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| MICROCOM GPU v1.0 MANUAL |
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| A hardware and software guide to using the Microcom GPUJanuary 3  10103  Authored by: J.Nock |



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# Microcom GPU v1.0 Manual

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| Technical Specifications Depending on the FPGA used in the Microcom GPU card, the following features will be available in varying capacities. Listed below are *minimum specifications* based on an Intel EP4CE6 FPGA (used in development of the GPU):   * FPGA graphics RAM, plus 1 KB for palettes * 7 (or more) graphics layers * 640x480 resolution at 60 fps (VGA)   **NOTE:** *All 16-bit words in the Microcom GPU are big-endian*. |
|  |
| Memory Map & Registers The Microcom GPU uses a vacant 512 KB slot in the host system’s memory space – see the Microcom’s manual for more information on this. This 512 KB window is filled with the GPU’s own RAM – if the GPU has less than 512 KB of RAM, accessing memory above the GPU’s upper memory limit will return FF values and be read-only (writes will be ignored).   * 0000-01FF – GPU HW registers:   + **00-07** = H&V triggers for 4 yellow test cursors   + **0C-0D** = H&V reset coordinates for all 15 MAGGIE\_Layer#s   + **10-11 + 4\*MAGGIE\_Layer#** = H&V top left edge of each MAGGIE\_Layer# window   + **60 + 10\*MAGGIE\_Layer#** = 16 byte controls for each of the 15 MAGGIE layers * 0200-11FF – Default IBM VGA 8x16 font. * 1200-5FFF – Video RAM (for text buffers / sprite data)   + **1200-1B5F** – Typical memory space for a full screen of text * 7C00-7FFF – Palettes:   + **7C00-7DFF** – primary palette (ARGB4444)   + **7E00-7FFF** – secondary palette (RGB565)   Without text you can mix 7 on-screen sprites, or 1 text layer and 5 sprites. Other than a RAM limitation, there are no other output limitations. Any mode and any resolution with any palette may all be mixed simultaneously onscreen. |
| New GPU project parameters:  NUM\_LAYERS = 2 through 15 = 2 layers through 15 layers.  PALETTE\_ADDR = Sets the base address for the 2 palettes. This one is automatically set to (2\*\*ADDR\_SIZE - 1024), so the palettes are the last 1024 bytes.MAGGIEs The **M**ultiple **A**ddress **G**enerator and **G**raphic **I**nstruction **E**ngines are the workhorses of the GPU. There are 7 MAGGIEs in the smallest system, numbered 0-6.  All MAGGIEs have their HV resets set to HV\_Trigger 0C & 0D.  MAGGIE top-left window X/Y positions:   * MAGGIE0 at HV\_Trigger 0010-11 & 0012-13 * MAGGIE1 at HV\_Trigger 0014-15 & 0016-17 * MAGGIE2 at HV\_Trigger 0018-19 & 001A-1B * MAGGIE3 at HV\_Trigger 001C-1D & 001E-1F * MAGGIE4 at HV\_Trigger 0020-21 & 0022-23 * MAGGIE5 at HV\_Trigger 0024-25 & 0026-27 * MAGGIE6 at HV\_Trigger 0028-29 & 002A-2B   MAGGIE register addresses – 16 bytes for each MAGGIE:   * MAGGIE0 – 0060 * MAGGIE1 – 0070 * MAGGIE2 – 0080 * MAGGIE3 – 0090 * MAGGIE4 – 00A0 * MAGGIE5 – 00B0 * MAGGIE6 – 00C0 |

### MAGGIE Registers

|  |  |  |
| --- | --- | --- |
| Address | Name | Function |
| Base + 00 | BP2RAST\_cmd | 8-bit composite. Video Mode setting. |
| Base + 01 | BP2RAST\_bgc | Background colour. |
| Base + 02 | BP2RAST\_fgc | Foreground colour. |
| Base + 03 | RST\_ADDR\_H | MSB bits of 24-bit base read address. |
| Base + 04 | RST\_ADDR\_M | MID bits of 24-bit base read address. |
| Base + 05 | RST\_ADDR\_L | LSB bits of 24-bit base read address. |
| Base + 06 | YINC\_ADDR\_H | MSB of 16-bit Y-line increment for read address. |
| Base + 07 | YINC\_ADDR\_L | LSB of 16-bit Y-line increment for read address. |
| Base + 08 | X\_SIZE\_H | MSB of 16-bit display width screen pixels. |
| Base + 09 | X\_SIZE\_L | LSB of 16-bit display width screen pixels. |
| Base + 0A | Y\_SIZE\_H | MSB of 16-bit display height screen lines. |
| Base + 0B | Y\_SIZE\_L | LSB of 16-bit display height screen lines. |
| Base + 0C | X\_SCALE | Two 4-bit words. Upper 4 controls x-increment every period, lower 4 is pixel period counter to define number of pixels until upper 4 bits are added to the address pointer. |
| Base + 0D | Y\_SCALE | Two 4-bit words. Upper 4 bits reserved for text tile mode y-size; lower 4 bits is line period counter to define number of lines until YINC\_ADDR is added to address pointer. |
| Base + 0E | X\_START\_SUB | 8-bit word. Defines an odd pixel start position within the period counter and x-position within a bit plane’s x-coordinate position. |
| Base + 0F | Y\_START\_SUB | 8-bit word. Defines an odd line start within the period counter and y-coordinates inside a font. |

