Single Chip Bluetooth™ Solution for Cable Replacement Applications

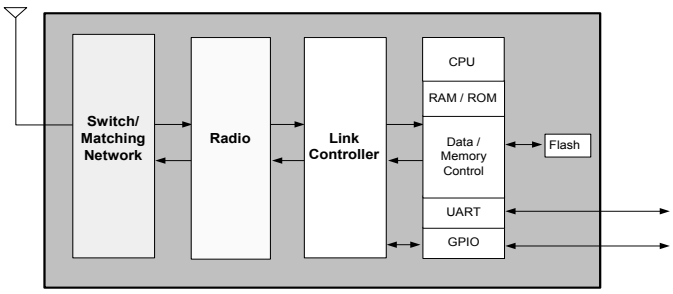
General Description

The TC2001P Z along with Zerial (Zeevo serial) application software provides system designers a turnkey Bluetooth cable replacement solution. The TC2001P Z incorporates a widely popular 32-bit ARM7TDMI™ CPU core with sufficient bandwidth to support a wide range of cable replacement applications.

Implemented in a 0.18 µm CMOS process with unique package technology all RF components, digital circuitry, and FLASH memory are integrated. The only external components needed are an antenna, crystal, reference resistor, and decoupling capacitors. The TC2001P Z is designed for very low power applications and requires a single 3.3V supply voltage.

The TC2001P Z provides Zerial interface per the Bluetooth 1.1 specification. Interoperability and Bluetooth compliance testing have been completed to facilitate rapid time-to-market. The TC2001P Z is manufactured in a 10.9 mm x 13.1 mm LTCC package with 65 balls.

TC2001P Z Basic Block Diagram



Typical Applications Requiring Cable Replacement

- Serial adapters
- Remote sensing
- Portable printers
- Home automation
- Industrial control
- Barcode scanners

Features and Benefits

Overview

- Bluetooth 1.1 compliant
- Highly integrated low cost solution: Radio, Link Control, and CPU are included
- Zerial interface software
- Bonding up to four devices
- Support for Low-power modes
- On-chip automatic crystal tuning
- Dynamic configuration

Radio Features

- Integrated RF interface connects directly to antenna
- High sensitivity design (-80 dBm typ.)
- Class 1 operation is supported with an external power amplifier interface
- Integrated RF shield
- Passes all Bluetooth specifications

Baseband and Software Features

- Standard Bluetooth Zerial interface over UART
- All Bluetooth data rates (57.6/723.2 Kbits/sec)
- All ACL packet types
- Park and sniff modes
- Point-to-point operation support
- Dedicated Inquiry Access Code (DIAC)
- Up to 128-bit encryption

CPU and Memory

- ARM7TDMI™ processor core
- 8 Kbytes of boot ROM
- 64 Kbytes of SRAM
- 512 Kbytes of FLASH

User Interfaces

- Programmable baud rate UART (9.6 Kbps – 921.6 Kbps)
- 8 General Purpose I/O
- AT Command set

TC2001P Z Hardware Features

Radio

- IF-enhanced direct-conversion receiver architecture
- Integrated TX/RX switch, balun, and matching network in an LTCC package
- Low power consumption receiver design
- Integrated class 2/3 power amplifier
- Multiplexed RX/TX antenna interface
- Fully integrated PLL synthesizer and loop filter—requires external 12 MHz crystal

Baseband Modem

- Demodulator, modulator, RX/TX self-calibration, burst timing control and transmitter burst spectral shaping.
- FEC encoder/decoder, data whitening, encryption-decryption, and cyclic redundancy check
- Link Controller for synchronization, frequency hop control, and receiver/transmitter slot timing

External Hardware Interfaces

UART

- 16450 register-set compatible UART
- 9600 and 19.2 K, 38.4 K, 57.6 K, 115.2 K, 230.4 K, 460.8 K, and 921.6 Kbps UART baud rates
- RTS and CTS flow-control signals for UART

