MICRO ROBOTICS

VM-1 Embedded Controller

5800/5801/5816

VM-1 Embedded Controller Datasheet

Introduction

The VM-1 is a credit-card-sized embedded controller intended for

- Intelligent instruments
- Hand-held devices
- Industrial automation
- Process control
- Security systems

and many other applications.

Coupled with the royalty-free *Venom-SC* programming language, it can handle Analogue and Digital I/O, Graphical User Interfaces, Communications protocols, Data and Text files and a wealth of other functions.

Power requirements

5V, 20 to 80 mA depending on activity level

CPU resources

- 16-bit Hitachi H8S processor running at 16MHz
- 128K or 512K RAM – battery backed
- 512K Flash (supplied separately) for *Venom-SC* and user application
- Optional PCF8583 Real Time Clock Calendar; alarm signal available
- Watchdog/Supervisor
- Indicator LED
- Program mode switch
- Baud rate / User switch

Variations

There are two RAM sizes: 128K and 512K bytes (product codes 5800 & 5801).

The *VM-1e* (Product code 5516) has an extra 512K Flash on board for larger user applications. It has 512K RAM.

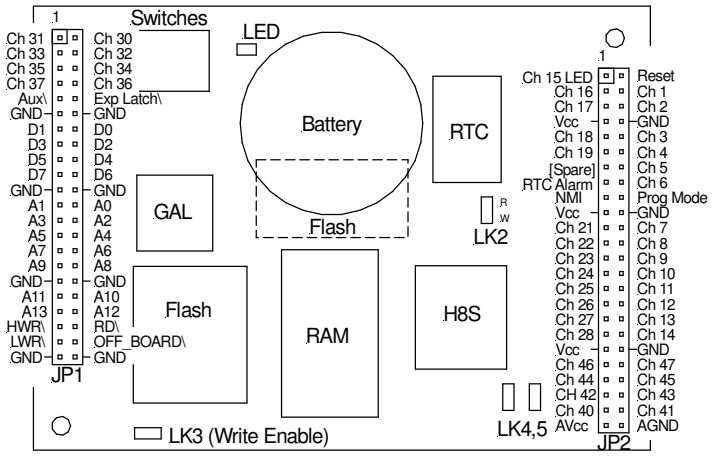
Variants with lower clock speeds are available to special order, for extra low current consumption.

I/O Resources

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

2	**x**	Serial Ports up to 38,400bd Async; 250Kbd Synch
1	**x**	Software serial port up to 9600bd.
2	**x**	I^2C Bus [Master only]
1	**x**	SPI Bus
1	**x**	Dallas 1-Wire bus (for ***iButtons*** etc.)
10	**x**	Pulse I/0 Channels (6 PWM, 4 Pulse counting…)
2	**x**	Quadrature shaft encoder inputs
8	**x**	10-bit Analogue inputs
2	**x**	8-bit Analogue outputs
42	**x**	Digital I/0
1	**x**	Alarm output for Zero Power mode

Pinout



LK1 is a pad under the board in issue D on.

.

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

Switches

There are two switches on the controller.
Switch 1 is the program mode switch. If this is in the PRG position, then the controller will start in Program mode, rather than running the user application. Moving this switch after power on will cause the controller to restart in the new mode.
Switch 2 is the baud rate and user switch. In Program mode it determines the baud rate on serial port 1 (either 9600 or 38,400). In run mode (and after the Clear Memory message in program mode) it may be used by the user application.

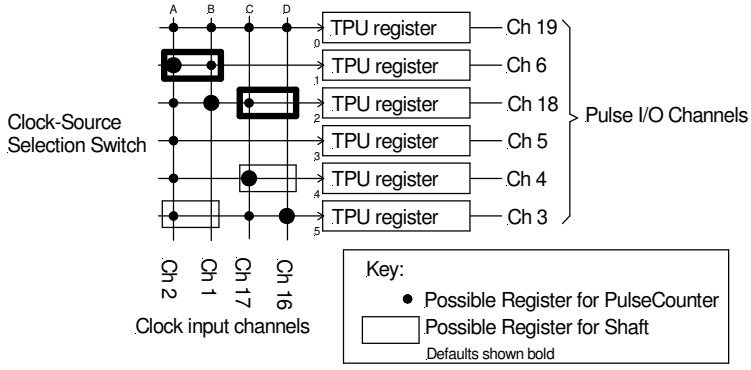
I/O Functions

Here is a list of channels that can perform each of the I/O functions. 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: Using Quadrature Shaft Encoder and Pulse Counting inputs will restrict the channels available for Pulse Width I/O. See the next section for details.

