

7.7 Interfacing a PIC Microcomputer with the ER1400 EAROM

INTRODUCTION

Organized as 100 14-bit words, the ER1400 is an electrically erasable and reprogrammable non-volatile memory. Individual words may be erased and reprogrammed.

The ER1400 consists of a memory array, control circuitry, twenty bit serial to parallel shift register for addressing, and a 14-bit serial to parallel, parallel to serial shift register for data I/O. In the accept address mode, the address is shifted serially into the ER1400. The address consists of two consecutive one-of-ten codes controlling the "tens" digit and the "units" digit respectively. The Accept Address command may be followed by either Erase, Accept Data, Write (for reprogramming), or Read, and Shift Data Out (for reading).

With its serial address/data flow, the ER1400 only requires 5 I/O ports to interface with the microcomputer: one for clocking, three for control, and one for addressing and data flow. On the other hand, a 64 word x 8 bit EAROM such as the ER2055 requires 17 I/O ports: one for clocking, two for control, six for addressing, and eight for bidirectional data flow. However, the read cycle time for the ER2055 is much shorter than the ER1400.

Data is transferred to or from the ER1400 by first serially inputting two ten bit address words and then serially shifting in or out the 14-bit data word. Control of these operations is done by three chip control lines and 14KHz clock. It is essential that the clock is not interrupted between Accept Address and Shift Data Out and between Accept Address and Accept Data. Write and erase cycles require a 18 msec delay (with clocking) before changing modes to guarantee data retention.

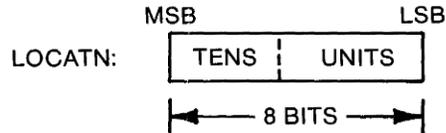
HARDWARE

A PIC with open drain outputs can directly drive the 10 volt I/O lines for the ER1400 as shown in Figure 46. The outputs of the PIC can be pulled more positive than the chip's power supply. High level outputs are pulled to the 10 volt supply by the 15K resistors, while low levels are pulled to ground by the output transistors on the PIC. In Figure 46, the point C2 is low for data or address transfers to the ER1400, and high for data transfers to the PIC. Thus the 100K resistor provides a pull-up for data write cycles and a 100K resistor is provided to ground when the ER1400 is outputting. Note that a logic "0" to the EAROM is a high voltage level, and a logic "1" is a low voltage level. According to Figure 46, a high voltage level is +10 volt and a low voltage level is 0 volt.

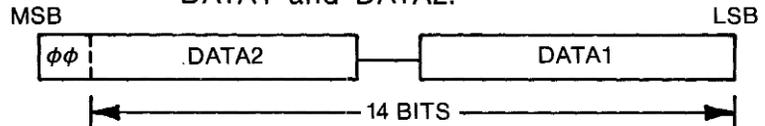
SOFTWARE

This software package consists of five subroutines as follow:

1. READ — Before calling READ, the read address should be stored in register LOCATN in BCD format as shown below.

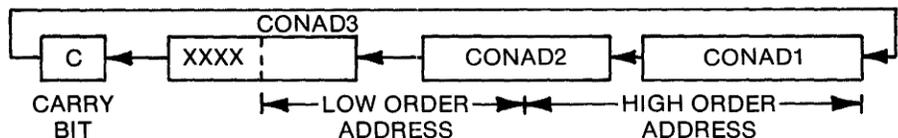


The subroutine ADEAR will be called to convert this BCD address into two 10-bit addresses in one-of-ten code as required by the ER1400 and transfer this address into the address register in the EAROM. After the content of this location has been read into the data register in the EAROM, this 14-bit data will be shifted out serially to two consecutive files in the PIC called DATA1 and DATA2.



When this is finished, the PIC will put the ER1400 into standby mode. A flowchart of the READ operation is shown on page 5.

