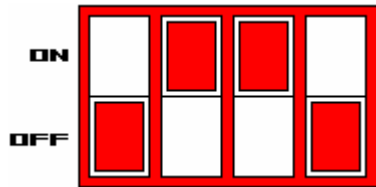


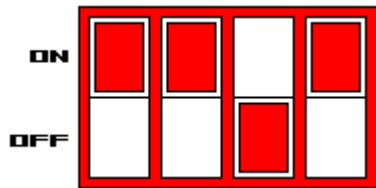
UNIVERSAL CARTRIDGE

The all new Alphaworks Universal Cartridge has been designed to work with either 8k (2764 series) EPROMS as well as 16k (27128 series) EPROMS. To set up the Universal Cartridge to accept 8k or 16k EPROMS please configure the dip switch with the following settings.



8k Cartridge (\$8000 - \$9FFF)

- 1 = OFF
- 2 = ON
- 3 = ON
- 4 = OFF



16k Cartridge (\$8000 - \$BFFF) *

- 1 = ON
- 2 = ON
- 3 = OFF
- 4 = ON

* *BASIC ROM will be switched out*

HOW TO PROGRAM AN AUTOSTART CARTRIDGE

The system provides for "auto-start" of the program in a Commodore 64 Expansion Cartridge. The cartridge program is started if the first nine bytes of the cartridge ROM starting at location 32768 (\$8000) contain specific data. The first two bytes must hold the Cold Start vector to be used by the cartridge program. The next two bytes at 32770 (\$8002) must be the Warm Start vector used by the cartridge program. The next three bytes must be the letters, CBM, with bit 7 set in each letter. The last two bytes must be the digits "80" in PET ASCII.

AUTOSTART 'CBM80' METHOD

The most common cartridge autostart method is known as the CMB80 method. It can be used by both 8K and 16K cartridges that reside at \$8000. Although this method is sometimes called the cartridge autostart option', it can be used equally well by RAM-based programs, and often is. One of the first things the KERNAL RESET routine does is check locations \$8004-08 for the string of characters CBM80. If these exact characters are NOT found there, the KERNAL RESET process continues normally.

If the "CBM80" is found, the RESET routine is interrupted and the processor immediately jumps to whatever location is specified by the **CARTRIDGE COLD—START VECTOR**. This vector is expected to be found at locations \$8000-01. You must place a pointer here, in standard b-byte / hi-byte order, directing the processor to the beginning of your cartridge code. From that point on, your cartridge must handle all the initialization itself for any functions it will use, such as the I/O devices or KERNAL or BASIC routines. Fortunately, you still have the KERNAL initialization routines available for use. Unless you know exactly what you are doing, your cartridge should use these routines to initialize the functions it needs.

Figure 1 presents a generic cartridge initialization routine. This routine duplicates most of the normal RESET process. In fact, its taken right from the main parts of the KERNAL (\$FCEF-FE) and BASIC (\$E394—9F) RESET routines. This generic routine will be adequate for 99% of all cartridges.

Figure 1: **CBM80 Cartridge Initialization**

```

8000 09 80          Cartridge cold-start vector = $8009
8002 25 80          " " warm " " ' " = 8025
8004 C3 C2 CD 38 30 CBM80 - Autostart key

                                KERNAL RESET Routine
8009 8E 16 DO      STX $D016      Turn on VIC for PAL / NTSC check
800C 20 A3 FD      JSR $FDA3      IOINIT - Init CIA chips
800F 20 50 FD      JSR $FD50      RANTAS - Clear/test system RAM
8012 20 15 FD      JSR $FD15      RESTOR - Init KERNAL RAM vectors
8015 20 5B FF      JSR $FF5B      CINT - Init VIC and screen editor
8018 58           CLI           Re-enable IRQ interrupts

                                BASIC RESET Routine
8019 20 53 E4      JSR $E453      Init BASIC RAM vectors
8D1C 20 BF E3      JSR $E3BF      Main BASIC RAM Init routine
801F 20 22 E4      JSR $E422      Power-up message / NEW command
8022 A2 FB         LDX #$FB
8024 9A           TXS           Reduce stack pointer for BASIC

8025           START YOUR PROGRAM HERE