Function	*Channels*
Module Addressing (Ethernet, QVGA)	30-37
Serial ports	Port 1: 11 – 14; Port 2: 25 – 28; Port 3: 5 & 6
I^2C Buses	Bus 1: 9 & 10; Bus 2: 23 & 24
SPI Bus	7, 8, 21, 22
Dallas 1-Wire bus[1]	3, [4]
'Module' Selects/Addresses	30 – 37
Graphics LCD[2]	30 – 37
Alpha LCD	30 – 37
Quadrature shaft encoder	1 & 2; 16 & 17
Pulse Counting	1, 2, 16, 17
Pulse Width I/O	3 – 6; 18,19 *(5 & 19 are the fastest)*
8-bit analogue output	46, 47
10-bit analogue input	40 – 47
Digital input only	1, 2, 19, 21, 40 – 47
Digital output only	15 (*the LED*)
Digital IO	3 – 12; 16 – 18; 22 – 28; 30 - 37

Relating Clock and Pulse I/O (Only read this if you are using lots of pulse I/O)

Each *PulseCounter* or *Shaft* object created uses a counter/timer register from the processor's internal *TPU* module to hold its count value. This means that a pulse I/O object[3] can't use the register. The diagram shows which registers a *Shaft* or *PulseCounter* may use, and consequently, which channels pulse I/O is not available on. These channels are still available for non-pulse functions such as *Digital*.



[1] The Dallas 1-Wire bus needs a pull-up resistor to 5V on the data line (channel 3) of nominally 5K. It may also need a p-channel MOSFET gated by channel 4 if the high-current pull-up feature is required.
[2] The Graphics LCDs supported may also use latch-write lines, which don't have channel numbers, and possibly the address, data and control buses. Extra circuits will also be needed to latch control signals and provide a negative bias voltage. These circuits are provided on some application boards. Please contact Micro-Robotics Ltd for more details.
[3] Such as *PulseWidthOut*, *PulseWidthIn, FrequencyIn, AsynchronousSerial (port3).*

Links

See the pin out diagram for the positions of the links. On VM-1e, LK1 is a pad on the bottom of the board.
LK1 is the 'battery freshness' link. If you power up the board for longer than 50mS while this link is made (even if the link is removed while power is on), then when you power down the battery will be disconnected from the RAM and Real Time Clock.
The controller should not be powered for long periods with LK1 made.
Don't make LK1 too early, as the battery drain is very high (~250uA) when the power is off.
Recommended sequence: make LK1, power up for >50mS, power down, unmake LK1.

LK2 provides test points for measuring the watchdog input and reset signals.

LK3 is the write-enable link for the flash memory. This must be linked in order to write or erase user applications in the flash. It may be removed to avoid the small risk of the application being erased in the field.

LK4 links Analogue GND to Digital GND, and LK5 links Analogue Vcc to Digital Vcc. They are pre-linked with copper traces on the underside of the board. If you need to keep the analogue and digital supplies separate on the board then the traces may be cut.

Miscellaneous signals

Reset

The Reset signal is an active low output (pin JP2.2). Reset is driven by the supervisor IC that monitors supply voltage and processor activity (the watchdog). If you intend to connect it to more than a couple of CMOS inputs then you should buffer it. On issue C boards and later, the Reset pin is decoupled from the supervisor IC by 10KΩ.
Reset is driven low at power-on, and also if the watchdog times out. It is not necessarily driven low when you type *Reset* or *Run* at the command line.

Prog Mode

This is an active low input in parallel with the Program Mode switch (pin JP2.18). You may connect this pin to ground to force the VM-1 into program mode if you don't have physical access to the switch. It is pulled high by 100K or to GND by the switch.

