Personal Communications Sector

TTA Bus Requirements
For Motorola TTA Bus
Phones And Accessories

Release 0.4

June 6, 2003

Document Revision History

Version	**Date**	**Author**	**Changes**
0.0	4/7/03	Albert Lim	Initial draft.
0.1	4/11/03	Albert Lim	Revise all sections. Working draft.
0.2	4/15/03	Dave Hess	Changed Title, Add text to clarify section 2.0, Reword section 3.1.1.3 to state Motorola's position on charging, remove 5.0V power supply column from pin-out section since it is not supported, Changed multiple pin definitions (highlighted in red) to clarify, Added Table 3, Sec. 3.2.25 to clarify logic levels (levels need to be corrected for TTA Bus),
		NOTE TBD	Decide on PCM OR analog audio, must not leave as a choice. Adjust logic levels for TTA Bus.
0.3	5/27/03	Albert Lim	Updates most headings, table of contents, list of figures, and list of tables. Modify Table 1 pin 4, 21, 22, 24. Add in Table 3 and modify section 3.2.5, 3.2.6, 3.2.22, 3.2.25, 3.3.1, 3.3.3, 3.5.1.1 and add 3.2.23; pin 4 is now also called charge enable pin, and pin 24 is now also called SWB+ Enable pin. Preference now is no charge indication signal from charger. Modify table 4 to update logic levels. Complete plug and receptacle dimensions.
		NOTE	Both PCM and analog audio are still preserved for now.
0.4	6/4/03	Albert Lim	Official Release to ODM

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1.0 Introduction

This document describes the electrical and mechanical requirements for the 24-pin external interface known commonly as TTA Bus. This interface, set as a standard by Korea Telecommunication Technology Association, will be the common interface for all Korea CDMA phones. Motorola is adopting this standard, including the enhancement that were made through several phone programs, and is internalizing it for all Motorola phones that is being designed using this TTA bus interface connector. Motorola will further enhance the TTA bus to cater for new accessories without affecting the core definition of the TTA bus spec.

The information contained in this document has been compiled from the references listed in section 1.2, and from discussion and correspondence between Motorola CPAD and ODM phone teams. The intent of this document is to provide a summary of all of the TTA bus requirements and the enhancement that has resulted from Motorola ODM phone programs.

1.1 Purpose and Scope

The purpose of this document is to specify all of the major components of the external interface, describe the function of and requirements for all signals crossing the interface, and specify the external connector dimensions and pin-outs. Issues and problems with regard to specific proposed hardware and software implementations will be discussed in the “Open Issues” sections of this document.

1.2 References

This document supercedes references 1.

1) Standard on I/O Connection Interface of Digital Cellular Phone X.2001 from Korea Telecommunication Technology Association
2) Universal Serial Bus Specification, revision 1.1, 9/23/98

1.3 Glossary & Acronyms

USB – Universal Serial Bus

2.0 TTA Bus Overview

The general requirements for the TTA bus are described in reference (1.) The TTA bus is intended to support connection to accessories, personal computers, and test systems. The bus connector has a total of 24 pins, 8 of which have multiple functions.

One of the functions the bus allows is charging of the phone's battery. The standard allows two basic architectures for this, charging circuits in the phone, and charging circuit in the external power supply. The approach Motorola has taken for charging is to put the charging function in the external power supply. This approach will be used for all accessories performing charging.

A second function of the bus is audio transmission to / from an accessory. There are two methods supported, analog audio and digital, PCM audio. Motorola requires all phones and accessories to support digital, PCM audio. Analog audio is optional.

A third function of the bus is data communication to a PC. Both USB and RS-232 (8-wire) communication formats are supported. Motorola requires the use of both USB and RS-232 (minimum of 4 wires) modes. USB high speed and USB OTG are not supported.

