FINEPOINT INNOVATIONS, INC.

ENGINEERING SPECIFICATION

"HOUSTON" 10.4-INCH CUSTOM

PEN INPUT SUBSYSTEM

FPI Project Name: Houston

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Document History

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X	Initial Release	nnnnn	11 Jul 2002
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Note: DCN stands for Document Change Notice

SPECIFICATION
PEN INPUT SUBSYSTEM FOR HOUSTON

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1.0 INTRODUCTION

The FinePoint Innovations, Inc (FPI) “Houston” configuration of the Pen Input System is designed specifically for use as a drop-in digitizer for the Toshiba LTM10C321K (“Kangaroo”) 10.4 inch LCD. It is a high-performance magnetic-component OEM tablet/digitizer consisting of two major components: a cordless battery-powered pen, a digitizer assembly. The digitizer assembly consists of a custom sensor grid and a pen system controller connected together by a flexible cable and adhesive. The sensor grid board mounts onto the back of the above-mentioned Toshiba LCD. It is specifically designed to slide between the LCD assembly and the LCD control card attached to the rear of it, and into the thin digitizer mounting “pocket”.

The FPI Pen Input System is designed for high-speed handwriting input and low-power usage. It utilizes a unique and ***proprietary*** position resolving system that combines both high accuracy and high-slew speeds for handwriting and character recognition applications. It can be used in a variety of pen based computer applications for writing directly on an LCD with a pen. The sensor grid assembly acts as a multiple wire antenna, and senses the electromagnetic signal from the pen through the LCD. The PSC is the receiving, processing and control element of the pen system. The PSC provides the physical and logical interface from the Pen Input System to the pen-based computer through a serial interface.

This particular design has been customized to include additional active area for several button or menu decode areas on one edge and optional LED drive for each of these areas. The LEDs and menu sensor area are controlled and decoded via the command interface and output format respectively. Therefore, custom functions are decoded and controlled by the host system driver.

