555 ./lex_make.bin*

7 Run the *lex_make* utility, specifying the name of the configuration file to be used. For example: *./lex_make lex_large.cfg*

The *lex_make* utility should produce similar output as the example shown above for Windows. Once you have created the update ZIP file, copy it to your phone or tablet and use it to update the RPTR-OLED using the procedure in Section 2.2.

A.2 Lexicon file format

The word files used by the *lex_make* utility have a simple format: 4 or 6 letters followed by either a space or the end of a line. Comment lines beginning with "//" may appear anywhere in the word files. The following sample shows the first few lines of the *flw_basic.txt* file:

```
// four letter words
aani aaru abac abas abba abby abed abel
abet abey abie abir able ably abox absi
abut acca acer ache achy acid acis acle
```

Similarly, this sample shows the first few lines of the *slw_basic.txt* file:

```
aahing aaliis aarrgh abacas abacus abakas abamps abased abaser abases
abasia abated abater abates abatis abator abayas abbacy abbess abbeys
abbots abduce abduct abeles abelia abhors abided abider abides abject
```

To mark a word as "dirty", simply capitalize one or more letters of the word. For example, to mark the word abacus as dirty, simply change the first line of the above sample to:

```
aahing aaliis aarrgh abacas abaCus abakas abamps abased abaser abases
```

You could use ABACUS, Abacus, aBaCuS or any other combination of capital and lowercase letters - as long as there is at least one capital letter, the word will be marked as dirty.

Note: There is no reason (other than convenience) that the dirty word lists and 4- and 6-word lists are stored in separate files. You can merge them into a single file (or any other way useful to you) if you prefer.

A.2.1 Suggestions for managing custom lexicons

We suggest that you create a new .cfg file using one of the existing ones as a template and that you also add your words to a separate lexicon file. Future updates to the RPTR-OLED firmware utility may overwrite the existing configuration and lexicon files. Using your own names for these files will ensure that your changes are preserved across updates. For example, you could create a file named *lex_custom.cfg* with these contents:

```
nrf-47.bin
nrf47-custom
CUSTOM
words/flw_dirty.txt
words/slw_dirty.txt
words/flw_large.txt
words/slw_large.txt
words/my_words.txt
```

You would then add your words to the *words/my_words.txt* file.

You may add foreign words to the lexicon files if you so desire. However, those words should be modified (if necessary) to contain only the English letters A through Z as the tubes in the clock can only display English letters.

The *lex_make* utility does not check for words which are duplicated in the input lexicons. You can use this to make one or words more likely to appear on the clock by simply adding the word to your custom lexicon. For example, if you wanted to have the word 'abacus' appear more often, you could add lines like this to your custom lexicon file:

```
abacus abacus abacus abacus abacus abacus abacus abacus abacus abacus
abacus abacus abacus abacus abacus abacus abacus abacus abacus abacus
```

This will make the word 'abacus' approximately 20 times more likely to appear. Most lexicons have tens of thousands of words, so even 20 times does not guarantee that a word will appear frequently.

Note: When you receive a new firmware update package, you should check to see if the name of the RPTR-OLED executable code file has changed, and make the corresponding changes to your .cfg file (the first and second lines). This ensures that your custom lexicon includes the latest RPTR-OLED firmware.

B Advanced updating techniques

The above clock updating procedure presumes that you are using the supplied updating dongle when updating the firmware. Clock firmware updates are also available (upon request) as .hex files for those who have their own programming capability. In this case, the firmware is directly installed onto the clock without using an updating dongle as an intermediary. As a minimum, you will need flashing software such as AVRDUDE (http://www.nongnu.org/avrdude) or eXtreme Burner (http://extremeelectronics.co.in/category/software/) as well as a compatible programmer such as the USBasp (http://www.fischl.de/usbasp). The choice of programming hardware and software is up to you. However, not all combinations (in fact, very few) have been tested by us so some experimentation may be needed. Here are some pointers which may be useful:

- The CPU on the clock is an ATMEGA168A and should be programmed at 5V.
- Many USBasp devices come with a 10-pin programming connector. In that case, you will need a 10-pin to 6-pin adapter for programming the MOD-SIX clock.
- On some programmers / adapters, the 6-pin connector has a large keying tab which may interfere with seating the adapter on the ISP connector.
- The dongle's checks for appropriate firmware type do not apply when directly programming the MOD-SIX clock. Therefore, it is definitely possible to flash something that doesn't work. As long as you do **NOT** reprogram the fuses, you should be able to recover by flashing a valid firmware image.
- If you are at all uncertain about the correct orientation / pinout of the ISP connectors on the clock, refer to the schematic and board artwork package provided with the clock.

