



## BackBit Chip Tester Pro Documentation

*Includes legacy tester details. Updated Sep 14, 2021 .*

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**⚠ WARNING: DO NOT operate Chip Tester on live electronics as this may cause damage to devices.**

### Summary of Features

- USB powered;
- Tests chips most common in vintage computer systems;
- Loose chip testing for DIP IC's;
- In-Circuit chip testing of **unpowered & unplugged** devices;
- Backlit 16x2 character LCD display with adjustable brightness, contrast and dimmer;
- Pass & fail LED indicators;
- Rotary control with push button selection;
- Push button control to activate tests;
- Apply 5V and GND to chip via jumpers;
- Ripping of ROM images to SD card;
- Ability to update firmware.

### Included Items

- 6' USB cable;
- Jumpers for configuring power & ground;
- Quick reference card.

# Firmware Upgrade

The latest firmware can be downloaded at <http://backbit.io/downloads/Firmware>.

## For Chip Tester Pro:

Update the firmware with SD card. Place CTPRO.UPG in the root folder of your SD card. Insert card and power cycle the device.

## For Legacy Chip Tester:

Download [Teensy Loader](#). Choose File -> Open HEX file. Plug in USB cable, highlight Auto button, and use small screwdriver to press the Update Firmware button.

# About Jumpers

As the pins of the tester's controller do not have driving capability, jumpers are used to power the chip. There is a jumper that maps to each pin of the ZIF socket, and each pin can be connected to power (RED) or ground (BLUE). After selecting a test, the tester intuitively instructs you where to place each jumper and does a scan to confirm proper placement.

## **It is important that there is no chip in the socket while jumper placement is arranged.**

Automatic jumper scanning cannot function when a chip is in the socket. It is helpful to remove all jumpers before changing placement, as extraneous grounded pins will not be detected. *If you've already confirmed correct jumper placement for a chip and want to skip the confirmation, twist the SELECT knob while pressing TEST.*

# Loose Testing

Following these simple steps to perform loose chip testing:

1. At the starting banner, twist or press the select knob to go to the main menu.
2. Choose a test category by twisting the select knob, then press to select.
3. Choose a specific test with the select knob, or Return to Main (at the end of the list).  
**Tip:** You can also press the knob for a full second to go back to the main menu.
4. You have the option at this point to select an in-circuit test by twisting the knob. For now, just leave it in Loose mode.
5. If instructed to place jumpers, first remove chip from socket as well any existing jumpers.
6. Place jumpers as requested, then press TEST to see if there are more jumpers to place.
7. When you see "Ready To Test", place the chip in the socket and lower the ZIF lever.
8. Press "TEST" to perform a test (*legacy tester requires holding*). A red light indicates failure while a green light indicates success. Both lights together indicate a file has been saved to the SD card.

# In-Circuit Testing



The **Clip Adapter** provides a convenient way to attach a chip clip for in-circuit testing. You will need both a clip adapter and jumper extension wire for each chip clip you want to use.

The minimum set of clips to test most chips in the Commodore 64 is are:

- 20-pin 0.3" width clip
- 24-pin 0.6" width clip
- 40-pin 0.6" width clip

[Check out this 3M catalog for a full listing of clips.](#)

***You can use a longer clip to test a shorter chip, but it must be the correct width, and the larger the clip, the more likely it will be blocked by other components.*** There is an option to place a clip at different vertical offsets to allow more options for fitting a overhanging clip

Make sure you get the right clips:

- Do not use "nail head" clips, as these will be difficult to attach to extension wire;
- Make sure you get the correct width through-hole clips. Get 0.3" width for clips 20-pins and smaller, and 0.6" width for clips 24-pins and larger;
- You can often find cheaper clips used or old stock.