GPIO

- Eight individually programmable general purpose I/Os
- Configurable for UART Wakeup hand-shaking
- Baseband and CPU activity indication

12 MHz Crystal

- Primary clock crystal
- Internal capacitors for trimming 12MHz oscillator
- Requires $\pm$ 20 ppm maximum frequency stability over temperature and aging

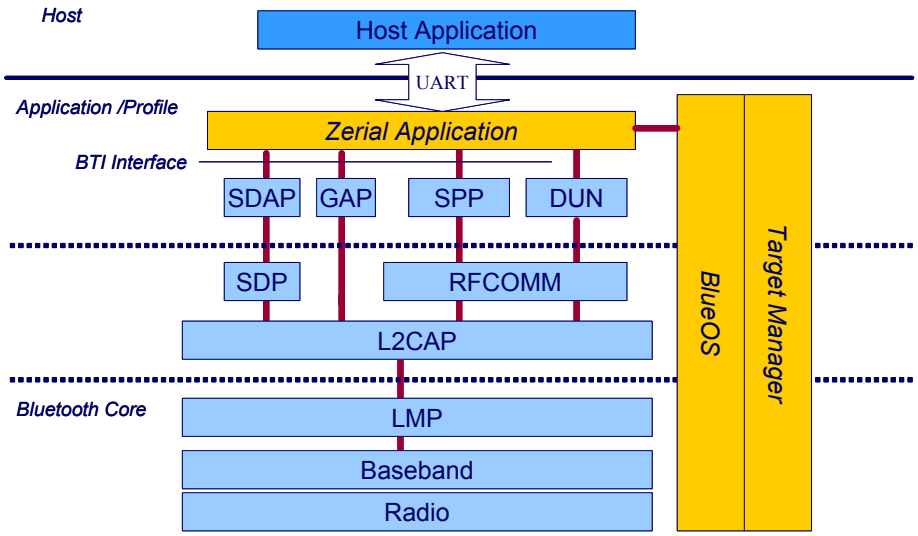
32 KHz Crystal

- Sleep crystal for low power modes
- Requires $\pm$ 250 ppm maximum frequency stability over temperature and aging

TC2001P Z Software

Zerial Software architecture

The TC2001P Z Zerial software delivers a complete Bluetooth stack solution for cable replacement applications. This includes a full Bluetooth lower and upper layer stack along with application support for SPP and DUN profiles. The Zerial application allows limited customization for the end user's application through dynamic configuration without requiring source code modification. For more complex application development, the source code for the Zerial application is provided to allow for end user modification and code development. Zerial software can be updated via the UART port of the TC2001P Z.



Zerial Architecture

Zerial Application program

The Zerial application interfaces to an external host via a simple AT command interface over a UART connection. Behavior is similar to an AT command-set based modem, with AT commands used to configure and initiate a data connection. Zerial supports UART data rates between 1200bps and 921Kbps and supports flow control to allow the TC2001P Z to interface to a wide variety of host devices.

Target Manager

The Target Manager provides an Application Programming Interface (API) to the UART and GPIO in TC2001P Z hardware to assist in application development.

BlueOS

The Zerial firmware utilizes Zeevo's BlueOS real-time operating system. BlueOS is optimized for the TC2001P Z hardware.

Upper Layer Stack

- SDAP, GAP, SPP, and DUN protocols
- RFComm, SDP, and L2CAP supported

Lower Layer Stack

- Full Bluetooth data rate (723.3kbps maximum)
- All ACL (Asynchronous Connection Less) packet types (DM1, DH1, DM3, DH3, DM5, DH5, AUX1)
- Authentication and encryption—encryption key length from 8-bits to 128-bits maximum
- Park and sniff modes
- Dedicated Inquiry Access Code—for improved inquiry scan performance
- Dynamic packet selection—channel quality driven data rate to optimize link performance
- Bluetooth test modes—per Bluetooth 1.1 specification
- Device power modes—active, sleep and deep sleep
- Persistent FLASH memory—for BD Address and radio parameter storage
- Vendor specific console commands—to support device configuration and certification test modes