### BP2RAST\_cmd

The BP2RAST\_cmd register is composed of the following bit settings:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
| text\_mode\_master | text\_mode\_slave | not used | mode\_565 | bart\_enable | 16\_bit\_mode | Video Mode | Video Mode |

### Bits 7-6 – Text\_mode\_master / text\_mode\_slave

When using text/font/tile mode, two adjacent MAGGIEs must be used. The first one must have the '*text\_mode\_master*' bit set in the '*BP2RAST\_cmd*' while the second MAGGIE must have the '*text\_mode\_slave*' bit set in the '*BP2RAST\_cmd*'. These bits must be zero for graphics output.

### Bit 4 – mode\_565

### Bit 3 – BART enable

This bit must be HIGH for the linked BART to output pixel data. If the bit is LOW, the MAGGIE/BART pipeline is effectively turned off, unless the MAGGIE is a text\_mode\_master.

### Bit 2 – 16\_bit\_mode

If HIGH, the BART works in 16-bit mode (so all addresses must be even) to use two-byte words when reading the pixel data.

### Bits 1-0 – Video Mode / pixels per byte

Determines the Video Mode, or pixels per byte. The table below shows how bits 2-0 work together to determine the Video Mode:

|  |  |  |  |
| --- | --- | --- | --- |
| Bit 2 | Bit 1 | Bit 0 | Video Mode |
| 0 | 0 | 0 | 1-bit colour |
| 0 | 0 | 1 | 2-bit colour |
| 0 | 1 | 0 | 4-bit colour |
| 0 | 1 | 1 | 8-bit colour |
| 1 | 0 | 0 | 16-bit, 8 pixels-per-word |
| 1 | 0 | 1 | 16-bit, 4 pixels-per-word |
| 1 | 1 | 0 | 16-bit, 2 pixels-per-word |
| 1 | 1 | 1 | 16-bit, true colour |

### Text Mode

Two MAGGIEs are required for text mode – a master and a slave – and they must be adjacent to each other (i.e. MAGGIE0 & MAGGIE1, MAGGIE3 & MAGGIE4 etc).

The master MAGGIE is responsible for the positioning of the window on the screen and pointing to the source data (*screen buffer*), whereas the slave MAGGIE controls the foreground and background colours.

The screen buffer location is specified in the master MAGGIE in the 24-bit word at register addresses +3 to +5.

The Video Mode in both MAGGIEs must match, except in the master where the BP2RAST\_cmd BART\_enable (bit 3) must be disabled; otherwise you will get junk on the screen.

In 16-bit text mode, each character tile is followed by a palette byte. The upper 4-bits control the foreground colour, the lower 4-bits control the background colour.

All other controls are the same as when using it as a bitmap graphics window.

The '*font\_y\_size*', combined upper bits of '{hw\_regs[Y\_START\_SUB][7:6], hw\_regs[Y\_SCALE][7:4]}' in the *text\_mode\_master* which must also be set to the font/tile height -1 (e.g.: 0=1 line, 7=8 lines, 15=16 lines, 31=32 lines) when in text/font/tile master mode.

For the *'text\_mode\_slave*' MAGGIE, the only functioning 4 controls are:

1. reset\_addr which points to the base memory address for font/tile graphics data,
2. period\_x[4] which defines a font as 16 pixels wide when set, or 8 pixels when low, and period\_x[3:0] which mask out the upper bits for fonts/tile addressing for 256, 512, 1024, 2048, 4096 characters (used in 16 bit addressing mode, otherwise set these bits to 0),
3. period\_y[1:0] which defines the font height (0=8, 1=16, 2=32, 3=64 lines tall), and
4. BP2RAST\_cmd which should match the *text\_mode\_master* MAGGIE settings except for the master and slave bit.

All base memory address settings should be on an even byte when using 16-bit mode. Fonts/tile graphics data should always begin on an even byte address.

## PALETTES

The palettes are held in memory at $7C00-$7FFF and are 512 entries wide, with the 4444 colour palette occupying the first 256x16 entries while the 565 palette occupies the second 256x16 entries. Both palettes are 16-bit.