### EEEN 3449

### Microprocessor Systems

# Addressing Mode

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**I. INTRODUCTION**

* 1. **Purpose**

The purpose of this experiment is to familiarize oneself with the various addressing modes of the HCS12 microcontroller, including Immediate Mode, Extended Mode, Constant Offset Index Addressing Mode, and Constant Indirect Indexed Addressing Mode. Additionally, one is to familiarize oneself with the Post- and Pre-Increment/Decrement operators.

* 1. **Problem**

Basic assembly programs consisting of simple load and store instructions to manipulate the values of the various CPU registers on the microcontroller will be executed. In program A, a 2 byte value will be loaded to D, stored in two memory locations, and then loaded back to D. In program B-1, the procedure will be repeated, but with 16 bytes- each byte with two identical nibbles- counting upwards from 00 to FF. Additionally, 5-bit, 9-bit, and 16-bit constant offset indexed addressing modes will be tested. Finally, 16-bit constant indirect indexed addressing mode will be tested. In program B-2, the offsets for each of the addressing modes will be changed, so as to verify that the addressing modes are working properly. In program B-3, pre- and post-increment operators will be added to the addressing modes.

* 1. **Scope**

The scope of this experiment is limited to the HCS12 microcontroller. Only a few basic instructions will be used from the HCS12 instruction set, including storing and loading instructions. No arithmetic or branching will be performed as part of this experiment.

**II. TEST AND EVALUATION**

**2.1 Apparatus**

The equipment used in this test includes: Dragon12-Junior development board, USB power cord, and laptop PC with AsmIDE.

**2.2 Procedure**

1. The development board was connected to the computer.
2. The COM port number was determined under Device Manager on PC. AsmIDE was launched. Under View -> Options -> COM Port, the COM port was set to the device’s number. The Terminal Window was enabled. Under Set COM Options, the default values were restored.
3. Program A (Appendix A) was opened, and then assembled. After no errors were recorded, program A was downloaded into the development board, by typing load in the Terminal Window in AsmIDE, then downloading the program.
4. br 2006 was typed to set a breakpoint. g 2000 was typed to execute the program. t was typed repeatedly to trace the program, line by line, until the program ended. As the program was traced, the values in A, B, and $1500-$1501 were verified correct.
5. Program B-1 (Appendix B) was opened, and then assembled. After no errors were recorded, program B-1 was downloaded into the development board.
6. br 2006 was typed to set a breakpoint. g 2000 was typed to execute the program. t was typed repeatedly to trace the program, line by line, until the program ended. As the program was traced, the values in A, B, and $1500-$1530 were verified correct.
7. Program B-1 was renamed and saved as Program B-2 (Appendix C). Each of the offset index addressing instructions were modified to change the offset. Program B-2 was assembled. After no errors were recorded, program B-2 was downloaded into the development board.
8. br 2006 was typed to set a breakpoint. g 2000 was typed to execute the program. t was typed repeatedly to trace the program, line by line, until the program ended. As the program was traced, the values in A, B, and $1500-$1530 were verified correct.
9. Program B-2 was renamed and saved as Program B-3 (Appendix D). Each of the offset index addressing instructions were modified to change the offset. Program B-3 was assembled. After no errors were recorded, program B-3 was downloaded into the development board.
10. br 2006 was typed to set a breakpoint. g 2000 was typed to execute the program. t was typed repeatedly to trace the program, line by line, until the program ended. As the program was traced, the values in A, B, and $1500-$1530 were verified correct.

**III. RESULTS**

* 1. **Data**

In program A, $BBCC was written to addresses $1500-1501. By tracing the program, this value was found in both locations (see Appendix A). In program B-1, B-2, and B-3, the values $00 through $FF was written to 16 bytes beginning at $1500 (see Appendix B, C, D). Using the md command, these values were found at the expected locations (see Appendix B, C, D). Additionally, the values written to the memory locations at the offset addresses.

1. **CONCLUSION**

**4.1 Assessment**

This experiment served as an introduction to the basic instructions of the Assembly language. Program A was an introduction to basic load and store instructions, as well as an introduction to setting breakpoints and executing the program. Program B-1 and B-2 focused on the various types of indexed addressing modes, including direct and indirect addressing modes. Finally, program B-3 focused on the pre- and post-increment operators and how they affect the offset and registers.

