



Device Features

- Compliant to Bluetooth specification V1.1
- Small footprint in 8mm x 8mm 81-ball BGA
- Fully integrated RF block with no external adjustments or trim
- USB V1.1 compliant
- Qualified Bluetooth firmware included
- Extensive built-in-self-test to minimise end product final test time
- RF reference designs available
- Low power consumption/optimisation
- Support for up to 7 slaves

BlueCore™01b

Single Chip Bluetooth Device

Product Data Sheet For:
BC01b-USB
(USB and UART version)
(BGA Packaging)

BC01b-URT
(UART only version)
(BGA Packaging)

BC01bv-USB
(USB and UART version)
(VFBGA Packaging)

BC01bv-URT
(UART only version)
(VFBGA Packaging)

General Description

BlueCore01b™ is a single chip radio and baseband IC for Bluetooth™ 2.4GHz radios, and is implemented in CMOS technology.

When used with external flash containing the CSR Bluetooth software stack, it provides a fully compliant Bluetooth system for data and voice communications.

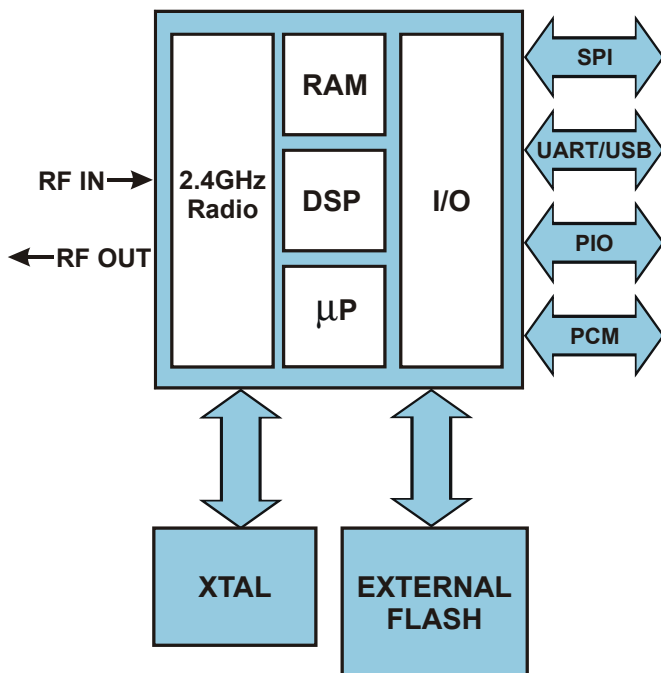


Figure 1: BlueCore01b Block Diagram

Applications

- Laptop and desktop PCs
- Mobile Phones
- Cordless Headsets
- Personal Digital Assistants (PDAs)
- Computer Accessories (Compact Flash, PCMCIA and SD cards)
- Domestic and industrial appliances

The design is optimised to require very few external RF components to facilitate rapid design of the application printed wiring board, and therefore the fastest possible time to market and lowest overall cost.

A low intermediate frequency receiver is utilised to allow on-chip channel filtering. All hardware is fully compliant with the Bluetooth specification.

The device operates from a regulated supply in the range 2.7V to 3.3V and is available in an 81-ball BGA package.





Key Features

Radio

- Qualified Bluetooth component
- Extensive built-in-self-test to minimise end product final test time
- No external trimming required in production
- Full RF reference designs available

Transmitter

- Up to 2dBm output power for Class 2 operation
- Support for external PA for Class 1 operation with level control and RSSI >30dB dynamic range

Receiver

- High out-of-band blocking immunity, sufficient for embedding into mobile phones
- Integrated channel filters
- Digital demodulator for superior co-channel rejection

Synthesiser

- Fully integrated; no external VCO varactor diode or resonator
- Closed loop during TX burst resulting in no carrier drift

Baseband

- All packet types supported. Piconet and Scatternet support
- Multiple physical application interfaces:
 - UART:** Data and voice to 1.5Mbs⁻¹
 - PCM:** Programmable, for voice: 13-bit 8kss⁻¹ synchronous bi-directional serial audio interface
 - USB:** Data and voice. V1.1 Compliant. Supports OHCI and UHCI
- Transcoders for A-law, μ -law and CVSD for HCI voice traffic
- Support for up to seven slaves

Firmware

- Link Controller, Link manager and HCI
- Optional build includes embedded L2CAP, RFCOMM and Service Discovery
- Extensive power saving modes, including PARK, HOLD and SNIFF

Ancillary Features

- Internal low-dropout regulator with low stand-by current (uses one external transistor)
- Crystal oscillator with digital trimming allows use of low cost reference crystal
- Power-On-Reset

