



# TESLA C2050 AND TESLA C2070 COMPUTING PROCESSOR BOARD

BD-04983-001\_v05 | September 2011

## Board Specification



# DOCUMENT CHANGE HISTORY

BD-04983-001\_v05

Version	Date	Authors	Description of Change
01	November 16, 2009	RK, SM	Initial Release (Preliminary information)
02	May 7, 2010	RK, SM	Pre Production Release
03	July 16, 2010	RK, SM	Updated specification with more recent boards
04	September 10, 2010	RK, SM	<ul style="list-style-type: none"><li>•Updated board power</li><li>•Added note to “Thermal Specifications” section</li></ul>
05	September 9, 2011	MC, SM	Updated Table 9 in the “Cooling Solution” section

# TABLE OF CONTENTS

<b>Overview</b> .....	<b>1</b>
Key Features .....	2
Computing Processor Description .....	3
Configuration .....	4
<b>Mechanical Specifications</b> .....	<b>5</b>
PCI Express System .....	5
Standard I/O Connector Placement .....	6
Internal Connectors and headers .....	7
External PCI Express Power Connectors .....	7
4-Pin Fan Connector .....	11
<b>Power Specifications</b> .....	<b>12</b>
Power by Rail .....	13
<b>Thermal Specifications</b> .....	<b>14</b>
Thermal Qualification Summary .....	14
Cooling Solution .....	16
<b>Support Information</b> .....	<b>17</b>
Certificates and Agencies .....	17
Agencies .....	17
Languages .....	18

## LIST OF FIGURES

Figure 1.	Tesla C2050 / Tesla C2070 Block Diagram .....	3
Figure 2.	Tesla C2050 / Tesla C2070 Computing Processor Board .....	5
Figure 3.	Tesla C2050 / Tesla C2070 Bracket .....	6
Figure 4.	6-Pin PCI Express Power Connector .....	8
Figure 5.	8-Pin PCI Express Power Connector .....	9
Figure 6.	4-Pin Fan Connector .....	11

## LIST OF TABLES

Table 1.	Board Configurations.....	4
Table 2.	6-Pin PCI Express Power Connector Pinout .....	10
Table 3.	8-Pin PCI Express Power Connector Pinout .....	10
Table 4.	4 Wire Thermal Control Pinout .....	11
Table 5.	Configuration with External PCI Express Connectors.....	12
Table 6.	Power by Rail .....	13
Table 7.	Test Setup and Configuration.....	15
Table 8.	Sample Thermal Results and Specification .....	15
Table 9.	Environmental Specifications and Conditions .....	16
Table 10.	Languages Supported .....	18

# OVERVIEW

The NVIDIA® Tesla™ C2050 / Tesla C2070 computing processor board is a PCI Express 2.0 full-height (4.376 inches by 9.75 inches) form factor computing add-in card based on the NVIDIA Tesla T20 graphics processing unit (GPU). This board is targeted as high-performance computing (HPC) solution for PCI Express systems.

The Tesla C2050 / Tesla C2070 is capable of running 515 GFLOPs/sec of double precision processing performance. Tesla C2050 comes standard with 3 GB of GDDR5 memory at 144 GB/s bandwidth. Tesla C2070 comes standard with 6 GB of GDDR5 memory.

Both the Tesla C2050 and Tesla C2070 can be configured by the end user to enable or disable ECC or error correcting codes that can fix single-bit errors and report double-bit errors. Enabling ECC will cause some of the memory to be used for the ECC bits so the user available memory will decrease to 2.625 GB for Tesla C2050 and 5.25 GB for Tesla C2070.

