

Lab 3: Exception Processing and System Control

ECE 441-02, Thursday Lab (L02)

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I. Introduction

➤ Purpose:

The purpose of this lab is to familiarize the student with the following topics: 68000 Exception Processing, TUTOR Exception Handling, and 68000 System Controls

➤ Background:

The following material should be reviewed by student:

- the Exceptions Processing section of the M68000 Programmer's Reference Manual
- the SANPER-1 User's Manual

II. Lab Procedure and Equipment List

➤ Equipment:

- SANPER-1 ELU
- PC with TUTOR Software
- Easy68K Software

➤ Procedure:

Refer to Lab Manual for detailed Procedure

III. Results and Analysis:

```
>> LO1
>> .D0 $FF
>> G $2000
PHYSICAL ADDRESS=00002000
1035 00FFFFFF 1039
BUS TRAP ERROR
PC=00002006 SR=A700=TS7..... US=7BFF393B SS=00000786
D0=000000FF D1=7EFF3FF7 D2=FFFFFFFF D3=FEEF6FFF
D4=FDFF7FFF D5=EF7E7DE7 D6=FFFFFF7F D7=BFDDFFFF
A0=FFFFFFFF A1=000000FF A2=FDFF7FFF A3=FE795ED7
A4=FFFFFFFF A5=DEFF7EFF A6=FFFF7FFF A7=00000786
-----002006 60F8          BRA.S $002000
```

```
>> LO1
>> MM $2000;W
>> G $2000
>> LO1
>> .SR $FFFF
>> DF
>> G $2000
>> LO1
>> .D1 $0000
>> .D2 $1000
>> G $2000
>> LO1
>> .D6 $3000
>> .D7 $3010
>> G $2000
>> MM $2000;W
>> G $2000
>> MM $2000;W
>> G $2000
>> LO1
>> MS $2000 'A BUS ERROR JUST OCCURRED!'
>> BS $900 $3FFF 'A BUS ERROR JUST OCCURRED!'
PHYSICAL ADDRESS=00000900 00003FFF
002000 'A BUS ERROR JUST OCCURRED!'
>> MM $8
>> LO1
>> G $1000
PHYSICAL ADDRESS=00001000
A BUS ERROR JUST OCCURRED!
>>
>> G $1000
>> LO1
>> G $950
PHYSICAL ADDRESS=00000950
A BUS ERROR JUST OCCURRED!
FF36 00B3 003F
>> LO1
>> G $950
PHYSICAL ADDRESS=00000950
A BUS ERROR JUST OCCURRED!
8232 0000 0992
>> MM 8

>> MM 950;DI
>> MM 8
>> G 1000
```

```

PHYSICAL ADDRESS=00001000
A BUS ERROR JUST OCCURRED!
1035 0005 0000
>> G $1000
PHYSICAL ADDRESS=00001000
A BUS ERROR JUST OCCURRED!
1035 00000005 0000

```

IV. Discussion Questions:

▪ 3.1 Discussion:

1. An updated version of the programs presented above with both global and local comments included.

i. Address Error Exception

```

MM $2000;DI <CR>          ; Modify memory at $2000
MOVE.W D0,A1 <CR>          ; Move word sized data from D0 to A1
MOVE.W D1,(A1)+ <CR>       ; Move word contents of D1 to (A1), increment (A1)
BRA $2000 <CR>             ;branch always to $2000
.<CR>

```

ii. Bus Error Exception

```

MM $2000;DI<CR>           ; Modify memory at $2000
MOVE.B $FFFFFF,D0<CR>    ; Move memory contents $FFFFFF to D0
BRA $2000<CR>             ; Branch always to $2000
.<CR>

```

iii. Illegal Instruction Exception

```

MM $2000;W                ; Modify memory $2000
4AFA<CR>                  ; invalid
.<CR>

```

iv. Privilege Violation Exception

```

MM $2000;DI               ; Modify memory $2000
ANDI.W #$0700;SR<CR>     ; and SR with $0700
BRA $2000<CR>             ; Branch always $2000
.<CR>

```

v. Zero Divide Exception

```

MM $2000;DI
DIVU D1,D2<CR>            ; D2/D1
BRA $2002<CR>             ; branch always to 2000
.<CR>

```

vi. Check Instruction Exception

```

MM $2000
CHK.W D6,D7<CR>           ; checks if value of contents in D7 is between 0 and D6
BRA $2002<CR>             ; branch always to $2002
.<CR>

```

vii. Line 1010 Emulator Exception

```

MM $2000;W

```

A000<CR> ; put A000 into memory at 2000
.<CR>

viii. Line 1111 Emulator Exception

MM \$2000;W
F000<CR> ; put F000 into \$2000
.<CR>

2.