Note: This TTA Bus specification describes the method for properly identifying and interfacing TTA Bus accessories. However, Motorola phones are not required to support all the accessories described herein. Support for any given accessory should be verified through the appropriate Software and Hardware engineering groups. If an accessory is not supported, the phone must still gracefully handle its attachment.

3.0 Electrical Requirements

3.1 Operational Modes

3.1.1 Standard Modes

The TTA standard supports 3 standard types of accessories – charger, data and audio - and two of these can be combined and connected to the phone to provide at least two modes of operation – data or audio mode. In both modes, the charging and power out is optional; there is no restriction. Mode selection is determined by accessory identification.

3.1.1.1 Data Mode

The accessory supported is either RS232 or USB type. For communication to the PC, the accessory will be either a RS232 or USB data cable. Memory module and digital camera will fall under the data type of accessory and could communicate to the phone through either RS232 or USB. If USB is used, the phone is always the device, never the host. High speed USB is also not supported.

3.1.1.2 Audio Mode

The accessory supported is either of digital or analog audio. No further identification is required as it will be unique to each manufacturer. An analog audio accessory is expected if the phone could only support analog audio. Likewise, a digital audio accessory is expected if the phone could only support digital audio.

3.1.1.3 Charging

The TTA specification allows for two different approaches for charging. Motorola requires that all phones use the “External Charger” mode of charging for backwards compatibility. All accessories containing the ability to charge the phone, will have charging circuitry and phones must be designed without internal chargers.

3.1.1.4 Switch B+

Pin 21 and 22 can be used to power phone accessories.

3.1.2 Non Standard Modes

The non standard modes are not documented in TTA standard. These will be used by manufacturer for phone programming or configuration purpose. Non standard modes should not use power pins, ground pins, battery ID pins, Hand-free pin, and on switch pin for mode entry.

3.2 Individual Pin Definitions

3.2.1 Connector Pin-out

The connector pin-out is described in the following tables.

Pin No.	Signal Name (Short Form)	IN (I) /OUT (O)	BATTERY CHARGING 4.2 V	RS 232 DATA CABLE	USB DATA CABLE	HAND FREE ANALOG	HAND FREE DIGITAL
1	BATTERY ID (ID)	I	ID				
2	HANDS-FREE MODE (HF)	I				HF	HF
3	DSR	O		DSR			
4	POWER (+5.0 V ~ 5.5 V) / CHARGING STATUS / CHARGE Enable	I	CHARGE ENABLE				
5	POWER (+5.0 V ~ 5.5 V)	I					
6	ON SWITCH (ON)	I				OPTION	OPTION
7	AUDIO IN/ PCM RX	I				AUDIO IN	PCM RX
8	PCM CLOCK	O					PCM CLOCK
9	PCM SYNC	O					PCM SYNC
10	USB D-	I			D-		
11	AUDIO OUT / PCM TX	O				AUDIO OUT	PCM TX
12	POWER GROUND (GND)	I	GND	GND	GND	GND	GND
13	RXD	I		RXD			
14	TXD	O		TXD			
15	USB D+	O			D+		
16	USB POWER (+5.0V)	I			USB POWER		
17	DCD	O		DCD			
18	RI	O		RI			
19	POWER GROUND (GND)	I	GND	GND	GND	GND	GND
20	RFR or RTS	O		RTS			
21	CHARGE (+4.2 V) / SWB +	I/O	+4.2 V				
22	CHARGE (+4.2 V) / SWB +	I/O	+4.2 V				
23	CTS	I		CTS			
24	DTR / SWB+ Enable	I		DTR			

Table 1

3.2.2 Battery ID (Pin 1)

The battery ID is provided by the battery pack in the form of resistance value. The battery ID is used by the charger to determine the appropriate amount of charging current to the battery pack. There are only three possible charging currents. The charging currents are listed below.

Charging Current Output	ID Resistor (Tolerance: 5%)
450mA	27K
750mA	4.7K
900mA	1.5K

Table 2

3.2.3 Hands-Free Mode (Pin 2)

The phone will route the audio to this interface if a logic 1 (less than 3.3 volt) is detected at this pin, and if headset is not connected.