## KEY FEATURES

### GPU

- ▶ Number of processor cores: 448
- ▶ Processor core clock: 1.15 GHz
- ▶ Voltage: 1.00 V
- ▶ Package size: 42.5 mm × 42.5 mm 1981-pin ball grid array (BGA)

### Board

- ▶ Ten layers printed circuit board (PCB)
- ▶ PCI Express Gen2 ×16 system interface
- ▶ Physical dimensions: 4.376 inches × 9.75 inches, dual slot
- ▶ Board power dissipation
  - Tesla C2050/Tesla C2070: Less than or equal to 238 W

### External Connectors

- ▶ Single port, dual-link DVI-I

### Internal Connectors and Headers

- ▶ One 6-pin PCI Express power connector
- ▶ One 8-pin PCI Express power connector
- ▶ 4-pin fan connector

### Memory

- ▶ Memory clock: 1.50 GHz
- ▶ Interface: 384-bit
  - Tesla C2050
    - 3 GB
    - 24 pieces 32M × 32 GDDR5 136-pin BGA, SDRAM
  - Tesla C2070
    - 6GB
    - 24 pieces 64M × 32 GDDR5 136-pin BGA, SDRAM

### BIOS

- ▶ 2Mbit Serial ROM

## COMPUTING PROCESSOR DESCRIPTION

Figure 1 is a block diagram of the Tesla C2050 / Tesla C2070 computing processor.

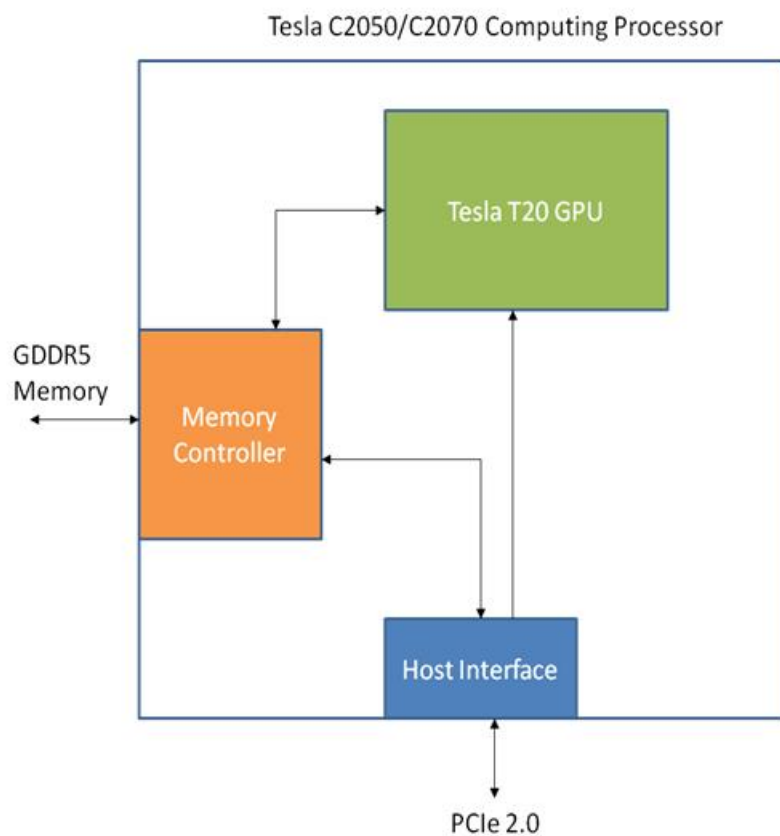


Figure 1. Tesla C2050 / Tesla C2070 Block Diagram

## CONFIGURATION

There is one configuration available (Table 1) for the Tesla C2050 / Tesla C2070 board.

Table 1. Board Configurations

Specification	Description
Generic SKU reference	900-21030-0000-000
Chip	Tesla T20 GPU
Package size GPU	42.5 mm x 42.5 mm
Processor clock	1.15 GHz
Memory clock	1.50 GHz
Memory size	<ul style="list-style-type: none"> <li>• 3 GB (Tesla C2050)</li> <li>• 6 GB (Tesla C2070)</li> </ul>
Memory I/O	384-bit GDDR5
Memory configuration	<ul style="list-style-type: none"> <li>• 24 pcs 32M x 32 GDDR5 SDRAM (Tesla C2050)</li> <li>• 24 pcs 64M x 32 GDDR5 SDRAM (Tesla C2070)</li> </ul>
External connectors	Single port, dual-link DVI-I
Internal connectors and headers	<ul style="list-style-type: none"> <li>• 8-pin PCI Express power connector</li> <li>• 6-pin PCI Express power connector</li> <li>• 4-pin fan connector</li> </ul>
Board power	< = 238 W (Tesla C2050 and Tesla C2070)
Thermal cooling solution	Custom active fan sink