AT Commands

Zerial uses an AT command interface to configure and connect devices. The following commands are supported:

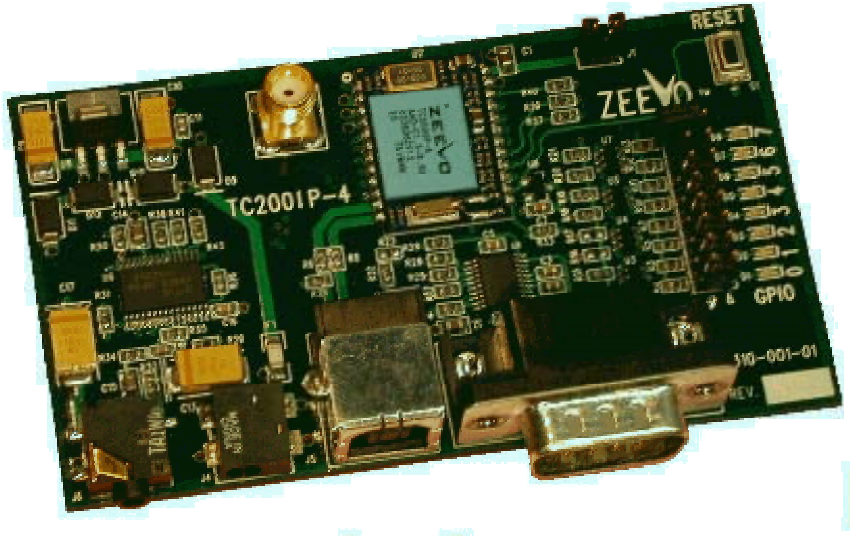
- Bond – Bond two Bluetooth devices
- Bypass – Default mode during connection
- ChangeBaud – Change baudrate of UART interface
- Console – Send vendor specific console command to device
- Disablebond – Remove bond between devices
- Discovery – Discover other Bluetooth devices
- Enablebond – Enable bonding in the device
- Erasebondtable – Remove all bond associations
- Exitpark – Remove the device from park mode
- Exitsniff – Remove the device from sniff mode
- Local Name – Changes the local name of the device
- Park – Switches the device from active to park mode
- Reset – Resets the zerial interface
- Security – Change encryption level
- Sniff – Switches the device to sniff mode
- SPPConnect – Connect to specified device using SPP
- DUNConnect – Connect to specified device using DUN
- SPPDisconnect – Terminate current connection
- DUNDisconnect – Terminate current connection
- Version – Query version number

TC2001P Z Support Hardware

Zeevo supplies supporting hardware for the evaluation and development of Zerial applications. The hardware kits described below are available directly from Zeevo, please contact your Zeevo sales representative for additional details.

BlueDolphin II Evaluation Kit

Zeevo's BlueDolphin II Evaluation Kit (order part# ZBEK-2001 Z-001) allows for the evaluation of the TC2001P Z system performance. It includes a hardware platform, evaluation copies of an Zerial Upper Layer Stack and extensive documentation about the capabilities of the TC2001P Z.



BlueShark II Development Kit

The Blue Shark II Development Kit (Part Number ZBDK-2001-001) allows for the modification of the Zerial application software for end user development. A development environment for the embedded ARM7TDMI processor of the TC2001P Z is provided along with extensive documentation about the Zerial application and Bluetooth stack interfaces.

