
maXTouch 1664-node Touchscreen Controller

Product Brief

Description

The ATMXT1664TD-C2UEN 2.0 uses a unique charge-transfer acquisition engine to implement Microchip's patented capacitive sensing method. Coupled with a state-of-the-art CPU, the entire touchscreen sensing solution can measure, classify and track a number of individual finger touches with a high degree of accuracy in the shortest response time. The ATMXT1664TD-C2UEN 2.0 allows for both mutual and self capacitance measurements, with the self capacitance measurements being used to augment the mutual capacitance measurements to produce reliable touch information.

maXTouch[®] Adaptive Sensing Technology

- Up to 41 X (transmit) lines and 71 Y (receive) lines for use by a touchscreen and/or key array
- A maximum of 1664 nodes can be allocated to the touch sensor
- Touchscreen size of 15.62 inches (16:10 aspect ratio), assuming a sensor electrode pitch of 6.5 mm. Other sizes are possible with different electrode pitches and appropriate sensor material
- Multiple touch support with up to 16 concurrent touches tracked in real time
- HID Mouse mode reporting of single touches to the host, subject to configuration

Touch Sensor Technology

- On-cell/touch-on display support including OLED and LCD
- Discrete/out-cell support including glass and PET film-based sensors
- Synchronization with display refresh timing capability
- Support for standard (for example, Diamond) and proprietary sensor patterns (review of designs by Microchip or a Microchip-qualified touch sensor module partner is recommended)

Front Panel Material and Design

- Works with PET or glass, including curved profiles (configuration and stack-up to be approved by Microchip or a Microchip-qualified touch sensor module partner)
- 10 mm glass (or 5 mm PMMA) with bare finger (dependent on sensor size, touch size, configuration and stack-up)
- 6 mm glass (or 3 mm PMMA) with multi-finger 5 mm glove (2.7 mm PMMA equivalent) (dependent on sensor size, touch size, configuration and stack-up)
- Support for non-rectangular sensor designs (for example, circular, rounded or with cutouts)

Touch Performance

- Moisture/Water Compensation
 - No false touch with condensation or water drop up to 22 mm diameter
 - One-finger tracking with condensation or water drop up to 22 mm diameter
- Multiple acquisition schemes for robust and sensitive multi-touch sensing, including:
 - Mutual capacitance capacitance measurements
 - Self Capacitance measurements
 - P2P Mutual Capacitance measurements
- Noise suppression technology to combat ambient and power-line noise
 - Up to 240 V_{PP} between 1 Hz and 1 kHz sinusoidal waveform (no touches)
 - Up to 20 V_{PP} between 1 kHz and 1 MHz sinusoidal waveform
- Stylus Support
 - Supports passive stylus with 1.5 mm contact diameter, subject to configuration, stack-up, and sensor design
- Burst Frequency
 - Flexible and dynamic Tx burst frequency selection to reduce EMC disturbance
 - Configurable Tx waveform shaping to reduce emissions
- Scan Speed
 - Typical report rate for 10 touches ≥ 110 Hz (subject to configuration)
 - Initial touch latency < 20 ms for first touch from idle (subject to configuration)
 - Configurable for power and speed optimization

- Touch panel failure detection
 - Automatic touch sensor diagnostics during run time to support the implementation of safety critical features
 - Diagnostics reported using dedicated output pin or by standard Object Protocol messages
 - Configurable test limits

Keys

- Up to 32 nodes can be allocated as mutual capacitance sensor keys in addition to the touchscreen, defined as 1 key array (subject to availability of X and Y lines and other configurations)
- Adjacent Key Suppression (AKS) technology is supported for false key touch prevention

PWM Signal Generation

- PWM Output for display backlight control, audible speaker/buzzer output, or simple haptic feedback

Enhanced Algorithms

- Lens bending algorithms to remove display noise
- Touch suppression algorithms to remove unintentional large touches
- Palm Recovery Algorithm for quick restoration to normal state
- Enhanced Touch Separation algorithm for improved two touch separation/tracking in all directions.

On-chip Gestures

- Reports one-touch and two-touch gestures

Data Store

- 60-byte CRC checksummed data area for use as a run-time Product Data Store Area
- 64-byte data area for user's custom data (not CRC checksummed)

Device Security

- Encrypted configuration parameters and touch coordinate reports (OBP messages) using customer's own security key
- Firmware Authentication mechanism to ensure the authenticity of the application firmware in the device

Power Saving

- Programmable timeout for automatic transition from Active to Idle state
- Pipelined analog sensing detection and digital processing to optimize system power efficiency

