COMPUTE MODULE OPERATING INSTRUCTIONS

POWERING THE MODULE

- The Compute Module has 6 separate supplies that must be present at all times (i.e. they must all be powered, you cannot leave any of them unpowered even if a specific interface or GPIO bank is unused).

1. VBAT is used to power the BCM2835 processor core (it feeds the SMPS that generates the chip core voltage)
2. 3V3 powers various BCM2835 PHYs, IO and the eMMC Flash
3. 1V8 powers various BCM2835 PHYs, IO and SDRAM
4. VDAC powers the composite (TV out) DAC
5. GPIO0-27_VREF powers the GPIO 0-27 IO bank
6. GPIO28-45_VREF powers the GPIO 28-45 IO bank

<table>
<thead>
<tr>
<th>SUPPLY</th>
<th>VOLTAGE / VOLTAGE RANGE</th>
<th>TOLERANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>VBAT</td>
<td>2.3-5V [1]</td>
<td>+/- 5%</td>
</tr>
<tr>
<td>3V3</td>
<td>3.3V</td>
<td>+/- 5%</td>
</tr>
<tr>
<td>1V8</td>
<td>1.8V</td>
<td>+/- 5%</td>
</tr>
<tr>
<td>VDAC</td>
<td>2.5-2.8V (can connect to 3V3 if unused)</td>
<td>+/- 5%</td>
</tr>
<tr>
<td>GPIO0-27_VREF</td>
<td>1.8-3.3V</td>
<td>+/- 5%</td>
</tr>
<tr>
<td>GPIO28-45_VREF</td>
<td>1.8-3.3V</td>
<td>+/- 5%</td>
</tr>
</tbody>
</table>

[1] **NOTE** that the voltage range for best SMPS efficiency is ~3.3-4.3V

POWER SEQUENCING

- Supplies must be synchronised to come up at exactly the same time, or staggered such that the highest voltage comes up first, then the next highest etc. This is to avoid forward biasing internal (on-chip) diodes between supplies and causing latch-up.

POWER REQUIREMENTS

- Exact power requirements will be heavily dependent upon the individual use case. If an on-chip subsystem is unused it is usually in a low power state or completely turned off. For instance if your application does not use 3D graphics then a large part of the core digital logic will never turn on and need power. Similarly for camera / display interfaces, HDMI, USB interfaces, video encode/decode etc.

- Powerchain design is critical for stable and reliable operation of the Compute Module. We strongly recommend that designers spend time measuring and verifying power requirements for their particular use case and application, as well as paying careful attention to power supply sequencing and maximum supply voltage tolerance.

- The following table gives a rough guide as to minimum supply requirements. **However, the user is responsible for verifying that their powerchain is designed sufficient for their application. In some more pathological use cases these minimum requirements may well be too low!**

<table>
<thead>
<tr>
<th>SUPPLY</th>
<th>MINIMUM REQUIREMENT (MA OR MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VBAT</td>
<td>2000mW [1]</td>
</tr>
<tr>
<td>3V3</td>
<td>250mA</td>
</tr>
<tr>
<td>1V8</td>
<td>250mA</td>
</tr>
<tr>
<td>VDAC</td>
<td>25mA</td>
</tr>
<tr>
<td>GPIO0-27_VREF</td>
<td>See note [2]</td>
</tr>
<tr>
<td>GPIO28-45_VREF</td>
<td>See note [2]</td>
</tr>
</tbody>
</table>

[1] **NOTE** VBAT is heavily dependent upon the application. E.g. with video encode, 3D and camera all running the power requirements can be substantial.

[2] **NOTE** that each GPIO bank will only need a few mW if unused, however when in use the requirements will vary depending on number of IOs in use, and the load on each. The designer is responsible for calculating or measuring this themselves based on their particular use case.
**NOTE** that the GPIO46_1V8 and GPIO47_1V8 pins are 1.8V IO only and are reserved for special functions (HDMI hot plug detect and boot control respectively). Please don’t use these pins for any other purpose (as the software for the Compute Module will always expect these pins to have these special functions). If unused please leave unconnected.

The remaining GPIOs are available for general use and are split into 2 banks. GPIO0 to GPIO27 are bank 0 and GPIO28-45 make up bank 1. GPIO0-27_VREF is the power supply for bank 0 and GPIO28-45_VREF is the power supply for bank 1. These supplies can be in the range 1.8V-3.3V. These supplies are not optional; each bank must be powered (even when none of the GPIOs for that bank are used).

All GPIOs except GPIO28, 29, 44 and 45 have weak in-pad pull-ups or pull-downs enabled from power on. Whether the GPIO is pulled up or down is documented in the BCM2835 peripherals section 6.2. **It is recommended to add off-chip pulls to GPIO28, 29, 44 and 45 to make sure they never float during power on / initial boot.**

**CSi (MIPI Serial Camera)**
- The Compute Module has 2 MIPI serial camera interfaces (CSI), Interface 0 and Interface 1.
- Interface 0 is a 2-lane interface (one clock lane and 2 data lanes).
- Interface 1 is a 4-lane interface (one clock lane and 4 data lanes).
- Note that the Raspberry Pi Model A/B camera connector uses Interface 1 (but only in a 2-lane configuration).

**DSI (MIPI Serial Display)**
- The Compute Module has 2 MIPI serial display interfaces (DSI), Interface 0 and Interface 1.
- Interface 0 is a 2-lane interface (one clock lane and 2 data lanes).
- Interface 1 is a 4-lane interface (one clock lane and 4 data lanes).
- Note that the Raspberry Pi Model A/B display connector uses Interface 1 (but only in a 2-lane configuration).

**USB OTG**
- The BCM2835 USB port is On-The-Go (OTG) capable. If using either as a fixed slave or fixed master please tie the USB_OTG pin to ground.
- The USB port (Pins USB_DP and USB_DM) must be routed as matched-90 ohm differential PCB traces.
- Note that the port is capable of being used as a true OTG port but currently there is no documentation / code / examples for this use case.

**COMPUTE MODULE TEMPERATURE RANGE**
- The operating temperature range of the module is set by the lowest maximum of any of the components, and the highest minimum of any of the components.
- The Samsung eMMC and Samsung LPDDR2 are all rated for -25 to +80 degrees C, so the range is -25 to +80. (BCM2835 and the analogue switch have a greater range; the ceramic capacitors are specified from -25 to +85).
- However that is the max range for the silicon die, so a user would have to take into account the heat generated when in use and make sure this does not cause the temperature to exceed 80C.

****NOTE** that the TV DAC is powered from the VDAC supply which must be a clean supply of 2.5-2.8V (it is recommended to generate this supply from 3V using a low noise LDO).**

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**THE USER IS RESPONSIBLE FOR DESIGNING AND TESTING THEIR SYSTEM SUCH THAT THESE LIMITS ARE NOT EXCEEDED.**

**COMPUTE MODULE FORM FACTOR**
- The Compute Module conforms to JEDEC MO-224 mechanical specification for 200 pin DDR2 (1.8V) SODIMM modules. (Please note that the pinout of the Compute Module is not the same as a DDR2 SODIMM module, they are **not** electrically compatible).
- The maximum component height on the underside of the Compute Module is 1.2mm
- The maximum component height on the top side of the Compute Module is 1.5mm
- The Compute Module PCB thickness is 1.0mm +/- 10%

**NOTE** that the location and arrangement of components on the Compute Module may change slightly over time due to revisions for cost and manufacturability; however maximum component heights and PCB thickness will be kept as specified.