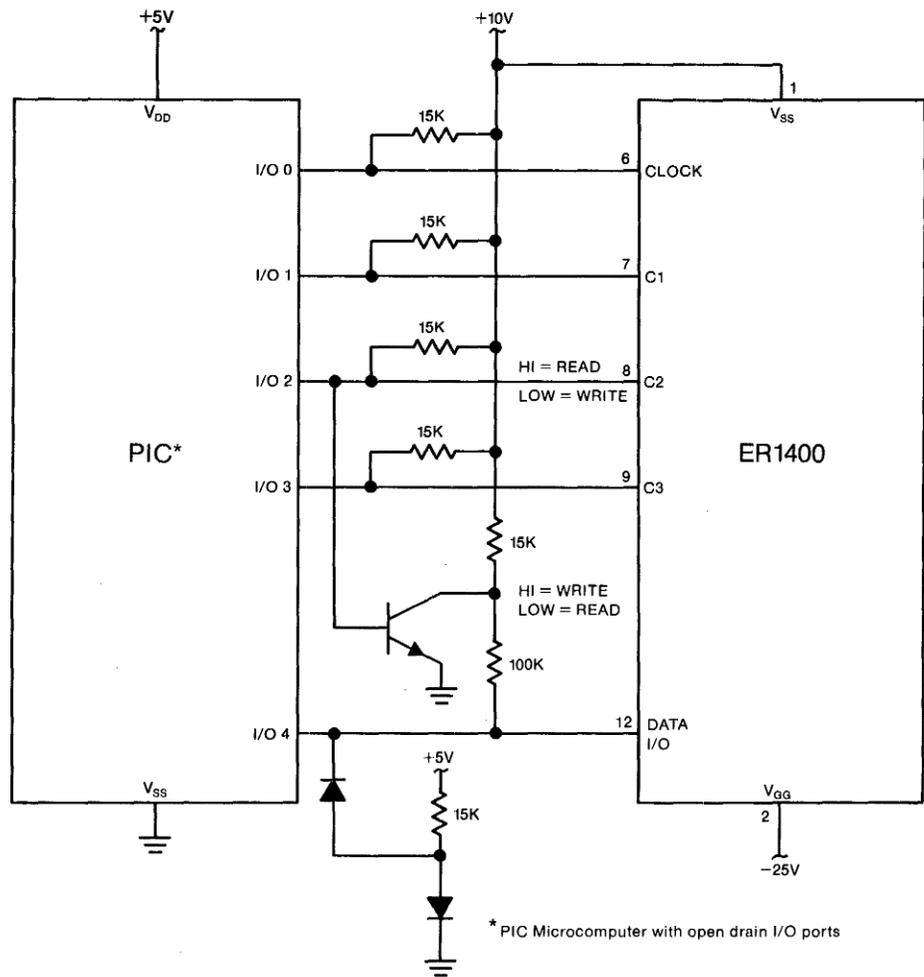
2. WRITE — Before calling WRITE, the write address in BCD format should be stored in file LOCATN as described above. The 14-bit data waiting to be written into the EAROM should be stored in files DATA1 and DATA2. By calling ADEAR, the write address will be transferred into the EAROM. The content of this location is erased to logic '1' before data can be written in. After the content of DATA1 and DATA2 has been written into the EAROM, the PIC will put the EAROM into standby mode. A flowchart for the WRITE operation is shown on page 6.
3. ADEAR — According to the 2 digit BCD address in LOCATN, this subroutine will create a 20-bit address (2 consecutive one-of-ten codes) which is required by the EAROM. This 20-bit address is stored in three consecutive files called CONAD1, CONAD2 and CONAD3 in the following configuration:



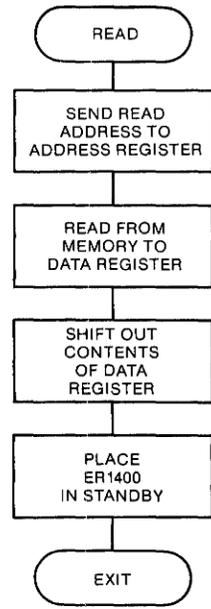
When this address is formed, this subroutine will automatically call ERTRAN which will send out the address to the EAROM.

4. ERTRAN — This subroutine transfers the 20-bit address to the EAROM or the 14-bit data to/from the EAROM. On entry, the W register should contain the EAROM control code, file COUNT should contain the number of clock cycles for the EAROM, and the File Select Register (F4) should point to the start of the information file waiting to be transferred. This subroutine clocks the information to/from the EAROM at a rate of 13.8KHZ. The internal oscillator on the PIC runs at 1MHz providing an instruction cycle time of 4 microseconds. Thus a programming loop of 18 instruction cycle times can be used to generate the 14KHz clock for the ER1400. The complete software listing for the PIC-EAROM interface is given on pages 209-211.
5. WI8MS — This subroutine waits 18ms while the PIC is clocking the EAROM. This is required when an erase or write operation to the EAROM is called for.

