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TEXAS INSTRUMENTS
EUROPEAN SEMICONDUCTOR GROUP

TM990 MICROSYSTEM E-SERIES

TM990/E255 EPROM EXPANSION MODULE DATA MANUAL

DECEMBER 1981

TEXAS INSTRUMENTS
Deutschland GmbH

TM990/E255 EPROM EXPANSION MODULE DATA MANUAL

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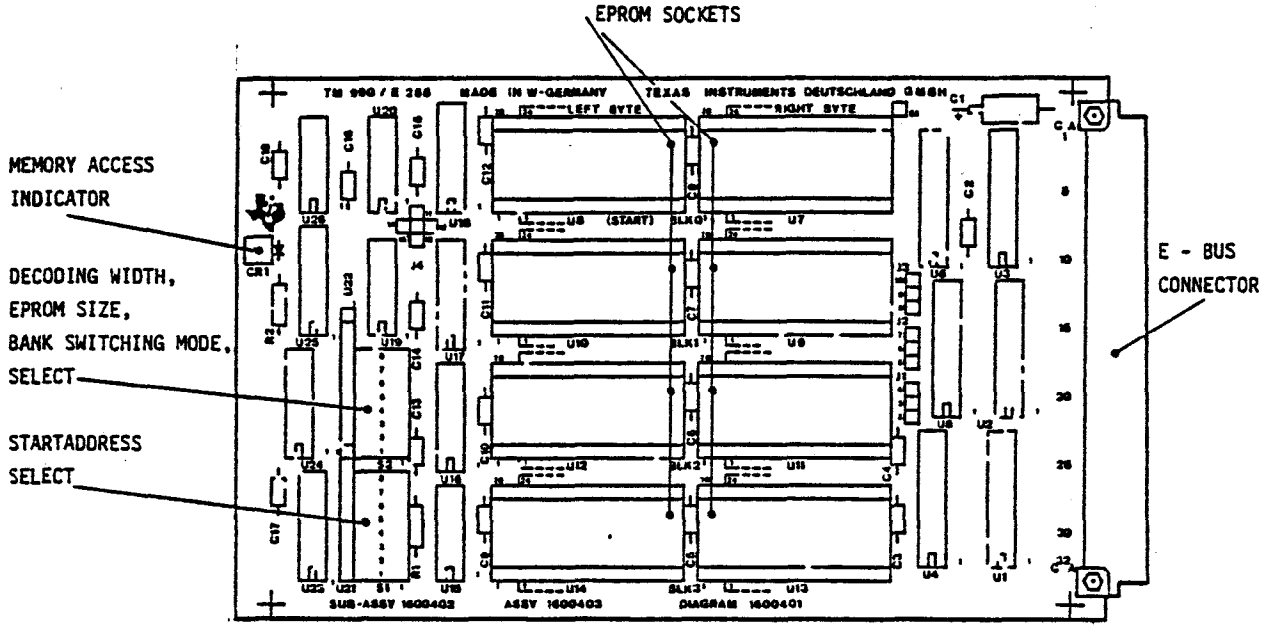


Figure 1 TM990/E255 EPROM Expansion Board

1 General.

The TM990/E255 EPROM expansion module is a member of the E-Bus compatible family of microcomputer modules in the single Eurocard format. The TM990/E255 module offers the user eight 28-pin EPROM sockets. By using eight TMS 2564 devices, the TM990/E255 can provide 64k-Bytes of EPROM memory. The TM990/E255 module is designed for four different size EPROMs (up to the future 128k-Bit device). This document describes the installation and the operation of the TM990/E255 EPROM-Module.

2 Key Features.

The TM990/E255 module offers the following features:

- Full E-bus compatible
- 8 Sockets for TMS2516, 2532, 2564 and 2528 EPROMs
- Up to 128k-Byte EPROM capacity
- 20 bit address decoding (1M-Byte)
- 8 or 16 bit data bus width
- Endaddress selectable in 4k-Byte steps
- Address decoding width selectable from 4 - 128k-Bytes
- Selectable wait states (0, 1, 2, 3, or 4)
- Bank switching to select one of the four EPROM-blocks
- Standard (DIN 41612) backplane connector
- Standard board size 100mm x 160mm