# MECHANICAL SPECIFICATIONS

## PCI EXPRESS SYSTEM

The Tesla C2050 / Tesla C2070 computing processor board (Figure 2) conforms to the PCI Express full height (4.376 inches by 9.75 inches) form factor.

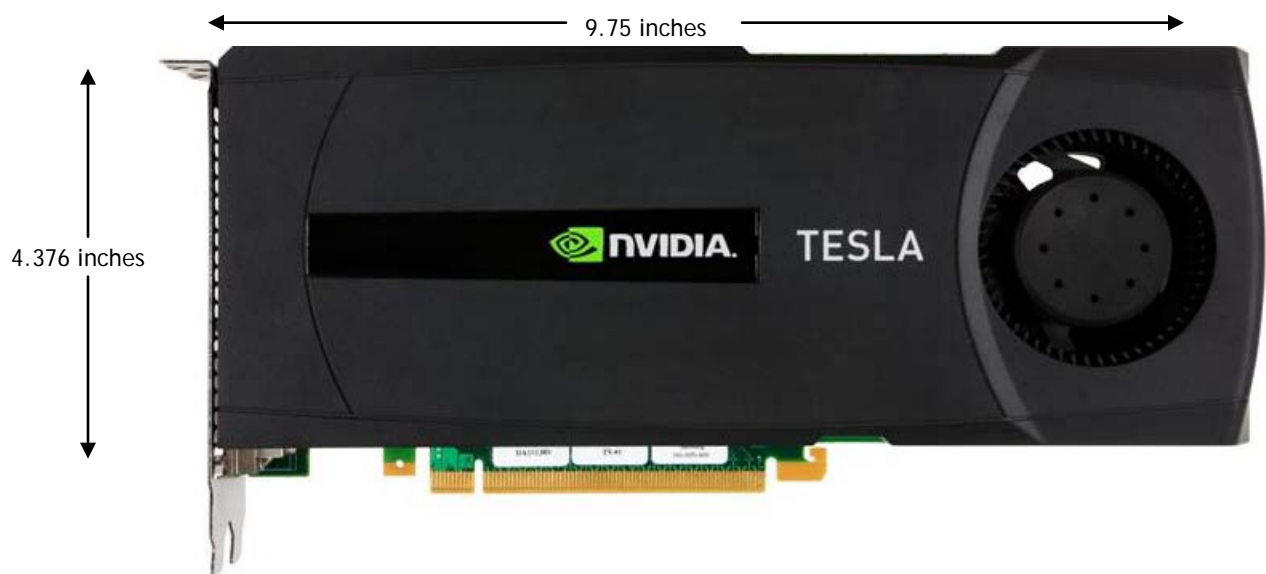


Figure 2. Tesla C2050 / Tesla C2070 Computing Processor Board

## STANDARD I/O CONNECTOR PLACEMENT

As shown in Figure 3, the Tesla C2050 / Tesla C2070 includes a single, dual-link DVI-I connector.

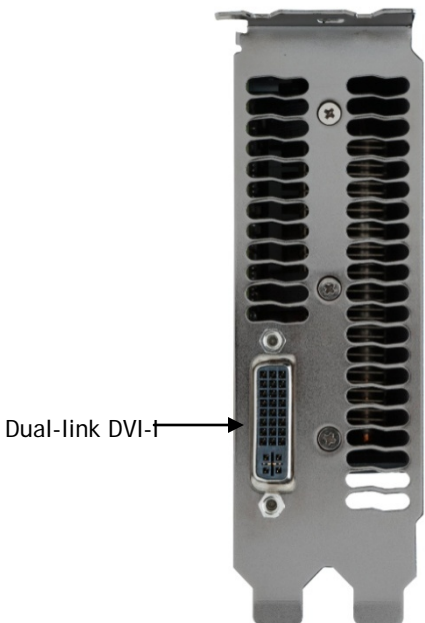


Figure 3. Tesla C2050 / Tesla C2070 Bracket

## INTERNAL CONNECTORS AND HEADERS

The Tesla C2050 / Tesla C2070 module supports the following internal connectors and headers.

