



BM1385

Bitcoin Hash ASIC

Datasheet

Bitmain Technologies Limited

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Revision History

| Revision Number | Author | Date | Description |
|-----------------|--------|-----------|----------------|
| 1.0 | Zhan | 2015.6.16 | Initial |
| 2.0 | Zhan | 2015.6.30 | Delete LDO_VSS |
| | | | |
| | | | |
| | | | |

1 Overview

This is a kind of high performance and low power consumption bitcoin mining ASIC.

1.1 Features

- Typical hash rate and power

| Voltage(V) | Hash Rate(GH/S) | Current(A) | Total power(W) | W/GH |
|------------|-----------------|------------|----------------|-------|
| 0.71 | 38.75 | 14.350 | 10.189 | 0.263 |
| 0.66 | 32.50 | 10.760 | 7.102 | 0.219 |
| 0.60 | 21.25 | 6.410 | 3.846 | 0.181 |

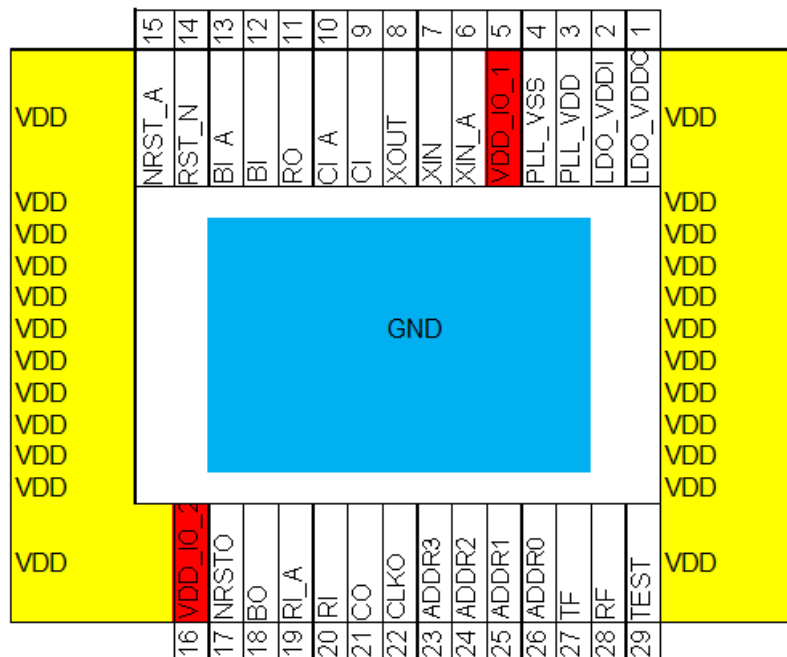
- Customized package
- Support UART communication interface
- Support chain mode, Max 256 chips per chain

1.2 Applications

- Bitcoin mining

2Pin Description

2.1 Pin Diagram



Top view

2.2 Signal Description

| Name | I/O | Active Level | Description |
|--------|-----|--------------|---|
| XIN | I | N/A | Oscillator input |
| XOUT | O | N/A | Oscillator output |
| RST_N | I | L | Reset signal |
| TEST | I | N/A | Internal pull down. 0: Normal mode 1: Test mode |
| CLKOUT | O | N/A | Clock output |
| NRSTO | O | L | Reset output |
| CI | I | N/A | Command Input. Schmitt input. |
| CO | O | N/A | Command Output |
| RI | I | N/A | Respond Input. Schmitt input and internal pullup. |
| RO | O | N/A | Respond Output |

| Name | I/O | Active Level | Description |
|-----------|-----|--------------|---|
| BI | I | H | Respond Busy Input. Schmit input and internal pulldown. |
| BO | O | H | Respond Busy Output |
| ADDR[3:0] | | | Address Input. Internal pullup. |
| RF | O | | RO open drain output; Command Rx Flag |
| TF | O | | Respond Tx Flag |
| PLL_VDD | | | PLL power (0.9V) |
| PLL_VSS | | | PLL ground |
| LDO_VDD1 | | | LDO power input. Typical 1.8V |
| LDO_VDDO | | | LDO power output 0.9V. 1uF external capacitor. |
| NRST_A | | | Reset input. Trigger level is (-VDD, VDDPST-VDD) |
| BI_A | | | BI input. Trigger level is (-VDD, VDDPST-VDD) |
| CI_A | | | CI input. Trigger level is (-VDD, VDDPST-VDD) |
| XIN_A | | | XIN input. Trigger level is (-VDD, VDDPST-VDD) |
| RI_A | | | RI input. Trigger level is (VDD, VDDPST+VDD) |

3 UART description

3.1 UART protocol

The default baud rate is 115200 when the XIN clock frequency is 25MHz. it can be set via command.