**APPENDIX A**

**ASSEEMBLY PROGRAM A**

org $2000 ; program start

ldd #$BBCC ; D = $BBCC

staa $1501 ; $1501 = A

stab $1502 ; $1502 = B

ldaa $1501 ; A = [$1501]

ldab $1502 ; B = [$1502]

swi

end

|  |  |
| --- | --- |
| **ADDRESS** | **CONTENT** |
| $1500 | CB |
| $1501 | BB |
| $1502 | CC |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **LDD #$BBCC** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2000 | 3C00 | 0000 | 0000 | BB | CC | 1001 1000 |
|  |  |  |  |  |  |  |
| **STAA $1501** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2003 | 3C00 | 0000 | 0000 | BB | CC | 1001 1000 |
|  |  |  |  |  |  |  |
| **STAB $1502** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2006 | 3C00 | 0000 | 0000 | BB | CC | 1001 1000 |
|  |  |  |  |  |  |  |
| **LDAA $1501** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2009 | 3C00 | 0000 | 0000 | BB | CC | 1001 1000 |
|  |  |  |  |  |  |  |
| **LDAB $1502** |  |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 200C | 3C00 | 0000 | 0000 | BB | CC | 1001 1000 |
|  |  |  |  |  |  |  |
| **SWI** |  |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 200F | 3C00 | 0000 | 0000 | BB | CC | 1001 1000 |

**APPENDIX B**

**ASSEEMBLY PROGRAM B-1**

org $2000 ; program start

; load incrementing values into memory: 00-0F, beginning at $1500

ldd #$0011 ; D = $0011

staa $1500 ; $1500 = A

stab $1501 ; $1501 = B

ldd #$2233 ; D = $2233

staa $1502 ; $1502 = A

stab $1503 ; $1503 = B

ldd #$4455 ; D = $4455

staa $1504 ; $1504 = A

stab $1505 ; $1505 = B

ldd #$6677 ; D = $6677

staa $1506 ; $1506 = A

stab $1507 ; $1507 = B

ldd #$8899 ; D = $8899

staa $1508 ; $1508 = A

stab $1509 ; $1509 = B

ldd #$AABB ; D = $aabb

staa $150A ; $150a = A

stab $150B ; $150b = B

ldd #$CCDD ; D = $ccdd

staa $150C ; $150c = A

stab $150D ; $150d = B

ldd #$EEFF ; D = $eeff

staa $150E ; $150e = A

stab $150F ; $150f = B

; 5 bit constant offset indexed addressing

ldx #$1509 ; X = $1509

ldaa 5,X ; A = [X + 5]

ldab -8,X ; B = [X - 8]

; 9 bit constant offset indexed addressing

ldy #$1590 ; Y = $1590

ldaa -140,Y ; A = [Y - 140]

ldy #$1490 ; Y = $1490

ldab $76,Y ; B = [Y + $76]

; 16 bit constant offset indexed addressing

ldx #$1000 ; X = $1000

ldaa $50F,X ; A = [X + $050F]

ldy #$2000 ; Y = $2000

ldab -$AF6,Y ; B = [Y - $0AF6]

; 16 bit constant indirect indexed addressing

ldd #$1505 ; D = $1505

staa $1515 ; $1515 = [A]

stab $1516 ; $1516 = [B]

ldx #$152D ; X = $152D

ldaa [-$18,X] ; A = [X - $18]

ldd #$1508 ; D = $1508

staa $1545 ; $1545 = [A]

stab $1546 ; $1546 = [B]

ldx #$152D ; X = $152D

ldab [$19,X] ; B = [X + $19]

