Getting Started

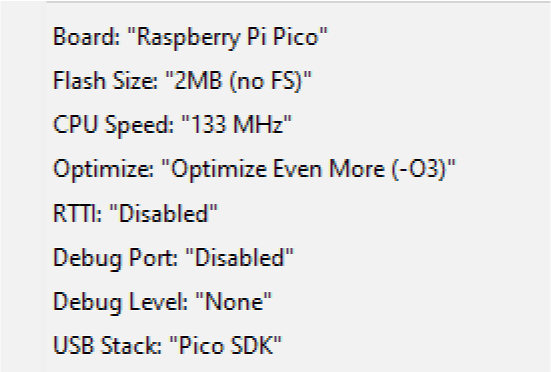
Simple-Circuit 2022

Installing sim680b.ino into your Pico board:

The Pico board requires that you install the Arduino IDE and Earle Philhower's Ardino-Pico port. Follow the instructions for "Installing via Arduino Boards Manager". These are found at:

https://github.com/earlephilhower/arduino-pico

Use the following settings:



```
Board: "Raspberry Pi Pico"
Flash Size: "2MB (no FS)"
CPU Speed: "133 MHz"
Optimize: "Optimize Even More (-O3)"
RTTI: "Disabled"
Debug Port: "Disabled"
Debug Level: "None"
USB Stack: "Pico SDK"
```

PICOBUG Commands:

Monitor Prompt: >
Hex data byte: hh
Enter new hex data byte: **hh**
Hex address: hhhh
Enter new hex address: **hhhh**
<CR> Carriage Return

>M **hhhh** hh <CR>	Examine Memory with no change
>M **hhhh** hh **hh**	Examine Memory and change
hhhh+1 hh	Continues to next address, enter new hex data value or <CR> to end
>N hhhh hh <CR>	Examine Next Memory with no change
>N hhhh hh **hh** <CR>	Examine Next Memory and change
>J **hhhh**	Jump to address hhhh and start running code
>J **1000**	Start FIG Forth
>D **hhhh hhhh**	Hex dump of data address hhhh to hhhh

>L Load S-record

>P **hhhh hhhh** Punch S-record address hhhh to hhhh

>X **hhhh hhhh** Generate comma delimited 0xhh data dump
Useful for converting memory data to C array data

>B **hhhh** Insert SWI break (0x3F) at address hhhh
B saves the instruction at hhhh
Prints all processor registers when the SWI is executed

>R Restore instruction from B command and do a return from interrupt
Note: Do not use multiple B commands prior to R

Hooks: If you have software that works with the MITS ROM Monitor, address jump hooks have been placed for calling to the original ROM functions. The original ROM monitor source and MITS Basic S-record (paper tape contents) is available at:

https://deramp.com/swtpc.com/Altair/Altair_Basic.htm

The PICOBUG L command will load the Basic S-record into memory. Use the monitor command J 0000 to start Basic.

Picobug Code JSR Address Hook Entry Points:

It is recommended to use the hook addresses. The base addresses can change as the software is updated.

getch 0xFF00 – returns 7-bit ascii byte in acc B, calls prtch if 0x00F3 msb is clear (echo input)
getbyte 0xFF53 – returns one byte in acc B, exits to prompt if input is not 0-9 or A-F
getwrd 0xFF62 – returns one word in reg X and at address 0x00FA, exits to prompt if input is not hex
prtch 0xFF81 – prints one 7-bit ascii byte from acc B
prtbyt 0xFF2D – prints one byte from acc A, calls getch
reset 0xFFD8 – processor reset entry point, sets the stack pointer then goes to prompt

Addresses 0x00E0 through 0x00FF are used for the stack and system variables.

SP is initialized to 0X00F1 and it moves down with pushes

FIG Forth:

The Forth Interest Group source was transferred by hand from a PDF file. Some content such as comments may be omitted in parts. Also, the serial data code was modified to allow function with the Pico board. The Free License is presented in both the Arduino source and the assembly source file. Due to possible type errors, malfunction is possible.

Forth is preloaded on power up but it is not updated upon a reset. The PICOBUG ROM area is updated upon a reset. PICOBUG will always work after a reset but the RAM area for Forth could be corrupted prior to the reset.

If you send a program file from simpleCRT.exe to Forth, check the LF filter to remove line feeds. Else, the text from the file will generate errors when defining the new dictionary values.

Hardware I/O:

Serial data is transmitted through the USB interface at 9600 baud. You will need a serial terminal program to communicate with the Pico. A Windows Serial Terminal program written in Lazarus, simpleCRT.exe, is included in the file folder. It has a buffer of 256 lines and can plot space delimited decimal data. Set the Baud to 9600 from the drop down menu. Next, select your Pico Com number. Click on Open to start communication.

An 8-bit input port is present at address 0xf011. The output port is at address 0xf010. Check the sim680b.ino listing for details of which instructions access ports. I/O was limited to a few op codes.

The ADC is read by writing the input pin number 1, 2 or 3 to address 0xf020. The high byte is read at 0xf020 and the low byte at 0xf021. Data is 12-bits.

