

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.

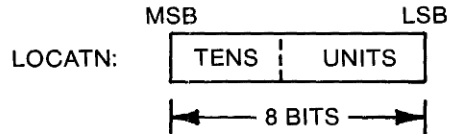
HARDWARE

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.

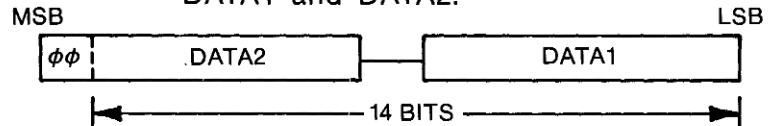
SOFTWARE

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.

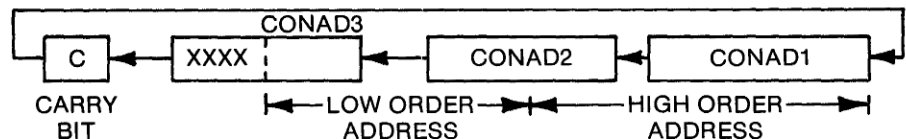


The subroutine ADEAR will be called to convert this BCD address into two 10-bit addresses in one-of-ten code as required by the ER1400 and transfer this address into the address register in the EAROM. After the content of this location has been read into the data register in the EAROM, this 14-bit data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

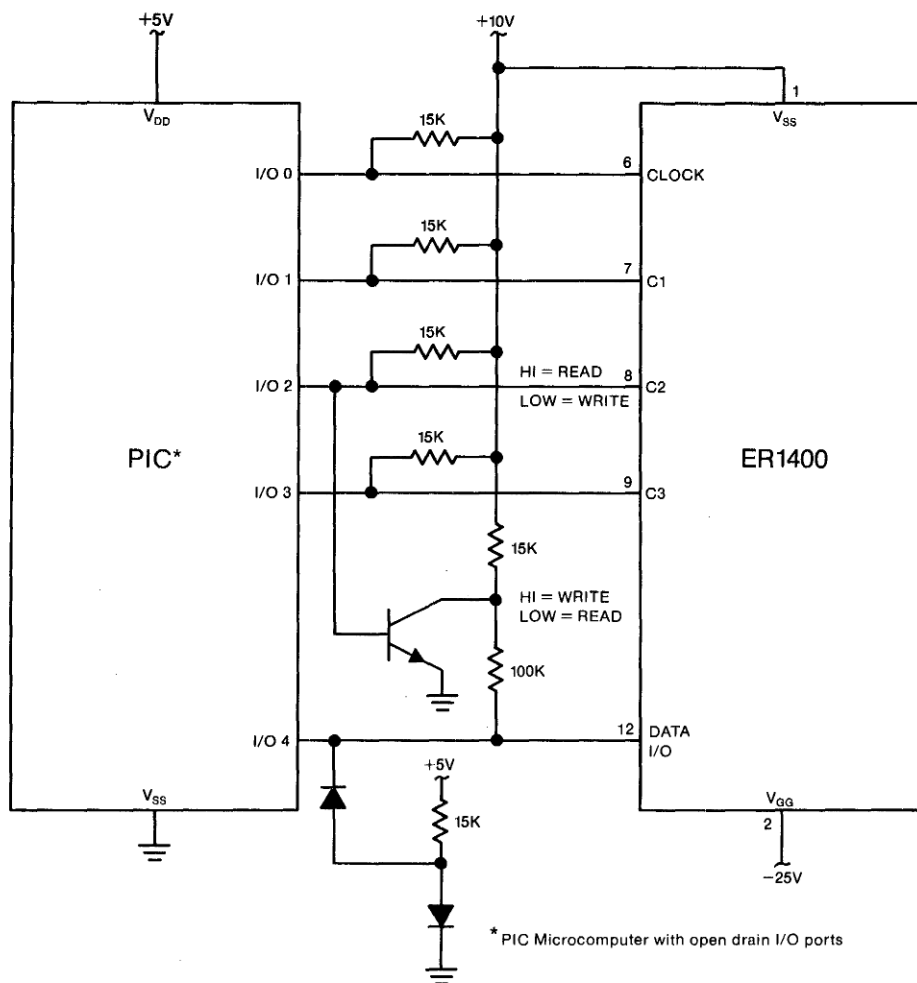
2. WRITE — Before calling WRITE, the write address in BCD format should be stored in file LOCATN as described above. The 14-bit data waiting to be written into the EAROM should be stored in files DATA1 and DATA2. By calling ADEAR, the write address will be transferred into the EAROM. The content of this 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:

