VM2 Embedded Controller Datasheet

Introduction

The VM2 is a small, fast, low current embedded controller intended for

- Intelligent instruments
- Hand-held devices
- Industrial automation
- Process control
- Security systems
- Automatic test equipment (ATE)

and many other applications.

Programmed in *Venom2*, it can immediately handle Analogue and Digital I/O, Graphical User Interfaces, Networking protocols, Data and Text files and a wealth of other functions.

It may also be programmed in C or other languages.

General features

- 32-bit ARM Cortex-M3 microcontroller running at 72MHz
- 1M byte SRAM – battery backed
- 8½M byte Flash for *Venom2* and user application
- TFT Display Controller (*VM2D only*)
- Real Time Clock Calendar
- Watchdog
- Power rail monitor
- Indicator LED
- 3.3V powered
- 5-Volt tolerant on most I/O pins
- Ultra low current consumption
- Scalable speed vs. power

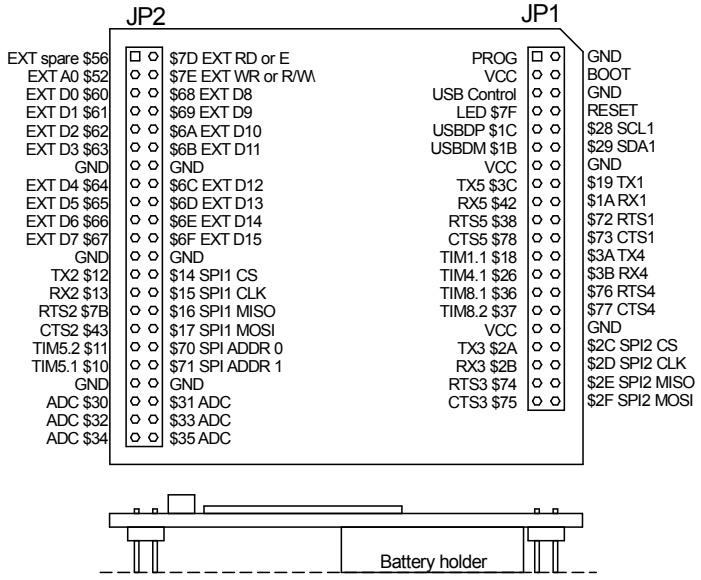
I/O Resources

Not all available at the same time – see tables on later pages

5	**x**	Serial Ports up to 4.5M baud
2	**x**	I^2C Bus
2	**x**	SPI Bus, 18 MHz
1	**x**	CAN Bus
1	**x**	USB (access to Flash Files)
8	**x**	PWM outputs
5	**x**	Pulse capture or count inputs
3	**x**	Shaft encoder channels
19	**x**	12-bit Analogue inputs
2	**x**	12-bit Analogue outputs
65+	**x**	General Purpose Digital I/0

Pin out

This is for VM2/VM2L. Pin out of VM2D appears on page 6



Warning: placing a VM2 (with battery fitted) onto a conducting surface, or otherwise shorting out the battery, may cause the battery to overheat or explode.

The Old Maltings
135 Ditton Walk
Cambridge
CB5 8QB

tel: +44 (0) 1223 523100
fax: +44 (0) 1223 524242
sales@microrobotics.co.uk
www.microrobotics.co.uk

I/O Functions

Each of the I/O pins on the VM2 has a channel number. The table below lists which channels are used for each function. When allocating functions to the channels it's usually best to start with those at the top of this table and work down. Take a copy of the 'I/O Channel Functions' table, provided at the end of this document, and tick off each of the channels as they are allocated.

Note: **VM2D** does not have channels $60-$6F, $52, $56, $7D, $7E, $10 as these pins are used for TFT signals.