Application Interfaces

- Client interface for main communication with the device. Can be one of:
 - I²C interface, with support for Standard mode (up to 100 kHz), Fast mode (up to 400 kHz), Fast-mode Plus (up to 1 MHz), High Speed mode (up to 3.4 MHz)
 - HID-I²C interface for Microsoft Windows 10
 - USB HID interface for Microsoft Windows 10
- Interrupt to indicate when a message is available
- Additional SPI Debug Interface to read the raw data for tuning and debugging purposes

Power Supply

- Digital (Vdd) 3.3V nominal
- Digital I/O (VddIO) 1.8V to 3.3V (I²C mode), 3.3V nominal (USB mode)
- Analog (AVdd) 3.3V nominal
- High voltage external X line drive (XVdd) up to 9.2V

Package

- 162-ball UFBGA 10 × 5 × 0.6 mm, 0.5 mm pitch

Operating Temperature

- –40°C to +85°C

Design Services

- Specific design and tuning tools available as maXTouch Studio plug-ins

ATMXT1664TD-C2UEN 2.0

PIN CONFIGURATION

162-ball UFBGA

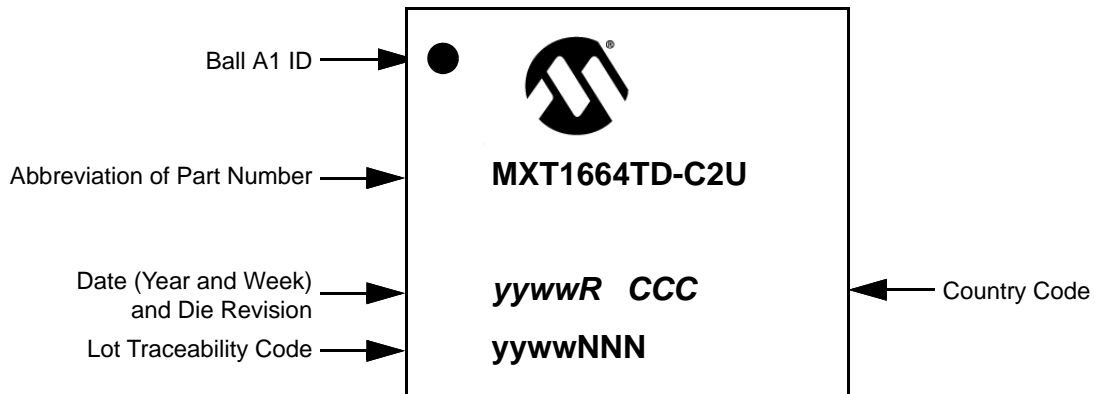
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
A	<div><div></div><div>SCL GPIO7</div></div>	<div><div></div><div>RESET</div></div>	<div><div></div><div>VDDIO</div></div>	<div><div></div><div>DS0</div></div>	<div><div></div><div>Y68</div></div>	<div><div></div><div>Y64</div></div>	<div><div></div><div>Y60</div></div>	<div><div></div><div>AVDD</div></div>	<div><div></div><div>GND</div></div>	<div><div></div><div>Y50</div></div>	<div><div></div><div>Y46</div></div>	<div><div></div><div>Y42</div></div>	<div><div></div><div>AVDD</div></div>	<div><div></div><div>GND</div></div>	<div><div></div><div>X38</div></div>	<div><div></div><div>X38</div></div>	<div><div></div><div>X39</div></div>	<div><div></div><div>X40</div></div>	<div><div></div><div>RSVD</div></div>	<div><div></div><div>RSVD</div></div>
B	<div><div></div><div>SDA</div></div>	<div><div></div><div>USBDM GPIO7</div></div>	<div><div></div><div>GND</div></div>	<div><div></div><div>Y70</div></div>	<div><div></div><div>Y67</div></div>	<div><div></div><div>Y63</div></div>	<div><div></div><div>Y59</div></div>	<div><div></div><div>Y56</div></div>	<div><div></div><div>Y53</div></div>	<div><div></div><div>Y49</div></div>	<div><div></div><div>Y45</div></div>	<div><div></div><div>Y41</div></div>	<div><div></div><div>Y38</div></div>	<div><div></div><div>VDDCORE</div></div>	<div><div></div><div>X33</div></div>	<div><div></div><div>X34</div></div>	<div><div></div><div>X35</div></div>	<div><div></div><div>X36</div></div>	<div><div></div><div>X37</div></div>	
C	<div><div></div><div>ADDSEL USBDP</div></div>	<div><div></div><div>COMMSSEL</div></div>	<div><div></div><div>AVDD</div></div>	<div><div></div><div>Y69</div></div>	<div><div></div><div>Y66</div></div>	<div><div></div><div>Y62</div></div>	<div><div></div><div>Y58</div></div>	<div><div></div><div>Y55</div></div>	<div><div></div><div>Y52</div></div>	<div><div></div><div>Y48</div></div>	<div><div></div><div>Y44</div></div>	<div><div></div><div>Y40</div></div>	<div><div></div><div>Y37</div></div>	<div><div></div><div>GND</div></div>	<div><div></div><div>X28</div></div>	<div><div></div><div>X29</div></div>	<div><div></div><div>X30</div></div>	<div><div></div><div>X31</div></div>	<div><div></div><div>X32</div></div>	
D	<div><div></div><div>I2CMODE</div></div>	<div><div></div><div>GPIO6</div></div>	<div><div></div><div>GND</div></div>	<div><div></div><div>GND</div></div>	<div><div></div><div>Y65</div></div>	<div><div></div><div>Y61</div></div>	<div><div></div><div>Y57</div></div>	<div><div></div><div>Y54</div></div>	<div><div></div><div>Y51</div></div>	<div><div></div><div>Y47</div></div>	<div><div></div><div>Y43</div></div>	<div><div></div><div>Y39</div></div>	<div><div></div><div>Y36</div></div>	<div><div></div><div>XVDD</div></div>	<div><div></div><div>X23</div></div>	<div><div></div><div>X24</div></div>	<div><div></div><div>X25</div></div>	<div><div></div><div>X26</div></div>	<div><div></div><div>X27</div></div>	