swi

end

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **ADDRESS** | **CONTENT** | **ADDRESS** | **CONTENT** | **ADDRESS** | **CONTENT** |
| $1500 | 00 | $1510 | DE | $1520 | A4 |
| $1501 | 11 | $1511 | 45 | $1521 | 6A |
| $1502 | 22 | $1512 | AA | $1522 | 12 |
| $1503 | 33 | $1513 | 58 | $1523 | E2 |
| $1504 | 44 | $1514 | 4B | $1524 | 83 |
| $1505 | 55 | $1515 | 15 | $1525 | 18 |
| $1506 | 66 | $1516 | 05 | $1526 | 38 |
| $1507 | 77 | $1517 | 01 | $1527 | 25 |
| $1508 | 88 | $1518 | 42 | $1528 | A6 |
| $1509 | 99 | $1519 | 10 | $1529 | 6D |
| $150A | AA | $151A | 9D | $152A | 9B |
| $150B | BB | $151B | 0B | $152B | 1D |
| $150C | CC | $151C | D4 | $152C | 85 |
| $150D | DD | $151D | BC | $152D | F8 |
| $150E | EE | $151E | 58 | $152E | D1 |
| $150F | FF | $151F | 81 | $152F | 21 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **STAB $1502** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2006 | 3C00 | 0000 | 0000 | BB | CC | 1001 1000 |
|  |  |  |  |  |  |  |
| **LDAA $1501** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2009 | 3C00 | 0000 | 0000 | BB | CC | 1001 1000 |
|  |  |  |  |  |  |  |
| **LDAB $1502** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 200C | 3C00 | 0000 | 0000 | BB | CC | 1001 1000 |
|  |  |  |  |  |  |  |
| **3F SWI** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 200F | 3C00 | 0000 | 0000 | BB | CC | 1001 1000 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |
| **STAB $1501** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2006 | 3C00 | 0000 | 0000 | 00 | 11 | 1001 0100 |
|  |  |  |  |  |  |  |
| **LDD #$2233** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2009 | 3C00 | 0000 | 0000 | 00 | 11 | 1001 0000 |
|  |  |  |  |  |  |  |
| **STAA $1502** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 200C | 3C00 | 0000 | 0000 | 22 | 33 | 1001 0000 |
|  |  |  |  |  |  |  |
| **STAB $1503** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 200F | 3C00 | 0000 | 0000 | 22 | 33 | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDD #$4455** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2012 | 3C00 | 0000 | 0000 | 22 | 33 | 1001 0000 |
|  |  |  |  |  |  |  |
| **STAA $1504** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2015 | 3C00 | 0000 | 0000 | 44 | 55 | 1001 0000 |
|  |  |  |  |  |  |  |
| **STAB $1505** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2018 | 3C00 | 0000 | 0000 | 44 | 55 | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDD #$6677** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 201B | 3C00 | 0000 | 0000 | 44 | 55 | 1001 0000 |
|  |  |  |  |  |  |  |
| **STAA $1506** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 201E | 3C00 | 0000 | 0000 | 66 | 77 | 1001 0000 |
|  |  |  |  |  |  |  |
| **STAB $1507** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2021 | 3C00 | 0000 | 0000 | 66 | 77 | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDD #$8899** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2024 | 3C00 | 0000 | 0000 | 66 | 77 | 1001 0000 |
|  |  |  |  |  |  |  |
| **STAA $1508** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2027 | 3C00 | 0000 | 0000 | 88 | 99 | 1001 1000 |
|  |  |  |  |  |  |  |
| **STAB $1509** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 202A | 3C00 | 0000 | 0000 | 88 | 99 | 1001 1000 |
|  |  |  |  |  |  |  |
| **LDD #$AABB** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 202D | 3C00 | 0000 | 0000 | 88 | 99 | 1001 1000 |
|  |  |  |  |  |  |  |
| **STAA $150A** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2030 | 3C00 | 0000 | 0000 | AA | BB | 1001 1000 |
|  |  |  |  |  |  |  |
| **STAB $150B** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2033 | 3C00 | 0000 | 0000 | AA | BB | 1001 1000 |
|  |  |  |  |  |  |  |
| **LDD #$CCDD** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2036 | 3C00 | 0000 | 0000 | AA | BB | 1001 1000 |
|  |  |  |  |  |  |  |
| **STAA $150C** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2039 | 3C00 | 0000 | 0000 | CC | DD | 1001 1000 |
|  |  |  |  |  |  |  |
| **STAB $150D** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 203C | 3C00 | 0000 | 0000 | CC | DD | 1001 1000 |
|  |  |  |  |  |  |  |
| **LDD #$EEFF** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 203F | 3C00 | 0000 | 0000 | CC | DD | 1001 1000 |
|  |  |  |  |  |  |  |
| **STAA $150E** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2042 | 3C00 | 0000 | 0000 | EE | FF | 1001 1000 |
|  |  |  |  |  |  |  |
| **STAB $150F** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2045 | 3C00 | 0000 | 0000 | EE | FF | 1001 1000 |
|  |  |  |  |  |  |  |
| **LDX #$1509** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2048 | 3C00 | 0000 | 0000 | EE | FF | 1001 1000 |
|  |  |  |  |  |  |  |
| **LDAA 5,X** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 204B | 3C00 | 1509 | 0000 | EE | FF | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDAB -8,X** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 204D | 3C00 | 1509 | 0000 | EE | FF | 1001 1000 |
|  |  |  |  |  |  |  |
| **LDY #$1590** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 204F | 3C00 | 1509 | 0000 | EE | 11 | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDAA -140,Y** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2052 | 3C00 | 1509 | 1590 | EE | 11 | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDY #$1490** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2055 | 3C00 | 1509 | 1590 | 44 | 11 | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDAB 118,Y** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2058 | 3C00 | 1509 | 1490 | 44 | 11 | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDX #$1000** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 205B | 3C00 | 1509 | 1490 | 44 | 66 | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDAA 1295,X** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 205E | 3C00 | 1000 | 1490 | 44 | 66 | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDY #$2000** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2062 | 3C00 | 1000 | 1490 | FF | 66 | 1001 1000 |
|  |  |  |  |  |  |  |
| **LDAB -2806,Y** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2065 | 3C00 | 1000 | 2000 | FF | 66 | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDD #$1505** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2069 | 3C00 | 1000 | 2000 | FF | AA | 1001 1000 |
|  |  |  |  |  |  |  |
| **STAA $1515** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 206C | 3C00 | 1000 | 2000 | 15 | 05 | 1001 0000 |
|  |  |  |  |  |  |  |
| **STAB $1516** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 206F | 3C00 | 1000 | 2000 | 15 | 05 | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDX #$152D** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2072 | 3C00 | 1000 | 2000 | 15 | 05 | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDAA [-24,X]** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2075 | 3C00 | 152D | 2000 | 15 | 05 | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDD #$1508** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2079 | 3C00 | 152D | 2000 | 55 | 05 | 1001 0000 |
|  |  |  |  |  |  |  |
| **STAA $1545** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 207C | 3C00 | 152D | 2000 | 15 | 08 | 1001 0000 |
|  |  |  |  |  |  |  |
| **STAB $1546** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 207F | 3C00 | 152D | 2000 | 15 | 08 | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDX #$152D** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2082 | 3C00 | 152D | 2000 | 15 | 08 | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDAB [25,X]** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2085 | 3C00 | 152D | 2000 | 15 | 08 | 1001 0000 |
|  |  |  |  |  |  |  |
| **3F SWI** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2089 | 3C00 | 152D | 2000 | 15 | FF | 1001 1000 |

