# RCB006

## 5 Bit Voltage Regulator Module (VRM) for Pentium® II Processors

For 12V Input Voltage

## Features

- Programmable 1.3V to 3.5V output
- Output current to 15A
- 5-bit digital input selects output voltage
- Typical efficiency > 82%
- DC output accuracy within ±60mV
- Current limiting short-circuit protection
- Power Good output
- Output Enable function
- Excellent transient response
- Meets Intel VRM specification 8.2

## Applications

- Pentium II Klamath VRM
- Next generation Pentium II VRM

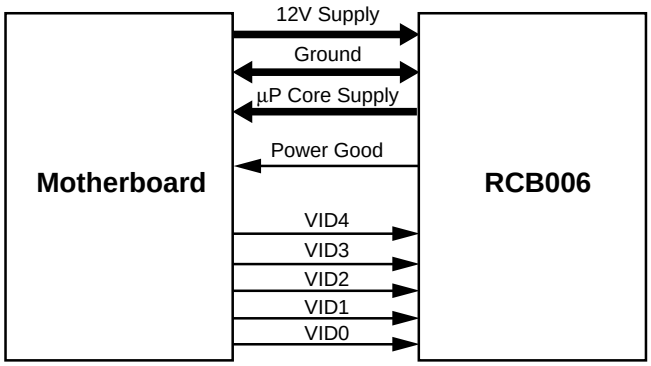
## Description

The RCB006 is a programmable DC-DC VRM designed to deliver the selectable processor core voltage required by Pentium II and Pentium Pro processors. This VRM converts the +12V power supply voltage to the voltage required by the CPU core.

By taking advantage of Raytheon's RC5051 programmable DC-DC controller IC, the RCB006 utilizes a synchronous architecture for maximum efficiency. In addition, this VRM integrates a 5-bit DAC function, Power Good, and Output Enable features. The result is a VRM with a minimum number of components that achieves high reliability at a competitive cost.

The RCB006 provides an extremely well regulated selectable output voltage from 1.3V to 3.5V. Voltage selection is accomplished through a 5-bit digital input. The Power Good output provides a logic LOW when an out-of-tolerance voltage is detected at the VRM output. Other features include high efficiency, short-circuit and over-voltage protection, output enable, and low package weight. The RCB006 has been designed as a point-of-load converter for Pentium II and Pentium Pro processors, minimizing the distribution losses normally occuring when drawing high currents from a centralized power supply.

## Block Diagram

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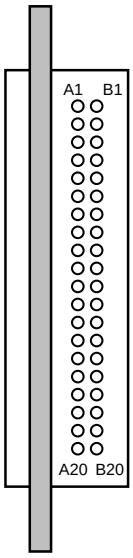
## Pin Orientation — Top View

**(Socket: AMPMOD2 532956-7 or equivalent)**




65-RCB005-2

**Table 1. RCB006 Pin Definitions**

| Pin # | Row A | Row B |
|---|---|---|
| 1 | 5Vin | 5Vin |
| 2 | 5Vin | 5Vin |
| 3 | 5Vin | 5Vin |
| 4 | 12Vin | 12Vin |
| 5 | 12Vin | NC[1] |
| 6 | NC[1] | OUTEN |
| 7 | VID0 | VID1 |
| 8 | VID2 | VID3 |
| 9 | VID4 | PWRGD |
| 10 | $V_{CC_{CORE}}$ | Vss |
| 11 | Vss | $V_{CC_{CORE}}$ |
| 12 | $V_{CC_{CORE}}$ | Vss |
| 13 | Vss | $V_{CC_{CORE}}$ |
| 14 | $V_{CC_{CORE}}$ | Vss |
| 15 | Vss | $V_{CC_{CORE}}$ |
| 16 | $V_{CC_{CORE}}$ | Vss |
| 17 | Vss | $V_{CC_{CORE}}$ |
| 18 | $V_{CC_{CORE}}$ | Vss |
| 19 | Vss | $V_{CC_{CORE}}$ |
| 20 | $V_{CC_{CORE}}$ | Vss |

