1994/01
Card65

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Date: 07.04.03

Abstract

This is a small tandem processor board which is to be plugged into a PC's 8-bit ISA-slot. The board contains a 6502A CPU. The clock (4.77 MHz) provided by the ISA-slot is divided by 2. So the 6502 is driven by 2.38 MHz. The memory is subdivided into 8 pages of 8kB each by using a 74138 to generate those 8 chip select signals from the 6502's address lines A13-A15. The PC can halt the 6502 and decouple it from it's memory. So the PC has full access over the 6502's 64kB memory address space. That's the way the PC can transfer programs/data to/from the tandem board. The PC can trigger the 6502's interrupts and the 6502 on the other hand can trigger the PC's interrupts. So they are able to send signals to each other to initiate a information interchange.

1 Project characteristics

Project code	1994/01
Project name	Card65
Started	25.09.94
Ended	14.04.95
Used tools and libraries	Self made 6502 assembler, Eagle 3.55 light.
Used for other projects or applications	Project #1992/01 (XR1)

2 Schema

Figure 1 shows the project's concept. There are 2 CPUs and a common address space. There are gates between the CPUs and the devices mapped into the space. If one is open the other is closed and vice versa. So there is only 1 CPU to control the memory space at the same time.

At the end the PC is the master. He is able to halt the 6502. If the '02 is halted the PC could enable him from his bus (74245 bus driver with three-state outputs). At the same time the '02 is gated the PC is the busmaster for the '02's 64k address space. Now programs and data could be stored for the 6502. After that the PC disables himself from the 02's bus and the 6502 is becoming the busmaster again. Then the PC starts the 6502 by applying a 0 to the HALT line. The 6502 continues his work.

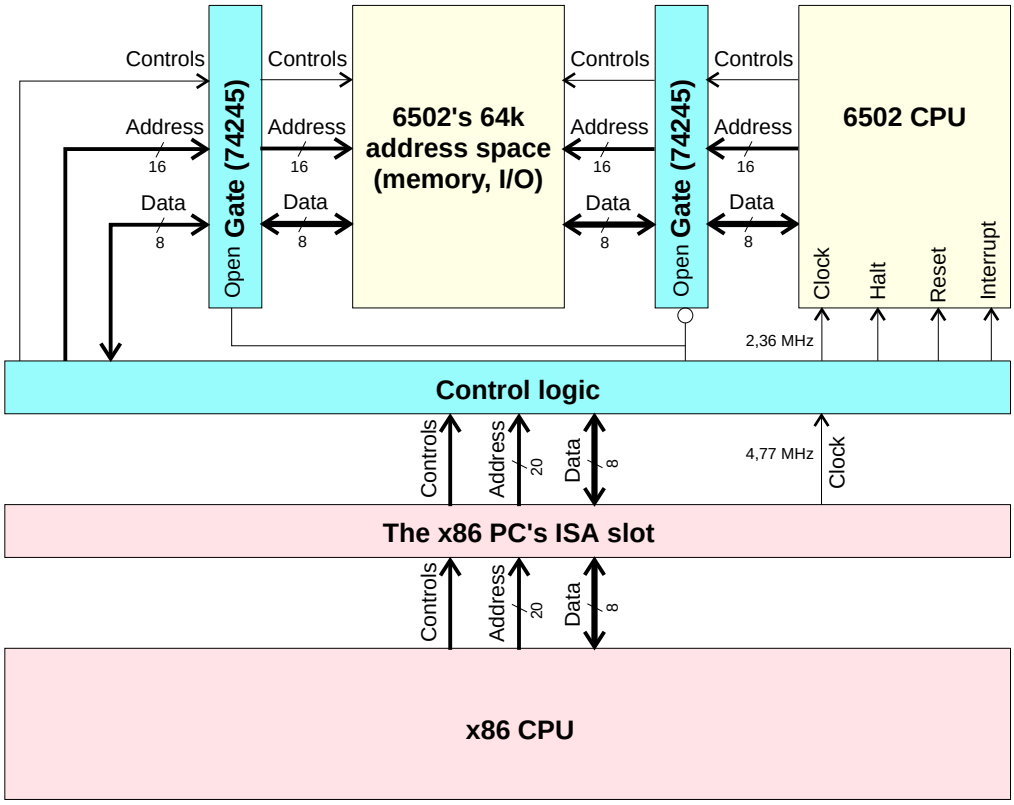

Figure 1: Card65's Concept

3 I/O Mapped Control Registers

There are 4 registers located on the tandem board and mapped into the PC's I/O area. Use jumper switches JPS1 and JPS2 to adjust the Card65's base address as illustrated in figure 2.