**APPENDIX C**

**ASSEEMBLY PROGRAM B-2**

org $2000 ; program start

; load incrementing values into memory: 00-0F, beginning at $1500

ldd #$0011 ; D = $0011

staa $1500 ; $1500 = A

stab $1501 ; $1501 = B

ldd #$2233 ; D = $2233

staa $1502 ; $1502 = A

stab $1503 ; $1503 = B

ldd #$4455 ; D = $4455

staa $1504 ; $1504 = A

stab $1505 ; $1505 = B

ldd #$6677 ; D = $6677

staa $1506 ; $1506 = A

stab $1507 ; $1507 = B

ldd #$8899 ; D = $8899

staa $1508 ; $1508 = A

stab $1509 ; $1509 = B

ldd #$AABB ; D = $aabb

staa $150A ; $150a = A

stab $150B ; $150b = B

ldd #$CCDD ; D = $ccdd

staa $150C ; $150c = A

stab $150D ; $150d = B

ldd #$EEFF ; D = $eeff

staa $150E ; $150e = A

stab $150F ; $150f = B

; 5 bit constant offset indexed addressing

ldx #$1509 ; X = $1509

ldaa 3,X ; A = [X + 3]

ldab -4,X ; B = [X - 4]

; 9 bit constant offset indexed addressing

ldy #$1590 ; Y = $1590

ldaa -78,Y ; A = [Y - 78]

ldy #$1490 ; Y = $1490

ldab $45,Y ; B = [Y + $45]

; 16 bit constant offset indexed addressing

ldx #$1000 ; X = $1000

ldaa $ABC,X ; A = [X + $ABC]

ldy #$2000 ; Y = $2000

ldab -$B9A,Y ; B = [Y - $B9A]