Function	Module Number	VM2 Channel numbers used – shown grey if the function is secondary.
Serial ports. *Hardware handshake lines shown in [ ]*	1	$19, $1A, [$72, $73]
	2	$12, $13, [$7B, $43]
	3	$2A, $2B, [$74, $75]
	4	$3A, $3B, [$76, $77]
	5	$3C, $42, [$38, $78]
USB or CAN		$1B, $1C (USB and CAN can't be used at the same time)
I^2C Bus	1	$28, $29
	2	$2A, $2B (can't use Serial 3 if you use this)
SPI Bus (SPI**2** is preferred)	1	$14, $15, $16, $17
	2	$2C, $2D, $2E, $2F, [$70, $71 – two 'address' lines]
1-Wire Bus		$18 (can't use Timer 1 if you use this), [$78 (Also used for CTS5)]
Graphics LCD (VM2)		$60 - $6F; $52, $56, $7D, 7E (parallel bus)
Graphics LCD (VM2D)		$60 - $6F; $52, $56, $7D, 7E are not available; $10 (& Timer 5) not available.
Alpha LCD		$60 - $66 (not available on VM2D)
Ethernet		$2C, $2D, $2E, $2F, $70, $71 (SPI Bus 2), $34 (also used for Analogue)
Pulse counting, Pulse width input Pulse counting on one chan only of each timer.	Timer 1	$18
	Timer 3	$16, $17 (can't use SPI 1 if you use this)
	Timer 4	$26
	Timer 5	$10, $11 (not available on VM2D)
	Timer 8	$36, $37
PWM/Pulse output	Timer 1	$18
	Timer 3	$16, $17 (can't use SPI 1 if you use this)
	Timer 4	$26
	Timer 5	$10, $11 (not available on VM2D)
	Timer 8	$36, $37
Shaft encoder input	Timer 3	$16, $17 (can't use SPI 1 if you use this)
	Timer 5	$10, $11 (not available on VM2D)
	Timer 8	$36, $37
Analogue input		$30 - $35. $10 - $17; $66 - 6A (can't use parallel bus, etc, if you use these ones)
Analogue output		$14 - $15 (can't use SPI 1 if you use this)
Digital IO[1]		All channels may be digital I/O. Most are 5V tolerant ('5VT').

[1] Any requirement for digital I/O that cannot be met on the controller can usually be satisfied by using PCF8574 ICs on an I^2C Bus.

Miscellaneous signals

Note: Please also see the application note Designing VM2 Application Boards *before you design an application board for the VM2.*

VCC & GND These are the 3.3V supply voltage pins. They are marked on the connectors with + and – signs.

Mode Pins

Three pins on JP1 are used to configure the module. In normal use these pins may be left open. You will probably want to provide links or switches on your application board that control the voltage on these pins.

- **PROG** is the Program mode link. If this link is pulled low when the controller starts up then the controller will start in Program mode, rather than running the Venom application.
- **B** is the BOOT link. Pulling this link ***high*** forces the controller into BOOT mode at the next reset. You can then download a new Venom operating system and language, via Serial Port 1, using VenomIDE or other suitable software.
- **USB Control** (Sometimes labelled **DFLT** or similar) is a signal determines whether the USB or the CAN subsystem is to be used; you can't use USB and CANBus at the same time. This signal is also used to control the USB pull up circuit (see Application Board schematics, etc). Pull this signal to GND if you want to use the CAN Bus. Note: the only use for USB currently is to provide external access to Venom's internal Flash Filing System.

TP1 is an unpopulated single pin that can provide backup power to the RAM filing system and RealTimeClock if you can't use the VM2's Lithium battery.

Reset

The RESET signal is an open drain, active low input *and* output, pulled high internally. It may be pulled low by the MCU's internal reset circuit, or the supervisor IC that monitors the supply voltage.

RESET is driven low at power-on, and also if the watchdog times out. It is driven low for a short time (~28uS) when you type *Reset* or *Run* at the command line.

Parallel Bus (synthesised in software; not available on the VM2D)

Ext Bus[D0 - D15] - The data bus.

Ext Bus RD\ or E: The read strobe or bus clock.

Ext Bus WR\ or R/W: The write strobe or read/write.

Ext Bus A0: Address line.

Ext Bus Spare: Spare for now: probably CS\

All of these Bus pins may also be used as simple digital I/O, and some may be used as Analogue inputs.

Electrical Characteristics

Absolute Maximum Ratings

Parameter	*Min*	*Max*	*Unit*
Operating Temperature[2]:	-40[3]	85	C
Supply Voltage (Vcc)	-0.3	4.0	V
Input Voltage (5V tolerant pins)	-0.3	+5.5	V
Input Voltage (other pins)	-0.3	Vcc + 0.3	V

Permissible output currents	*Current*	*Unit*
Max total current into or out of MCU power pins	150	mA
Max source or sink from any I/O pin	25	mA
Max injected current on any pin	5	mA
Max total injected current on all pins	25	mA

Stresses greater than these Absolute Maximum Ratings may cause permanent damage to the device. Functional operation should be restricted to the recommended operating conditions. Exposure to absolute maximum rating conditions may affect reliability.