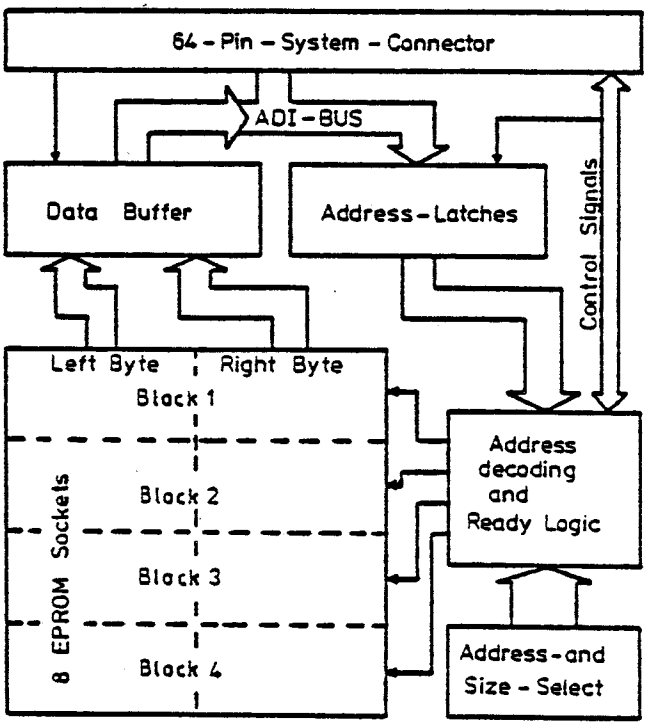


Figure 2: Functional Block diagram

3 Functional Description.

3.1 Theory of Operation.

The TM990/E255 module is designed for TMS25XX series EPROMs from Texas Instruments. The TMS25XX EPROMs are single +5V supply, erasable, programmable, read-only memorys *. The TM990/E255 module is physically organized in 16 bit words. Therefore each word is split, with the left byte in one EPROM and the right byte in another.
A rather sophisticated decoding scheme is implementated on this board to privide the customer with the highest level of flexibility. Therefore it is mandatory to check the following items carefully, before the jumper and switch positions are set up.

- Mode of operation (Normal or Bank-switching mode)
- EPROM type to be used
- Desired address space (given by the number and type of EPROM's used)
- Endaddress of the desired address space

As mentioned above, the TM990/E255 can operate in one of two modes: The normal mode and the bank-switching mode. A brief description of the normal mode follows below.
The TM990/E255 comprises of eight EPROM sockets which are grouped into four blocks of two sockets each (figure 4). It is possible to move the desired address space in steps of 4k bytes through the whole address space from >0 to >FFFFF.
In some cases it might be desirable to use less than four blocks of EPROM's while still operating in normal mode (e.g. when XA0 ... XA3 can't be manipulated). In those cases one or more EPROM blocks can be masked out by setting the appropriate switches (S2.3 .. 7) according to table 3. The first block that will be masked out while changing the state of S2 is block 0, then block 1 and so on (figure 3).
Note, if only one block is to be accessed, the EPROMs have to be installed into the EPROM sockets labled with block 3 and the switches S2.3 ... 7 have to be set up according to the address space to be accessed.
Care should be taken, while setting switch S1. It is recommended to calculate the value of S1 from the endaddress of the desired address space, since the address where the first block starts moves up in direction higher order addresses, when one or more EPROM blocks are to be masked out (Figure 3).

*See also the "MOS Memory Data Book" (LCC4782)

There are sixteen possible endaddresses in one map of 64k bytes. The according switch positions are listed in table 1a.
There are 16 possible maps that can be accessed via the address XA0 ... XA3. The according switch positions are listed in table 2b. The appropriate start address of the desired address space can be determined easyly by subtracting the desired address space minus 1 from the endaddress.

ENDADDRESS	SWITCH S1				
	POSITION	4	3	2	1
>X0FFF	Cn	OFF	OFF	OFF	OFF
>X1FFF	|	OFF	OFF	OFF	ON
>X2FFF	|	OFF	OFF	ON	OFF
>X3FFF	|	OFF	OFF	ON	ON
>X4FFF	|	OFF	ON	OFF	OFF
>X5FFF	|	OFF	ON	OFF	ON
>X6FFF	|	OFF	ON	ON	OFF
>X7FFF	|	OFF	ON	ON	ON
>X8FFF	|	ON	OFF	OFF	OFF
>X9FFF	|	ON	OFF	OFF	ON
>XAFFF	|	ON	OFF	ON	OFF
>XBFFF	|	ON	OFF	ON	ON
>XCFFF	|	ON	ON	OFF	OFF
>XDFFF	|	ON	ON	OFF	ON
>XEFFF	V	ON	ON	ON	OFF
>XFFFF	Cn	ON	ON	ON	ON