3.2.4 DSR (Pin 3)

This pin contains the DSR signal for RS-232 mode. The output conforms to the logic levels shown in section 3.2.26 below. External level translators are to be used to provide true RS-232 levels, if needed.

3.2.5 Power (+5.0 V ~ 5.5 V) / Charging Status / Charge Enable (Pin 4)

Power Mode: This is NOT the preferred mode to power the phone.

Charging Status Mode: This is NOT the preferred mode of operation. This is a travel charger input to the phone to indicate the charging status of the battery pack when pins 21 and 22 are used to provide charge to the battery pack by the travel charger. The charger shall following guide to provide analog charge status signal through pin 4 to the phone.

CHARGING STATUS (BATTERY VOLTAGE)	CHARGING STATUS DISPLAY SIGNAL (PIN4 OUTPUT VOLTAGE)
V_BATT < 3.95V±0.05V	1.2V±0.2V
3.95V±0.05V ≤ V_BATT < 4.15V±0.05V	1.7V±0.2V
4.15V±0.05V ≤ V_BATT	2.2V±0.2V
CHARGING END	2.7V±0.2V

Table 3

Charge Enable Mode: This is a travel charger input to the phone to enable charging path to the phone battery. It shall be a logic high signal above 1.7 volt and below 2.7 volt.

3.2.6 Power (+5.0 V ~ 5.5 V) (Pin 5)

Power Mode: This is NOT the preferred mode to power the phone. This pin should be left unconnected.

3.2.7 On Switch (Pin 6)

This is an external accessory input to the phone to power up the phone. The phone shall power up if a logic 1 (less than 3.3 volt) is detected at this pin.

3.2.8 Audio In / PCM Rx (Pin 7)

This is an audio receiver signal line and can be either analog or digital audio.

3.2.9 PCM Clock (Pin 8)

This is used by phone for digital hand-free audio.

3.2.10 PCM Sync (Pin 9)

This is used by phone for digital hand-free audio.

3.2.11 USB D- (Pin 10)

This pin contains the negative signal for the USB. This line needs to be twisted with USB+ (see below, 3.2.16) and shielded in the cable as described in section 4.2.1.

3.2.12 Audio Out / PCM Tx (Pin 11)

This is an audio transmitter signal line and can be either analog or digital audio.

3.2.13 Power Ground (Pin 12)

TTA does not make distinction between power ground and audio ground. This pin should be connected to the audio ground if one is available.

3.2.14 RXD (Pin 13)

This pin contains the receive data for RS-232 mode. The input conforms to the logic levels shown in section 3.2.26 below. External level translators are to be used to receive true RS-232 levels, if needed.

3.2.15 TXD (Pin 14)

This pin contains the transmit data for RS-232 mode. The output conforms to the logic levels shown in section 3.2.26 below. External level translators are to be used to provide true RS-232 levels, if needed.

3.2.16 USB D+ (Pin 15)

This pin contains the positive signal for the USB bus and needs an internal pull-up of 1.5 k ohms +/- 5% to 3.3 Volts +/- 0.3 Volts in the phone to signal that the phone is a full speed device. This line needs to be twisted with USB- (see above, 3.2.11) and shielded in the cable as described in section 4.2.1.

3.2.17 USB Power (+5.0 V) (Pin 16)

This pin inputs the 5-Volt power when a USB host is attached. This line needs to be grouped with USB+ (see above, 3.2.16) and USB- (see above, 3.2.11) and shielded in the cable as described in section 4.2.1. A valid level on this line to indicate that a USB host is attached is > 4.0 Volts. The phone will draw a maximum of 100mA on this line.

3.2.18 DCD (Pin 17)

This pin contains the DCD signal for RS-232 mode. The output conforms to the logic levels shown in section 3.2.26 below. External level translators are to be used to provide true RS-232 levels, if needed.

