7I98 ETHERNET ANYTHING I/O MANUAL

Version 1.0

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GENERAL

DESCRIPTION

The MESA 7I98 is a low cost, general purpose, FPGA based programmable I/O card intended for motion control appications and with a 100 BaseT Ethernet host connection. The 7I98 that uses standard parallel port pinouts and connectors for compatibility with most parallel port interfaced motion control / CNC breakout cards/ multi axis step motor drives, allowing a motion control performance boost while retaining a reliable real time Ethernet interface. Unlike the parallel port that the 7I98 replaces, each I/O bit has individually programmable direction and function.

The 7I98 has a simplified UDP host data transfer systems that allows operation in real time and compatibility with standard networks. The 7I98 provides 3 parallel port compatible I/O ports with a total of 51 I/O bits (17 per connector). All I/O bits are 5V tolerant and have selectable pull-up or pull-down resistors. A power source option allows the 7I98 to supply 5V power to breakout boards if desired. This 5V power is protected by per connector PTCs.

Firmware modules are provided for hardware step generation, quadrature encoder counting, PWM generation, digital I/O, Smart Serial remote I/O, BISS, SSI, SPI, UART interfaces and more. Configurations are available that are compatible with common breakout cards and multi axis step motor drives like the Gecko G540 and Leadshine MX3660. All motion control firmware is open source and easily modified to support new functions or different mixes of functions.

There are currently nine 7I98 compatible breakout cards available from Mesa, the 7I74 through 7I78 and 7I85, 7I85S, 7I88 and 7I89. The7I98 supports three breakout cards.

HARDWARE CONFIGURATION

GENERAL

Hardware setup jumper positions assume that the 7I98 card is oriented in an upright position, that is, with the Ethernet connector towards the left and the I/O connectors towards the right.

CONNECTOR 5V POWER

The 7I98 has the option to supply 5V power to the breakout board. This option is used by all Mesa breakout boards to simplify wiring. The option uses 4 parallel cable signals that are normally used as grounds for supplying 5V to the remote breakout board (DB25 pins 22,23,24 and 25). These pins are AC bypassed on both the 7I98 and Mesa breakout cards so do not compromise AC signal integrity. The 5V power option is individually selectable for each of the three I/O connectors. The breakout 5V power is protected by per connector PTC devices so will not cause damage to the 7I98 or system if accidentally shorted. This option should only be enabled for Mesa breakout boards or boards specifically wired to accept 5V power on DB25 pins 22 through 25.

JUMPER	POS	FUNCTION
W3,W7,W12	UP	Breakout power enabled (P1,P2,P3)
W3,W7,W12	DOWN	Breakout power disabled (P1,P2,P3) (Default)

5V I/O TOLERANCE

The FPGA used on the 7I98 has a 4V absolute maximum input voltage specification. To allow interfacing with 5V inputs, the 7I98 has bus switches on all I/O pins. The bus switches work by turning off when the input voltage exceeds a preset threshold. *The 5V I/O tolerance option is the default and should normally be left enabled.*

For high speed applications where only 3.3V maximum signals are present, the 5V I/O tolerance option can be disabled. When 5V tolerance mode is enabled the I/O pullup resistor source is 5V. When 3.3V tolerance mode is selected, the I/O pull-up resistor source is 3.3V.

JUMPER	POS	FUNCTION
W1,W5,W10	UP	5V Tolerance enabled (P1,P2,P3) (Default)
W1,W5,W10	DOWN	5V Tolerance disabled (P1,P2,P3)

HARDWARE CONFIGURATION

PULL-UP/PULL-DOWN SELECTION

Each I/O connector on the 7I98 can have its I/O termination resistors set to pull-up or pull-down mode. These resistors set the I/O voltage level when the pins are not driven by the FPGA. For Mesa daughtercards, the option should always be set for pull-up mode.

It may be desirable with some parallel port type breakout boards to choose the pull-down mode, so that the FPGA outputs are in the low state at power up.

JUMPER	POS	FUNCTION
W2,W6,W11	UP	Pull-up mode (P1,P2,P3) (Default)
W2,W6,W11	DOWN	Pull-down mode (P1,P2,P3)

