Datasheet

TCS1/TCS2-TCD58E TouchChip Chipset Datasheet

Release: 1.0

Note: In September, 2010, AuthenTec and UPEK merged into one company,. Some drawings, photos, etc., in this datasheet may retain UPEK labels or logos provided the information is deemed otherwise accurate.

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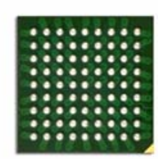
1 Features

- **TouchChip® Sensor**
  - TCS1x: 256 x 360 pixel array
    - 18.0mm x 12.8mm imaging area
  - TCS2x: 208 x 288 pixel array
    - 14.4mm x 10.4mm imaging area
  - TCSxC: Tough polymer coating
    - 2 million finger placements
  - TCSxS: Tougher SteelCoat™ coating
    - 4 million finger placements
  - TCS2SS/TCS1xT: Integrated Bezel
  - TCS1C: FIPS-201 capability
  - 508 DPI, 8 bits per pixel
  - Up to IEC 61000-4-2 Level 4 ESD tolerance

TCS1CM
(Additional sensor photos on next page.)



TCD58E

- **TouchChip® TCD58E Companion Chip**
  - 32-bit RISC architecture
  - Up to 144 MIPS
  - Internal NVM available for biometric data
    - More than 100,000 erase/write cycles
    - More than 20 years data retention
  - Internal storage for up to 180 templates
  - Template match speed up to 56 per second

- **Security Features**
  - PKI Support
  - Latent print detection
  - Encrypted communication to PC supported
  - Support for trusted paths to other digital entities

- **Environmental Specifications**
  - Operating temperature:
    - TCS1: -30° C to +85° C
    - TCD58E: -40° C to +85° C
  - Storage temperature: –40° C to +125° C
  - Storage/operating humidity: 5% to 93% RH without condensation
  - RoHS compliant and Low Halogen

- **Power Consumption**
  - USB power management compliant with ACPI specifications
  - Deep sleep: 900 uA @ 3.3 V
  - Standby: 1150 uA @ 3.3 V (finger detect active)
  - Imaging mode: sensor ~20mA @ 4.55V, companion chip ~67mA @ 3.3V
  - Wake-up time: <15 ms (Deep sleep or standby to imaging)

- **Host Interfaces**
  - USB 2.0 full speed (12 Mbps) interface
  - UART interface (up to 230.4 Kbps)
  - SPI interface (up to 7.2Mbps)

- **Firmware/Software Components**
  - PerfectTrust® command interface
  - BSAPI: Biometric Services Application Programming Interface

2 TouchChip Biometric Subsystem

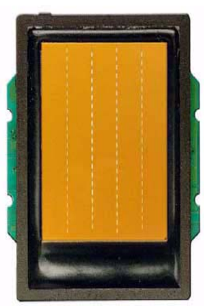
AuthenTec's TouchChip chipset is a trusted biometric security system that designers can use to embed advanced, highly secure fingerprint acquisition and verification technologies within their products.

The TouchChip TCS1x/TCS2x-TCD58E chipset is an all-in-one solution capable of performing all the necessary functions to match a live finger that is placed on the TouchChip sensor surface against a pre-enrolled fingerprint template. The pre-enrolled template may have been stored internally or sent to the chipset from outside.

The TCD58E supports both symmetric (DES and AES) and asymmetric (PKI) encryption.

Functionality of the previous generation chipset is supported or enhanced. Secure communication insures that all PC-to-chipset communication is protected against snooping, replay, simulation, or man-in-the-middle attacks. Flexible authentication methods mean that different applications can securely share the chipset resources. Match/sign operations allow secure communication and transactions with remote entities, allowing the establishment of trusted paths and enabling local or remote entities to trust the results of all biometric operations. These operations enable the security of the chipset to be extended outward to other security hardware, or to secure network resources. The TCD58E includes support for One Time Password (OTP) generation using standard algorithms to simplify integration into existing network infrastructure in a convenient and secure way.

Sensors versions shown below:



TCS1CM
Standard Coating

TCS1SM
SteelCoat

TCS2CN
Standard Coating

TCS2SN
SteelCoat

TAB packs

TCS1CT

TCS1ST

TCS2SS

Integrated Bezels

3 Highlights

Maximum integration
The TouchChip chipset significantly reduces development time and costs, as it can easily be incorporated in any application environment (embedded system or PC system), using a comprehensive API function set.

Suitable for a wide range of embedded applications
With key features such as low power consumption, ease of use, and multiple host interfaces, the TouchChip chipset is an ideal solution for embedded applications such as mobile identification and inventory tracking devices.

Suitable for a wide range of PC-based applications
The USB interface, In conjunction with other PC-related tools such as BIOS security extensions and password management utilities, enable the TouchChip chipset to be used for Notebook and PC-based applications.

Enhanced Performance
When compared to the first generation TCD21 co-processor, the TCD58E supports more templates, performs faster matching, has lower False Rejection Ratio, improves ESD recovery, supports new imaging modes, and includes an enhanced template mode. When used together with a conductive bezel the chipset also now supports FIPS-201 imaging, SteelCoat™ sensor coating, latent print detection and low power finger detection. Note that FIPS-201 is supported only on the TCS1C and requires a special license from AuthenTec.

When compared to the TCD50D co-processor the TCD58E includes optimized firmware for area sensors as well as additional firmware capacity for any potential future upgrades.

Choice of Protective Coatings
The TouchChip sensor is available in two protective coatings. Both coatings offer excellent biometric performance while meeting specific market needs. TCS1C/TCS2C comes with our gold colored standard polymer coating, which has been in production for years and is well proven and accepted. Also available is the TCS1S/TCS2S with black SteelCoat™ protective coating which increases sensor durability and minimizes the impact of latent images. Sensors with SteelCoat must be used with an active bezel and EIM-Lite imaging mode. SteelCoat is 100-500% tougher than the polymer coating.

With or Without Integrated Bezel
The use of a bezel is required for EIM (FIPS-201) and EIM-Lite modes. Only traditional Standard Imaging Mode (not recommend for new designs) may omit the bezel. New designs can take advantage of the packaging, assembly and part count reduction provided by sensors with integrated bezels.

The TCD58E also comes with:

- Serial line support for any or no operating system, including Windows 2000®, Windows XP®, Windows CE®, Windows Mobile, Android and Symbian®
- USB support including a Microsoft-signed USB driver for Windows 2000®, Windows XP®, Windows Vista®, Windows® 7, as well as driver support for Linux and Mac OS® X

4 TouchChip Chipset Functionality

The TouchChip chipset incorporates AuthenTec's Digital ID engine, which performs all of the processes required for biometric functionality on a secure processor. This section describes the various processes that can be performed.

4.1 PerfectPrint™ Image Optimization

The TouchChip chipset incorporates a state-of-the-art PerfectPrint™ algorithm to capture fingerprint images. The PerfectPrint firmware embedded in the TCD58E includes image optimization functions that allow the sensor to capture the best-quality fingerprint image, according to environmental conditions and skin types. This chipset does not support PerfectPrint software running on an external host, as do other AuthenTec area sensor reader products such as TCRU1C and EikonTouch™. The TCD58E internal PerfectPrint library is only accessible via AuthenTec's PTAPI and BSAPI[1].

4.1.1 Image Capture Modes

The TouchChip chipset supports three image capture modes. These three modes define the image capture characteristics of the TouchChip fingerprint sensor, in turn optimizing the balance between image quality, system cost, usability and grab speed for different market applications. AuthenTec uses an image gradient compensation method to optimize the TouchChip image quality for each imaging mode, providing AuthenTec TouchChip sensors with a wide range of fingerprint image capture capabilities, and offering excellent reliability and usability for a broad range of users and environmental conditions. The image capture mode and gradient compensation information is programmed into the TouchChip chipset system once during manufacturing by USB versions of Reader Calibration software and remains constant for the life of the device.

4.1.1.1 Standard Image Mode

Standard mode is AuthenTec's original TouchChip image capture mode and is widely used today. Standard mode captures the fingerprint image without an external bezel. Standard mode is the simplest and lowest cost image capture method. Standard mode only supports the TCS1/2C standard (gold) sensor coating, SteelCoat sensors are not supported.

NOTE: Standard mode is not recommended for new designs.

4.1.1.2 Enhanced Image Mode (FIPS-201)

Enhanced Image Mode (EIM) improves captured image quality over standard mode by adding a conductive bezel around the sensor and modifying the calibration process to increase the signal-to-noise ratio (SNR) for the captured image. Improving the SNR increases the image contrast ratio. EIM makes use of extensive image post-processing by mapping a full byte per pixel correction image for gradient correction. EIM also improves dry finger performance and helps reject latent images.The TCS1C sensor is the first and only silicon fingerprint sensor to meet the FBI's FIPS-201 image quality criteria. EIM requires signing the AuthenTec EIM license agreement, implementing a conductive bezel and use of an enhanced version of the device calibration process. Only the standard (gold) TCS1C sensor coating is supported.

4.1.1.3 Light Version of Enhanced Image Mode (EIM-Lite)

EIM-Lite supports the valuable bezel aided SNR improvements of full EIM minus the image post-processing. EIM-Lite also improves dry finger performance compared to Standard mode and helps reject

1. The BSAPI Reference Manual refers to TCD58E for area sensors as "TCD50v3"

latent images. EIM-Lite may be used with both the standard (gold) and SteelCoat (black) sensor coatings, but SteelCoat is recommended for its durability and anti-latent advantages. This mode reduces some of the implementation overhead of the full Enhanced Imaging Mode, but still brings most of the image quality improvements.

4.1.2 Captured Image Readout

The image readout functionality includes the ability to change the DPI resolution (sub-sampling), pixel bit-depth, and filtering/binarization of the raw sensor image. The sensor always delivers an image of 508/508/8, all scaling takes place in the companion chip. The parenthetical numbers following the descriptions below reflect the PT/BSAPI image format value (eg: ABS_PKEY_IMAGE_FORMAT). The three image readout modes supported by the TCD58E are as follows:

- 381/381/8: 4-to-3 pixel scaling (Image_Format = 2, also aliased to 19)
- 381/381/1: 4-to-3 pixel scaling and filtered/binarized (Image_Format = 4)
- 508/508/8_Scan: Full resolution (Image_Format = 34)

The following table shows the different captured image formats supported and the approximate readout times in milliseconds for the three interfaces:

Table 1: Image Readout Times[1]

Image	I/O	Sensor	EIM (Full)	EIM-Lite	Standard	Units
508/508/8	USB[2]	TCS1	261	296	270	mS
		TCS2	N/A	234	211	mS
	UART[3]	TCS1	4935	4950	4942	mS
		TCS2	N/A	3118	3118	mS
	SPI	TCS1	501	504	509	mS
		TCS2	N/A	376	371	mS
381/381/8	USB	TCS1	323	397	364	mS
		TCS2	N/A	285	260	mS
	UART	TCS1	2934	3038	2975	mS
		TCS2	N/A	2016	1973	mS
	SPI	TCS1	455	538	509	mS
		TCS2	N/A	386	363	mS
381/381/1	USB	TCS1	442	513	484	mS
		TCS2	N/A	371	346	mS
	UART	TCS1	902	1007	965	mS
		TCS2	N/A	706	672	mS
	SPI	TCS1	518	602	570	mS
		TCS2	N/A	431	406	mS

1. All times represent the “no wait” state. “Wait” requires more time but supports image stabilization, image segmentation and anti-latent check (when available).
2. USB readout time can be increased by the presence of other active peripherals on the bus.
3. Estimates for UART running at 230.4kbps.

4.1.3 Image Filtering/Binarization

TCD58E supports an image filtering function, mentioned above, which results in a binarized (1-bit per pixel) representation of the 508/508/8 raw fingerprint image in 381/381/1 format. This binary image mode can be used for high-speed image transfer over slow communication links (i.e., UART) for fingerprint display and other user interface or non-biometric purposes.

4.1.4 Fingerprint Quality

TCD58E PerfectPrint firmware performs a quality check on the acquired image prior to releasing the image for output or template extraction. This quality check assures that the image meets an acceptable level of quality, primarily concerning finger positioning and image contrast.

This quality check is transparent as long as the acquired fingerprint image is of sufficient quality. Any time the fingerprint image does not meet minimum standards the API function which has been called will return an error code identifying the source of the error (see API documentation for details).

4.2 PefectMatch™ Fingerprint Template Extraction

Embedded PerfectMatch technology performs the fingerprint minutia-based extraction from live fingers. Two different AuthenTec template formats are supported. The standard (aka "consolidated") template is similar to those used in previous companion chips. The enhanced (aka "super") template is a combination of multiple data inputs and averages 3 times larger in size. The increased template size enables improved biometric performance and usability compared to the standard template. The actual size of the template depends on the particular fingerprint. The maximum size of the template is limited to 428 bytes for standard and 2200 bytes for enhanced templates. Note that it will be very rare for an enhanced template to reach maximum size.

TCD58E supports converting from/to AuthenTec templates to/from either ANSI-378 or ISO 19794-2 templates. This is supported directly via PTAPI, or with the addition of a special library with BSAPI.

4.2.1 Fingerprint Template Enrollment

Following extraction, the PerfectMatch firmware allows a live fingerprint template to be:
- stored locally into the NVM of the TCD58E (enrolled to internal biometric database)
- transferred over to and managed by the host application
- used for various verification/matching operations while available in the LGT (Last Good Template) register of the TCD58E

TCD58E supports the latest dynamic enrollment process. During dynamic enrollment multiple fingerprint images are grabbed and processed until the template meets the template quality criteria. The dynamic process permits a higher quality template combining the most important features extracted from the enrollment data. A minimum of five and a maximum of ten images are required to complete dynamic enrollment.

4.2.2 Fingerprint Template Matching

TCD58E PerfectMatch firmware also performs the fingerprint match, it does this by comparing the live fingerprint template against a fingerprint template retrieved from memory. The enrollment template can be stored locally, on a server, or on another system component such as a smart card. The match algorithm supports different security settings, and the time required for the match algorithm will depend on both the security setting used, as well as the specific fingerprint being matched. Average template match time is shown in the following table.

Template Type	Typical Template Match Time
Standard	56.5 per Second
Enhanced	13.4 per Second

The matching feature can be used in a number of scenarios:

- 1:1 verification of live finger against a selected fingerprint template stored in chipset's biometric database.
- 1:1 verification of live finger against a fingerprint template supplied to the chipset from outside.
- 1:1 matching of two fingerprint templates: One or both templates can be stored either on the chipset in biometric database or can be supplied to the chipset from outside. This feature allows using the chipset as a biometric matcher.
- 1:few identification: Identification of a live finger against a given set of fingerprint templates. Templates against which identification is being performed can reside on the chipset or can be supplied from outside of the module for the sole purpose of this operation. The identification template set can also combine templates from both sources.
- 1:few identification: Identification of a live finger against all templates stored in the chipset's biometric database.