Figure 2: I/O-Address Selection via Jumper Switches (JPS1, JPS2)

Table 2 shows what the PC will read or write on the Card65 control registers (CR0-CR4).

Address	**74155 Signal**	**Meaning**	**Read/Write**
base	2Y0	CR0: -	Read
base+1	2Y1	CR1: -	
base+2	2Y2	CR2: content of currently selected 6502 address	
base+3	2Y3	CR3: 6502 and gate status	
base	1Y0	CR0: current 6502 address low	Write
base+1	1Y1	CR1: current 6502 address high	
base+2	1Y2	CR2: write to currently selected 6502 address	
base+3	1Y3	CR3: set 6502 and gate status	

Table 2: Jumper Switches 1 and 2 for Adjusting the Base Address

4 Control Register CR3

The control register CR3 controlls the operation of the tandem board. Figure 3 shows the register and which functionality is triggered by each bit. Only the four least significant bits are used.

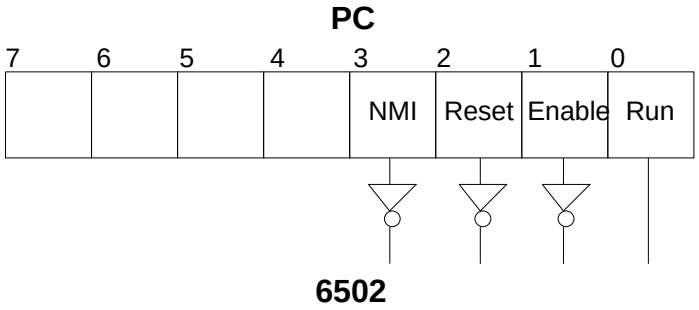

Figure 3: Control Register CR3

5 Interrupts

Both machines can exchange interrupts. The 6502 has a primitive 8 bit parallel output. Bit 7 (0x80) is connected with a jumper. You can configure the PC's interrupts IRQ3, IRQ5, IRQ6 and IRQ7 with this jumper. On the other hand the PC can interrupt the 6502, too. This might be used to trigger a information interchange. The programs on the x86 and 6502 could declare an

area within the 02's address space in which the information has to be stored. If one machine has some information in this area it is sending an interrupt to the other CPU. The associated interrupt service routine (ISR) could read the information and trigger a data processing on that data.

6 6502 Memory Map

You might ask your self why Card65 has two blocks of memory located at different addresses. The 6502 needs memory at the lower border of his address space for the stack which is always located at 0x0100 up to 0x01FF. On the other hand the 6502 needs memory at the upper border of his memory space because the NMI, reset and IRQ vectors are located at 0xFFFA up to 0xFFFF.

From 0x0000–0x7FFF there is 32kB SRAM, at 0xA000 there is a primitive 8-bit parallel output with bit 7 connected to the PC's IRQs and at 0xE000 up to 0xFFFF there is another 8kB SRAM.