Minimum RX guard time: 1 bit

TX guard time: 2 bit

RX IDLE: 16 bits

Bit order: LSB

3.2 Work format

| Byte0~31 (32bytes) | Byte32~35 (4bytes) | Byte36~39 (4bytes) | Byte40~43 (4bytes) | Byte44~47 (4bytes) | Byte48~50 (3bytes) | Byte51 | | Byte52~63 (12bytes) |
|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|--------|----------|------------------------|
| Midstate | Ignore | TM | HCN | SNO | Ignore | Bit[7] | Bit[6:0] | Data2 |
| | | | | | | Ignore | WC | |

SNO: Start Nonce Offset.

WC: Work Count. It is used to index the input works.

HCN: Hash counting number. When HCN is reached, the hash core will stop hashing.

TM: Ticket Mask. It is used to set the difficulty of return nonce.

3.3 Work timing

| PLLDiv1 | PLLDiv2 | FBDIV[11:0] | REFDIV [5:0] | POSTDIV1 [2:0] | POSTDIV2[2:0] | Freq(Mhz) | step(Mhz) |
|---------|---------|-----------------|-----------------|-------------------|-------------------|-----------|-----------|
| 0x20040 | 0x420 | 32 | 2 | 4 | 1 | 100.00 | 0.00 |
| 0x28040 | 0x420 | 40 | s2 | 4 | 1 | 125.00 | 25.00 |
| 0x30040 | 0x420 | 48 | 2 | 4 | 1 | 150.00 | 25.00 |
| 0x38040 | 0x420 | 56 | 2 | 4 | 1 | 175.00 | 25.00 |
| 0x40040 | 0x420 | 64 | 2 | 4 | 1 | 200.00 | 25.00 |
| 0x48040 | 0x420 | 72 | 2 | 4 | 1 | 225.00 | 25.00 |
| 0x50040 | 0x420 | 80 | 2 | 4 | 1 | 250.00 | 25.00 |
| 0x58040 | 0x420 | 88 | 2 | 4 | 1 | 275.00 | 25.00 |
| 0x60040 | 0x420 | 96 | 2 | 4 | 1 | 300.00 | 25.00 |
| 0x68040 | 0x420 | 104 | 2 | 4 | 1 | 325.00 | 25.00 |