E	<div><div></div><div>CHG</div></div>	<div><div></div><div>DBG_SS GPIO0</div></div>	<div><div></div><div>AVDD</div></div>	<div><div></div><div>GND</div></div>	<div><div></div><div>GND</div></div>	<div><div></div><div>Y29</div></div>	<div><div></div><div>Y25</div></div>	<div><div></div><div>Y18</div></div>	<div><div></div><div>Y15</div></div>	<div><div></div><div>Y11</div></div>	<div><div></div><div>Y7</div></div>	<div><div></div><div>Y3</div></div>	<div><div></div><div>Y0</div></div>	<div><div></div><div>XVDD</div></div>	<div><div></div><div>X14</div></div>	<div><div></div><div>X15</div></div>	<div><div></div><div>X16</div></div>	<div><div></div><div>X17</div></div>	<div><div></div><div>X18</div></div>	
F	<div><div></div><div>GPIO1</div></div>	<div><div></div><div>GPIO2</div></div>	<div><div></div><div>GND</div></div>	<div><div></div><div>GND</div></div>	<div><div></div><div>Y29</div></div>	<div><div></div><div>Y25</div></div>	<div><div></div><div>Y21</div></div>	<div><div></div><div>Y18</div></div>	<div><div></div><div>Y15</div></div>	<div><div></div><div>Y11</div></div>	<div><div></div><div>Y7</div></div>	<div><div></div><div>Y3</div></div>	<div><div></div><div>Y0</div></div>	<div><div></div><div>XVDD</div></div>	<div><div></div><div>X14</div></div>	<div><div></div><div>X15</div></div>	<div><div></div><div>X16</div></div>	<div><div></div><div>X17</div></div>	<div><div></div><div>X18</div></div>	
G	<div><div></div><div>GPIO3</div></div>	<div><div></div><div>SYNC GPIO4</div></div>	<div><div></div><div>VDDIO</div></div>	<div><div></div><div>Y33</div></div>	<div><div></div><div>Y30</div></div>	<div><div></div><div>Y26</div></div>	<div><div></div><div>Y22</div></div>	<div><div></div><div>Y19</div></div>	<div><div></div><div>Y16</div></div>	<div><div></div><div>Y12</div></div>	<div><div></div><div>Y8</div></div>	<div><div></div><div>Y4</div></div>	<div><div></div><div>Y1</div></div>	<div><div></div><div>GND</div></div>	<div><div></div><div>X9</div></div>	<div><div></div><div>X10</div></div>	<div><div></div><div>X11</div></div>	<div><div></div><div>X12</div></div>	<div><div></div><div>X13</div></div>	
H	<div><div></div><div>GPIO5</div></div>	<div><div></div><div>DBG_CLK XIN</div></div>	<div><div></div><div>VDDIN</div></div>	<div><div></div><div>Y34</div></div>	<div><div></div><div>Y31</div></div>	<div><div></div><div>Y27</div></div>	<div><div></div><div>Y23</div></div>	<div><div></div><div>Y20</div></div>	<div><div></div><div>Y17</div></div>	<div><div></div><div>Y13</div></div>	<div><div></div><div>Y9</div></div>	<div><div></div><div>Y5</div></div>	<div><div></div><div>Y2</div></div>	<div><div></div><div>XVDD</div></div>	<div><div></div><div>X4</div></div>	<div><div></div><div>X5</div></div>	<div><div></div><div>X6</div></div>	<div><div></div><div>X7</div></div>	<div><div></div><div>X8</div></div>	
J	<div><div></div><div>DBG_DATA XOUT</div></div>	<div><div></div><div>TEST</div></div>	<div><div></div><div>VDDCORE</div></div>	<div><div></div><div>Y35</div></div>	<div><div></div><div>Y32</div></div>	<div><div></div><div>Y28</div></div>	<div><div></div><div>Y24</div></div>	<div><div></div><div>AVDD</div></div>	<div><div></div><div>GND</div></div>	<div><div></div><div>Y14</div></div>	<div><div></div><div>Y10</div></div>	<div><div></div><div>Y6</div></div>	<div><div></div><div>AVDD</div></div>	<div><div></div><div>GND</div></div>	<div><div></div><div>VREGBOOST</div></div>	<div><div></div><div>X0</div></div>	<div><div></div><div>X1</div></div>	<div><div></div><div>X2</div></div>	<div><div></div><div>X3</div></div>	