; 16 bit constant indirect indexed addressing

ldd #$1505 ; D = $1505

staa $1515 ; $1515 = [A]

stab $1516 ; $1516 = [B]

ldx #$152D ; X = $152D

ldaa [-$11,X] ; A = [X - $11]

ldd #$1508 ; D = $1508

staa $1545 ; $1545 = [A]

stab $1546 ; $1546 = [B]

ldx #$152D ; X = $152D

ldab [$24,X] ; B = [X + $24]

swi

end

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **ADDRESS** | **CONTENT** | **ADDRESS** | **CONTENT** | **ADDRESS** | **CONTENT** |
| $1500 | 00 | $1510 | DE | $1520 | A4 |
| $1501 | 11 | $1511 | 45 | $1521 | 6A |
| $1502 | 22 | $1512 | AA | $1522 | 12 |
| $1503 | 33 | $1513 | 58 | $1523 | E2 |
| $1504 | 44 | $1514 | 4B | $1524 | 83 |
| $1505 | 55 | $1515 | 15 | $1525 | 18 |
| $1506 | 66 | $1516 | 05 | $1526 | 38 |
| $1507 | 77 | $1517 | 01 | $1527 | 25 |
| $1508 | 88 | $1518 | 42 | $1528 | A6 |
| $1509 | 99 | $1519 | 10 | $1529 | 6D |
| $150A | AA | $151A | 9D | $152A | 9B |
| $150B | BB | $151B | 0B | $152B | 1D |
| $150C | CC | $151C | D4 | $152C | 85 |
| $150D | DD | $151D | BC | $152D | F8 |
| $150E | EE | $151E | 58 | $152E | D1 |
| $150F | FF | $151F | 81 | $152F | 21 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **STAB $1501** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2006 | 3C00 | 0000 | 0000 | 00 | 11 | 1001 0100 |
|  |  |  |  |  |  |  |
| **LDD #$2233** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2009 | 3C00 | 0000 | 0000 | 00 | 11 | 1001 0000 |
|  |  |  |  |  |  |  |
| **STAA $1502** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 200C | 3C00 | 0000 | 0000 | 22 | 33 | 1001 0000 |
|  |  |  |  |  |  |  |
| **STAB $1503** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 200F | 3C00 | 0000 | 0000 | 22 | 33 | 1001 0000 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |
| **LDD #$4455** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2012 | 3C00 | 0000 | 0000 | 22 | 33 | 1001 0000 |
|  |  |  |  |  |  |  |
| **STAA $1504** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2015 | 3C00 | 0000 | 0000 | 44 | 55 | 1001 0000 |
|  |  |  |  |  |  |  |
| **STAB $1505** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2018 | 3C00 | 0000 | 0000 | 44 | 55 | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDD #$6677** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 201B | 3C00 | 0000 | 0000 | 44 | 55 | 1001 0000 |
|  |  |  |  |  |  |  |
| **STAA $1506** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 201E | 3C00 | 0000 | 0000 | 66 | 77 | 1001 0000 |
|  |  |  |  |  |  |  |
| **STAB $1507** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2021 | 3C00 | 0000 | 0000 | 66 | 77 | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDD #$8899** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2024 | 3C00 | 0000 | 0000 | 66 | 77 | 1001 0000 |
|  |  |  |  |  |  |  |
| **STAA $1508** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2027 | 3C00 | 0000 | 0000 | 88 | 99 | 1001 1000 |
|  |  |  |  |  |  |  |
| **STAB $1509** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 202A | 3C00 | 0000 | 0000 | 88 | 99 | 1001 1000 |
|  |  |  |  |  |  |  |
| **LDD #$AABB** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 202D | 3C00 | 0000 | 0000 | 88 | 99 | 1001 1000 |
|  |  |  |  |  |  |  |
| **STAA $150A** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2030 | 3C00 | 0000 | 0000 | AA | BB | 1001 1000 |
|  |  |  |  |  |  |  |
| **STAB $150B** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2033 | 3C00 | 0000 | 0000 | AA | BB | 1001 1000 |
|  |  |  |  |  |  |  |
| **LDD #$CCDD** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2036 | 3C00 | 0000 | 0000 | AA | BB | 1001 1000 |
|  |  |  |  |  |  |  |
| **STAA $150C** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2039 | 3C00 | 0000 | 0000 | CC | DD | 1001 1000 |
|  |  |  |  |  |  |  |
| **STAB $150D** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 203C | 3C00 | 0000 | 0000 | CC | DD | 1001 1000 |
|  |  |  |  |  |  |  |
| **LDD #$EEFF** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 203F | 3C00 | 0000 | 0000 | CC | DD | 1001 1000 |
|  |  |  |  |  |  |  |
| **STAA $150E** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2042 | 3C00 | 0000 | 0000 | EE | FF | 1001 1000 |
|  |  |  |  |  |  |  |
| **STAB $150F** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2045 | 3C00 | 0000 | 0000 | EE | FF | 1001 1000 |
|  |  |  |  |  |  |  |
| **LDX #$1509** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2048 | 3C00 | 0000 | 0000 | EE | FF | 1001 1000 |
|  |  |  |  |  |  |  |
| **LDAA 3,X** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 204B | 3C00 | 1509 | 0000 | EE | FF | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDAB -4,X** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 204D | 3C00 | 1509 | 0000 | CC | FF | 1001 1000 |
|  |  |  |  |  |  |  |
| **LDY #$1590** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 204F | 3C00 | 1509 | 0000 | CC | 55 | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDAA -78,Y** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2052 | 3C00 | 1509 | 1590 | CC | 55 | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDY #$1490** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2055 | 3C00 | 1509 | 1590 | D5 | 55 | 1001 1000 |
|  |  |  |  |  |  |  |
| **LDAB 69,Y** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2058 | 3C00 | 1509 | 1490 | D5 | 55 | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDX #$1000** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 205B | 3C00 | 1509 | 1490 | D5 | C2 | 1001 1000 |
|  |  |  |  |  |  |  |
| **LDAA 2748,X** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 205E | 3C00 | 1000 | 1490 | D5 | C2 | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDY #$2000** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2062 | 3C00 | 1000 | 1490 | 61 | C2 | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDAB -2970,Y** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2065 | 3C00 | 1000 | 2000 | 61 | C2 | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDD #$1505** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2069 | 3C00 | 1000 | 2000 | 61 | 91 | 1001 1000 |
|  |  |  |  |  |  |  |
| **STAA $1515** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 206C | 3C00 | 1000 | 2000 | 15 | 05 | 1001 0000 |
|  |  |  |  |  |  |  |
| **STAB $1516** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 206F | 3C00 | 1000 | 2000 | 15 | 05 | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDX #$152D** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2072 | 3C00 | 1000 | 2000 | 15 | 05 | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDAA [-17,X]** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2075 | 3C00 | 152D | 2000 | 15 | 05 | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDD #$1508** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2079 | 3C00 | 152D | 2000 | 20 | 05 | 1001 0000 |
|  |  |  |  |  |  |  |
| **STAA $1545** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 207C | 3C00 | 152D | 2000 | 15 | 08 | 1001 0000 |
|  |  |  |  |  |  |  |
| **STAB $1546** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 207F | 3C00 | 152D | 2000 | 15 | 08 | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDX #$152D** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2082 | 3C00 | 152D | 2000 | 15 | 08 | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDAB [36,X]** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2085 | 3C00 | 152D | 2000 | 15 | 08 | 1001 0000 |
|  |  |  |  |  |  |  |
| **3F SWI** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2089 | 3C00 | 152D | 2000 | 15 | 74 | 1001 0000 |