| | | | | | | | |
|---------|-------|-----|---|---|---|--------|-------|
| 0x70040 | 0x420 | 112 | 2 | 4 | 1 | 350.00 | 25.00 |
| 0x78040 | 0x420 | 120 | 2 | 4 | 1 | 375.00 | 25.00 |
| 0x80040 | 0x420 | 128 | 2 | 4 | 1 | 400.00 | 25.00 |
| 0x61040 | 0x320 | 97 | 2 | 3 | 1 | 404.17 | 4.17 |
| 0x41040 | 0x220 | 65 | 2 | 2 | 1 | 406.25 | 2.08 |
| 0x62040 | 0x320 | 98 | 2 | 3 | 1 | 408.33 | 2.08 |
| 0x42040 | 0x220 | 66 | 2 | 2 | 1 | 412.50 | 4.17 |
| 0x63040 | 0x320 | 99 | 2 | 3 | 1 | 412.50 | 4.17 |
| 0x64040 | 0x320 | 100 | 2 | 3 | 1 | 416.67 | 4.17 |
| 0x43040 | 0x220 | 67 | 2 | 2 | 1 | 418.75 | 2.08 |
| 0x65040 | 0x320 | 101 | 2 | 3 | 1 | 420.83 | 2.08 |
| 0x44040 | 0x220 | 68 | 2 | 2 | 1 | 425.00 | 4.17 |
| 0x66040 | 0x320 | 102 | 2 | 3 | 1 | 425.00 | 4.17 |
| 0x67040 | 0x320 | 103 | 2 | 3 | 1 | 429.17 | 4.17 |
| 0x45040 | 0x220 | 69 | 2 | 2 | 1 | 431.25 | 2.08 |
| 0x68040 | 0x320 | 104 | 2 | 3 | 1 | 433.33 | 2.08 |
| 0x46040 | 0x220 | 70 | 2 | 2 | 1 | 437.50 | 4.17 |
| 0x69040 | 0x320 | 105 | 2 | 3 | 1 | 437.50 | 4.17 |
| 0x6a040 | 0x320 | 106 | 2 | 3 | 1 | 441.67 | 4.17 |
| 0x47040 | 0x220 | 71 | 2 | 2 | 1 | 443.75 | 2.08 |
| 0x6b040 | 0x320 | 107 | 2 | 3 | 1 | 445.83 | 2.08 |
| 0x48040 | 0x220 | 72 | 2 | 2 | 1 | 450.00 | 4.17 |
| 0x6c040 | 0x320 | 108 | 2 | 3 | 1 | 450.00 | 4.17 |
| 0x6d040 | 0x320 | 109 | 2 | 3 | 1 | 454.17 | 4.17 |
| 0x49040 | 0x220 | 73 | 2 | 2 | 1 | 456.25 | 2.08 |
| 0x6e040 | 0x320 | 110 | 2 | 3 | 1 | 458.33 | 2.08 |
| 0x4a040 | 0x220 | 74 | 2 | 2 | 1 | 462.50 | 4.17 |
| 0x6f040 | 0x320 | 111 | 2 | 3 | 1 | 462.50 | 4.17 |
| 0x70040 | 0x320 | 112 | 2 | 3 | 1 | 466.67 | 4.17 |
| 0x4b040 | 0x220 | 75 | 2 | 2 | 1 | 468.75 | 2.08 |
| 0x71040 | 0x320 | 113 | 2 | 3 | 1 | 470.83 | 2.08 |
| 0x4c040 | 0x220 | 76 | 2 | 2 | 1 | 475.00 | 4.17 |
| 0x72040 | 0x320 | 114 | 2 | 3 | 1 | 475.00 | 4.17 |
| 0x73040 | 0x320 | 115 | 2 | 3 | 1 | 479.17 | 4.17 |
| 0x4d040 | 0x220 | 77 | 2 | 2 | 1 | 481.25 | 2.08 |
| 0x74040 | 0x320 | 116 | 2 | 3 | 1 | 483.33 | 2.08 |
| 0x4e040 | 0x220 | 78 | 2 | 2 | 1 | 487.50 | 4.17 |
| 0x75040 | 0x320 | 117 | 2 | 3 | 1 | 487.50 | 4.17 |
| 0x76040 | 0x320 | 118 | 2 | 3 | 1 | 491.67 | 4.17 |
| 0x4f040 | 0x220 | 79 | 2 | 2 | 1 | 493.75 | 2.08 |
| 0x77040 | 0x320 | 119 | 2 | 3 | 1 | 495.83 | 2.08 |
| 0x50040 | 0x220 | 80 | 2 | 2 | 1 | 500.00 | 4.17 |
| 0x78040 | 0x320 | 120 | 2 | 3 | 1 | 500.00 | 4.17 |