IP ADDRESS SELECTION

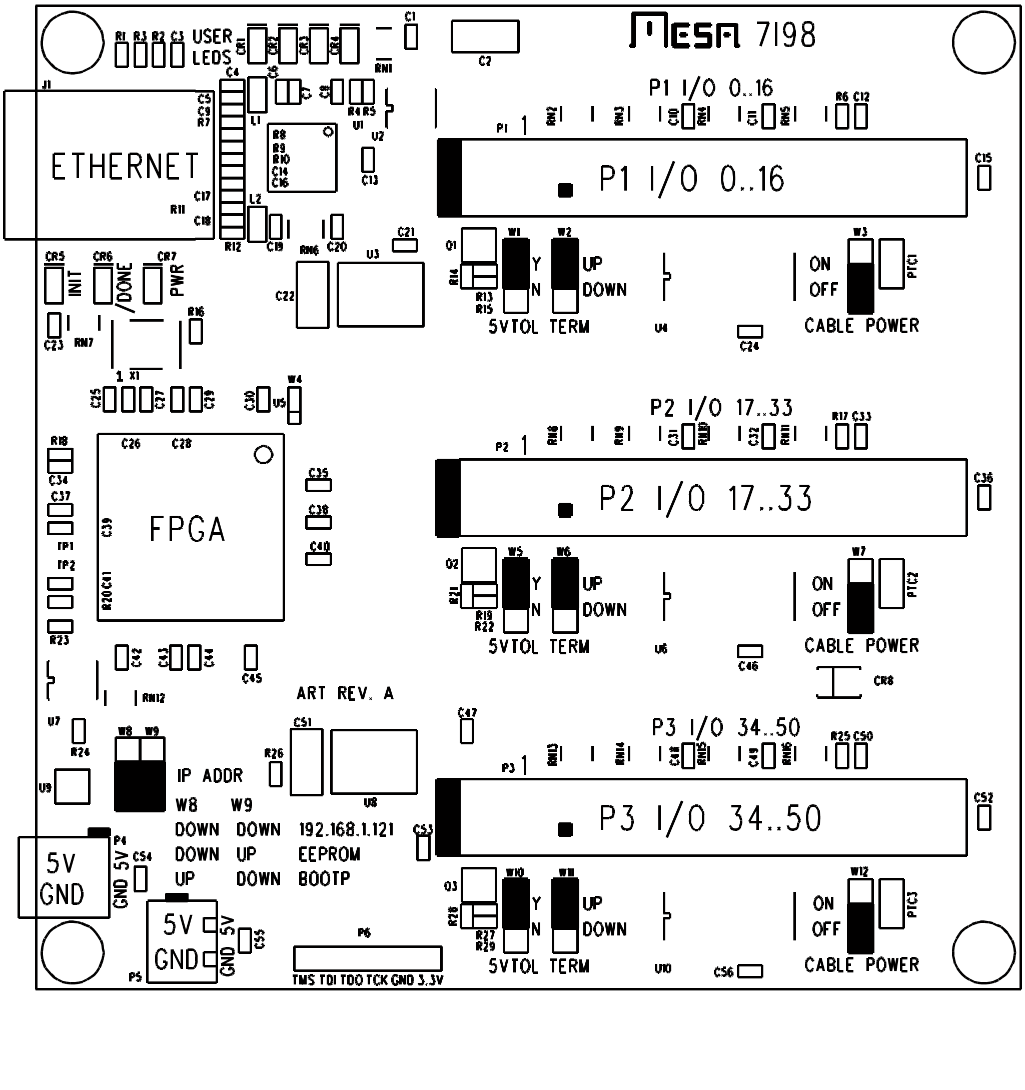
The 7I98 has three options for selecting its IP address. These options are selected by Jumpers W8 and W9.

W8	W9	IP ADDRESS	
DOWN	DOWN	FIXED 192.168.1.121	(DEFAULT)
DOWN	UP	FIXED FROM EEPROM	
UP	DOWN	BOOTP	
UP	UP	INVALID	

Note that the default (as shipped) EEPROM IP address is 10.10.10.10, but this can be changed by the user.

CONNECTORS

CONNECTOR LOCATIONS AND DEFAULT JUMPER POSITIONS



CONNECTORS

I/O CONNECTORS

The 7I98 has 3 I/O connectors, P1 through P3. Each I/O connector is a 26 pin header with ejector/latch. In addition to the header pin-out, the equivalent DB25 pin-out is listed since the 7I98 I/O cables will often be terminated with DB25 connectors.7I98 I/O connector pin-outs are as follows:

P1 FIRST I/O CONNECTOR PIN-OUT

HDR26 PIN	DB25 PIN	FUNCTION	HDR26 PIN	DB25 PIN	FUNCTION
1	1	IO0	2	14	IO1
3	2	IO2	4	15	IO3
5	3	IO4	6	16	IO5
7	4	IO6	8	17	IO7
9	5	IO8	10	18	GND
11	6	IO9	12	19	GND
13	7	IO10	14	20	GND
15	8	IO11	16	21	GND
17	9	IO12	18	22	GND or 5V
19	10	IO13	20	23	GND or 5V
21	11	IO14	22	24	GND or 5V
23	12	IO15	24	25	GND or 5V
25	13	IO16	26	XX	GND or 5V

CONNECTORS

I/O CONNECTORS

P2 FIRST SECOND CONNECTOR PIN-OUT

HDR26 PIN	DB25 PIN	FUNCTION	HDR26 PIN	DB25 PIN	FUNCTION
1	1	IO17	2	14	IO18
3	2	IO19	4	15	IO20
5	3	IO21	6	16	IO22
7	4	IO23	8	17	IO24
9	5	IO25	10	18	GND
11	6	IO26	12	19	GND
13	7	IO27	14	20	GND
15	8	IO28	16	21	GND
17	9	IO29	18	22	GND or 5V
19	10	IO30	20	23	GND or 5V
21	11	IO31	22	24	GND or 5V
23	12	IO32	24	25	GND or 5V
25	13	IO33	26	XX	GND or 5V

CONNECTORS

I/O CONNECTORS

P3 THIRD I/O CONNECTOR PIN-OUT

HDR26 PIN	DB25 PIN	FUNCTION	HDR26 PIN	DB25 PIN	FUNCTION
1	1	IO34	2	14	IO35
3	2	IO36	4	15	IO37
5	3	IO38	6	16	IO39
7	4	IO40	8	17	IO41
9	5	IO42	10	18	GND
11	6	IO43	12	19	GND
13	7	IO44	14	20	GND
15	8	IO45	16	21	GND
17	9	IO46	18	22	GND or 5V
19	10	IO47	20	23	GND or 5V
21	11	IO48	22	24	GND or 5V
23	12	IO49	24	25	GND or 5V
25	13	IO50	26	XX	GND or 5V

CONNECTORS

POWER CONNECTOR PINOUT

P5 is the 7I98s power connector. P5 is a 3.5MM plug-in screw terminal block. P1 pinout is as follows:

PIN	FUNCTION	
1	+5V	TOP, SQUARE PAD
2	GND	BOTTOM, ROUND PAD

JTAG CONNECTOR PINOUT

P6 is a JTAG programming connector. This is normally used only for debugging or if both EEPROM configurations have been corrupted. In case of corrupted EEPROM contents the EEPROM can be re-programmed using Xilinx's Impact tool.

P6 JTAG CONNECTOR PINOUT

PIN	FUNCTION
1	TMS
2	TDI
3	TDO
4	TCK
5	GND
6	+3.3V

OPERATION

FPGA

The 7I98 use a Xilinx Spartan6 FPGA in a 144 lead QFP package: XC6SLX9–2TQG144C.