[2]Some CR2032 Li batteries may have a lower temperature specification than the VM2 controller.

[3] Be aware that condensation can adversely affect the operation of the device by shorting out high impedance circuits.

DC characteristics

Parameter	*Comment*	*Min*	*Typ*	*Max*	*Unit*
VIL		-0.5		0.8	V
VIH		2		Vcc + 0.5	V
VIH (5V tolerant)		2		5.5	V
Schmitt hysteresis		200			mV
Schmitt hysteresis (5VT)		5% Vcc, or 100mV			
Input leakage current				±1	uA
Input leakage current	Vin = 5V: 5V tol pins			3	uA
Internal pull up/down resistor[4]	Vin at opposite rail	30	40	50	KΩ
VOL	8 pins sinking current at same time – 8mA each			0.4	V
VOH	8 pins sourcing current at same time – 8mA each	Vcc-0.4			V
VOL	8 pins sinking current at same time – 20mA each			1.3	V
VOH	8 pins sourcing current at same time – 20mA each	Vcc-1.3			V

ADC and DAC characteristics

Resolution: 12 Bits. The analogue reference voltages are connected to Vcc and Gnd.

Timing

Parameter	*Min*	*Typ*	*Max*	*Unit*
Reset Pulse Width generated by internal ccts		TBA		mS
Reset end until Venom2 *startup* procedure	-	TBA	-	mS

Power consumption

The following table gives measured current consumption figures at different clock speeds[5]. These are approximate.

				Unit
Clock speed[6]	72	48	16	MHz
VM2 idling[7]	19	14	6	mA
VM2 running code	45	32	14	mA
VM2 in Stop[8] Mode	~55	~55	~55	µA

The VM2D's display driver IC adds around 8-10mA to the mA figures above.

Supply Voltage

Parameter	*Min*	*Typ*	*Max*	*Unit*
Power Supply	3.0	3.3	3.6	V
Power Supervisor Reset	2.66	2.78	2.9	V

[4] The internal resistors are true resistors in series with a MOSFET that contributes < 10% of the total resistance.
[5] Processing power decreases with decreasing clock speed, but less than proportionally: 1/3rd clock speed gives better than 1/3rd processing power, due to removal of wait states in the memories.
[6] Clock speed may be changed under program control. See the software manuals.
[7] The controller will *idle* whenever a Venom2 command or object is waiting for an external event or a timed interval. Thus the average current consumption in many applications will tend towards the idle level. See language manuals for more information.
[8] Stop Mode: all internal clocks are stopped but the I/O state and memory contents are retained. The CPU wakes periodically or when defined inputs change state to check if anything needs to be done.

Battery Life (at 25 °C)

Parameter	*Min*	*Typ*	*Max*	*Unit*
Battery voltage for data retention	-	3.0	-	V
Battery Shelf Life	-	10	-	Years
Battery Life, VM2 powered up	Shelf life	-	-	Years
Battery Life, Backing up SRAM and RTC	-	Shelf life	-	Years

When the VM2 is powered up there is no external drain at all on the battery, thus if the unit is used in situations where it is mainly powered then the battery drain will be minimal. If the unit is intended to be stored, unused, for some time then it is recommended that the battery is removed from the holder. Higher ambient temperatures will result in increased battery drain.

The worst-case conditions for short battery life are applications where the unit powers up for short periods between long periods of inactivity in a high ambient temperature environment.

There may be a condition that increases battery drain when the VM2 is 'powered down': if the power rail to the VM2 is goes negative by more than 0.3V then the battery drain may be significantly increased.

Battery

To provide backup power for the Real Time Clock and the external SRAM a Lithium battery may be mounted in the battery holder located on the underside of the board. This holder has specified shock and vibration resistance. The battery type is CR 2032.

Battery replacement

- To remove a battery: lever it out using a small plastic screwdriver blade inserted between the battery and the **battery holder**. Don't lever between the battery and the PCB as this will lift the PCB pads. Avoid using a metal blade as you can easily short out the battery to itself or other parts of the circuit.
- To insert a battery: put one end of the battery under the two fingers of the **+** electrode and then press it into place.