You will also need jumper extension wire. I recommend these wires with configurable headers. You can put several of them in a row. Avoid the wires with individual headers on each pin, as they will get crowded and difficult to put in long rows. Here are the products I've used:

<https://www.adafruit.com/product/3633>

<https://www.digikey.com/product-detail/en/adafruit-industries-llc/3145/1528-2179-ND/7244965>

# In-Circuit Test Plans

When testing in-circuit, all chips on the rail will be powered in addition to the one tested, so inputs are often fixed. To compensate for this issue, the “in-circuit” mode of each test will typically test if an input is fixed and compensate accordingly. This offers a less thorough test than a loose test, but is a good workaround for an otherwise untestable chip.

In-circuit testing can also be challenging due to contention on the address and data buses. That is, many chips try to access these busses and need nudging to get them to stay off the bus.

To assist with quieting the busses, I came up with the Private Eyes™ test chip. In the case of the Commodore 64, it replaces the U17 PLA, forcing chip selects to default to the disabled state. While this does quiet the data bus, there can still be contention on the address bus. So in addition to using Private Eyes™, sometimes it is necessary to install jumper wires from the tester’s GND or 5V pins to a pin on a specific chip. This allows a stronger voltage and/or current than can be provided by the tester’s processor alone. You can use the included jumper wires to connect to the tester’s GND and 5V pins, but you will need IC test hooks (like the one pictured to the right) to attach to the required contact point in the machine. It can also help to have alligator clips as extensions. Instructions specific to your machine will be necessary to accomplish a quiet bus. Feel free to ask on the BackBit Forum if you would like your system added to this list of test plans.



## Commodore 64 In-Circuit Test Plan

- To free up data bus, use Private Eyes™.
- To free up address bus, remove CPU & VIC. If removing CPU is not an option, tie CAEC or DMA low.
- To test main RAM additionally tie AEC and ~AEC high.
- To test color RAM additionally tie CS (pin 8) low.

# Supported Chips

## 4000 Series

Tests that gates perform correct operation(s). Bus contention is common with in-circuit tests due to cascading logic.

- **14-pin detection (for chips with VCC at pin 14)**
- **16-pin detection (for chips with VCC at pin 16)**
- **4001, 4002, 4009-13, 4016-17, 4019, 4021, 4023, 4028-30, 4042 4049-52, 4066**
- **4069-71, 4081**

## 7400 Series

Tests that gates perform correct operation(s). Bus contention is common with in-circuit tests due to cascading logic.

- **14-pin detection (for chips with VCC at pin 14)**
- **16-pin detection (for chips with VCC at pin 16)**
- **20-pin detection (for chips with VCC at pin 20)**
- **7400-12, 7414-17, 7419-21, 7424-28, 7430, 7432-33, 7437-38, 7442, 7446-47, 7451**
- **7454, 7460, 7470, 7473-76, 7483, 7485-86, 7490, 7493, 74109, 74111-112, 74121**
- **74123, 74125-126, 74132-133, 74136, 74138-139, 74147-148, 74151, 74153-158**
- **74160-166, 74169-170, 74174-177, 74180, 74184, 74190-194, 74196-197, 74221**
- **74240-241, 74244-245, 74251, 74253, 74257-259, 74266, 74273, 74279, 74283**
- **74350, 74365-368, 74373-374, 74393, 74629, 74901-902**

## MOS Technology / Commodore Semiconductor Group

- **6502 CPU**  
Loose tests checks for correct clock signal and walks wide range of addresses.  
In-circuit test checks for correct reset sequence. Reports "SALLY" if Atari variation is detected.  
Failures: **c** = clock, **w** = walking, **r** = reset
- **6510 / 8500 CPU**  
Loose tests clock signal, address enable, peripheral port, and walks wide range of addresses.  
In-circuit test checks for correct reset sequence..  
Failures: **c** = clock, **a** = aec, **i** = peripheral in, **o** = peripheral out, **w** = walking, **r** = reset
- **6520/1 PIA**  
Tests registers, data ports, timers, and interrupts. Failures: **a** = data-A, **b** = data-B, **i** = interrupts
- **6522 VIA**  
Tests registers, data ports, timers, and interrupts.  
Failures: **a** = data port A, **b** = data port B, **1** = timer A, **2** = timer B, **i** = interrupts
- **6526 / 8520 / 8521 CIA**  
Rigorous test of features, including registers, data ports, time of day, timers, alarm, and interrupts.  
Failures: **a** = data port A, **b** = data port B, **1** = timer A, **2** = timer B, **t** = time of day, **i** = interrupts