Table 1a

ENDADDRESS	SWITCH S1				
	POSITION	4	3	2	1
>0XFFF	Cn	OFF	OFF	OFF	OFF
>1XFFF	|	OFF	OFF	OFF	ON
>2XFFF	|	OFF	OFF	ON	OFF
>3XFFF	|	OFF	OFF	ON	ON
>4XFFF	|	OFF	ON	OFF	OFF
>5XFFF	|	OFF	ON	OFF	ON
>6XFFF	|	OFF	ON	ON	OFF
>7XFFF	|	OFF	ON	ON	ON
>8XFFF	|	ON	OFF	OFF	OFF
>9XFFF	|	ON	OFF	OFF	ON
>AXFFF	|	ON	OFF	ON	OFF
>BXFFF	|	ON	OFF	ON	ON
>CXFFF	|	ON	ON	OFF	OFF
>DXFFF	|	ON	ON	OFF	ON
>EXFFF	V	ON	ON	ON	OFF
>FXFFF	Cn	ON	ON	ON	ON

Table 1b

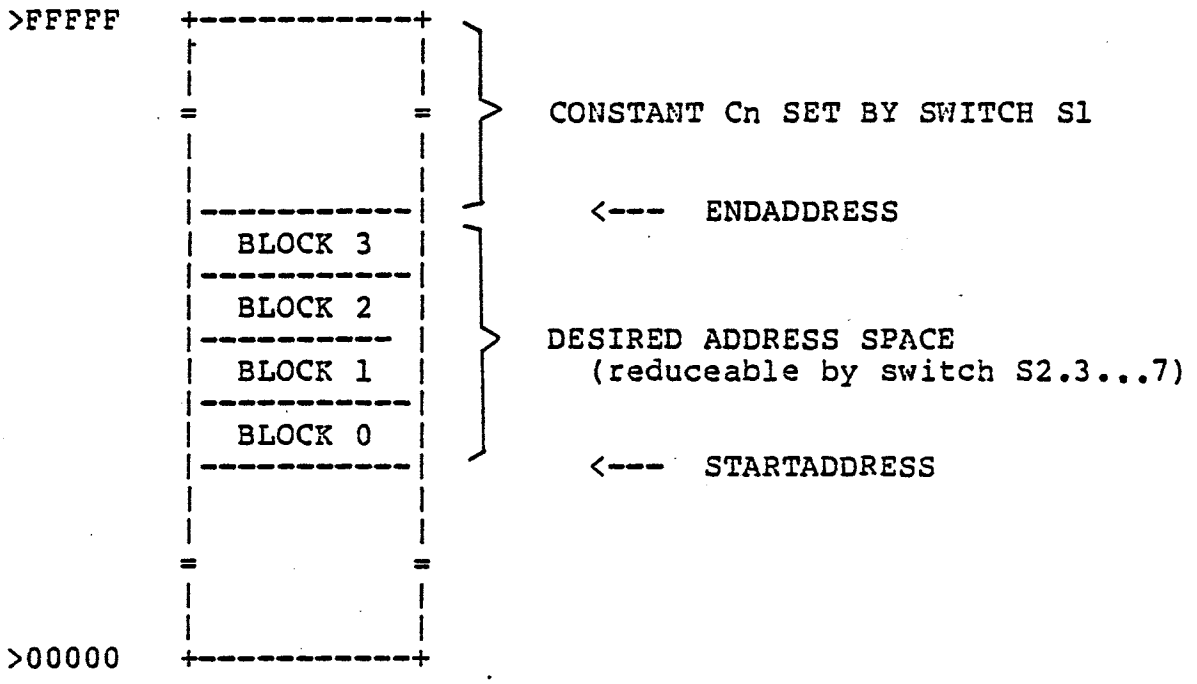
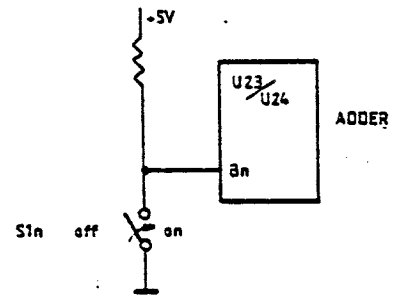


Figure 3

Cn = >_FFFFF - STARTADDRESS - DESIRED ADDRESS SPACE - 1

Cn... reflects the binary value applied to the adder inputs of the decoding circuitry.



OFF = 5V = HIGH = SWITCH OPEN
OF = 0V = LOW = SWITCH CLOSED

3.2 Selecting the EPROM Devices.

The positions of the jumpers J1 - J3 and switch S2 are set, depending on the EPROM sizes. Table 2 shows the positions for the possible devices TMS2516, 2532, 2564 and 2528.