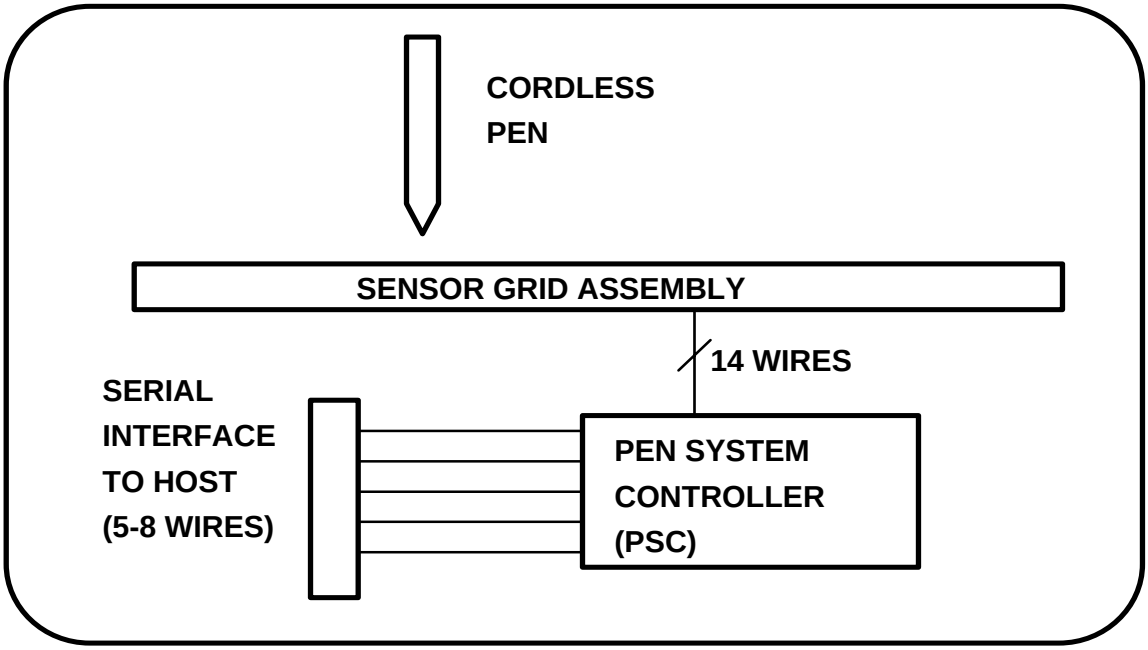
1.1 Scope

This document includes a technical description of the FPI “Houston” Pen Input Subsystem. This component configuration is specifically designed to be integrated with the 10.4 inch Toshiba LTM10C321K LCD, although it can potentially be used in other applications.

1.2 Pen System Controller (PSC) Operation

In operation, the cordless pen sends a signal through the LCD and into the sensor grid. In turn, the sensor grid receives the pen signal and sends the analog signals to the Pen System Controller (PSC). The PSC controls the scanning of the grid, reads and interprets the pen signal, and translates it into digital codes that identify the absolute pen coordinate position and other “status” information. A bi-directional serial interface allows the PSC to output data to the “host”, and receive commands to test or control the pen system.

1.3 FPI Pen System Standard Configuration Diagram



1.4 "Houston" Custom Configuration Description

The FPI Pen System hardware as applied to the Houston configuration consists of three major components. Cordless Pen, Sensor Grid Assembly, and PSC Assembly.

1.4.1 *Cordless Active Writing Pen*

Acustomized cordless pen (A.T. Cross Model CP430-01); active pen designed for handwriting, tip switch and one side (barrel) switch.

1.4.2 *Digitizer Assembly*

The Digitizer Assembly consists of three subassemblies: the Sensor Grid assembly, the Pen System Controller assembly, and the flexible cable assembly to connect the Sensor Grid and Controller assemblies. The Digitizer Assembly is designated by FPI part number 11283-0001. This part number will be updated to reflect corrections incorporated into the firmware that will optimize the Pen Input Subsystem to meet the OEM customer's particular design.

Custom designed PCB sensor grid, for integration with the Toshiba model LTM10C321K LCD. It consists of a very thin PCB, "mux" chips at one edge to reduce the number of interconnections to the PSC, an "electrostatic" shield on the top of the PCB (to eliminate noise induced by the backlight and other sources), and an electromagnetic shield on the bottom of the PCB (to eliminate effects from the host computer below it). It connects to the FPI PSC via a narrow flex cable.

The PSC is mounted on a board that interfaces to the back of the sensor grid through a flexible cable. It also includes the interface to the host computer through a low profile board-to-cable connector. The two primary components of the PSC consists of a Pen Signal Receiver (PSR6) ASIC operating in combination with a Microchip PIC Microcontroller containing proprietary FPI Pen System firmware.

2.0 PEN SPECIFICATION

2.1 Pen – Mechanical Performance Specification

2.1.1 Switch Performance

Tip Switch - The device contains a tip switch that is activated when the pen tip is depressed.

The switch is normally closed when the tip is not depressed.

The tip switch shall be capable of 10 million cycles from the normally closed position to full actuation at a maximum load of 125 g_f (4.4 oz).

Single Action Side Switch - The device may contain a side switch that is actuated independently of the tip switch by a user action.

The side switch is a normally open momentary on/off switch with tactile feel.

The side switch shall be activated by application of 160 ± 60 g_f (5.6 ± 2.1 oz).

The side switch shall be capable of 500,000 cycles of 0 g_f to 220 g_f (0 oz to 7.7 oz).

Dual Action Side Switch - The device may contain a dual action switch (rocker switch) or two independent side switches.

Each switch is a normally open momentary on/off switch with tactile feel.

Each switch shall be activated by the application of 160 ± 60 g_f (5.6 ± 2.1 oz).

Each switch shall be capable of independently cycling 500,000 times between 0 g_f and 220 g_f (0 and 7.7 oz).