- **6529** SPI  
Open drain variant of 74LS245.
- **6532** RIOT  
Tests registers, RAM, data ports, timer, and interrupts.  
Failures: **r** = RAM, **a** = data port A, **b** = data port B, **t** = timer, **i** = interrupts
- **6551 / 8551** ACIA  
Tests registers, signals, and interrupts
- **6560 / 6561** VIC  
Tests that registers properly retain data and correct # of raster lines  
Reports **PAL / NTSC**. Failures: **r** = registers, **I** = raster lines
- **6566 / 6567 / 6569 / 8562 / 8565** VIC-II  
Tests that registers properly retain data, IRQ works, correct # of raster lines, active color signal, active luma signal, and row/col strobes. Reports **PAL / NTSC**. Failures:  
**r** = registers, **i** = IRQ, **I** = raster lines, **c** = color, **b** = brightness/luma, **y** = RAS, **x** = CAS
- **6581 / 6582 / 8580** SID  
Tests logic & voice 3 characteristics. Failures: **x** = x-potentiometer, **y** = y-potentiometer, **e** = voice 3 envelope, **o** = voice 3 oscillator, **t** = voice 3 triangle, **s** = voice 3 sawtooth, **p** = voice 3 pulse/square, **n** = voice 3 noise, **v** = audio out voltage
- **7360** TED (*Pro only*)  
Tests that registers properly retain data, IRQ works, correct # of raster lines, active signals, key input and memory addressing:  
**r** = registers, **i** = IRQ, **I** = raster lines, **c** = color, **b** = brightness, **s** = signals, **k** = keys, **m** = mem
- **7501 / 8501** CPU  
Loose tests clock signal, address enable, peripheral port, and walks wide range of addresses.  
In-circuit test checks for correct reset sequence..  
Failures: **a** = aec, **i** = peripheral in, **o** = peripheral out, **w** = walking, **r** = reset
- **7701 / 8701** CLOCK  
Tests both PAL and NTSC functionality of clock generator. Does not work in-circuit due to crystal interference.
- **7707 / 7708 / 7709 / 7711 / 7712 / 7713 / 7714** LOGIC  
Same as 74x06, 74x257, 74x258, 74x139, 74x08, 74x04, 74x02 tests, respectively.
- **8502** CPU  
Loose tests address enable, peripheral port, and walks wide range of addresses.  
In-circuit test checks for correct reset sequence..  
Failures: **a** = aec, **i** = peripheral in, **o** = peripheral out, **w** = walking, **r** = reset
- **8551** ACIA  
Tests status, commands, and interrupts.
- **8564 / 8566 / 8569** VIC-IIe (*Pro only*)  
Tests that registers properly retain data, IRQ works, correct # of raster lines, and active signals.  
Reports **PAL / NTSC**.  
Failures: **r** = registers, **i** = IRQ, **I** = raster lines, **c** = color, **b** = brightness, **s** = signals
- **8721** PLA (*Pro only*)  
Full logic test.
- **8722** MMU (*Pro only*)  
Full logic test.
- **325572** GATE ARRAY for 1541  
Full logic test, failure codes: **f** = flip/flop, **l** = load, **m** = motor, **s** = sig out, **d** = data out
- **906114 / 251641** PLA  
Full logic test with reporting on specific bit results in case of inexact result.  
Results list output lines in order with codes **fail**, **pass**, and **good** (formulas ok but not bitwise)

## RAM

Tests that chip retains data properly. Requires 4 passes for full test (random, inverted, alternating and inverted alternating).