| | | | | | | | |
|---------|-------|-----|---|---|---|--------|------|
| 0x79040 | 0x320 | 121 | 2 | 3 | 1 | 504.17 | 4.17 |
| 0x51040 | 0x220 | 81 | 2 | 2 | 1 | 506.25 | 2.08 |
| 0x7a040 | 0x320 | 122 | 2 | 3 | 1 | 508.33 | 2.08 |
| 0x52040 | 0x220 | 82 | 2 | 2 | 1 | 512.50 | 4.17 |
| 0x7b040 | 0x320 | 123 | 2 | 3 | 1 | 512.50 | 4.17 |
| 0x7c040 | 0x320 | 124 | 2 | 3 | 1 | 516.67 | 4.17 |
| 0x53040 | 0x220 | 83 | 2 | 2 | 1 | 518.75 | 2.08 |
| 0x7d040 | 0x320 | 125 | 2 | 3 | 1 | 520.83 | 2.08 |
| 0x54040 | 0x220 | 84 | 2 | 2 | 1 | 525.00 | 4.17 |
| 0x7e040 | 0x320 | 126 | 2 | 3 | 1 | 525.00 | 4.17 |
| 0x7f040 | 0x320 | 127 | 2 | 3 | 1 | 529.17 | 4.17 |
| 0x55040 | 0x220 | 85 | 2 | 2 | 1 | 531.25 | 2.08 |
| 0x80040 | 0x320 | 128 | 2 | 3 | 1 | 533.33 | 2.08 |
| 0x56040 | 0x220 | 86 | 2 | 2 | 1 | 537.50 | 4.17 |
| 0x57040 | 0x220 | 87 | 2 | 2 | 1 | 543.75 | 6.25 |
| 0x58040 | 0x220 | 88 | 2 | 2 | 1 | 550.00 | 6.25 |
| 0x59040 | 0x220 | 89 | 2 | 2 | 1 | 556.25 | 6.25 |
| 0x5a040 | 0x220 | 90 | 2 | 2 | 1 | 562.50 | 6.25 |
| 0x5b040 | 0x220 | 91 | 2 | 2 | 1 | 568.75 | 6.25 |
| 0x5c040 | 0x220 | 92 | 2 | 2 | 1 | 575.00 | 6.25 |
| 0x5d040 | 0x220 | 93 | 2 | 2 | 1 | 581.25 | 6.25 |
| 0x5e040 | 0x220 | 94 | 2 | 2 | 1 | 587.50 | 6.25 |
| 0x5f040 | 0x220 | 95 | 2 | 2 | 1 | 593.75 | 6.25 |
| 0x60040 | 0x220 | 96 | 2 | 2 | 1 | 600.00 | 6.25 |
| 0x61040 | 0x220 | 97 | 2 | 2 | 1 | 606.25 | 6.25 |
| 0x62040 | 0x220 | 98 | 2 | 2 | 1 | 612.50 | 6.25 |
| 0x63040 | 0x220 | 99 | 2 | 2 | 1 | 618.75 | 6.25 |
| 0x64040 | 0x220 | 100 | 2 | 2 | 1 | 625.00 | 6.25 |
| 0x65040 | 0x220 | 101 | 2 | 2 | 1 | 631.25 | 6.25 |
| 0x66040 | 0x220 | 102 | 2 | 2 | 1 | 637.50 | 6.25 |
| 0x67040 | 0x220 | 103 | 2 | 2 | 1 | 643.75 | 6.25 |
| 0x68040 | 0x220 | 104 | 2 | 2 | 1 | 650.00 | 6.25 |
| 0x69040 | 0x220 | 105 | 2 | 2 | 1 | 656.25 | 6.25 |
| 0x6a040 | 0x220 | 106 | 2 | 2 | 1 | 662.50 | 6.25 |
| 0x6b040 | 0x220 | 107 | 2 | 2 | 1 | 668.75 | 6.25 |
| 0x6c040 | 0x220 | 108 | 2 | 2 | 1 | 675.00 | 6.25 |
| 0x6d040 | 0x220 | 109 | 2 | 2 | 1 | 681.25 | 6.25 |
| 0x6e040 | 0x220 | 110 | 2 | 2 | 1 | 687.50 | 6.25 |
| 0x6f040 | 0x220 | 111 | 2 | 2 | 1 | 693.75 | 6.25 |
| 0x70040 | 0x220 | 112 | 2 | 2 | 1 | 700.00 | 6.25 |
| 0x71040 | 0x220 | 113 | 2 | 2 | 1 | 706.25 | 6.25 |
| 0x72040 | 0x220 | 114 | 2 | 2 | 1 | 712.50 | 6.25 |
| 0x73040 | 0x220 | 115 | 2 | 2 | 1 | 718.75 | 6.25 |