Device Diagram

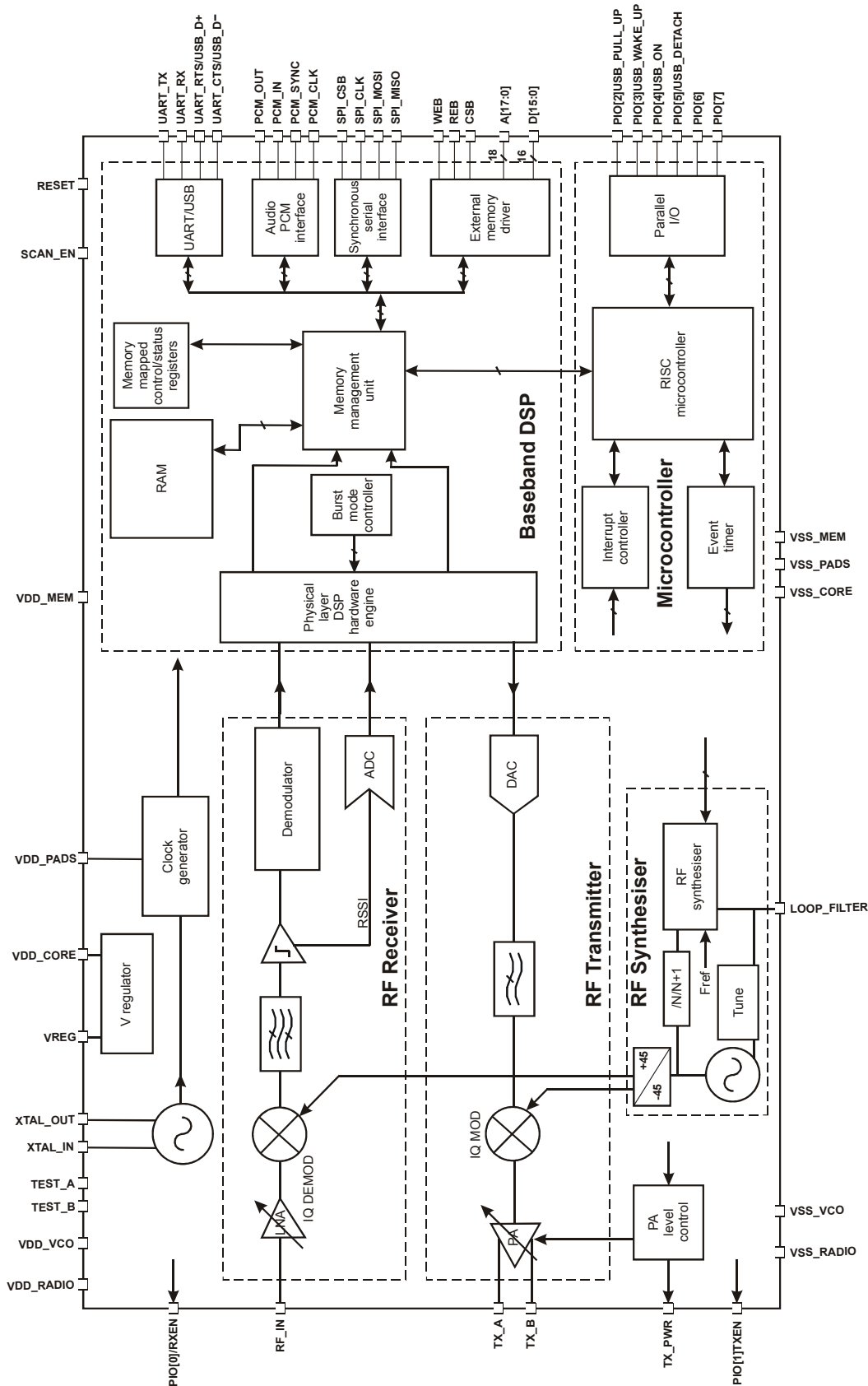


Figure 2: BlueCore01b Device Diagram

Device Pinout Diagram

Orientation from top of device

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|-------------------------|-------------------------|------------------|------------------------|----------|---------|-------|-------|-------|
| A | VSS_PADS | VDD_PADS | UART_TX | UART_RTS / USB_D+ | VDD_MEM | VSS_MEM | WEB | A[0] | A[1] |
| B | PIO[3] / USB_WAKE_UP | PIO[4] / USB_ON | UART_RX | UART_CTS / USB_D- | PCM_SYNC | A[6] | A[3] | A[4] | A[2] |
| C | RESET | PIO[2] / USB_PULL_UP | SPI_MISO | SPI_MOSI | PCM_IN | D[15] | A[9] | A[7] | A[5] |
| D | TX_PWR | PIO[0] / RXEN | SPI_CLK | SPI_CSB | PCM_CLK | A[12] | A[11] | A[10] | A[8] |
| E | RF_IN | VSS_RADIO | PCM_OUT | SCAN_EN | NC | D[13] | A[15] | A[13] | A[14] |
| F | TX_B | VSS_RADIO | PIO[1] / TXEN | PIO[5] / USB_DETACH | D[11] | D[12] | D[10] | A[17] | CSB |
| G | TX_A | VDD_RADIO | PIO[6] | PIO[7] | D[14] | D[7] | D[9] | A[16] | REB |
| H | VSS_VCO | LOOP_FILTER | TEST_B | VDD_CORE | VSS_CORE | D[6] | D[4] | D[3] | D[0] |
| J | VDD_VCO | TEST_A | XTAL_OUT | XTAL_IN | VREG | D[8] | D[5] | D[2] | D[1] |

