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VL-7709a
VL-7709b
VL-77CT09a
VL-77CT09b

64/256K Memory Card
for the STD Bus

Model VL-7709
64/256K Memory Card for the STD Bus
REFERENCE MANUAL

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M7709

Model VL-7709
64/256K Memory Card

REFERENCE MANUAL

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Section 1 OVERVIEW

INTRODUCTION

This manual details the installation and operation of VersaLogic's VL-7709 memory card. The VL-7709 card accepts 8K or 32K RAM and ROM devices, and is available with battery backup option for totally non-volatile operation. It features 16 and 20 bit addressing, and is compatible with all common STD Bus processor types. It is fully compatible with the Pro-Log 7709 memory board.

The "B" versions of the board (VL-7709B, VL-77CT09B) include an on-board backup battery and related support circuitry.

Throughout this manual "VL-7709" will be used to refer to all versions of the board, unless specifically noted otherwise.

OVERVIEW

The VL-7709 memory card includes eight 28-pin JEDEC sockets which can be jumpered to accept 8K or 32K memory chips. This provides a capacity of 64K (with 8K chips) or 256K (with 32K chips) of memory. RAM and ROM chips (of a similar size) can be mixed on the same board.

The board provides both 16-bit addressing (for Z80, 8085, etc.) and extended 20-bit addressing for use with STD 8088 systems. In addition, a programmable bank select port allows selection of multiple memory boards in 16-bit systems (in either 32K or 64K blocks). Multiple VL-7709 boards (up to 1M byte) can be directly addressed in 20-bit systems.

The MEMEX signal is decoded for use with bootstrap applications, or for further extending the number of boards that can be addressed.

The battery backup option provides a completely self-contained data retention system for use in nonvolatile memory applications. The long life lithium battery, and complete power monitoring circuitry allow the on-board data to be retained for 5-10 years (depending on the chips used) with or without the presence of system power.

Write inhibit switches allow on-board RAM to be protected (to act as ROM) to simplify testing during software development.

FEATURES

- 64K to 256K byte capacity.
- Eight 28-pin JEDEC memory sockets.
- Accepts 8K and 32K byte RAMs and ROMs.
- 16-bit and 20-bit address decoding.
- Bank select and MEMEX decoding.
- Optional lithium battery backup.
- Write inhibit switches.
- Extended temperature version available.
- Universal STD Bus processor compatible.
- Three year warranty.

DESCRIPTION

Addressing

Both 16 and 20-bit addressing are supported. The 20-bit mode is STD 8088 Bus compatible. It extends the system addressing capability by strobing and latching A16-A19 from the D0-D3 bus lines when operation with an 8088 CPU card. The 20-bit addressing mode allows large amounts of memory (1M bytes) to be directly addressed by the CPU.

The 16-bit addressing mode is compatible with most 8 bit CPUs (Z80, 8085, 6809, etc.). It includes a programmable memory bank control that allows these systems to address more than 64K of memory. 64 banks of 32K or 64K bytes of memory can be selected by the processor for up to 4M bytes of system memory. The Bank Control port can be addressed at any I/O location (00-FF).

Both 16 and 20-bit addressing can be extended (capacity doubled) using the MEMEX signal which is also decoded by the VL-7709.

Memory Sockets

Eight 28-pin JEDEC compatible memory sockets accept either 8K or 32K byte RAM and ROMs. Each pair of sockets can be jumper configured for RAM/ZRAM/EEROM or ROM/PROM use, and whether or not they will be powered by the on-board battery (optional) when system power is not available. Each socket can be individually disabled to remove it from the memory map. The VL-7709 board has a capacity of 64K (8K chips) or 256K bytes (32K chips) depending on the memory chips used.

Memory Chips

Memory chips used with the VL-7709 should be selected according to the capacity required (8K or 32K per socket), speed of the system CPU, and power required in standby mode (if the chip will be battery backed-up). The tables below detail these parameters.