| | | | | | | | |
|---------|-------|-----|---|---|---|---------|-------|
| 0x74040 | 0x220 | 116 | 2 | 2 | 1 | 725.00 | 6.25 |
| 0x75040 | 0x220 | 117 | 2 | 2 | 1 | 731.25 | 6.25 |
| 0x76040 | 0x220 | 118 | 2 | 2 | 1 | 737.50 | 6.25 |
| 0x77040 | 0x220 | 119 | 2 | 2 | 1 | 743.75 | 6.25 |
| 0x78040 | 0x220 | 120 | 2 | 2 | 1 | 750.00 | 6.25 |
| 0x79040 | 0x220 | 121 | 2 | 2 | 1 | 756.25 | 6.25 |
| 0x7a040 | 0x220 | 122 | 2 | 2 | 1 | 762.50 | 6.25 |
| 0x7b040 | 0x220 | 123 | 2 | 2 | 1 | 768.75 | 6.25 |
| 0x7c040 | 0x220 | 124 | 2 | 2 | 1 | 775.00 | 6.25 |
| 0x7d040 | 0x220 | 125 | 2 | 2 | 1 | 781.25 | 6.25 |
| 0x7e040 | 0x220 | 126 | 2 | 2 | 1 | 787.50 | 6.25 |
| 0x7f040 | 0x220 | 127 | 2 | 2 | 1 | 793.75 | 6.25 |
| 0x80040 | 0x220 | 128 | 2 | 2 | 1 | 800.00 | 6.25 |
| 0x41040 | 0x120 | 65 | 2 | 1 | 1 | 812.50 | 12.50 |
| 0x42040 | 0x120 | 66 | 2 | 1 | 1 | 825.00 | 12.50 |
| 0x43040 | 0x120 | 67 | 2 | 1 | 1 | 837.50 | 12.50 |
| 0x44040 | 0x120 | 68 | 2 | 1 | 1 | 850.00 | 12.50 |
| 0x45040 | 0x120 | 69 | 2 | 1 | 1 | 862.50 | 12.50 |
| 0x46040 | 0x120 | 70 | 2 | 1 | 1 | 875.00 | 12.50 |
| 0x47040 | 0x120 | 71 | 2 | 1 | 1 | 887.50 | 12.50 |
| 0x48040 | 0x120 | 72 | 2 | 1 | 1 | 900.00 | 12.50 |
| 0x49040 | 0x120 | 73 | 2 | 1 | 1 | 912.50 | 12.50 |
| 0x4a040 | 0x120 | 74 | 2 | 1 | 1 | 925.00 | 12.50 |
| 0x4b040 | 0x120 | 75 | 2 | 1 | 1 | 937.50 | 12.50 |
| 0x4c040 | 0x120 | 76 | 2 | 1 | 1 | 950.00 | 12.50 |
| 0x4d040 | 0x120 | 77 | 2 | 1 | 1 | 962.50 | 12.50 |
| 0x4e040 | 0x120 | 78 | 2 | 1 | 1 | 975.00 | 12.50 |
| 0x4f040 | 0x120 | 79 | 2 | 1 | 1 | 987.50 | 12.50 |
| 0x50040 | 0x120 | 80 | 2 | 1 | 1 | 1000.00 | 12.50 |

3.4 Nonce respond format

| | | |
|--------|--------|-----------|
| 4bytes | Bit[7] | Bit[6:0] |
| Nonce | 1 | WorkCount |

3.5 Configuration description

Support two modes:

- FIL (Fixed Input Length)
- VIL (Variable Input Length)

When system reset (RST_N is low), if ADDR3 is HIGH, it is FIL mode; else it is VIL mode.

3.5.1 Command

| | | |
|-----|----------|------------------------------------|
| ALL | CMD[6:0] | command |
| 0/1 | 1 | SetAddress |
| 1 | 2 | SetPLLDivider2 |
| 0/1 | 4 | GetStatus |
| 1 | 5 | ChainInactive |
| 0/1 | 6 | SetBaudOPS |
| 1 | 0x7 | SetPLLDivider1 |
| 0/1 | 0x8 | SetConfig. Only valid in VIL mode. |

3.5.2 SetAddress

FIL:

| | | | | | |
|-----|-------|-------|----------|----------|-------|
| 31 | 30:24 | 23:16 | 15:8 | 7:6 | [5:0] |
| ALL | CMD | ADDR | Reserved | Reserved | CRC5 |

VIL:

| | | | | | | | |
|--------|-------|-----|----------|-------|----------|----------|------|
| Byte0 | | | Byte1 | Byte2 | Byte3 | Byte4 | |
| 7:5 | 4 | 3:0 | 7:0 | 7:0 | 7:0 | 7:5 | 4:0 |
| TYPE=2 | ALL=0 | CMD | Length=5 | ADDR | Reserved | Reserved | CRC5 |

3.5.3 ChainInactive

FIL:

| | | | | | |
|-----|-------|----------|----------|----------|------|
| 31 | 30:24 | 23:16 | 15:8 | 7:5 | 4:0 |
| ALL | CMD | Reserved | Reserved | Reserved | CRC5 |

VIL:

| | | | | | | | |
|--------|-------|-----|----------|----------|----------|----------|------|
| Byte0 | | | Byte1 | Byte2 | Byte3 | Byte4 | |
| 7:5 | 4 | 3:0 | 7:0 | 7:0 | 7:0 | 7:5 | 4:0 |
| TYPE=2 | ALL=1 | CMD | Length=5 | Reserved | Reserved | Reserved | CRC5 |

3.5.4 SetPLLDivider

SetPLLDivider1:

| | | | | | | |
|----|-------|----|-------|----|------|-----|
| 31 | 30:24 | 23 | 23:12 | 11 | 10:5 | 4:0 |
|----|-------|----|-------|----|------|-----|

| | | | | | | |
|----------|-----|----------|-------------|----------|-------------|------|
| Reserved | CMD | Reserved | FBDIV[11:0] | Reserved | REFDIV[5:0] | CRC5 |
|----------|-----|----------|-------------|----------|-------------|------|