Top View

1.0 PACKAGING INFORMATION

1.1 Package Marking Information

1.1.1 162-BALL UFBGA



1.1.2 ORDERABLE PART NUMBERS

The product identification system for maXTouch devices is described in [“Product Identification System” on page 10](#). That section also lists example part numbers for the device.

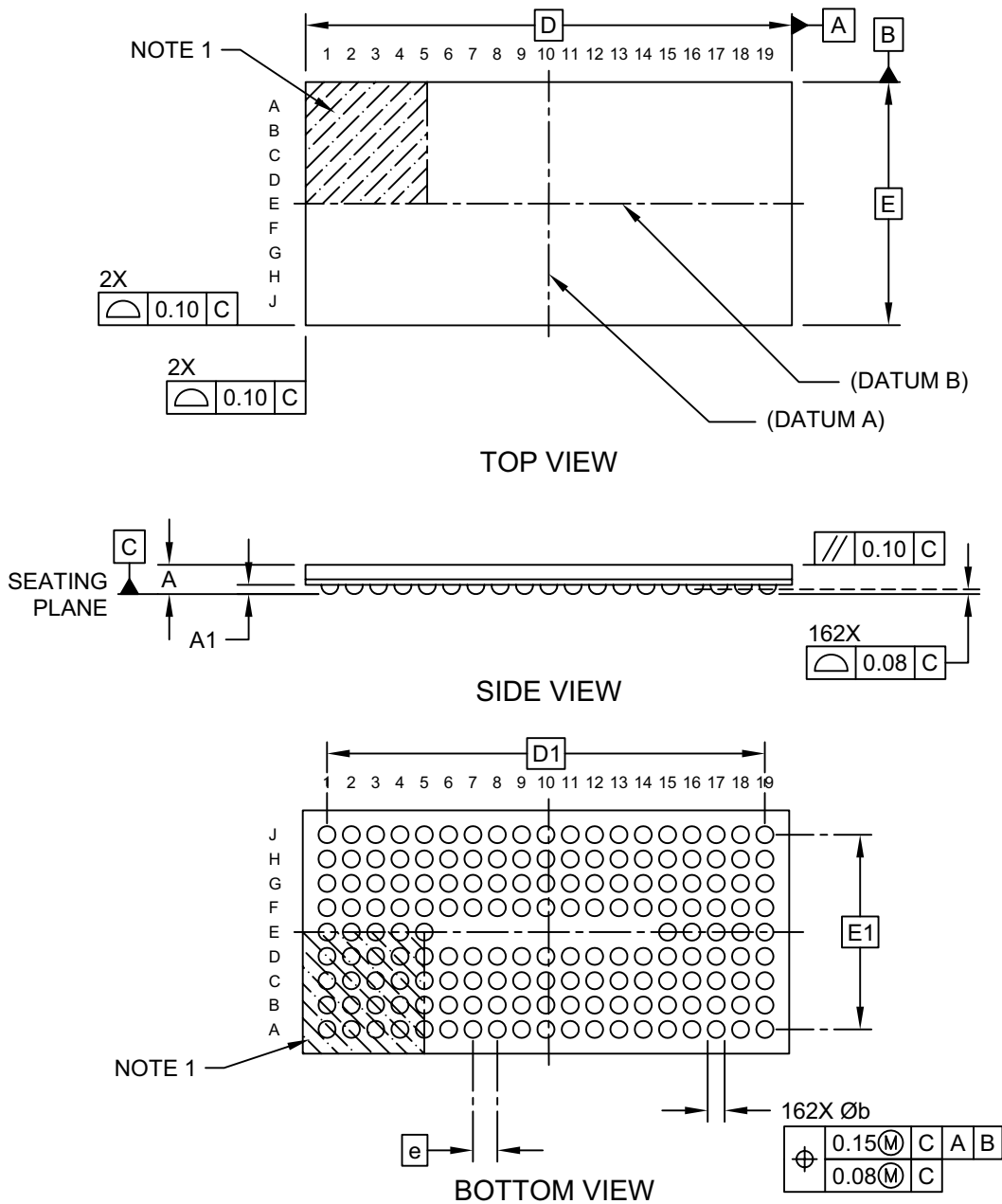
ATMXT1664TD-C2UEN 2.0

1.2 Package Details

162-Ball Ultra Thin Fine Pitch Ball Grid Array (C6B) - 10x5x0.6 mm Body [UFBGA]