In case multiple operations against the live fingerprint template are needed, the live fingerprint template is stored in the chipset's session memory. This allows multiple uses of the live fingerprint template (e.g., for multiple 1:1 verification operations), instead of requiring the user to place the finger over the sensor repeatedly for each operation.

4.3 Biometric Database Functionality

The attached NVM flash, internal or external depending on reference schematic, is used to store several types of information, including templates. Each template stored in the database is assigned a record number, called a slot number. Stored templates can be used for verification/matching operations or can be deleted. In the case of full EIM the internal memory is insufficient even before adding a single template, so in this configuration the available reference designs include an external 256kB (2Mb) Flash that is used in lieu of the internal device. This external memory configuration can also be used in the other two image modes for increasing template storage space, if desired, but in any case the internal and external memories are exclusive of each other. Data transfers between the TCD58E and external memory are encrypted.

TCD58E is compatible with the following biometric database management features:

- Enroll a live finger to a biometric database (Add database record)
- Supply a template from outside of the module and store it in the database (Add database record)
- Delete a specified record from the database
- Delete all records from the database
- Read, store, modify or delete a data tag associated with the record
- List database (Lists all slot numbers and content of each record's data tag)

One or more data tags can be stored in the database record along with each enrollment template. Data tags can be used to store application-specific data of any type. A data tag can be edited, deleted, or modified within a database record at any time. Data tags can be either public (readable anytime) or private. Private data tags are readable only after the associated template is matched against a live finger, and they therefore allow user passwords or other credentials to be stored securely, with hardware-protected access.

The granularity of record storage in the memory is 256 bytes, meaning that any element stored will consume some multiple of 256 bytes. Thus a standard template with average size will consume 512 bytes of storage. Each data tag will also consume a minimum of 256 bytes.

The table below shows the average number of templates that can be stored for various cases.

Table 2: Local Template Storage

		Template Type			
		TCS1		TCS2	
Image Mode	**Memory**	**Standard**	**Enhanced**	**Standard**	**Enhanced**
Standard	Internal 128kB	120	40	120	120
EIM-Lite		120	40	120	48
EIM		N/A	N/A	N/A	N/A
All	External 256kB	180	60	180	72

The device includes recovery mechanisms to guard against data loss in the event that power is removed during a write operation. This mechanism is not completely power-failure safe: if a file is being written when the power fail occurs, that file may be lost.

4.4 Additional Features

TouchChip chipset offers a number of useful additional features.

4.4.1 GUI Callbacks

All live fingerprint-scanning operations offer to the application the option to display a GUI feedback. The application can choose the level of callback communication, from simple (only requests to put/lift finger) to a full finger positioning feedback (e.g., advising user/application to move finger more to left, right etc.).

4.4.2 Finger Detection

The finger detection feature allows putting the TouchChip chipset into a time-limited or infinite-wait cycle, including Standby, until a finger is detected on the bezel. Upon finger detection, the function reports back to the application, which can proceed with further action (e.g., verification). Finger detect requires a conductive bezel. The TCD58E contains two internal frequency generators whose nominal frequencies are determined by external components. One generator connects to the bezel, the other to a single capacitor. The presence of a finger on the bezel effects the frequency of the generator. An internal comparison circuit detects when the bezel frequency reaches one-half the reference frequency, when this happens an interrupt flag will be set. Response to this flag is determined by the calling function.

4.4.3 Latent Print Detection

Latent and faint fingers are detected and rejected, with an error message being returned to the calling function. This feature requires the use of a conductive bezel, therefore it does not work in standard image mode.

4.4.4 On-Chip NVM Storage of Application-Specific Data

The TouchChip chipset supports storage of limited application-specific data in the on-chip NVM. Two memory areas are available for this purpose:

- Application Memory Area: Accessible for read and write operations by all applications. The available memory size is limited to 256 bytes.
- OEM Memory Area: Accessible by OEM customers wishing to pre-load some OEM-specific data within their chipsets. The available memory size is limited to 256 bytes.

4.4.5 Functional States

The TouchChip chipset supports two low-power states:

1. **DEEP SLEEP mode:**
   In this mode, the TouchChip chipset is still powered but every part of the system is turned off. In this mode the power consumption used by the chipset is the minimum possible. The chip can be awakened and go to active mode only via an external WAKEUP signal supplied by the host (generic GPIO, or with the UART's CTS flow control signal if RTS/CTS flow control is used), or USB resume.
2. **STAND-BY mode:**
   In this mode, the TouchChip chipset is still powered at a minimal amount sufficient to operate the finger detect function. In this mode, all circuit blocks are turned off with the exception of those needed for the finger detect function, and power consumption used by the chipset is very low. The TouchChip chipset can be awakened and go to active mode via an external wake-up signal or by the hardware finger detect.

4.4.6 USB Power Management Support

The TouchChip chipset driver supports the following:

- USB Power Management Capabilities Query. TouchChip chipset is able to report to the USB host via the Standard Power Descriptors. These address power consumption, latency time, wake support, battery support and status notification.
- USB Power Management State Transition Commands. The USB host, via the standard SET_FEATURE command, controls TouchChip chipset power states. USB device power states are queried via the standard USB GET_STATUS command.

4.4.7 USB Selective Suspend

In Microsoft Windows XP® and later operating systems, the USB core stack supports a feature known as "Selective Suspend." This feature allows a device driver to turn off the USB device it controls when the device becomes idle, even while the system itself remains in a fully operational power state (S0). This feature is primarily intended to conserve battery power in notebook PCs. It should be recognized that user authentication devices connected to the USB port are used relatively infrequently during the operation of the notebook PC. The TouchChip chipset implements this support to provide reasonable battery life for the user. Implementing this simple mechanism provides power reduction in three instances: one for the USB controller, the USB device itself, and for the host CPU in the notebook PC. Once suspended, the TouchChip chipset sensor can be awakened either by a USB resume signal from the host, or due to remote wake-up request (finger detect). For additional information, see the timing diagrams.

4.4.8 LED Interface Support

The TouchChip chipset has two signal outputs which can be used to connect user interface LEDs. The LED behavior can be defined by the host application in order to facilitate the creation of a user interface in embedded applications. The APIs allow switching the LEDs on, off, or letting them blink at different rates and patterns. Refer to AuthenTec's reference design documentation for more information regarding the LED interface.

4.4.9 Secure Communication Channel

The TCD58E supports encryption of the host communication channel. The encryption can use DES (56-bit) or AES with a key length of 128 or 256-bits. Some variations may require a government export license. The session key is based on a random number generated by the TCD58E and transferred to the host during the course of a 3-way challenge-response authentication. Secure communication can be initiated at any time during the session, and remains active until the session is terminated.

4.4.10 External Memory Support

Some features, for example full EIM mode with template storage, require more memory than provided by the default 1Mbit in the TCD58E. The memory space can be increased by the use of an external 2Mbit Flash device (see reference schematics for details). This external memory completely replaces, not extends, the internal memory. In EIM designs the additional space is required for the increased amount of calibration information. In the other image modes this feature may also prove valuable for increasing total template space, with the caveat that average search time will increase with the total number of templates stored.

5 TouchChip Fingerprint Sensors (TCS1, TCS2)

5.1 Technology

AuthenTec's TouchChip sensing system uses advanced technology to capture high quality fingerprint images from every finger. AuthenTec uses a unique, patented, dual-plate, active-pixel design which gives a stronger signal with less noise. This leads to the best fingerprint image possible, superior to competing systems that use only single-plate passive-pixel or RF imaging designs. TouchChip sensing penetrates through outer skin layers to read live layers under the skin

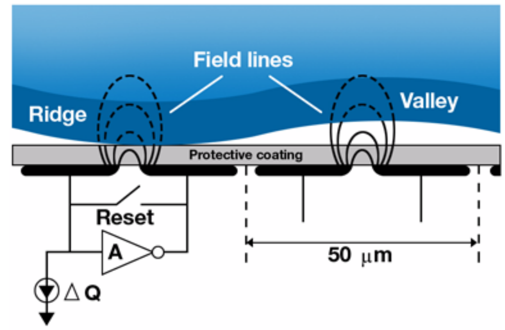


Figure 2: Principle of Operation

When combined with a bezel the system uses three different capacitive sensing methods: DC, AC, and differential AC, unlike competing systems that can use only one method. This gives optimal performance with the widest variations of skin types, even at extremes of temperature and humidity.

This advanced sensing methodology has enabled AuthenTec to meet the stringent image quality requirements defined by NIST and the FBI and is FIPS-201 certified, something that no other silicon fingerprint sensor has achieved. Furthermore this ultra-sensitive imaging system enables the non-FIPS-201 use of SteelCoat, a thick, tough, protective layer for maximum durability and optimal cosmetic appearance.

5.2 Sensor Coatings

AuthenTec offers two coating options for TouchChip sensors. These coatings both offer exellent biometric performance with different capabilities for specific market needs.

5.2.1 Standard Coating (gold color)

TouchChip sensors with the gold colored coating have been in production for years and are well proven. This coating provides high image quality with durability well matched to a desk top environment. Only TCS1 with this standard coating is in compliance with FIPS-201.

5.2.2 SteelCoat™ (black color)

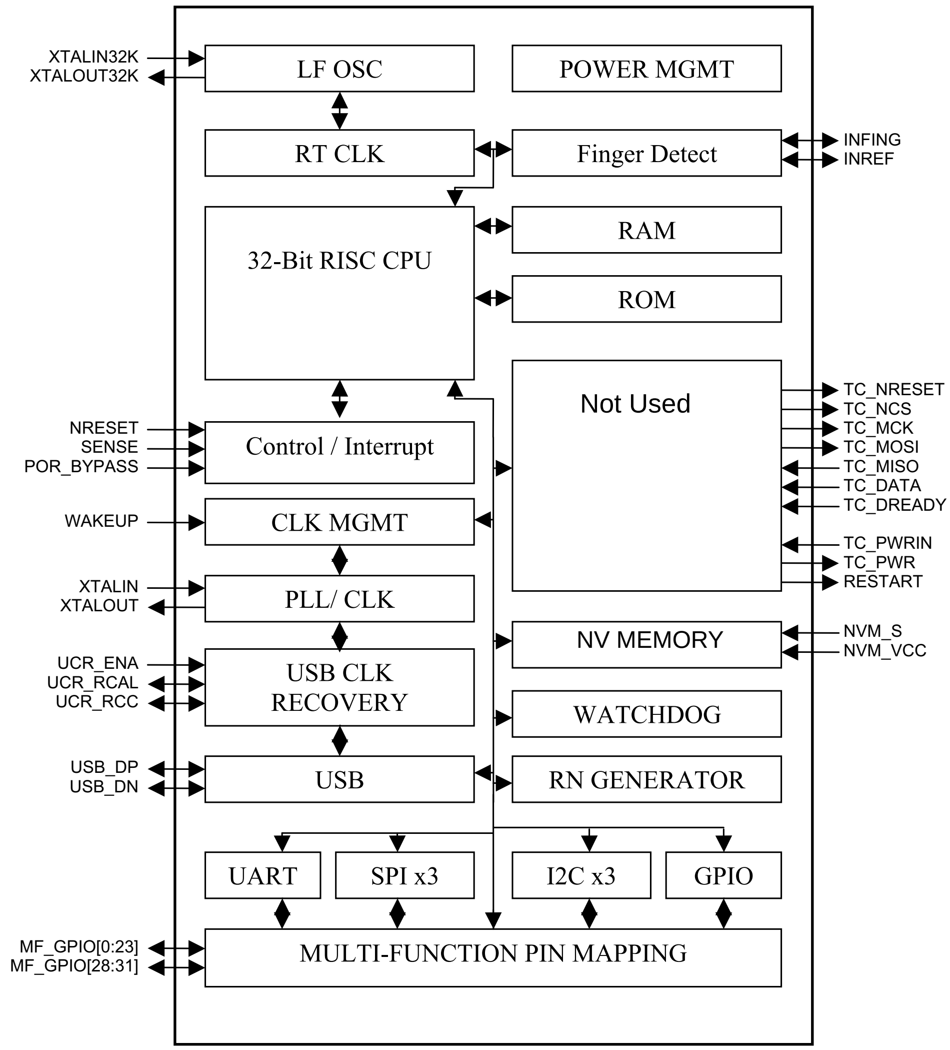
TouchChip sensors are also offered with AuthenTec's SteelCoat protective coating. SteelCoat increases durability while also minimizing the impact of latent images. SteelCoat is not FIPS-201 compliant. SteelCoat is only supported by EIM-Lite imaging mode.

Table 3: Coating Comparison

Test	Standard Coating	SteelCoat
Pen Drop	8cm	60cm
Pen Scratch	4.5N	18N
Pencil Scratch	10N, 6H	20N, 6H
Touches	2 Million	4 Million

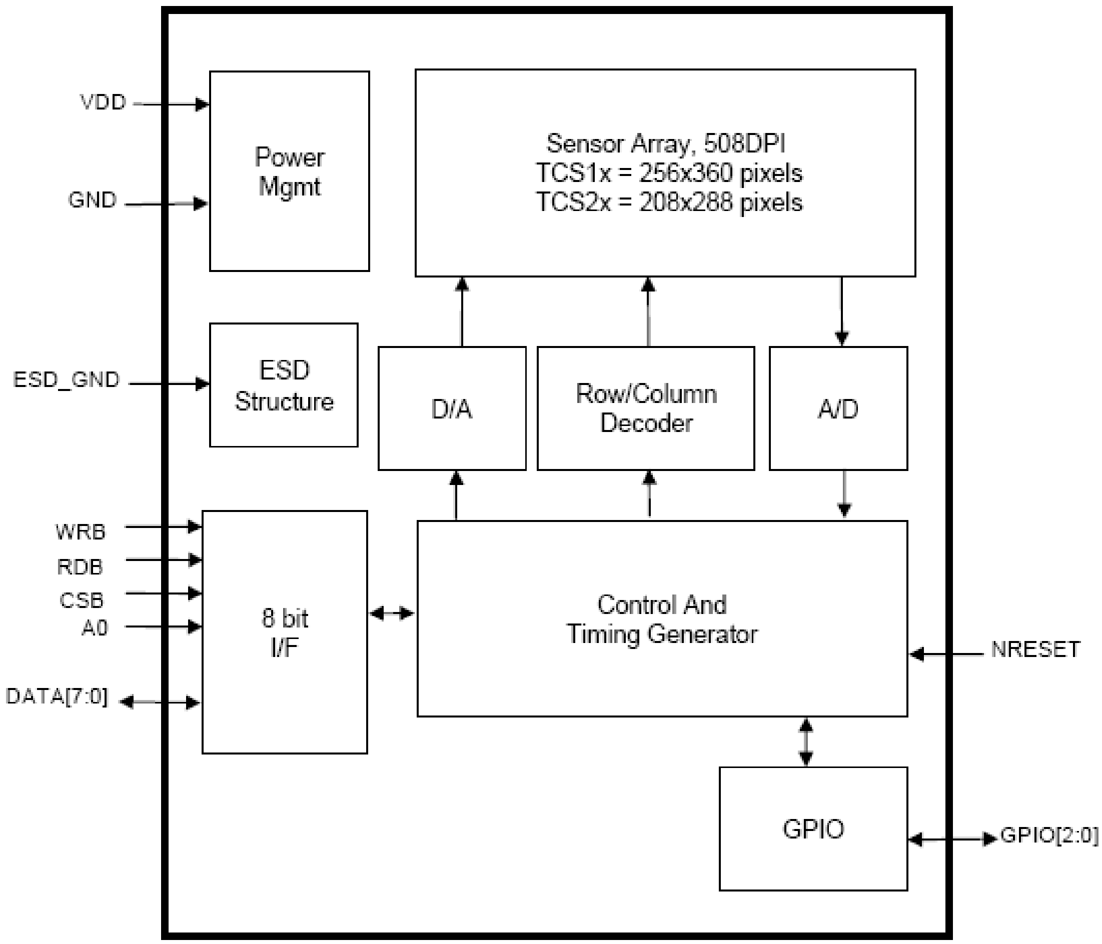
6 TouchChip Chipset Hardware Architecture

6.1 TCD58E Block Diagram



Note that the SPIX interface is not used in this implementation. The sensor data buss and control lines are primarily sourced from the multi-function pins. See the appropriate reference design for details.