C Supported combinations of hardware and firmware

This manual assumes that your MOD-SIX System consists of the latest versions of all of the clock hardware. However, many users will be upgrading some or all hardware components as part of a "refresh" of their MOD-SIX. This section attempts to provide some guidance for what combinations will or will not work.

The only officially-validated hardware / firmware combinations are:

- The latest hardware versions of all components, with the latest firmware on each
- As above, but with a GEN II (marked "CPU 1.8") CPU, running V08-08 firmware
- As above, but with "CPU 1.8" CPU, running V09-18 firmware

However, other combinations are likely to work as long as the hardware and firmware combination supports the expected features - for example, keyfob support requires minimum CPU firmware of V08-08. Refer to Chapter 3 to find when a particular feature was introduced. In general, features are only added, not removed. However, hard-wired PS/2 GPS receiver support was removed in firmware V09-15 and later as the hardware to support it was also removed from the "CPU-7.6" board.

C.1 Physical component compatibility

One common upgrade is to transplant existing clock components into a newer-style case.

C.1.1 Older components into newest case

This is likely to be the most common scenario. You will need a new stepped ("ziggurat") baseplate and new acrylic top, as well as the latest "CPU 7.6" CPU board. You will also need a 7/64" Allen® wrench (hex key) and either a fine file or sandpaper. A nail file will also work nicely. You may also wish to use cotton gloves to avoid getting fingerprints on the acrylic clock cover, tubes, and other components. Perform the following steps in sequence to complete the upgrade:

- Note your existing clock settings as you will need to re-enter them on the new CPU board when the upgrade is complete.
- Disconnect power and any accessories from your existing MOD-SIX clock.
- Find a suitable location to place both your old clock and the new components and move them there.
- Remove the acrylic cover from your existing clock and set it aside.

- Carefully unplug each of the 6 B-7971 tubes in sequence and set them aside for later. Ensure they remain in the same order for re-installation, as the tube pins may have been adjusted to fit specific sockets on your clock.
- Remove the 4 Allen screws and black plastic washers from the PSU board and carefully slide the PSU board to the left to remove it from the clock baseplate.
- Remove the 4 Allen screws and washers from the CPU board and carefully slide the CPU board to the right to remove it from the clock baseplate.
- Remove the 5 Allen screws and washers from each of the 3 TDU boards. You may lift the set of 3 joined TDU boards as a single assembly. Take care to not flex the assembly at the joints between the 3 boards.
- Set the old baseplate, acrylic cover and CPU aside. You may wish to use the packing material the new components were shipped in to store them.
- Using the file or sandpaper, carefully file the 2 outside corners (the corners without connectors) of your existing PSU board to fit the radiused corners of the new baseplate. Test-fit the PSU to ensure sufficient clearance from the baseplate at those corners and confirm that the 4 mounting holes in the PSU line up with the mounting points on the baseplate. It is better to take off too little material with the file than too much. Repeat until you have a good fit between the PSU and the baseplate. Finish by bolting the PSU to the baseplate with 4 Allen screws and black plastic washers. At this point, hand-tighten the screws. Hand-tighten **only**!
- Lift the 3-board TDU assembly and carefully slide its connector pins into the sockets on the PSU board. Use 5 Allen screws and washers to attach each TDU board to the baseplate. You may need to wiggle the TDU boards to get the holes to line up with the mounting holes in the baseplate. Hand-tighten the screws.
- Plug the new CPU board into the rightmost TDU board and use the remaining 4 Allen screws and washers to attach the CPU board to the baseplate. As above, you may need to wiggle the CPU board to get the holes to line up with the baseplate. Hand-tighten the screws.
- Tighten each of the 23 Allen screws finger-tight **only**.
- Reinstall the 6 B-7971 Nixie tubes on the 3 TDU boards. As noted above, ensure they are reinstalled in the same order.
- Inspect your work area for any missed items such as screws and washers.
- Apply power to the clock and verify that it powers up properly and all tubes are functioning as expected. Refer to the *MOD-SIX Nixie Clock System User's Guide* for additional information and troubleshooting procedures.