External backup power

If you want to use a different source of backup power, this may be connected via link TP1. You may have to fit a pin into this position. When you are using external backup power the battery is redundant and may be removed. The maximum voltage at TP1 should be 3.6V.

Storage

We recommend that you store VM2s with the battery removed so that no battery discharge takes place.

Also, be careful never to place a VM2 on to a conducting surface as the battery and battery holder both have terminals that could short circuit and discharge the battery quickly, and possibly dangerously.

Examples of conducting surfaces are: metal surfaces, black foam used to protect ICs, and black plastic bags used to protect ICs.

Crystal Oscillator

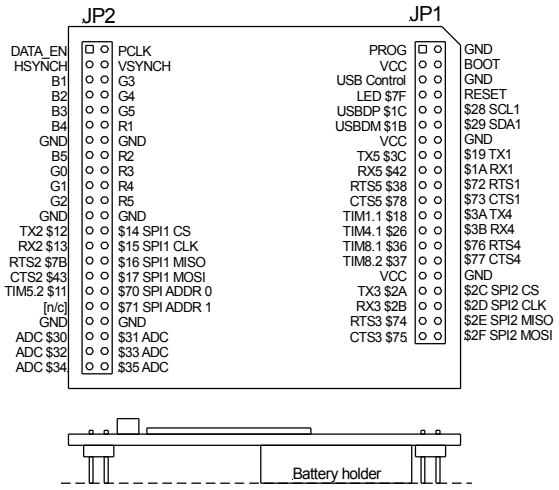
Parameter	*Min*	*Typ*	*Max*	*Unit*
Frequency	-	8.000	-	MHz
Accuracy (25C)	-	-	TBA	ppm
Accuracy (0C to 60C)	-	-	TBA	ppm

VM2D (5907)

The VM2D is a version of the VM2 controller with a built-in TFT Display Controller (EPSON S1D13742).

The EPSON S1D13742 can support resolutions up to 800 x 480 (WVGA) using the standard Venom2 colour format of 16 bits per pixel in RGB 5:6:5 format. The TFT signal levels are at the VM2D's supply voltage, 3.3V.

VM2D Pin out



TFT Signal descriptions

Note: these signals don't have channel numbers because they are not VM2 channels in the usual sense.

Signal name	Description
HSYNCH	The line synch signal that indicates the end of each pixel line's data.
VSYNCH	The frame synch signal that indicates the end of each frame of lines.
DATA_EN	A combined synchronisation signal, combining H and V Synch, as used on many modern TFT displays.
PCLK	The pixel clock
R1-5, G0-5, B1-5	These are the colour data signals, Red, Green and Blue. The higher numbers are the more significant bits of the colour value. For 18 bit per pixel displays, drive the display's R0 and B0 signals with R5 and B5 respectively. For 15 bit per pixel displays, don't use G0.

***VM2D** does not have channels $60-$6F, $52, $56, $7D, $7E, $10 as these pins are used for the TFT signals. Timer 5 is not available as it is used to clock the display driver IC.*

VM2-D2 (5920)

Not yet in full production; Pre-production units are available.

The VM2-D2 is a version of the VM2D controller with an updated display controller (SSD1963) and 2MB of SRAM (double the size). The SSD1963 can support display resolutions up to WVGA and can also drive SVGA displays at reduced size (e.g. 740 x 560). The TFT signal levels are at the VM2-D2's supply voltage, 3.3V.

The VM2-D2 will be able to generate a backlight PWM signal on pin 2.35, which was Chan $10 on the VM2 and n/c on VM2D.

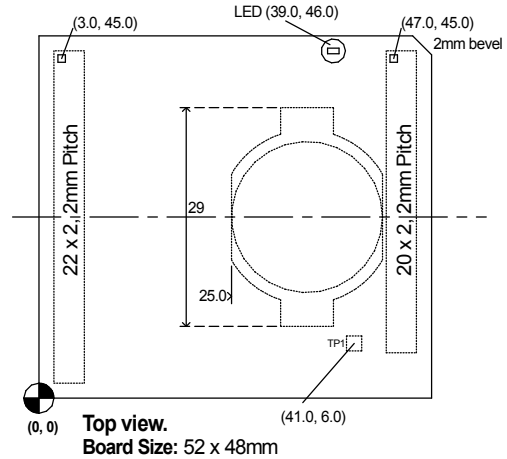
VM2L (5901)

The VM2L is a special version of the VM2 controller with no external SRAM or Flash memories. This makes it lower cost and slightly faster, but also means that it can't perform some of the functions of the rest of the VM2 range:

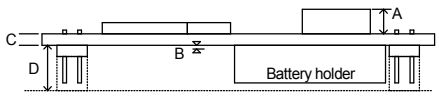
- No filing systems
- No remote firmware update
- No Graphics LCD or Touchscreen

Mechanical

Weight: 18g, including battery.