Hardware Specifications

Absolute Maximum Ratings[1]

Rating	Minimum	Typical	Maximum	Unit
Storage temperature range	-40	-	+150	°C
Supply voltage, V_{DD}	-0.3	-	+ 3.6	Volts
RF input power	-	-	+ 15	dBm

Recommended Operating Conditions [1]

Rating	Minimum	Typical	Maximum	Unit
Operating Temperature Range	0	-	70	°C
Supply Voltage V_{DD}	3.0	3.3	3.6	Volts
Signal Pin Voltage	-	3.3	-	Volts
RF Frequency	2400	-	2483.5	MHz

I/O Operating Characteristics (V_{DD} = 3.3 V, unless otherwise specified)

Symbol	Parameter	Minimum	Maximum	Unit	Test Conditions
V_{IL}	Low-Level Input Voltage	-	0.8	Volts	
V_{IH}	High-Level Input Voltage	2.0	-	Volts	
V_{OL}	Low-Level Output Voltage	-	0.4	Volts	I_{OL} = 2mA
V_{OH}	High-Level Output Voltage	2.4	-	Volts	I_{OH} = 2mA
I_{OL}	Low -Level Output Current	-	2.2	mA	V_{OL} = 0.4 V
I_{OH}	High-Level Output Current	-	3.1	mA	V_{OH} = 2.4 V
I_I	Input Leakage Current	-1	+1	uA	@V_I = 3.3V or 0V
V_{T+}	Schmitt Trigger Low to High Threshold Pt.	1.47	1.50	Volts	
V_{T-}	Schmitt Trigger High to Low Threshold Pt.	0.89	0.95	Volts	
R_{PU}	Pull-up Resistor	53	113	KΩ	Resistor Turned On
R_{PD}	Pull-down Resistor	43	118	KΩ	Resistor Turned On
C_I	Input Capacitance		7.5	pF	

USB I/O Operating Characteristics (V_{DD} = 3.3 V)

Symbol	Parameter	Minimum	Maximum	Unit	Test Conditions
V_{IL}	Low-Level Input Voltage	-	0.8	Volts	
V_{IH}	High-Level Input Voltage	2.0	-	Volts	
V_{OL}	Low-Level Output Voltage	-	0.3	Volts	
V_{OH}	High-Level Output Voltage	2.8	-	Volts	
Cin	Input Capacitance	-	25	pF	DP or DM to GND

[1] ABSOLUTE MAXIMUM RATINGS indicate limits beyond which damage to the device may occur. RECOMMENDED OPERATING CONDITIONS indicate conditions for which the device is intended to be functional, but do not guarantee specific performance limits. ELECTRICAL CHARACTERISTICS document specific minimum and/or maximum performance values at specified test conditions and are guaranteed. Typical values are for informational purposes only which are based on design parameters or device characterization and are not guaranteed.

Current Consumption

General Conditions: V_{DD}= 3.3V, temperature = 25°C, frequency = 2.402 - 2.480 GHz, 50 Ω antenna, 12 MHz ext crystal, and 32 KHz ext sleep crystal.

Modes	Avg.	Unit
Power Consumption TC2001P Z *(typical)*		
ACL data over 115K Baud UART at maximum throughput (Master)	37.5	mA
ACL data over 115K Baud UART at maximum throughput (Slave)	34.0	mA
Connection, no data traffic, master	19.1	mA
Connection, no data traffic, slave	29.0	mA
Connection in sniff (Tsniff=100ms), no data traffic, master	12.61	mA
Connection in sniff (Tsniff=100ms), no data traffic, slave	12.89	mA
Connection in sniff (Tsniff=375ms), no data traffic, master	3.55	mA
Connection in sniff (Tsniff=375ms), no data traffic, slave	3.65	mA
No scan, deep sleep (including on-die regulator and flash)	0.250	mA
Page/Inquiry scan	3.3	mA
Peak current	65	mA

** All current consumption numbers include on-die regulators and flash memory*

Selected RF Characteristics

General Conditions: V_{DD}= 3.3V, temperature = 25°C, frequency = 2.402 - 2.480 GHz, 50 Ω antenna, 12 MHz ext crystal, and 32 KHz ext sleep crystal.