6.2 TCS1/TCS2 Block Diagram



7 Additional Features

This section describes additional hardware features of the chipset.

7.1 TCD58E NVM Considerations

The TCD58E includes non-volatile memory (NVM) consisting of 128 KBytes of Flash. This memory is used for various purposes, including storage of a template database, storage of sensor calibration information, device configuration information, and firmware updates which can enhance or extend the TCD58E's built-in ROM code. The NVM interface makes use of GPIO4:7 of the TCD58E. GPIO4:6 are routed internally. Note that proper operation of the TCD58E NVM requires the GPIO7 signal to be routed to NVM_CS externally on the customers' assembly, as noted in all chipset reference schematics. The standard memory size is insufficient for EIM (FIPS201) usage, so an external 256KByte NVM must be substituted.

7.1.1 NVM Security

Sensitive NVM data is protected by encryption against malicious intrusions. The encryption algorithm and key length will usually be 256-bit AES, but other options are also supported. The encryption is based on keys that are hard-coded in the TCD58E ROM code. Because the TCD58E uses a Harvard architecture, with separate instruction and data busses, there is no mechanism for these ROM keys to be read out externally.

7.1.2 Firmware Updates

The TCD58E includes a mechanism to load firmware extensions into the NVM. This allows for the functionality of the TCD58E to be extended or enhanced for custom applications, and to counteract code problems that are identified after manufacture.The default state of TCD58E NVM is blank. The TCD58E is not application-ready until a final firmware image has been loaded.

In order to prevent malicious firmware from being loaded, all firmware images must be signed with a code-signing key, which is controlled by AuthenTec. Unsigned firmware uploads will be rejected by the TCD58E. The firmware update command verifies that the NVM file has been successfully written prior to sending a confirmation back to the host, so that the update process can be guaranteed.

7.1.3 Manufacturing Test and Sensor Calibration

The TouchChip chipset must be calibrated prior to use in an application. Because of normal variations in semiconductor manufacturing, certain analog properties of the sensor cannot be controlled to the level of precision required for image capture operations. The calibration process allows variations of the sensor to be measured so that image capture operations can be optimized. (Note that the properties of each sensor are tested at the factory to guarantee that they fall within the required limits.) The calibration information is stored in the TCD58E controlled NVM. This calibration must be performed on the chipset after the particular sensor and TCD58E processor have been assembled together. The calibration information about a particular sensor is associated with the TCD58E, therefore the calibration will be invalidated if the particular TCD58E and sensor units are separated. Calibration takes place on the host, not the TCD58, and the large amount of data exchanged during this process makes the use of USB highly recommended. Currently calibration and image quality functions are not supported by embedded commands.

AuthenTec provides all needed support to allow customers to perform firmware updating, calibration, and testing during manufacture of the chipset assembly. The particulars of this process will vary by application. PC based tools are required as key functionality can not be recreated with API commands (calibration and image quality, as mentioned above).

7.2 Finger Detection and Host Wake-Up

In order to facilitate optimal power management and user convenience, the TouchChip supports a hardware finger detection feature. This feature allows the chipset to be in a sleep mode, consuming minimal power, when not in active use. In USB mode, the TouchChip USB driver has full support for Selective Suspend, so that the host system can also go into power saving states. This maximizes battery life while preserving convenience for the user.

The arrival of a finger on the bezel can be detected by the TCD58E. Depending on the configuration, the response to the arrival of the finger can include one or more of the following:

- Activate the sensor and begin to capture an image. The image capture can proceed even though the host may remain inactive, or while the host is resuming from a suspended state.
- Wake up the host, either by means of the “AWAKE” signal, or by using the remote wake-up mechanism of USB.
- Signal the arrival of a finger to the host.

The finger detect feature makes use of the metal bezel and the electrical connection of this metal ring to the TouchChip TCD58E companion chip[1]. The finger detect feature is activated when a human finger comes into electrical contact with the metal bezel, therefore it is not supported in Standard Image Mode.

The finger detect feature is enabled through commands sent by the host. Activation of the AWAKE signaling or Remote Wake-up will occur within 20 msec of contact of a finger to the metal ring.

Finger detection is based on a comparison of two oscillators. The REF_OSC pin drives the reference oscillator; the FING_OSC pin drives the second oscillator. In the absence of any extra load, these two oscillators will run at approximately the same frequency. The additional load of a finger on the FING_OSC pad will lower the oscillation frequency of the FING_OSC oscillator. When the frequency of the FING_OSC oscillator is approximately ½ of the REF_OSC frequency, the finger detect circuitry will trigger the internal finger detection interrupt.

In case of USB interface, the finger detect feature is activated in response to an API command. In case the OS subsequently suspends the device, finger detection will result in a wake-up notification to the host. Finger detect can be also optionally activated by closing a USB communication session. An API command defines if finger detect is active when out-of-session.

7.3 Overcurrent sensing

The TCD58E includes a current sensing block associated with the internal power switch. This automatically cycles sensor power if too much current is demanded, such as during an ESD-induced sensor latch-up or other conditions resulting in excessive current flow. In response to this condition the TCD58E will cycle the sensor power, followed by an attempt to recover and continue with the operation in progress.

7.4 TCD58E Boot Considerations

Upon de-assertion of the NRESET, the TCD58E begins a boot sequence. It initializes the state of internal hardware blocks, performs various software initializations, and checks NVM for firmware enhancements. During this time there is activity on GPIO4:7. It is particularly important that the GPIO7 be routed to the /S(NVM) when the internal NVM is used.

1. For connection details please refer to the reference design schematics.

8 I/O and Interfaces

The main communication link between the TCD58E and any host system is via the USB, SPI or UART interfaces. All commands, status, and data are transmitted over a link based on one of these interfaces.

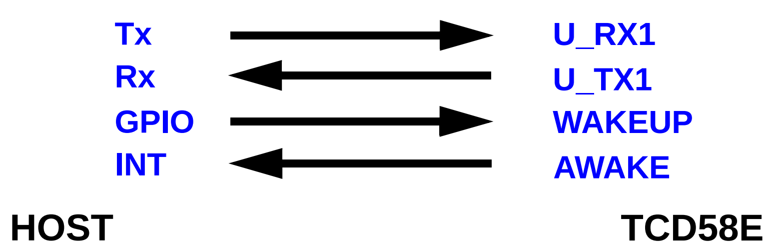
8.1 USB 2.0 Full Speed Bulk (12 Mbps)

The USB interface is fully compliant with USB 2.0 full speed (12 Mbps) specification. This interface is used for both command communication and image data transfer. The normal 1.5K ohm pull-up resistor from USB_DP to the USB Connect control is internally realized.

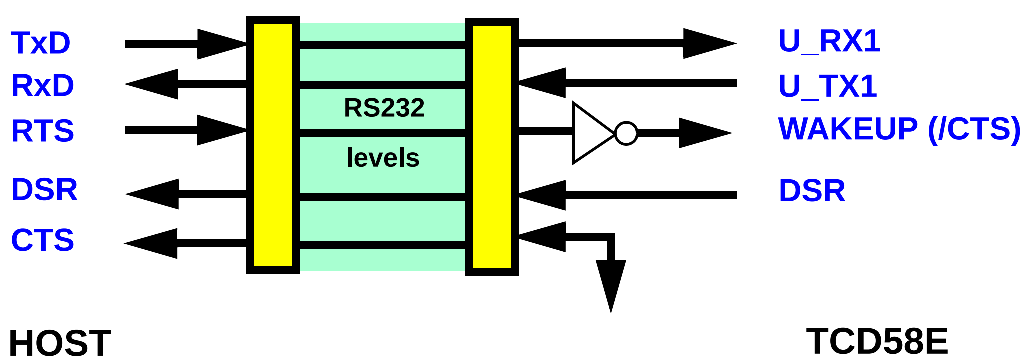
8.2 UART

The UART interface is a standard Universal Asynchronous Receive/Transmit interface compliant with the 16C550 UART specification. The UART interface is intended to be used as a primary command and communication interface, though it can also be used for image data transfer (depending on image transfer speed requirements). The UART interface supports speeds from 9600 bps to 230.4 kbps and supports modems signal DSR and CTS[1].

The figure below shows the actual connection of the TCD58E UART interface with a HOST UART when the HOST UART does not support any modem control signals.



In case the HOST UART supports modem control signals like RTS and DSR, it is possible to make use of such signals for advance wake-up functionality as described in the figure below.



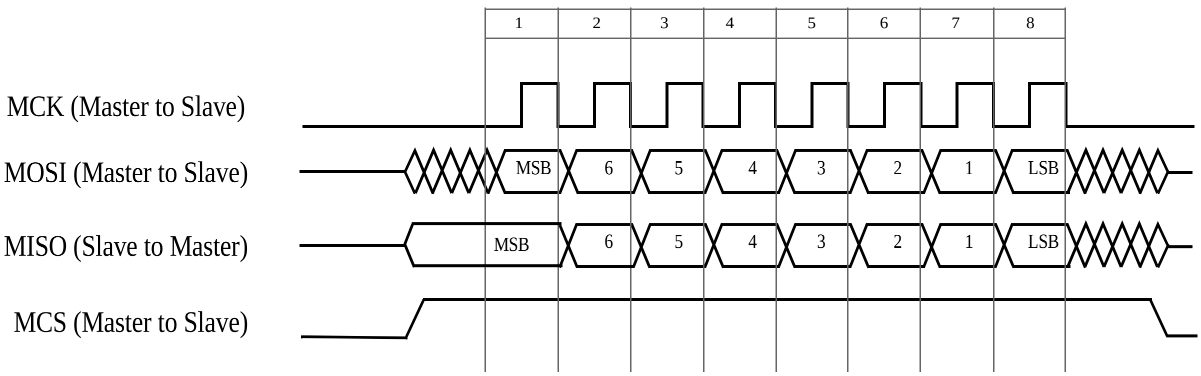
1. The support by the TCD58E of Host DSR and RTS signals is not completely standard: they are used for an advanced system wake-up implementation. Please contact AuthenTec for further details. Please note the inversion of the RTS/CTS signal.

8.3 SPI

The TCD58E incorporates an SPI interface that can be used to communicate to a host processor. This is a slave interface, i.e., the host acts as the SPI bus master. The range of supported clock speeds are up to 7.2 MHz.

The SPI block is configured in Slave mode, 8 bits per byte, 9 bytes per frame, CPOL = 0, CPHA = 0 (mode 0), chip select (MCS) active high. Note that active-high chip select polarity differs from typical Mode 0 implementations.

See the TCD58E Pin Assignment table and AuthenTec reference designs for pin assignment details of the SPI interface.



Note: MCS shown terminating after one byte for illustrative purposes only, actual transfers must maintain MCS in the active state for one frame of 9 bytes.

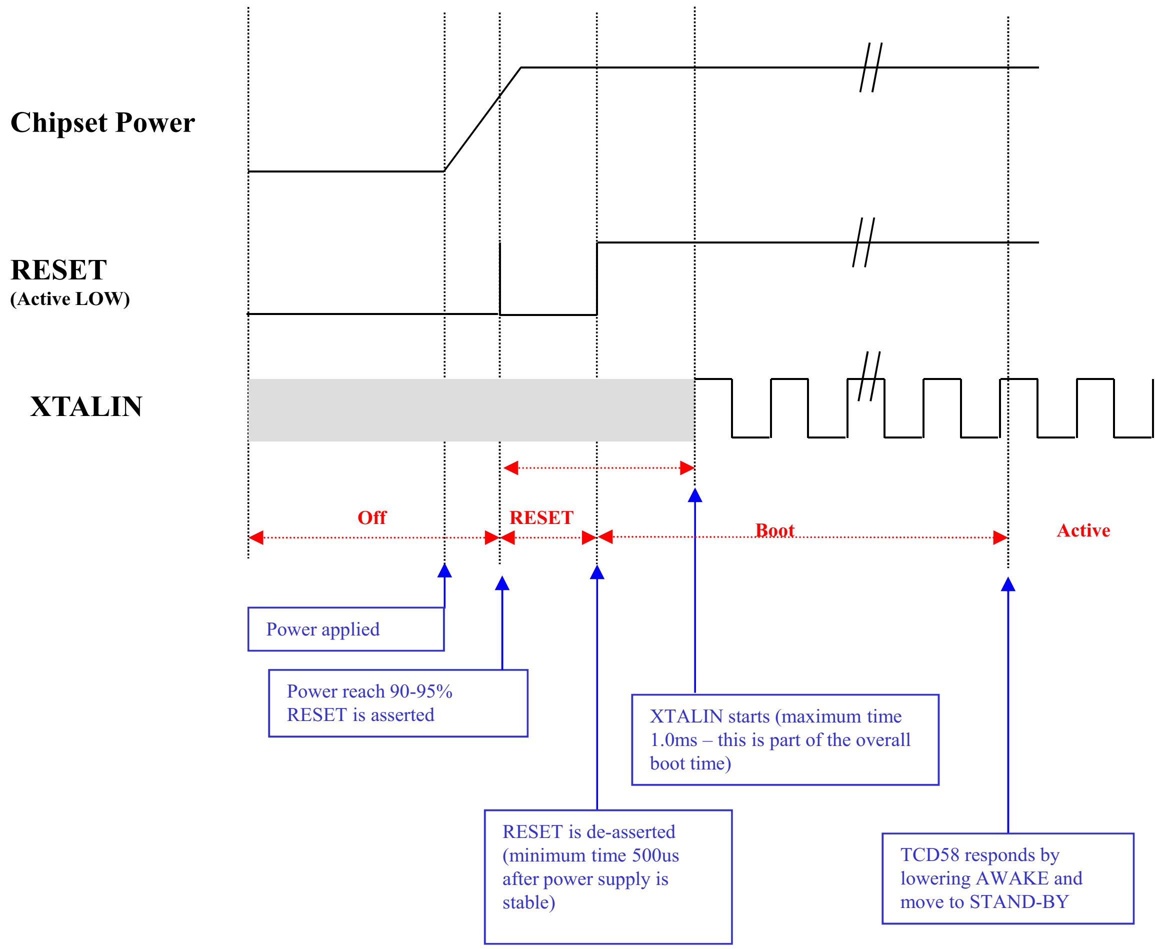
8.4 Host Interface Auto-detection

TCD58E will auto-detect the intended communication interface at boot time. If the TCD58E is attached to a USB bus the USB host controller will pull both USB D+ and USB D- lines low. To enforce a serial (UART or SPI) interface, USB D- needs to be pulled up or tied to VDD. USB D+ will then be used to select between UART and SPI. TCD58E firmware will read both USB D+ and USB D- line values at boot time to determine the active interface. Some firmware variants may potentially override this auto-detection feature and have the selected interface hardcoded.