Top view.
Board Size: 52 x 48mm
All dimentions mm



A: Component height above the board: 4.2mm;
B: Below the board: 0.5mm - not including battery.
C: Board Thickness: 1.6mm
D: Space between PCB and application board: 5.9mm

Note: there are no mounting holes on the VM2. The friction in the connectors is enough to hold it in place in the majority of applications. If you need a more positive retention than this then you will need to design separate mechanical restraints.

Connectors used on VM2 controller series

JP1: Harwin M22-2022005

JP2: Harwin M22-2022205

These are 2mm pitch DIL pin headers, fitted under the board.

Suggested mating parts for Application Boards

JP1: Harwin M22-7142042

JP2: Harwin M22-7142242

Note: Distributors don't always stock the 20x2 and 22x2 parts, in which case it's possible to cut down 25x2 way parts:

Harwin M22-7142542

Farnell 110-9740

RS 605-8718

Ordering Information

Product name	Description	RAM size	Application code size	Product Code
VM2	Standard controller	1M Byte	1M Byte	5900
VM2D	Display Driver option	1M Byte	1M Byte	5907
VM2L	Reduced memory	64K Bytes	64K Bytes	5901

I/O Channel Function

The following table lists the functions that each of the channels can perform. A spreadsheet of this table is available on our website – you can use the spreadsheet sort function to sort the table on any column.

Some signals are limited to the range 0 – 3.3 Volts. Some signals may take 5V inputs. Voltages outside the correct range will damage the VM2 and void the warranty.

Each channel can usually only take one function at a time. Take a copy of this table and use the tick boxes; Tick off channels in the order given by the table on page 2.

VM2 Channel number	Primary Function	Secondary functions	5VT[9]	Connector pin: JPn.m	VM2D Func	☐
$10	Timer 5, Channel 1	Shaft5, Digital I/O, Wakeup, Analogue Input		2.35	[n/c]	
$11	Timer 5, Channel 2	Shaft5, Digital I/O, Analogue Input		2.33		
$12	Serial2 Tx	Analogue Input		2.25		
$13	Serial2 Rx	Analogue Input		2.27		
$14	SPI1 CS\	Analogue input and output		2.26		
$15	SPI1 CLK	Analogue input and output		2.28		
$16	SPI1 MISO	Timer 3, Channel 1; Shaft3; Analogue input		2.30		
$17	SPI1 MOSI	Timer 3, Channel 2; Shaft3; Analogue input		2.32		
$18	Timer 1, Channel 1	1-Wire Bus I/O	Yes	1.23		
$19	Serial1 Tx		Yes	1.16		
$1A	Serial1 Rx		Yes	1.18		
$1B	USB DM	CAN Rx	Yes	1.11		
$1C	USB DP	CAN Tx	Yes	1.09		
$20	PROG MODE			1.01		
$22	BOOT		Yes	1.04		
$26	Timer 4, Channel 1		Yes	1.25		
$28	I2C1 SCL		Yes	1.10		
$29	I2C1 SDA		Yes	1.12		
$2A	Serial3 Tx	I2C2 SCL	Yes	1.33		
$2B	Serial3 Rx	I2C2 SDA	Yes	1.35		
$2C	SPI2 CS\		Yes	1.34		
$2D	SPI2 CLK		Yes	1.36		
$2E	SPI2 MISO		Yes	1.38		
$2F	SPI2 MOSI		Yes	1.40		
$30	Analogue input			2.39		
$31	Analogue input			2.40		
$32	Analogue input			2.41		
$33	Analogue input			2.42		
$34	Analogue input			2.43		
$35	Analogue input			2.44		
$36	Timer 8, Channel 1	Shaft8, Digital I/O	Yes	1.27		
$37	Timer 8, Channel 2	Shaft8, Digital I/O	Yes	1.29		
$38	Serial5 RTS	SDIO D0	Yes	1.19		
$39	USB Control		Yes	1.05		
$3A	Serial4 Tx		Yes	1.24		
$3B	Serial4 Rx		Yes	1.26		
$3C	Serial5 Tx	SDIO CK	Yes	1.15		
$42	Serial5 Rx	SDIO CMD	Yes	1.17		
$43	Serial2 CTS		Yes	2.31		
$52	Ext Bus A0		Yes	2.03	Hsynch	
$56	Ext Bus control spare		Yes	2.01	Data_en	
$60	Ext Bus D0		Yes	2.05	B1	
$61	Ext Bus D1		Yes	2.07	B2	
$62	Ext Bus D2		Yes	2.09	B3	
$63	Ext Bus D3		Yes	2.11	B4	
$64	Ext Bus D4		Yes	2.15	B5	
$65	Ext Bus D5		Yes	2.17	G0	
$66	Ext Bus D6	Analogue input		2.19	G1	