NMI

This is the Non-Maskable Interrupt pin (pin JP2.17). It is unlikely you will need to use it. It is pulled high by 100K.

Processor Bus:

D[0-7] - The 8-bit data bus.
A[0-13] - Some lower order address lines.
HWR\ - The processor High Byte write signal – used for all 8-bit accesses.
LWR\ - The processor Low Byte write signal – not used currently.
RD\ - The processor read signal.
Exp Latch\ - used to clock an expansion latch for graphics LCD; at address $414000.
Aux\ - this can clock a latch at address $410000.
OFF_BOARD\ - an address decode signal for addresses $600000 - $7FFFFF.

RTC Alarm

This is the PCF8583 Clock-Calendar Alarm output (open drain). The alarm output may be used control the power supply to the VM-1 application. This allows the application to 'sleep' consuming zero power, waking when the alarm output is activated. The alarm may be set using the SleepUntil message of the RealTimeClock object. Please see our website[4] for suitable circuit designs.

[4] Try www.microrobotics.co.uk/docs/pdf/sleep.pdf

Electrical

Absolute Maximum Ratings

Parameter	*Min*	*Max*	*Unit*
Operating Temperature:	0	70	C
Supply Voltage (Vcc)	-0.3	6	V
Analogue Supply Voltage (Avcc)	-0.3	7	V
Input Voltage	-0.3	Vcc + 0.3	V
Analogue Input & Ref Voltage	-0.3	AVcc + 0.3	V
Real Time Clock Alarm Output	-0.8	7	V

Permissible output currents	*Current*	*Unit*
Ch 19, 21, 2, 1,6, 17, 18, 16; per channel	10	mA
Low, all other channels; per channel	2.0	mA
Low, total output current	120	mA
High, all channels, per channel	2.0	mA
High, total output current	40	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.

DC characteristics

Parameter	*Comment*	*Min*	*Typ*	*Max*	*Unit*
Schmidt input Vt-	Ch 3, 4, 5, 7, 8, 9, 10, 11, 22, 23, 24, 25, 34, 35	1.0	-	-	V
Vt+		-	-	Vcc x 0.7	V
Hysteresis		0.4	-	-	V
Input High Voltage	Ch 20 (NMI)	Vcc - 0.7	-	Vcc + 0.3	V
	Ch 40-47	2.0	-	Avcc + 0.3	V
	Other Ch (not Schmidt)	2.0	-	Vcc + 0.3	V
Input Low Voltage	All Ch (not Schmidt)	-0.3	-	0.8	V
Output High @ -200uA	All Ch, not Ch15	Vcc - 0.5	-	-	V
Output High @ -1mA	All Ch, not Ch15	3.5	-	-	V
Output Low @ 1.6mA	All Ch, not Ch15	-	-	0.4	V
Output Low @ 10mA	Ch 19, 21, 2, 1,6, 17, 18, 16	-	-	1.0	V
Input Leakage Current	Ch 14, 40 - 47	-	-	1.0	µA
Pull-up	All Ch. But those below	95	-	105	KΩ
Pull-up	Ch 9	9.5	-	10.5	KΩ
Pull-down	Ch 11, 25	95	-	105	KΩ
No pull-up	Ch 14, 40 - 47	-	-	-	-
Pull up: current source[5]	Ch 30 - 37	50	-	300	µA
ADC source impedance	Ch 40 - 47	-	-	5	KΩ
DAC resistive load	Ch 46, 47 (1 LSB accuracy)	4	-	-	MΩ

[5] This may be switched off.

Timing

[Bus timing: To be determined – in the mean time refer to Hitachi Data Book for H8S2340. Signals AUX_SEL & EXP_LATCH_SEL are generated from combining the address bus and HWR in a 15nS PLD. Connect them to a +Ve clock to interface output latches to the data bus.]

Flash: use 29F040B (**70nS**) from either AMD or ST.