Fig. 46 PIC MICROCOMPUTER TO ER1400 INTERFACE

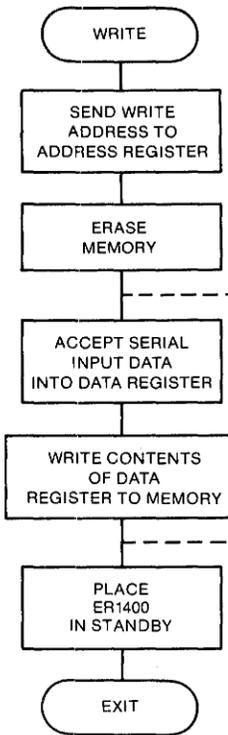


CLOCK CYCLES	ER1400 MODE CONTROL		
	C1	C2	C3
20	0	1	1
1	1	0	0
14	1	0	1
	0	0	0



INPUT: 20 BIT READ ADDRESS FOR ER1400
 OUTPUT: 14 BIT DATA FROM READ ADDRESS

CLOCK CYCLES	ER1400 MODE CONTROL		
	C1	C2	C3
20	0	1	1
	0	1	0
14	1	1	1
	1	1	0
	0	0	0



INPUT: a) 20 BIT WRITE ADDRESS FOR ER1400
 b) 14 BIT DATA TO BE WRITTEN INTO WRITE ADDRESS
 OUTPUT: NONE


```

LINE   ADDR   B1   B2   1650-ER1400
75     000000
76
77     ;*****
78     ;* FILE REGISTER ASSIGNMENTS. *
79     ;*
80     ;* THIS EAROM INTERFACE ROUTINE UTILIZES *
81     ;* F30 TO F37 IN THE PIC1650. IT IS *
82     ;* IMPORTANT THAT THESE EIGHT REGISTERS *
83     ;* ARE DEDICATED TO THIS ROUTINE ONLY. *
84     ;*
85     ;*****
86     000000
87     000004   FSR       =    4           ;FILE SELECT REGISTER.
88     000030   COUNT      =   30           ;EAROM ROUTINE INTERNAL COUNTER.
89                                     ;THIS COUNTER IS USED TO COUNT THE
90                                     ;NUMBER OF EAROM CLOCKS.
91     000031   CONAD3     =   31           ;THE LSB OF THE 20-BIT EAROM
92     000032   CONAD2     =   32           ;ADDRESS IN ONE-OUT-OF TEN
93     000033   CONAD1     =   33           ;CODE FORMAT.
94     000034   TEMP       =   34           ;TEMPORARY REGISTER USED BY EAROM.
95     000035   LOCATN    =   35           ;ON ENTRY, THIS REGISTER CONTAINS
96                                     ;THE BCD EAROM ADDRESS. THIS
97                                     ;ROUTINE WILL CONVERT THIS BCD
98                                     ;INTO THE FINAL ONE OF TEN CODE
99     000036   DATA1    =   36           ;THIS IS THE LSB OF THE 14 BITS
100
101     000037   DATA2    =   37           ;EAROM DATA.
102
103     000000   ;THIS IS THE MSB OF THE 14 BITS
104                                     ;EAROM DATA.
LINE   ADDR   B1   B2   1650-ER1400
105
106     ;*****
107     ;* THIS IS THE READ EAROM ROUTINE. THE FOLLOWING *
108     ;* PARAMETER ARE NEEDED BEFORE CALLING THIS ROUTINE: *
109     ;*
110     ;*   PARAMETER: LOCATN (F35)--- THE BCD ADDRESS OF *
111     ;*   THE EAROM LOCATION THAT HAS TO *
112     ;*   BE READ. *
113     ;*
114     ;*   OUTPUT: DATA1 (F36)--- THE LSB OF THE 14 *
115     ;*   BITS EAROM DATA. *
116     ;*   DATA2 (F37)--- THE MSB OF THE 14 *
117     ;*   BITS EAROM DATA. *
118     ;*
119     ;*****
120     000000
121     000000   READ      RES    0           ;READ EAROM ROUTINE ENTRY POINT.
122     000000 04446   CALL     ADEAR   ;ADDRESS ER1400. COUNT LEFT AT ZERO
123     000001 02430   BSF     COUNT,0  ;SET COUNTER TO ONE
124     000002 06375   MOVLW  B'11111101' ;CONTROL CODE FOR READ
125                                     ;DATA AND CLOCK HIGH
126     000003 04474   CALL     ERTRAN  ;READ THE DATA REGISTER, COUNT LEFT AT ZE
127     000004 02630   BSF     COUNT,4  ;SHIFT OUT 16 BITS (14 PLUS 2 TO
128                                     ;NORMALIZE DATA TO LOWER
129                                     ;6 BITS OF DATA2 )
130     000005 06036   MOVLW  DATA1   ;
131     000006 00044   MOVWF  FSR      ;POINT TO DATA REGISTERS
132     000007 06345   MOVLW  B'11100101' ;CON CODE FOR SHIFT DATA OUT
133     000010 04474   CALL     ERTRAN  ;SHIFT DATA OUT. LEAVE 77 IN W
134     000011 00577   ANDWF  DATA2   ;ENSURE BITS 6-7 CLEAR