**APPENDIX D**

**ASSEEMBLY PROGRAM B-3**

org $2000 ; program start

; load incrementing values into memory: 00-0F, beginning at $1500

ldd #$0011 ; D = $0011

staa $1500 ; $1500 = A

stab $1501 ; $1501 = B

ldd #$2233 ; D = $2233

staa $1502 ; $1502 = A

stab $1503 ; $1503 = B

ldd #$4455 ; D = $4455

staa $1504 ; $1504 = A

stab $1505 ; $1505 = B

ldd #$6677 ; D = $6677

staa $1506 ; $1506 = A

stab $1507 ; $1507 = B

ldd #$8899 ; D = $8899

staa $1508 ; $1508 = A

stab $1509 ; $1509 = B

ldd #$AABB ; D = $aabb

staa $150A ; $150a = A

stab $150B ; $150b = B

ldd #$CCDD ; D = $ccdd

staa $150C ; $150c = A

stab $150D ; $150d = B

ldd #$EEFF ; D = $eeff

staa $150E ; $150e = A

stab $150F ; $150f = B

; 5 bit constant post/pre increment offset indexed addressing

ldx #$1509 ; X = $1509

ldaa 3,X+ ; A = [X + 3], X = X + 1

ldab 4,+X ; B = X = X + 1, [X + 4]