3.2.19 RI (Pin 18)

This pin contains the RI signal for RS-232 mode. The output conforms to the logic levels shown in section 3.2.26 below. External level translators are to be used to provide true RS-232 levels, if needed.

3.2.20 Power Ground (Pin 19)

TTA does not make distinction between power ground and audio ground. This pin should be connected to the power ground.

3.2.21 RTS (Pin 20)

This pin contains the RTS signal for RS-232 mode. The input conforms to the logic levels in section 3.2.26 below. External level translators are to be used to receive true RS-232 levels, if needed.

3.2.22 Charge (+4.2 V) / SWB + (Pin 21)

Charge Mode: Charging to the phone battery pack is done through this pin at 4.2 volt nominal with a tolerance of +/-50 mV. Charge Mode may be enabled in conjection with an active high at pin 4. The charging current will be based on the ID resistor at pin 1.

SWB+ Mode: Power can be sourced from this pin when it is not in Charge mode. SWB+ Mode may be enabled in conjunction with a active low at pin 24. The maximum current that can be sourced from this pin shall be 450 mA at less than 4.2 volt.

3.2.23 Charge (+4.2 V) / SWB + (Pin 22)

Charge Mode: Charging to the phone battery pack is done through this pin at 4.2 volt nominal with a tolerance of +/-50 mV. Charge Mode may be enabled in conjection with an active high at pin 4. The charging current will be based on the ID resistor at pin 1.

SWB+ Mode: Power can be sourced from this pin when it is not in Charge mode. SWB+ Mode may be enabled in conjunction with a active low at pin 24. The maximum current that can be sourced from this pin shall be 450 mA at less than 4.2 volt.

3.2.24 CTS (Pin 23)

This pin contains the CTS signal for RS-232 mode. The output conforms to the logic levels shown in section 3.2.26 below. External level translators are to be used to provide true RS-232 levels, if needed.

3.2.25 DTR / SWB+ Enable (Pin 24)

RS232 mode: This pin contains the DTR signal for RS-232 mode. The input conforms to the logic levels shown in section 3.2.26 below. External level translators are to be used to receive true RS-232 levels, if needed.

SWB+ mode: This is an external accessory input to the phone to enable SWB+ out from pin 21 and 22. The phone shall provide a power 2.7 volt out if a logic zero is detected at this pin. This pin shall be pulled to ground via a 100k resistor in the accessory.

3.2.26 Logic Input / Outputs

Several pins use logic levels. These requirements are listed below and are referenced to GND (see above, 3.2.20):

Symbol	Parameter [1]	Signal	Condition	Min.	Max.	Units
V_{oh}	Output High Voltage	All	I_{oh} = -100uA	2.0	3.3	V
V_{ol}	Output Low Voltage	All	I_{ol} = 100uA	0.0	0.8	V
V_{ih}	Input High Voltage	All		2.0	3.3	V
V_{il}	Input Low Voltage	All		0.0	0.4	V
I_{ih}	Input High Current	All	V_{in} = 2.775V		50	uA
I_{il}	Input Low Current	All	V_{in} = GND		50	uA

Table 4

Note 1: These limits are taken from the phone point of view, i.e. the phone outputs are what the accessory gets and the phone inputs are what the accessory must provide for correct operation.

3.3 Detection and Identification of Accessories

3.3.1 External Power / Charging

External power can come from a variety of sources. These include, but are not limited to, Desktop chargers, Wall chargers, Cigarette Lighter Adapters (CLA's), Professional and User installed hands-free kits, desktop hands-free kits, etc. The 5.0 volt power through pin 4 and 5 will be detected by ways of detection of a voltage on the pin. The charging through pin 21 and 22 can be detected by detecting the presence of active high (charge enable) signal or a charge status indication signal at pin 4.

3.3.2 USB

The phone will detect the presence of a USB Host when > 4.0 Volts is applied to the USB PWR pin. The identification of the specific USB Host will be implemented via messages in the USB enumeration process.