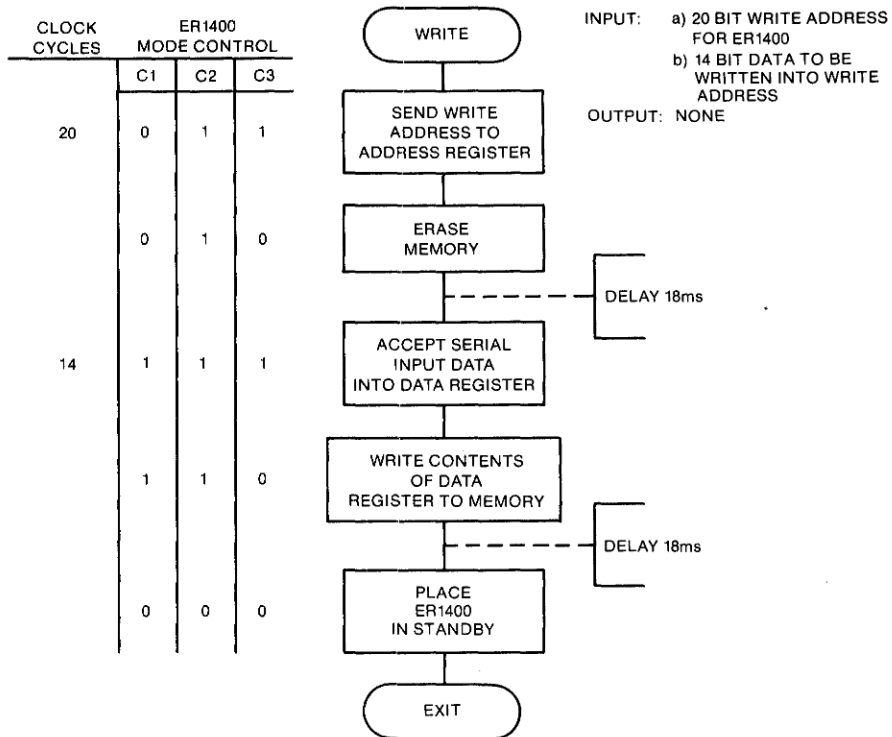
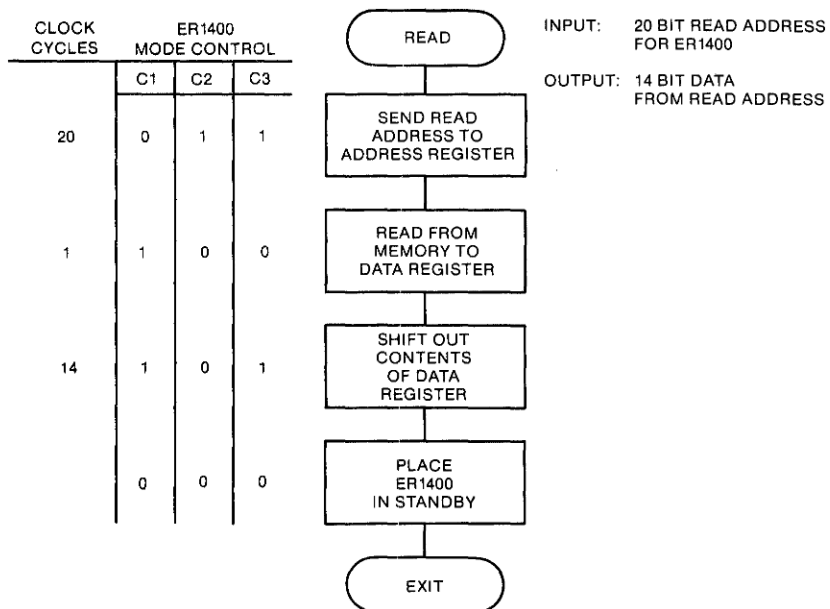


When this address is formed, this subroutine will automatically call ERTRAN which will send out the address to the EAROM.