; 9 bit constant post/pre increment offset indexed addressing

ldy #$1590 ; Y = $1590

ldaa 8,Y+ ; A = [Y + 8], Y = Y + 1

ldy #$1490 ; Y = $1490

ldab 5,+Y ; Y = Y + 1, B = [Y + 5]

; 16 bit constant post/pre increment offset indexed addressing

ldx #$1000 ; X = $1000

ldaa 4,+X ; A = X = X + 1, [X + 4]

ldy #$2000 ; Y = $2000

ldab 6,Y+ ; B = [Y + 6], Y = Y + 1

; 16 bit constant post/pre increment indirect indexed addressing

ldd #$1505 ; D = $1505

staa $1515 ; $1515 = [A]

stab $1516 ; $1516 = [B]

ldx #$152D ; X = $152D

ldaa [5,X] ; A = [X - 5], X = X + 1

ldd #$1508 ; D = $1508

staa $1545 ; $1545 = [A]

stab $1546 ; $1546 = [B]

ldx #$152D ; X = $152D

ldab [2,X] ; X = X + 1, B = [X + 2]

swi

end

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **ADDRESS** | **CONTENT** | **ADDRESS** | **CONTENT** | **ADDRESS** | **CONTENT** |
| $1500 | 00 | $1510 | DE | $1520 | A4 |
| $1501 | 11 | $1511 | 45 | $1521 | 6A |
| $1502 | 22 | $1512 | AA | $1522 | 12 |
| $1503 | 33 | $1513 | 58 | $1523 | E2 |
| $1504 | 44 | $1514 | 4B | $1524 | 83 |
| $1505 | 55 | $1515 | 15 | $1525 | 18 |
| $1506 | 66 | $1516 | 05 | $1526 | 38 |
| $1507 | 77 | $1517 | 01 | $1527 | 25 |
| $1508 | 88 | $1518 | 42 | $1528 | A6 |
| $1509 | 99 | $1519 | 10 | $1529 | 6D |
| $150A | AA | $151A | 9D | $152A | 9B |
| $150B | BB | $151B | 0B | $152B | 1D |
| $150C | CC | $151C | D4 | $152C | 85 |
| $150D | DD | $151D | BC | $152D | F8 |
| $150E | EE | $151E | 58 | $152E | D1 |
| $150F | FF | $151F | 81 | $152F | 21 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **STAB $1501** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2006 | 3C00 | 0000 | 0000 | 00 | 11 | 1001 0100 |
|  |  |  |  |  |  |  |
| **LDD #$2233** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2009 | 3C00 | 0000 | 0000 | 00 | 11 | 1001 0000 |
|  |  |  |  |  |  |  |
| **STAA $1502** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 200C | 3C00 | 0000 | 0000 | 22 | 33 | 1001 0000 |
|  |  |  |  |  |  |  |
| **STAB $1503** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 200F | 3C00 | 0000 | 0000 | 22 | 33 | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDD #$4455** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2012 | 3C00 | 0000 | 0000 | 22 | 33 | 1001 0000 |
|  |  |  |  |  |  |  |
| **STAA $1504** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2015 | 3C00 | 0000 | 0000 | 44 | 55 | 1001 0000 |
|  |  |  |  |  |  |  |
| **STAB $1505** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2018 | 3C00 | 0000 | 0000 | 44 | 55 | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDD #$6677** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 201B | 3C00 | 0000 | 0000 | 44 | 55 | 1001 0000 |
|  |  |  |  |  |  |  |
| **STAA $1506** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 201E | 3C00 | 0000 | 0000 | 66 | 77 | 1001 0000 |
|  |  |  |  |  |  |  |
| **STAB $1507** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2021 | 3C00 | 0000 | 0000 | 66 | 77 | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDD #$8899** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2024 | 3C00 | 0000 | 0000 | 66 | 77 | 1001 0000 |
|  |  |  |  |  |  |  |
| **STAA $1508** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2027 | 3C00 | 0000 | 0000 | 88 | 99 | 1001 1000 |
|  |  |  |  |  |  |  |
| **STAB $1509** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 202A | 3C00 | 0000 | 0000 | 88 | 99 | 1001 1000 |
|  |  |  |  |  |  |  |
| **LDD #$AABB** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 202D | 3C00 | 0000 | 0000 | 88 | 99 | 1001 1000 |
|  |  |  |  |  |  |  |
| **STAA $150A** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2030 | 3C00 | 0000 | 0000 | AA | BB | 1001 1000 |
|  |  |  |  |  |  |  |
| **STAB $150B** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2033 | 3C00 | 0000 | 0000 | AA | BB | 1001 1000 |
|  |  |  |  |  |  |  |
| **LDD #$CCDD** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2036 | 3C00 | 0000 | 0000 | AA | BB | 1001 1000 |
