

# # ROM PlusPlus (ROM++) For the Apple II/II+

ROM++ is an extended ROM for the Apple II/II+ equipped with the [ROMX+](<https://theromexchange.com/hardware/romx-plus>).

ROM++ makes use of the INTCXROM softswitch support of the ROMX+ in order to support new features.

## ## New Features

### ### Enhanced Reset

In general, during normal operation:

- \* A single RESET does as usual.
- \* Two resets in quick succession will restart the machine.
- \* Three (or more) resets in quick succession will bring up the boot menu (see below).

Immediately after a cold start from the ROMX+ menu or power switch (if no delay set in the ROMX+), only one additional reset is required to reach the boot menu.

Once the system starts to boot a disk, but before software has used the KEYIN routine, only two resets are required to reach the boot menu.

### ### Boot Menu

The following functions are available in the boot menu:

- \* Hit ESC to resume normal boot.
- \* 0: Finish reset and enter the monitor.
- \* 1-7: Finish reset and boot the given slot if it contains a recognized storage device.
- \* 8: Finish reset and enter BASIC.
- \* 9: Enter the ROMX+ menu immediately (see note below).

Additional resets while the boot menu is displayed will return to the boot menu, unless another key has been pressed in between, after which a reset will cause the machine to reboot.

Note: when the ROMX+ menu is selected, the code will attempt to enable the internal ROM of the ROMX+ and jump to the menu. The code checks ID bytes for the ROMX+ and if they do not match, a jump to the RESET vector is made instead. This will occur if ROM++ is loaded into an Apple IIe emulator, for instance.

### ### Boot SmartPort Devices

The boot code has been updated to the same slot scan as the Enhanced Apple IIe, so SmartPort devices may be booted directly. Note that SmartPort devices may assume that there is 65C02 and enhanced interrupt support in the firmware.

### ### Enhanced Keyboard Input

The following ESC+char combinations are available:

```
* ``8`` -> ``[``  
* ``9`` -> ``]``  
* ``(`` -> ``{`` (ESC+SHIFT+8)  
* ``)`` -> ``}`` (ESC+SHIFT+9)  
* ``-`` -> ``_``  
* ``/`` -> ``\``  
* ``^`` -> ``~`` (ESC-SHIFT-N)  
* ``?`` -> ``|`` (ESC-SHIFT-/)  
* ``'`` -> backtick (`)  
* ``@`` -> delete
```

Some of the above characters are not available in machines without lower-case character ROMs.

Additionally, the arrow keys work with ESC.

The AND #\$DF that converts keyboard input to upper case has been replaced with AND #\$FF, this may allow lower-case input if you have a keyboard that supports it, but it has not been tested and no patches have been made for BASIC to accept lower-case input.

### ### Mini Assembler

The Mini Assembler is back! Enter it with ``!`` in the monitor, and return to the monitor by pressing ``RETURN`` on a line by itself.

IRQs are disabled while in the Mini Assembler.

Tip: Explore the CXXX ROM by using monitor commands (precede with \$) in the Mini Assembler.

### ### AppleSoft Bugs

Fixed:

\* The bug in FOR/NEXT described in "All About Applesoft", pp. 100-101 is fixed.

Not fixed:

- \* PRINT comma bug with window width less than 33.
  - \* Not fixed because some software may not display correctly if this is changed.
- \* A=-32768.00049:A%=A:PRINT A,A% -> "32768.0005 32767"
  - \* Probably never an issue, but if someone has a decent fix I will consider putting it in.

## ## Implementation Notes

Patches to the ROM are made in the same manner as the Apple IIe, with the patches located in the main ROM in the same locations where possible.

### ### Relocated Functions

The following routines are relocated to the CX ROM.

- \* Keyboard input ("IRQ sniffing" supported)
- \* Screen scrolling (IRQs disabled)
- \* Monitor tape I/O (IRQs disabled)

The keyboard input routine is adapted from the unenhanced IIe and uses the inverse space character as the cursor. This allows cursoring over lower-case letters on your screen if your machine has a lower-case chip.

### ### IRQ Support

In general, the original Apple II/II+ has poor IRQ support, often not disabling interrupts during critical functions (such as tape and game I/O) and overwriting zero page location \$45 each interrupt. ROM++ has minimal changes to keep a similar level of IRQ support as the unenhanced Apple IIe, which is not much better. Hardware/software combinations capable of using interrupts on the original II/II+ should continue to function.

One notable change: IRQs are disabled during screen scrolling, if you have an issue with IRQs being missed during scrolling, we may be able to address this.

Tape I/O cannot support IRQs as it is timing-critical, and so they are disabled during tape operations.

### ### Checksums/Diagnostics

No effort is made to make the ROM pass checksum or diagnostic programs.

This may require the use of [Anti-M](<https://github.com/a2-4am/anti-m>) to boot some software that checksums the ROM for copy protection purposes.

## ## Planned Features

- \* Maybe: Add step and trace back to the monitor.
- \* Maybe: IRQ support similar to the Enhanced Apple IIe.
- \* Patch AppleSoft for lower-case input.

Some of the above will require relocating some or all of the AppleSoft tape code (LOAD/SAVE/SHLOAD) to the CXXX ROM.

## ## Legal

Because most of the code in this project is legally a derived work of Apple II ROM code, the author claims no legal rights over most of the code in this project.

Apple has mostly turned a blind eye to Apple II hobbyists in recent years, however that may change at any time.

## ## Credits

- \* Dean Claxton and Jeff Mazur for creating the ROMX+ and other ROM exchange products. They have graciously provided me with ROMX hardware which has helped me develop enhanced ROM products such as ROM++.
- \* Andy McFadden for his SourceGen disassembler and related projects.
- \* Steve Wozniak
- \* Everyone who continues to say "Apple II Forever!"

## ## Changelog

24-06A:

- \* Move year to front of version number.
- \* Trap additional resets in boot menu until a key is pressed.
- \* Bypass full reset if ROMX+ menu is selected.