135
136     000012   EXEAK   RES    0           ;
137     000012 06377   MOVLW  B'11111111' ;CONTROL CODE FOR STANDBY
138                                     ;WITH CLOCK BIT SET
139     000013 00045   MOVWF  IOREG   ;OUTPUT CONTROL CODE
140     000014 04000   RETLW  0

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LINE   ADDR  B1   B2       1650-ER1400

142  000015
143
144
145
146
147
148
149
150
151
152
153
154
155
156
157
158
159
160  000015
161  000015
162  000015 04446
163  000016 06373
164
165  000017 00045
166  000020 04436
167
168  000021 00070
169  000022 06036
170  000023 00044
171
172  000024 06361
173
174  000025 04474
175
176  000026 06371
177  000027 00045
178  000030 04436
179  000031 05012
180
181
182  000032
183  000032
LINE   ADDR  B1   B2       1650-ER1400

185  000032
186
187
188
189
190
191
192
193
194
195  000032
196  000032
197  000032 00645
198  000033 03030
199  000034 04016
200  000035 02430
201  000036
202  000036 00174
203  000037
204  000037 01374
205  000040 05042
206  000041 05032
207  000042
208  000042
209  000042 06001
210  000043 00645
211  000044 05045
212  000045 05037
213  000046
214  000046
215  000046
216  000046

;*****
;*
;* THIS IS THE EAROM WRITE ROUTINE.  THE FOLLOWING
;* PARAMETERS MUST BE SET UP BEFORE THIS ROUTINE
;* IS INVOKED.
;*
;* PARAMETERS: LOCATN (F55)--- THE BCD ADDRESS OF THE
;* EAROM LOCATION THAT NEW
;* DATA IS GOING TO BE STORED INTO
;* DATA1 (F56)--- THE LOWER 8 BITS OF
;* NEW DATA.
;* DATA2 (F57)--- THE UPPER 6 BITS OF THE
;* NEW DATA PLUS TWO DON'T CARE BITS.
;*
;* OUTPUT: NONE
;*
;*****
WRITE  RES    0           ;EAROM WRITE ENTRY POINT.
      CALL  ADEAR        ;ADDRESS THE EAROM.
      MOVLW B'11111011'  ;CON CODE FOR EREASE
                          ;DATA & CLOCK HIGH
      MOVWF IOREG        ;
      CALL  W18MS        ;DELAY 18MS. ON RETURN,
                          ;14 IS STORED IN W.
      MOVWF COUNT        ;SEND OUT 14 CLOCK PULSES.
      MOVLW DATA1       ;STORE THE ADDRESS OF THE LOW
      MOVWF FSR          ;BYTE OF NEW DATA INTO 'FSR'.
                          ;
      MOVLW B'11110001'  ;CON CODE FOR ACCEPT DATA
                          ;DATA & CLOCK HIGH
      CALL  ERTRAN       ;SHIFT THE DATA INTO THE EAROM.
                          ;
      MOVLW B'11111001'  ;CON CODE FOR WRITE
      MOVWF IOREG        ;DATA & CLOCK HIGH
      CALL  W18MS        ;DELAY 18MS WITH CONTINOUS CLOCK.
      GOTO  EXEAR        ;EXIT FROM THIS EAROM INTERFACE
                          ;ROUTINE AND RETURN TO MAIN PROGRAM.
                          ;THE ER1400 IS PUT INTO STANDBY MODE.

;*****
;*
;* THIS IS AN 18MS DELAY ROUTINE REQUIRED WHEN *
;* WRITING DATA INTO THE ER1400 EAROM. DURING *
;* THIS 18MS PERIOD, A 14 KHZ EAROM CLOCK MUST *
;* BE MAINTAINED. ON RETURN, THIS ROUTINE PUT *
;* A DECIMAL NUMBER 14 INTO THE W REGISTER.
;*
;*****
WMID   RES    0           ;TOGGLE THE EAROM CLOCK
      XORWF IOREG
      BTFSC COUNT,0
      NEILW .14          ;RETURN TO CALLING ROUTINE.
      BSF  COUNT,0
W18MS  RES    0           ;ENTRY POINT FOR 18 MS DELAY.
      CLRF TEMP
W36US  RES    0
      DECFSZ TEMP
      GOTO WNZYET
      GOTO WMID
WNZYET RES    0
      MOVLW 1
      XGRWF IOREG        ;TOGGLE THE EAROM CLOCK.
      GOTO WPAD
      GOTO W36US
WPAD   RES    0
      GOTO W36US