IP ADDRESS SELECTION

Initial communication with the 7I98 requires knowing its IP address. The 7I98 has 3 IP address options: Default, EEPROM, and Bootp, selected by jumpers W1 and W2. Default IP address is always 192.168.1.121. The EEPROM IP address is set by writing Ethernet EEPROM locations 0x20 and 0X22. BootP allows the 7I98 address to be set by a DHCP/ BootP server. If BootP is chosen, the 7I98 will retry BootP requests at a ~1 Hz rate if the BootP server does not respond.

HOST COMMUNICATION

The 7I98 standard firmware is designed for low overhead real time communication with a host controller so implements a very simple set of IPV4 operations. These operations include ARP reply, ICMP echo reply, and UDP packet receive/send for host data communications. UDP is used so that the 7I98 can be used on a standard network with standard tools for non-real time applications. No fragmentation is allowed so maximum packet size is 1500 bytes.

UDP

All 7I98 data communication is done via UDP packets. The 7I98 socket number for UDP data communication is 27181. Read data is routed to the requesters port number. Under UDP, a simple register access protocol is used. This protocol is called LBP16.

LBP16

LBP16 allows read and write access to up to eight separate address spaces with different sizes and characteristics. Current firmware uses seven of these spaces. For efficiency, LBP16 allows access to blocks of registers at sequential increasing addresses. (Block transfers)

WINDOWS ARP ISSUES

The Windows TCP stack on older windows versions has a characteristic that causes it to drop outgoing UDP packets when refreshing its ARP cache. Because of this you must either verify packet transmission via echoing data from the 7I98 for every transaction (reading RXUDPCount is suggested) and retrying failed transactions, or alternatively, setting up a static entry for the 7I98 in the ARP table. This is done with windows ARP command.

OPERATION

CONFIGURATION

The 7I98 is configured at power up by a SPI FLASH memory. This flash memory is an 16M bit chip that has space for two configuration files. Since all Ethernet logic on the 7I98 is in the FPGA, a problem with configuration means that Ethernet access will not be possible. For this reason there is a backup method to recover from FPGA boot failures.

FALLBACK

The backup system is called Fallback. The 7I98 flash memory normally contains two configuration file images, A user image and a fallback image. If the primary user configuration is corrupted, the FPGA will load the fallback configuration so the flash memory image can be repaired remotely without having to resort JTAG programming.

Note that if you program the 7I98 with a valid bitfile for a XC6SLX9 but not designed for a 7I98, you will likely "brick" the card. The only way a bricked card can be recovered is by using JTAG..

OPERATION

EEPROM LAYOUT

The EEPROM used on the 7I98 for configuration storage is the M25P16. The M25P16 is a 16 M bit (2 M byte) EEPROM with 32 64K byte sectors. Configuration files are stored on sector boundaries to allow individual configuration file erasing and updating. Standard EEPROM sector layout is as follows:

0x000000	BOOT BLOCK
0x010000	FALLBACK CONFIGURATION BLOCK 0
0x020000	FALLBACK CONFIGURATION BLOCK 1
0x030000	FALLBACK CONFIGURATION BLOCK 2
0x040000	FALLBACK CONFIGURATION BLOCK 3
0x050000	FALLBACK CONFIGURATION BLOCK 4
0x060000	FALLBACK CONFIGURATION BLOCK 5
0x070000	FALLBACK CONFIGURATION BLOCK 6
0x080000	UNUSED/FREE
0x090000	UNUSED/FREE
0x0A0000	UNUSED/FREE
0x0B0000	UNUSED/FREE
0x0C0000	UNUSED/FREE
0x0D0000	UNUSED/FREE
0x0E0000	UNUSED/FREE
0x0F0000	UNUSED/FREE

OPERATION

EEPROM LAYOUT

0x100000	USER CONFIGURATION BLOCK 0
0x110000	USER CONFIGURATION BLOCK 1
0x120000	USER CONFIGURATION BLOCK 2
0x130000	USER CONFIGURATION BLOCK 3
0x140000	USER CONFIGURATION BLOCK 4
0x150000	USER CONFIGURATION BLOCK 5
0x160000	USER CONFIGURATION BLOCK 6
0x170000	UNUSED/FREE
0x180000	UNUSED/FREE
0x190000	UNUSED/FREE
0x1A0000	UNUSED/FREE
0x1B0000	UNUSED/FREE
0x1C0000	UNUSED/FREE
0x1D0000	UNUSED/FREE
0x1E0000	UNUSED/FREE
0x1F0000	UNUSED/FREE

OPERATION

BITFILE FORMAT

The configuration utilities expect standard FPGA bitfiles without any multiboot features enabled. If multiboot FPGA files are loaded they will likely cause a configuration failure. In addition for fallback to work, the -g next_config_register_write:disable, -g reset_on_error:enable and -g CRC:enable bitgen options must be set.

MESAFLASH

Linux and Windows utility programs MESAFLASH are provided to write configuration files to the 7I98 EEPROM. These files depend on a simple SPI interface built into both the standard user FPGA bitfiles and the fallback bitfile. *The MESAFLASH utilities expect standard FPGA bitfiles without any multiboot features enabled. If multiboot FPGA files are loaded they will likely cause a configuration failure.*

If mesaflash is run with a –help command line argument it will print usage information.

The following examples assume the target 7I98 is using the ROM IP address of 192.168.1.121.

```
mesaflash --device 7i98 --write FPGAFILE.BIT
```

Writes a standard bitfile FPGAFILE.BIT to the user area of the EEPROM.

```
mesaflash --device 7i98 --verify FPGAFILE.BIT
```

Verifies the user EEPROM configuration against the bit file FPGAFILE.BIT.

```
mesaflash --device 7i98 --fallback --write FALLBACK.BIT
```

Writes the fallback EEPROM configuration to the fallback area of the EEPROM. In addition if the bootblock is not present in block 0 of the EEPROM, it re-writes the bootblock.