Note: NC = Do not connect

Figure 3: BlueCore01b Device Pinout



Device Terminal Functions

| Terminal Name | Pad Type | Ball | Description |
|-----------------------------------|---------------------------|------|---|
| Radio | | | |
| RF_IN | - | E1 | Receiver RF input |
| TX_A | - | G1 | Transmitter RF output |
| TX_B | - | F1 | Transmitter RF output (complement of TX_A) |
| PIO[0] / RXEN | Bidirectional pulled down | D2 | Control output for external switch or LNA (if fitted) |
| PIO[1] / TXEN | Bidirectional pulled down | F3 | Control output for external switch or PA (if fitted) |
| TX_PWR | Current DAC | D1 | Current DAC output to set external PA level |
| Synthesiser and Oscillator | | | |
| XTAL_IN | - | J4 | Sense for crystal or external clock input |
| XTAL_OUT | - | J3 | Drive for crystal |
| LOOP_FILTER | - | H2 | Synthesiser external loop filter |
| External Memory Port | | | |
| A[17:0] | CMOS output | (1) | Address bus for external memory |
| D[15:0] | Bidirectional | (1) | Data bus for external memory |
| WEB | CMOS output | A7 | Write Enable for external memory (active low) |
| REB | CMOS output | G9 | Read Enable for external memory (active low) |
| CSB | CMOS output | F9 | Chip Select for external memory (active low) |
| PCM Interface | | | |
| PCM_SYNC | Bidirectional pulled down | B5 | Synchronous data strobe |
| PCM_CLK | Bidirectional pulled down | D5 | Synchronous data clock |
| PCM_IN | CMOS input pulled down | C5 | Synchronous 8kss ⁻¹ data input |
| PCM_OUT | CMOS output | E3 | Synchronous 8kss ⁻¹ data output |

Note:

(1) See Address and Data Bus tables at the end of this section.



| Terminal Name | Pad Type | Ball | Description |
|----------------------------------|---|------|--|
| UART or USB⁽¹⁾ | | | |
| UART_TX | CMOS output | A3 | UART data output |
| UART_RX | CMOS input, 5V tolerant pulled down | B3 | UART data input |
| UART_RTS / USB_D+ | CMOS output | A4 | UART Ready To Send / USB D+ |
| UART_CTS / USB_D- | CMOS input | B4 | UART Clear To Send / USB D- |
| PIO[2] / USB_PULL_UP | Bidirectional pulled down | C2 | USB Pull-Up (via 1.5kΩ resistor to D+) |
| PIO[3] / USB_WAKE_UP | Bidirectional pulled down | B1 | Output goes high to wake up PC when in USB mode |
| PIO[4] / USB_ON | Bidirectional pulled down | B2 | USB On (input senses when VBUS is high, wakes BlueCore01b) |
| PIO[5] / USB_DETACH | Bidirectional pulled down | F4 | Chip detaches from USB when this line is high |
| Test and Debug | | | |
| SPI_CSB | CMOS input, 5V tolerant pulled up | D4 | SPI Chip Select |
| SPI_CLK | CMOS input, 5V tolerant pulled down | D3 | SPI Clock |
| SPI_MOSI | CMOS input, 5V tolerant pulled down | C4 | SPI Data Input |
| SPI_MISO | CMOS output Tristate | C3 | SPI Data Output |
| TEST_A | - | J2 | Analog test port A |
| TEST_B | - | H3 | Analog test port B |
| RESET | CMOS input with weak internal pull-down | C1 | Reset |
| SCAN_EN | CMOS input with weak internal pull-down | E4 | For test purposes only (leave unconnected) |
| PIO Port | | | |
| PIO[0] /RXEN | Bidirectional pulled down | D2 | Input/Output port or high when RX is enabled |
| PIO[1] /TXEN | Bidirectional pulled down | F3 | Input/Output port or high when TX is enabled |
| PIO[2] /USB_PULL_UP | Bidirectional pulled down | C2 | Input/Output port or USB |
| PIO[3] /USB_WAKE_UP | Bidirectional pulled down | B1 | Input/Output port or USB |
| PIO[4] /USB_ON | Bidirectional pulled down | B2 | Input/Output port or USB |
| PIO[5] /USB_DETACH | Bidirectional pulled down | F4 | Input/Output port or USB |
| PIO[6] | Bidirectional pulled down | G3 | Input/Output port |
| PIO[7] | Bidirectional pulled down | G4 | Input/Output port |