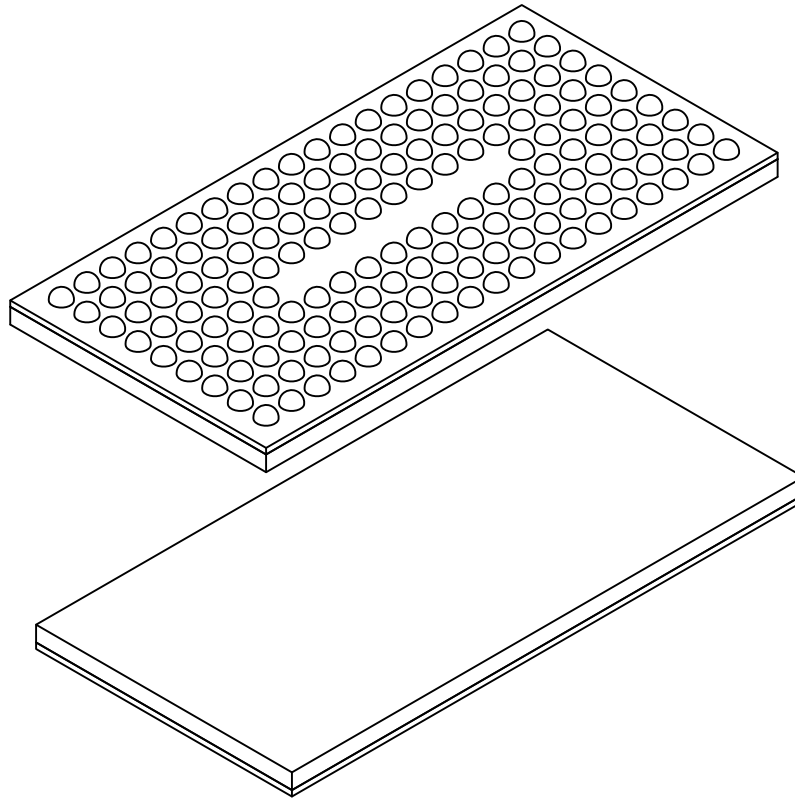
Atmel Legacy Global Package Code CAK

Note: For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



162-Ball Ultra Thin Fine Pitch Ball Grid Array (C6B) - 10x5x0.6 mm Body [UFBGA] Atmel Legacy Global Package Code CAK

Note: For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Number of Terminals	N	162		
Pitch	e	0.50 BSC		
Overall Height	A	0.488	0.546	0.60
Standoff	A1	0.120	0.155	0.190
Overall Length	D	10.00 BSC		
Overall Ball Spacing	D1	9.00 BSC		
Overall Width	E	5.00 BSC		
Exposed Pad Width	E1	4.00 BSC		
Ball Diameter	b	0.20	0.25	0.30

Notes:

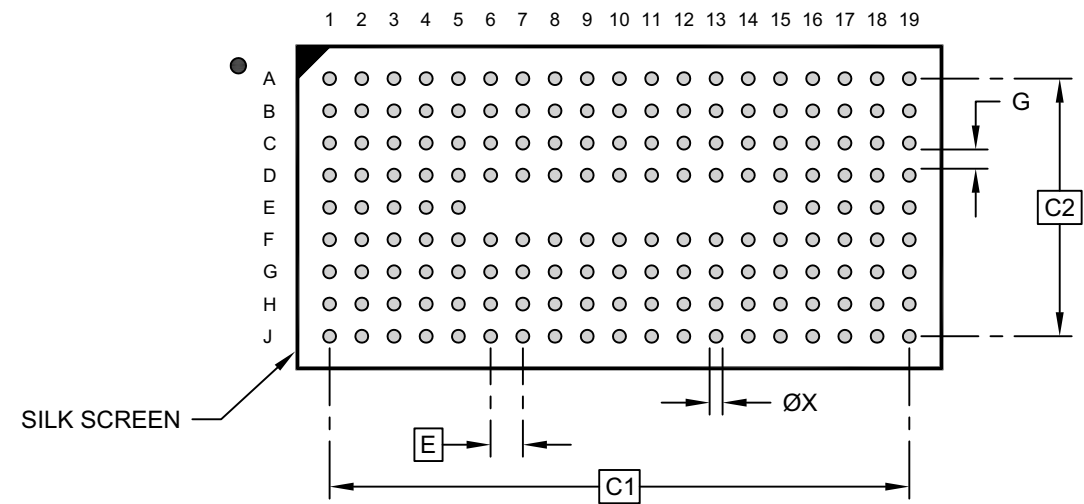
- Pin 1 visual index feature may vary, but must be located within the hatched area.
- Dimensioning and tolerancing per ASME Y14.5M
BSC: Basic Dimension. Theoretically exact value shown without tolerances.
REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-21167 Rev A Sheet 2 of 2