SETTING EEPROM IP ADDRESS

MESAFLASH can also write the EEPROM IP address of the 7I98:

```
MESAFLASH --device 7i98 --set ip=192.168.0.100
```

The above examples assume the 7I98 has its default ROM IP address (192.168.1.121). If the 7I98 is using another IP address, this must be specified on the command line with a –addr XX.XX.XX.XX command line argument.

OPERATION

FREE FLASH MEMORY SPACE

Seventeen 64K byte blocks are free on the 7I98 It is suggested that only the last three blocks, 0x1D0000 through a 0x1F0000 in the user area, be used for FPGA application flash storage.

FALLBACK INDICATION

Mesa’s supplied fallback configurations blink the red INIT LED on the top right hand side of the card if the primary configuration fails and the fallback configuration loaded successfully. If this happens it means the user configuration is corrupted or not a proper configuration for the 7I98s FPGA. This can be fixed by running the configuration utility and re-writing the user configuration**.**

FAILURE TO CONFIGURE

The 7I98 should configure its FPGA within a fraction of a second of power application. If the FPGA card fails to configure, the red /DONE LED CR2 will remain illuminated. If this happens the secondary EEPROM boot should be used. If booting from the secondary EEPROM fails, the 7I98s EEPROMs must be re-programmed via the JTAG connector or (faster) JTAG FPGA load followed by Ethernet EEPROM update.

CLOCK SIGNALS

The 7I98 has a single 50 MHz clock signal from an on card crystal oscillator. The clock a can be multiplied and divided by the FPGAs clock generator block to generate a wide range of internal clock signals. The 50 MHz clock is also used to generate the 25MHz clock for the Ethernet interface chip.

OPERATION

LEDS

The 7I98 has four FPGA driven user LEDs (User 0 through User 3 = Green), two FPGA driven status LEDs (red) and one power LED (yellow). The user LEDs can be used for any purpose, and can be helpful as a simple debugging feature. The default Ethernet setup counts received packets on the user LEDs. The status LEDs reflect the state of the FPGA's DONE, and /INIT pins. The /DONE LED lights until the FPGA is configured at power-up. The /INIT LED lights when the power on reset is asserted, when there has been a CRC error during configuration. When using Mesa's configurations, the /INIT LED blinks when the fallback configuration has been loaded. In addition, the /INIT LED lights when the hostmot2 watchdog has bitten.

PULLUP RESISTORS

All I/O pins are provided with pull-up or pull-down resistors to allow connection to open drain, open collector, or OPTO devices. These resistors have a value of 3.3K so have a maximum pull-up/pull down current of ~1.6 mA (5V pull-up) or ~1.0 mA at 3.3V.

IO LEVELS

The Xilinx FPGAs used on the 7I98 have programmable I/O levels for interfacing with different logic families. The 7I98 does not support use of the I/O standards that require input reference voltages. All standard Mesa configurations use LVTTL levels.

Note that even though the 7I98 can tolerate 5V signal inputs, its outputs will not swing to 5V. The outputs are push pull CMOS that will drive to the output supply rail of 3.3V (when pull-ups are enabled) This is sufficient for TTL compatibility but may cause problems with some types of loads. For example when driving an LED that has its anode connected to 5V, in such devices as OPTO isolators and I/O module rack SSRs, the 3.3V high level may not completely turn the LED off. To avoid this problem, either drive loads that are ground referred, Use 3.3V as the VCC for VCC referred loads, or use open drain mode.

STARTUP I/O VOLTAGE

After power-up or system reset and before the FPGA is configured, the per connector pull-up or pull-down resistors will pull all I/O signals per connector to a high or low level. If the FPGA is used for motion control or controlling devices that could present a hazard when enabled, external circuitry should be designed so that this initial state results in a safe condition.

OPERATION

INTERFACE CABLES

Most Mesa daughtercards and parallel port type breakout boards for use with the 7I98 will have a DB25 connection. Mesa can supply the 26 pin header to DB25M or DB25F cables required for this connection.

BREAKOUT POWER OPTION

When used with Mesa breakout/daughter cards, the 7I98 can supply up to 1A of 5V power to each of the daughter cards. This option is disabled by default to avoid possible damage to standard breakout boards, so must be specifically enabled for Mesa daughtercards.

PLUG AND GO KITS

Motion control kits with pre-programmed 7I98, interface cable, and daughtercard(s) are available to simplify system integration.

SUPPLIED CONFIGURATIONS

HOSTMOT2

All supplied configurations are part of the HostMot2 motion control firmware set. All HostMot2 firmware is open source and easily extendible to support new interfaces or different sets of interfaces embedded in one configuration. For detailed register level information on Hostmot2 firmware modules, see the regmap file in the hostmot2 source code directory.

5ABOBX3

5ABOBx3 is a configuration intended to work with up to three common 5 Axis BOB like the SainSmart ST-V3 card. The configuration includes twelve hardware step generators, three encoder inputs and three PWM generators, a watchdog timer and GPIO.

G540X3

G540X3 is a configuration intended to work with three Gecko G540 four axis step motor drives. It includes twelve hardware step generators, three PWM generators, six GPIO outputs, twelve GPIO inputs, 3 charge pump drivers and a watchdog timer.

7I76X2

7I76x2 is a configuration for two 7I76 five axis step/dir daughtercards on P1and P2 and GPIO on P3 .

7I77X2

7I77X2 is a configuration intended to work with the 7I77 six axis analog servo daughtercard. It will support two 7I77 daughtercards. It includes twelve encoder inputs, six smart serial interfaces (four used locally on the 7I77s and two fed through for additional remotes), a watchdog timer and GPIO on P3.