Note:

⁽¹⁾ BC01b-USB supports both USB and UART (but not simultaneous operation). BC01b-URT supports UART only.



| Terminal Name | Pad Type | Ball | Description |
|-----------------------------------|----------|--------|--|
| Power Supplies and Control | | | |
| VREG | - | J5 | LDO voltage regulator output to external pass transistor |
| VDD_CORE | VDD | H4 | For internal digital circuitry |
| VDD_RADIO | VDD | G2 | For RF circuitry |
| VDD_VCO | VDD | J1 | For VCO and synthesiser |
| VDD_PADS | VDD | A2 | For all Input/Output except memory port |
| VDD_MEM | VDD | A5 | For external memory port |
| VSS_CORE | VSS | H5 | For internal digital circuitry |
| VSS_RADIO | VSS | F2, E2 | For RF circuitry |
| VSS_VCO | VSS | H1 | For VCO and synthesiser |
| VSS_PADS | VSS | A1 | For Input/Output except memory port |
| VSS_MEM | VSS | A6 | For external memory port |

| Address Lines | |
|---------------|------|
| Terminal | Ball |
| A[0] | A8 |
| A[1] | A9 |
| A[2] | B9 |
| A[3] | B7 |
| A[4] | B8 |
| A[5] | C9 |
| A[6] | B6 |
| A[7] | C8 |
| A[8] | D9 |
| A[9] | C7 |
| A[10] | D8 |
| A[11] | D7 |
| A[12] | D6 |
| A[13] | E8 |
| A[14] | E9 |
| A[15] | E7 |
| A[16] | G8 |
| A[17] | F8 |

| Data Bus | |
|----------|------|
| Terminal | Ball |
| D[0] | H9 |
| D[1] | J9 |
| D[2] | J8 |
| D[3] | H8 |
| D[4] | H7 |
| D[5] | J7 |
| D[6] | H6 |
| D[7] | G6 |
| D[8] | J6 |
| D[9] | G7 |
| D[10] | F7 |
| D[11] | F5 |
| D[12] | F6 |
| D[13] | E6 |
| D[14] | G5 |
| D[15] | C6 |



Electrical Characteristics

| Absolute Maximum Ratings | | |
|--|----------|----------|
| Rating | Min | Max |
| Storage Temperature | -30°C | 85°C |
| Supply Voltage, VDD | -0.4V | 3.6V |
| Other Terminal Voltages (except 5V tolerant) | VSS-0.4V | VDD+0.4V |
| 5V Tolerant Terminals | -0.4V | 5.5V |

| Recommended Operating Conditions | | |
|--|----------------------|---------------------|
| Operating Condition | Min | Max |
| Temperature | -20°C ⁽¹⁾ | 70°C ⁽¹⁾ |
| Supply Voltage, all VDD terminals | 2.7V | 3.3V ⁽²⁾ |
| Supply Voltage, VDD_PADS for USB operation | 3.0V | 3.4V |
| Difference between any two VDD terminals | - | 0.3V |

Notes:

- ⁽¹⁾ The device is fully functional across this range.
The guaranteed radio performance is shown in the Radio Characteristics section.
- ⁽²⁾ The recommended supply voltage is 3.3V (to be compatible with industry standard regulators) but the device will function up to 3.4V.

Input/Output Terminal Characteristics

VDD = 3.0V (except as specified)

| Digital Terminals | Min | Typ | Max | Unit |
|---|---------------------|-----|-------------------------|------|
| Input voltage | | | | |
| V _L input logic level low | -0.4 | - | 0.3V x VDD | V |
| V _H input logic level high | 0.7VDD | - | VDD+0.4 | V |
| Input current | | | | |
| CMOS input only (V _I = 0V or V _I = 3.3V, VDD = 3.3V) | -1 | - | 1 | μA |
| CMOS input + pull-up (V _I = 0V, VDD = 3.3V) | -20 | - | -125 | μA |
| CMOS input + pull-down (V _I = 3.3V, VDD = 3.3V) | 20/2 ⁽¹⁾ | - | 125/12.5 ⁽¹⁾ | μA |
| Output voltage | | | | |
| V _{OL} output logic level low (I _O = 4.0mA) | - | - | 0.2 | V |
| V _{OH} output logic level high (I _O = -4.0mA) | VDD-0.2 | - | - | V |
| Tristate leakage current | -1 | - | 1 | μA |
| C _I Input capacitance | 2.5 | - | 10 | pF |

Note:

- ⁽¹⁾ PIO terminals have weak pull-down resistors (1/10th current of standard pull-down resistors).