Parameters	Conditions	BT Spec	Min.	Typ.	Max.	Unit
Antenna						
Antenna load				50		Ω
Radio Receiver						
Sensitivity level	BER < .001 with DH5	≤ -70	-	-80	-	dBm
Maximum usable level	BER < .001 with DH1	≥ -20	-	-11	-	dBm
Input VSWR			-	2.5:1	-	
Radio Transmitter						
Maximum output power	50 Ω load	-6 to +4	-	0.5	-	dBm
Power control range		≥ 16	-	30	-	dB
Power control resolution		2 to 8	-	4	-	dB
Initial Carrier Frequency Tolerance		± 75	-	18	-	kHz
20 dB Bandwidth for modulated carrier		≤ 1000	-	930	-	kHz

Product Quality and Reliability Tests

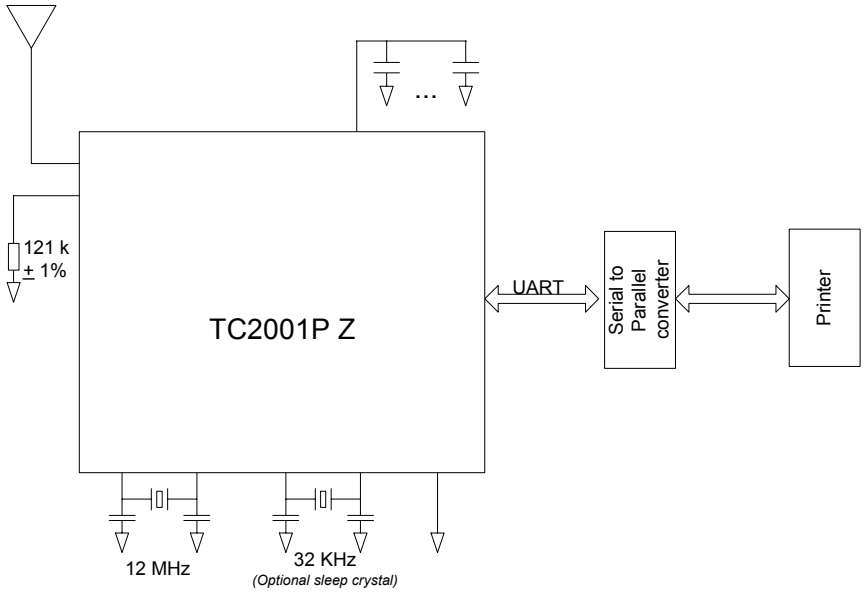
Product Qualification Tests

Stress	Qualification condition and duration (extended duration where applicable)
ESD	JESD22-A114, 2000Volts, 1500 Ohms, 100pF
Latch-up	JEDEC78, ±140mA @25^0 C, Voltage Ramp 1.5x V Supply
HTOL (High temperature operating life)	Mil-Std-883, M1005, 125^0 C, 3.6Volts, Dynamic, 1000 hours
High Temperature Storage	JESD22-A103, 150^0 C, 1000 hours
Low Temperature Storage	JESD22-A103, -40^0 C, 1000 hours
Moisture Preconditioning	JESD22-A113-B, Level 3, 30^0 C, 60% RH, 192 hours
IR Reflow	3 passes @220^0 C
Temperature Cycle (post Preconditioning)	JESD22-A104, Cond. B, -40^0 C to +125^0 C, 30 minutes per cycle, 1000 cycles
THB 85/85 (post Preconditioning)	JESD22-A101, 85^0 C/85%RH, Biased, 1000 hours

PCB Mounted Product Qualification Tests

Stress	Qualification condition and duration (extended duration where applicable)
Vibration, Variable Frequency	JESD22-B103-B, 20 – 2000Hz, 20 G's Peak, 4 Minutes / sweep, 4 times per axis
Mechanical Shock	JESD22-B104-B, Condition A, 1 ms Pulse, at 500 G's Peak Acceleration
Bending Test	PCB Thickness 0.8mm, 2.0mm Deflection for 10 secs, 5 times (for 70mm and 90mm Span)