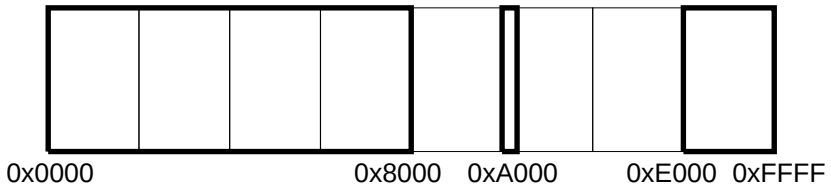

Figure 4: Card65's Memory Map

A Parts list

Name	Part/value	Comments
	Prototype board	IBM PC-XT ISA slot compatible
C1	100nF	Capacitor
C2	100nF	Capacitor
C3	1nF	Capacitor
IC1	SN74HCT688	8-Bit comparator
IC10	6502A	8-Bit CPU, 2MHz version
IC11	SN74HCT245	Octal bus transceiver (3-state)
IC12	SN74HCT245	Octal bus transceiver (3-state)
IC13	SN74HCT00	Four NAND gates
IC14	SN74HCT245	Octal bus transceiver (3-state)
IC15	SN74HCT157	Four 2:1 selectors/multiplexers
IC16	SN74HCT138	3:8 decoder/demultiplexer
IC17	6264	SRAM, 8kB
IC18	62256	SRAM, 32kB
IC19	SN74HCT04	Six inverters (NOT)
IC2	SN74HCT155	Two 2:4 decoders/demultiplexers
IC20	SN74HCT02	Four NOR gates
IC21	SN74HCT245	Octal bus transceiver (3-state)
IC22	SN74HCT273	Octal D-FF
IC3	SN74HCT04	Six inverters (NOT)
IC4	SN74HCT245	Octal bus transceiver (3-state)
IC5	SN74HCT273	Octal D-FF
IC6	SN74HCT245	Octal bus transceiver (3-state)
IC7	SN74HCT574	Octal D-FF (3-state)
IC8	SN74HCT574	Octal D-FF (3-state)

Table 3: Parts List

Name	Part/value	Comments
IC9	SN74HCT393	Two 4-Bit counters
Q1	BC237	Transistor
R1	3k3Ω	Resistor
R2	3k3Ω	Resistor
R3	560Ω	Resistor
R4	1kΩ	Resistor
R5	4k7Ω	Resistor

Table 3: Parts list

B List of project files

File Name	Comments
CARD65.PAS	Firmware library with basic control functions.
card65.sch	Wiring diagram.
DUMP.EXE	Command line tool dumps 6502 memory area.
DUMP.PAS	Command line tool dumps 6502 memory area.
INT6502.ASM	Tests the Card65 NMI. File for Card65.
INT6502.BAT	Tests the Card65 NMI. Translates the .asm file.
INT6502.EXE	Tests the Card65 NMI. File for PC.
INT6502.PAS	Tests the Card65 NMI. File for PC.
INT80X86.ASM	Test the Card65 ability to send an interrupt to PC. File for Card65.
INT80X86.BAT	Test the Card65 ability to send an interrupt to PC. Translates the .asm file.
INT80X86.EXE	Test the Card65 ability to send an interrupt to PC. File for PC.
INT80X86.PAS	Test the Card65 ability to send an interrupt to PC. File for PC.
LOAD.EXE	Command line tool uploads a file from PC to Card65.
LOAD.PAS	Command line tool uploads a file from PC to Card65.
NMI.EXE	Command line tool triggers NMI at Card65.
NMI.PAS	Command line tool triggers NMI at Card65.
PORTIN.EXE	Command line tool reads an I/O port address.
PORTIN.PAS	Command line tool reads an I/O port address.
PORTOUT.EXE	Command line tool writes to an I/O port address.
PORTOUT.PAS	Command line tool writes to an I/O port address.
RESET.EXE	Command line tool resets Card65.
RESET.PAS	Command line tool resets Card65.
START.EXE	Command line tool starts Card65 operation.
START.PAS	Command line tool starts Card65 operation.
STATUS.EXE	Command line tool views status of Card65 control register.
STATUS.PAS	Command line tool views status of Card65 control register.
WATCH.EXE	Command line tool implements a cyclic pump of a Card65 memory area.
WATCH.PAS	Command line tool implements a cyclic pump of a Card65 memory area.
XLOAD.EXE	Command line tool uploads a program to Card65 , sets reset vector and starts the program.
XLOAD.PAS	Command line tool uploads a program to Card65 , sets reset vector and starts the program.

Table 4: Project files

C Related web pages

[W1] **Welcome to www.6502.org!**
`www.6502.org/`

A page for 6502 enthusiasts. A great source for 6502 related information, data sheets and projects.

D Related literature

[B1] **Texas Instruments**:
The TTL Data Book Volume 1
Texas Instruments (1985), ISBN 3-88078-078-1

Describes almost every Standard, Low-Power Schottky and Schottky TTL. Pinout, schematics, function tables, physical/electrical characteristics. INDISPENSABLE!

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