

TWIN

Technical Note

Hardware

Number : HW 008
 Subject : Programming 2732 and 2732A
 Date : 12-3-82

In HW 003 the procedure and modifications necessary to program 2704/08/16 was discussed. By modifying the hardware and software as detailed in that technical note it is possible to program 2732 and 2732A EPROMS by removing the 2704/8 portion of the programmer. Programming 2716's is still possible.

1. The 2732 EPROM

This PROM is a 32K UV erasable PROM organized in a 4Kx8 bit matrix operating from a single +5V supply. The pin configuration can be seen in Fig. 1.

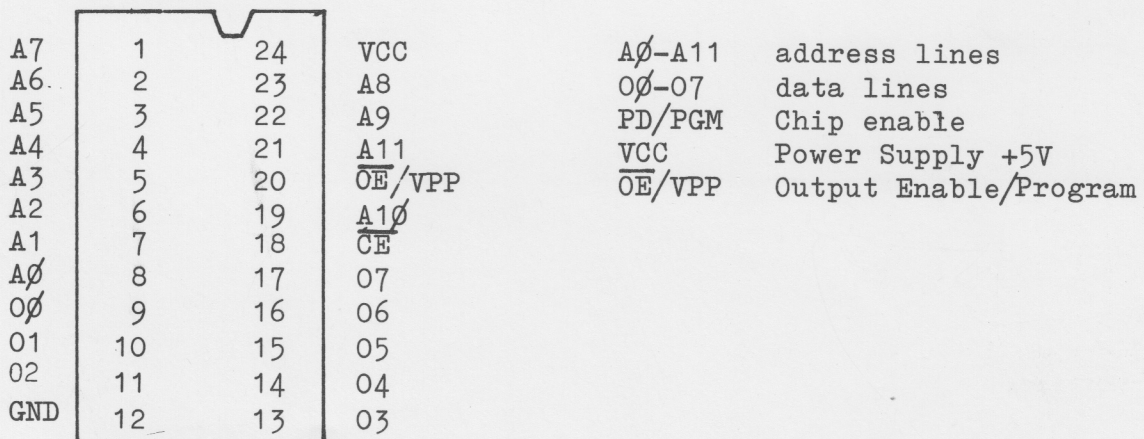


Fig. 1

There are five different modes in which this PROM can operate:

MODE \ PINS	CE (18)	OE/VPP (20)	VCC (24)	OUTPUTS (19-11,13-17)
READ	VIL	VIL	+5	DOUT
POWER DOWN	VIH	DON'T CARE	+5	HIGH Z
PROGRAM	PULSED VIL TO VIH	VPP	+5	DIN
PROGRAM VERIFY	VIL	VIL	+5	DOUT
PROGRAM INHIBIT	VIH	VIH	+5	HIGH Z

VPP is 25V + 1 V FOR 2732
 21V + 0.5V FOR 2732A

2. Programming

Programming is simple since all signals are TTL compatible. After erasure all bit locations are set to 1's. Programming is accomplished by raising the CS input to logic 1 thus selecting the data lines to the input/high impedance-output state. OE/VPP is then raised to 25v + 1v (in our case 25.2) then the required address together with the required data is supplied. After a minimum of 2 uS setting time a 50mS programming pulse is applied to the CE pin. The "next" required address and data is presented and again a pulse is applied. This sequence is then repeated until all locations to be programmed have been selected.

There is no restriction on the address selection sequence nor do all addresses have to be programmed. The only timing requirement with regard to the programming pulse is that the rise and fall times exceed 5nS. This limit will never be reached since this pulse is TTL generated.

It is important that the jumper across the ener diode for OE/VPP is removed if a 2732A is to be programmed otherwise damage to the device may occur.

Note

Since the ground connection is not very satisfactory a connection at the rear of the front pannel should be made between pin 12 and 0v. 0v can be found on the adjacent print where the one red (+5v) and the two black (0v) wires are connected.

Software

The additional software is available under 12NC 9390 281 10000. A listing can be found in the appendix.