| Input/Output Terminal Characteristics (continued) | | | | |
|---|-------------|------------|-------------|-------------|
| Power-on Reset | Min | Typ | Max | Unit |
| VDD falling threshold | 2.30 | 2.40 | 2.50 | V |
| VDD rising threshold | 2.50 | 2.60 | 2.70 | V |
| Hysteresis | 180 | 200 | 220 | mV |
| USB Terminals | Min | Typ | Max | Unit |
| Input threshold | | | | |
| V _{IL} input logic level low | - | - | 0.3VDD_PADS | V |
| V _{IH} input logic level high | 0.7VDD_PADS | - | - | V |
| Input leakage current | -1 | - | 1 | μA |
| C _I Input capacitance | 2.5 | - | 10 | pF |
| Output levels to correctly terminated USB cable | | | | |
| V _{OL} input logic level low | 0 | - | 0.2 | V |
| V _{OH} input logic level high | 2.8 | - | VDD_PADS | V |
| Voltage Regulator (VREG) | Min | Typ | Max | Unit |
| Output regulation voltage ⁽¹⁾ | 2.74 | 2.79 | 2.84 | V |
| | 3.1 | 3.15 | 3.2 | V |
| Maximum allowable voltage on V _{reg} pad | - | - | 5 | V |
| Bias current | 5 | - | - | μA |
| Maximum regulation current | - | - | 100 | mA |

Note:

⁽¹⁾ The regulated voltage is selected by a variable stored in the flash ROM.

Power Consumption⁽¹⁾

VDD = 3.0V Temperature = 20°C

| Mode | Avg | Peak | Unit |
|--|-----|------|------|
| SCO connection HV3 (1s interval sniff mode) (Slave) | 41 | - | mA |
| SCO connection HV3 (1s interval sniff mode) (Master) | 42 | - | mA |
| SCO connection HV1 (Slave) | 78 | - | mA |
| SCO connection HV1 (Master) | 77 | - | mA |
| ACL data transfer 115.2kbps UART (Master) | 29 | - | mA |
| ACL data transfer 720kbps USB (Slave) | 81 | - | mA |
| ACL data transfer 720kbps USB (Master) | 82 | - | mA |
| Peak current during RF burst | - | 135 | mA |
| ACL connection, Sniff Mode 40ms interval, 38.4kbps UART | 5.5 | - | mA |
| ACL connection, Sniff Mode 1.28s interval, 38.4kbps UART | 1.1 | - | mA |
| Parked Slave, 1.28s beacon interval, 38.4kbps UART | 1.1 | - | mA |
| Deep Sleep Mode | 90 | | μA |

Note:

⁽¹⁾ Power consumption is for BC01b-USB module including external flash ROM.



Radio Characteristics at 20°C

VDD = 3.0V f=2.45GHz

| Receiver | Min | Typ | Max | Bluetooth Specification | Unit |
|---|-----|-----|-----|-------------------------|------|
| Sensitivity at 0.1% BER ⁽¹⁾ | - | -79 | -75 | -70 | dBm |
| Sensitivity at 0.1% BER ⁽¹⁾ with additional off-chip LNA | - | -89 | - | -70 | dBm |
| Maximum received signal ⁽¹⁾ | - | -5 | - | -20 | dBm |
| C/I co-channel ⁽¹⁾ | - | 9 | - | 11 | dB |
| Adjacent channel selectivity C/I 1MHz ⁽¹⁾ | - | -2 | - | 0 | dB |
| 2nd adjacent channel selectivity C/I 2MHz ⁽¹⁾ | - | -34 | - | -30 | dB |
| 3rd adjacent channel selectivity C/I >3MHz ^{(1) (2)} | - | -45 | - | -40 | dB |
| Image rejection C/I ^{(1) (3)} | - | -14 | - | -9 | dB |
| Maximum level of intermodulation interferers ^{(1) (4)} | - | -30 | - | -39 | dBm |
| 1dB compression point at 1.9GHz | - | -12 | - | - | dBm |
| Transmitter | Min | Typ | Max | Bluetooth Specification | Unit |
| RF transmit power ⁽¹⁾ | -2 | 2 | 6 | -6 to +4 | dBm |
| RF power control range ⁽¹⁾ | - | 30 | - | 16 | dB |
| RF power range control resolution | - | 2 | - | - | dB |
| 20dB bandwidth for modulated carrier | - | 885 | - | 1000 | kHz |
| 2nd adjacent channel transmit power ⁽¹⁾ | - | -47 | - | -20 | dBc |
| 3rd adjacent channel transmit power ⁽¹⁾ | - | -52 | - | -40 | dBc |

Radio Characteristics at 50°C

VDD = 3.0V f=2.45GHz

| Receiver | Min | Typ | Max | Bluetooth Specification | Unit |
|---|-----|-----|-----|-------------------------|------|
| Sensitivity at 0.1% BER ⁽¹⁾ | - | -74 | -70 | -70 | dBm |
| Sensitivity at 0.1% BER ⁽¹⁾ with additional off-chip LNA | - | -88 | - | -70 | dBm |
| Transmitter | Min | Typ | Max | Bluetooth Specification | Unit |
| RF transmit power ⁽¹⁾ | -5 | -1 | 3 | -6 to +4 | dBm |

Notes:

- ⁽¹⁾ Measured according to the Bluetooth specification.
- ⁽²⁾ Up to five spurious responses within Bluetooth limits are allowed.
- ⁽³⁾ At carrier -3MHz.
- ⁽⁴⁾ Measured at f₁-f₂=5MHz.