	<u>Chip</u>	<u>Size</u>	<u>Bits</u>	<u>Pins</u>	<u>Type</u>
•	<b>2112</b>	128B	4	16	static
•	<b>2115/2125</b>	128B	1	16	static
•	<b>4164/4264</b>	8K	1	16	dynamic
•	<b>41256</b>	32K	1	16	dynamic
•	<b>2114</b>	512B	4	18	static
•	<b>CY 147</b>	512B	1	18	static
•	<b>4416</b>	8K	4	18	dynamic
•	<b>4464</b>	32K	4	18	dynamic
•	<b>1000/1024</b>	128K	1	18	dynamic
•	<b>2142</b>	512B	4	20	static
•	<b>4256</b>	128K	4	20	dynamic
•	<b>6550</b>	512B	4	20	static
•	<b>5561</b>	8K	1	22	static
•	<b>4118</b>	1K	8	24	static
•	<b>2016/6116</b>	2K	8	24	static
•	<b>CY 171</b>	2K	4	24	static

## ROM

Tests if data matches a known ROM, and on loose tests that chip select works properly. Rips can be saved if reading is consistent. Shows CHECKSUM computed by 16-bit checksum [prefixed with 8-bit XOR](#) scheme to distinguish ROMs with same checksum.

	<u>Chip</u>	<u>Size</u>	<u>Pins</u>
•	<b>2S23/123</b>	32B	16
•	<b>2S126/129</b>	128B	16
•	<b>2S130/131</b>	256B	16
•	<b>2S137</b>	512B	18
•	<b>2316 MOS</b>	2K	24
•	<b>2716</b>	2K	24
•	<b>2332 MOS</b>	4K	24
•	<b>2532</b>	4K	24
•	<b>2732</b>	4K	24
•	<b>2364 MOS</b>	8K	24
•	<b>6540 MOS</b>	2K	28
•	<b>2764</b>	8K	28
•	<b>27128</b>	16K	28
•	<b>27256</b>	32K	28
•	<b>27512</b>	64K	28
•	<b>271000</b>	128K	28

- **CartRip™**  
Rips ROM from Commodore 64/128 cartridges
- **CartRipVic™**  
Rips ROM from Commodore VIC 20 cartridges
- **CornBit™ (23\*\*/2732)**  
24-pin Flash ROM; can be programmed with the tester  
If using 2732, use specified test, otherwise use 23\*\* for 2316,2332,2364,2532, and 2716.
- **CornBitXL™**  
28-pin Flash ROM; can be programmed with the tester

## Other Series / Manufacturers

- **555 Timer / 556 Dual Timer**  
Tests reset and discharge capability. Not functional in-circuit.
- **GAL 16V8 / 20V8**  
Capable of saving logic equations to file.
- **MC4044 Phase Detector**  
Tests all logical components.
- **uA8T26A / uA8T28**  
Tests bus logic.
- **WDC W65C02**  
Loose tests checks for correct clock signal and walks wide range of addresses.  
In-circuit test checks for correct reset sequence.
- **WDC WD1770/1772 Disk Controller**  
Tests inputs, outputs, registers, and all Type-I commands.
- **Zilog Z80 CPU**  
Loose test checks for correct clock signal and walks full range of addresses.
- **ZX81 ULA 2C184E**  
Tests RAM/ROM select and input from keyboard/country/tape.

**More tests will be added based on available hardware. Please inquire on the BackBit Forum ([forum.backbit.io](http://forum.backbit.io)) if you would like to donate hardware for generating tests.**



# Test Results

A passing test result indicates a very strong likelihood that a chip is good. However, a failing test can result from a number of circumstances. The most reliable tests are loose chip tests, but in-circuit tests can offer helpful clues when a chip is soldered onto a board. Report your results on the BackBit forum for help and feedback.