- a. Describe how and why the above Address Trap exception occurred.
 - The error occurred because it is addressing onto an odd number address whereas Word size can only be at even address
- b. Describe how and why the Bus Trap Error exception occurred, and at what instruction.
 - Error occurred due to incorrect size trying to be moved into D0 which is byte. Because we're trying to move from an address outside the accessible range.
- c. Describe why the Illegal Instruction exception occurred. What is the purpose of the \$4AFA instruction? List any other opcodes, instructions, etc., which cause this exception to occur.
 - Error occurred because \$4AFA does not correspond to any instruction.
- d. Describe how and why the Privilege Violation exception occurred. If you don't understand why, trace through the program.
 - Error occurred because in user mode we cannot modify SR and we are not in supervisor mode. First time it runs instruction ANDI it is in supervisor mode and second time it is in user mode and trying to change SR.t
- e. Describe how and why the above Zero Divide exception occurred.
 - Error occurs because dividing by zero.
- f. When performing a division operation and an overflow condition occurs, will exception processing occur? If yes, describe which exception occurs. If no, describe a method for invoking an exception for overflow conditions.
 - No; create a subroutine that throws an error when V (overflow) in CCR is set.
- g. Describe how and why the CHK Instruction exception occurred. Describe the advantages of the CHK Instruction.
 - Error occurred because D7 is greater than D6
- h. Describe why the LINE 1010 Emulator exception occurred. What purpose does this exception serve?
 - Error occurred because instruction cannot start with \$A = 1010 binary -- reserved
- i. Describe why the LINE 1111 Emulator exception occurred. What purpose does this exception serve? What is this exception specifically intended for?
 - Error occurred because instruction cannot start with \$F = 1111 binary -- coprocessor interface

▪ 3.2 Discussion

1. Add both global and local comments to the programs in Procedures #1, #5 and #12.
#1:

```

MOVE.L #$2000,A5      ; move imm value $2000 to A5
MOVE.L #$201A,A6      ; move imm value $201A to A6
MOVE.B #227,D7        ; display string
TRAP #14              ; call trap function
MOVE.B #228,D7        ; exit program
    TRAP #14          ; call trap

#5:
    MOVE.B #50000,D0   ; Copying $50000 into D0 would invoke a bus error
    BRA $1000          ; Branches back to $1000 to loop over and over

#12:
    MOVE.L #$2000,A5   ; Move address $2000 to A5
    MOVE.L #$201A,A6   ; Move address $201A to A6
    MOVE.B #227,D7     ; Syscall for printing a string to terminal
    TRAP #14           ; TRAP function
    MOVE.W (SP)+,D0     ; Move SSW to D0
    MOVE.W #232,D7     ; Syscall to convert 4 hex digits (word) to ASCII
    TRAP #14           ; TRAP function
    MOVE.B #$20,(A6)+   ; Hex for space character
    MOVE.L (SP)+,D0     ; Move BA from SP to D0
    MOVE.W #230,D7     ; Syscall to convert 8 hex digits (long) to ASCII
    TRAP #14           ; TRAP function
    MOVE.B #$20,(A6)+   ; Adding another space
    MOVE.W (SP)+,D0     ; Move IR from SP to D0
    MOVE.W #232,D7     ; Syscall to convert 4 hex digits (word) to ASCII
    TRAP #14           ; TRAP function
    MOVE.W #227,D7     ; Syscall to print registers
    TRAP #14           ; Trap function
    MOVE.W #228,D7     ; go to TUTOR
    TRAP #14           ; Trap function

```

2. If you were writing your own Bus Error Exception routine, what type of functions or features would you include in your routine and why?
 - Create features to adjust registers that contain any invalid address values or skip lines that cause any errors.
3. Explain why the string 'A BUS ERROR JUST OCCURRED' didn't appear on the screen after the program was executed a second time.
 - The string didn't appear because depressing the reset button changed the contents of the vector table.

▪ 3.3 Discussion

1. A commented version of the program outlined in Procedure Step No. 1 (include both global and local comments).

MOVE.B \$50000,D0	; moves a byte from \$50000 into D0 (invalid)
BRA \$1000	; branches back to 1000

2. With regard to this sample program, describe in detail the sequence of events, which caused the 68000 to enter its HALTED state.
 - Two bus errors must occur consecutively to put the SANPER into a halted state.
3. In general, what sequences of events causes a double bus fault to occur?
 - When a bus error occurs in the program and also in the exception routine.
4. Describe what effect a double bus error condition has on the 68000's HALT signal. Discuss the advantages and disadvantages of this feature.
 - The SANPER is put into a halted state.
5. Describe the result of depressing the ABORT switch and explain the reason for this.
 - Abort button didn't do anything since the SANPER was already in a halted state, therefore there was no program to abort.
6. Describe the result of depressing the RESET switch and explain the reason for this.
 - The reset button takes it out of the halted state.
7. Explain the differences between the RESET and ABORT switches. Under what conditions would you use the ABORT switch? When you reset the lab unit, what happens to the contents of the Exception Vector Table?
 - The abort switch just exits the SANPER out of the current program, while the reset switch resets all memory and registers completely.
8. What are the differences between manually activating the RESET pushbutton, and having the 68000 execute the RESET instruction?
 - Using the instruction won't reset the vector table.