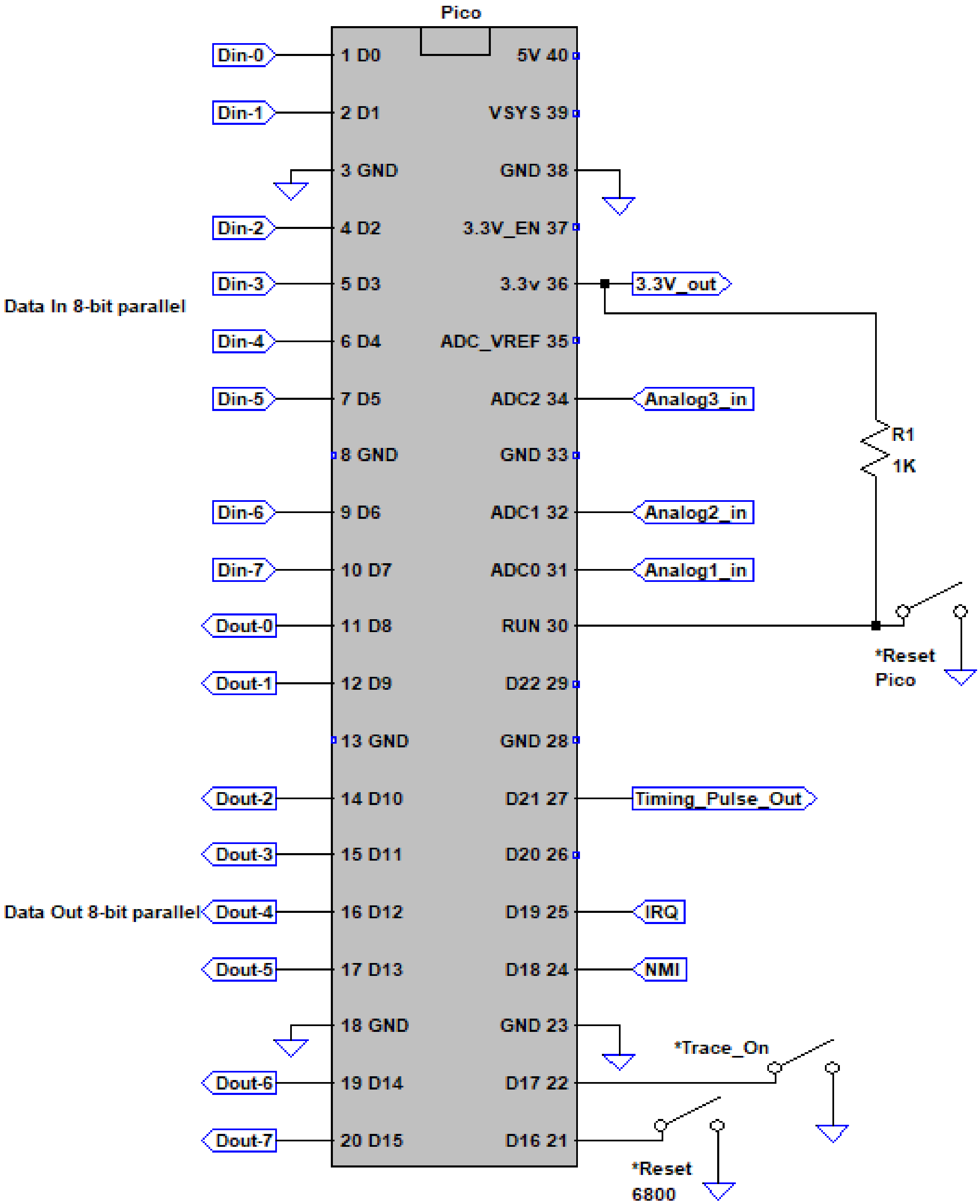
Example Forth I/O definitions:

```
HEX
: ADC 1 F020 C! F020 C@ 100 * F021 C@ + ;
: DIGOUT F010 C! ;
: DIGIN F011 C@ ;
: PLOTADC BEGIN ADC . CR ?TERMINAL UNTIL ;
DECIMAL
```

Example Basic ADC I/O:

```
10 POKE 61472,1
20 A = PEEK(61472)
30 B = PEEK(61473)
40 C = (A*256+B)*0.0008057
50 PRINT C
60 GOTO 10
```

Hardware Connections:

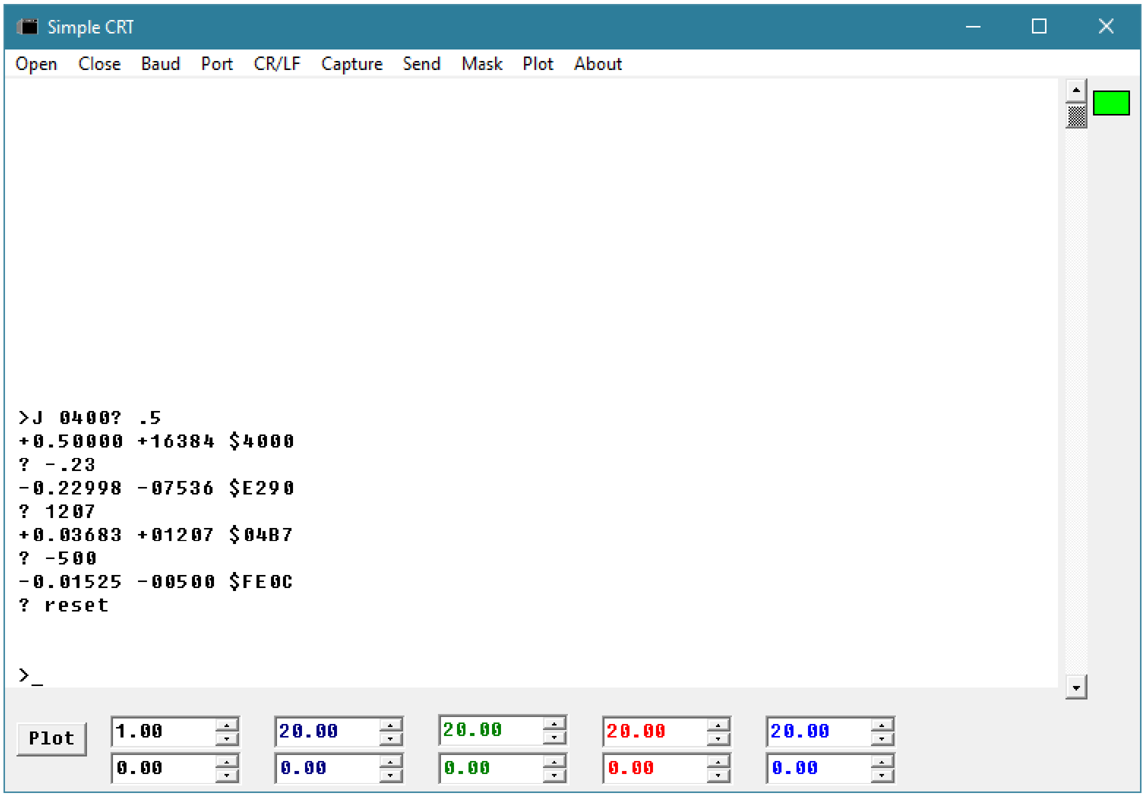


Example Assembly Language:

Copy the following S-record data and save it to a file. Then, use the L (load command) and file send to load the program. J 0400 will run a program the reads decimal integers or decimal fractions and converts them to binary values. The binary values are then printed as a decimal fraction, decimal integer and the binary hexadecimal value. Do a hardware reset to exit.

J 0500 will read the ADC channel 1 and print the value as a fraction. The value can be plotted in simpleCRT. Press any key to exit.