Parameter	*Min*	*Typ*	*Max*	*Unit*
Reset Pulse Width	140	200	280	mS
Reset end until Venom-SC *startup* procedure	-	20	-	mS

Crystal Oscillator

Parameter	*Min*	*Typ*	*Max*	*Unit*
Frequency	-	16.000	-	MHz
Accuracy (25C)	-	-	[TBA]	ppm
Accuracy (0C to 60C)	-	-	[TBA]	ppm

Battery Life (at 25 °C)

Parameter	*Min*	*Typ*	*Max*	*Unit*
Battery voltage for data retention	2.6	3.0	-	V
Battery Shelf Life	-	10	-	Years
Battery Life, Battery freshness enabled	Shelf life	-	-	Years
Battery Life, VM-1 powered up	Shelf life	-	-	Years
Battery Life, Backing up RAM	3.0	Shelf life	-	Years
Battery Life, RAM & Clock	2.5	Shelf life	-	Years

When the VM-1 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 Freshness is enabled. Higher ambient temperatures will result in increased battery drain.
The worst-case conditions for short battery life are applications involving the Real Time Clock where the unit powers up for short periods between long periods of inactivity in a high ambient temperature environment.
There is an obscure condition that increases battery drain when the VM-1 is 'powered down', whether in battery freshness mode or not: if the power rail to the VM-1 is goes negative by more than 0.3V then the battery drain is significantly increased. This has happened when an RS232 handshake input is linked to Vcc by a 'pull-up' resistor when the handshake is in the negative state.

Power consumption

The following table gives measured current consumption figures.

	16MHz Clock Crystal (normal)	4MHz Clock Crystal (special)
VM-1idling	18 – **20** mA	6 mA
VM-1 running code	45 – **83** mA	13 – 24 mA

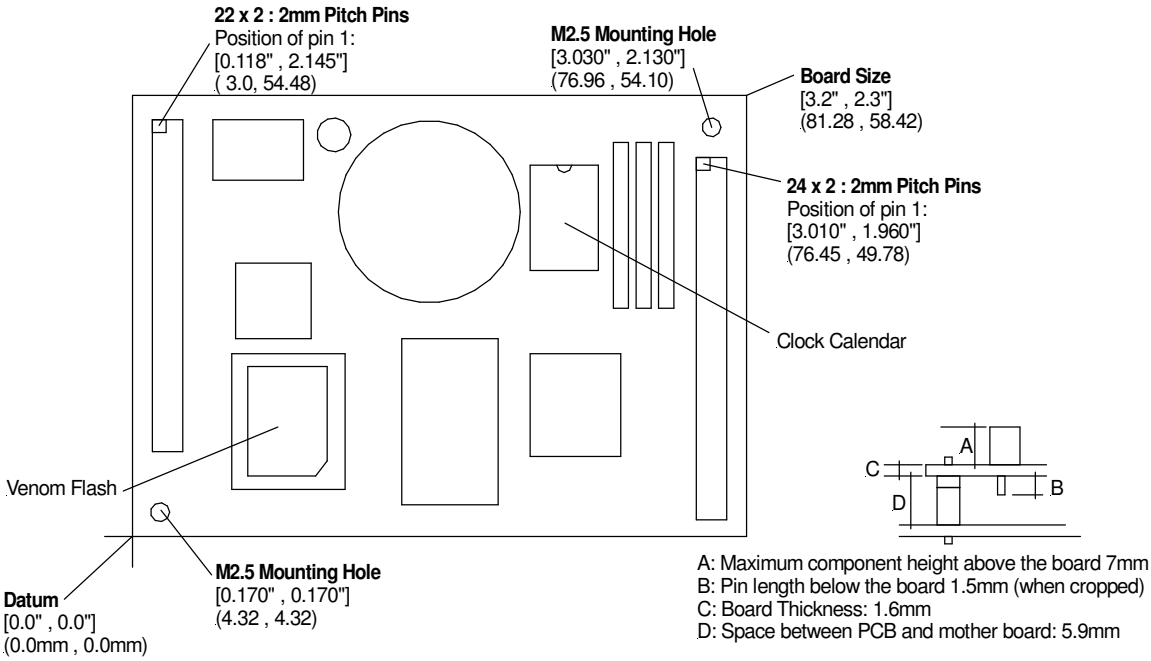
The controller will *idle* whenever a Venom-SC command or object is waiting for an external event or a timed interval. Thus the average current consumption in many applications will tend towards the idle level. See language manuals for more information.
The spread in current values reflects the different current consumption figures for *Programmable Logic Devices* from different manufacturers fitted to the VM-1.
It is possible to order special variants of the VM-1 with clock crystals at other frequencies. The table shows the current figures for a 4MHz device. When running at 4MHz, everything runs four times slower apart from the Real Time Clock. This covers the Serial Ports, Task swap timing and WAITs etc.