**Note:**
1. Not used on module; no current is drawn.

## VRM Connector Pin Reference

| Pin Description | Input/Output | Function |
|---|---|---|
| 12Vin | I | Primary module supply voltage. |
| 5Vin | I | IC bias supply voltage. |
| OUTEN (Output Enable) Open collector TTL input. | I | If OUTEN = HIGH (floating), output enabled.If OUTEN = LOW, output disabled and PWRGD output LOW. |
| VID0 to VID4 (Voltage Identification Code) Open collector TTL inputs. | I | These five signals are used to indicate the voltage required by the processor. See Table 2. |
| PWRGD (Power Good) Open collector TTL output. | O | If PWRGD = HIGH, output voltage within specifications. If PWRGD = LOW, output voltage not within ±10% of nominal. The PWRGD output will change to the proper state within 5ms of the output coming into or going out of its specified range. |
| $V_{CC_{CORE}}$ | O | Processor core voltage. |
| Vss | I, O | Ground. |

## Table 2. Output Voltage vs. Voltage Identification CodeNote:

| VID4 | VID3 | VID2 | VID1 | VID0 | Nominal Voltage to CPU ($V_{CCCORE}$) |
|---|---|---|---|---|---|
| 0 | 1 | 1 | 1 | 1 | 1.30V |
| 0 | 1 | 1 | 1 | 0 | 1.35V |
| 0 | 1 | 1 | 0 | 1 | 1.40V |
| 0 | 1 | 1 | 0 | 0 | 1.45V |
| 0 | 1 | 0 | 1 | 1 | 1.50V |
| 0 | 1 | 0 | 1 | 0 | 1.55V |
| 0 | 1 | 0 | 0 | 1 | 1.60V |
| 0 | 1 | 0 | 0 | 0 | 1.65V |
| 0 | 0 | 1 | 1 | 1 | 1.70V |
| 0 | 0 | 1 | 1 | 0 | 1.75V |
| 0 | 0 | 1 | 0 | 1 | 1.80V |
| 0 | 0 | 1 | 0 | 0 | 1.85V |
| 0 | 0 | 0 | 1 | 1 | 1.90V |
| 0 | 0 | 0 | 1 | 0 | 1.95V |
| 0 | 0 | 0 | 0 | 1 | 2.00V |
| 0 | 0 | 0 | 0 | 0 | 2.05V |

| VID4 | VID3 | VID2 | VID1 | VID0 | Nominal Voltage to CPU ($V_{CCCORE}$) |
|---|---|---|---|---|---|
| 1 | 1 | 1 | 1 | 1 | 2.0V |
| 1 | 1 | 1 | 1 | 0 | 2.1V |
| 1 | 1 | 1 | 0 | 1 | 2.2V |
| 1 | 1 | 1 | 0 | 0 | 2.3V |
| 1 | 1 | 0 | 1 | 1 | 2.4V |
| 1 | 1 | 0 | 1 | 0 | 2.5V |
| 1 | 1 | 0 | 0 | 1 | 2.6V |
| 1 | 1 | 0 | 0 | 0 | 2.7V |
| 1 | 0 | 1 | 1 | 1 | 2.8V |
| 1 | 0 | 1 | 1 | 0 | 2.9V |
| 1 | 0 | 1 | 0 | 1 | 3.0V |
| 1 | 0 | 1 | 0 | 0 | 3.1V |
| 1 | 0 | 0 | 1 | 1 | 3.2V |
| 1 | 0 | 0 | 1 | 0 | 3.3V |
| 1 | 0 | 0 | 0 | 1 | 3.4V |
| 1 | 0 | 0 | 0 | 0 | 3.5V |

**Note:**

1. "0" indicates processor pin is tied to 0V ($V_{SS}$)
   "1" indicates it is tied to 5V or is open.

# Electrical Specifications

5Vin = +5V, 12Vin = +12V, $T_A$ = 0°C to 60°C, $Vcc_{CORE}$ = 2.8V, and airflow of 100LFM, unless otherwise specified.