8 EPROMs TMS 25..	S2. 1	2	3	4	5	6	7	8	J1	J2	J3
16	ON	ON	ON	ON	ON	OFF	OFF	ON	E3-E2	E6-E5	X
32	OFF	ON	ON	ON	OFF	OFF	OFF	ON	E3-E4	E6-E5	X
64	ON	OFF	ON	OFF	OFF	OFF	OFF	ON	E3-E4	E6-E7	E9-E8
28	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	E3-E4	E6-E7	E9-E10

X = don't care

Table 2: EPROM Size Select

Table 2 is only valid for a fully populated TM990/E255 module (8 EPROMs). It is possible to use only two or four EPROMs without a waste of memory address space. In these cases the address space of the TM990/E255 module can be decreased by changing the switches S2.3-S2.7. The following table shows the positions of S2.3-S2.7 as a function of the number and types of EPROMs used. S2.1 and S2.2 depend only on the type of EPROMs used (see table 2). The jumpers J1, J2 and J3 are set up according table 2 also.

desired Address Space	EPROM Type			S2. 3	4	5	6	7
4k Byte	2x2516	-	-	ON	ON	ON	ON	ON
8k Byte	2x2532	4x2516	-	ON	ON	ON	ON	OFF
16k Byte	2x2564	4x2532	8x2516	ON	ON	ON	OFF	OFF
32k Byte	2x2528	4x2564	8x2532	ON	ON	OFF	OFF	OFF
64k Byte	-	4x2528	8x2564	ON	OFF	OFF	OFF	OFF
128k Byte	-	-	8x2528	OFF	OFF	OFF	OFF	OFF

Table 3: Address Space Select

Note: EPROM's of different size may not be mixed on the TM990/E255 module.

3.3 Bank Switching.

The TM990/E255 module provides a horizontal "Bank switching" by using the extended address lines XA2 and XA3. In this case the access to one of the four EPROM-blocks (figure 4) depends only on the state of XA2 and XA3 (see table 4), and allows the user an easy way to switch between different software modules. The address lines XA0, XA1 and A0 to A3 are decoded as usual.
Example: The TM990/E255 EPROM-module is to be used together with the TM990/E155 MC-module (which allows to change the extended address lines via CRU). By using eight TMS2564 EPROMs, four different 16k-Byte software modules share the normal 16k-Byte memory address area.

Note, the TM990/E155 applies addresses to the E-BUS, while reading or writing to onboard memory. Therefore, the TM990/E255 will respond by turning on the access LED, if it is put on a address that corresponds to a TM990/E155 onboard decoded address. However, the data buffer of the TM990/E1255 is disabled, to prevent interference from extraneous data from the E-BUS, while reading of writing to onboard memory.

XA2	XA3	selected EPROM-Block*
0	0	BLK 0
0	1	BLK 1
1	0	BLK 2
1	1	BLK 3 (END)

* paragraph 6.6 shows the assignment of these blocks

Table 4: Bank Switching

3.3.1 Selecting the Bank Switching Mode.

The bank switching mode of the TM990/E255 module is selected by setting switch S2.8 to the OFF-state. The positions of the jumpers J1-J3 and the switches S2.3 - S2.7 still depend on the EPROMs used (See table 2). In Bank switching mode the positions of S2.1 and S2.2 are ignored.

Example: Four 8k-Byte software modules each in two TMS2532s, are to be installed on a TM990/E255. The following jumper and switch positions are selected:

```
J1              : E3-E4
J2              : E6-E5
S2.1 - S2.2     : DON'T CARE
S2.3 - S2.7     : ON
S2.7 and S2.8   : OFF
```

Note: To determine the positions of S1 in the Bank switching Mode, the address lines XA3 and XA2 must be ignored (use zero for calculation purposes). Use only the following addresses: >0X000, >4X000, >8X000, >CX000 (X = 0...F).

3.4 Selecting the Number of Wait States.

The position of the jumper J4 depends on the required number of wait states. The TM990/E255 module generates both READY- and AREADY- signals. READY- (active low) indicates that a memory cycle is ready to complete during the present BUSCLK-cycle. AREADY- (Advanced Ready) indicates that a memory cycle will be ready to complete during the next BUSCLK-cycle. The number of wait states are selectable by J4 for both signals as following:

J4	Wait states
E15-none	none
E15-E11	1
E15-E12	2
E15-E13	3
E15-E14	4

Table 5: Number of Wait States

The following table shows the required number of wait states for two different MC-modules. The duration of a wait state depends on the BUSCLK- (Pin 2c of the E-Bus). The TM990/E150 generates a 2,5MHz BUSCLK- and the TM990/E155 a 3MHz BUSCLK-.