The software format is as detailed in HW003 and is called by the following commands:

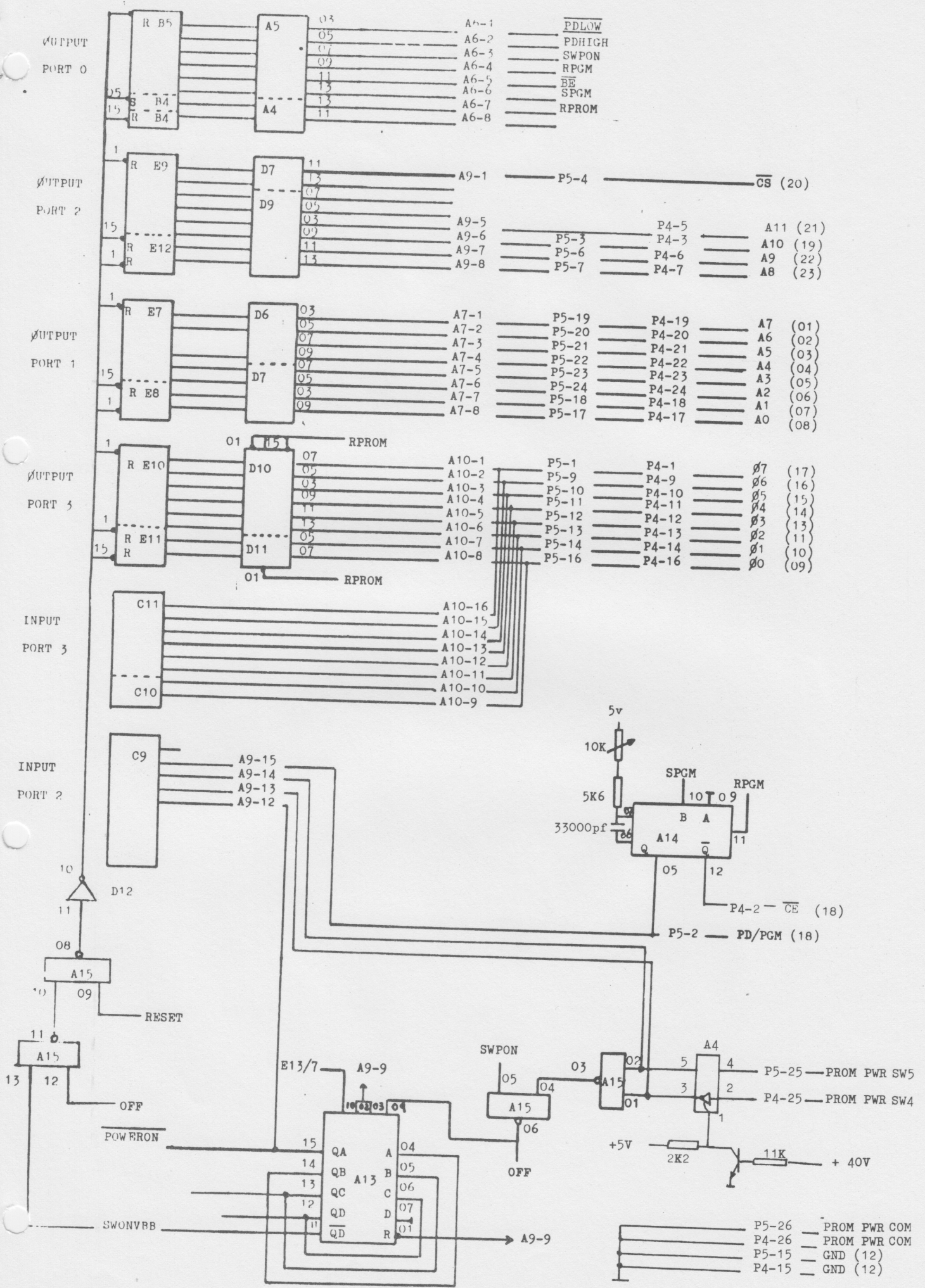
WP2732	write prom
RP2732	read prom
CP2732	compare prom