These results were measured on the BlueCore01b chip. Results shown relate to power at the output of the balun and at the input to the RX matching network. The loss of the RF filter and switch in the application circuit are not taken into account.

BlueCore01b meets the Bluetooth specification when used in a suitable application circuit between -20°C and 50°C. When used with an off-chip LNA the sensitivity can be enhanced and the operating temperature range extended.

Package Dimensions

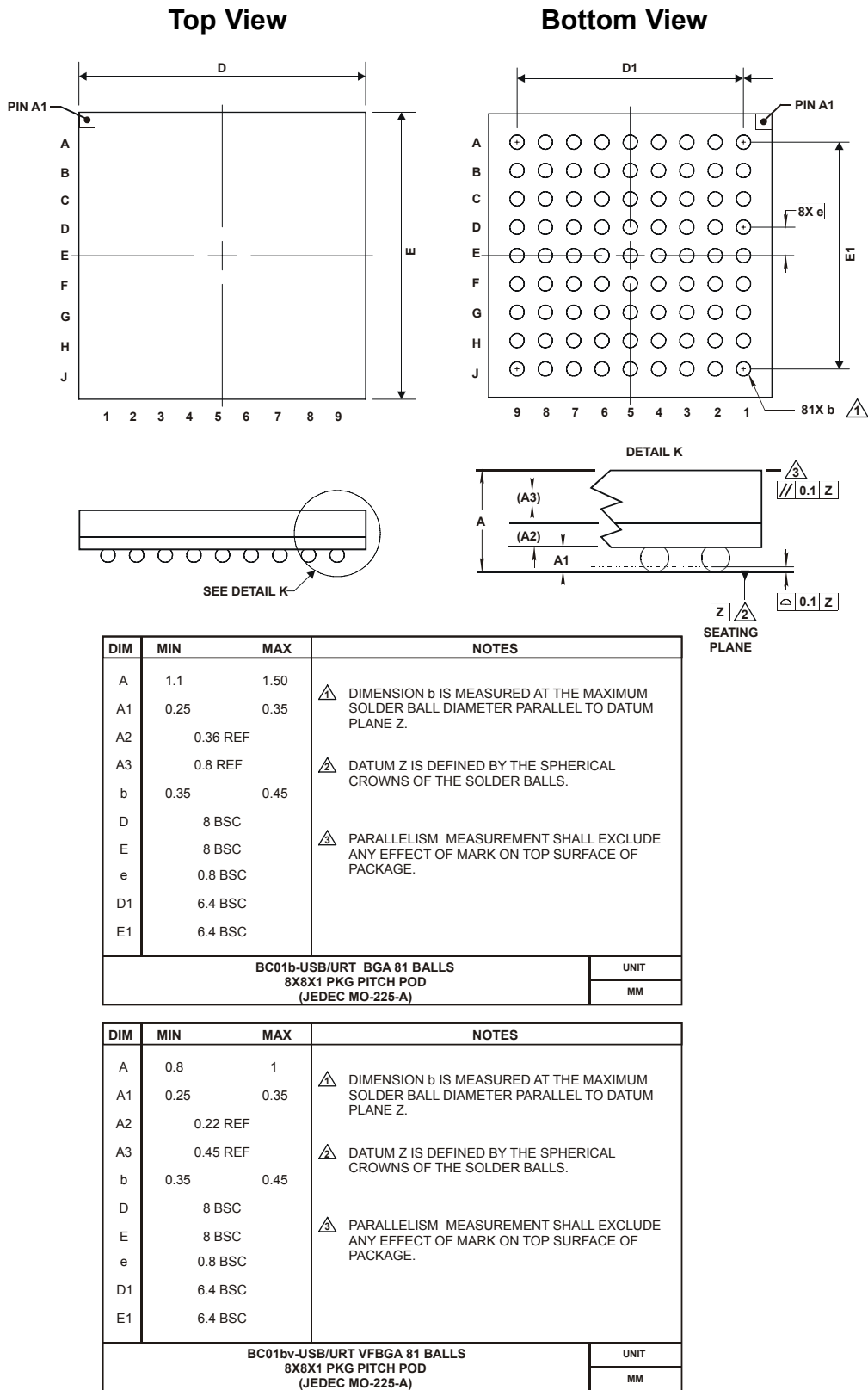


Figure 4: BlueCore01b package dimensions

Assembly Guidelines

Figures 5 and 6 show the re-flow solder profile that was used to qualify the BlueCore01b packages.