TC2001P Z Application Example



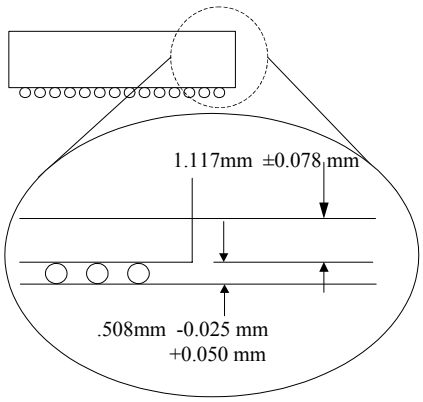
TC2001P Z Application Schematic – Printer (Typical System)

Pin Assignments by Functional Grouping

Name	Type	TC2001P Z Pin # / Ball	Description
		Clock and Reset	
RESET_B	I	B15	Reset input (active low for 5 ms); Schmitt triggered
SLP_XTAL_IN	I	D15	Sleep crystal oscillator input (32 KHz ± 250 ppm; C_{Load} = 12.5 pF)
SLP_XTAL_OUT	O	D14	Sleep crystal oscillator output
XTAL_IN	I	B1	Crystal oscillator input, external clock input (12 MHz ± 20 ppm, C_{Load} = 9 pF)
XTAL_OUT	O	C1	Crystal oscillator output
		GPIO	
GPIO [0]	I/O-PD	G3	General Purpose Input/Output, Prog. Pull-Down
GPIO [1]	I/O-PD	F3	General Purpose Input/Output, Prog. Pull-Down
GPIO [2]	I/O-PD	F2	General Purpose Input/Output, Prog. Pull-Down
GPIO [3]	I/O-PD	F1	General Purpose Input/Output, Prog. Pull-Down
GPIO [4]	I/O-PU	E3	General Purpose Input/Output, Prog. Pull-Up
GPIO [5]	I/O-PU	E2	General Purpose Input/Output, Prog. Pull-Up
GPIO [6]	I/O-PU	E1	General Purpose Input/Output, Prog. Pull-Up
GPIO [7]	I/O-PU	D2	General Purpose Input/Output, Prog. Pull-Up
		PCM Interface	
PCM_CLK	I/O	G15	PCM Clock
PCM_SYNC	I/O	H14	PCM Sync
PCM_IN	I	F14	PCM In
PCM_OUT	O	G14	PCM Out
		UART Interface	
RXD	I-PD	K14	Receive data, Prog. Pull-Down
TXD	O	J14	Transmit data
CTS_B	I-PD	K15	Clear to send (active low), Prog. Pull-Down
RTS_B	O	L15	Request to send (active low)
		USB Interface	
DM	I/O	H15	Data pin for USB
DP	I/O	J15	Data pin for USB
		RF/Analog Interface	
ANT	RF I/O	L1	50 Ohm Rx/Tx connection to antenna
BIAS_REF	I	A2	Resistor for Analog (121 kΩ ± 1%)
PA_CTRL	O	F13	PA Control for Class-1
TX_EN	O	E14	TX Enable for Class-1
RX_EN	O	C14	RX Enable for Class-1
		Test Interface	
ATDO	O	H2	ARM® JTAG test data output
ATDI	I-PU	G1	ARM JTAG test data input, Pull-Up
ATCK	I-PD	D1	ARM JTAG clock, Prog. Pull-Down
ATMS	I-PU	H1	ARM JTAG mode select, Pull-Up
ATRST_B	I-PD	J3	ARM JTAG reset (active low), Prog. Pull-Down
N/C	I/O	E15, J1, J2, J13, K3, K13, L3	No connects
		Power and Ground	
VDD_VCO		B3, C3	VCO VDD
VDD_PLL		B13	PLL VDD
RVDD		A3, A13	RF VDD
RVSS		A15, C15, K1, K2, L2	RF VSS
VDD		B14, C2, D13, E13, G2, H13, L14	VDD
VSS		A14, B2, C13, D3, F15, G13, H3, L13	VSS