```

```

LINE      ADDR  B1  B2      1650-ER1400

218 000046
219
220
221
222
223
224
225
226
227
228
229
230
231
232 000046
233 000046
234 000046 01035
235 000047 07017
236 000050 00074
237 000051 06012
238 000052 00070
239 000053 06001
240 000054 00274
241
242 000055 01573
243 000056 01572
244 000057 01571
245 000060 01370
246 000061 05054
247 000062 03505
248 000063 05067
249 000064 02105
250 000065 01635
251 000066 05047
252 000067 06033
253 000070 00044
254 000071 06024
255 000072 00070
256 000073 06363
257
258
LINE      ADDR  B1  B2      1650-ER1400

260
261
262
263
264
265
266
267
268
269
270
271
272
273
274 000074
275 000074
276 000074 00045
277 000075 06010
278 000076 00074
279 000077
280 000077 02405
281 000100 03105
282 000101 05107
283 000102
284 000102 02605
285 000103 01440
286 000104 03403
287 000105 02205
288 000106 05114
289 000107
290 000107 02605
291 000110 02003
292 000111 03205
293 000112 02403
294 000113 01440
295 000114

*****
;*
;* THIS ROUTINE TRANSFORMS THE BCD EAROM ADDRESS
;* STORED IN REGISTER 'LOCATN' INTO THE 20-BIT
;* ONE-OUT-OF-TEN CODE REQUIRED BY THE ER1400 EAROM.
;* THIS ONE-OF-TEN CODE IS STORED IN 'CONAD1',
;* 'CONAD2' AND 'CONAD3' WITH THE LSB IN 'CONAD3'.
;*
;* WHEN THIS 20-BIT ADDRESS IS FORMED, IT IS AUTO-
;* MATICALLY SENT TO THE EAROM BY EXECUTING THE
;* 'ERTRAN' ROUTINE.
;*
*****
ADEAR    RES    0                ;ENTRY POINT FOR ADDRESS TRANSFORM.
MOVWF   LOCATN
ANDLW   17                ;PUT LOW NIBBLE OF ADDRESS
IN LOW NIBBLE OF TEMP
MOVWF   TEMP
MOVLW   .10              ;NO OF LOOPS BEFORE
COUNT  1                ;THIS ADDRESS PART COMPLETE
DECREM  1                ;DECREMENT FOR ADDRESS
ROT3SR  SUBWF  TEMP       ;CLRS CARRY IF THIS PART OF ADDRESS
HAS NOW REACHED ZERO
RLF     CONAD1           ;SHIFT THE 'SHIFT REGISTER'
RLF     CONAD2
RLF     CONAD3
DECFSZ  COUNT           ;.10 SHIFTS DONE YET ?
NOT YET
BTFS   IOREG,2         ;YES. WAS THIS SECOND ADDRESS ?
BTFS   IOREG,2         ;YES. NOW OUTPUT CONVERTED ADDRESS
BCF    IOREG,2         ;NO. NOW CONVERT HIGH ADDRESS
SWAPF  LOCATN,0        ;READY FOR HIGH NIBBLW OF ADDRESS
GOTO   LOADDC          ;GO DO HIGH ADDRESS
OPADD  MOVLW  CONAD1    ;PT FSR TO START OF CONVERTED ADDRESS
MOVWF  FSR             ;3-REGISTER 'SHIFT REGISTER'
MOVLW  .20            ;SET FOR 10 BIT TRANSFER TO ER1400
MOVWF  COUNT          ;ACCEPT ADDRESS CONTROL CODE
MOVLW  B'11110011'    ;DATA HIGH, CLOCK HIGH
GO INTO I/O ROUTINE 'ERTRAN'

*****
;*
;* TRANSFER DATA OR ADDRESS TO OR FROM THE ER1400
;*
;* ON ENTRY
;* -----
;* FSR (F4) - POINTS TO START OF INFORMATION FILE
;* (CONAD1 IF ADDRESS, DATA1 IF DATA)
;*
;* FILE COUNT - NUMBER OF ER1400 CLOCK CYCLES OR BITS
;*
;* W - ER1400 CONTROL CODE
*****
ERTRAN   RES    0
MOVWF   IOREG          ;OUTPUT CONTROL WORD
MOVLW   .8            ;OUTPUT 8 BITS BEFORE
MOVWF   TEMP          ;MOVING TO NEXT INFO FILE
STLOOP  RES    0
BSF    IOREG,ERCLK    ;SET THE EAROM CLOCK BIT
BTFS   IOREG,C2       ;INPUTTING TO THE PIC?
GOTO   RECEIV        ;YES, INPUT TO PIC FROM ER1400.
GIVE    RES    0      ;ELSE, OUTPUT DATA FROM
BSF    IOREG,ERDATA   ;PIC TO EAROM
RRF    0              ;ROTATE INFO FILE INTO CARRY
SKPC   0              ;IS THE INFO BIT A ZERO ?
BCF    IOREG,ERDATA   ;YES, SHIFT A ZERO TO EAROM.
GOTO   NEXTI         ;GET NEXT INFO BIT
RECEIV  RES    0      ;RECEIVE DATA FROM EAROM.
BSF    IOREG,ERDATA   ;ENSURE PIN NOT LATCHED AT ZERO
CLRC   0              ;READ THE INPUT FROM EAROM
BTFS   IOREG,ERDATA   ;IS IT A LOGIC '1' ?
SETC   0              ;YES
RRF    0              ;STORE THE DATA INTO PIC.
NEXTI   RES    0

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296 000114 02005      BCF      IOREG,ERCLK      ;CLEAR THE EAROM CLOCK BIT
297 000115 01374      DECFSZ   TEMP              ;DONE 8 BITS YET ?
298 000116 05125      GOTO     STPAD             ;NO, MORE TO GO
299 000117 02574      BSF      TEMP,3           ;ELSE, RESET COUNTER TO EIGHTH
300 000120 01244      INCF     FSR              ;INCREMENT FSR TO NEXT INFO FILE
301 000121              FINL?    RES      0
302 000121 01370      DECFSZ   COUNT           ;FINISH ALL INFO FILES ?
303 000122 05077      GOTO     STLOOP          ;NO.
304 000123 02405      BSF      IOREG,ERCLK     ;ELSE, SET EAROM CLOCK BIT HIGH
305 000124 04077      RETLW   77              ;END OF EAROM I/O WITH 77 IN W.
306 000125              STPAD   RES      0
307 000125 05121      GOTO     FINL?           ;TIMING COMPENSATION.
308 000126
309 000126              END