3.3.3 RS232

The phone will detect the presence of a RS232 data cable through the data high at RxD. The identification of the specific RS232 device will be implemented via messages in the RS232 enumeration process.

3.3.4 Audio

The phone will detect the presence of an audio device through the hand-free pin set as high.

3.3.5 Headset Detection

The headset will use a standard 2.5mm phone jack. The phone will detect the presence of a headset using a pin within the headset jack. This pin is aligned with the ground sleeve of the headset plug and will be pulled to a logic low whenever the headset plug is inserted into the jack.

The headset may contain a momentary switch, which is normally closed and is in series with the microphone cartridge. When the momentary switch is pressed, the bias current being supplied to the microphone will be interrupted. The phone must detect this action. An appropriate response to this action would be to answer a call, end a call, or dial the last number from scratchpad.

The earpiece will be 32 ohms +/- 15%. The earpiece amplifier should have an output impedance of 68 ohms and, with an input of -16dBm0 (-18dBm0) into the CODEC, should produce an output of -28.33dBVrms (-30.33dBVrms) at the earpiece at 1kHz (across the 32 ohm load, there will be a nominal -9.89 dB loss as a result of the output impedance).

The microphone will use a 4.7k pull-up resistor as bias. The microphone amplifier should have an input impedance of 10Kohm. An input voltage of -58.0 dBVrms (-60.0 dBVrms) at 1KHz should produce -16dBm0 (-18dBm0) at the input of the CODEC A/D.

For an earbud type headset, the microphone output voltage signal level should be created using an input of 89.3dBSpl (to yield -16 dBm0) at the MRP of a B&K Head and Torso Simulator into the microphone. In this set-up, there will be nominal -13dB of acoustic path loss between the microphone and the MRP.

3.4 Operational Requirements

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3.5 Specific Accessory Interface Requirements

This section lists the known accessories and their required interfaces. Detection and interaction with other accessories will also be discussed.

3.5.1 Power Supplies

3.5.1.1 Wall Chargers and CLA's

This class of accessories is detected as detailed in section 3.3.1. They may be plugged into any other accessory or transport that provides a 24 pin connector.

Starting from new Motorola TTA compliant charger from May 2003, this class of accessories shall not provide charge status indication at pin 4 to the phone. Rather, an active high signal is provided as required by certain phone models. In addition, the function of reading the temperature and charge enable determination will now be performed by the phone.

3.5.1.2 Desktop Chargers

Desktop chargers could charge the battery via the 24 pin connector or via a delicate charging pads on the battery behind the phone. If the former case is used (which is unlikely for most TTA bus phones), the detection is as detailed in section 3.3.1. Otherwise, the phone does not detect the accessory.

3.5.2 Data Cables (Transports)

3.5.2.1 RS-232 Data Cable

The RS-232 data cable will be detected as detailed in section 3.3.3. It will contain level translators for interfacing directly to a computer or other RS-232 device and a side 24-pin connector for providing external power to the phone or charging to the phone battery. The level translators must be capable of receiving SWB+ or from the PC The RS-232 data cable can be plugged into anything containing a 17-pin connector and only a power supply or charger can be plugged into it. Note that no Hardware Reset is available.

3.5.2.2 USB Data Cable

The USB data cable will be detected as detailed in section 3.3.2. It will contain a side 24-pin connector for providing external power to the phone or charging to the phone battery. The USB data cable can be plugged into anything containing a 24-pin connector and only a power supply or charger can be plugged into it.

3.5.3 Cabled Accessories

3.5.3.1 Easy Install Hands-Free Kit (EIHF)

The EIHF will be detected as detailed in section 3.3.4. The EIHF will not have a pass through connector of any kind so no cabled accessories are compatible with it, however, it can be plugged into any accessory with a 24-pin pass through connector.

3.6 Open Issues

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4.0 Mechanical Requirements

The connector shall be designed to mate with a full 24-pin connector or a partial filled pin connector for charging only.