7I77_7I76

7I77_7I76 is a configuration intended to work with one 7I77 six axis analog servo daughtercard on P1 and a 7I76 daughtercard on P2 and GPIO on P3.

ADDITIONAL FIRMWARE

The 7I98 distribution zip archive may contain additional firmware files

PIN FILES

Each of the configurations has an associated file with file name extension .pin that describes the FPGA functions included in the configuration and the I/O pinout. These are plain text files that can be printed or viewed with any text editor.

REFERENCE INFORMATION

LBP16

LBP16 COMMANDS

LBP16 is a simple remote register access protocol to allow efficient register access over the Ethernet link. All LBP16 commands are 16 bits in length and have the following structure:

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
W	A	C	M	M	M	S	S	I	N	N	N	N	N	N	N

W Is the write bit (1 means write, 0 means read)

A Is the includes Address bit. If this is '1' the command is followed by a 16 bit address and the address pointer is loaded with this address. if this is 0 the current address pointer for the memory space is used. Each memory space has its own address pointer.

C Indicates if memory space itself (C=’0') or associated info area for the memory will be accessed (C= ‘1')

M Is the 3 bit memory space specifier 000b through 111b

S Is the transfer element size specifier (00b = 8 bits, 01b = 16 bits 10b = 32 bits and 11b = 64 bits)

I Is the Increment address bit. if this is '1' the address pointer is incremented by the element transfer size (in bytes) after every transfer ('0' is useful for FIFO transfers)

N Is the transfer count in units of the selected size. 1 through 127. A transfer count of 0 is an error.

LBP16 read commands are followed by the 16 bit address (if the A bit is set). LBP16 Write commands are followed by the address (if bit A is set) and the data to be written. LBP16 Addresses are always byte addresses. LBP data and addresses are little endian so must be sent LSB first.

REFERENCE INFORMATION

LBP16

INFO AREA

There are eight possible memory spaces in LBP16. Each memory space has an associated read only info area. The first entry has a cookie to verify correct access. The next two entries in the info area are the MemSizes word and the MemRanges word. Only 16 bit read access is allowed to the info area.

0000	COOKIE = 0X5A0N WHERE N = ADDRESS SPACE 0..7
0002	MEMSIZES
0004	MEMRANGES
0006	ADDRESS POINTER
0008	SPACENAME 0,1
000A	SPACENAME 2,3
000C	SPACENAME 4,5
000E	SPACENAME 6,7

INFO AREA MEMSIZES FORMAT

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
W	T	T	T	T	T	T	T	X	X	X	X	A	A	A	A

W Memory space is Writeable

T Is type: 01 = Register, 02 = Memory, 0E = EEPROM, 0F = Flash

A Is access types (bit 0 = 8 bit, bit 1 = 16 bit etc)so for example 0x06 means 16 bit and 32 bit operations allowed

REFERENCE INFORMATION

LBP16

INFO AREA MEMRANGES FORMAT

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
E	E	E	E	E	P	P	P	P	P	S	S	S	S	S	S

E	Is erase block size
P	Is Page size
S	Ps address range

Ranges are 2^E, 2^P, 2^S. E and P are 0 for non-flash memory

REFERENCE INFORMATION

LBP16

INFO_AREA ACCESS

As discussed above, all memory spaces have an associated information area that describes the memory space. Information area data is all 16 bits and read-only.The hex command examples below are written in LSB first order for convenience. In the hex command examples, the NN is the count/increment field of the LBP16 command and the LLHH is the low and high bytes of the address.

Ispace 0 read with address	NN61LLHH	HostMot2 space
Ispace 0 read	NN21	
Ispace 1 read with address	NN65LLHH	Ethernet chip space
Ispace 1 read	NN25	
Ispace 2 read with address	NN69LLHH	Ethernet EEPROM space
Ispace 2 read	NN29	
Ispace 3 read with address	NN6DLLHH	FPGA flash space
Ispace 3 read	NN2D	
Ispace 6 read with address	NN79LLHH	LBP16 R/W space
Ispace 6 read	NN39	
Ispace 7 read with address	NN7DLLHH	LBP16 R/O space
Ispace 7 read	NN3D	

REFERENCE INFORMATION

LBP16

7I98 SUPPORTED MEMORY SPACES

The 7I98 firmware supports 6 address spaces. These will be described individually with example hexadecimal commands. The hex command examples below are written in LSB first order for convenience. In the hex command examples, the NN is the count/increment field of the LBP16 command and the LLHH is the low and high bytes of the address.

SPACE 0: HOSTMOT2 REGISTERS

This address space is the most important as it gives access to the FPGA I/O. This is a 64K byte address range space with 32 bit R/W access.

Space 0 read with address	NN42LLHH
Space 0 write with address	NNC2LLHH
Space 0 read	NN02
Space 0 write	NN82

REFERENCE INFORMATION

LBP16

SPACE 0: HOSTMOT2 REGISTERS

Example: read first 5 entries in hostmot2 IDROM:

85420004

85	; 85 == NN = 5 | Inc bit (0x80) so address is incremented after each access
42	; Read from space 0 with address included after command
00	; LSB of address (IDROM starts at 0x0400)
04	; MSB of address (IDROM starts at 0x0400)

Example: write 4 GPIO ports starting at 0x1000:

84C20010AAAAAAAABBBBBBBBCCCCCCCCDDDDDDDD

84	; 84 == NN = 4 | Inc bit so address is incremented after each access
C2	; Write to space 0 with address included after command
00	; LSB of address (GPIO starts at 0x1000)
10	; MSB of address (GPIO starts at 0x1000)
AAAAAAAA	; 32 bit data for GPIO port 0 at 0x1000
BBBBBBBB	; 32 bit data for GPIO port 0 at 0x1004
CCCCCCCC	; 32 bit data for GPIO port 0 at 0x1008
DDDDDDDD	; 32 bit data for GPIO port 0 at 0x100C

Note like all LBP16 data, write data is LS byte first

REFERENCE INFORMATION

LBP16

SPACE 1: ETHERNET CHIP ACCESS

Space 1 allows access to the KSZ8851-16 registers for debug purposes. All accesses are 16 bit.