```

ASSEMBLER ERRORS = 0

1650-ER1400

CROSS REFERENCE

LABEL	VALUE	REFERENCE
ADEAR	000046	122 162 -233
C1	000001	-64
C2	000002	-65 281
C3	000003	-66
CONAD1	000033	-93 242 252
CONAD2	000032	-92 243
CONAD3	000031	-91 244
COUNT	000030	-88 123 127 168 198 200 238 245 255 302
DATA1	000036	-99 130 169
DATA2	000037	-101 134
ERCLK	000000	-63 280 296 304
ERDATA	000004	-67 284 287 290 292
ERTRAN	000074	126 133 174 -275
EXEAR	000012	-136 179
FINL?	000121	-301 307
FSR	000004	-87 131 170 253 300
GIVE	000102	-283
IOREG	000005	-47 139 165 177 197 210 247 249 276 280 281 284 287 290 292 296 304
LOADDC	000047	-235 251
LOCATN	000035	-95 234 250
NEXTI	000114	288 -295
OPADD	000067	248 -252
READ	000000	-121
RECEIV	000107	282 -289
ROT3SR	000054	-240 246
STLOOP	000077	-279 303
STPAD	000125	298 -306
TEMP	000034	-94 202 204 236 240 278 297 299
W18MS	000036	166 178 -201
W36US	000037	-203 212
WMID	000032	-196 206
WNZYET	000042	205 -208
WPAD	000045	211 -212
WRITE	000015	-161

EOF:366

0: >