	8085 6.25 MHz	Z80 4 MHz	Z80 6 MHz	8088 5 MHz	8088 8 MHz
Access Time (min.)	415	200	110	325	180 ns

Minimum RAM/ROM Access Times

8K RAM

Hitachi HM6264LP* (2uA)#
Toshiba TC5564PL* (.01uA)#

32K RAM

Hitachi HM62256LP* (2uA)#
Toshiba TC55257PL* (2uA)#

8K PROM

Intel 2764A
Intel 27C64*
Hitachi HN482764
Hitachi HN27C64*
AMD AM2764A
TI TMS2764

32K PROM

Intel 27256
Intel 27C256*
Hitachi HN27256
Hitachi HN27C6256*
AMD AM27256

* CMOS part. # Standby current rating.

Typical Memory Devices

Memory Mapping

With 20-bit addressing the board can be located at any 64K (with 8K chips) or 256K (with 32K chips) boundary. With 16-bit addressing the board can be configured as 64K of memory, 64K of bank selectable memory, or two overlapping 32K blocks of bank selectable memory.

Battery Backup

The battery backup option provides automatic backup power for on-board RAMs. The high capacity lithium battery assures data retention for short or long term outages (5-10 years). The backup circuitry also monitors the system power level and protects on-board RAM from spurious writes during power up and power down. A board-edge LED indicator, and Battery Low output signal allow the condition of the battery to be monitored if desired.

SPECIFICATIONS

Size: Meets all STD Bus mechanical specifications.

Storage Temperature:

- VL-7709: -40° to +75° C.
- VL-77CT09: -40° to +85° C.

Free Air Operating Temperature:

- VL-7709: 0° to +65° C.
- VL-77CT09: -40° to +85° C.

Memory Sockets: Eight 28 pin JEDEC compatible.

Power Requirements:

- VL-7709: 5V \pm 5% at 150 ma typ. (without on-board memory).
5V \pm 5% at 175 ma typ. (with 8 low power RAMs).
- VL-77CT09: 5V \pm 10% at 25 ma typ. (without on-board memory).
5V \pm 10% at 70 ma typ. (with 8 low power RAMs).

Battery Type: Lithium.

Battery Voltage: 3.5V nominal (2.5V min.)

Battery Capacity: 750 mAH

Data Retention Time/ Battery Life (at 25°C):

- 64K bytes (8x8K chips) @ 2uA/chip: 4 years.
- 64K bytes (8x8K chips) @ .01uA/chip: 10 years min.
- 256K bytes (8x32K chips) @ 2uA/chip: 4 years.

**Section 2
OPERATION****INTRODUCTION**

Since the function of the VL-7709 board is simply to hold RAM or ROM for use by the system CPU, there is very little attention needed to the board once it is installed. However, since there are several ways that the board can be configured, careful thought should be given to the board's operation before it is installed in the system.

This section briefly discusses the various options that are available with this board including 16 and 20-bit addressing, bank selection, battery backup, and the write protection switches.

Details of configuring the board for these options can be found in Section 4 of this manual.

SELECTING AN ADDRESS MODE**Address Bus**

The VL-7709 operates in two address modes, 16-bit (for Z80, 8085, 6800, 6500, etc. systems) and 20-bit (for STD 8088 systems).

Most non-8088 users will select the 16-bit bit addressing mode. In this mode up to 64K bytes of memory can be directly addressed. The bank selection feature can be used to allow software selection of additional 32K or 64K blocks of memory.

In the 20-bit mode, data lines D0-D3 act as address lines A16-A19 during part of the read/write cycle and are automatically latched by the VL-7709 board. Up to 1M byte of memory can be directly addressed in this mode. Bank selection is not available.

Both addressing modes support the MEMEX control. This signal, which is usually controlled by the system CPU, allows a "main" and "secondary" memory area to be selected. It can be used for startup/bootstrap operation, or to double the amount of accessible memory in a system. See Using MEMEX in this section for further information.

Memory Chip Selection

Before the board can be configured for the desired addressing and mapping options, the type of memory chips to be used must be known. The VL-7709 supports both 8K and 32K byte types.

Only one size can be used on the board. 8K and 32K chips can not be mixed.

The selection of memory chips will normally be based on current chip pricing. An exception to this is in systems that will use larger amounts of memory. 32K chips will usually be appropriate in these cases since 256K of memory can reside on a single board, versus only 64K bytes per board using 8K chips. The extra expense of 32K chips (if any) is usually outweighed by the expense of additional memory boards, bus slots, etc.