EXTERNAL SYMBOL DICTIONARY

SYMBOL	TYPE	VALUE	LENGTH
	SD	1000	0166
READPR	LD	1000	
READCL	LD	1003	
WRITPR	LD	1006	
WRITEN	LD	1009	

LOC	OBJECT	ADDR	E	STMT	SOURCE LINE
-----	--------	------	---	------	-------------

					2 *****
					3 * STANDARD SYMBOL DEFINITION - THIS FILE MAY BE APPENDED TO THE
					4 * FRONT OF ANY USER'S SOURCE DECK
					5 * REGISTER EQUATES
0000		6	R0	EQU 0	REGISTER 0
0001		7	R1	EQU 1	REGISTER 1
0002		8	R2	EQU 2	REGISTER 2
0003		9	R3	EQU 3	REGISTER 3
		10			* CONDITION CODES
0001		11	P	EQU 1	POSITIVE RESULT
0000		12	Z	EQU 0	ZERO RESULT
0002		13	N	EQU 2	NEGATIVE RESULT
0002		14	LT	EQU 2	LESS THAN
0000		15	EQ	EQU 0	EQUAL TO
0001		16	GT	EQU 1	GREATER THAN
0003		17	UN	EQU 3	UNCONDITIONAL
		18			* PSW LOWER EQUATES
0000		19	CC	EQU H'00'	CONDITIONAL CODES
0020		20	IDC	EQU H'20'	INTERDIGIT CARRY
0010		21	RS	EQU H'10'	REGISTER BANK
0008		22	MC	EQU H'08'	1=WITH 0=WITHOUT CARRY
0004		23	OVF	EQU H'04'	OVERFLOW
0002		24	COM	EQU H'02'	1=LOGIC 0=ARITHMETIC COMPARE
0001		25	C	EQU H'01'	CARRY/BORROW
		26			* PSW UPPER EQUATES
0080		27	SENS	EQU H'80'	SENSE BIT
0020		28	II	EQU H'20'	INTERRUPT INHIBIT
0007		29	SP	EQU H'07'	STACK POINTER
		30			* END OF EQUATES



- PDLOW
- PDHIGH
- SWPON
- RPGM
- BE
- SPGM
- RPPROM

- A9-1
- A9-5
- A9-6
- A9-7
- A9-8
- P5-4
- P5-3
- P5-6
- P5-7
- P4-5
- P4-3
- P4-6
- P4-7
- A11 (21)
- A10 (19)
- A9 (22)
- A8 (23)

- A7-1
- A7-2
- A7-3
- A7-4
- A7-5
- A7-6
- A7-7
- A7-8
- P5-19
- P5-20
- P5-21
- P5-22
- P5-23
- P5-24
- P5-18
- P5-17
- P4-19
- P4-20
- P4-21
- P4-22
- P4-23
- P4-24
- P4-18
- P4-17
- A7 (01)
- A6 (02)
- A5 (03)
- A4 (04)
- A3 (05)
- A2 (06)
- A1 (07)
- A0 (08)

- A10-1
- A10-2
- A10-3
- A10-4
- A10-5
- A10-6
- A10-7
- A10-8
- P5-1
- P5-9
- P5-10
- P5-11
- P5-12
- P5-13
- P5-14
- P5-16
- P4-1
- P4-9
- P4-10
- P4-11
- P4-12
- P4-13
- P4-14
- P4-16
- Ø7 (17)
- Ø6 (16)
- Ø5 (15)
- Ø4 (14)
- Ø3 (13)
- Ø2 (11)
- Ø1 (10)
- Ø0 (09)

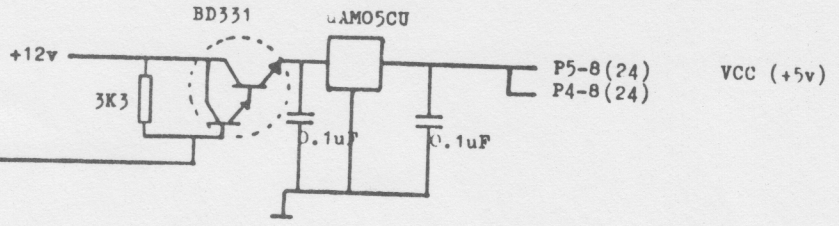
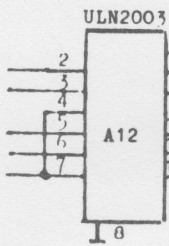
- A10-16
- A10-15
- A10-14
- A10-13
- A10-12
- A10-11
- A10-10
- A10-9