2.1.2 Battery

Type - The device shall use a non-rechargable "AAAA" battery conforming to ANSI/NEDA 25A or IEC LR61.

The battery shall be installed with the positive terminal toward the front PCB and the negative terminal toward the back of the barrel.

The device shall have the capability of internal battery removal and replacement by screwing/unscrewing the barrel section from the front section by hand without the use of separate tools.

There shall be no damage to the front section or barrel after application of 0.53 N-m (75 in-oz) of torque (the “Maximum Torque”) to tighten the threaded joint.

2.1.3 Refill Insertion and Removal

The refill (stylus or inking refill) shall be capable of being inserted with a maximum force of 4 kg_f (9 lb_f.) and shall require a removal force of 140 g_f (5 oz.) minimum.

2.2 Pen – Electrcial Performance Specification

2.2.1 Operational States

Standby Operation - Pen is inactive and has no output signal.

Normal Operation - Pen is transmitting signal.

State switching - The pen will activate from Standby to Normal by actuating the tip switch. The pen will change from Normal to Standby after 10.5 ± 3.5 minutes of no tip switch activity with a fresh battery.

2.2.2 Power

The pen shall be capable of accepting a "AAAA" battery size as defined by ANSI/NEDA specification 25A or IEC specification LR61.

The pen shall operate according to specification with a battery supply voltage between 1.1 and 1.6 volts.

Power Consumption:	Normal Operation	400 µA max
	Standby Operation	3.5 µA max

2.2.3 Transmission Frequencies and Amplitude

Table 1 shows the nominal limits of pen output frequency and amplitude of the magnetic field for various switch-setting combinations with the pen in Normal mode. The nominal limits are valid for a battery supply voltage of 1.5 volts and ambient conditions of 20°C to 26.5°C and 20% to 60% relative humidity and the pen axis held vertical with respect to the test surface.

Switch Status	**Frequency (kHz)**	**Amplitude***
Idle (no switches)	458.0-465.0	1250-1550
Tip switch only	482.0-494.0	1250-1550
Tip switch + Single Side Switch or Primary dual side switch	433.8-445.4	1200-1525
Single Side Switch or Primary dual side switch only	415.0-424.0	1125-1450

*Amplitude is A/D converter output count measured at the test surface

2.2.4 Tilt Performance

The pen shall be capable of achieving Nominal Limits of output in Table 1 with the pen angled ± 45° from vertical with respect to the test surface.

2.3 Pen – Environmental Specification

The pen shall be capable of operation under the following operating conditions and sustain no damage after exposure to the non-operating conditions. The pen shall be capable of normal operation after removal from exposure to the non-operating conditions.

2.3.1 Temperature

Operating	0°C to +50°C	(+32°F to +122°F)
Non-Operating (continuous)	-20°C to +60°C	(-4°F to +140°F)
Extreme (10 minutes)	99°C	(210°F)

Thermal Cycling (non-operating) - The unit shall be capable of cycling between the extremes of the non-operating temperatures shown above.

2.3.2 Relative Humidity (Non-Condensing)

Operating	5% to 95% RH
Non-Operating	5% to 95% RH

2.3.3 Altitude

Operating	<3657m above MSL	(12,000 ft.)
Non-Operating	<12,000 m above MSL	(39,360 ft.)

2.3.4 Shock

The pen shall operate as specified after dropping from 91.5 cm (36 in.) and landing in any orientation on to a linoleum-covered concrete floor. This requirement does not apply to the stylus but one must be installed for proper testing.

When properly packaged, the pen shall operate after being dropped from a height of 152.5 cm (60 in.) and landing on any package edge or vertex on a concrete floor.

2.3.4 Vibration (non-operating)

Random	6.1G, rms
Sine	1.0G, peak, 5Hz to 500Hz
Packaged	Packaged product shall be capable of withstanding the vibration set fort in the National Safe Transit Association Pre Shipment Test Procedures Project 1A, section B, Part 1.