Bank Selection

In the 16-bit addressing mode the VL-7709 supports bank selection. This method of memory expansion allows the processor to switch a number of blocks (banks) of memory in and out of its basic 64K addressing space. When a bank is selected it takes its place in the addressing space and may be read and written in normal fashion. When a different bank is selected the memory on the old bank is no longer accessible by the CPU. The data is simply retained in the bank until it is once again selected by the CPU.

The VL-7709 allows a bank size of either 32K or 64K bytes. Depending on the bank size, and the type of chips used, each bank may be physically located on the same or different VL-7709 boards.

The process of selecting a bank involves simply writing a bank number to the Bank Control port (see example below). The desired bank is immediately selected and the previously selected bank is de-selected. The VL-7709 board always selects bank 00 at power-up, or whenever the system is reset.

Note that for proper bank select operation the Bank Control port address (normally EE) must be the same on all memory cards in the system.

```

                                ; Bank selection example for Z80 CPU
                                ;
                                BankCnt1 equ EEH
                                ;
                                ;
0417 3E 02      LD A,02H          ;Select memory bank #2
0419 D3 EE      OUT (BankCnt1),A
                                ;
                                ;(Continuation of program)

```

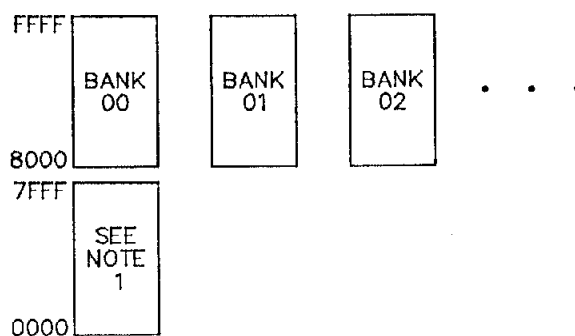
Figure 2-1. Bank Selection Example.

When using bank switching there are several special programming considerations. Most important is maintaining software continuity when switching banks. If the currently executing program is located in a bank that is being switched out of use, identical or "mating" code must be available in the new bank for the CPU to continue execution. The CPU is not aware that it is in a new memory area; it simply increments the

program counter and expects to read the next program instruction.

This software problem can be dealt with in several ways. First, by selecting a 32K bank size, only half of the memory map is switched in/out at a time. This allows the routine that does the bank switching to be located in a portion of the address space that is not being switched. A typical example is shown in Figure 2-2.

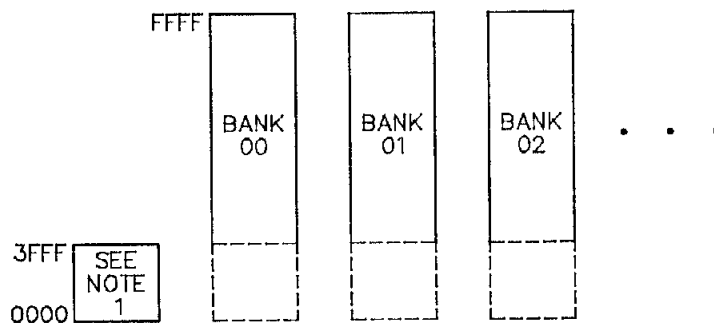
In this example the lower 32K of memory is fixed (not bank selectable). It holds the program code for bank switching so that the upper half of the map can be switched without concern for program continuity. Note that the lower 32K block must be configured for no bank selection so that it will not be switched out when the upper 32K banks are selected.



(1) Primary RAM or ROM. Contains bank switching routine.

Figure 2-2. Typical 32K Bank Switching.

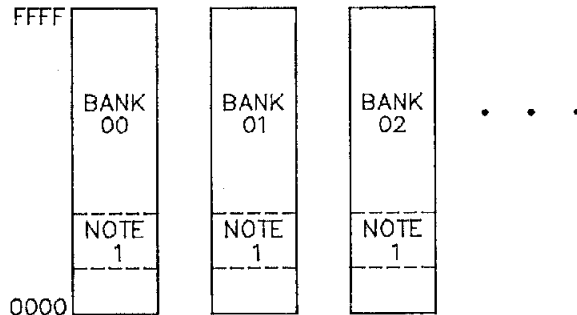
When 8K chips are used, a similar scheme can be employed by using 64K banks and de-selecting one or more chips at the bottom of each bank. This empty space in each bank can then be used for some non-bank selected memory (on a VL-7709 or the system CPU board) that can reside at the bottom of the map. The figure below illustrates this approach.