Space 1 read with address	NN45LLHH
Space 1 write with address	NNC5LLHH
Space 1 read	NN05
Space 1 write	NN85

Example: read Ethernet chip CIDER register: 0145C000

01	; = NN = read 1 16 bit value
45	; read space 1 with address included
C0	; LSB of CIDER address
00	; MSB of CIDER address

SPACE 2: ETHERNET EEPROM CHIP ACCESS

This space is used to store the Ethernet MAC address, card name, and EEPROM settable IP address. The Ethernet EEPROM space is accessed as 16 bit data. The first 0x20 bytes are read only and the remaining 0x60 bytes are read/write.

Space 2 read with address	NN49LLHH
Space 2 write with address	NNC9LLHH
Space 2 read	NN09
Space 2 write	NN89

REFERENCE INFORMATION

LBP16

SPACE2: ETHERNET EEPROM CHIP ACCESS

Writes and erases require that the EEPROMWEna be set to 5A02. *Note that EEPROMWEna is cleared at the end of every LPB packet so the write EEPROMWEna command needs to prepended to all EEPROM write and erase packets.* For EEPROM write operations a LBP16 read operation should follow the write(s) for host synchronization.

Example: write EEPROM IP address with 192:168.0.32 (C0:A8:0:20 in hex)

01D91A00025A	Enable EEPROM area writes
82C920002000A8C0	Write 2 words to 0020 : C0A80020 (with inc). Note this must be in the same packet and the EEPROMWEna write

ETHERNET EEPROM LAYOUT

ADDRESS	DATA
0000	Reserved RO
0002	MAC address LS Word RO
0004	MAC address Mid Word RO
0006	MAC address MS Word RO
0008	Reserved RO
000A	Reserved RO
000C	Reserved RO
000E	Unused RO

REFERENCE INFORMATION

LBP16

ETHERNET EEPROM LAYOUT

ADDRESS	DATA
0010	CardNameChar-0,1 RO
0012	CardNameChar-2,3 RO
0014	CardNameChar-4,5 RO
0016	CardNameChar-6,7 RO
0018	CardNameChar-8,9 RO
001A	CardNameChar-10,11 RO
001C	CardNameChar-12,13 RO
001E	CardNameChar-14,15 RO
0020	EEPROM IP address LS word RW
0022	EEPROM IP address MS word RW
0024	EEPROM Netmask LS word RW (V16 and > firmware)
0026	EEPROM Netmask MS word RW (V16 and > firmware)
0028	DEBUG LED Mode (LS bit determines HostMot2 (0) or debug(1)) RW
002A	Reserved RW
002C	Reserved RW
002E	Reserved RW
0030..007E	Unused RW

REFERENCE INFORMATION

LBP16

SPACE 3: FPGA FLASH EEPROM CHIP ACCESS

Space 3 allows access to the FPGAs configuration flash memory. All flash memory access is 32 bit. Flash memory access is different from other memory spaces in that it is done indirectly via a 32 bit address pointer and 32 bit data port.

Space 3 read with address	NN4ELLHH
Space 3 write with address	NNCELLHHDDDDDDDD

Space 3 read NN0E

Space 3 write NN8E

FLASH MEMORY REGISTERS

Flash memory spaces have only 4 accessible registers:

ADDRESS	DATA	
0000	FL_ADDR	32 bit flash address register
0004	FL_DATA	32 bit flash data register
0008	FL_ID	32 bit read only flash ID register
000C	SEC_ERASE	32 bit write only sector erase register

Unlike other memory spaces, flash memory space is accessed indirectly by writing the address register (FL_ADDR) and then reading or writing the data (FL_DATA). The flash byte address is automatically incremented by 4 each data access.

Note that reads can read all of flash memory with consecutive read operations but write operations can only write a flash page worth of data before the page write must be started. Also unless you are doing partial page writes, page write should always start on a page boundary.

The page write is started by writing the flash address, reading the flash address, reading flash data, reading flash ID or issuing a erase sector command. For host synchronization, a read operation should follow every sector erase or page write.

REFERENCE INFORMATION

LBP16

SPACE 3: FPGA FLASH EEPROM CHIP ACCESS

Example: read 1024 bytes (0100h doublewords) of flash space at address 00123456:

01CE000056341200	Write FL_ADDR (0000) with pointer (0x00123456)
404E0400	Issue read command (FL_DATA = 0004) With count of 0x40 double words (256 bytes). Note do not use LBP16 increment bit! Flash address always autoincremented
400E	Next 0x40 doublewords = 256 bytes
400E	Next 0x40 doublewords = 256 bytes
400E	Next 0x40 doublewords = 256 bytes

Note that this is close to the maximum reads allowed in a single LBP packet (~1450 bytes)

Writes and erases require that the EEPROMWEna be set to 5A03. *Note that EEPROMWEna is cleared at the end of every LPB packet so the write EEPROMWEna command needs to prepended to all flash write and erase packets. The following is written on separate lines for clarity but must all be in one packet for correct operation.*

Example: Write a 256 byte page of flash memory starting at 0xC000:

01D91A00035A	Write EEPROMWEna with 0x5A03
01CE000000C00000	Write flash address
40CE0400	Issue write flash data command with count
12345678	Doubleword 0
ABCD8888	Doubleword 1
...	
FFFFFFFF	Doubleword 63 (= 256 bytes)
014E0000	Read new address to commit write and so some data is returned for host synchronization (so host waits for write to complete)

REFERENCE INFORMATION

LBP16

SPACE 3: FPGA FLASH EEPROM CHIP ACCESS

Example: Erase flash sector 0x00010000:

01D91A00035A	Write EEPROMWEna with 0x5A03
01CE000000000100	Write flash address with 0x 00010000
01CE0C0000000000	Write sector erase command (with dummy 32 bit data = 0)
014E0000	Read flash address for host synchronization (this will echo the address _after_ the sector is erased)

REFERENCE INFORMATION

LBP16

SPACE 4 LBP TIMER/UTILITY AREA

Address space 4 is for read/write access to LBP specific timing registers. All memory space 4 access is 16 bit.