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. W18MS — 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





```

1
2
3
4 000000
5 000000
6 000000
7 000000
8 000000
9
10
11
12
13
14
15
16
17
18
19
20
21
22 000000
23 000000
24 000000
25 000000
26 000000
27 000000
28
29
30
31
32
33
34
35
36
37
38
39 000000
40 000000
41
42
43
44
45
46 000000
47 000005
48 000000
49 000000
50 000000
51 000000
52
53
54
55
56
57
58
59
60
61
62 000000
63 000000
64 000001
65 000002
66 000003
67 000004
68 000000
69 000000
70 000000
71 000000
72 000000
73 000000

TITLE '1650-ER1400'
LIST E,X,P=1650

*****
* *****
* *
* * PROJECT: PIC1650-ER1400 INTERFACE *
* *
* * ADDRESS: GENERAL INSTRUMENT CORP. *
* * MICROELECTRONICS DIVISION *
* * 600 WEST JOHN STREET *
* * HICKSVILLE, NY 11802 *
* * PHONE: (516) 733-3000 *
* *
* *****
*****

*****
* *****
* *
* * COPYRIGHT 1982 GENERAL INSTRUMENT CORPORATION *
* * THIS PROGRAM IS PROTECTED AS AN UNPUBLISHED *
* * WORK UNDER THE COPYRIGHT ACT OF 1976 AND THE *
* * COMPUTER SOFTWARE ACT OF 1980. *
* *
* *****
*****

LINE ADDR B1 B2
1650-ER1400

*****
*
* I/O FILE ASSIGNMENT *
*
*****

IOREG = 5 ; ADDRESS OF PORT A

*****
*
* I/O BITS ASSIGNMENT FOR PORT A (F5) *
*
* A +5 VOLT ON THE CONTROL BIT MEANS *
* LOGIC 0 FOR THE EAROM. 0 VOLT ON *
* THE CONTROL BIT MEANS LOGIC 1 FOR *
* THE ER1400 EAROM. *
*
*****

ERCLK = 0 ; 14 KHZ CLOCK TO THE ER1400.
C1 = 1 ; EAROM CONTROL BIT 1.
C2 = 2 ; " " " 2.
C3 = 3 ; " " " 3.
ERDATA = 4 ; SERIAL DATA TO OR FROM EAROM.

```

```

LINE   ADDR   B1   B2   1650-ER1400

75 000000
76
77
78
79
80
81
82
83
84
85
86 000000
87 000004      FSR      =      4      ;FILE SELECT REGISTER.
88 000030      COUNT    =      30      ;EARM ROUTINE INTERNAL COUNTER.
89
90
91 000031      CONAD3    =      31      ;THIS COUNTER IS USED TO COUNT THE
92 000032      CONAD2    =      32      ;NUMBER OF EARM CLOCKS.
93 000033      CONAD1    =      33      ;THE LSB OF THE 20-BIT EARM
94 000034      TEMP      =      34      ;ADDRESS IN ONE-OUT-OF TEN
95 000035      LOCATN    =      35      ;CODE FORMAT.
96
97
98
99 000036      DATA1    =      36      ;TEMPORARY REGISTER USED BY EARM.
100
101 000037      DATA2    =      37      ;ON ENTRY, THIS REGISTER CONTAINS
102
103 000000
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
119
120 000000
121 000000      READ      RES      0      ;READ EARM 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
126 000003 04474      CALL      ERTRAN      ;DATA AND CLOCK HIGH
127 000004 02630      BSF      COUNT,4    ;READ THE DATA REGISTER, COUNT LEFT AT Z
128
129
130
131 000005 06036      MOVLW    DATA1      ;SHIFT OUT 16 BITS (14 PLUS 2 TO
132 000006 00044      MOVWF    FSR          ;NORMALIZE DATA TO LOWER
133 000007 06345      MOVLW    B'11100101' ;6 BITS OF DATA2 )
134 000010 04474      CALL      ERTRAN      ;POINT TO DATA REGISTERS
135 000011 00577      ANDWF    DATA2      ;CON CODE FOR SHIFT DATA OUT
136
137 000012          EXEAK    HEB      0      ;SHIFT DATA OUT. LEAVE 77 IN W
138 000012 06377      MOVLW    B'11111111' ;ENSURE BITS 6-7 CLEAR
139
140 000013 00045      MOVWF    IOREG      ;
141 000014 04000      RETLW    0          ;CONTROL CODE FOR STANDBY
                                           ;WITH CLOCK BIT SET
                                           ;OUTPUT CONTROL CODE