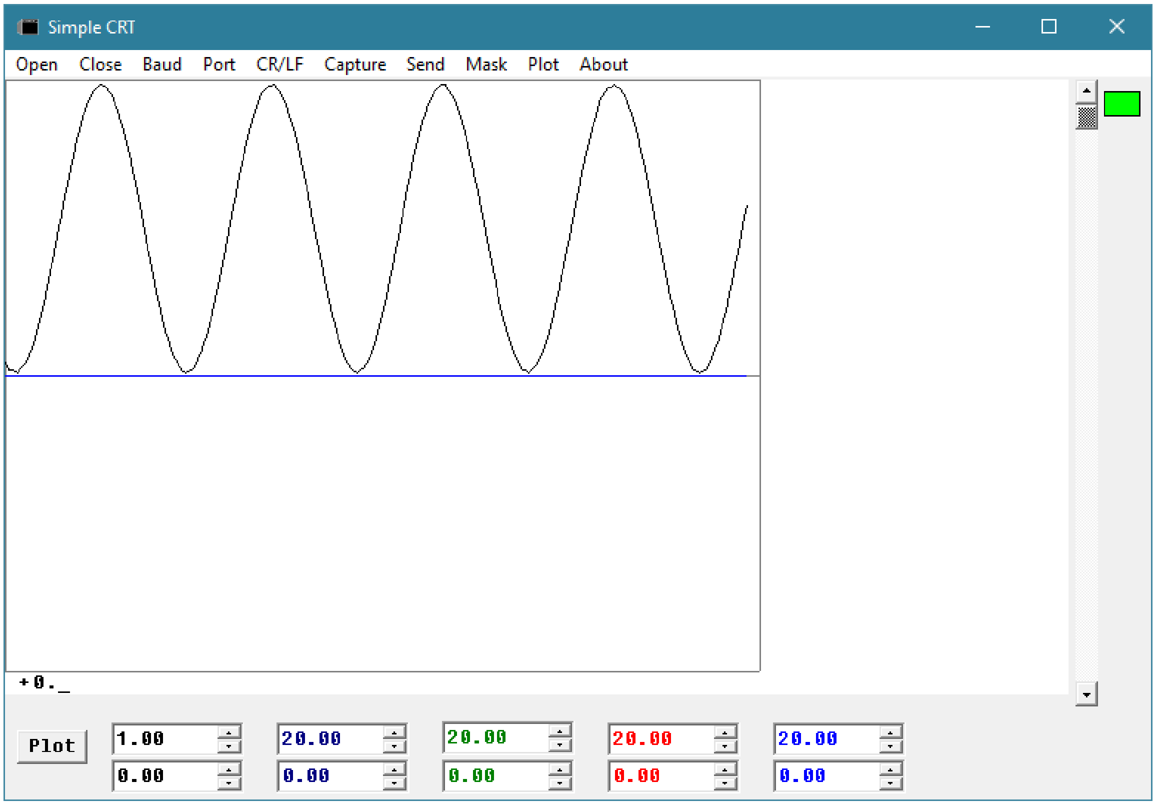
```
S1210400BDD00E9634D635BDD1B19634D635BDD1109634C624BDFF819634BDFF6D963E
S114041E35BDFF6DC60DBDFF81C60ABDFF817E0400CC
S1210500C601F7F020F6F02017F6F021584958495849BDD1B1C60DBDFF81C60ABDFF29
S10D051E81F6F0005424DB7EFFD8C0
S121D000E6002706BDFF810820F6393F2000CED00BBDD00086307F0038CE003AC60097
S121D01ED73AD73BD73CD73DD73ED73FBDFF00C12B2707C12D2606730038BDFF00C163
S121D03C2E2739C1302511C139220DE700088C003F2705BDFF0020EBCE003ABDD0E0D2
S121D05AD63596347D00382A064353CB0189009734D735C60DBDFF81C60ABDFF8139E2
S121D078BDFF00C130250EC139220AE700088C003E270220EBCE003ABDD09520C54F45
S121D096973497359730973186 04E6005858585858790031790030587900317900302C
S121D0B4587900317900305879003179003008 4A26DAC60F96319B311997319630990A
S121D0D2301997307900357900345A26E9394F97349735E6002726C40F088C003F2E42
S121D0F01ED730780035790034D635963458495849DB359934DB3089009734D7352020
S121D10ED6394D2A1A81802608C1002604CB0189004353CB018900D7319730C62D2023
S121D12C06D7319730C62BBDFF819630D6317F0039C01082272B09D73197307C003928
S121D14A20F1D639CB30BDFF819630D6317F0039C0E882032B09D73197307C003920E1
S121D168F1D639CB30BDFF819630D6317F0039C06482002B099730D7317C003920F179
S121D186D639CB30BDFF81D6317F0039C00A2B07D7317C003920F5D639CB30BDFF816C
S121D1A4D631CB30BDFF81C620BDFF8139D73197302B04C62B201CD6319630818026AF
S121D1C208C1002604CB0189004353CB0189009730D731C62DBDFF81C630BDFF81C620
S121D1E02EBDFF81780031790030CE00057F00327F00337800317900307900329632 75
S121D1FE9733D6319630584979003358497900 33DB319930D731973024037C003396CE
S115D21C329B338B3016BDFF810926C5C620BDFF81399E
S9
```



```
>J 0400? .5
+0.50000 +16384 $4000
? -.23
-0.22998 -07536 $E290
? 1207
+0.03683 +01207 $04B7
? -500
-0.01525 -00500 $FE0C
? reset


>_
```