(1) Primary RAM or ROM. Appears in all banks.

Figure 2-3. 64K Banks With Chip De-Selection.

Finally, full 64K banks can be used by placing a small section of identical code (the bank switching routine) in each bank. Figure 2-4 illustrates this scheme.



(1) Bank switching routine (a copy in each bank).

Figure 2-4. 64K Bank Switching

Using MEMEX

The MEMEX (memory expansion) signal on the STD Bus can be used to select between two different memory banks or maps. It is simply another way to enable/disable certain memory board(s) in the system. It can be used to double the available memory (similar to selecting between two banks), or to control a bootstrap PROM (that disappears from the map after power-up). The MEMEX signal is usually controlled by (or jumpered to ground on) the system CPU card.

The VL-7709 decodes MEMEX in both the 16 and 20-bit addressing modes. MEMEX is usually low (default) to select the standard or normal memory map. MEMEX high typically selects a secondary or alternate memory map. Boards that ignore the state of MEMEX will appear in both memory maps.

As shipped the MEMEX jumper (V2h) is set to ignore the MEMEX signal. The VL-7709 board will be addressed whether MEMEX is high or low. Refer to MEMEX Options in the Configuration section for further information.

Since the MEMEX signal causes program memory to be switched in and out of the CPU's address space, the same software cautions apply to using MEMEX as to bank switching in general (see Bank Selection above).

BATTERY BACKUP

The "B" versions of the VL-7709 feature an on-board backup battery and associated support circuitry. The battery can backup some or all of the on-board RAM chips so that data is not lost when the system power fails.

The backup battery used on the VL-7709 is a long life lithium type. It does not require charging or setup prior to being placed in service.

The data retention (battery life) time for the battery depends primarily on the type of RAM chip used. Typical unpowered backup time is 4-10 years. Some examples are listed in Specifications in the Overview section. Note that with extremely low power RAMs, the data retention calculation must be artificially limited since the shelf life of the battery is not guaranteed past 10 years.

The power backup of on-board chips is jumper selectable for each socket pair. Each chip pair may use standard (non-backed-up) system power, or automatically backed-up power. Be certain that only sockets using RAM chips are jumpered for backup power. Jumpering PROM chips for backup power will result in unnecessary battery drain and shortened battery life.

A low battery signal and on-board LED indicator are available to indicate that the on-board battery is getting weak. The LED indicator, which is located at the edge of the board, will light whenever the battery is low and the system power is on (the LED is powered by the system, not by the battery).

The low battery signal is available at connector J1 (see Figure 3-2). It is normally used for connection to an I/O card in the system for automatic monitoring of the battery condition. This signal goes low when the battery is getting weak. The low battery signal is valid only when the system power is on.

The low battery signal occurs when the battery output falls below 2.5 volts.

For special applications the power backup circuit may be connected to an external backup battery (instead of the on-board lithium cell). The external battery must be between 3.3 and 4.5 volts. If required the VL-7709 can supply a charging current for this battery by installing the R-OPT resistor on the board.

WRITE PROTECTION SWITCHES

The VL-7709 provides four on-board switches that can write protect on-board RAM chips. The switches located at the board edge are accessible while the board is inserted in a card cage.

When the switch is up (off, open) the current contents of associated RAM chips can not be altered (written to) by the system CPU. This is useful during software development for simulating ROM based software, or for debugging software that overwrites itself in error. The switch can be set to the down (on) position at any time to allow writing to RAM.

Each write protect switch is associated with a pair of memory sockets. As shown below these pairs are identical to those controlled by the configuration jumpers (A-D).

Write Switch	Controlled Sockets
A	M0, M1
B	M2, M3
C	M4, M5
D	M6, M7

Figure 2-5. Write Protect Switch Function

**Section 3
INSTALLATION****HANDLING**

**** CAUTION **** The VL-7709 card uses chips which are sensitive to static electricity discharges. Normal precautions, such as discharging yourself, work stations, and tools to ground before touching the board should be taken whenever the board is handled.

The board should also be protected during shipment or storage by placing it in a conductive bag (such as the one it was received in) or by wrapping it in metal foil.

INSTALLATION

The VL-7709 card can be installed in any slot of an STD Bus card cage.