Package Dimensions

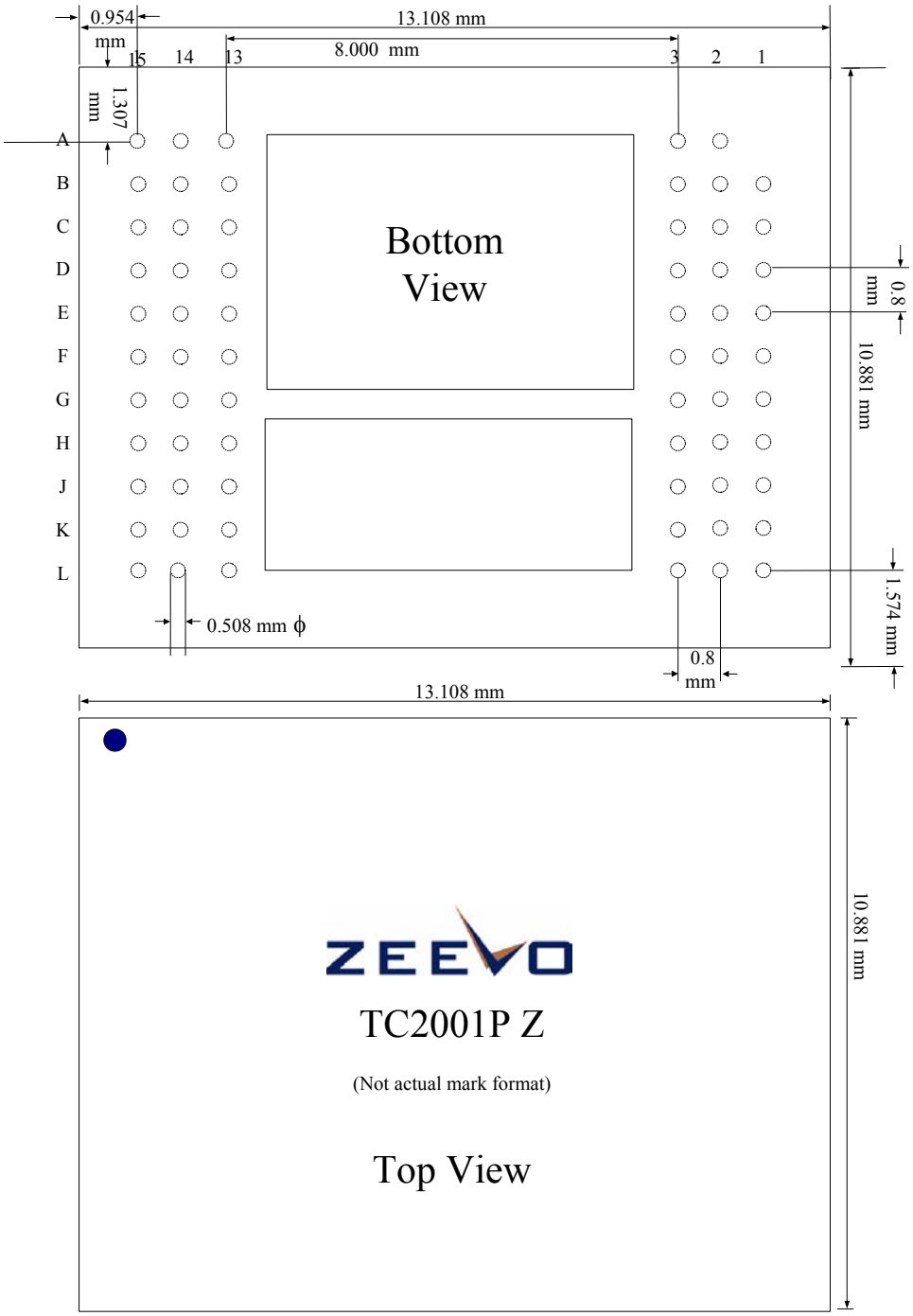
Package Parameter	Minimum	Typical	Maximum	Unit
Length	-	10.9	-	mm
Width	-	13.1	-	mm
Height		1.63	1.75	mm
Number of solder balls	-	65	-	
Solder ball grid pitch	-	0.8	-	mm
Solder ball diameter parallel to the primary datum	-	508	558	microns
Ceramic thickness	1039	1117	1195	microns