ATMXT1664TD-C2UEN 2.0

162-Ball Ultra Thin Fine Pitch Ball Grid Array (C6B) - 10x5x0.6 mm Body [UFBGA] Atmel Legacy Global Package Code CAK

Note: For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



RECOMMENDED LAND PATTERN

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Contact Pitch	E	0.50 BSC		
Contact Pad Spacing	C1	9.00 BSC		
Contact Pad Spacing	C2	4.00 BSC		
Contact Pad Diameter (X162)	X1			0.20
Contact Pad to Contact Pad	G	0.30		

- Notes:
1. Dimensioning and tolerancing per ASME Y14.5M
BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing C04-23167 Rev A

APPENDIX A: REVISION HISTORY

Revision A (April 2024)

Initial edition for firmware revision 2.0.AA – Release

ATMXT1664TD-C2UEN 2.0

PRODUCT IDENTIFICATION SYSTEM

The table below gives details on the product identification system for maXTouch devices. See [“Orderable Part Numbers”](#) below for example part numbers for the mXT1664TD-C2UEN.

To order or obtain information, for example on pricing or delivery, refer to the factory or the listed sales office.

<u>PART NO.</u>	<u>-XXX</u>	<u>[X]</u>	<u>[X]</u>	<u>[XXX]</u>
Device	Package	Temperature Range	Tape and Reel Option	Pattern

Device:	Base device name			
Package:	C2	=	UFBGA (Ultra Thin Fine-pitch Ball Grid Array)	
	NH	=	UFBGA (Ultra Thin Fine-pitch Ball Grid Array)	
	C4	=	X1FBGA (Extra Thin Fine-pitch Ball Grid Array)	
	MA	=	XQFN (Super Thin Quad Flat No Lead Sawn)	
	MA5	=	XQFN (Super Thin Quad Flat No Lead Sawn)	
Temperature Range:	U	=	-40°C to +85°C (Grade 3)	
Tape and Reel Option: ⁽¹⁾	Blank	=	Standard Packaging (Tube or Tray)	
	R	=	Tape and Reel	
Pattern:	Extension, QTP, SQTP, Code or Special Requirements (Blank Otherwise)			

Note 1: Tape and Reel identifier only appears in the catalog part number description. This identifier is used for ordering purposes and is not printed on the device package. See [“Orderable Part Numbers”](#) below or check with your Microchip Sales Office for package availability with the Tape and Reel option.

Orderable Part Numbers

Orderable Part Number	Firmware Revision	Family ID	Variant ID	Description
ATMXT1664TD-C2UEN1 (Supplied in trays)	2.0.AA	0xA4	0x5C	162-ball UFBGA 10 × 5 × 0.6 mm, RoHS compliant Industrial grade; not suitable for automotive characterization
ATMXT1664TD-C2UREN1 (Supplied in tape and reel)				

Note the following details of the code protection feature on Microchip products:

- Microchip products meet the specifications contained in their particular Microchip Data Sheet.
 - Microchip believes that its family of products is secure when used in the intended manner, within operating specifications, and under normal conditions.
 - Microchip values and aggressively protects its intellectual property rights. Attempts to breach the code protection features of Microchip products is strictly prohibited and may violate the Digital Millennium Copyright Act.
 - Neither Microchip nor any other semiconductor manufacturer can guarantee the security of its code. Code protection does not mean that we are guaranteeing the product is “unbreakable”. Code protection is constantly evolving. Microchip is committed to continuously improving the code protection features of our products.
-

This publication and the information herein may be used only with Microchip products, including to design, test, and integrate Microchip products with your application. Use of this information in any other manner violates these terms. Information regarding device applications is provided only for your convenience and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. Contact your local Microchip sales office for additional support or, obtain additional support at <https://www.microchip.com/en-us/support/design-help/client-support-services>.

THIS INFORMATION IS PROVIDED BY MICROCHIP "AS IS". MICROCHIP MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL, STATUTORY OR OTHERWISE, RELATED TO THE INFORMATION INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF NON-INFRINGEMENT, MERCHANTABILITY, AND FITNESS FOR A PARTICULAR PURPOSE, OR WARRANTIES RELATED TO ITS CONDITION, QUALITY, OR PERFORMANCE.