- A9-15
- A9-14
- A9-13
- A9-12
- A14
- SPGM
- RPGM
- P4-2 - CE (18)
- P5-2 - PD/PGM (18)

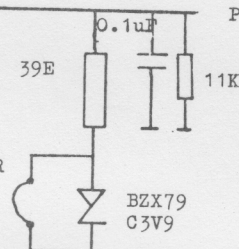
- RESET
- OFF
- POWERON
- SWONVBB
- SWPON
- OFF
- PROM PWR SW5
- PROM PWR SW4
- +5V
- 2K2
- 11K
- + 40V

- P5-26 - PROM PWR COM
- P4-26 - PROM PWR COM
- P5-15 - GND (12)
- P4-15 - GND (12)

SWOFFVCC
BE
PDHIGH
PDLOW
SWOFFVPP

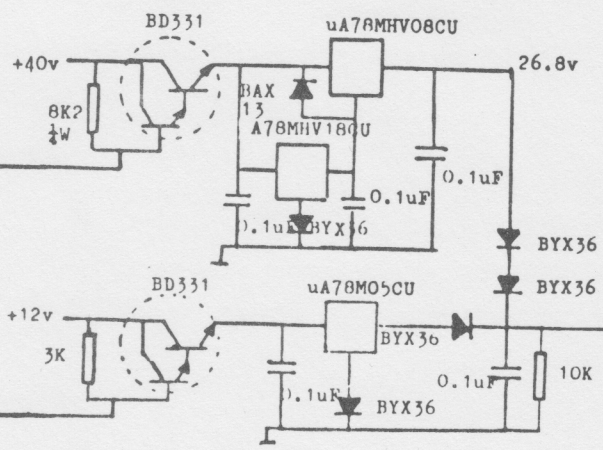


REMOVE JUMPER FOR 2732A



P4-4(20) OE VPP (0/21V) (0/25V)

P5-5(21) VPP (+5/25V)