USB_DN	USB_DP	Selected Interface
L	L	USB
H	H	UART
H	L	SPI

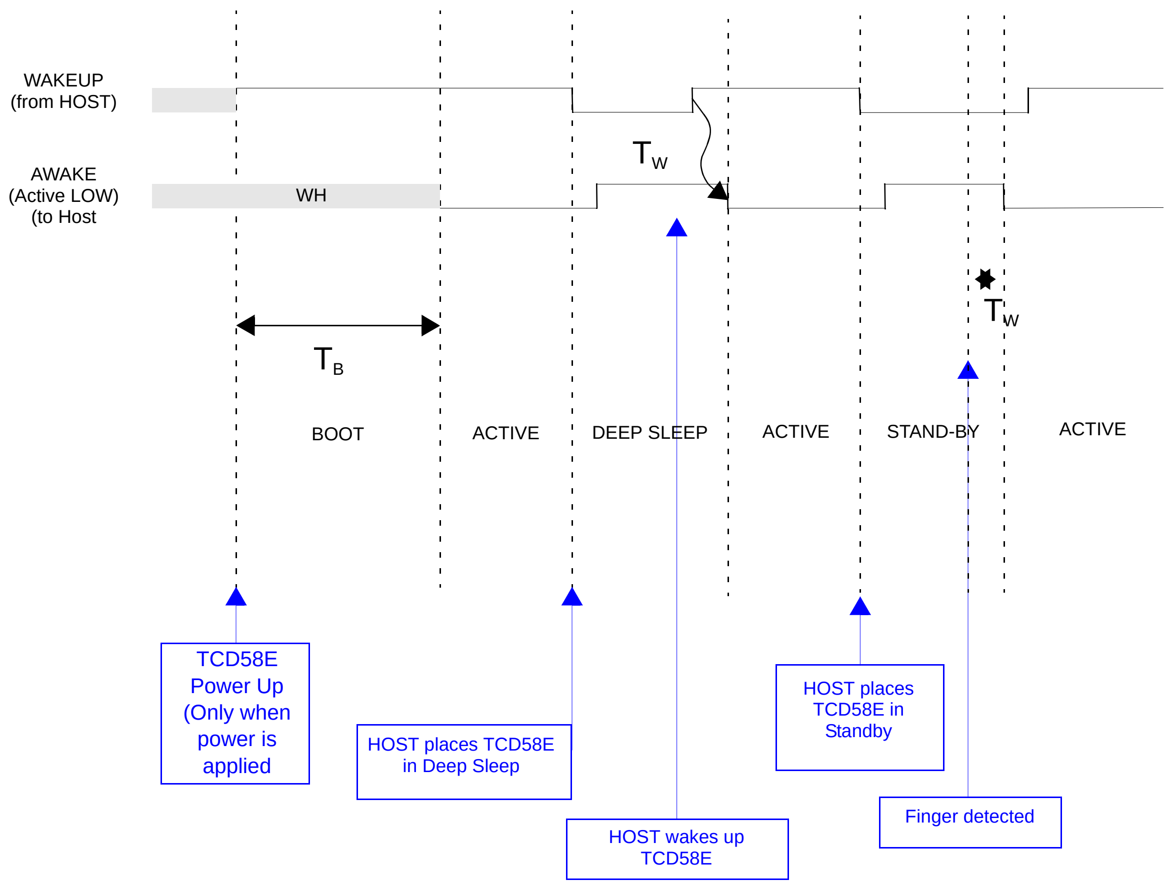
8.5 Signal Timing Diagrams

8.5.1 RESET Diagram



8.5.2 Functional State Diagram (UART Mode)

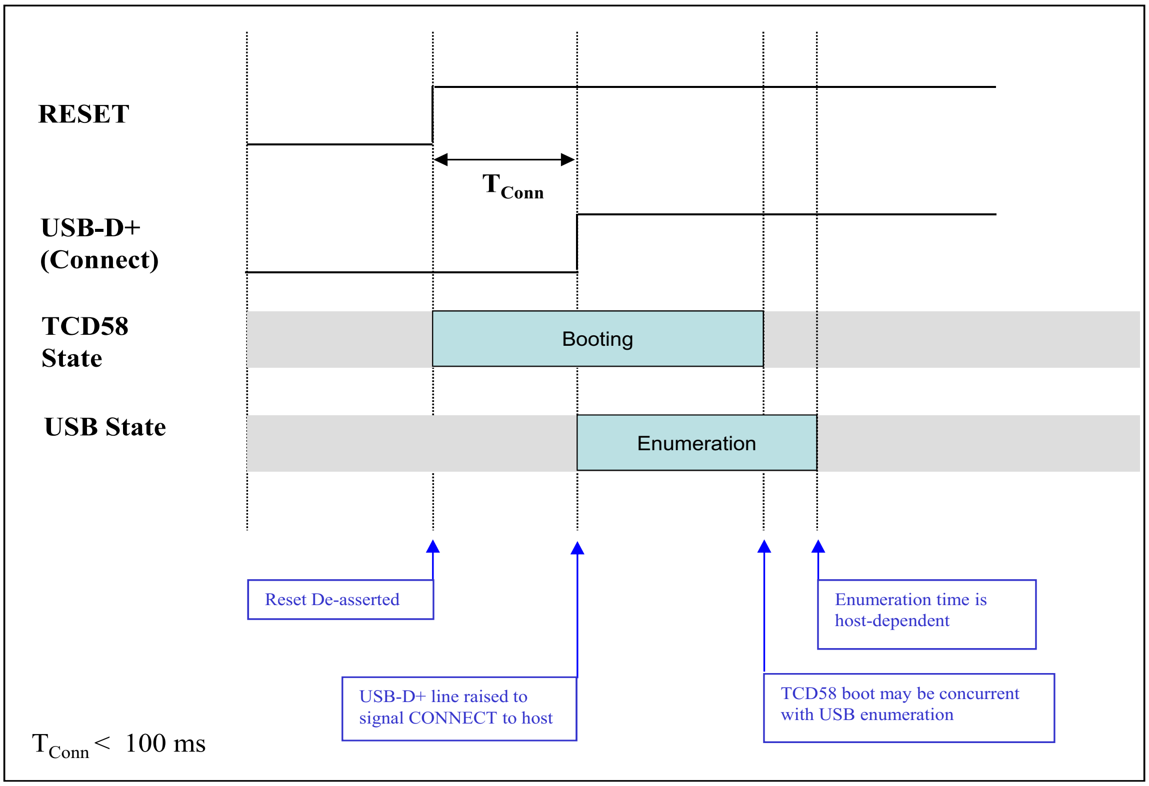
The following timing diagram shows the typical signal transactions and timing between the different states supported by the TouchChip chipset in UART mode when the AWAKE is configured to be active LOW (default).



T_W <= 20 ms, T_B < 260 ms

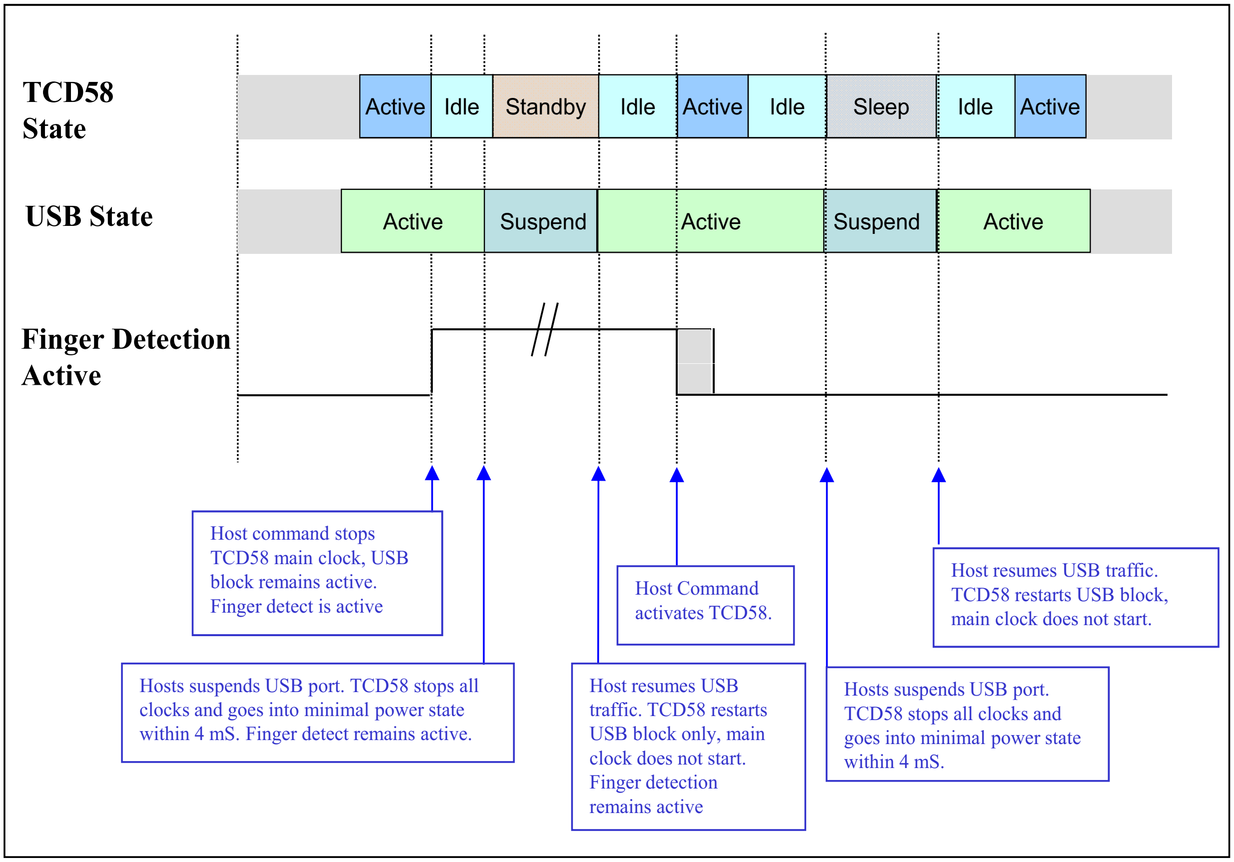
8.5.3 USB Enumeration

This diagram shows the USB enumeration sequence. In USB mode the USB D+ line will be raised within 100 milliseconds after the TCD58E reset signal deasserts. It is possible that the TCD58E boot sequence will still be in process at this time. The boot process can run concurrently with USB enumeration.



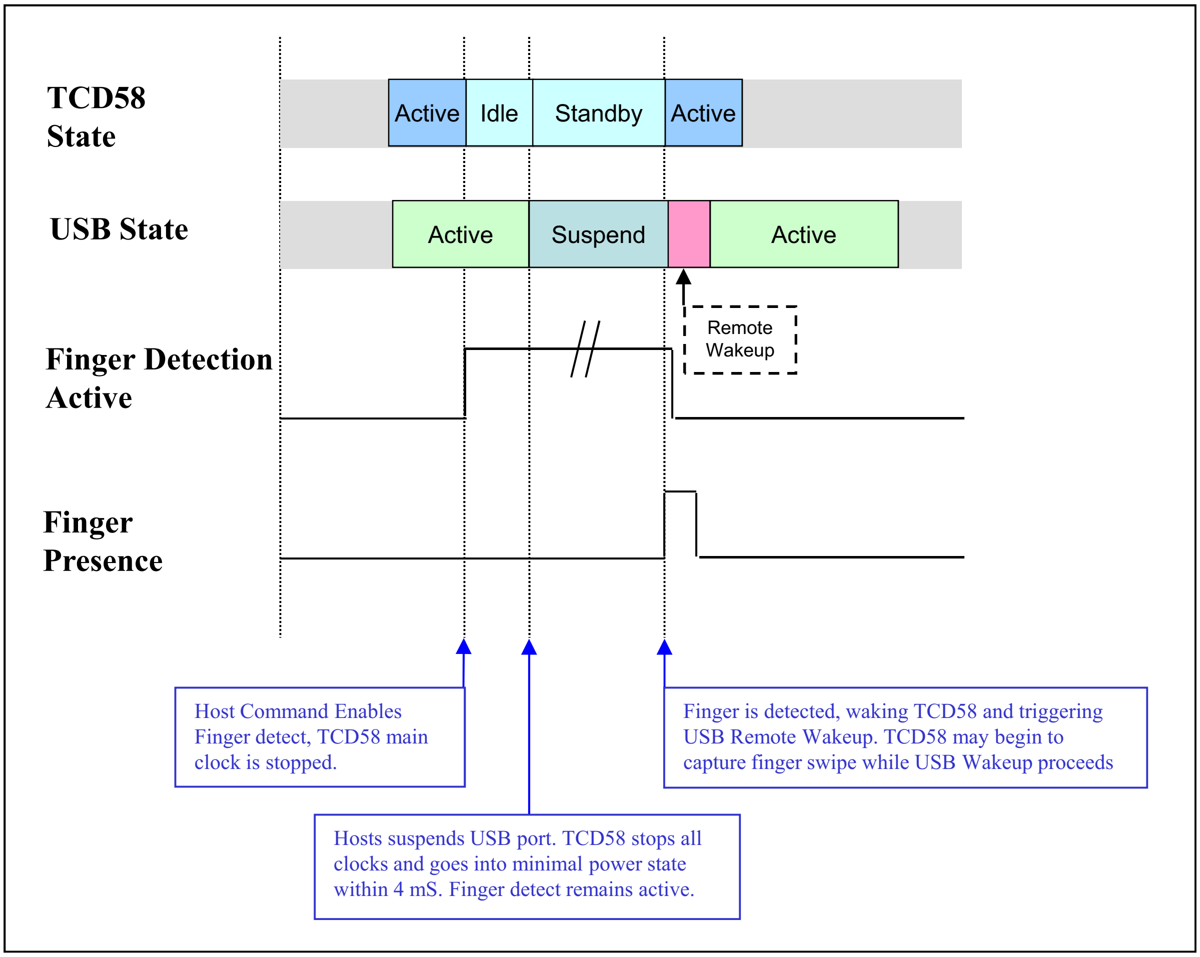
8.5.4 Idle, Standby, and Sleep States with USB

This diagram shows power-state transitions under USB operation. Idle state means that USB communication is active, even if the TCD58E is inactive. If USB communication is suspended, then the TCD58E will transition to “Standby” state if finger detection is active, or “Sleep” state if finger detection is inactive.