IN NO EVENT WILL MICROCHIP BE LIABLE FOR ANY INDIRECT, SPECIAL, PUNITIVE, INCIDENTAL, OR CONSEQUENTIAL LOSS, DAMAGE, COST, OR EXPENSE OF ANY KIND WHATSOEVER RELATED TO THE INFORMATION OR ITS USE, HOWEVER CAUSED, EVEN IF MICROCHIP HAS BEEN ADVISED OF THE POSSIBILITY OR THE DAMAGES ARE FORESEEABLE. TO THE FULLEST EXTENT ALLOWED BY LAW, MICROCHIP'S TOTAL LIABILITY ON ALL CLAIMS IN ANY WAY RELATED TO THE INFORMATION OR ITS USE WILL NOT EXCEED THE AMOUNT OF FEES, IF ANY, THAT YOU HAVE PAID DIRECTLY TO MICROCHIP FOR THE INFORMATION. Use of Microchip devices in life support and/or safety applications is entirely at the buyer's risk, and the buyer agrees to defend, indemnify and hold harmless Microchip from any and all damages, claims, suits, or expenses resulting from such use. No licenses are conveyed, implicitly or otherwise, under any Microchip intellectual property rights unless otherwise stated.

Trademarks

The Microchip name and logo, the Microchip logo, Adaptec, AVR, AVR logo, AVR Freaks, BesTime, BitCloud, CryptoMemory, CryptoRF, dsPIC, flexPWR, HELDO, IGLOO, JukeBlox, KeeLoq, Klear, LANCheck, LinkMD, maXStylus, maXTouch, MediaLB, megaAVR, Microsemi, Microsemi logo, MOST, MOST logo, MPLAB, OptoLyzer, PIC, picoPower, PICSTART, PIC32 logo, PolarFire, Prochip Designer, QTouch, SAM-BA, SenGenuity, SpyNIC, SST, SST Logo, SuperFlash, Symmetricom, SyncServer, Tachyon, TimeSource, tinyAVR, UNI/O, Vectron, and XMEGA are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

AgileSwitch, ClockWorks, The Embedded Control Solutions Company, EtherSynch, Flashtec, Hyper Speed Control, HyperLight Load, Libero, motorBench, mTouch, Powermite 3, Precision Edge, ProASIC, ProASIC Plus, ProASIC Plus logo, Quiet-Wire, SmartFusion, SyncWorld, TimeCesium, TimeHub, TimePictra, TimeProvider, and ZL are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Adjacent Key Suppression, AKS, Analog-for-the-Digital Age, Any Capacitor, AnyIn, AnyOut, Augmented Switching, BlueSky, BodyCom, Clockstudio, CodeGuard, CryptoAuthentication, CryptoAutomotive, CryptoCompanion, CryptoController, dsPICDEM, dsPICDEM.net, Dynamic Average Matching, DAM, ECAN, Espresso T1S, EtherGREEN, EyeOpen, GridTime, IdealBridge, iGAT, In-Circuit Serial Programming, ICSP, INICnet, Intelligent Paralleling, IntelliMOS, Inter-Chip Connectivity, JitterBlocker, Knob-on-Display, KoD, MarginLink, maxCrypto, maxView, memBrain, Mindi, MiWi, MPASM, MPF, MPLAB Certified logo, MPLIB, MPLINK, mSiC, MultiTRAK, NetDetach, Omniscient Code Generation, PICDEM, PICDEM.net, PICKit, PICtail, Power MOS IV, Power MOS 7, PowerSmart, PureSilicon, QMatrix, REAL ICE, Ripple Blocker, RTAX, RTG4, SAM-ICE, Serial Quad I/O, simpleMAP, SimpliPHY, SmartBuffer, SmartHLS, SMART-I.S., storClad, SQL, SuperSwitcher, SuperSwitcher II, Switchtec, SynchroPHY, Total Endurance, Trusted Time, TSHARC, Turing, USBCheck, VariSense, VectorBlox, VeriPHY, ViewSpan, WiperLock, XpressConnect, and ZENA are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

SQTP is a service mark of Microchip Technology Incorporated in the U.S.A.

The Adaptec logo, Frequency on Demand, Silicon Storage Technology, and Symmcom are registered trademarks of Microchip Technology Inc. in other countries.

GestIC is a registered trademark of Microchip Technology Germany II GmbH & Co. KG, a subsidiary of Microchip Technology Inc., in other countries.

All other trademarks mentioned herein are property of their respective companies.

© 2024, Microchip Technology Incorporated and its subsidiaries.

All Rights Reserved.

ISBN: 978-1-6683-4241-1

For information regarding Microchip's Quality Management Systems, please visit www.microchip.com/quality.