ALL RESISTORS 1/8W UNLESS OTHERWISE SPECIFIED

```

LOC OBJECT  ADDR E STMT  SOURCE LINE
32 *****
33 *
34 *
35 *          WRITE A PROM TYPE 2732
36 *
37 *-----*
38 *
39 *          ENTRY POINTS  WRITER  WRITE PROM
40 *                          WRITER  END OF WRITE ROUTINE
41 *                          READPR  READ PROM
42 *                          READCL  END OF READ ROUTINE
43 *
44 *          PARAMETERS    R0-R1  PROM ADDRESS
45 *                          R2    STATUS RETURN REG
46 *                          R3    BYTE WRITTEN/READ
47 *
48 *-----*
49 *
50 *          RETURN STATUS VALUES ARE :
51 *
52 *          00  NO ERROR
53 *          07  WRITE ERROR
54 *          29  PROM POWER NOT ON
55 *          34  PROM ADDRESS RANGE EXCEEDED
56 *          52  INCORRECT CONNECTOR USED
57 *
58 *****
59 *
60 *
61 *
00E8 62  CONTR0 EQU      H'ES      CONTROL PORT
63 *
0080 64  NPDLOW EQU     H'80'     PD SET TO 5V NOT
0040 65  NPDHIG EQU     H'40'     PD SET TO 26V NOT
0020 66  SWPON  EQU     H'20'     SWITCH POWER ON
0010 67  NRPGM  EQU     H'10'     RESET PGM MONO-FLOP NOT
0008 68  BE     EQU     H'08'     BEGIN ENABLING
0004 69  SPGM  EQU     H'04'     SET PROGRAM MODE
0002 70  RPPROM EQU     H'02'     WRITE PROM NOT

72 *****
73 *
74 *          WARNING *****
75 *
76 *          ON NO ACCOUNT SHOULD 'BE' BE 1 IF NPDHIG OR NPDLOW IS 0
77 *          AND PREFERABLY NEVER SWITCH AT THE SAME TIME
78 *
79 *****
80 *
81 *
82 *
00EA 83  STATUS EQU     H'EA      STATUS PORT
84 *
0080 85  CSLOW  EQU     H'80'     CHIP SELECT LOW (WRITE ENABLED)
0040 86  PGM    EQU     H'40'     PROGRAM MODE PULSE
    
```

```

LOC OBJECT  ADDR E STMT  SOURCE LINE
0020 87  N2716 EQU     H'20'     2716 CONNECTED NOT
0010 88  N2732 EQU     H'10'     2732 CONNECTED NOT
0008 89  POWONN EQU     H'08'     POWER SUPPLIES SWITCHED ON NOT
0007 90  NC     EQU     H'07'     NOT CONNECTED INPUTS
91 *
92 *
00EA 93  ADDRH  EQU     H'EA'     ADDRESS HIGH ORDER PORT
94 *
0080 95  NCS    EQU     H'80'     CHIP SELECT
96 *
97 *
00E9 98  ADDR0  EQU     H'E9'     ADDRESS LOW ORDER PORT
99 *
100 *
101 *          ALL OF THE ABOVE SIGNALS WITH THE EXCEPTION OF RPPROM
102 *          WILL BE RESET TO 0 IF RESET, SWPON, OR RPPMRN GO TO
103 *          ZERO  RPPROM WILL BE SET TO 1
104 *
105 *
00EB 106 DATAA EQU     H'EB'     DATA I-O PORT
    
```

LOC OBJECT	ADDR	E	STMT	SOURCE	LINE	
			108	*		
			109	*		
1000			110	ORG	H 1000'	
	1000		111	READPR	EGU	\$
1000	1F10B8		112	BCTA,UN	R2700	
		1003	113	READCL	EGU	\$
1003	1F10A6		114	BCTA,UN	P2703	
		1006	115	WRITPR	EGU	\$
1006	1F1013		116	BCTA,UN	P2700	
		1009	117	WRITEN	EGU	\$
1009	1F10A6		118	BCTA,UN	P2703	
100C			119	SDATA	RES	1
100D			120	SADD	RES	2
100F			121	STAT	RES	1
1010			122	CON	RES	1
1011	00		123	FLAG	DATA	0
		0010	124	MAXADD	EGU	<4096
1012			125	RETRY	RES	1

SAVED DATA BYTE
 SAVED ADDRESS BYTES
 STATUS BYTE
 CONTROL INFO BYTE
 INITIALIZATION INDICATOR
 MAXIMUM ALLOWED ADDRESS+1 FOR 2732
 RETRY WRITE COUNTER