4.1 Wire Gauges

4.1.1 External Power / Power Ground

External power and Power Ground require as heavy gauge as the cable / connector can tolerate. 22 Gauge is recommended as an absolute minimum with 20 Gauge being the preferred gauge. Shorter length cables can be allowed to have a smaller gauge (i.e. in the data cables that have a "Y" for the power lines) but consideration must be made for the voltage drop taken in whatever is plugging into it.

4.1.2 Switched Battery

Switched Battery is expected to carry 500mA and so should be a heavier gauge than the data lines. 24 Gauge is the recommended gauge for Switched Battery.

4.1.3 USB D+ / USB D- / USB Power

The USB specific lines in the cord should conform to the USB specification, section 6.6.2.

4.1.4 All Other Lines

All of the other lines on the connector only carry data and so need not be a very heavy gauge. 28 Gauge is a good tradeoff between size and reliability of the cable. A smaller gauge may be less reliable and more difficult to build a cable with. A larger gauge would add unnecessary size to the cables. 28 Gauge is the preferred gauge for the data lines. It should be noted that the Audio Ground must only be used for a reference in any accessory and not to carry large currents, AC or DC. It has been the author's experience that a larger gauge wire for Audio Ground not only doesn't necessarily help with noise concerns (supply rejection, "Buzz", etc.) sometimes a larger gauge wire can be detrimental.

4.2 Cable Construction

This section details specific construction details for cables where there are specific requirements such as shielding, twisting, or specific arrangement of wires within the cable.

4.2.1 USB Lines

Any accessories using USB mode in a cabled configuration must use the configuration for the three USB lines shown in Figure 1 below. Please note the addition of an additional drain wire, which is not connected to any pins on the connector, but connected to the grounding posts. The twisted signaling pair are 28 AWG diameter wire and must be twisted according to the USB spec, section 6.6.2