Space 4 read with address	NN51LLHH
Space 4 write with address	NND1LLHHDDDD
Space 4 read	NN11
Space 4 write	NN91DDDD

MEMORY SPACE 4 LAYOUT:

ADDRESS	DATA
0000	uSTimeStampReg
0002	WaituSReg
0004	HM2Timeout
0006	WaitForHM2RefTime
0008	WaitForHM2Timer1
000A	WaitForHM2Timer2
000C	WaitForHM2Timer3
000E	WaitForHM2Timer4
0010..001E	Scratch registers for any use

The uSTimeStamp register reads the free running hardware microsecond timer. It is useful for timing internal 7I98 operations. Writes to the uSTimeStamp register are a no-op. The WaituS register delays processing for the specified number of microseconds when written, (0 to 65535 uS) reads return the last wait time written. The HM2TimeOut register sets the timeout value for all WaitForHM2 times (0 to 65536 uS).

All the WaitForHM2Timer registers wait for the rising edge of the specified timer or reference output when read or written, write data is don’t care, and reads return the wait time in uS. The HM2TimeOut register places an upper bound on how long the WaitForHM2 operations will wait. HM2Timeouts set the HM2TImeout error bit in the error register.

REFERENCE INFORMATION

LBP16

SPACE 6 LBP STATUS/CONTROL AREA

Address space 6 is for read/write access to LBP specific control, status, and error registers. All memory space 6 access is 16 bit. The RXUDPCount and TXUDPCount can be used as sequence numbers to verify packet reception and transmission.

Space 6 read with address	NN59LLHH
Space 6 write with address	NND9LLHHDDDD
Space 6 read	NN19
Space 6 write	NN99DDDD

MEMORY SPACE 6 LAYOUT:

ADDRESS	DATA
0000	ErrorReg
0002	LBPParseErrors
0004	LBPMemErrors
0006	LBPWriteErrors
0008	RXPktCount
000A	RXUDPCount
000C	RXBadCount
000E	TXPktCount
00010	TXUDPCount
00012	TXBadCount

REFERENCE INFORMATION

LBP16

MEMORY SPACE 6 LAYOUT:

ADDRESS	DATA	
0014	LEDMode	If LSb is 0, LEDs are "owned" by HostMot2, otherwise LEDs are local debug LEDs
0016	DebugLEDPtr	What variable in space 6 local debug LEDs show (default is RXPktCount).
0018	Scratch	Can be used for sequence numbers
001A	EEPROMWEna	Must be set to 5A0N to enable EEPROM or flash writes or erases (N is memory space of EEPROM or flash) Note that this is cleared at the end of every packet.
001C	LBPReset	Setting this to a non-zero value will do a full reset of the LBP16 firmware. The 7I98 will read its IP address jumpers and re-assign its IP address. The 7I98 will be unresponsive for as much as ½ of a second after this command.
001E	FPGAICAP	FPGA ICAP-16 register to allow remote FPGA reload and other low level FPGA access.

ERROR REGISTER FORMAT

BIT	ERROR
0	LBPParseError
1	LBPMemError
2	LBPWriteError
3	RXPacketErr
4	TXPacketErr
5	HM2TimeOutError
6..15	Reserved

REFERENCE INFORMATION

LBP16

SPACE 7: LBP READ ONLY AREA

Memory space 7 is used for read only card information. Memory space 7 is accessed as 16 bit data.

Space 7 read with address	NN5DLLHH
Space 7 read	NN1D

MEMORY SPACE 7 LAYOUT:

ADDRESS	DATA	
0000	CardNameChar-0,1	
0002	CardNameChar-2,3	
0004	CardNameChar-4,5	
0006	CardNameChar-6,7	
0008	CardNameChar-8,9	
000A	CardNameChar-10,11	
000C	CardNameChar-12.13	
000E	CardNameChar-14,15	
0010	LBPVersion	
0012	FirmwareVersion	
0014	Option Jumpers	
0016	Reserved	
0018	RecvStartTS	1 uSec timestamps
001A	RecvDoneTS	For performance monitoring
001C	SendStartTS	Send timestamps are
001E	SendDoneTS	from ***previous*** packet

REFERENCE INFORMATION

LBP16

ELBPCOM

ELBPCOM is a very simple demo program in Python (2.x) to allow simple checking of LBP16 host communication to the 7I98. ELBPCOM accepts hexadecimal LBP16 commands and data and returns hexadecimal results. Note that the timeout value will need to be increased to about 2 seconds to try flash sector erase commands.

```
import socket
s = socket.socket(socket.AF_INET,socket.SOCK_DGRAM,0)
sip  = "192.168.1.121"
sport = 27181
s.settimeout(.2)
while(2 >0):
 sdata = raw_input ('>')
 sdata = sdata.decode('hex')
 s.sendto(sdata,(sip,sport))
 try:
  data,addr = s.recvfrom(1280)
  print ('>'),data.encode('hex')
 except socket.timeout:
  print ('No answer')
```

```
Sample run:

>01420001                      ; read hostmot2 cookie at 0x100
> fecaaa55                     ; 7I98 returns 0x55AACAFE

>82492000                      ; read EEPROM IP address at 0x0020
> 450a5863                     ; 63:58:0A:45 = 99.88.10.69
                               ;(for example)

>01D91A00025A82C920000100a8C0 ; write EEPROM IP address
                               ;(at 0x0020) with
                               ; C0:A8:0:1 = 192.168.0.1
```