The VL-7709 does not use the STD Bus priority interrupt chain. However, the priority IN and OUT pins on this board are connected together so that the priority chain will not be broken. This board may be inserted between other boards that are using the priority chain.

**** CAUTION **** When cards are installed in an STD Bus card cage they must be oriented correctly (usually with the card ejector toward the top of the cage). Refer to the card cage documentation for the correct way to insert the STD Bus cards.

**** CAUTION **** Cards should be inserted or removed from the STD Bus card cage only when the system power is off.

Note: VL-7709B versions (with battery backup) utilize a long life lithium battery for the backup power source. This battery does not require charging or other maintenance during installation.

EXTERNAL CONNECTIONS

Connection to the low battery indicator signal (J1) on the VL-7709B board can be made with the mating connector listed below. Connector J1 is a two-pin right angle header which is accessible at the outside edge of the board. Pin one, marked with a dot, is oriented nearest to the card ejector.

VL-7709B**Connector Mating Connector**

J1 AMP #530554-1 + (2) #530553-5 or equiv. two-pin connector.

Figure 3-1. VL-7709B I/O Connector.

J1 Pin	Signal Name	Output Drive (Sink ma)
1	GND	-
2	LOW BATTERY*	5 ma

Figure 3-2. Low Battery Connector (J1) Pinout.

**Section 4
CONFIGURATION****JUMPER SUMMARY**

Various options available on the VL-7709 card are selected using removable jumper plugs (shorting plugs). Features are selected or deselected by installing or removing the jumper plugs as noted. The terms "IN" or "JUMPED" are used to indicate an installed plug. "OUT" or "OPEN" indicates the absence of a jumper plug.

Figure 4-1 shows the jumper block locations on the VL-7709 board. It indicates the position of the jumper plugs as shipped from the factory. The function of each jumper block is detailed in Figure 4-2.