8.5.5 USB Remote Wake-up

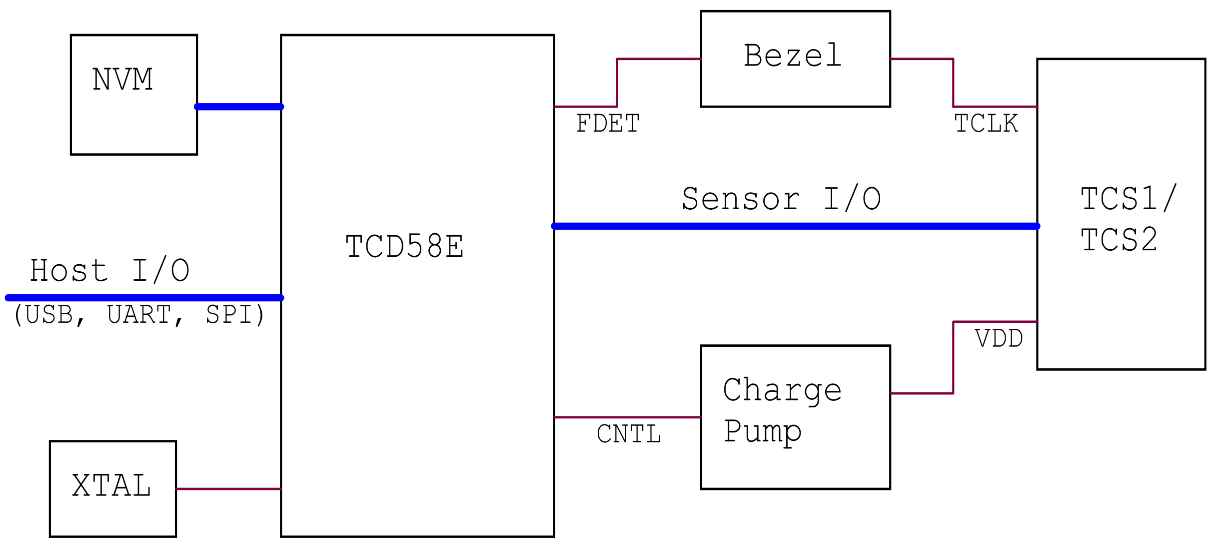
This diagram shows USB remote wakeup operation. If finger detection is enabled, the companion chip can initiate a Remote Wakeup over USB, bringing the host system out of a low power state in response to a finger placement. Note that the companion chip can begin to capture fingerprint data even before the host is awake.



9 System Clock Generation

9.1 System Block Diagram

The diagram, below, shows the relationships between the major system components, it is intended only to aid the reader in visualizing the final system. The bezel and charge pump are not required for Standard Image Mode. In the cases of TCS2SS and TCS1xT the bezel and sensor are a single assembly.

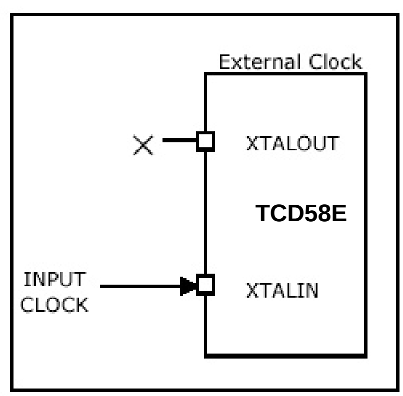


9.2 System Clock Sources

The TCD58E supports the following configurations in order to provide the required 12 MHz clock.

9.2.1 External Clock

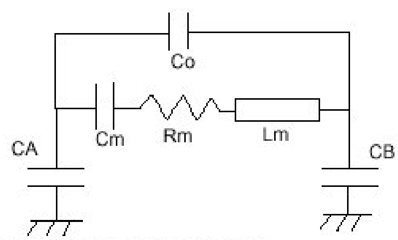
In case the system has the availability of a 12 MHz clock according to the spec of Table 5, it can be provided through XTALIN.



9.2.2 Crystal Oscillator

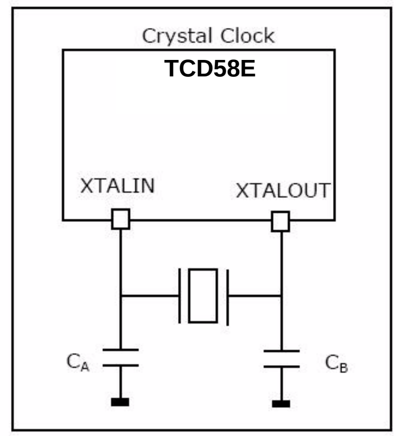
The TCD58E includes a high frequency oscillator which allows the use of a 12 Mhz crystal to generate the internal system clock.

Crystal Freq	L_M	R_M	C_M	C_O	C_A	C_B
12 MHz	5.6 mH	7.9 ohms	26.76 fF	4.4 pF	22 pF	22 pF



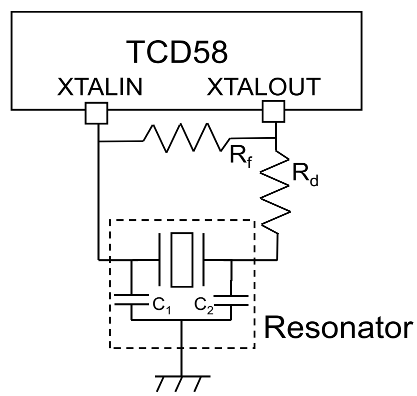
Equivalent circuit of a quartz crystal

The tables are relative to fundamental quartz crystal only (not ceramic resonator).
Recommended value for C_A and C_B for generating 12 MHz clock to the TCD58E chipset is 22 pF.



9.2.3 Ceramic Resonator

A ceramic resonator is typically lower in cost than a crystal. The part number from Murata described in the table below has been tested with the TCD58E and enables clock generation that is compliant to USB requirements.



Frequency (Hertz)	Murata Part Number	C1 (pF)	C2 (pF)	Rf (Ohms)	Rd (Ohms)
12.000M	CSTCE12M0GH5L11-R0	(33)	(33)	1M	0

(C1 and C2 are built into the resonator)

10 TCS1/TCS2 Electrical Specifications

10.1 Absolute Maximum Ratings

Table 4: Sensor Absolute Maximum Ratings

Symbol	Parameter	Min	Max	Unit
VDD	Sensor supply voltage	-0.5	6.0	V
VIO	DC voltage on any other pin (other than VDD)	-0.5	VDD +0.5	V
TSTG	Storage temperature	-40	+125[1]	°C
IK DC	Diode current		20	mA
IO DC	Output source sink current		20	mA
ICC/IGND	DC VCC or ground current		100	mA
VESD	PIN electrostatic discharge voltage[2]	-2000	+2000	V

1.Based on temperature cycling, device inactive
2.JEDEC Std JESD22-A114-A (R=1.5 Kohm, C=100 pF)

10.2 Operating Characteristics

Symbol	Parameter	Min	Typ	Max	Unit	Condition
V_{DD}	Supply Voltage- Standard Image Mode	4.4	5.0	5.5	V	V_{DD}
V_{DD}	Supply Voltage- Enhanced and EIM-Lite Image Mode	4.50	4.55	4.60	V	V_{DD}
I_{DDQ}	Imaging mode Sleep mode		20 1	30 4	mA mA	I_{DD}
V_{IH}	High Level Input	2.0		V_{DD} +0.3	V	V_{IH}
V_{IL}	Low Level Input	–0.3		0.8	V	V_{IL}
V_{OH}	Output High DIG_OUT/$I_{OH=4mA}$	3.15			V	V_{OH}
	Output High DIG_BID/$I_{OH=4mA}$	3.15	–	–	V	
V_{OL}	Output Low DIG_OUT[1]/$I_{OL=4mA}$			0.5	V	V_{OL}
	Output Low DIG_BID[2]/$I_{OL=4mA}$			0.5	V	
I_{OH}	Output Current High DIG_OUT/ $V_{OH=3.15V}$	–4		–	mA	I_{OH}
	Output Current High DIG_BID	–4	–	–	mA	
I_{OL}	Output Current Low DIG_OUT/ $V_{OL=0.5V}$			4	mA	I_{OL}
	Output Current Low DIG_BID/$V_{OL=0.5V}$			4	mA	
T_R	Recommended Temperature Range	0	25	40	°C	T_R
T_E	Extended Temperature Range [2]	-20	25	50	°C	T_E
T_O	Operating Temperature Range [3]	-30	-	+85	°C	T_O

1. DIG_OUT = Digital Output
   DIG_BID = Digital Bi-directional Pins (Open Drain)
   Nominal conditions: 5V, room temp., 10pf, ram mode, no output loads.
2. Extended temperature range characterized for capture of images of air suitable for built-in-self-test (BIST) at capture rate of 10 frames/sec (max). Human contact with the sensor at extreme temperatures is not recommended.
3. The sensor has not been characterized for biometric operation at the extremes of the Operating Temperature Range.

11 TCD58E Electrical Specifications

11.1 Absolute Maximum Ratings

Table 5: TCD58 Absolute Maximum Ratings

Symbol	Parameter	Min	Max	Unit
VDD	3.3 V chip supply voltage	-0.5	4.2	V
TRvdd	Supply Rise Time[1]	<170	>750	uS
V_IO	DC voltage on any IO pin	-0.5	6.0	V
V_ANA	DC voltage on any ANA pin	-0.5	VDD +0.5	V
TSTG	Storage temperature	-40	+125[2]	ºC
IK DC	Diode current		+/- 20	mA
IO DC	Output source sink current		+/- 20	mA
ICC/IGND	DC VCC or ground current		+/- 200	mA
VESD	PIN Electrostatic discharge voltage[3]	-2000	+2000	V

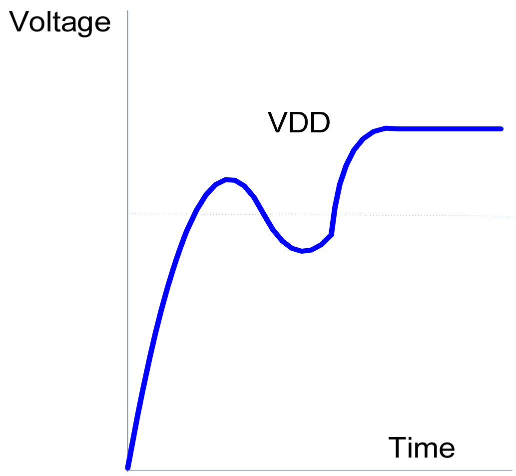
1. Power supply rise time (measured 10-90%) must be less than 170uS or greater than 750uS, in between is an exclusion zone. Supply must also be montonic.
2. Based on temperature cycling, device inactive
3. JEDEC Std JESD22-A114-A (R = 1.5 Kohm, C = 100 pF)

11.2 Recommended Operating Characteristics

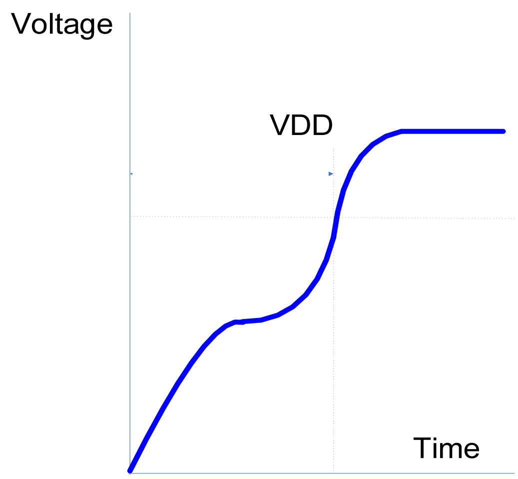
Symbol	Parameter	Min	Typ	Max	Unit	Condition
VDD	Supply voltage	3.0	3.3	3.6	V	
TOP	Operating temperature	-40° C		+85° C		

11.3 Power Supply Rise Condition

In addition to the restricted rise time range as stated in “TCD58 Absolute Maximum Ratings” on page 26 the supply rise must be monotonic, as illustrated below:



Not Monotonic



Monotonic

11.4 DC Characteristics

Table 6: DC Characteristics

Symbol	Parameter	Min	Typ	Max	Unit	Condition
IDD	Sleep mode Stand-by Imaging		900 950 67	1200 1300 80	uA uA mA	
VIH	High level input	2.0		VDD + 0.3	V	
VIL	Low level input	-0.3		0.8	V	
VOH	Output high 2 mA pads	VDD-0.5			V	IOH=2 mA
VOL	Output low 2 mA pads			0.4	V	IOL=2 mA

Unless otherwise stated, typical values are based on T = 25C and VDD = 3.3V

11.5 AC Characteristics

This section summarizes the AC characteristic of the device. The parameters in the AC characteristic tables that follow are derived from tests performed under the AC Measurement Conditions. The designer should check that the operating conditions in their circuit match the measurement conditions when relying on the quoted parameters.