Supply Voltage

Parameter	*Min*	*Typ*	*Max*	*Unit*
Power Supply	4.75	5.0	5.5	V
Power Supervisor Reset	4.50	4.65	4.75	V

Mechanical

Weight: 33g



(Dimensions in millimetres) [Dimensions in inches]

IC Sockets

There are two sockets on the VM-1. One is for the Venom system flash memory and the other is for the PCF8583 Real Time Clock / Calendar IC.

You might damage these ICs if they are inserted incorrectly.

Venom Flash

To insert the Venom Language flash, place the device on top of the socket making sure the corner cut-outs on the IC and the socket are aligned. Press it firmly in place.
To remove the Venom Language flash, use the correct extractor tool (supplied in the VM-1 Starter Kit): put the two prongs of the extractor down the two slots in the socket and squeeze firmly.
If you want to buy and program your own flash devices then use **29F040B** (70nS[6]) from either AMD or ST.

Clock Calendar

To insert the Clock/Calendar IC, position it above the 8-way 'socket pins' labelled U4. Make sure the notch for pin 1 is aligned with the legend on the board. Make sure all the legs are in their matching hole and press it firmly into place.
To remove it, use a plastic screwdriver or similar to gently lever it up and out a little at a time from each end.

[6]70nS flash devices are normally specified for VM-1. We have checked the specification for 90nS devices from AMD and ST: these are both OK to use in the VM-1 for reading (i.e. running code); we have not checked the specs for writing (i.e 'Protecting' code) at this time, but have seen no problems.

I/O Channel Functions

The following table lists the functions that each of the channels can perform.

All signals are in the range 0 – 5 Volts. Voltages outside this range will damage the VM-1 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.
Channels 29, 38, 39 don't exist.

Channel	❑	Functions – only one at a time	Pinout
1	❑	Digital **Input** (pulled high 100K)	4 (JP2)
	❑	Shaft 1B	
	❑	Pulse Counting	
2	❑	Digital **Input** (pulled high 100K)	6 (JP2)
	❑	Shaft 1A	
	❑	Pulse Counting	
3	❑	Digital I/O (pulled high 100K)	10 (JP2)
	❑	Pulse I/O	
	❑	Dallas 1-Wire bus data line **NB: pull up needed, nom. 4K7**	
4	❑	Digital I/O (pulled high 100K)	12 (JP2)
	❑	Pulse I/O	
	❑	Dallas 1-Wire bus active pull-up control	
5	❑	Digital I/O (pulled high 100K)	14 (JP2)
	❑	Pulse I/O	
	❑	Serial Port 3: Tx ('software serial')	
6	❑	Digital I/O (pulled high 100K)	16 (JP2)
	❑	Pulse I/O	
	❑	Serial Port 3: Rx ('software serial')	
7	❑	Digital I/O (pulled high 100K)	22 (JP2)
	❑	SPI Dout	
8	❑	Digital I/O (pulled high 100K)	24 (JP2)
	❑	SPI CS\	
	❑	[WAIT\ signal]	
9	❑	Digital I/O (pulled high ***10K***)	26 (JP2)
	❑	I2C Bus 1: SDA	
10	❑	Digital I/O (pulled high 100K)	28 (JP2)
	❑	I2C Bus 1: SCL	
11	❑	Digital I/O (pulled ***low*** 100K)	30 (JP2)
	❑	Serial Port 1: Handshake Input	
12	❑	Digital I/O (pulled high 100K)	32 (JP2)
	❑	Serial Port 1: Handshake Output	
13	❑	Serial Port 1: RX (pulled high 100K)	34 (JP2)
14	❑	Serial Port 1: TX ***(not pulled)***	36 (JP2)
15	❑	LED Signal (Pulled High by LED and 3K3)	1 (JP2)
16	❑	Digital I/O (pulled high 100K)	3 (JP2)
	❑	Shaft 2B	
	❑	Pulse Counting	
17	❑	Digital I/O (pulled high 100K)	5 (JP2)
	❑	Shaft 2A	
	❑	Pulse Counting	
18	❑	Digital I/O (pulled high 100K)	9 (JP2)
	❑	Pulse I/O	
19	❑	Digital **Input** (pulled high 100K)	11 (JP2)
	❑	Pulse I/O / FrequencyIn	
20	❑	NMI (pulled high 100K)	17 (JP2)
21	❑	Digital **Input** (pulled high 100K)	21 (JP2)
	❑	SPI Din	
22	❑	Digital I/O (pulled high 100K)	23 (JP2)
	❑	SPI CLK	
23	❑	Digital I/O (pulled high 100K)	25 (JP2)
	❑	I2C Bus 2: SDA **NB: pull up needed, nom. 10K**	
24	❑	Digital I/O (pulled high 100K)	27 (JP2)
	❑	I2C Bus 2: SCL	
25	❑	Digital I/O (pulled ***low*** 100K)	29 (JP2)
	❑	Serial Port 2: Handshake Input	