```

The cartridge cold-start vector and autostart key (CBM80) have already been discussed. The warm-start vector at \$8002-03 is a feature that allows you to re—enter your program after a full initialization has already been done. Once a cold—start has been done, it usually doesn't need to be done again. Pressing the RESTORE key calls the NMI routine (NON-MASKABLE INTERRUPT), which will see the CBM80 and jump to the location indicated by the warm-start vector. This is why many programs restart themselves when you press the RESTORE key. In our initialization routine we have pointed the warm-start vector to the start of your program; you could also point it to \$8009 to perform a full cold-start on RESTORE. If you want to disable the RESTORE key entirely, point the warm—start vector to \$FEBC (return from NMI).

We have included the BASIC RESET process in this cartridge initialization routine too. Actually, the normal BASIC RESET routine dead-ends with a jump to the BASIC direct mode interpreter, also known as “READY” mode. This prints the “READY.” prompt and then sits there waiting for, you to type a BASIC command. You won't usually want to exit into READY mode at this point since BASIC will take over and your cartridge will lose control. If you do want to exit to BASIC now or later, you may do so with JMP \$E386. By the way, the routine called at \$801F (JSR \$E422) prints the normal power-up screen and does a NEW command. If you want to skip the power—up message, just call the NEW command directly using JSR \$A644 instead of JSR \$E422.

To summarize, the CBM80 method can be used with either 8K or 16K standard cartridges (which start at \$8000). The cartridge initialization routine above will be sufficient for the vast majority of cartridges. KERNAL initialization must be done at least once (on power—up or RESET). BASIC initialization can be skipped if you're not using BASIC, and MUST be skipped if you're using a 16K cartridge. Through the cartridge warm-start vector, the RESTORE key can be set up to re-enter your program

or it can be disabled entirely. The CBM80 method is by far the most common cartridge autostart method.

AUTOSTART '\$A000' METHOD

If you don't need the BASIC system, you can "trick" the KERNAL RESET process into doing all your initialization for you and then autostarting your cartridge. After completing its own initialization tasks, the KERNAL RESET routine attempts to "cold-start" (initialize) BASIC. It does this by jumping to the location specified by the BASIC COLD-START VECTOR. Like all vectors, the BASIC cold-start vector consists of two consecutive bytes containing a memory address. The address is stored in lo-byte / hi-byte order, which means the low order (least significant) byte is first and the high order (most significant) byte is second. The KERNAL expects the BASIC cold-start vector to be found in locations \$A000 - \$A001, which is normally at the very beginning of the BASIC ROM. The contents of these two locations in the BASIC ROM are \$94 and \$E3 respectively, which means they "point" to location \$E394 (vectors are also called pointers). This location is the start of the BASIC cold-start routine.

If we could change the BASIC cold-start vector, we could make it point to our cartridge program. Our cartridge would start up automatically after all kernal initialization was finished. But since this vector is in the BASIC ROM, how do we change it? Answer: replace the BASIC ROM. Not physically, of course, but by using a standard 16k cartridge. Recall that standard 16k cartridges reside at \$8000-\$BFFF. The PLA switches out the BASIC ROM and selects the 16k cartridge configuration when it senses that both of the GAME and EXROM lines are grounded. A 16k (27128 series) EPROM is required for a 16k of memory on the cartridge. All you have to do is put a vector at \$A000-\$A001 which points to the beginning of your program, and the cartridge will be started automatically at the end of KERNAL initialization.

eg: A000 00 80 Your program starts at location \$8000

IMPORTANT

Never plug in or remove a cartridge board while your computer is turned on, always turn off your computer before inserting or removing the cartridge.

It is extremely important that you insert the PCB the correct way up on your Commodore 64 as to avoid problems. On the underside (bottom) of the PCB it contains the words -

8k Cartridge

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C64-PCB REV 8K-R3

Universal 8/16k Cartridge

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C64-PCB REV 8K/16K R1