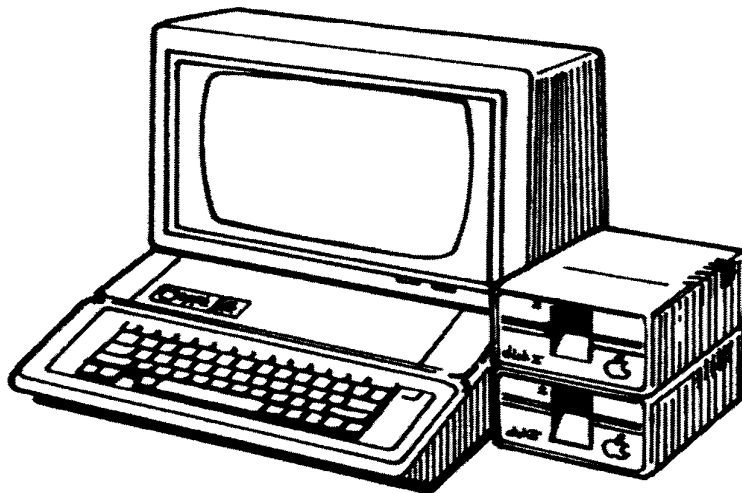Apple][Computer Information

Floppy Disk I/O Controller
IWM Chip Memo

Peter Baum -- Apple Computer, Inc. -- May 24, 1984

TOPIC
Differences between the IWM and the Apple // Disk Controller

SOURCE
Brutal Deluxe Software web site -- www.brutal-deluxe.fr
31 December 2008

Peter Baum   Apple Computer   May 24, 1984
20525 Mariani Ave.   MS 22-W   Copyright 1984
Cupertino, Ca. 95014

Differences Between the IWM and the Apple // Disk Controller

The IWM (Integrated Woz Machine) is a single chip (LSI)
implementation of the Disk][Controller state machine,
designed and patented by Steve Wozniak. It is not an exact
replica of the state machine, and though all of Apple's disk
operating systems (DOS 3.3, ProDOS) work with it, 3rd party
developers will find that some of their software will not
work. This document describes all the known differences
between the IWM, currrently used in the Apple //c, and the
state machine used in the Apple][and //e disk controller
card. This document only exists to describe differences and
is not intended as a specification for the IWM or Apple //
Disk Controller. The correct method of using the disk
interface is described in another document, "Software Control
of the Disk][or IWM Controller", which is required reading
before perusing this document. The document is distributed to
registered developers under the auspices of Apple //
Developer Technical Support. (For more information contact:
Apple Computer at above address - Certification/Registration
Program, Mail Stop 23AF). This document will be updated as
more differences are uncovered.

The Differences

1) When reading the write protect switch only the most
significant bit (MSB) should be tested for the status. On the
Disk Controller other bits can be tested, but this will not
work on the IWM.

2) The IWM will not work properly in an Apple // if it is
placed into a mode where both Q6H and Q7H are set and the
motor is off (Q4L). If the chip is placed in this mode at any
time then all subsequent operations of the IWM may not work
properly.

3) The IWM does not require the false-read cycle, which
occurs on indexed write instructions such as STA $C05E,X, to
work properly. The Disk Controller state machine depends on
the false read cycle during the STA Q7H,X instruction to
store data properly into the shift register. This anamoly
means that software which may work with the IWM will not work
with the Disk Controller. This type of problem will generally
appear if a store absolute instruction is used to set Q7H
(STA $C0EF), since there is no false-read cycle on store
absolute operations.

1/2

Other Notes of Interest

The IWM has never been sold in a Disk Controller card for the Apple // and there are no plans to do this. All Disk][Controller Cards, sold with either the Disk][or the Duodisk, use the state machine.

In the Apple //c the 65C02 processor, manufactured by GTE and NCR, is used. Some of the instructions use different cycle times than the corresponding instructions in the NMOS 6502 used in the Apple //e and][+. If these instructions are used as part of the 32usec. or 40usec. loops required in the disk write routines, then the write routines will not work properly in both the Apple //e (or][+) and Apple //c.

Other documents and books which may prove helpful:

Beneath Apple DOS, by Don Worth and Pieter Lechner, from
    Quality Software

Understanding the Apple II, by Jim Sather, from Quality
    Software

Software Control of the IWM or Disk][Controller , Apple
    Computer*

The 6502 False-read cycles, Apple Computer*

* -- These documents are distributed to registered developers
    under the auspices of Apple // Developer Technical
    Support. (For more information contact: Apple Computer
    at above address - Certification/Registration Program,
    Mail Stop 23AF).

2/2