11.5.1 System Clocks

Table 7: AC Characteristics System Clock

Symbol	Parameter	Min	Nom	Max	Unit	Conditions
XTALIN	TCD58E system frequency clock	12.0 +/- 2500 ppm			MHz	USB interface active
		12.0 +/- 1%			MHz	UART or SPI interface active[1]

1. Specification applies for all UART communication speeds from 9600 bps to 115200 bps, and includes high speed UART mode up to 250 kbps

Table 8: AC Measurement Conditions

Symbol	Parameter	Min	Norm	Max	Unit
C_L	Load capacitance	18			pF
T_{RISE}, T_{FALL}	Input rise and fall times	5	10	15	ns

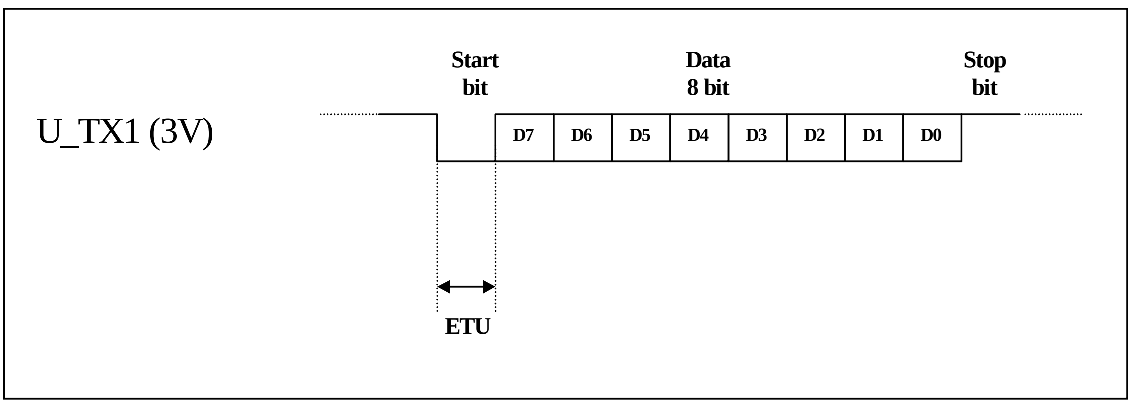
11.5.2 UART

Table 9: AC Characteristics - HOST UART CHANNEL: Protocol “8N1”

Time Name	Min	Nom	Max	Units	Conditions	Load
ETU[1]		8680 17360 26041 52083 104166		ns	115200 bps 57600 bps 38400 bps 19200 bps 9600 bps	20 pF
TX T_{RISE}		9.5		ns		20 pF
TX T_{FALL}		10.5		ns		20 pF
RX T_{RISE}			13			N/A
RX T_{FALL}			13			N/A

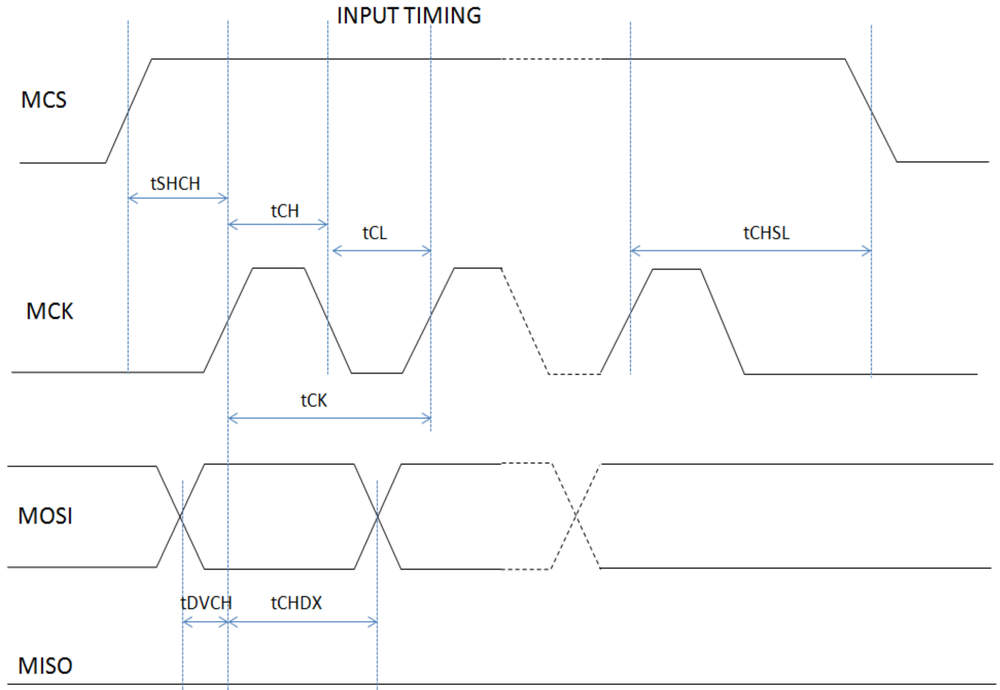
1. This timing tolerance depends on XTALIN tolerance

UART Transmission Sequence

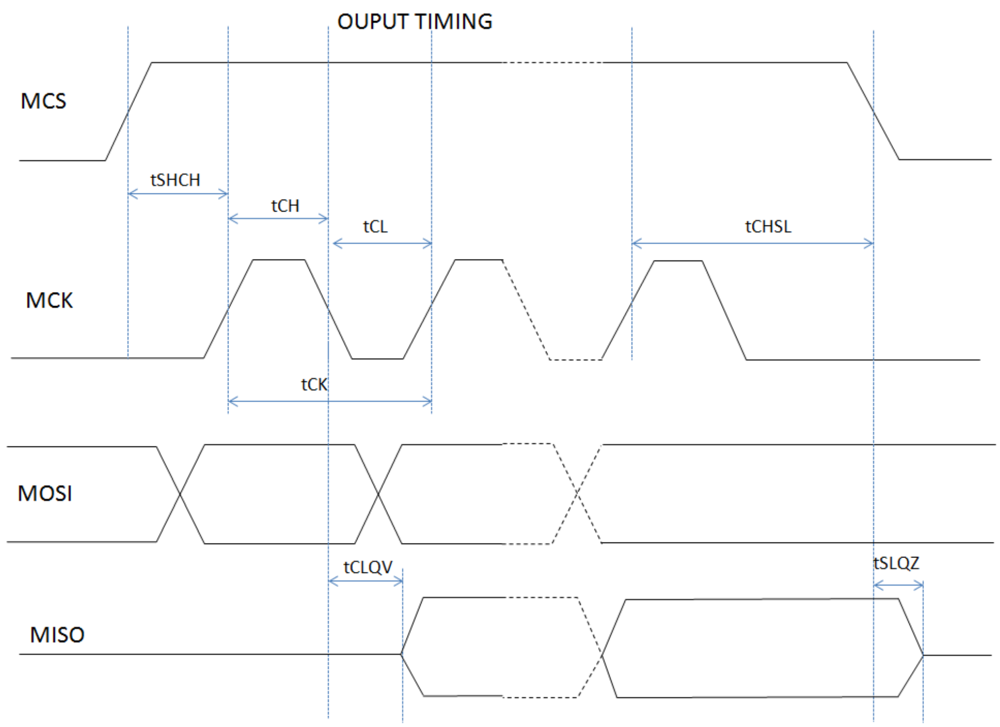


11.5.3 Serial Peripheral Interface (SPI)

11.5.3.1 SPI Input Timing Diagram



11.5.3.2 SPI Output Timing Diagram



11.5.4 SPI Timing Table

Table 10: SPI Timing

Symbol	Parameter	Min	Typ	Max	Unit
tSHCH	CS Active Setup Time	5			nS
tCH	Clock High Time	60			nS
tCL	Clock Low Time	60			nS
tCHSL	CS Deselect Time	10			nS
tCK	Clock Period	138.8			nS
tDVCH	Data IN Setup Time	7			nS
tCHDX	Data IN Hold Time	7			nS
tCLQV	Clock Low to Output Valid			50	nS@20pF
				45	nS@10pF
tSLQZ	Output Disable Time			10	nS

12 Chipset Electrical Specifications

Specifications for when the TCD58E and area sensor are used together.

12.1 Chipset USB Power

When using the chipset in a USB application with the AuthenTec reference design, the following table can be used to understand the power used in active and standby states. The need to maintain the "connected" status by pulling up the USB D+ data line during USB suspend can add significantly to the current draw.

Table 11: USB Power Usage

Power State	Typical	Max	Unit
Active (Normal imaging)	80	88	mA
Active (Fast Imaging)	105	116	mA
Idle (USB active, crystal clock mode)	25	28	mA
Standby (USB suspended, finger detect active)	1350	1485	uA

12.2 Chipset Supply Noise

Table 12: Critical Pin Type Signal Noise Characteristics

Pin Type	Parameter	Min	Nom	Max	Unit
VDD	Digital voltage supply noise			100	mV p-p
AVDD	Analog voltage power noise			70	mV p-p

13 Pin Assignments

Legend: **L:** active drive low
Pad Types: **GND:** Ground pad
PWR: Supply pad
IO: Input/Output pad
I: Input pad

The sensor connector is a low insertion force flat flex connector with 20 positions on a 0.5mm pitch. It can mate with a wide variety of custom and standard flex cables from companies such as Molex and Parlex. One example part number is Molex 210200205. The total trace length from the sensor to the TCD58 should ideally be less than 6 inches (15cm). The connector is not keyed so care must be taken to correctly lay out the mating host side connector.

13.1 TouchChip Pin Assignment

Table 13: TCS1 / 2 Pinout[1]

Pin #	Name	Description	Type
1	ESD-GND	ESD Ground	GND
2	GND	Signal Ground	GND
3	WRB	Write	I, L
4	NRST	Reset	I, L
5	RDB	Read	I, L
6	CSB	Chip Select	I, L
7	INT	No Connect (Legacy Interrupt)	NC
8	A0	Address Zero	I
9	DATA[0]	Data Bus Bit 0	IO
10	DATA[1]	Data Bus Bit 1	IO
11	DATA[2]	Data Bus Bit 2	IO
12	DATA[3]	Data Bus Bit 3	IO
13	DATA[4]	Data Bus Bit 4	IO
14	DATA[5]	Data Bus Bit 5	IO
15	DATA[6]	Data Bus Bit 6	IO
16	DATA[7]	Data Bus Bit 7	IO
17	GPIO2	General Purpose I/O	IO
18	TCLK/GPIO1	Bezel Clock / GPIO	IO
19	GPIO0	General Purpose I/O	IO
20	VDD	Power Input	PWR

1. On TCS2SS and TCS1xT the following pin numbers should be connected to ground: 7, 17 and 19.

13.2 TCD58E Pin Assignment

Legend: **H:** Active drive high (3.3 V)
L: Active drive low (0 V)
PU: Weak pull-up to 3.3 V
PD: Weak pull-down to 0 V
Z: High impedance state

Ball #	Name	Description	Pad Type	Tie To	Power-Up State		
					PU/PD	DIR	H/L
G2	AVDD	Analog power input	PWR	VDD	-	-	-
G3	DC_BYPASS	Internal regulator bypass (test only)	IO	GND	PD	IN	-
E7	DVDD	Digital power input	PWR	VDD	-	-	-
A9	GND	Pad ring ground	GND	GND	-	-	-
G1	GND	Pad ring ground	GND	GND	-	-	-
G9	GND	Pad ring ground	GND	GND	-	-	-
F5	GND	Voltage regulator ground	GND	GND	-	-	-
F7	GND	Voltage regulator ground	GND	GND	-	-	-
B1	GPIO0/MISO[1]	SPI Data Output	IO	-	PU	IN	-
A1	GPIO1/MOSI	SPI Data Input	IO	-	PU	IN	-
C1	GPIO2/MCLK	SPI Clock Input	IO	-	PU	IN	-
D3	GPIO3/MCS	SPI Chip Select Input	IO	-	PU	IN	-
G6	GPIO4/NVM_Q	NVM Data In	IO	-	PD	IN	-
E6	GPIO5/NVM_D	NVM Data Out	IO	-	PD	IN	-
E5	GPIO6/NVM_C	NVM Clock	IO	-	PD	IN	-
J4	GPIO7/CS_OUT	Chip Select (to NVM)	IO	-	PD	IN	-
A6	GPIO8/D)	Sensor Data 0	IO	-	PD	IN	-
A7	GPIO9/D1	Sensor Data 1	IO	-	PD	IN	-
A8	GPIO10/D2	Sensor Data 2	IO	-	PD	IN	-
A5	GPIO11/D3	Sensor Data 3	IO	-	PD	IN	-
E3	GPIO12/D4	Sensor Data 4	IO	-	PD	IN	-
G8	GPIO13/D5	Sensor Data 5	IO	-	PD	IN	-
E2	GPIO14/D6	Sensor Data 6	IO	-	PD	IN	-
F4	GPIO15/PWR_CNT	Sensor Power Control	IO	-	PD	IN	-
A3	GPIO16/AWAKE	AWAKE response	IO	-	PD	IN	-
D5	GPIO17/LED0	LED 0	IO	-	PD	IN	-
B4	GPIO18/LED1	LED 1	IO	-	PD	IN	-
A4	GPIO19/D7	Sensor Data 7	IO	-	PD	IN	-
B9	GPIO20/TX	UART Transmit	IO	-	PD	IN	-
D8	GPIO21/RX	UART Receive	IO	-	PD	IN	-

Ball #	Name	Description	Pad Type	Tie To	Power-Up State		
					PU/PD	DIR	H/L
C5	GPIO22/FD_BIAS	Finger Detect Bias Control	IO	-	PD	IN	-
B5	GPIO23	Not Used	IO	-	PD	IN	-
C9	GPIO28/CSB	Sensor Chip Select	IO	-	PD	IN	-
D7	GPIO29/A0	Sensor Address 0	IO	-	PD	IN	-
D9	GPIO30/WRB	Sensor Write	IO	-	PD	IN	-
E9	GPIO31/RDB	Sensor Read	IO	-	PD	IN	-
J1	FING_OSC	Finger detect sense oscillator	ANA	-	-	-	-
J2	REF_OSC	Finger detect reference oscillator	ANA	-	-	-	-
H8	NRESET	TCD58E Reset input (active low)	I	-	-	IN	-
B8	NVM_VCC	Non-volatile memory power	PWR	-	-	-	-
J9	NVM_S	Non-volatile memory chip select	I	-	-	IN	-
C8	VDD_PAD	Pad frame power input	PWR	VDD	-	-	-
H4	VDD_PAD	Pad frame power input	PWR	VDD	-	-	-
H7	VDD_PAD	Pad frame power input	PWR	VDD	-	-	-
F1	VDD_PLL	Oscillator 1.2V power input	PWR	(F6)[2]	-	-	-
J8	POR_BYPASS	Power-on reset bypass	IN	GND	PD	IN	-
J7	RESTART	Sensor restart	OUT	-	-	OUT	Z
E8	SENSE	Sense interrupt input	IO	-	-	IN	-
F9	TC_DATA	Not Used	IO	-	PD	IN	-
G7	TC_DREADY	Not Used	IO	-	PD	IN	-
E1	TC_MCK	Not Used	IO	-	PD	OUT	L
C2	TC_MISO	Not Used	IO	-	PD	IN	-
D1	TC_MOSI	Not Used	IO	-	PD	OUT	L
D2	TC_NCS	Not Used	IO	-	PU	OUT	H
H9	TC_NRESET	Reset Output to Sensor	IO	-	PU	OUT	L
H1	TC_PWR	Sensor power switch output	ANA	-	-	-	-
H2	TC_PWRIN	Sensor power switch input	ANA	VDD	-	-	-
B6	TCK	Test / debug pad	IO	DNC	PU	-	-
D6	TDI	Test / debug pad	IO	DNC	PU	-	-
C6	TDO	Test / debug pad	IO	DNC	PU	OUT	H
G5	TEST_EN	Test / debug pad	I	GND	PD	-	-
C4	TEST0	Test / debug pad	IO	DNC	PD	IN	-
C3	TEST1	Test / debug pad	IO	DNC	PD	IN	-
E4	TEST2	Test / debug pad	IO	DNC	PD	IN	-
D4	TEST3	Test / debug pad	IO	DNC	PD	IN	-
B3	TEST4	Test / debug pad	IO	DNC	PD	IN	-

Ball #	Name	Description	Pad Type	Tie To	Power-Up State		
					PU/PD	DIR	H/L
A2	TEST5	Test / debug pad	IO	DNC	PD	IN	-
B2	TEST6	Test / debug pad	IO	DNC	PD	IN	-
C7	TMS	Test /debug pad	IO	DNC	PU	-	-
B7	UCR_ENA	(Not used)	IN	-	-	IN	-
J3	UCR_RCAL	UCR Resistor	ANA	-	-	-	-
H3	UCR_RCC	(Not used)	ANA	-	-	-	-
J5	USB_DN	USB data N	XCVR	-	-	-	-
G4	USB_DP	USB data P	XCVR	-	-	-	-
H6	VBAT	Real time clock power supply	PVDD	2	-	-	-
F6	VREG_OUT	Voltage regulator output	PVDD	2	-	-	-
F8	WAKEUP	Wake-up interrupt	IO	-	PD	IN	-
F2	XTALIN	12 Mhz crystal oscillator/clock input	ANA	-	-	-	-
H5	XTALIN32K	32 Khz RTC oscillator input	ANA	-	-	-	-
F3	XTALOUT	12 Mhz crystal oscillator/clock output	ANA	-	-	-	-
J6	XTALOUT32K	32 Khz RTC oscillator output	ANA	-	-	-	-

1.GPIO[3:0] form SPI. TCD58E is the Slave, external host is the Master.
2. Normally, the 1.2 V PLL power is provided by VREG_OUT

14 Environmental Robustness

14.1 TouchChip Chipset Lifetime

TouchChip chipset lifetime is expected to be at least 10 years, based on extrapolation of accelerated life test data.