- ▶ 8-pin PCI Express power connector (can be used with a 6-pin power cable)
- ▶ 6-pin PCI Express power connector
- ▶ 4-pin fan connector

## External PCI Express Power Connectors

The Tesla C2050 / Tesla C2070 module is a performance-optimized, high-end product and utilizes power from the PCI Express connector as well as external power connectors. The board can be used in two different ways.

- ▶ One 8-pin PCI Express power connector and one 6-pin PCI Express power connector or
- ▶ One 8-pin PCI Express power connector (if system power supply can supply enough load)

Figure 4 and Figure 5 show the specifications and Table 2 and Table 3 show the pinouts for the 6-pin and 8-pin PCI Express power connectors.

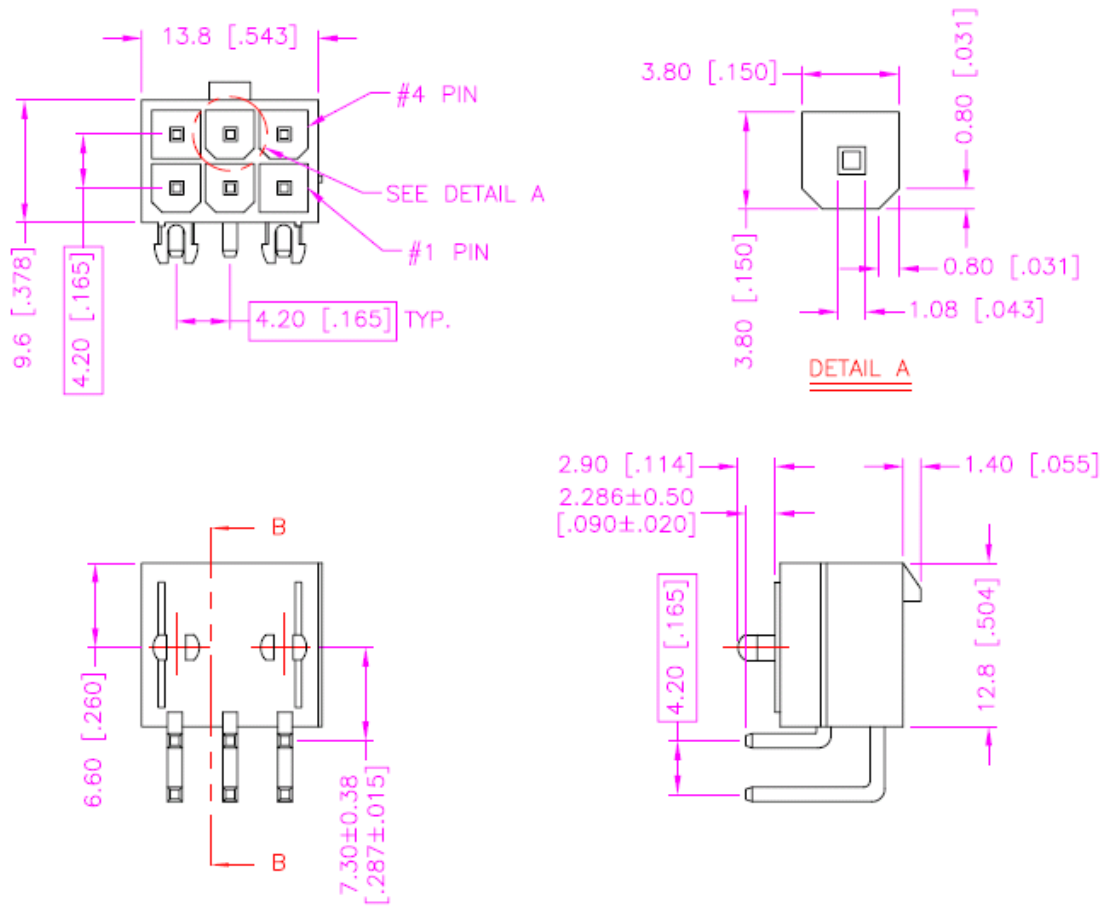


Figure 4. 6-Pin PCI Express Power Connector

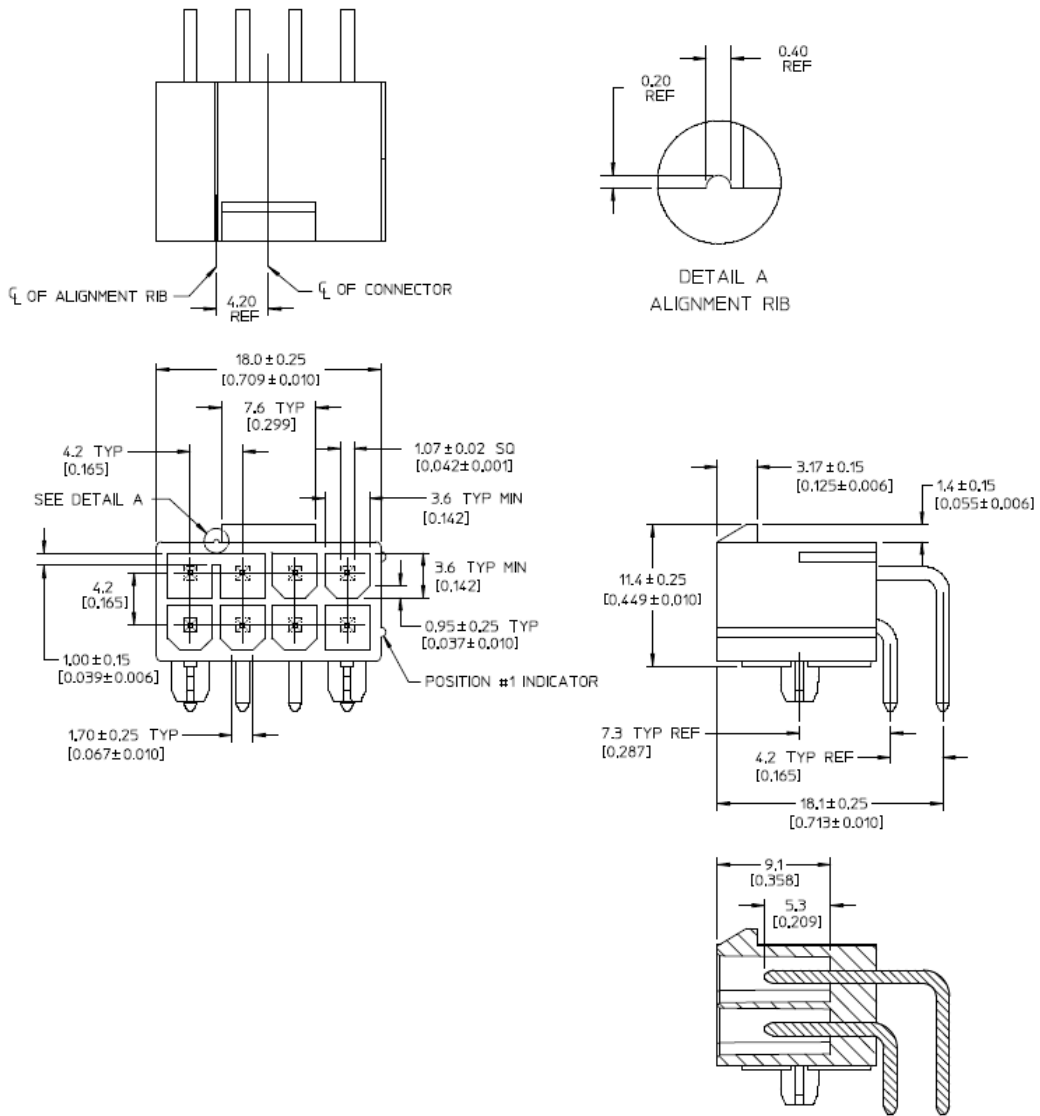


Figure 5. 8-Pin PCI Express Power Connector

Table 2. 6-Pin PCI Express Power Connector Pinout

Pin Number	Description
1	+12 V
2	+12 V
3	+12 V
4	GND
5	Sense
6	GND

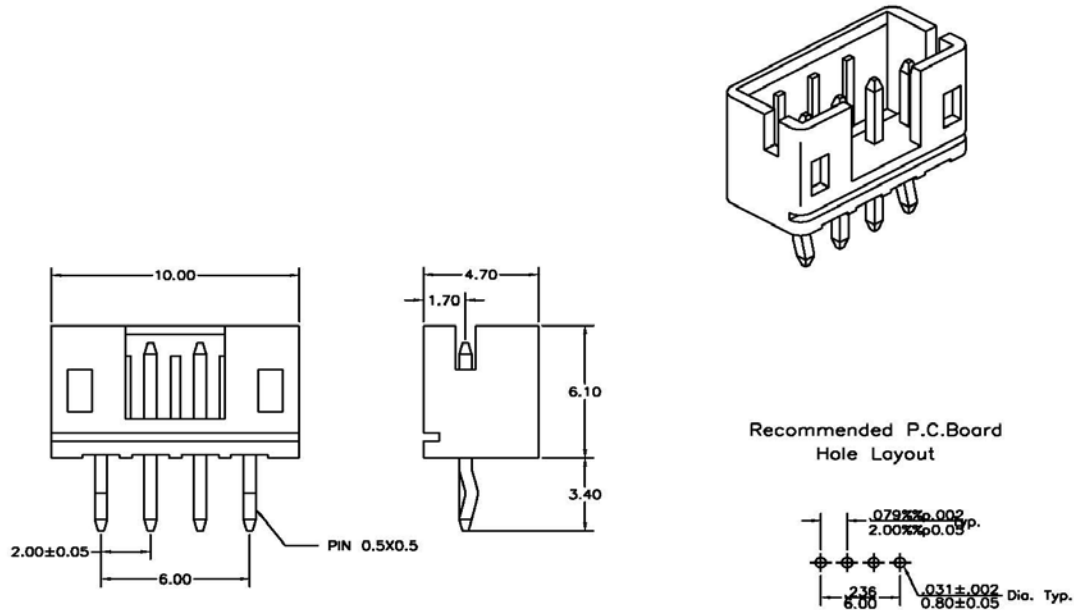
Table 3. 8-Pin PCI Express Power Connector Pinout

Pin Number	Description
1	+12 V
2	+12 V
3	+12 V
4	Sense1
5	GND
6	Sense0
7	GND
8	GND

## 4-Pin Fan Connector

The Tesla C2050 / Tesla C2070 board uses a 4-pin fan to control the fan speed of the thermal solution. The details of the connector (P/N: PH-T-4) are given in Figure 6. This part is a 2.0 mm (0.079") pitch disconnectable connector.

Table 4 lists the pin assignments for this connector.



Tolerance :  $\pm 0.25\text{mm}$

### Specifications:

- \* Current Rating : 2A AC, DC
- \* Voltage Rating : 250V AC, DC
- \* Temperature Range :  $-40^{\circ}\text{C}$  to  $+105^{\circ}\text{C}$
- \* Contact Resistance : Initial Value/10  $\text{m}\Omega$  Max.  
After Environmental Testing  
/20  $\text{m}\Omega$  Max.
- \* Insulation Resistance : 1000  $\text{M}\Omega$  Min.
- \* Withstand Voltage : 1500 VAC/Minute
- \* RoHS compliant.