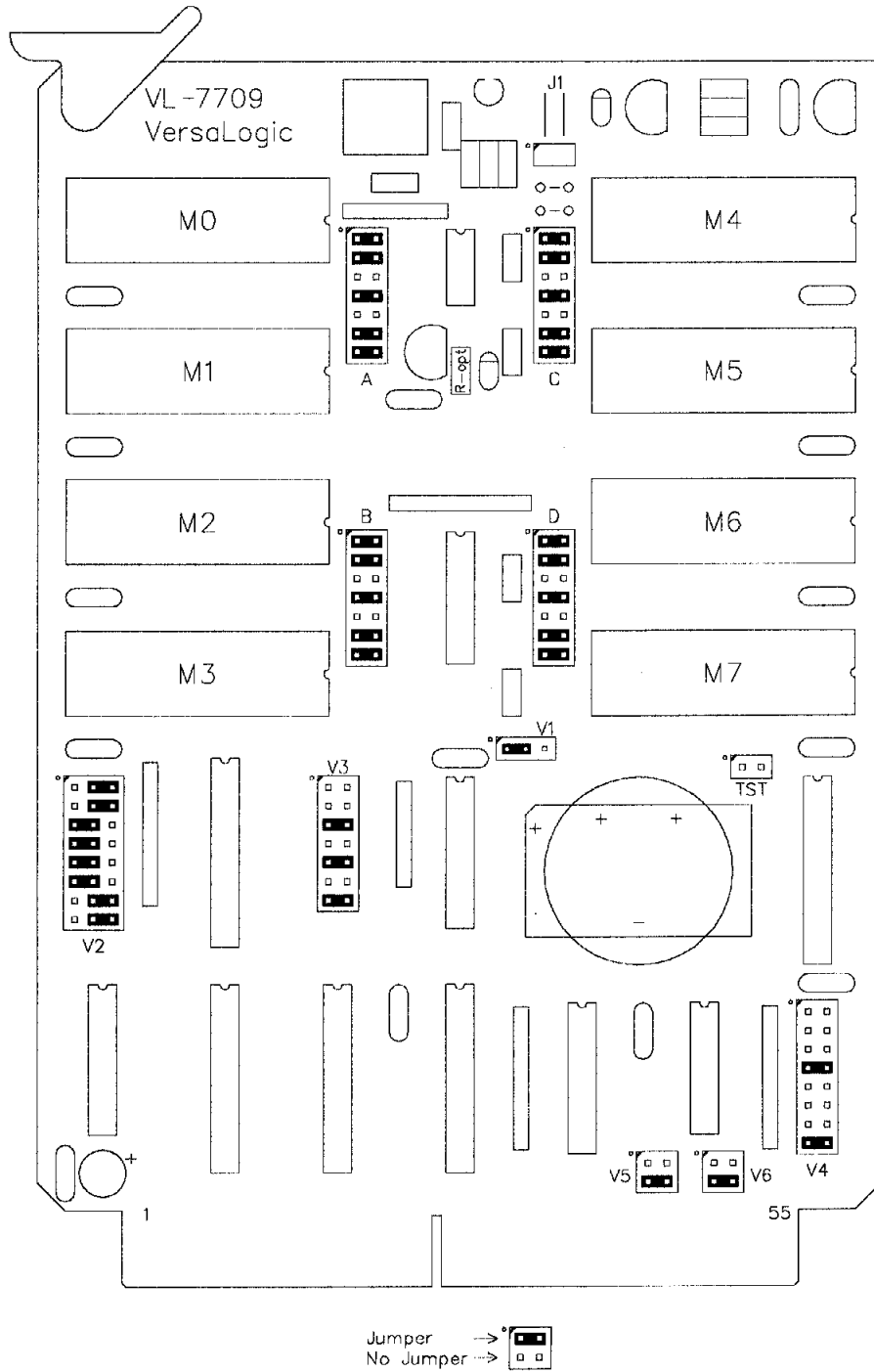


Figure 4-1. Jumper Block Locations

Jumper Block	Description	As Shipped
A-D	Memory socket options. See <u>Memory Socket Configuration</u> section.	All 8K RAMs
V1	Battery backup source. (VL-7709B version) a - Off-board (STD pin 5). b - On-board battery	a - IN b - out
V2	Board Address. See addressing sections.	
V3	Memory map selection. a, d, f - 32K parts in a 256K block. b, e, g - 8K parts, 32K blocks, bank sel. c, e, g - 8K parts in a 64K block.	out out IN
V4	Bank Control port I/O address. See <u>Bank Control Port Address</u> section.	Hex EE
V5	IOEXP select (for Bank Control port). a - Active high. b - Active low. - - Don't care (both jumpers out).	a - out b - IN
V6	Addressing mode. a - 20-bit (8088) b - 16-bit with bank select. - - 16-bit without bank select (no jumpers).	a - out b - IN

Figure 4-2. Jumper Functions

MEMORY CONFIGURATION

The VL-7709 has eight on-board memory sockets which can accommodate 8K or 32K byte RAM and ROM devices. RAMs and ROMs of the same size can be mixed on the board. Individual memory sockets can be disabled to remove them from the memory map.

The board can be addressed with 16 or 20-bit addressing with bank selection available in the 16-bit mode.

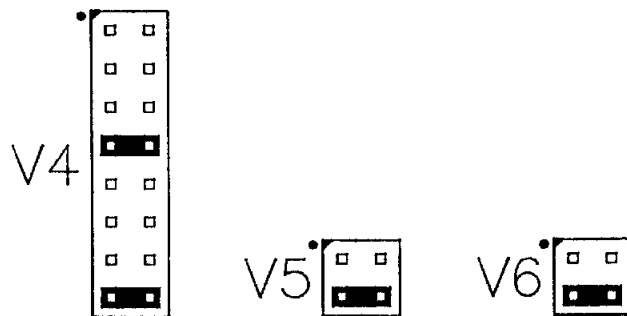
The jumpers needed to make these selections are detailed below. See the Operation section for more information on selecting and using these address modes.

When selecting the desired memory map, note that the addressing jumpers determine only the memory space that is reserved for each memory socket. Whether or not the socket is enabled, and whether a socket holds RAM or ROM, is determined by the memory socket jumpers (jumper blocks A-D) which are discussed later in this section.

16-BIT ADDRESS

The 16-bit addressing mode is available for use with most STD Bus systems with 8-bit CPU cards including Z80, 8085, 6800, and 6500 types. In this mode up to 64K of memory can be directly addressed by the processor. Bank selection, provided by the VL-7709 card, allows multiple banks of memory to be switched in and out of the CPU's address space. A new memory bank is enabled by writing to the Bank Control port. Up to 4M bytes of memory can be accessed by the CPU using this method.