MC-Module TM990/E...	Number of Wait States	max. Access Time from Address	from CS/PD
150	0	435ns	370ns
	1	835ns	770ns
	2	1234ns	1170ns
	3	1635ns	1570ns
	4	2035ns	1970ns
155	0	272ns	207ns
	1	405ns	340ns
	2	738ns	673ns
	3	1071ns	1006ns
	4	1405ns	1340ns

Table 6: Required Wait States

3.5 Eight and Sixteen Bit Data Bus.

The TM990/E255 is designed to be used within E-Bus compatible MC- or MMC-modules having either an eight or sixteen bit data-path width. The data path width is controlled by the signal MEMWIDTH (pin 31a of the E-BUS). A high level indicates that 8 bit wide transfers are being used, and the data transfer takes place in two cycles via the bus lines A8/D8-A15/D15/CRUOUT. A low level on MEMWIDTH indicates 16 bit wide transfers, and the bus lines A0/D0/INT0 - A15/D15/CRUOUT. are used for a data transfer. MEMWIDTH must be controlled by the MC- or MMC-Module currently accessing to the E-Bus.

4 Electrical Specification

Memory: Up to eight EPROMs of the single +5V supply family (TMS25XX).

Power Supply: +5V typ. 750mA (without EPROM)
typ. 1,3A with 8 TMS2564
max. 2,7A with 8 TMS2564

Environmental:
Operating Temperature: 0-70 degree C
Humidity : 0-95 % non condensing
Shock : will stand 1m vertical drop in a chassis

Board size: Single Eurocard 100mm x 160mm

Interface: E-Bus compatible using 64-Pin female connector (DIN 41612)

5 User Options and Ordering Number.

Ordering Number	Type
TM990/E255	EPROM expansion Module with eight sockets for TMS2516, 2532, 2564 or 2528 EPROMs.

6 Jumper and Switch Descriptions.

6.1 Wait states for READY- and AREADY- (J4).

J4	Number of Wait States
E15-none	none
E15-E11	1
E15-E12 *	2
E15-E13	3
E15-E14	4

6.2 Jumper Positions J1, J2, J3.

J1	J2	J3	EPROM
E3-E2	E6-E5	X	TMS2516
E3-E4*	E6-E5*	X	TMS2532
E3-E4	E6-E7	E9-E8*	TMS2564
E3-E4	E6-E7	E9-E10	TMS2528

6.3 Switch S2.8.

ON *	Normal Mode
OFF	Bank switching Mode

6.4 Switches S2.1 - S2.2 (S2.8 = ON).

EPROM-Type	S2.1	S2.2
TMS2516	ON	ON
TMS2532*	OFF	ON
TMS2564	ON	OFF
TMS2528	OFF	OFF

*Factory configuration

6.5 Switches S2.3 - S2.7.

Desired Address Space	S2.3	S2.4	S2.5	S2.6	S2.7
4k-Byte	ON	ON	ON	ON	ON
8k-Byte	ON	ON	ON	ON	OFF
16k-Byte	ON	ON	ON	OFF	OFF
32k-Byte*	ON	ON	OFF	OFF	OFF
64k-Byte	ON	OFF	OFF	OFF	OFF
128k-Byte	OFF	OFF	OFF	OFF	OFF