14.2 Electrostatic Discharge

The TouchChip sensors TCS1C, TCS2C and TCS2S meet the IEC61000 -4-2 test specifications of +/-15KV air discharge, +/-8KV contact (bezel) discharge, while the TCS1S air discharge is derated to +/-8KV.

14.3 Scratch/Abrasion

The coatings on the surface of the TouchChip sensor provides protection from scratching and abrasion due to normal contact with fingertips and any incidental contact with fingernails. Applications requiring protection from direct contact of sharp metal objects with the sensor surface should provide such protection at the system (i.e., a sliding cover or some other means).

Small scratches on the sensor surface will not affect operation of the sensor. AuthenTec provides a Visual Mechanical Inspection specification which details the procedures and criterion that may be used for quality control audits of incoming parts.

14.4 Chemical Contact

The coatings on the TouchChip sensor provides protection from exposure to a wide variety of chemical contaminants. Agents anticipated to come in contact with the sensor surface in normal use have been identified and tested. They do not cause damage or identifiable degradation in sensor performance or characteristics. These chemicals include common items such as hand creams and soaps, beverages, common household cleaners, petroleum products, acid solutions and isoprophyl alchohol which is used to clean other contaminants. A detailed list of the contaminants that have been tested is available upon request.

15 Chipset Packaging

The TouchChip chipset consist of two stand-alone components, the TouchChip Sensor (TCS1/TCS2) and TouchChip Companion Chip (TCD58E).

15.1 TouchChip Package

The traditional TouchChip sensor is a chip-n-board package with an overall size of 27 mm by 20.4 mm and a nominal thickness of 3.51 mm. The I/O interconnection is by way of a 20 pin 0.5mm flex connector. Devices with integrated bezels share the same connector but vary in size. For more information see the mechanical drawings. Note that mechanical specifications are subject to change.

The TouchChip is shipped according to the IPC/JEDEC J-STD-020B Level 3 "Moisture/Reflow Sensitivity Classification for Non-Hermetic Solid State Devices" and IPC/JEDEC J-STD033A "Handling, Packing, Shipping and Use of Moisture/Reflow Sensitive Surface Mount Devices" standards.

The non-bezel TouchChip is shipped in tubes with end plugs. There are 18 sensors per tube. Tubes are shipped in vacuum-sealed anti-static bags. A bulk shipment consists of 20 tubes in a bulk box, for a total of 360 units per box. Sensors with integrated bezels are shipped in JEDEC trays, 36 units per tray, 10 trays in a bulk box, for a total of 360 units per box. The sensors are not dry packed.

15.2 TCD58E Package

The TCD58E Companion chip package is a Ball Grid Array (BGA) with a size of 8 mm x 8 mm and an un-mounted thickness of 1.21 mm. The I/O interconnection is a Sn-Ag-Cu solder ball array 9 x 9 (81 total balls) on a 0.8 mm pitch. For more information, see the mechanical drawing. Note that mechanical specifications are subject to change.

TCD58E is shipped according to IPC/JEDEC J-STD-020B Level 3 "Moisture/Reflow Sensitivity Classification for Non-Hermetic Solid State Devices" and IPC/JEDEC J-STD033A "Handling, Packing, Shipping and Use of Moisture/Reflow Sensitive Surface Mount Devices" standards.

TCD58E is shipped in Jedec Standard BGA tray format (tray quantity is 360). Multiple trays (6) will be dry packed and vacuum-sealed in conductive bag.

15.3 TouchChip Chipset Customer System Integration Recommendations

- I/O ball numbering complies with JEDEC Standard for BGA packages[1].
- Standard BGA reflow processes are recommended for next level assembly for the TCD58E.
- Normally the TCD58E is mounted to product system printed circuit board (PCB), provided by the customer.
- The TouchChip is connected to the PCB via a twenty position, 0.5mm pitch, flex connector of the customer's choice.

1. "JEDEC JC-11 Standard Procedures and Practices SPP-010, Subject: Grid Array Terminal Position Numbering".

16 Ordering Information

16.1 Sensor

Product Code: TC S x x x 6A x

TouchChip

Sensor

Sensor Array Size
1 = 12.8 x 18.0 mm
2 = 10.4 x 14.4 mm

Sensor Coating
C = Standard (FIPS201 option)
S = SteelCoat™

Bezel Options
M = TCS1 TAB package without Bezel
N = TCS2 TAB package without Bezel
S = TCS2 with Integrated Bezel
T = TCS1 with Integrated Bezel

Software
Standard

Shipping Pack
0 = JEDEC Tubes, 18 per tube
2 = JEDEC Trays, 36 per tray

16.2 Companion Processor

Product Code: TC D 58 E 2 DM 0

TouchChip

Companion Device

Companion Type

Functionality
E - Optimized for TCS1, TCS2 and TCS4K

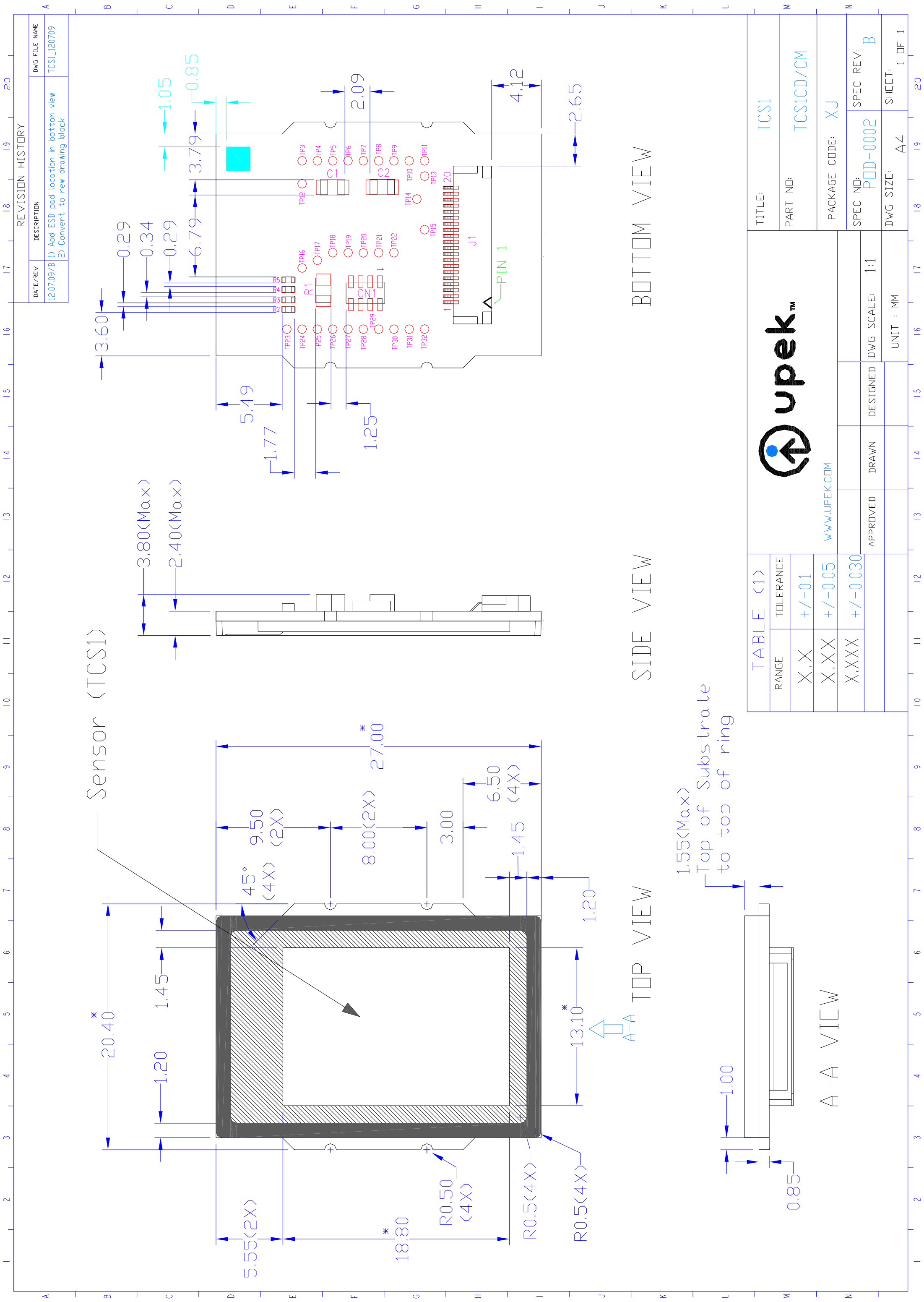
Biometric Data Memory Size
2 - 128KBytes

Package Type
DM = 8mm x 8mm

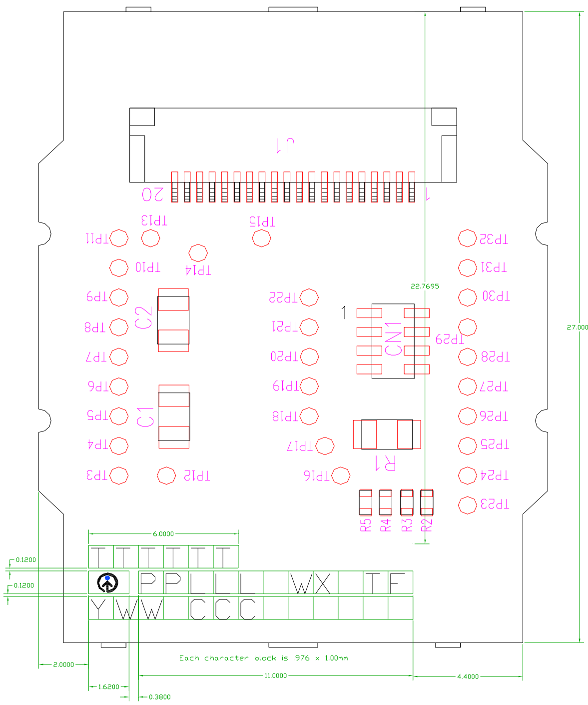
Package Option
0 - JEDEC Tray with 360 Pieces

17 Mechanical Drawings

17.1 TouchChip TCS1 Sensor



17.2 TCS1/TCS2 Sensor Marking Diagrams

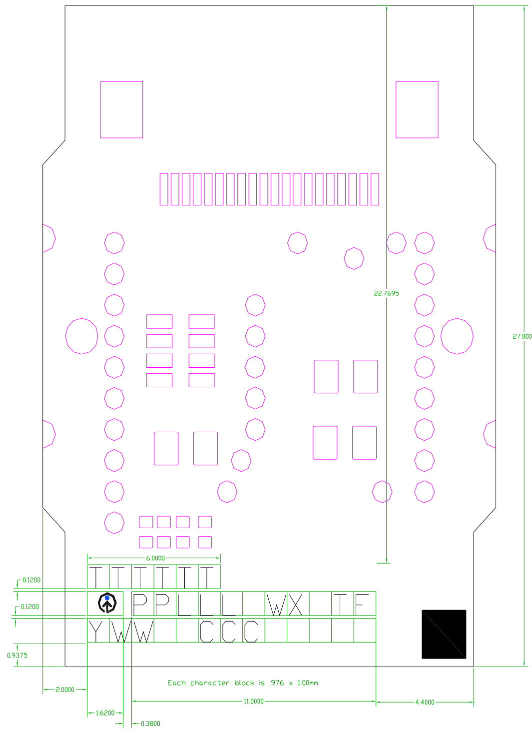


TCS1 MARKING - PRODUCTION MARKING
REVISION 07.29.09

LINE 1: 6 DIGIT OF SHORT CP CODE FROM UPEK PRODUCT CODE 13 DIGITS

LINE 2: UPEK LOGO, PP= ASSEMBLY PLANT CODE. LLL= SEQUENTIAL CODE FOR EACH LOT. WX= WAFER FAB PLANT CODE. TF= TEST AND FINISHING PLANT CODE.

LINE 3: YWW= LAST DIGIT OF YEAR FOLLOWED BY WORKWEEK WITHIN THE YEAR ASSEMBLY LOT STARTED. CCC= ASSEMBLY SITE COUNTRY OF ORIGIN.