This temperature profile was repeated three times during the qualification of the BlueCore01b packages with a maximum temperature of 235°C.

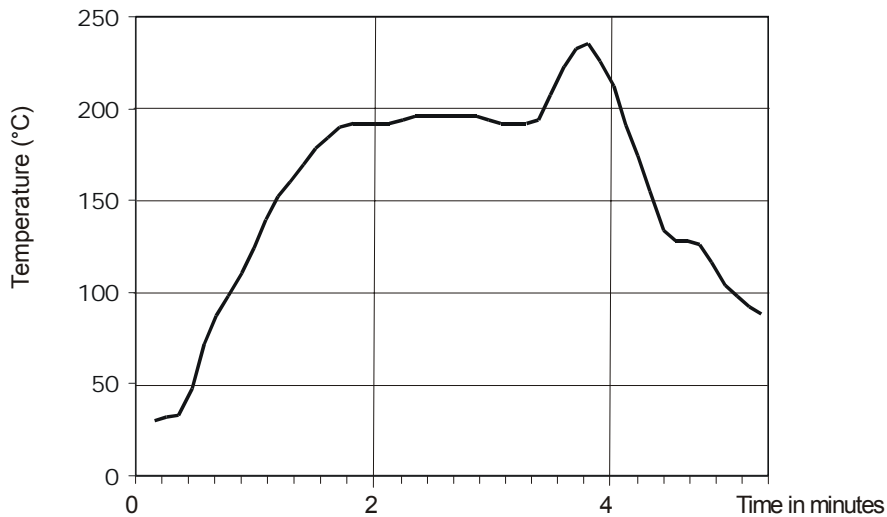


Figure 5: Re-flow solder profile 1

Whereas the above profile was used to confirm the reliability of the BlueCore01b packages, the following (figure 6) is the recommended solder profile to use when assembling BlueCore01b onto a circuit board.

Recommended Solder Profile

Initial Ramp: 60°C to 120°C/minute to 140°C to 150°C equilibrium 90°C to 120°C/minute ramp to 210°C to 220°C maximum temperature. Time over liquidus should be 45 to 90 seconds. Rapid quenching provides superior cosmetic appearance and bond strength.