J 0400 convert program



```
+0._
```

J 0500 readadc program

M68HC11 Absolute Assembler   Version 2.70C:CONVERT.ASC

```
  1 A               **EXAMPLE ASSEMBLY PROGRAMS SIMPLE-CIRCUIT 2022
  2 A
  3 A     0030              ORG      $0030              FREE MEMORY NOT USED BY ANY PROGRAMS
  4 P 0030 0002      TEMP      RMB      2
  5 P 0032 0002      TEMP2     RMB      2
  6 P 0034 0004      RSLT      RMB      4
  7 P 0038 0001      SGN       RMB      1
  8 P 0039 0001      COUNT     RMB      1
  9 P 003A 0006      STRG      RMB      6
 10 A     FF81      PRTCH     EQU      $FF81
 11 A     FF00      GETCH     EQU      $FF00
 12 A     FF6D      PRT2H     EQU      $FF6D
 13 A     FFD8      RESET     EQU      $FFD8
 14 A     F020      ADC       EQU      $F020
 15 A     F000      STATUS    EQU      $F000
 16 A 0040
 17 A               **READ AN INTEGER +/-DDDDD OR FRACTION +/-.DDDDD WHERE D=DECIMAL DIGIT
 18 A               **THEN PRINT THE FRACTION AND INTEGER VALUES
 19 A
 20 A     0400              ORG      $0400
 21 A 0400 BDD00E    START     JSR      READ               CONVERT DECIMAL NUMBER
 22 A 0403 9634                LDAA     RSLT            LOAD BINARY RESULT
 23 A 0405 D635                LDAB     RSLT+1
 24 A 0407 BDD1B1              JSR      PRINT             PRINT DECIMAL FRACTION
 25 A 040A 9634                LDAA     RSLT            LOAD BINARY RESULT
 26 A 040C D635                LDAB     RSLT+1
 27 A 040E BDD110              JSR      PRINTI            PRINT DECIMAL INTEGER
 28 A 0411 9634                LDAA     RSLT            LOAD BINARY RESULT
 29 A 0413 C624                LDAB     #'$
 30 A 0415 BDFF81              JSR      PRTCH             PRINT $
 31 A 0418 9634                LDAA     RSLT
 32 A 041A BDFF6D              JSR      PRT2H             PRINT HEX VALUE
 33 A 041D 9635                LDAA     RSLT+1
 34 A 041F BDFF6D              JSR      PRT2H             PRINT HEX VALUE
 35 A 0422 C60D                LDAB     #$0D
 36 A 0424 BDFF81              JSR      PRTCH             PRINT <CR>
 37 A 0427 C60A                LDAB     #$0A
 38 A 0429 BDFF81              JSR      PRTCH             PRINT <LF>
 39 A 042C 7E0400              JMP      START             LOOP BACK TO START, GROUND RESET PIN TO END
```

```
A 042F
A 042F
A              **READ THE ADC AND PRINT THE VALUE AS A FRACTION
A     0500              ORG     $0500
A 0500 C601     READADC LDAB    #1
A 0502 F7F020           STAB    ADC             READ ADC CHANNEL 1
A 0505 F6F020           LDAB    ADC
A 0508 17               TBA
A 0509 F6F021           LDAB    ADC+1
A 050C 58               LSLB                    NORMALIZE FOR .0000 TO .9999
A 050D 49               ROLA
A 050E 58               LSLB
A 050F 49               ROLA
A 0510 58               LSLB
A 0511 49               ROLA
A 0512 BDD1B1           JSR     PRINT           PRINT FRACTION
A 0515 C60D             LDAB    #$0D
A 0517 BDFF81           JSR     PRTCH           <CR>
A 051A C60A             LDAB    #$0A
A 051C BDFF81           JSR     PRTCH           <LF>
A 051F F6F000           LDAB    $F000
A 0522 54               LSRB
A 0523 24DB             BCC     READADC         LOOP UNTIL KEY PRESSED
A 0525 7EFFD8           JMP     RESET           RETURN TO PROMPT
A 0528
A     D000              ORG     $D000
A              **PRINT A STRING POINTED TO BY X, END ON NULL
A D000 E600     PRNST   LDAB    0,X
A D002 2706             BEQ     PRNST2
A D004 BDFF81           JSR     PRTCH
A D007 08               INX
A D008 20F6             BRA     PRNST
A D00A 39       PRNST2  RTS
A D00B
A D00B 3F20     PROMPT  FCC     /? /
A D00D 00               FCB     0
A D00E
A              ** PARSE AND READ INTEGER OR FRACTION
A              ** [+-].NNNN OR [+-]NNNNN
A D00E CED00B   READ    LDX     #PROMPT
A D011 BDD000           JSR     PRNST
A D014 8630             LDAA    #'0
A D016 7F0038   READ1   CLR     SGN
A D019 CE003A           LDX     #STRG
```

```
 84 A D01C C600            LDAB    #0             MARK END OF ASCII STRING
 85 A D01E D73A            STAB    STRG           ASCII DIGIT
 86 A D020 D73B            STAB    STRG+1         ASCII DIGIT
 87 A D022 D73C            STAB    STRG+2         ASCII DIGIT
 88 A D024 D73D            STAB    STRG+3         ASCII DIGIT
 89 A D026 D73E            STAB    STRG+4         ASCII DIGIT
 90 A D028 D73F            STAB    STRG+5         ASCII DIGIT
 91 A D02A BDFF00          JSR     GETCH
 92 A D02D C12B            CMPB    #'+            CHECK FOR SIGN CHARACTER
 93 A D02F 2707            BEQ     READP