LOC OBJECT	ADDR	E	STMT	SOURCE	LINE	
			127	*		
			128	*		
			129	*		
			130	P2700	EGU	\$
1013	CD100E		131	STRA,1	SADD+1	
1016	CF100C		132	STRA,3	SDATA	
1019	CC100D		133	STRA,0	SADD	SAVE ADDRESS & DATA
101C	E410		134	COM1,0	MAXADD	CHECK IF ADDRESS WITHIN LIMITS
101E	9E1117		135	BCFA,LT	ADDERR	JIF ERROR
1021	0419		136	LODI,0	25	SET RETRY COUNT
1023	CC1012		137	STRA,0	RETRY	
1026	CC1011		138	LODA,0	FLAG	IF INITIALIZED
1029	9C1061		139	BCFA,2	P2702	JUMP
			140	*		
			141	*		
			142	*	INITIALIZE ROUTINE	
			143	*		
			144	*		
102C	04C2		145	LODI,0	NPDLOW+NPDHIG+RPRM	
102E	CC1011		146	STRA,0	FLAG	SET INITIALIZED
1031	CC1010		147	STRA,0	CON	SAVE INITIAL STATE
1034	D4E8		148	WRTE,0	CONTR0	SET INITIAL STATE
1036	54EA		149	REDE,0	STATUS	
1038	4470		150	ANDI,0	-1-CSLOW-NC-POWANN	REMOVE IRRELEVANT STATUS BITS
103A	E430		151	COM1,0	N2732+N2716	PROM POWER SWITCHED ON
103C	9E1123		152	BCFA,LT	POWERR	JIF NOT
103F	E420		153	COM1,0	N2716	INCORRECT CONNECTOR
1041	9C111D		154	BCFA,EQ	CONERR	JIF INCORRECT
1044	0C1010		155	LODA,0	CON	GET CONTROL SETTING
1047	6430		156	IORI,0	S&PON+NRPGM	AND
1049	D4E8		157	WRTE,0	CONTR0	SWITCH POWER ON
104B	CC1010		158	STRA,0	CON	SAVE CONTROL SETTING
104E	0403		159	LODI,0	3	
1050	F87E		160	BDRR,0	\$	WAIT 20US
1052	0C1010		161	LODA,0	CON	GET CONTROL BYTE
1055	2442		162	EORI,0	RPRM+NPDHIG	& SET FOR WRITE
1057	CC1010		163	STRA,0	CON	SAVE CONTROL BYTE
105A	D4E8		164	WRTE,0	CONTR0	
105C	07B0		165	LODI,3	176	2MSEC WAIT FOR POWER SUPPLIES TO
105E	C0		166	P2701	NOP	REACH CORRECT LEVEL
105F	F87D		167	BDRR,3	P2701	

LOC OBJECT	ADDR	E	STMT	SOURCE LINE
			169	*
			170	*
			171	*
			172	*
			173	*
	1061		174	P2702 EQU \$
1061	54EA		175	REDE.0 STATUS
1063	24FF		176	EORI.0 H'FF'
1065	F408		177	TMI.0 PGMONN
1067	9C1123	1123	178	BCFA.EQ POWERR
106A	0C100D	100D	179	LODA.0 .ALL
106D	0D100E	100E	180	LODA.1 SADD+1
1070	0E100C	100C	181	LODA.2 SDATA
1073	D4EA		182	WRITE.0 ADH
1075	D5E9		183	WRITE.1 ADDL
1077	D6EB		184	WRITE.2 DATAA
1079	0C1010	1010	185	LODA.0 CON
107C	0703		186	LODI.3 3
107E	066B		187	LOOP3 LODI.2 107
1080	0506		188	LOOP2 LODI.1 6
1082	6404		189	IORI.0 SPGM
1084	D4E8		190	WRITE.0 CONTRO
1086	2404		191	EORI.0 SPGM
1088	D4E8		192	WRITE.0 CONTRO
108A	F97E	108A	193	LOOP1 BDRR.1 LOOP1
108C	S5EA		194	REDE.1 STATUS
108E	6404		195	IORI.0 SPGM
1090	D4E8		196	WRITE.0 CONTRO
1092	2404		197	EORI.0 SPGM
1094	D4E8		198	WRITE.0 CONTRO
1096	F540		199	TMI.1 PGM
1098	9C1129	1129	200	BCFA.EQ WRIERR
109B	FA63	1080	201	BDRR.2 LOOP2
109D	FBSF	107E	202	BDRR.3 LOOP3
109F	44EF		203	ANDI.0 -1-NRPGM
10A1	D4E8		204	WRITE.0 CONTRO
10A3	1F112F	112F	205	BA VERIFY
			206	*