* Factory configuration

6.6 Assignment of the 4 EPROM-Blocks.

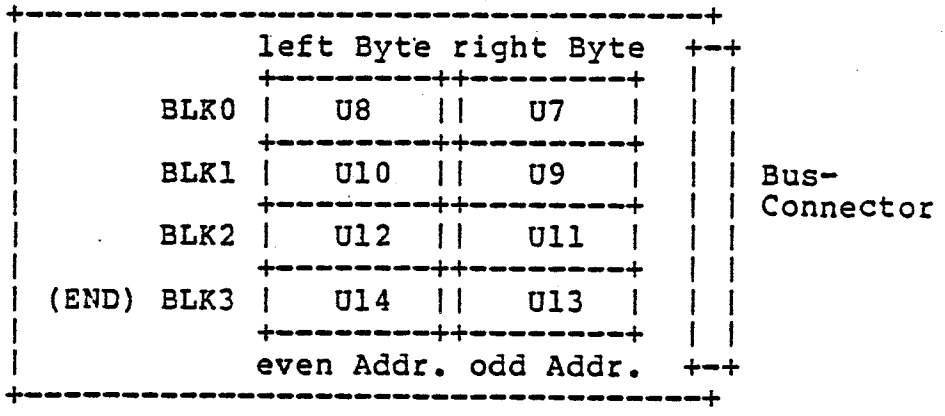


Figure 4: The 8 EPROM-Sockets of the TM990/E255 Module

Note: Mark 1 adjacent to the EPROM sockets refers to pin 1 of the EPROM types TMS2564/28.
Mark 1 adjacent to the EPROM sockets refers to pin 1 of the EPROM types TMS2516/32.

EPROM Block	EPROM-Sockets left Byte	EPROM-Sockets right Byte	relative block-startaddress* TMS2516	TMS2532	TMS2564	TMS2528
BLK0	U8	U7	0	0	0	0
BLK1	U10	U9	>1000	>2000	>4000	>8000
BLK2	U12	U11	>2000	>4000	>8000	>C000
BLK3	U14	U13	>4000	>8000	>C000	>18000

*S2.8 = ON (Normal mode - not Bank switching)

7 E-Bus Connector and Bus Loading

Figure 5 shows the signal assignments for the E-Bus connector P1.

		a	b	c		
GND	1	o	o	o	1	GND
NC	2	o	o	o	2	BUSCLK-
NC	3	o	o	o	3	NC
NC	4	o	o	o	4	NC
+5V	5	o	o	o	5	+5V
NC	6	o	o	o	6	reserved
reserved	7	o	o	o	7	reserved
reserved	8	o	o	o	8	reserved
reserved	9	o	o	o	9	reserved
NC	10	o	o	o	10	ALATCH
XA0	11	o	o	o	11	XA1
XA2	12	o	o	o	12	XA3
A0/D0/INT0	13	o	o	o	13	A1/D1/INT1
A2/D2/INT2	14	o	o	o	14	A3/D3/INT3
A4/D4/INT4	15	o	o	o	15	A5/D5/INT5
A6/D6/INT6	16	o	o	o	16	A7/D7
A8/D8	17	o	o	o	17	A9/D9
A10/D10	18	o	o	o	18	A11/D11
A12/D12	19	o	o	o	19	A13/D13
A14/D14	20	o	o	o	20	A15/D15/CRUOUT
AREADY-	21	o	o	o	21	MEMEN-
DEN-	22	o	o	o	22	READY
GRANTIN	23	o	o	o	23	GRANTOUT
NC	24	o	o	o	24	NC
GND	25	o	o	o	25	GND
NC	26	o	o	o	26	NC
NC	27	o	o	o	27	NC
NC	28	o	o	o	28	NC
NC	29	o	o	o	29	NC
+5V	30	o	o	o	30	+5V
MEMWITH	31	o	o	o	31	NC
GND	32	o	o	o	32	GND

NC = no connection on the board

Figure 5: E-Bus connector pinout

TM990/E255 EPROM-Module					
E-Bus Signal	IN/ OUT	Driving UBL's		Consuming UBL'S	
		LOW	HIGH	LOW	HIGH
A0/D0/INT0- A6/D6/INT6 A7/D7	I/O	240	750	3.25	4.5
A8/D8- A15/D15/CRUOUT	I/O	240	750	5.25	4.5
XA0 - XA3	In	-	-	2	2.5
INTEN-	-	-	-	-	-
ALATCH-	In	-	-	2	2.5
MEMEN-	In	-	-	2	2,5
DEN-	In	-	-	2	1
WE-	-	-	-	-	-
BUSY-	-	-	-	-	-
READY-	Out	100	-	-	-
AREADY-	Out	100	-	-	-
MEMWIDTH	In	-	-	2	2.5
BUSCLK-	In	-	-	2	2.5
PRES-	-	-	-	-	-
IORST-	-	-	-	-	-
NMI-	-	-	-	-	-
PWRFAIL-	-	-	-	-	-
GRANTIN	-	-	-	-	-
GRANTOUT	-	-	-	-	-
CRUIN	-	-	-	-	-
CRUCLK-	-	-	-	-	-

1 UBL (LOW) =0.2mA; @Vol = 0.5V;
UBL = UNIT BUS LOAD

1 UBL (HIGH) = 0.02mA @Voh = 2.4V

Figure 6: E-Bus unit bus loading

8 Installation.

To install the TM990/E255 in a Microcomputer system the following equipment is necessary:

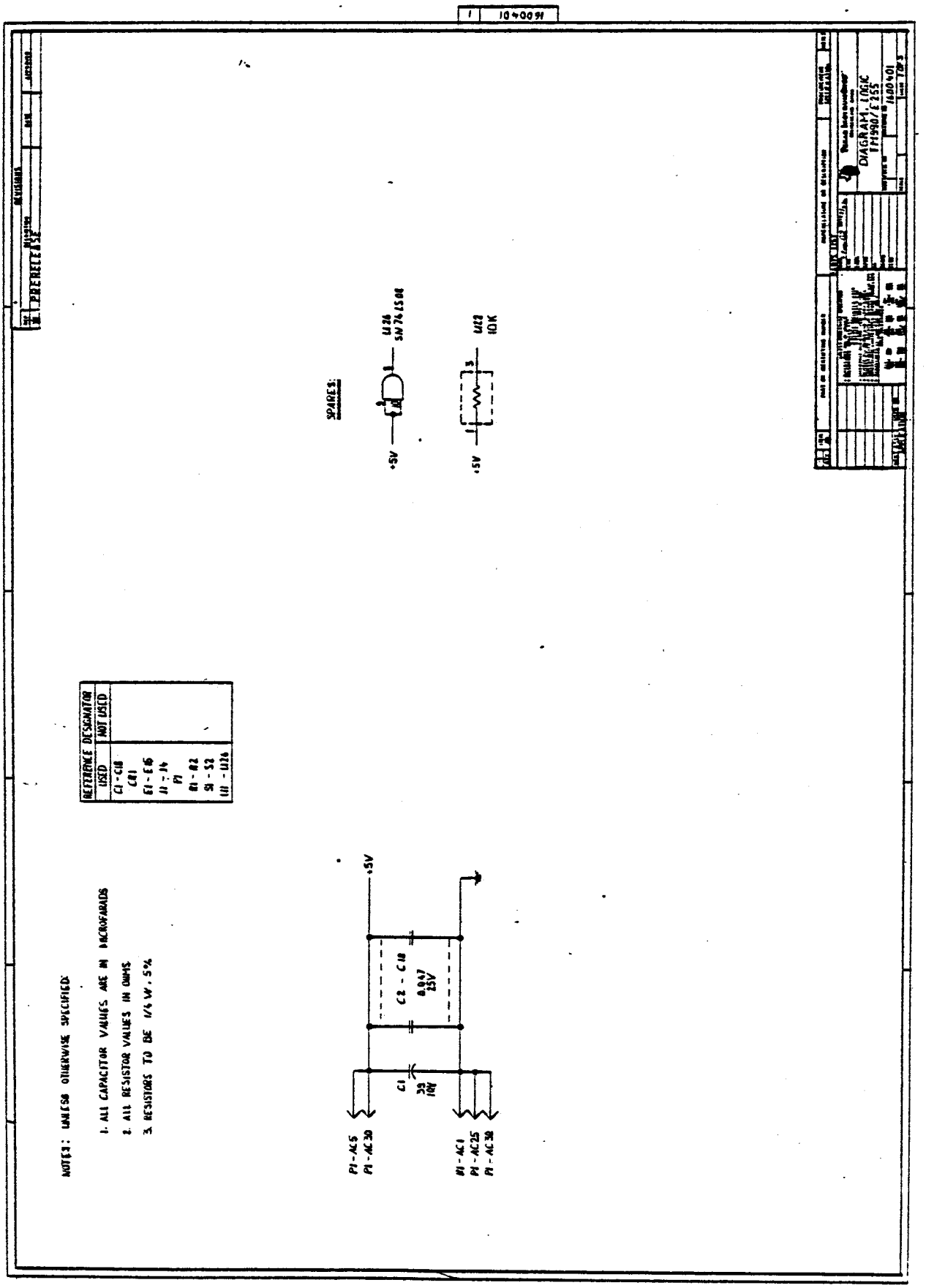
* TM990/E150 or TM990/E155 MC-Module with an EIA-module
* TM990/E5000 Backplane or equivalent
* Standard Eurocard rack
* Power Supplies (+5V, +/-12V)
* Data Terminal with RS-232 or TTY interface
* Monitor program EUROBUG 2 or 4
* 1, 2 or 4 TMS25XX EPROM-pairs with software