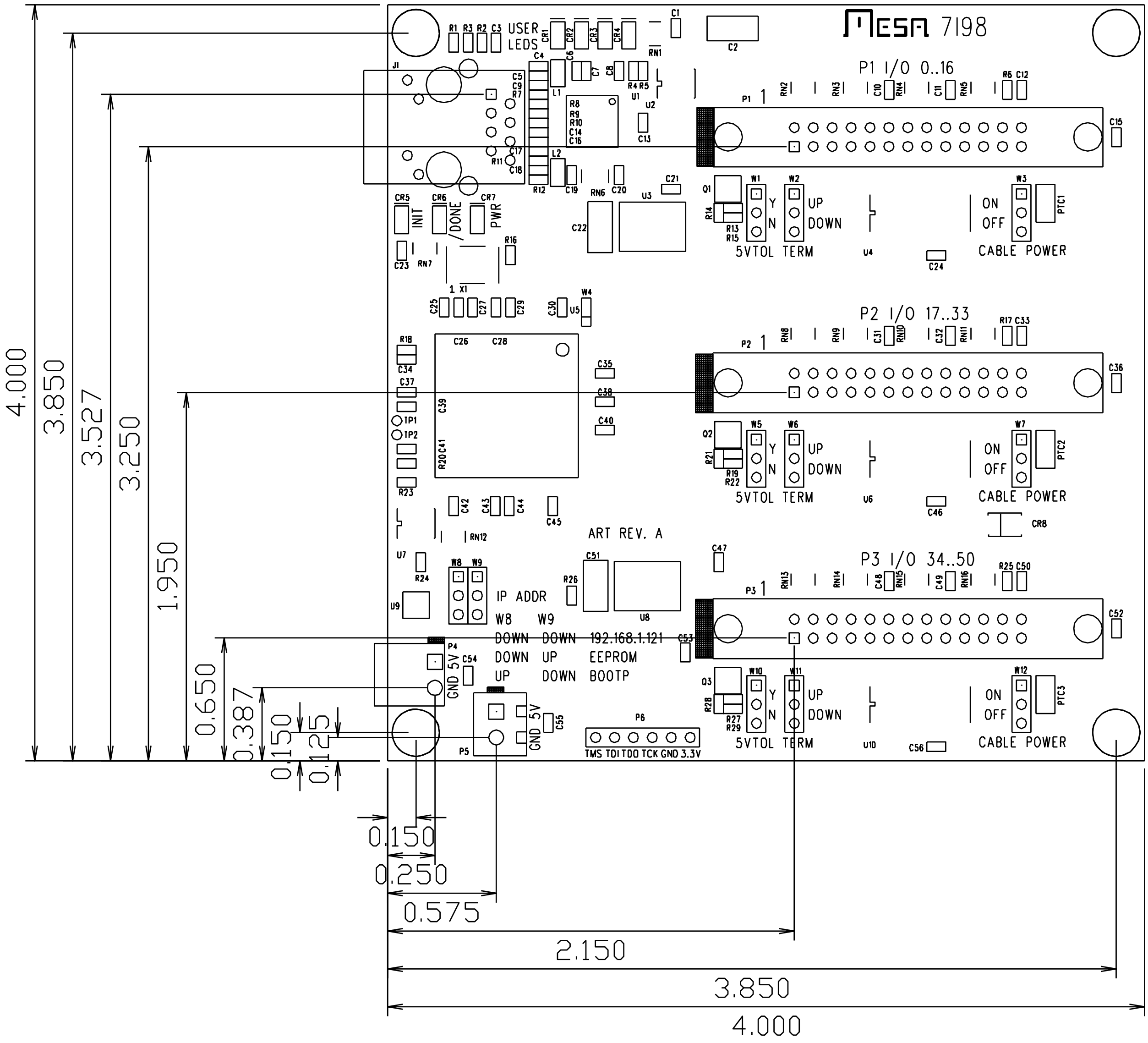
REFERENCE

SPECIFICATIONS

POWER	MIN	MAX	NOTES:
5V POWER SUPPLY	4.5V	5.5V	P5 supplied 5V
5V POWER CONSUMPTION:	----	5A	Depends on FPGA configuration and external load Typical current drain with no load is 200 mA
MAX 5V CURRENT TO I/O CONNS	---	2000 mA	Each (PTC Limit)
INPUT VOLTAGE	-0.5V	+7V	Absolute maximum
OUTPUT VOLTAGE HIGH (pullup)	3.3V	5V	no load
OUTPUT VOLTAGE HIGH (pulldown)	2.7V	3.3V	no load
OUTPUT VOLTAGE HIGH (pullup)	2.5V	3.3V	1 K load to GND
OUTPUT VOLTAGE LOW (pullup)	0V	0.3V	300 Ohm load to 5V
TEMPERATURE RANGE -C version	0 ^{o}C	+70 ^{o}C	
TEMPERATURE RANGE -I version	-40 ^{o}C	+85 ^{o}C	

REFERENCE INFORMATION

CARD DRAWING



MESA 7I98
USER LEDS
CR1 CR2 CR3 CR4
INIT
/DONE
PWR
P1 I/O 0..16
P2 I/O 17..33
P3 I/O 34..50
5VTOL TERM
Y N
UP DOWN
ON OFF
CABLE POWER
ART REV. A
IP ADDR
W8 W9
DOWN DOWN 192.168.1.121
DOWN UP EEPROM
UP DOWN BOOTP
GND 5V
P4
P5
P6
TMS TDI TDO TCK GND 3.3V
J1
4.000
3.850
3.527
3.250
1.950
0.650
0.387
0.150
0.125
0.150
0.250
0.575
2.150
3.850
4.000