2.3.5 Electromagnetic Interference Emissions

The unit must comply with the emissions requirements of the following:

IEC CISPR Publication 22 for a Class B device
FCC Rules and Regulations, Title 47, Part 15, Subpart B for a Class B device.
VCCI Class B ITE

The unit must comply with the immunity requirements of IEC 61000-4-3

2.3.6 Electrostatic Discharge Immunity

Contact Discharge - The unit shall be capable of accepting an electrostatic contact discharge of ± 15kV with no user intervention required to resume proper functioning.

Air Discharge - The unit shall be capable of accepting an electrostatic air discharge of ± 15kV with no user intervention required to resume proper functioning.

3.0 SENSOR GRID AND PSC ELECTRONICS SPECIFICATION

3.1 Physical Specification

3.1.1 Size and Weight (Sensor Grid Assembly)

Length (longest portion)	240.46mm (9.467 inches) (plus 6.6mm at screw-hole "tab" area)
Width	177.8mm (7.00 inches)
Weight (entire assembly including all components and shields)	75.0 grams ± 20%

Thickness of Items related to Grid Stack Up Height (non-component area)

Item Number	Description	Nominal Thickness		Tolerance	
		mm	(Inches)	mm	(Inches)
1	PCBA	0.300	(0.0120)	0.076	(0.0030)
2	ES Shield Assembly (with adhesive)	0.120	(0.0047)	0.013	(0.0005)
3	EM Shield Assembly (with adhesive)	0.175	(0.0069)	0.016	(0.0006)

Nominal Stack-up over most of area (Item 1+2+3)	=	0.595	(0.0234)
Worst Case Stack-up of above, with tolerances	=	0.700	(0.0276)
Nominal Stack-up in bottom slot of LCD (Item 1+3)	=	0.475	(0.0187)
Worst Case Stack-up in bottom slot, with tolerances	=	0.567	(0.0223)

Note: The above stack-up dimension does not include the components (ICs and discrete components) located to the far edge and on the top side of the sensor grid board assembly. Also, a small piece copper tape with conductive adhesive (.06mm nominal thickness) is located in a non-critical area to provide electrical connection to the EM shield.

3.1.2 Size and Weight (PSC Assembly)

Length	44.96mm (1.770 inches)
Width	37.97mm (1.495 inches)
PCB Thickness	0.381mm (0.150 inches), ± 20%
Maximum Component Height (above PCB)	2.20mm (0.083 inches)
Weight (entire assembly w/ all components)	2.8 grams ± 25%

3.2 Electrical Specification

3.2.1 Supply Voltage Range

Absolute	0 to 5.5 VDC
Operating	+3.3 ± 0.30 VDC

3.2.2 Power Consumption - Sensor Grid and PSC (+3.3 VDC, LEDs OFF)

	NOMINAL	MAXIMUM
Operating Power Usage	12 mW	20 mW
Standby Mode Power Usage	4 mW	8 mW

3.2.3 Power Supply Ripple

Using a Regulated Supply at +3.3 VDC ± 5% the following ripple requirements are recommended:

Ripple:

< 1 kHz	< 100 mV,p-p
> 1 kHz	decreasing 6 dB per octave until 50 kHz

Increased ripple has an adverse effect on system accuracy and noise performance and must be evaluated as required.

3.2.4 Host Interface

Transfer Method:	Asynchronous
Baud Rate:	19,200
Protocol:	Full Duplex
Voltage Levels:	(Min/Max per Microchip @ extreme temperatures & currents)

Transmit Output Levels	Voltage (V) Min	Max	TTL/CMOS
Space Output	V_{SS}	0.6V	Logic 0 (low)
Mark (idle) Output	V_{DD}-0.7V_{DD}	V_{DD}	Logic 1 (high)

Receive Input Levels	Voltage (V) Min	Max	TTL/CMOS
Space Input	V_{SS}	0.8V	Logic 0 (low)
Mark (idle) Input	0.8V_{DD}	V_{DD}	Logic 1 (high)