 94 A D031 C12D            CMPB    #'-
 95 A D033 2606            BNE     READP1
 96 A D035 730038          COM     SGN            FLAG NEGATIVE SIGN
 97 A D038 BDFF00  READP   JSR     GETCH
 98 A D03B C12E    READP1  CMPB    #'.
 99 A D03D 2739            BEQ     READF          DO FRACTION IF DECIMAL POINT
100 A D03F C130    READI   CMPB    #'0
101 A D041 2511            BLO     READX          EXIT IF NOT 0-9 DIGIT OR 5 DIGITS MAX
102 A D043 C139            CMPB    #'9
103 A D045 220D            BHI     READX
104 A D047 E700            STAB    0,X
105 A D049 08              INX
106 A D04A 8C003F          CPX     #STRG+5
107 A D04D 2705            BEQ     READX
108 A D04F BDFF00          JSR     GETCH          GET NEXT DIGIT
109 A D052 20EB            BRA     READI
110 A D054 CE003A  READX   LDX     #STRG          POINT TO STRING START
111 A D057 BDD0E0          JSR     ITOB           CONVERT INTEGER TO BINARY
112 A D05A D635    READXF  LDAB    RSLT+1
113 A D05C 9634            LDAA    RSLT
114 A D05E 7D0038          TST     SGN
115 A D061 2A06            BPL     READXF1        IF NEGATIVE SIGN THEN NEGATE RESULT
116 A D063 43              COMA
117 A D064 53              COMB
118 A D065 CB01            ADDB    #1
119 A D067 8900            ADCA    #0
120 A D069 9734    READXF1 STAA    RSLT           SAVE ACC A AND ACC B TO RESULT
121 A D06B D735            STAB    RSLT+1
122 A D06D C60D            LDAB    #$0D           PRINT <CR><LF>
123 A D06F BDFF81          JSR     PRTCH
124 A D072 C60A            LDAB    #$0A
125 A D074 BDFF81          JSR     PRTCH
126 A D077 39              RTS                    RETURN FROM SUB
127 A D078 BDFF00  READF   JSR     GETCH
```

```
A D07B C130              CMPB   #'0          EXIT IF NOT 0-9 DIGIT
A D07D 250E              BLO    READF1
A D07F C139              CMPB   #'9
A D081 220A              BHI    READF1
A D083 E700              STAB   0,X
A D085 08                INX
A D086 8C003E            CPX    #STRG+4      READ 4 DIGITS MAX
A D089 2702              BEQ    READF1
A D08B 20EB              BRA    READF
A D08D CE003A     READF1 LDX    #STRG        POINT TO START OF STRING
A D090 BDD095            JSR    FTOB         CONVERT FRACTION TO BINARY
A D093 20C5              BRA    READXF
A D095
A D095
A            **CONVERT UNSIGNED FRACTION TO BINARY
A            **REGISTER X CONTAINS START ADDRESS OF DECIMAL STRING
A            **RSLT, RSLT+1 CONTAINS BINARY RESULT
A D095 4F         FTOB   CLRA
A D096 9734              STAA   RSLT
A D098 9735              STAA   RSLT+1
A D09A 9730              STAA   TEMP
A D09C 9731              STAA   TEMP+1
A D09E 8604              LDAA   #4
A D0A0 E600       FTOB1  LDAB   0,X          GET DIGIT
A D0A2 58                ASLB                SHIFT LOWER NIBBLE TO HIGH NIBBLE
A D0A3 58                ASLB
A D0A4 58                ASLB
A D0A5 58                ASLB
A D0A6 58                ASLB                SHIFT NIBBLE INTO 16-BIT TEMP AREA
A D0A7 790031            ROL    TEMP+1
A D0AA 790030            ROL    TEMP
A D0AD 58                ASLB
A D0AE 790031            ROL    TEMP+1
A D0B1 790030            ROL    TEMP
A D0B4 58                ASLB
A D0B5 790031            ROL    TEMP+1
A D0B8 790030            ROL    TEMP
A D0BB 58                ASLB
A D0BC 790031            ROL    TEMP+1
A D0BF 790030            ROL    TEMP
A D0C2 08                INX
A D0C3 4A                DECA                GET ALL FOUR DIGITS INTO TEMP
A D0C4 26DA              BNE    FTOB1
A D0C6 C60F       FTOB2  LDAB   #15
```

```
172 A D0C8 9631      FTOB3    LDAA     TEMP+1            DECIMAL MULTIPLY TEMP BY 2
173 A D0CA 9B31               ADDA     TEMP+1
174 A D0CC 19                 DAA
175 A D0CD 9731               STAA     TEMP+1
176 A D0CF 9630               LDAA     TEMP
177 A D0D1 9930               ADCA     TEMP
178 A D0D3 19                 DAA
179 A D0D4 9730               STAA     TEMP
180 A D0D6 790035             ROL      RSLT+1            SHIFT CARRY INTO RESULT
181 A D0D9 790034             ROL      RSLT
182 A D0DC 5A                 DECB                       REPEAT 15X
183 A D0DD 26E9               BNE      FTOB3
184 A D0DF 39                 RTS
185 A D0E0
186 A                *CONVERT UNSIGNED INTEGER INPUT TO BINARY
187 A                **REGISTER X CONTAINS START ADDRESS OF DECIMAL STRING
188 A                **RSLT, RSLT+1 CONTAINS BINARY RESULT
189 A D0E0 4F        ITOB     CLRA
190 A D0E1 9734               STAA     RSLT
191 A D0E3 9735               STAA     RSLT+1