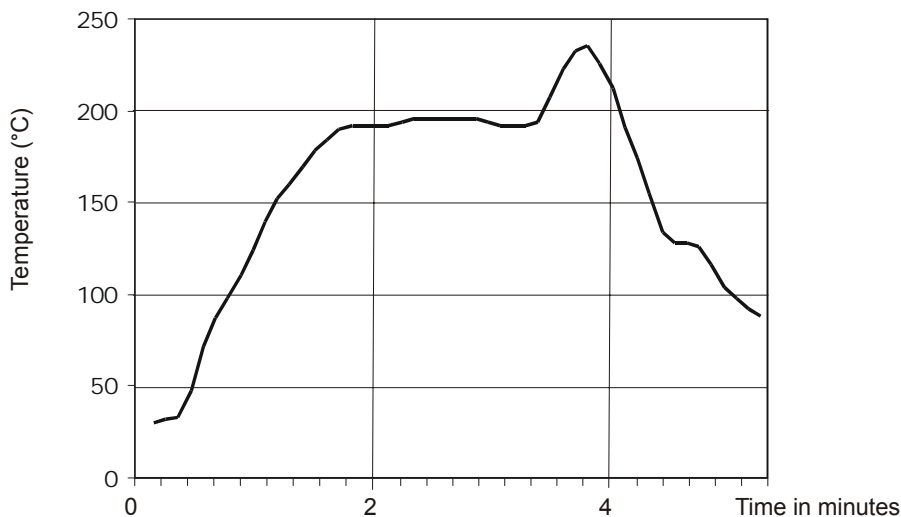


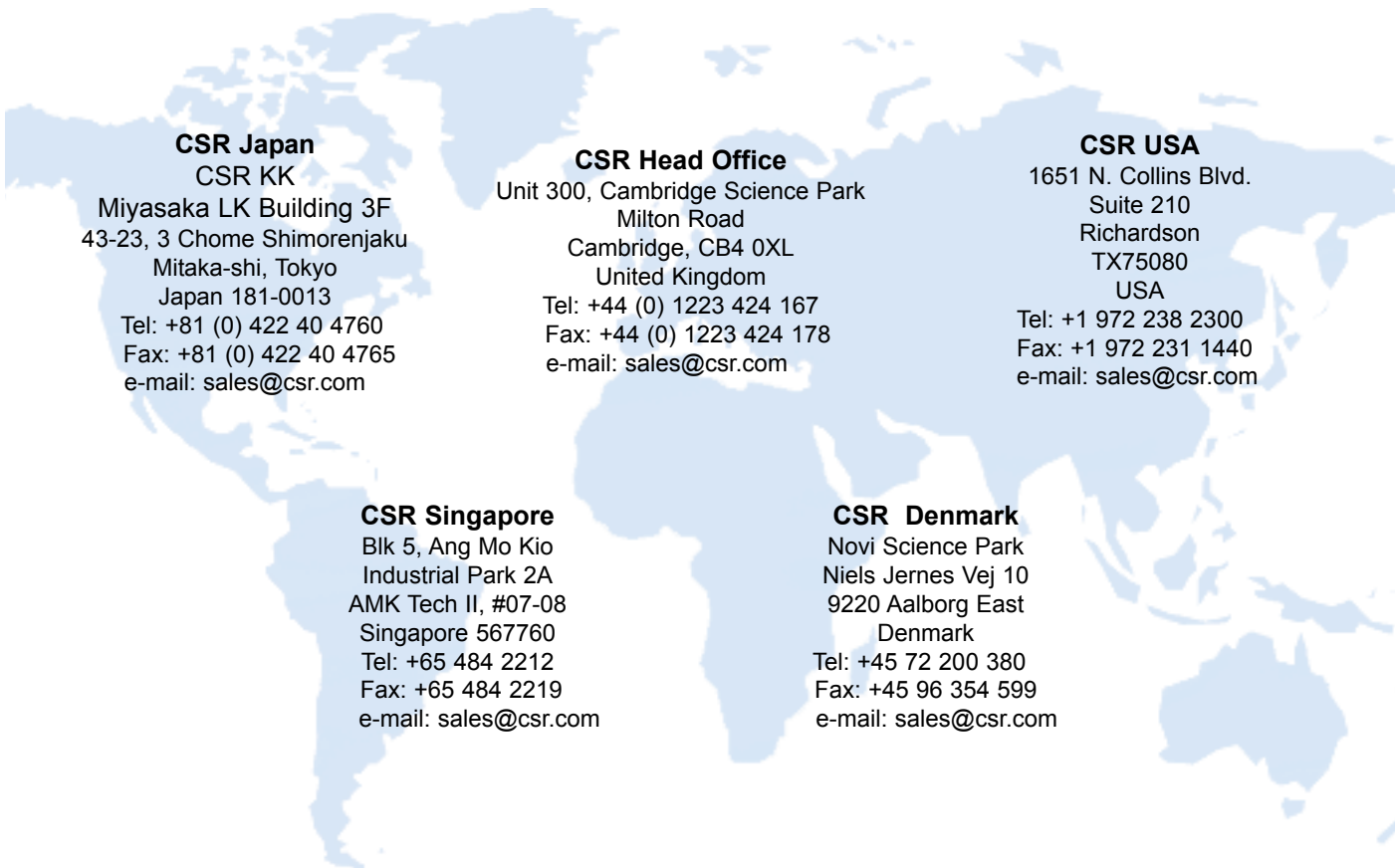
Figure 6: Re-flow solder profile 2



Ordering and Contact Information

| Order Number | Interface Version | Shipment Method |
|---------------|-------------------|-----------------|
| BC01b-USB-TR | USB and UART | Tape and reel |
| BC01b-USB | USB and UART | Tray (dry pack) |
| BC01b-URT-TR | UART only | Tape and reel |
| BC01b-URT | UART only | Tray (dry pack) |
| BC01bv-USB-TR | USB and UART | Tape and reel |
| BC01bv-USB | USB and UART | Tray (dry pack) |
| BC01bv-URT-TR | UART only | Tape and reel |
| BC01bv-URT | UART only | Tray (dry pack) |

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Status of Information

bc01b-ds-003d

BlueCore01b Product Data Sheet

July 2001

Advance Information

Information for designers on the target specification for a CSR product now in development. All detailed specifications including pinouts and electrical specifications may be changed by CSR without notice.

Pre-Production Information

Final pinout and mechanical dimensions. All electrical specifications can be changed by CSR without notice.

Production Information

Final data sheet including the guaranteed minimum and maximum limits for the electrical specifications. Production datasheets supersede all previous versions.

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CSR's products are not authorised for use in life-support or safety-critical applications.

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This is the product overview version of the BlueCore01b data sheet. The long form version is available separately from CSR.



Record of Changes

| Date: | Revision: | Reason for Change: |
|--------------------|------------------|---|
| 21st February 2001 | bc01b-ds-003a | Input/Output terminal characteristics information updated |
| 23rd March 2001 | bc01b-ds-003b | Minor modifications to RF characteristics based upon latest characterisation data |
| 6th July 2001 | bc01b-ds-003c | System features added and power consumption figures expanded |
| 26th July 2001 | bc01b-ds-003d | Package dimensions added for bc01bv VFBGA packaging |

BlueCore01b Product Data Sheet

bc01b-ds-003d

July 2001

BlueCore™01b Product Data Sheet