WRITE 1 BYTE

INVERT STATUS
CHECK POWER (STILL) ON
JIF NOT
GET HIGH ORDER ADDRESS
GET LOW ORDER ADDRESS
& DATA TO BE WRITTEN

SELECT PROM
GET CONTROL BYTE
WAIT 50MS LOOP

(RE-)TRIGGER PULSE

RE-TRIGGER PULSE

CHECK THAT PROGRAM HAS NOT BEEN
INTERUPTED

RESET MONOFLOP
RESET

LOC OBJECT	ADDR	E	STMT	SOURCE LINE
			208	*
			209	*
			210	*
			211	*
			212	*
	10A6		213	P2703 EQU \$
10A6	05E0		214	LODI.1 MPDHIG+MPDL0W+SWPON
10A8	D5E8		215	WRITE.1 CONTRO
10AA	20		216	EORZ 0
10AB	C2		217	STRZ 2
10AC	D4E9		218	WRITE.0 ADDL
10AE	D4EA		219	WRITE.0 ADDH
10B0	2520		220	EORI.1 SWPON
10B2	D5E8		221	WRITE.1 CONTRO
10B4	CC1011	1011	222	STRA.0 FLAG
10B7	17		223	RETC.UN
			224	*

SWITCH OFF ROUTINE

RESET MONOFLOPS

AND SET FOR READ MODE
SET STATUS TO NO ERROR

SWITCH OFF POWER SUPPLIES

RESET INITIALIZATION FLAG

LOC	OBJECT	ADDR	STMT	SOURCE	LINE	
		10B8	226	R2700	EGU	\$
10B8	CD100E	100E	227		STRA.1	SADD+1
						SAVE REGISTERS 0 & 1
10BB	CC100D	100D	228		STRA.0	SADD
10BE	E410		229		COMI.0	MAXADD
						CHECK IF ADDRESS WITHIN LIMITS
10C0	9E1117	1117	230		BCFA.LT	ADDERR
						JIF ERROR
10C3	0C1011	1011	231		L0DA.0	FLAG
						IF INITIALIZED
10C6	9C10F4	10F4	232		BCFA.Z	R2702
			233	*		JUMP
			234	*		
			235	*		INITIALIZE ROUTINE
10C9	04CA		236		L0DI.0	NPDHIG+NPDLOW+RPROM+BE
10CB	CC1011	1011	237		STRA.0	FLAG
						SET INITIALIZED
10CE	CC1010	1010	238		STRA.0	CON
						SAVE INITIAL STATE
10D1	D4E8		239		WRTE.0	CONTR0
						SET INITIAL STATE
10D3	54EA		240		REDE.0	STATUS
10D5	4470		241		ANDI.0	-1-CSLOW-NC-POWONN
						REMOVE IRRELEVANT STATUS BITS
10D7	E430		242		COMI.0	N2732+N2716
						PROM POWER SWITCHED ON
10D9	9E1123	1123	243		BCFA.LT	POWERR
						JIF NOT
10DC	E420		244		COMI.0	N2716
						INCORRECT CONNECTOR
10DE	9C111D	111D	245		BCFA.EQ	CONERR
						JIF INCORRECT
10E1	0C1010	1010	246		L0DA.0	CON
						GET CONTROL SETTING
10E4	6430		247		I0RI.0	SMPON+NRPGM
						AND
10E6	D4E8		248		WRTE.0	CONTR0
						SWITCH POWER ON
10E8	CC1010	1010	249		STRA.0	CON
						SAVE CONTROL SETTING
10EB	0403		250		L0DI.0	3
10ED	F87E	10ED	251		BDRR.0	\$
						WAIT 20US
10EF	07B0		252		L0DI.3	176
						2MSEC WAIT FOR POWER SUPPLIES TO
10F1	C0		253	R2701	NOP	REACH CORRECT LEVEL
10F2	FB7D	10F1	254		BDRR.3	R2701
			255	*		
			256	*		
		10F4	257	R2702	EGU	\$
10F4	54EA		258		REDE.0	STATUS
10F6	24FF		259		E0RI.0	H'FF'
						INVERT STATUS
10F8	F408		260		TMI.0	POWONN
						CHECK POWER (STILL) ON
10FA	9C1123	1123	261		BCFA.EQ	POWERR
						JIF NOT
10FD	0C100D	100D	262		L0DA.0	SADD
						GET HIGH ORDER ADDRESS
1100	0D100E	100E	263		L0DA.1	SADD+1
						GET LOW ORDER ADDRESS
1103	D4EA		264		WRTE.0	ADDH
1105	D5E9		265		WRTE.1	ADDL
1107	0E1010	1010	266		L0DA.2	CON
110A	6604		267		I0RI.2	SPGM
						ENABLE CHIP
110C	D6E8		268		WRTE.2	CONTR0
110E	2604		269		E0RI.2	SPGM
1110	D6E8		270		WRTE.2	CONTR0
1112	57EB		271		REDE.3	DATAA
						SELECT PROM
1114	0600		272		L0DI.2	0
						SET STATUS TO NO ERROR
1116	17		273		RETC.UN	
			274	*		
		1117	275	ADDERR	EGU	\$
1117	3F10A6	10A6	276		BSTA.UN	P2703
						GO AND SWITCH OFF
111A	0634		277		L0DI.2	H'34'
						SET INVALID ADDRESS CODE
111C	17		278		RETC.UN	
			279	*		
		111D	280	CONERR	EGU	\$