|  |  |  |  |  |  |  |
| **STAA $150C** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2039 | 3C00 | 0000 | 0000 | CC | DD | 1001 1000 |
|  |  |  |  |  |  |  |
| **STAB $150D** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 203C | 3C00 | 0000 | 0000 | CC | DD | 1001 1000 |
|  |  |  |  |  |  |  |
| **LDD #$EEFF** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 203F | 3C00 | 0000 | 0000 | CC | DD | 1001 1000 |
|  |  |  |  |  |  |  |
| **STAA $150E** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2042 | 3C00 | 0000 | 0000 | EE | FF | 1001 1000 |
|  |  |  |  |  |  |  |
| **STAB $150F** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2045 | 3C00 | 0000 | 0000 | EE | FF | 1001 1000 |
|  |  |  |  |  |  |  |
| **LDX #$1509** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2048 | 3C00 | 0000 | 0000 | EE | FF | 1001 1000 |
|  |  |  |  |  |  |  |
| **LDAA 3,X+** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 204B | 3C00 | 1509 | 0000 | EE | FF | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDAB 4,+X** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 204D | 3C00 | 150C | 0000 | 99 | FF | 1001 1000 |
|  |  |  |  |  |  |  |
| **LDY #$1590** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 204F | 3C00 | 1510 | 0000 | 99 | DE | 1001 1000 |
|  |  |  |  |  |  |  |
| **LDAA 8,Y+** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2052 | 3C00 | 1510 | 1590 | 99 | DE | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDY #$1490** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2054 | 3C00 | 1510 | 1598 | 64 | DE | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDAB 5,+Y** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2057 | 3C00 | 1510 | 1490 | 64 | DE | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDX #$1000** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2059 | 3C00 | 1510 | 1495 | 64 | 4B | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDAA 4,+X** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 205C | 3C00 | 1000 | 1495 | 64 | 4B | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDY #$2000** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 205E | 3C00 | 1004 | 1495 | 3B | 4B | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDAB 6,Y+** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2061 | 3C00 | 1004 | 2000 | 3B | 4B | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDD #$1505** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2063 | 3C00 | 1004 | 2006 | 3B | CC | 1001 1000 |
|  |  |  |  |  |  |  |
| **STAA $1515** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2066 | 3C00 | 1004 | 2006 | 15 | 05 | 1001 0000 |
|  |  |  |  |  |  |  |
| **STAB $1516** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2069 | 3C00 | 1004 | 2006 | 15 | 05 | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDX #$152D** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 206C | 3C00 | 1004 | 2006 | 15 | 05 | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDAA [5,X]** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 206F | 3C00 | 152D | 2006 | 15 | 05 | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDD #$1508** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2073 | 3C00 | 152D | 2006 | C7 | 05 | 1001 1000 |
|  |  |  |  |  |  |  |
| **STAA $1545** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2076 | 3C00 | 152D | 2006 | 15 | 08 | 1001 0000 |
|  |  |  |  |  |  |  |
| **STAB $1546** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2079 | 3C00 | 152D | 2006 | 15 | 08 | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDX #$152D** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 207C | 3C00 | 152D | 2006 | 15 | 08 | 1001 0000 |
|  |  |  |  |  |  |  |
| **LDAB [2,X]** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 207F | 3C00 | 152D | 2006 | 15 | 08 | 1001 0000 |
|  |  |  |  |  |  |  |
| **3F SWI** | |  |  |  |  |  |
| **PC** | **SP** | **X** | **Y** | **A** | **B** | **SXHI NZVC** |
| 2083 | 3C00 | 152D | 2006 | 15 | 13 | 1001 0000 |