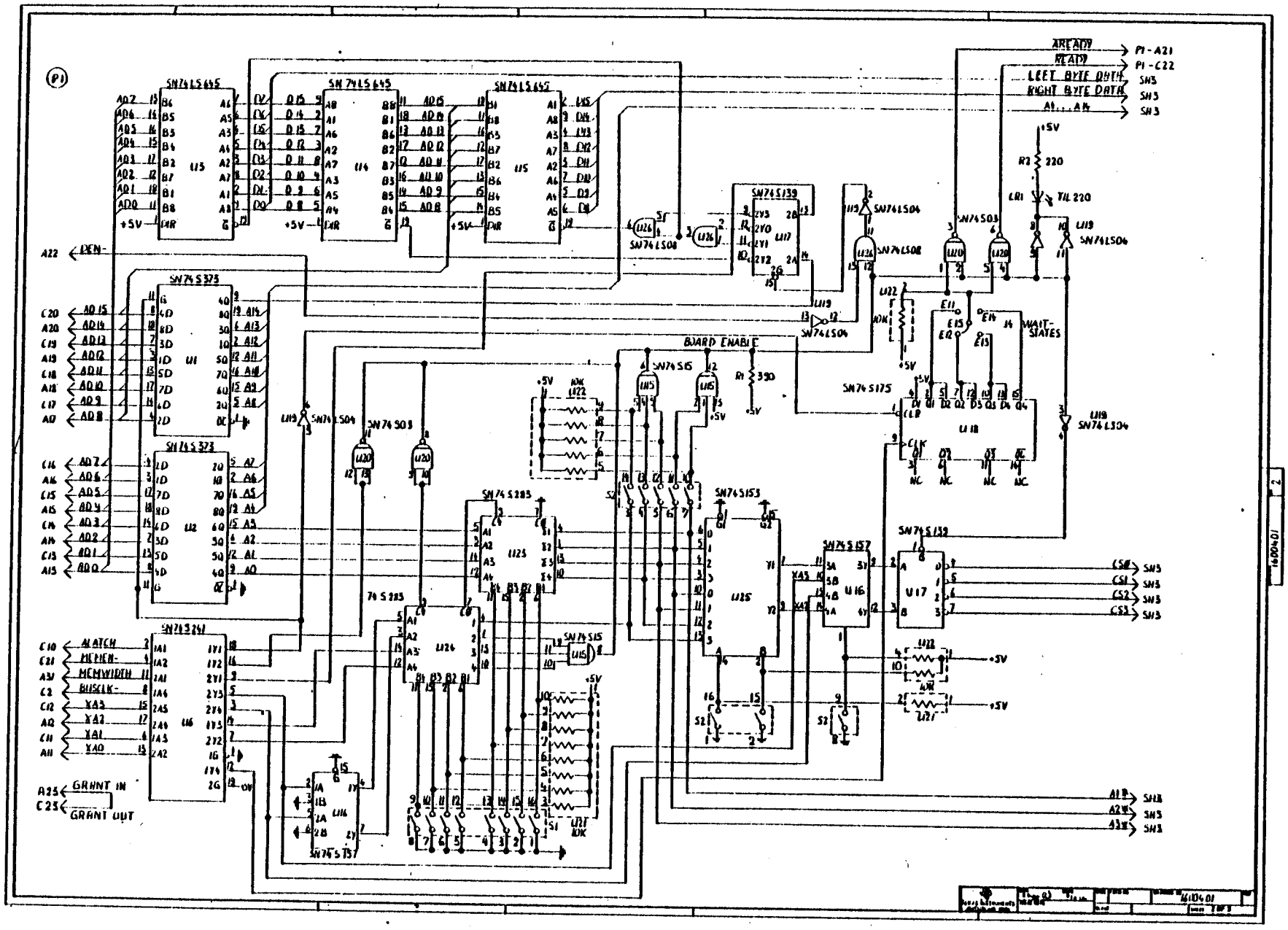
Each EPROM-pair consists of two TMS25XX which are programmed "parallel" with the left and right byte. Set all switches and jumpers as described in paragraph 3. A program may be started by the "G"-command of EUROBUG. Access to the TM990/E255 module will be indicated by the on board LED.

NOTE

Software programmed into EPROMs of the TM990/E255 module must be word, not byte organised (as on TM990/E250 module). Therefore at least two TMS25XX EPROMs are always necessary.

Appendix A: Circuit Diagram

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SN74S175
SN74S285
SN74S15
74S285
BOARD ENABLE
WAIT-STATES
AREADY
READY
LEFT BYTE DATA
RIGHT BYTE DATA
A1...A4
MATCH
MEMEN-
MEMWIDTH
BUSCLK-
GRANT IN
GRANT OUT
DEN-
+5V