### Features:

- **Wafer**
- Model No. : PH-T-4
- Circuits : 4
- Material : Post : Brass Tin/Plated  
Base : Nylon 66, UL94V-0
- P.C.Board Thickness : 1.6mm(.063")

Figure 6. 4-Pin Fan Connector

Table 4. 4 Wire Thermal Control Pinout

Pin Number	Description
1	PWM (to fan)
2	TACH (from fan)
3	+12 V
4	GND

# POWER SPECIFICATIONS

The Tesla C2050 / Tesla C2070 computing processor is a performance-optimized, high-end board solution. Power is taken from the PCI Express host bus as well as the 8-pin and the 6-pin PCI Express power connectors.

Without auxiliary power provided to the Tesla C2050 / Tesla C2070 board, the board will boot at reduced power and functionality and LED lights on the board will light up as listed in Table 5. This table outlines the different possible scenarios as well as the resulting behaviors.

Table 5. Configuration with External PCI Express Connectors

8-Pin Power Connector	6-Pin Power Connector	Result
Connected (either 8-pin or 6-pin)	Connected	Full power - LED light on the bracket is GREEN by default
8-pin connected	Not connected	Full power - LED light on the bracket is GREEN by default
6-pin connected	Not connected	LED light is RED - board will display warning banner to the user
Not connected	Connected	LED light is RED - board will display warning banner to the user
Not connected	Not connected	LED light is RED - board will display warning banner to the user



## POWER BY RAIL

Table 6 lists the power by rail numbers for the Tesla C2050 / Tesla C2070 board. Power by rail measurements are worst case scenarios per rail while maximum TDP power is based on our worst case power application.

Table 6. Power by Rail

PEX12V	PEX3V3	EXT12V	Total Board Power
$\leq 65 \text{ W}$	$\leq 10 \text{ W}$	$\leq 184 \text{ W}$	Less than or equal to 238 W

# THERMAL SPECIFICATIONS

## THERMAL QUALIFICATION SUMMARY

The information contained in this summary report is intended to provide users of the Tesla C2050 / Tesla C2070 computing processor with thermal information necessary to assist in thermal management efforts. This information is not intended to provide a specific thermal management solution. However, it does show an approach that result in the reliable operation of the Tesla C2050 / Tesla C2070.



**Note:** The ambient air temperature around the inlet of the GPU fan should never exceed 45 °C.

The product and cooling solutions used are:

- ▶ Device product: Tesla C2050 / Tesla C2070 board
- ▶ Thermal Test Application: NBODY
- ▶ Result: Under the operating conditions described in the following tables, the Tesla C2050 / Tesla C2070 passed thermal qualification.

Table 7. Test Setup and Configuration

System Part	Configuration
PC	Motherboard attached to a chassis frame - entire unit placed in an acrylic box
Motherboard	NVIDIA nForce® 790i Ultra SLI
Power supply	ThermalTake 1000 W
CPU	Intel Core 2 Extreme QX9650 Yorkfiled 3.0 GHz 12 MB L2 Cache LGA 775 130 W Quad-Core processor
SDRAM	DDR5 2000; 2 - 1 GB OCZ memory cards
PC operating system	Windows XP 32-bit
GPU computing processing board	Tesla C2050
BIOS	70.00.24.00.00
Display driver	197.69
GPU	Tesla T20
Clock speed	1.15 GHz (core) 1500 MHz (mclk)

Table 8. Sample Thermal Results and Specification

Test Application	T <sub>junction</sub> (°C)*	T <sub>A</sub> (°C)**	Cooling solution
Test 1: NBODY	95	45.4	097-0006-001
GPU junction maximum temperature specification under any operating conditions	Thermal Slowdown: 100	At any ambient temperature	
	Thermal Shutdown: 105		

\* Junction temperature is reported by NVIDIA thermal sensor

\*\* Ambient air temperature - average of 3 sensors positioned at the inlet to the GPU fan

## COOLING SOLUTION

NVIDIA will utilize a Cooler Master active fan sink to cool the GPU, memories and power components. For environmental specifications refer to Table 9.