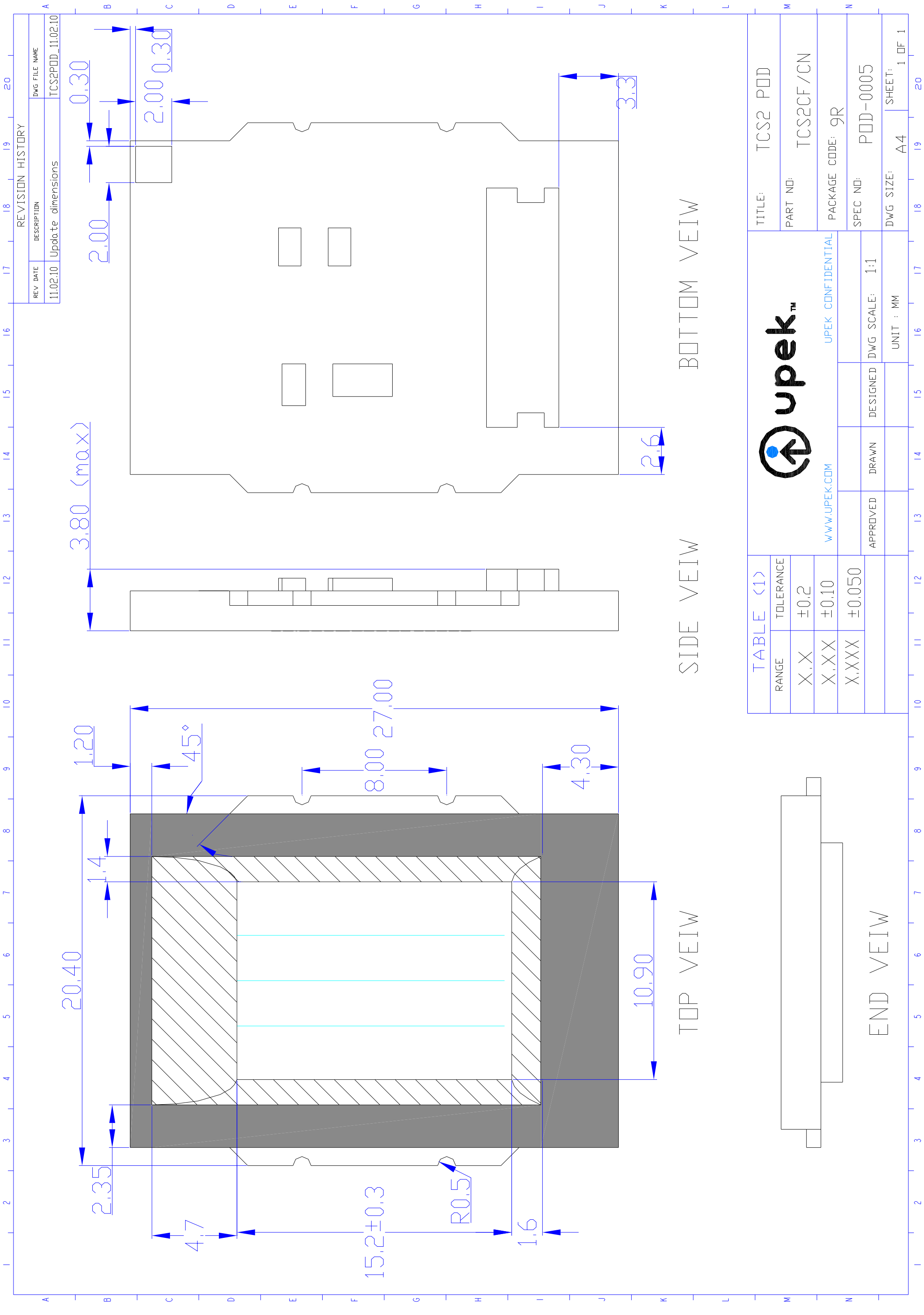
TCS2 MARKING - >= MAT 29
REVISION 07.29.2009

LINE 1: 6 DIGIT OF SHORT CP CODE FROM UPEK PRODUCT CODE 13 DIGITS

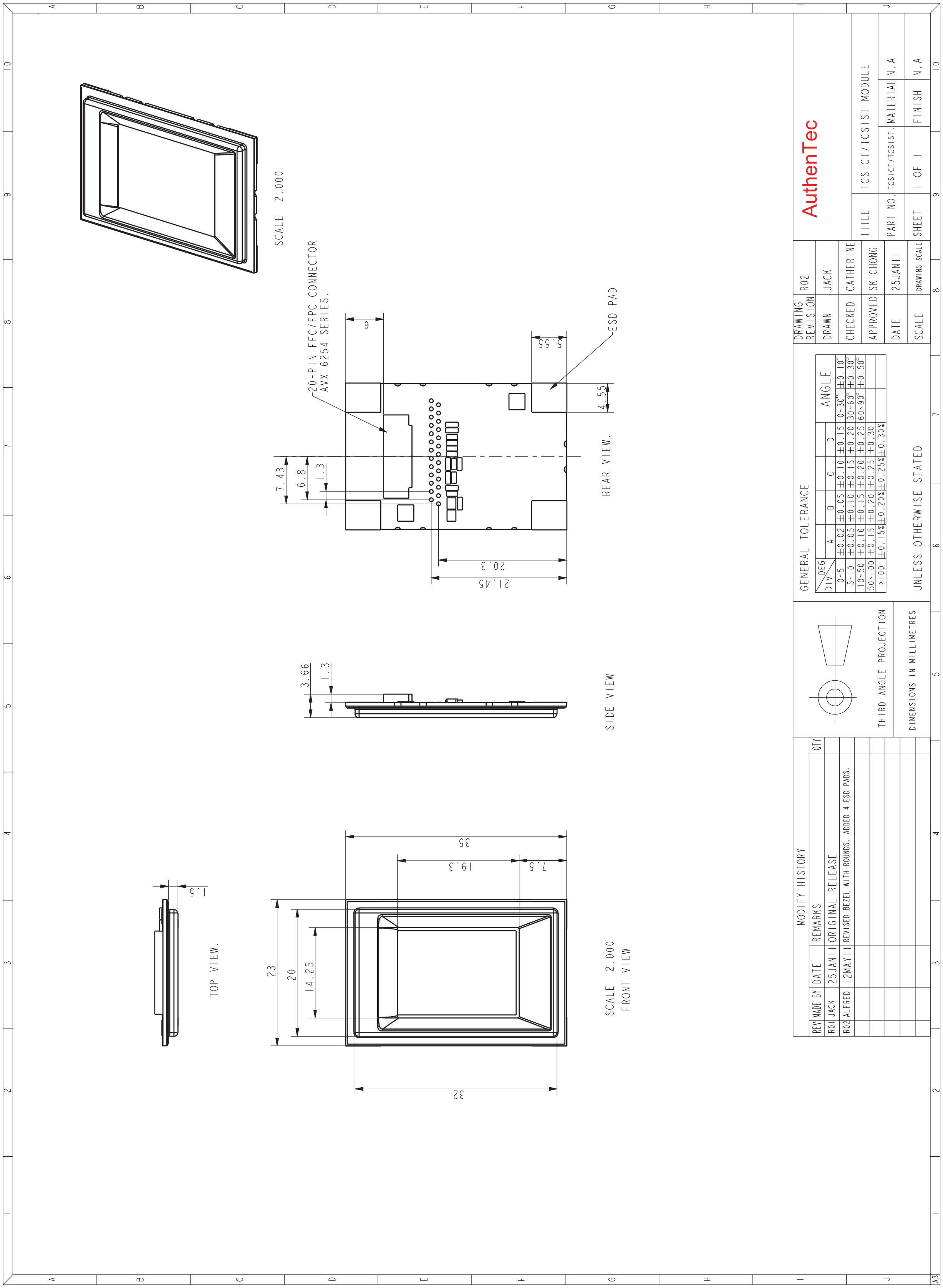
LINE 2: UPEK LOGO, PP= ASSEMBLY PLANT CODE. LLL= SEQUENTIAL CODE FOR EACH LOT. WX= WAFER FAB PLANT CODE. TF= TEST AND FINISHING PLANT CODE.

LINE 3: YWW= LAST DIGIT OF YEAR FOLLOWED BY WORKWEEK WITHIN THE YEAR ASSEMBLY LOT STARTED. CCC= ASSEMBLY SITE COUNTRY OF ORIGIN.

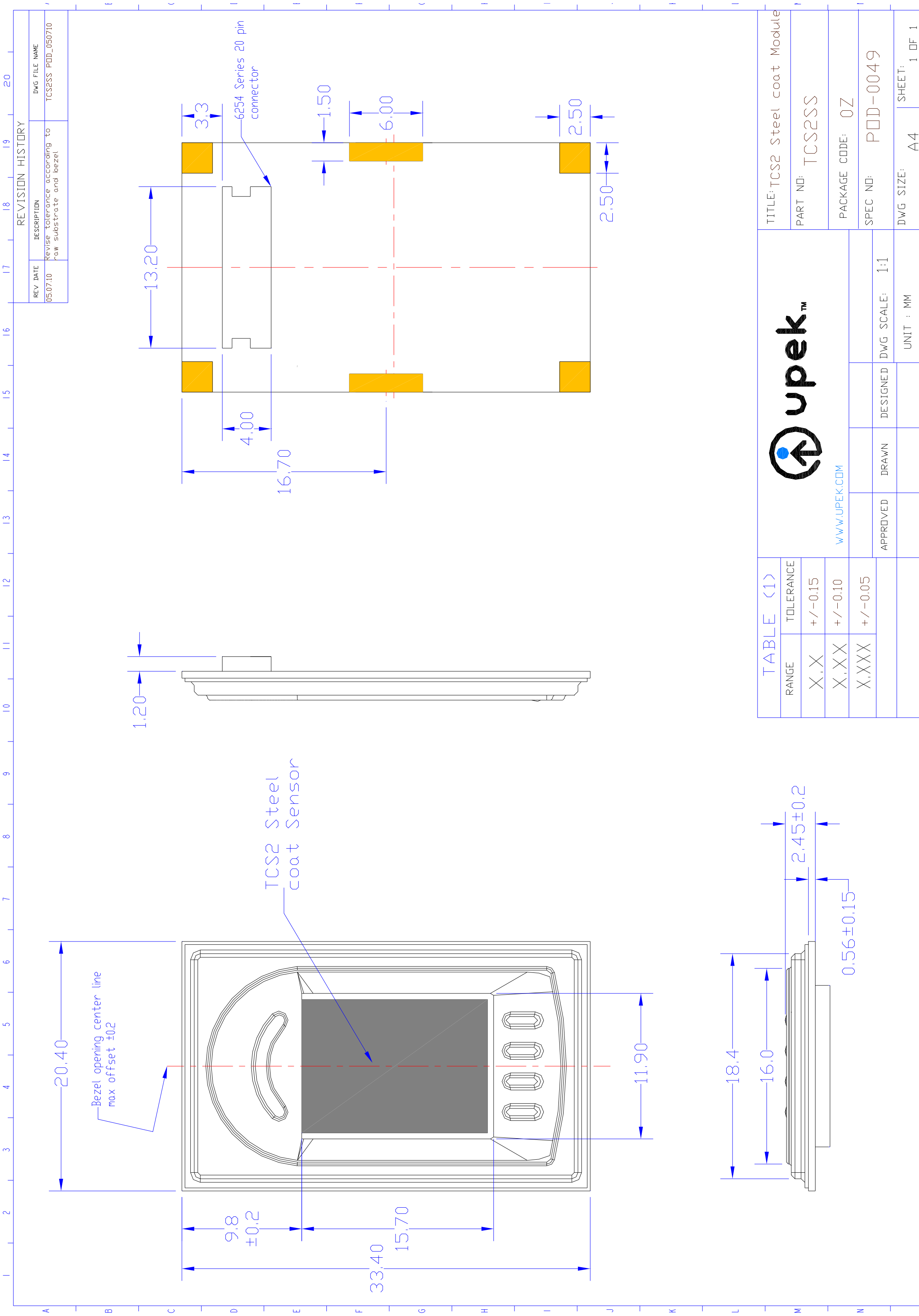
17.3 TouchChip TCS2xN Sensor



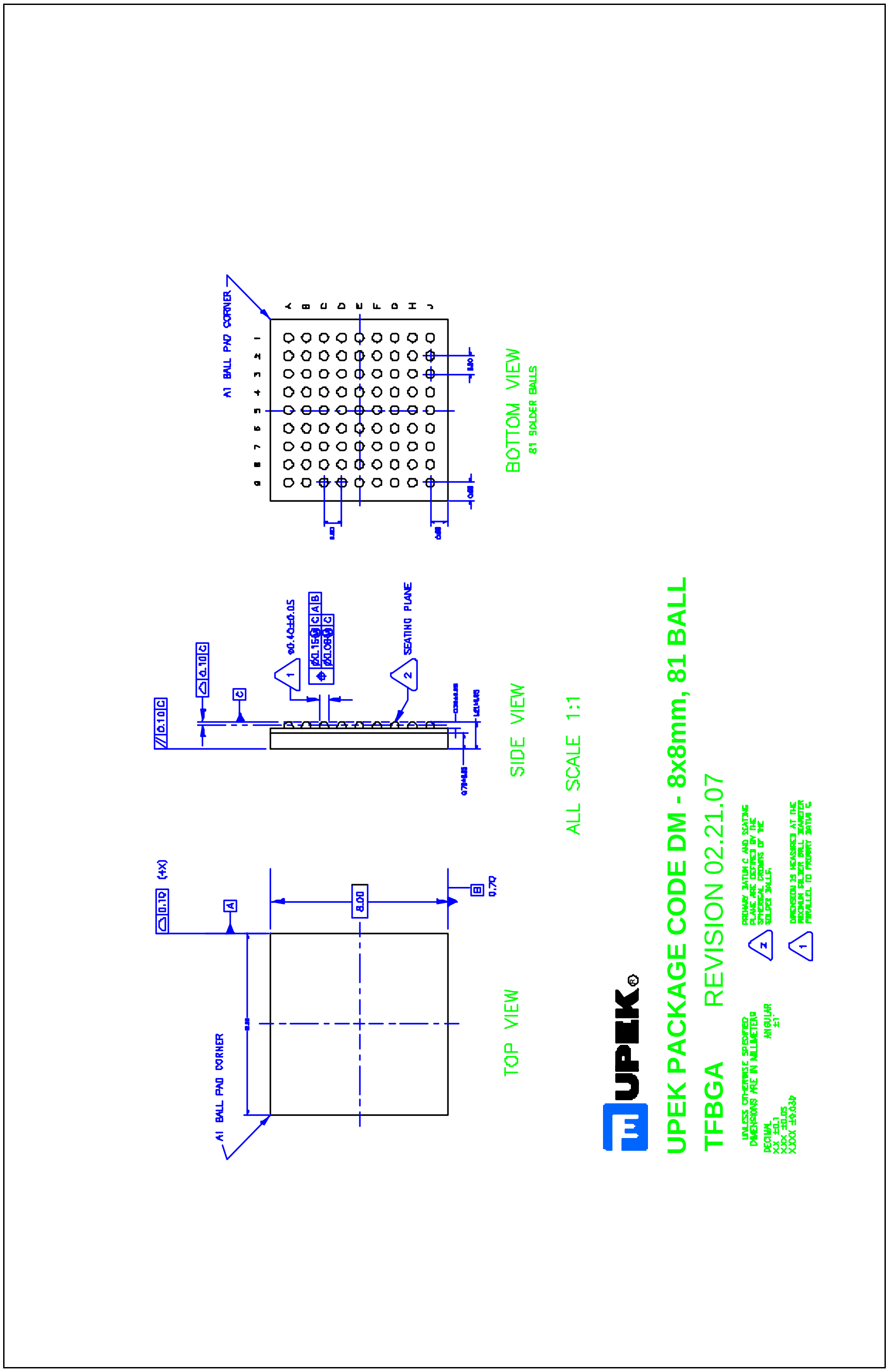
17.4 TouchChip TCS1xT Sensor



17.5 TouchChip TCS2SS Sensor



17.6 TouchChip Companion Chip TCD58E Mechanical Drawing



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