```

```

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 E2PROM WRITE ROUTINE. THE FOLLOWING
;* PARAMETERS MUST BE SET UP BEFORE THIS ROUTINE
;* IS INVOKED.
;*
;* PARAMETERS: LOCATN (F55)--- THE BCD ADDRESS OF THE
;* E2PROM 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           ;E2PROM WRITE ENTRY POINT.
        CALL  ADEAR       ;ADDRESS THE E2PROM.
        MOVLW B'11111011' ;CON CODE FOR E2PROM
                           ;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 E2PROM.
        MOVLW B'11111001' ;CON CODE FOR WRITE
                           ;DATA & CLOCK HIGH
        MOVWF IOREG
        CALL  W18MS       ;DELAY 18MS WITH CONTINUOUS CLOCK.
        GOTO  EXEAR       ;EXIT FROM THIS E2PROM 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 E2PROM. DURING *
;* THIS 18MS PERIOD, A 14 KHZ E2PROM CLOCK MUST *
;* BE MAINTAINED. ON RETURN, THIS ROUTINE PUT *
;* A DECIMAL NUMBER 14 INTO THE W REGISTER.
;*
;*****
WMID    RES   0           ;TOGGLE THE E2PROM CLOCK
        XORWF IOREG
        BTFSC COUNT,0
        RETURN           ;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
        XORWF IOREG       ;TOGGLE THE E2PROM CLOCK.
        GOTO  WPAD
        GOTO  W36US
WPAD    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 EARM ADDRESS
; STORED IN REGISTER 'LOCATN' INTO THE 20-BIT
; ONE-OUT-OF-TEN CODE REQUIRED BY THE ER1400 EARM.
; 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 EARM BY EXECUTING THE
; 'ERTRAN' ROUTINE.
;
*****
ADEAR RES 0 ;ENTRY POINT FOR ADDRESS TRANSFORM.
LOADDC MOVWF LOCATN ;PUT LOW NIBBLE OF ADDRESS
ANDLW 17 ;IN LOW NIBBLE OF TEMP
MOVWF TEMP
MOVLW .10 ;NO OF LOOPS BEFORE
MOVWF COUNT ;THIS ADDRESS PART COMPLETE
MOVLW 1 ;DECREMENT FOR ADDRESS
ROT3SR SUBWF TEMP ;CLRS CARRY IF THIS PART OF ADDRESS
;HAS NOW REACHED ZERO
;SHIFT THE 'SHIFT REGISTER'
RLF CONAD1
RLF CONAD2
RLF CONAD3
DECFBZ COUNT ;.10 SHIFTS DONE YET ?
GOTO ROT3SR ;NOT YET
BTFSB IOREG,2 ;YES. WAS THIS SECOND ADDRESS ?
GOTO OPADD ;YES. NOW OUTPUT CONVERTED ADDRESS
BCF IOREG,2 ;NO. NOW CONVERT HIGH ADDRESS
SWAPF LOCATN,0 ;READY FOR HIGH NIBBLE 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 EARM CLOCK BIT
BTFSB IOREG,C2 ;INPUTTING TO THE PIC?
GOTO RECEIV ;YES, INPUT TO PIC FROM ER1400.
RES 0 ;ELSE, OUTPUT DATA FROM
BSF IOREG,ERDATA ;PIC TO EARM
RRF 0 ;ROTATE INFO FILE INTO CARRY
SKPC ;IS THE INFO BIT A ZERO ?
BCF IOREG,ERDATA ;YES, SHIFT A ZERO TO EARM.
GOTO NEXTI ;GET NEXT INFO BIT
RECEIV RES 0 ;RECEIVE DATA FROM EARM.
BSF IOREG,ERDATA ;ENSURE PIN NOT LATCHED AT ZERO
CLRC ;READ THE INPUT FROM EARM
BTFSB IOREG,ERDATA ;IS IT A LOGIC '1' ?
SETC ;YES
RRF 0 ;STORE THE DATA INTO PIC.
NEXTI RES 0

```



```

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:)