Table 9. Environmental Specifications and Conditions

Specifications	Conditions
Acoustic noise	25 to 37 dB A
Storage temperature	-40 °C to 75 °C
Storage humidity	5% to 95% RH

# SUPPORT INFORMATION

## CERTIFICATES AND AGENCIES

### Agencies

- ▶ Australian Communications Authority and Radio Spectrum Management Group of New Zealand (C-Tick)
- ▶ Bureau of Standards, Metrology, and Inspection (BSMI)
- ▶ Conformité Européenne (CE)
- ▶ Federal Communications Commission (FCC)
- ▶ Industry Canada - Interference-Causing Equipment Standard (ICES)
- ▶ Korean Communications Commission (KCC)
- ▶ Underwriters Laboratories (cUL)
- ▶ Voluntary Control Council for Interference (VCCI)

## LANGUAGES

Table 10. Languages Supported

	Windows XP	Windows 7	Windows Vista	Linux
English (US)	X	X	X	X
English (UK)	X	X	X	
Arabic	X	X	X	
Chinese, Simplified	X	X	X	
Chinese, Traditional	X	X	X	
Danish	X	X	X	
Dutch	X	X	X	
Finnish	X	X	X	
French	X	X	X	
French (Canada)	X	X	X	
German	X	X	X	
Italian	X	X	X	
Japanese	X	X	X	
Korean	X	X	X	
Norwegian	x	x	x	
Portuguese (Brazil)	X	X	X	
Russian	X	X	X	
Spanish	X	X	X	
Spanish (Latin America)	X	X	X	
Swedish	X	X	X	
Thai	X	X	X	

**NOTE:** NVIDIA's CUDA software is only supported in English (U.S.)

## Notice

ALL NVIDIA DESIGN SPECIFICATIONS, REFERENCE BOARDS, FILES, DRAWINGS, DIAGNOSTICS, LISTS, AND OTHER DOCUMENTS (TOGETHER AND SEPARATELY, "MATERIALS") ARE BEING PROVIDED "AS IS." NVIDIA MAKES NO WARRANTIES, EXPRESSED, IMPLIED, STATUTORY, OR OTHERWISE WITH RESPECT TO THE MATERIALS, AND EXPRESSLY DISCLAIMS ALL IMPLIED WARRANTIES OF NONINFRINGEMENT, MERCHANTABILITY, AND FITNESS FOR A PARTICULAR PURPOSE.

Information furnished is believed to be accurate and reliable. However, NVIDIA Corporation assumes no responsibility for the consequences of use of such information or for any infringement of patents or other rights of third parties that may result from its use. No license is granted by implication of otherwise under any patent rights of NVIDIA Corporation. Specifications mentioned in this publication are subject to change without notice. This publication supersedes and replaces all other information previously supplied. NVIDIA Corporation products are not authorized as critical components in life support devices or systems without express written approval of NVIDIA Corporation.

## HDMI

HDMI, the HDMI logo, and High-Definition Multimedia Interface are trademarks or registered trademarks of HDMI Licensing LLC.

## ROVI Compliance Statement

NVIDIA Products that are ROVI-enabled can only be sold or distributed to buyers with a valid and existing authorization from ROVI to purchase and incorporate the device into buyer's products.

This device is protected by U.S. patent numbers 6,516,132; 5,583,936; 6,836,549; 7,050,698; and 7,492,896 and other intellectual property rights. The use of ROVI Corporation's copy protection technology in the device must be authorized by ROVI Corporation and is intended for home and other limited pay-per-view uses only, unless otherwise authorized in writing by ROVI Corporation. Reverse engineering or disassembly is prohibited.

## OpenCL

OpenCL is a trademark of Apple Inc. used under license to the Khronos Group Inc.

## Trademarks

NVIDIA, the NVIDIA logo, CUDA and Tesla are trademarks or registered trademarks of NVIDIA Corporation in the U.S. and other countries. Other company and product names may be trademarks of the respective companies with which they are associated.

## Copyright

© 2009, 2010, 2011 NVIDIA Corporation. All rights reserved.