SetPLLDivider2:

| | | | | | | |
|-----|-------|-------|----------|---------------|---------------|------|
| 31 | 30:24 | 23:16 | 15:12 | 10:8 | 7:5 | 4:0 |
| ALL | CMD | ADDR | Reserved | POSTDIV1[2:0] | POSTDIV2[2:0] | CRC5 |

FBDIV: PLL feedback divider, range from 60 to 160.

REFDIV: PLL reference clock divider, range from 1 to 63.

POSTDIV1: PLL post divide 1, range 1 to 7.

POSTDIV2: PLL post divide 2, range 1 to 7. Total post divide is POSTDIV1* POSTDIV2.

The value of POSTDIV1 should ALWAYS be greater than or equal to POSTDIV2.

- $FOUTVCO = FREF/REFDIV \times FBDIV$
- $FOUTPOSTDIV = (FREF/REFDIV) \times FBDIV/POSTDIV1/POSTDIV2$

3.5.5 GetStatus

| | | | | | |
|-----|-------|-------|---------|----------|------|
| 31 | 30:24 | 23:16 | 15:8 | 7:5 | 4:0 |
| ALL | CMD | ADDR | REGADDR | Reserved | CRC5 |

Register Respond format:

| | | |
|-----------------------|----------|----------|
| 4bytes | Bit[7:5] | Bit[4:0] |
| Read data of register | 000 | CRC5 |

3.5.6 SetConfig

Only valid in VIL mode.

| | | | | | | | | |
|--------|-----|-----|----------|-------|---------|---------|----------|------|
| Byte0 | | | Byte1 | Byte2 | Byte3 | Byte4~7 | Byte8 | |
| 7:5 | 4 | 3:0 | 7:0 | 7:0 | 7:0 | | 7:5 | 4:0 |
| TYPE=2 | ALL | CMD | Length=9 | ADDR | REGADDR | REGDATA | Reserved | CRC5 |

4 Electrical Character

4.1 Absolute Maximum Rating

| Symbol | Parameter | Max value | Unit |
|------------------|---------------------|-----------|------|
| VDD | Core Voltage | 1.2 | V |
| VCC | IO Voltage | 1.98 | V |
| PLL_DVDD | PLL Digital power | 1.2 | V |
| PLL_AVDD | PLL analog Power | 1.92 | V |
| T _{STG} | Storage Temperature | -65~150 | °C |

4.2 Recommended Operation Conditions

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|------------------|-----------------------|------|------|------|------|
| VDD | Core Voltage | 0.60 | 0.66 | 0.8 | V |
| IO_VDD | IO Voltage | 1.62 | 1.8 | 1.98 | V |
| PLL_VDD | PLL Digital power | 0.81 | 0.9 | 0.99 | V |
| T _{OPT} | Operation Temperature | 0 | 25 | 125 | °C |

4.3 DC Characters

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|-----------------------|--|------|------|------|------|
| V _{IL} | Input Low Voltage | -0.3 | | 0.63 | V |
| V _{IH} | Input High Voltage | 1.17 | | 1.98 | V |
| V _{OL} | Output Low Voltage | | | 0.45 | V |
| V _{OH} | Output High Voltage | 1.35 | | | V |
| I _L | Input Leakage Current | | | ±10 | uA |
| V _T | I/O threshold point | 0.81 | 0.89 | 0.97 | V |
| V _{T+} | Schmitt input low to high threshold pint | 0.95 | 1.03 | 1.10 | V |
| V _{T-} | Schmitt input high to low threshold pint | 0.64 | 0.75 | 0.86 | V |
| R _{PU} | I/O internal pull-up resistor | 47K | 69K | 106K | Ω |
| R _{PD} | I/O internal pull-down resistor | 49K | 85K | 159K | Ω |
| I _{CC} (VCC) | Supply current of VCC | | 10 | | mA |
| I _{CC} (PLL) | Supply current of PLL_DVDD and PLL_AVDD | | 4 | | mA |
| CB _{IN} | Input pin capacitance | | 10 | | pF |

| | | | | | |
|-------------------|------------------------|--|----|--|----|
| CB _{OUT} | Output pin capacitance | | 10 | | pF |
|-------------------|------------------------|--|----|--|----|