- A chip that PASSES may not actually be a good chip. The reason is that even with the most exhaustive tests, a real world test case can interpret digital voltages differently:

	LOW signal voltage	HIGH signal voltage
Chip Tester Input	0 - 1.2V	2.3V - 5V
Chip Tester Output	0V	3.3V
TTL Input	0 - 0.8V	2V - 5V
TTL Output	0 - 0.4V	2.4V - 5V
CMOS Input	0 - 1.5V	3.5V - 5V
CMOS Output	0V	5V

If a chip is damaged and outputs a voltage in between the specification for LOW and HIGH, it could behave fine in the chip tester but not in a real world application.

Therefore, it's good to confirm that a passing chip works in a real world case.

- A failure can be the result of a poor connection. Make sure no pins on the chip are bent or tarnished. In the case of an in-circuit test, make sure your wiring rig is intact (test for continuity if necessary).
- An in-circuit failure can result from a variety of conditions:
  - Damaged or shorted wiring;
  - Neighboring chips that override the data bus. Use the PrivateEyes™ PLA test chip on breadbin/longboard model C64s to reduce bus contention;
  - Signal contention due to other chips also getting power;
  - Poor connections from socketed chips;
  - Nearby components that prevent a firm physical connection.

## Ripping ROMs

It is possible to rip a ROM chip to a binary file on a Micro-SD card. This is supported for all ROM tests on the tester.

To rip a ROM, insert a FAT32-formatted SD card. Perform the ROM test, and when the same ROM data is read twice (i.e. verified), you will see a message that says “SAVED TO FILE” along with both red and green lights turned on.

Check on your SD card, and you will see a file named ROM####.BIN with the ripped data.

*Using the optional CartRip™ accessory, you can also rip a cartridge without having to desolder or clip the ROM chip. Select the CartRip™ test, and data will be saved to RIP####.BIN instead.*

## Programming the CornBit™ or CornBitXL™

The CornBit™ and CornBitXL™ can only be programmed with the chip tester. To do so, first you will need a binary file with appropriate content.

For the CornBit™, there are 4 slots, each 8KB in size. Do a binary appending of the individual ROMs to make a 32KB file. Make sure the file is exactly 32768 bytes long.

For the CornBitXL™, there are 8 slots, each 16KB in size. Do a binary appending of the individual ROMs to make a 128KB file. Make sure the file is exactly 131072 bytes long.

Now, follow these simple steps with the tester:

- Insert MicroSD card with your binary file;
- Select the CornBit™ or CornBitXL™ test from the ROM tests menu;
- Navigate to the binary file using the rotary knob. Press the button to select a file or enter a subdirectory;
- Perform a “test” like normal. Make sure all DIP switches on the CornBit™ are set to the OFF position;
- If the programming is successful, you will see a green light along with “PROGRAMMED”;
- If the programming is not successful, make sure to remove the attached socket (very carefully with a flat blade screwdriver). Also make sure the chip is completely level.

## Optional Accessories

These accessories go along with your chip tester:

- Additional Clip Adapters: Allows you to attach additional chip clips with jumper extension wire to your chip tester easily without having to rewire on configuration changes;
- CartRip™: Allows you to plug a C64 or C128 cartridge into your chip tester to identify and/or extract the contents;
- CartRipVic™: Allows you to plug a VIC 20 cartridge into your chip tester to identify and/or extract the contents. Also tests RAM expansion;
- CornBit™ and CornBitXL™: Multi-ROM replacements which are programmable using the tester;
- PrivateEyes™: Reduces bus contention when testing a C64 breadbin/longboard;
- All accessories are available for purchase at <http://store.backbit.io>

## The BackBit Forum™

The Chip Tester is being actively supported, so if you have any trouble or would like to share your results, please join the public forum at <http://forum.backbit.io>