192 A D0E5 E600      INTBNX   LDAB     0,X               GET DECIMAL DIGIT
193 A D0E7 2726               BEQ      INTBRET
194 A D0E9 C40F               ANDB     #$0F              MASK FOR LOWER NIBBLE
195 A D0EB 08                 INX
196 A D0EC 8C003F             CPX      #STRG+5
197 A D0EF 2E1E               BGT      INTBRET
198 A D0F1 D730               STAB     TEMP              MULTIPLY RESULT BY 10
199 A D0F3 780035             ASL      RSLT+1
200 A D0F6 790034             ROL      RSLT
201 A D0F9 D635               LDAB     RSLT+1
202 A D0FB 9634               LDAA     RSLT
203 A D0FD 58                 ASLB
204 A D0FE 49                 ROLA
205 A D0FF 58                 ASLB
206 A D100 49                 ROLA
207 A D101 DB35               ADDB     RSLT+1
208 A D103 9934               ADCA     RSLT
209 A D105 DB30               ADDB     TEMP              ADD NEXT DIGIT TO RESULT
210 A D107 8900               ADCA     #0
211 A D109 9734               STAA     RSLT
212 A D10B D735               STAB     RSLT+1
213 A D10D 20D6               BRA      INTBNX
214 A D10F 39        INTBRET  RTS
215 A D110
```

```
216 A               *PRINT 2'S COMPLEMENT 16-BIT INTEGER IN ACC A ACC B
217 A D110
218 A D110 4D         PRINTI    TSTA
219 A D111 2A1A                 BPL      PRINTI1          CHECK SIGN
220 A D113 8180                 CMPA     #$80             FIX $8000 OVERFLOW
221 A D115 2608                 BNE      PRINTI2
222 A D117 C100                 CMPB     #$00
223 A D119 2604                 BNE      PRINTI2
224 A D11B CB01                 ADDB     #1
225 A D11D 8900                 ADCA     #0
226 A D11F 43         PRINTI2   COMA                      NEGATE IF NEGATIVE
227 A D120 53                   COMB
228 A D121 CB01                 ADDB     #1
229 A D123 8900                 ADCA     #0
230 A D125 D731                 STAB     TEMP+1
231 A D127 9730                 STAA     TEMP
232 A D129 C62D                 LDAB     #'-              PRINT MINUS
233 A D12B 2006                 BRA      PRINTI3
234 A D12D D731       PRINTI1   STAB     TEMP+1
235 A D12F 9730                 STAA     TEMP
236 A D131 C62B                 LDAB     #'+              PRINT PLUS
237 A D133 BDFF81     PRINTI3   JSR      PRTCH
238 A D136 9630                 LDAA     TEMP
239 A D138 D631                 LDAB     TEMP+1
240 A D13A 7F0039               CLR      COUNT
241 A D13D C010       PRINTI4   SUBB     #$10             DIV BY 10000 (USING SUBTRACT LOOP)
242 A D13F 8227                 SBCA     #$27
243 A D141 2B09                 BMI      PRINTI5
244 A D143 D731                 STAB     TEMP+1
245 A D145 9730                 STAA     TEMP
246 A D147 7C0039               INC      COUNT
247 A D14A 20F1                 BRA      PRINTI4
248 A D14C D639       PRINTI5   LDAB     COUNT            PRINT 10K DIGIT
249 A D14E CB30                 ADDB     #$30
250 A D150 BDFF81               JSR      PRTCH
251 A D153 9630                 LDAA     TEMP
252 A D155 D631                 LDAB     TEMP+1
253 A D157 7F0039               CLR      COUNT
254 A D15A C0E8       PRINTI6   SUBB     #$E8             DIV BY 1000
255 A D15C 8203                 SBCA     #$03
256 A D15E 2B09                 BMI      PRINTI7
257 A D160 D731                 STAB     TEMP+1
258 A D162 9730                 STAA     TEMP
259 A D164 7C0039               INC      COUNT
```

```
260 A D167 20F1             BRA     PRINTI6
261 A D169 D639    PRINTI7  LDAB    COUNT           PRINT 1K DIGIT
262 A D16B CB30             ADDB    #$30
263 A D16D BDFF81           JSR     PRTCH
264 A D170 9630             LDAA    TEMP
265 A D172 D631             LDAB    TEMP+1
266 A D174 7F0039           CLR     COUNT
267 A D177 C064    PRINTI8  SUBB    #$64            DIV BY 100
268 A D179 8200             SBCA    #0
269 A D17B 2B09             BMI     PRINTI9
270 A D17D 9730             STAA    TEMP
271 A D17F D731             STAB    TEMP+1
272 A D181 7C0039           INC     COUNT
273 A D184 20F1             BRA     PRINTI8
274 A D186 D639    PRINTI9  LDAB    COUNT           PRINT 100'S DIGIT
275 A D188 CB30             ADDB    #$30
276 A D18A BDFF81           JSR     PRTCH
277 A D18D D631             LDAB    TEMP+1
278 A D18F 7F0039           CLR     COUNT
279 A D192 C00A    PRINTIA  SUBB    #$0A            DIV BY 10
280 A D194 2B07             BMI     PRINTIB
281 A D196 D731             STAB    TEMP+1
282 A D198 7C0039           INC     COUNT
283 A D19B 20F5             BRA     PRINTIA