Worldwide Sales and Service

AMERICAS

Corporate Office
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7200
Fax: 480-792-7277
Technical Support:
[http://www.microchip.com/
support](http://www.microchip.com/support)
Web Address:
www.microchip.com

Atlanta
Duluth, GA
Tel: 678-957-9614
Fax: 678-957-1455

Austin, TX
Tel: 512-257-3370

Boston
Westborough, MA
Tel: 774-760-0087
Fax: 774-760-0088

Chicago
Itasca, IL
Tel: 630-285-0071
Fax: 630-285-0075

Dallas
Addison, TX
Tel: 972-818-7423
Fax: 972-818-2924

Detroit
Novi, MI
Tel: 248-848-4000

Houston, TX
Tel: 281-894-5983

Indianapolis
Noblesville, IN
Tel: 317-773-8323
Fax: 317-773-5453
Tel: 317-536-2380

Los Angeles
Mission Viejo, CA
Tel: 949-462-9523
Fax: 949-462-9608
Tel: 951-273-7800

Raleigh, NC
Tel: 919-844-7510

New York, NY
Tel: 631-435-6000

San Jose, CA
Tel: 408-735-9110
Tel: 408-436-4270

Canada - Toronto
Tel: 905-695-1980
Fax: 905-695-2078

ASIA/PACIFIC

Australia - Sydney
Tel: 61-2-9868-6733

China - Beijing
Tel: 86-10-8569-7000

China - Chengdu
Tel: 86-28-8665-5511

China - Chongqing
Tel: 86-23-8980-9588

China - Dongguan
Tel: 86-769-8702-9880

China - Guangzhou
Tel: 86-20-8755-8029

China - Hangzhou
Tel: 86-571-8792-8115

China - Hong Kong SAR
Tel: 852-2943-5100

China - Nanjing
Tel: 86-25-8473-2460

China - Qingdao
Tel: 86-532-8502-7355

China - Shanghai
Tel: 86-21-3326-8000

China - Shenyang
Tel: 86-24-2334-2829

China - Shenzhen
Tel: 86-755-8864-2200

China - Suzhou
Tel: 86-186-6233-1526

China - Wuhan
Tel: 86-27-5980-5300

China - Xian
Tel: 86-29-8833-7252

China - Xiamen
Tel: 86-592-2388138

China - Zhuhai
Tel: 86-756-3210040

ASIA/PACIFIC

India - Bangalore
Tel: 91-80-3090-4444

India - New Delhi
Tel: 91-11-4160-8631

India - Pune
Tel: 91-20-4121-0141

Japan - Osaka
Tel: 81-6-6152-7160

Japan - Tokyo
Tel: 81-3-6880- 3770

Korea - Daegu
Tel: 82-53-744-4301

Korea - Seoul
Tel: 82-2-554-7200

Malaysia - Kuala Lumpur
Tel: 60-3-7651-7906

Malaysia - Penang
Tel: 60-4-227-8870

Philippines - Manila
Tel: 63-2-634-9065

Singapore
Tel: 65-6334-8870

Taiwan - Hsin Chu
Tel: 886-3-577-8366

Taiwan - Kaohsiung
Tel: 886-7-213-7830

Taiwan - Taipei
Tel: 886-2-2508-8600

Thailand - Bangkok
Tel: 66-2-694-1351

Vietnam - Ho Chi Minh
Tel: 84-28-5448-2100

EUROPE

Austria - Wels
Tel: 43-7242-2244-39
Fax: 43-7242-2244-393

Denmark - Copenhagen
Tel: 45-4485-5910
Fax: 45-4485-2829

Finland - Espoo
Tel: 358-9-4520-820

France - Paris
Tel: 33-1-69-53-63-20
Fax: 33-1-69-30-90-79

Germany - Garching
Tel: 49-8931-9700

Germany - Haan
Tel: 49-2129-3766400

Germany - Heilbronn
Tel: 49-7131-72400

Germany - Karlsruhe
Tel: 49-721-625370

Germany - Munich
Tel: 49-89-627-144-0
Fax: 49-89-627-144-44

Germany - Rosenheim
Tel: 49-8031-354-560

Israel - Ra'anana
Tel: 972-9-744-7705

Italy - Milan
Tel: 39-0331-742611
Fax: 39-0331-466781

Italy - Padova
Tel: 39-049-7625286

Netherlands - Drunen
Tel: 31-416-690399
Fax: 31-416-690340

Norway - Trondheim
Tel: 47-7288-4388

Poland - Warsaw
Tel: 48-22-3325737

Romania - Bucharest
Tel: 40-21-407-87-50

Spain - Madrid
Tel: 34-91-708-08-90
Fax: 34-91-708-08-91

Sweden - Gothenberg
Tel: 46-31-704-60-40

Sweden - Stockholm
Tel: 46-8-5090-4654

UK - Wokingham
Tel: 44-118-921-5800
Fax: 44-118-921-5820