LOC	OBJECT	ADDR	E	STMT	SOURCE	LINE	
111D	3F10A6	10A6		281	BSTA,UN	P2703	GO & SWITCH OFF
1120	0652			282	LODI,2	H'52'	SET INVALID DEVICE
1122	17			283	RETC,UN		
				284	*		
		1123		285	POWERR	EGU	\$
1123	3F10A6	10A6		286	BSTA,UN	P2703	GO & SWITCH OFF
1126	0629			287	LODI,2	H'29'	SET INVALID DEVICE
1128	17			288	RETC,UN		
				289	*		
		1129		290	WRIERR	EGU	\$
1129	3F10A6	10A6		291	BSTA,UN	P2703	GO & SWITCH OFF
112C	0607			292	LODI,2	H'07'	SET INVALID DEVICE
112E	17			293	RETC,UN		
		112F		295	VERIFY	EGU	\$
112F	0C1010	1010		296	LODA,0	CON	
1132	64C2			297	IORI,0	NPDHIG+NPDLOW+RPROM	SET FOR READ
1134	DAE8			298	WRITE,0	CONTR0	
1136	CC1010	1010		299	STRA,0	CON	
1139	6408			300	IORI,0	BE	OUTPUT ENABLE
113B	DAE8			301	WRITE,0	CONTR0	
113D	CC1010	1010		302	STRA,0	CON	
1140	3F10F4	10F4		303	BSA	R2702	READ A BYTE
1143	0C1010	1010		304	LODA,0	CON	PRESET FOR WRITE
1146	2408			305	EORI,0	BE	
1148	DAE8			306	WRITE,0	CONTR0	
114A	2442			307	EORI,0	NPDHIG+RPROM	
114C	CC1010	1010		308	STRA,0	CON	
114F	DAE8			309	WRITE,0	CONTR0	
1151	02			310	LODZ	2	GET ERROR STATUS
1152	16			311	RETC,LT		JIF ERROR OCCURED
1153	15			312	RETC,GT		" "
1154	EF100C	100C		313	COMA,3	SDATA	SEE IF DATA CORRECTLY WRITTEN
1157	14			314	RETC,EQ		JIF OK
1158	0C1012	1012		315	LODA,0	RETRY	GET RETRY COUNT
115B	A401			316	SUBI,0	1	
115D	CC1012	1012		317	STRA,0	RETRY	DECREMENT
1160	9C1061	1061		318	BNZA	P2702	WRITE BYTE AGAIN
1163	0607			319	LODI,2	7	SET WRITE ERROR CONDITION
1165	17			320	RETC,UN		
				321	*		
				322	*		
				323	ENTRY	WRITEN,WRITPR,READCL,READPR	
				324	END		
				325	*		
				326	*		
				327	*	TIMING LOOP IS IN CYCLES 12+(X(6 3+Y(42+Z(3 6))))	
				328	*	WHERE X IS R3, Y IS R2, Z IS R1	
				329	*	Z IS 6 TO GIVE A CONTINUOUS PULSE	
				330	*	SO 12+(X(6 3+Y(42+18))) (0 0024) MSECS	

TOTAL NUMBER OF ERRORS 0