To jumper the board for the 16-bit addressing mode set jumpers V4-V6 as shown below.



Jumper Block	Description	Setting
V2	Board Address and MEMEX.	Refer To Text
V3	Memory map selection. a, d, f - 32K parts, 256K block b, e, g - 8K parts, 32K blocks, bank sel. c, e, g - 8K parts, 64K block.	Refer To Text
V4	Bank Control port I/O address. See <u>Bank Control Port Address</u> for special configurations.	(Port EE) a-c - out d - IN e-g - out h - IN
V5	IOEXP select (for Bank Control port). a - Active high. b - Active low. - - Either (both jumpers out).	a - out b - IN
V6	Addressing mode. a - 20-bit (8088) b - 16-bit with bank select. - - 16-bit without bank select (no jumpers).	a - out b - IN

Figure 4-3. 16-bit Address Mode Selection

16-bit Address With 8K Chips

When 16-bit addressing and 8K chips are used the board can hold up to 64K bytes of memory. This can be arranged as one 64K block (with or without bank selection), or two 32K blocks (at the same address) with bank selection. These options are discussed separately below.

64K Bank

When 16-bit addressing with 8K chips will be used in a single 64K block (the most standard configuration) set jumper blocks V2 and V3 as shown below.

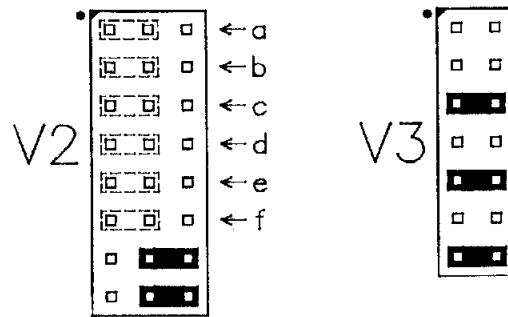
If bank switching is not needed jumpers V2a-f should all be installed (bank zero). Otherwise jumpers V2a-f should be set to select the board for the desired bank number as shown in Figure 4-5. Figure 4-4 details the address of each memory socket on the board.

The Bank Control port is initialized to bank zero when power is applied to the system. This will change only if data is written to the Bank Control port (I/O port EE as shipped). If desired the Bank Control port can be disabled completely. Refer to the Bank Control Port Address section for further details.

This jumper configuration ignores the state of the MEMEX signal in addressing the board. For systems that will use MEMEX, refer to the MEMEX Options section.

Memory Socket							
0	1	2	3	4	5	6	7
0000-	2000-	4000-	6000-	8000-	A000-	C000-	E000-
1FFF	3FFF	5FFF	7FFF	9FFF	BFFF	DFFF	FFFF

Figure 4-4. 8K Chip / 64K Bank Memory Map



V2						Memory Bank	V2						Memory Bank
a	b	c	d	e	f		a	b	c	d	e	f	
X	X	X	X	X	X	00*	-	X	X	X	X	X	20
X	X	X	X	X	-	01	-	X	X	X	X	-	21
X	X	X	X	-	X	02	-	X	X	X	-	X	22
X	X	X	X	-	-	03	-	X	X	X	-	-	23
X	X	X	-	X	X	04	-	X	X	-	X	X	24
X	X	X	-	X	-	05	-	X	X	-	X	-	25
X	X	X	-	-	X	06	-	X	X	-	-	X	26
X	X	X	-	-	-	07	-	X	X	-	-	-	27
X	X	-	X	X	X	08	-	X	-	X	X	X	28
X	X	-	X	X	-	09	-	X	-	X	X	-	29
X	X	-	X	-	X	0A	-	X	-	X	-	X	2A
X	X	-	X	-	-	0B	-	X	-	X	-	-	2B
X	X	-	-	X	X	0C	-	X	-	-	X	X	2C
X	X	-	-	X	-	0D	-	X	-	-	X	-	2D
X	X	-	-	-	X	0E	-	X	-	-	-	X	2E
X	X	-	-	-	-	0F	-	X	-	-	-	-	2F
X	-	X	X	X	X	10	-	-	X	X	X	X	30
X	-	X	X	X	-	11	-	-	X	X	X	-	31
X	-	X	X	-	X	12	-	-	X	X	-	X	32
X	-	X	X	-	-	13	-	-	X	X	-	-	33
X	-	X	-	X	X	14	-	-	X	-	X	X	34
X	-	X	-	X	-	15	-	-	X	-	X	-	35
X	-	X	-	-	X	16	-	-	X	-	-	X	36
X	-	X	-	-	-	17	-	-	X	-	-	-	37
X	-	-	X	X	X	18	-	-	-	X	X	X	38
X	-	-	X	X	-	19	-	-	-	X	X	-	39
X	-	-	X	-	X	1A	-	-	-	X	-	X	3A
X	-	-	X	-	-	1B	-	-	-	X	-	-	3B
X	-	-	-	X	X	1C	-	-	-	-	X	X	3C
X	-	-	-	X	-	1D	-	-	-	-	X	-	3D
X	-	-	-	-	X	1E	-	-	-	-	-	X	3E
X	-	-	-	-	-	1F	-	-	-	-	-	-	3F