Channel	❑ Functions – only one at a time	Pinout
26	❑ Digital I/O (pulled high 100K) ❑ Serial Port 2: Handshake Output ❑ Data Direction for RS485 on serial port 2	31 (JP2)
27	❑ Serial Port 2: RX ❑ Digital I/O (pulled high 100K)	33 (JP2)
28	❑ Serial Port 2: TX ❑ Digital I/O (pulled high 100K)	35 (JP2)
30	❑ Digital I/O (Default Internal pull up 50 - 300µA) ❑ Alpha LCD: D4 ❑ GLCD D0 ❑ Intra-module address A14	2 (JP1)
31	❑ Digital I/O (Default Internal pull up 50 - 300µA) ❑ Alpha LCD: D5 ❑ GLCD D1 ❑ Intra-module address A15	1 (JP1)
32	❑ Digital I/O (Default Internal pull up 50 - 300µA) ❑ Alpha LCD: D6 ❑ GLCD D2 ❑ Intra-module address A16	4 (JP1)
33	❑ Digital I/O (Default Internal pull up 50 - 300µA) ❑ Alpha LCD: D7 ❑ GLCD D3 ❑ Intra-module address A17	3 (JP1)
34	❑ Digital I/O (Default Internal pull up 50 - 300µA) ❑ Alpha LCD: RS ❑ GLCD D4 ❑ Module select 0	6 (JP1)
35	❑ Digital I/O (Default Internal pull up 50 - 300µA) ❑ Alpha LCD: R/W ❑ GLCD D5 ❑ Module select 1	5 (JP1)
36	❑ Digital I/O (Default Internal pull up 50 - 300µA) ❑ Alpha LCD: E ❑ GLCD D6 ❑ Module select 2	8 (JP1)
37	❑ Digital I/O (Default Internal pull up 50 - 300µA) ❑ Alpha LCD: Select driver: used in some 4-line displays ❑ GLCD D7 ❑ Module select 3	7 (JP1)
40	❑ 10-bit analogue input ❑ Digital input ***(not pulled)***	45 (JP2)
41	❑ 10-bit analogue input ❑ Digital input ***(not pulled)***	46 (JP2)
42	❑ 10-bit analogue input ❑ Digital input ***(not pulled)***	43 (JP2)
43	❑ 10-bit analogue input ❑ Digital input ***(not pulled)***	44 (JP2)
44	❑ 10-bit analogue input ❑ Digital input ***(not pulled)***	41 (JP2)
45	❑ 10-bit analogue input ❑ Digital input ***(not pulled)***	42 (JP2)
46	❑ 10-bit analogue input ❑ 8-bit analogue output ❑ Digital input ***(not pulled)***	39 (JP2)
47	❑ 10-bit analogue input ❑ 8-bit analogue output ❑ Digital input ***(not pulled)***	40 (JP2)