284 A D19D D639    PRINTIB  LDAB    COUNT           PRINT 10'S DIGIT
285 A D19F CB30             ADDB    #$30
286 A D1A1 BDFF81           JSR     PRTCH
287 A D1A4 D631             LDAB    TEMP+1          PRINT ONE'S DIGIT
288 A D1A6 CB30             ADDB    #$30
289 A D1A8 BDFF81           JSR     PRTCH
290 A D1AB C620    PRINTIC  LDAB    #$20            PRINT SPACE
291 A D1AD BDFF81           JSR     PRTCH
292 A D1B0 39               RTS
293 A D1B1
294 A              *PRINT 2'S COMPLEMENT 16-BIT FRACTION IN ACC A ACC B
295 A D1B1 D731    PRINT    STAB    TEMP+1
296 A D1B3 9730             STAA    TEMP
297 A D1B5 2B04             BMI     PRINT2          TEST SIGN
298 A D1B7 C62B             LDAB    #'+
299 A D1B9 201C             BRA     PRINT3          PRINT PLUS
300 A D1BB D631    PRINT2   LDAB    TEMP+1
301 A D1BD 9630             LDAA    TEMP
302 A D1BF 8180             CMPA    #$80            AJUST $8000 OVERFLOW
303 A D1C1 2608             BNE     PRINT6
```

```
304 A D1C3 C100             CMPB    #$00
305 A D1C5 2604             BNE     PRINT6
306 A D1C7 CB01             ADDB    #1
307 A D1C9 8900             ADCA    #0
308 A D1CB 43       PRINT6  COMA                    NEGATE VALUE
309 A D1CC 53               COMB
310 A D1CD CB01             ADDB    #1
311 A D1CF 8900             ADCA    #0
312 A D1D1 9730             STAA    TEMP
313 A D1D3 D731             STAB    TEMP+1
314 A D1D5 C62D             LDAB    #'-
315 A D1D7 BDFF81   PRINT3  JSR     PRTCH           PRINT MINUS
316 A D1DA C630             LDAB    #'0
317 A D1DC BDFF81           JSR     PRTCH
318 A D1DF C62E             LDAB    #'.
319 A D1E1 BDFF81           JSR     PRTCH
320 A D1E4 780031           ASL     TEMP+1          REMOVE SIGN BIT
321 A D1E7 790030           ROL     TEMP
322 A D1EA CE0005           LDX     #5
323 A D1ED 7F0032   PRINT4  CLR     TEMP2           OVERFLOW
324 A D1F0 7F0033           CLR     TEMP2+1         RESULT
325 A D1F3 780031           ASL     TEMP+1          MULTIPLY BY 2
326 A D1F6 790030           ROL     TEMP
327 A D1F9 790032           ROL     TEMP2
328 A D1FC 9632             LDAA    TEMP2
329 A D1FE 9733             STAA    TEMP2+1
330 A D200 D631             LDAB    TEMP+1
331 A D202 9630             LDAA    TEMP
332 A D204 58               ASLB                    MULTIPLY BY 8
333 A D205 49               ROLA
334 A D206 790033           ROL     TEMP2+1
335 A D209 58               ASLB
336 A D20A 49               ROLA
337 A D20B 790033           ROL     TEMP2+1
338 A D20E DB31             ADDB    TEMP+1          SUM FOR MULTIPLY BY 10
339 A D210 9930             ADCA    TEMP
340 A D212 D731             STAB    TEMP+1
341 A D214 9730             STAA    TEMP
342 A D216 2403             BCC     PRINT5
343 A D218 7C0033           INC     TEMP2+1
344 A D21B 9632     PRINT5  LDAA    TEMP2
345 A D21D 9B33             ADDA    TEMP2+1
346 A D21F 8B30             ADDA    #$30
347 A D221 16               TAB
```

```
 348 A D222 BDFF81            JSR      PRTCH              PRINT DECIMAL DIGIT

 349 A D225 09               DEX
 350 A D226 26C5              BNE      PRINT4             LOOP UNTIL 5 DIGITS PRINTED
 351 A D228 C620              LDAB     #$20
 352 A D22A BDFF81            JSR      PRTCH
 353 A D22D 39               RTS
 354 A D22E
 355 A                     END

SYMBOL TABLE:  Total Entries=   53
ADC             F020    PRINTIB         D19D
COUNT           0039    PRINTIC         D1AB
FTOB            D095    PRNST           D000
FTOB1           D0A0    PRNST2          D00A
FTOB2           D0C6    PROMPT          D00B
FTOB3           D0C8    PRT2H           FF6D
GETCH           FF00    PRTCH           FF81
INTBNX          D0E5    READ            D00E
INTBRET         D10F    READ1           D016
ITOB            D0E0    READADC         0500
PRINT           D1B1    READF           D078
PRINT2          D1BB    READF1          D08D
PRINT3          D1D7    READI           D03F
PRINT4          D1ED    READP           D038
PRINT5          D21B    READP1          D03B
PRINT6          D1CB    READX           D054
PRINTI          D110    READXF          D05A
PRINTI1         D12D    READXF1         D069
PRINTI2         D11F    RESET           FFD8
PRINTI3         D133    RSLT            0034
PRINTI4         D13D    SGN             0038
PRINTI5         D14C    START           0400
PRINTI6         D15A    STATUS          F000
PRINTI7         D169    STRG            003A
PRINTI8         D177    TEMP            0030
PRINTI9         D186    TEMP2           0032
PRINTIA         D192
Total errors: 0
```