* Use bank 00 if bank switching will not be used.
 X = Install jumper in location shown
 - = Remove jumper

Figure 4-5. 8K Chip / 64K Bank Addressing

32K Banks

16-bit addressing with 8K chips can also be configured as two 32K memory banks. In this mode both 32K blocks occupy the same memory space, and switching between them is accomplished with the Bank Control port. To select this mode set jumper blocks V2 and V3 as shown below.

Jumpers V2a-e are used to select the board for the desired banks as shown in Figure 4-6. Jumper V2g is used to select one of the two memory maps detailed in Figure 4-6.

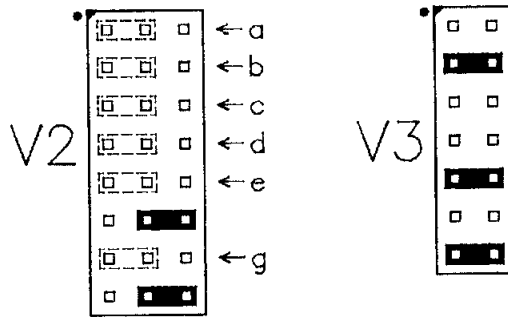
This jumper configuration ignores the state of the MEMEX signal in addressing the board. For systems that will use MEMEX, refer to the MEMEX Options section.

Map#	Memory Socket							
	0	1	2	3	4	5	6	7
	----- Odd Bank -----				----- Even Bank -----			
0*	0000- 1FFF	2000- 3FFF	4000- 5FFF	6000- 7FFF	0000- 1FFF	2000- 3FFF	4000- 5FFF	6000- 7FFF
1*	8000- 9FFF	A000- BFFF	C000- DFFF	E000- FFFF	8000- 9FFF	A000- BFFF	C000- DFFF	E000- FFFF

* Map 0 - V2g installed as shown below.

Map 1 - V2g removed.

Figure 4-6. 8K Chip / 32K Bank Memory Map



V2					32K BANK	
a	b	c	d	e	Memory 0-3	Socket 4-7
X	X	X	X	X	01	00
X	X	X	X	-	03	02
X	X	X	-	X	05	04
X	X	X	-	-	07	06
X	X	-	X	X	09	08
X	X	-	X	-	0B	0A
X	X	-	-	X	0D	0C
X	X	-	-	-	0F	0E
X	-	X	X	X	11	10
X	-	X	X	-	13	12
X	-	X	-	X	15	14
X	-	X	-	-	17	16
X	-	-	X	X	19	18
X	-	-	X	-	1B	1A
X	-	-	-	X	1D	1C
X	-	-	-	-	1F	1E
-	X	X	X	X	21	20
-	X	X	X	-	23	22
-	X	X	-	X	25	24
-	X	X	-	-	27	26
-	X	-	X	X	29	28
-	X	-	X	-	2B	2A
-	X	-	-	X	2D	2C
-	X	-	-	-	2F	2E
-	-	X	X	X	31	30
-	-	X	X	-	33	32
-	-	X	-	X	35	34
-	-	X	-	-	37	36
-	-	-	X	X	39	38
-	-	-	X	-	3B	3A
-	-	-	-	X	3D	3C
-	-	-	-	-	3F	3E

X = Install jumper in location shown
 - = Remove jumper

Figure 4-7. 8K Chip / 32K Bank Addressing