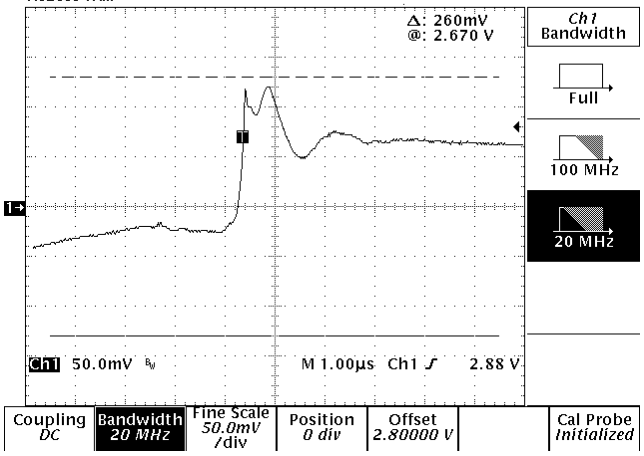
| Parameter | | Test Conditions[1] | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| **Input Specifications** | | | | | | |
| Primary Module Supply, 12Vin | | | 11.4 | 12.0 | 12.6 | V |
| IC Bias Supply, 5Vin | | | 4.75 | 5.0 | 5.25 | V |
| **Output Specifications** | | | | | | |
| Output Voltage Range, $Vcc_{CORE}$ | | See Table 2 | 1.3 | | 3.5 | V |
| Output Voltage Regulation | Steady State[2] | $Vcc_{CORE}$ = 2.8V, $Icc_{CORE, Max}$ = 14.2A | 2.74 | 2.80 | 2.90 | V |
| | Transient[3] | $Vcc_{CORE}$ = 2.8V, $Icc_{CORE}$ = 1.0 to 14.2A | 2.67 | 2.80 | 2.93 | |
| Output Voltage Regulation | Steady State[2] | $Vcc_{CORE}$ = 2.0V, $Icc_{CORE, Max}$ = 11.1A | 1.94 | 2.0 | 2.06 | V |
| | Transient[3] | $Vcc_{CORE}$ = 2.0V, $Icc_{CORE}$ = 0.5 to 11.1A | 1.90 | 2.0 | 2.10 | |
| Output Current, $Icc_{CORE}$ | | | 0.3 | | 15 | A |
| Initial Voltage Setpoint | | $Icc_{CORE}$ = 6A, $T_A$ = 25°C | | ±20 | | mV |
| Load Regulation | | $Icc_{CORE}$ = 0.8A to 14.2A | | -40 | | mV |
| Line Regulation | | 5Vin = 4.75V to 5.25V | | ±2 | | mV |
| Output Ripple | | 20MHz BW, $Icc_{CORE}$ = 14.2A | | 20 | | mVp-p |
| Output Temperature Drift | | | | +10 | | mV |
| Efficiency | | $Icc_{CORE}$ = 0.5A<br>$Icc_{CORE}$ = 14A | 40<br>80 | 65<br>82 | | % |
| Turn-on Response Time | | | | | 10 | ms |
| **General Specifications** | | | | | | |
| Switching Frequency | | | | 120 | | kHz |
| Short Circuit Protection | | | | 18 | | A |

**Notes:**

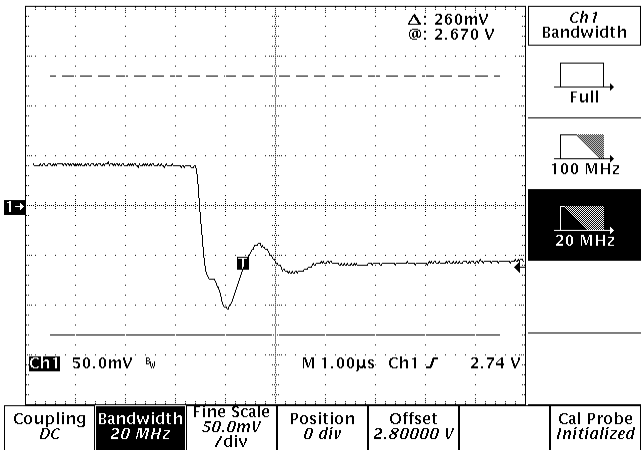
1. The voltage tolerance is measured at the DC-DC converter Header Output on the motherboard.
2. The Steady State Voltage Regulation includes Initial Voltage Setpoint, DC load regulation, Output Ripple and temperature drift, measured with a digital voltmeter with 1mV resolution. $Icc_{CORE, MIN}$ = 0.1A unless otherwise specified.
3. The output voltage is measured using the Intel provided EMT Tester (Rev. 1.0). It is assumed that a minimum of 20 x 0.1µF ceramic capacitors are placed directly next to the CPU to provide adequate high-speed decoupling. Additional bulk capacitors may be required as closely as possible to the CPU socket on the motherboard when using the VRM. See Application Bulletin AB 5 for details.