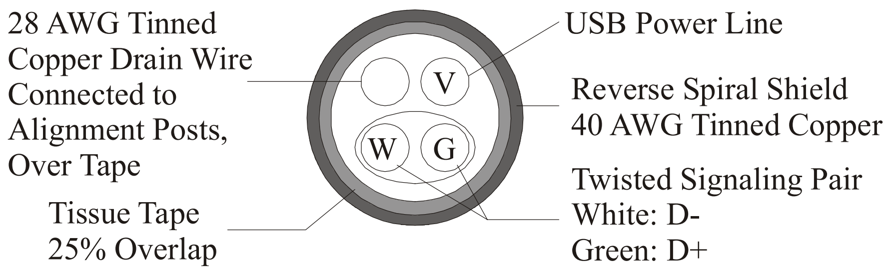

Figure 1

4.3 Connector Drawings

4.3.1 Phone Connector

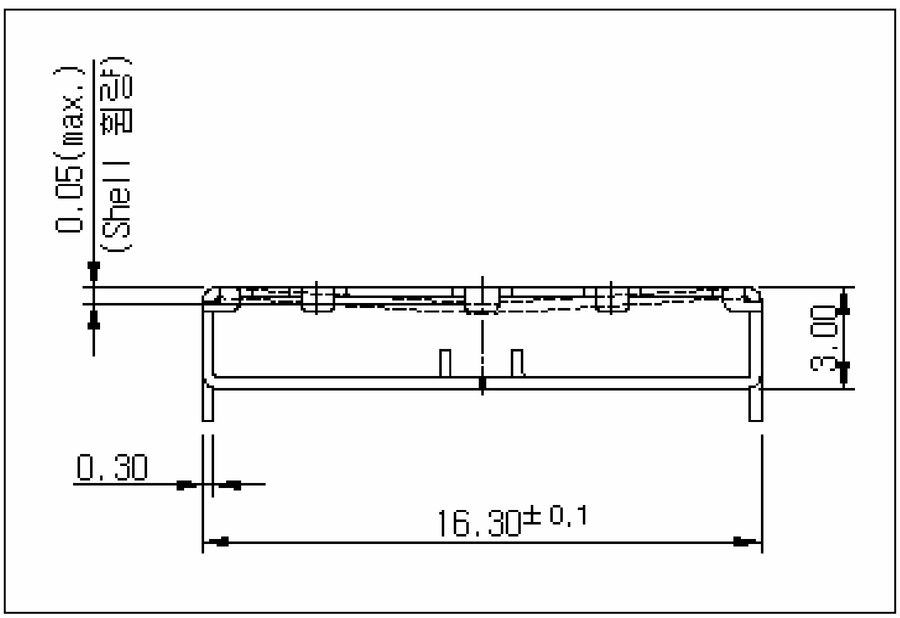

Figure 2 Outer Dimension of the Receptacle

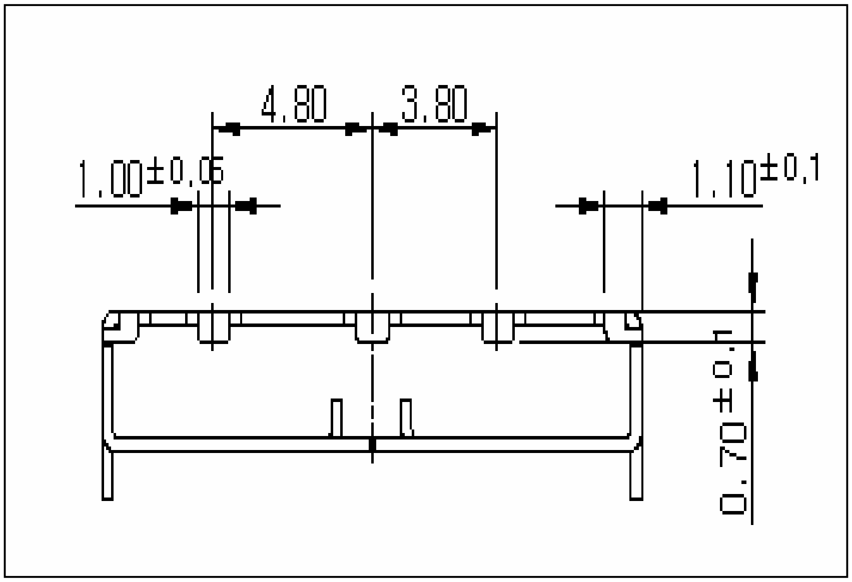

Figure 3 **Outer Dimension of the Receptacle Selective Insert Key**

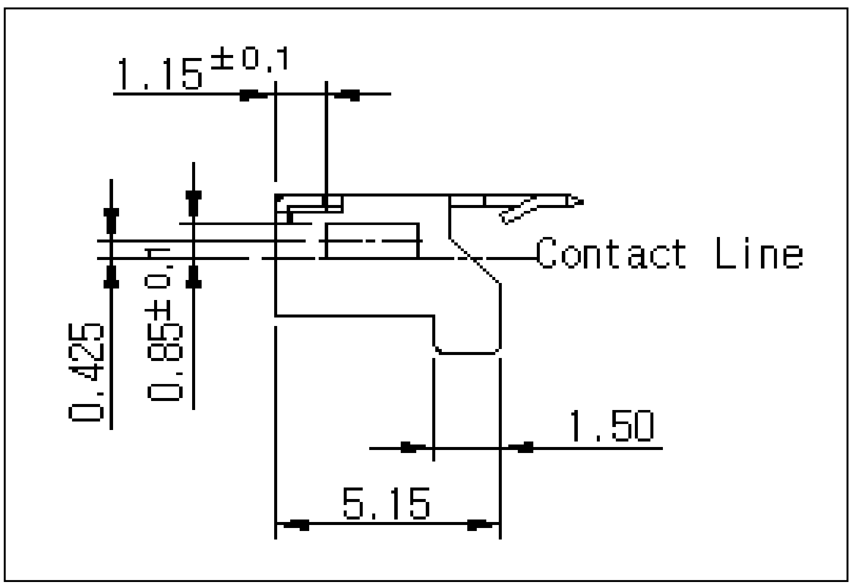