[9] 5VT means 5V Tolerant pin – see DC characteristics.

VM2 Channel number	Primary Function	Secondary functions	5VT	Connector pin: JPn.m	VM2D Func	
$67	Ext Bus D7	Analogue input		2.21	G2	
$68	Ext Bus D8	Analogue input		2.06	G3	
$69	Ext Bus D9	Analogue input		2.08	G4	
$6A	Ext Bus D10	Analogue input		2.10	G5	
$6B	Ext Bus D11			2.12	R1	
$6C	Ext Bus D12			2.16	R2	
$6D	Ext Bus D13			2.18	R3	
$6E	Ext Bus D14			2.20	R4	
$6F	Ext Bus D15			2.22	R5	
$70	SPI Address 0			2.34		
$71	SPI Address 1			2.36		
$72	Serial1 RTS		Yes	1.20		
$73	Serial1 CTS		Yes	1.22		
$74	Serial3 RTS		Yes	1.37		
$75	Serial3 CTS		Yes	1.39		
$76	Serial4 RTS		Yes	1.28		
$77	Serial4 CTS		Yes	1.30		
$78	Serial5 CTS	1-Wire Bus ‘Strong Pull up’ drive	Yes	1.21		
$7B	Serial2 RTS		Yes	2.29		
$7D	Ext Bus RD\ or E		Yes	2.02	Pclk	
$7E	Ext Bus WR\ or RD/WR\		Yes	2.04	Vsynch	
$7F	LED Output			1.07		

Important Notes:

- All channels may be used for digital I/O.
- All channels are high impedance at startup, until your application program configures them differently. If VM2 is driving high impedance inputs, you may need to pull them to a defined state with a high value resistor such as 100K or 1M.
- All unused I/O channels on the VM2 should be defined to some definite state to prevent the pin floating to an undefined logic state, where it will raise the quiescent current of the device: *Input pulled low* is recommended. See system.Low in the Venom2 Help File.
- **VM2D** does not bring out channels $60-$6F, $52, $56, $7D, $7E, $10 as these pins are used for TFT signals. Timer 5 is not available as it is used to clock the display driver IC. On the VM2D the unavailable channels (the Ext Bus) are automatically pulled high when the GraphicsLCD object is created.
- Timers: each timer can do a single Pulse width input, Pulse count input, Shaft input or two PWM outputs. Shaft (quadrature) input, or dual PWM outputs, are only possible if both channel 1 and 2 for a timer are brought out to pins.
- It may not make sense to use some channels in a secondary function due to their use in configuring the controller. Examples are BOOT, Program mode, USB Control, Serial 1: Tx, Rx, RTS, CTS.
- The I2C Bus will need pull up resistors on both SDA and SCL. A value of 4K7 is workable for most applications. The pullups may be connected to any voltage up to the 5V tolerance limit.
- The 1-Wire Bus signals need pull-up resistors. 4K7 is a suitable value for most applications. These pull-ups may need to pull to 5V. The ‘Strong Pull-up’ signal is intended to drive a PMOS transistor gate.
- When the VM2 starts up, Serial Port 1 is configured with no handshaking. This is later reconfigured in the default startup procedure to use hardware handshaking. You can override the default startup procedure.
- It can be very useful to include a simple USB port in your application board design for production programming of VM2/VM2D. (Not VM2L)

Essential further reading

Please also see the application note *Designing VM2 Application Boards* before you design in a VM2.