# Transient Plots

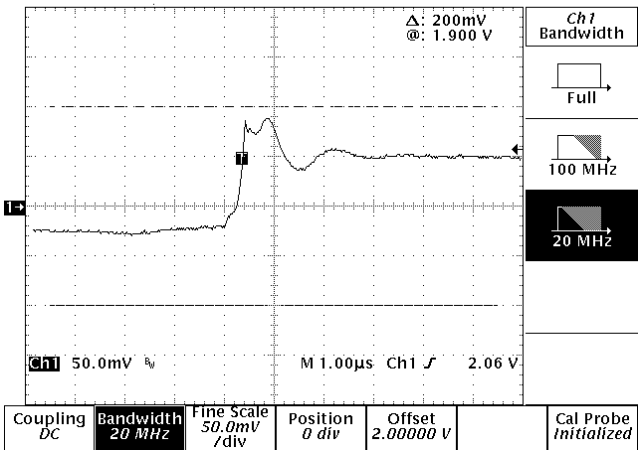
Transient Plot, Vout=2.8v, Iload=14.2A to 0.8A
RCB006 VRM



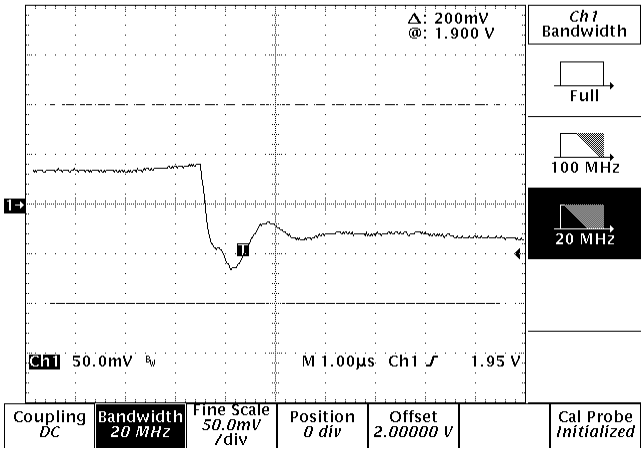

Transient Plot, Vout = 2.8V, Iload = 0.8A to 14.2A
RCB006 VRM




Transient Plot, Vout=2.0V, Iload=11.1A to 0.5A
RCB006 VRM

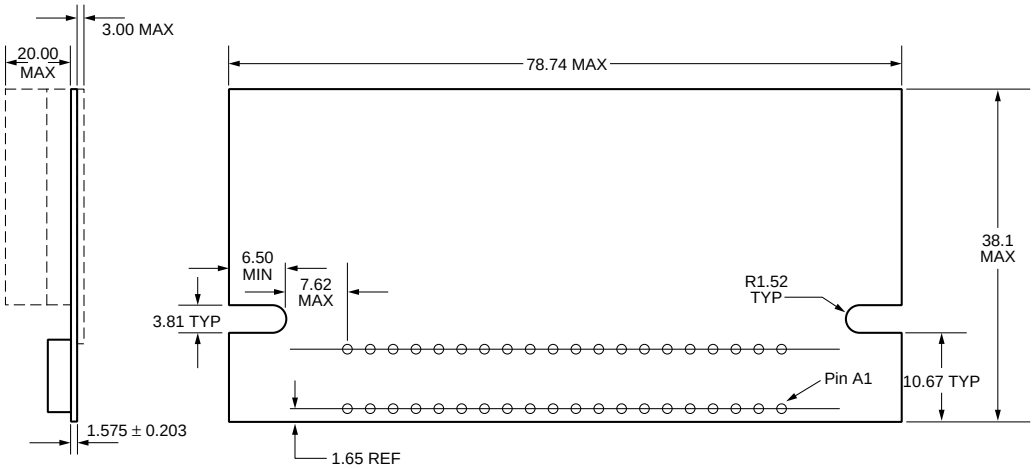



Transient Plot, Vout=2.0v, Iload=0.5A to 11.1A
RCB006 VRM



## Notes:

# Mechanical Dimensions (mm)



## Ordering Information

| Part Number | Input | Output Current |
|---|---|---|
| RCB006 | 12V DC | 15A |



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