Balls are non-collapsing and 90 Pb/10Sn

Package Dimensions

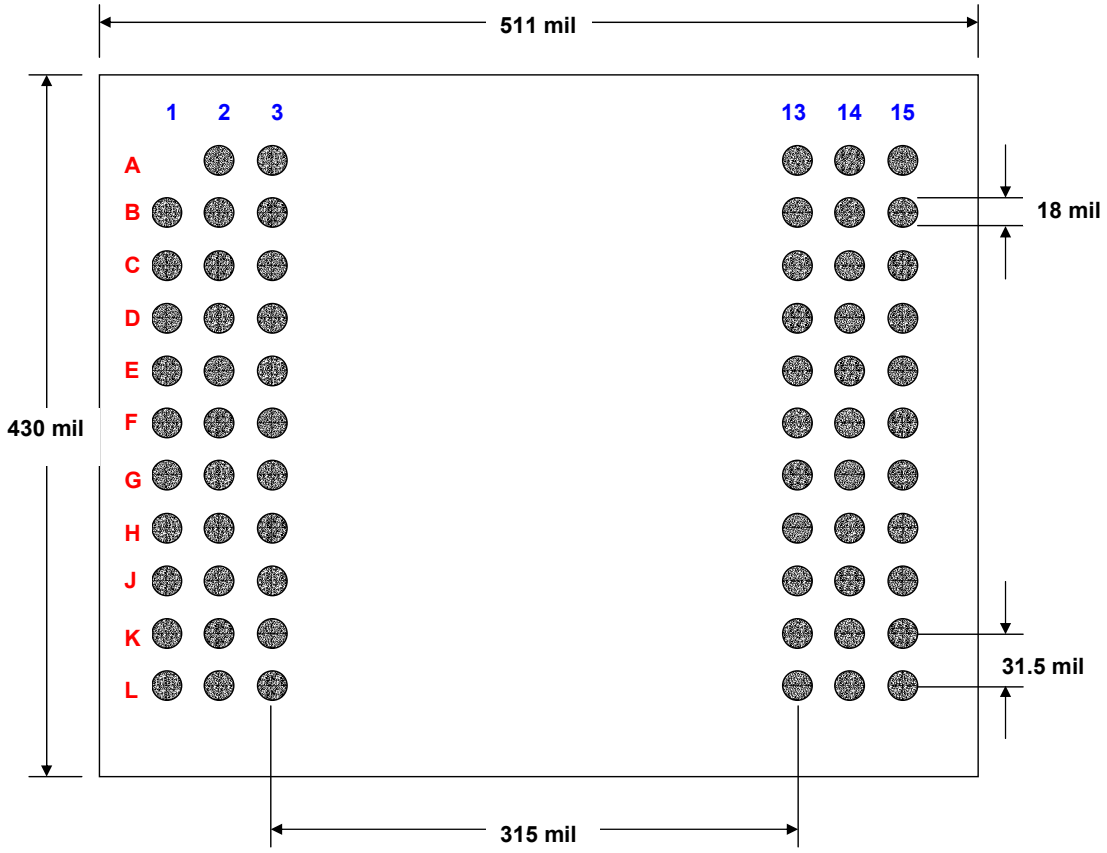
Mechanical Dimensions



65-Ball LTCC Packaging for the TC2001P Z

Ball position "A1" is not present in order to identify ball array orientation.

PCB Land Pattern



Ordering Information

Part Numbers

TC2001P Z	65 ball in an LTCC package.

Contact Information:

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