Figure 4 **Outer Dimension of the Receptacle Locking Part**

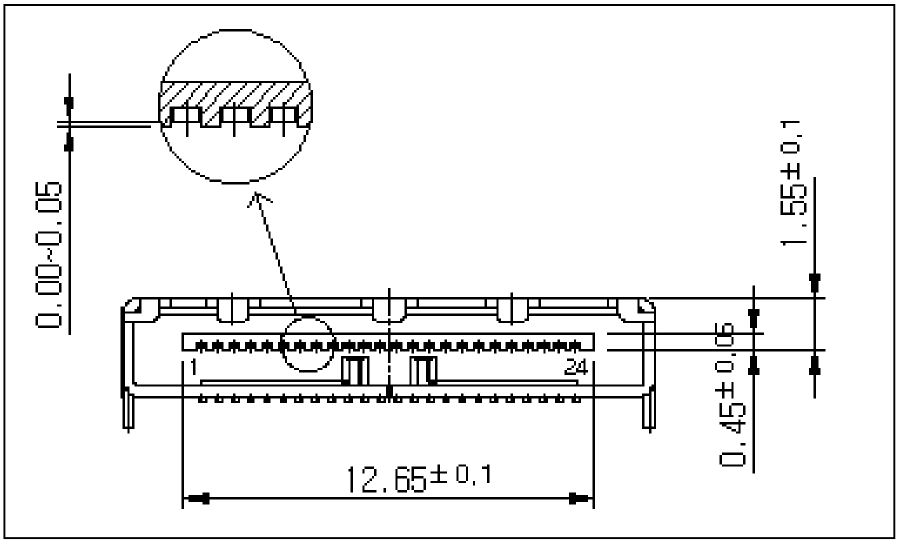

Figure 5 Outer Dimension with the Pin Arrangement

4.3.2 Accessory Connector

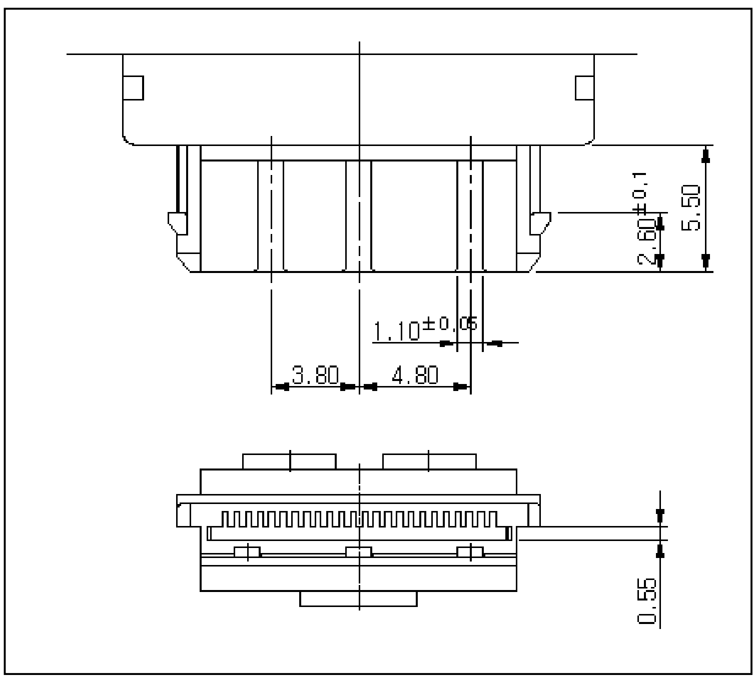

Figure 6 Outer Dimension of the Plug

4.4 Open Issues

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