- Using the clock's menus, configure your CPU board with your desired options. If you were previously running firmware older than V09-15, note that some menu items have been changed and new ones added.
- Install the new acrylic cover on the clock.
- Install the clock in the desired location. Note that the control knob on the CPU board has moved from the right side to the rear of the clock, so you may want to allow a little extra space for it.

Notes: The GEN V acrylic cover is shorter than the GEN I and GEN II covers. Attempting to re-use an older cover by cutting an opening in the back of the cover for the control knob and PIR will result in a cover with a large gap between the tops of the tubes and the top of the cover. We strongly suggest ordering the new baseplate and cover as a set.

Similarly, attempting to use a GEN V cover on a GEN I or II clock will result in the cover resting on the tops of the tubes instead of seating on the baseplate, due to the GEN V cover being shorter than the GEN I or GEN II cover.

Cautions: The tubes are extremely fragile, so you should take care to temporarily store them somewhere they won't roll off a table or hit each other and break.

Take care to not scratch the new baseplate when installing any components in it. Also, hand-start the Allen screws when mounting components to the new baseplate. As the baseplate is made of relatively soft aluminum, it is possible to damage the component mounting threads by "cross-threading" the screws. The screws should turn freely when hand tightened.

Like all electronic devices, the clock can be damaged by static electricity. Take care to avoid damaging any of the clock components. Use of an anti-static mat is ideal if you have one. Otherwise, an anti-static bag or foam will work fine. Do not use a pure conductive material such as aluminum foil, as the CPU module contains a battery which can be shorted out by the foil.

C.1.2 2nd-generation CPU into original case

Note: This information is provided for completeness; this is not an upgrade likely to be performed at this time.

You may install a second-generation "CPU 1.8" board in an original MOD-SIX clock with a "CPU 1.0" board. Simply remove the 4 Allen screws and black plastic washers attaching the CPU to the baseplate, swap the CPU board, and reinstall the 4 Allen screws and washers. Unless you plan on using a hard-wired PS/2 GPS receiver with this CPU, you can re-use your existing acrylic cover. If you do plan on using a hard-wired PS/2 GPS receiver, you will need a GEN II type acrylic cover with matching cutout for the PS/2 connector.

Note: Hard-wired PS/2 GPS support was removed in clock firmware V09-15 and newer. If you plan on using this feature, ensure you are running firmware older than V09-15.

GEN I acrylic covers only have a single notch in the rear for the power connector, while GEN II covers have a second notch for the PS/2 connector. Both GEN I and GEN II covers have a notch on the right side for the CPU board control knob. GEN V covers are not compatible with GEN I or GEN II clocks as the CPU control knob (and corresponding cover cutout) has moved to the rear on GEN V clocks. Refer to Section C.1.1 for the procedure to upgrade a GEN I or GEN II clock to a GEN V.

C.2 PIR support on older CPUs

While not officially supported, the PIR sensor should work on GEN II CPUs (marked "CPU 1.8") with firmware V09-15 or newer installed. You will need to build a custom cable as described below. This mode of operation is incompatible with both the GEN II CPU's hard-wired PS/2 GPS connection and the optional GEN I CPU's RF-LINK daughterboard.

Refer to the *MOD-SIX Nixie Clock System User's Guide* for information on configuring the PIR options on the clock.

PIR Pin	Description	EXP (J5) Connection
Tip	5V power to PIR	Pin 2
Ring	Activity detection from PIR	Pin 3
Sleeve	Ground	Pin 1

C.3 Firmware compatibility

The latest CPU firmware can be installed on GEN I and GEN II clocks. Note that hard-wired PS/2 GPS receiver support has been removed from CPU firmware V09-15 and later, so in the unlikely event that you are using that feature you should continue to use firmware **older** than V09-15.

GPS repeater / RPTR-OLED firmware is only compatible within its specific generation. So you should use firmware V27 for 1st-generation GPS repeaters, firmware V41 for 2nd-generation GPS repeaters, and firmware V46 or later for the current RPTR-OLED. Refer to Section 3.2 to identify which generation of GPS repeater you have.

Similarly, keyfob firmware is only compatible with hardware from the matching keyfob generation. However, as there has never been a customer firmware update for the keyfob, this should not be a concern.

At this time there is only a single generation of TimeLink receiver hardware, so all TimeLink receiver firmware is compatible.