WakeUp Output Levels	Voltage (V) Min	Max	TTL/CMOS
Active	V_{SS}	0.6V	Logic 0 (low)
Inactive/Standby	V_{DD}-0.7V_{DD}	V_{DD}	Logic 1 (high)

Reset Input Levels	Voltage (V) Min	Max	TTL/CMOS
Active	V_{SS}	0.2V_{DD}	Logic 0 (low)
Inactive (run)	0.8V_{DD}	V_{DD}	Logic 1 (high)

(NOTE: minimum low pulse length, 50 microseconds)

3.2.5 Hardware Reset Operation

The FPI PSC processor can be reset by a Power ON RESET, or with an external RESET input. The external reset input line is provided so that the system can hard-reset or stop the digitizer at any time. When the power is turned ON, or the external reset is toggled low (for 50 microseconds or longer) to high, the PSC goes through an initialization routine. At the completion of this routine, the system status is as follows:

Receive serial port:	Ready to receive
Transmit serial port:	Ready to transmit

3.2.6 Sensor Grid to Control Card (PSC) Interface Connectors

Connector Type	Molex 52745-1590
Mated Height	2.0mm
No. of Positions	15
No. of Rows	Dual
Centerline Spacing	0.5mm

Pin Assignments	Description
1	AGND
2	YRET
3	SIG
4	XRET
5	VCCA
6	GS0
7	GS1
8	GS2
9	GS3
10	GS4
11	GS5
12	LED1
13	LED2
14	AGND
15	LED3

Signal Definitions (All signals to/from the Pen System Control Card):

AGND (Pins 1 & 14)	Analog Ground (from PSC)
YRET & XRET (Pins 2 &4)	Reference for the Y and X gridlines, respectively (from PSC): Very low current at a voltage of approximately 0.7VDC, although it may vary in amplitude very slightly the grid scan rate of 1600 Hz
SIG (Pin 3)	Signal (to PSC): This is the analog signal from the presently selected X or Y grid line. It is referenced at the X/YRET DC reference level (approximately 0.7V), and modulated with the pen signal (415-494 KHz). The maximum signal level is approximately 10MV peak-to-peak, and is typically much smaller.
VCCA (Pin 5)	Analog inout supply voltage (from PSC): This is the VCC supplied to the PSC from the OEM system (typically 3.3VDC), but filtered through a 10 ohm series resistor & 10uF Cap to ground on the control card.
GS0 to GS5 (Pins 6 to 11)	Grid "Select" lines GS0 to GS5 (from PSC): These are port lines from the PSC Mictrocontroller , at the CMOS output levels, and toggling at a rate no faster than 1600 Hz.
LED1 (Pin 12)	Drive Signal for LED Controlled Externally
LED2 (Pin 13)	Drive Signal for LED Controlled Externally
LED3 (Pin 15)	Drive Signal for LED Controlled Externally

3.2.6 PSC to Host Interface Connection

The physical PSC to host Interface is implemented on the PSC card via a 14-pin connector. This electrical interface includes the following signals:

Serial Connector (10 pins, Molex 52745-1090):

Pin	**Descrpition**
1	VCCD (3.3VDC)
2	TxD
3	RxD
4	Dwakeup
5	Reset
6	DGND
7	RC1
8	RB6
9	RB7

10	PGM/MCLR

Signal Definitions:

TxD	Transmit (Output Serial Data): This line is a Pen System output used to transmit asynchronous data to the Host System at 19,200 Baud.
RxD	Receive (Input Serial Data): This line is a Pen System input used to receive asynchronous data (download commands) from the Host System at 19,200 Baud.
Dwakeup	Output, normally LOW: It goes HIGH when an ASCII 'W' (057 Hex) is received on the RxD input. This places the Pen Input System into a low power "standby" mode. The Pen Input System continues to scan the grid on occasion (typically every 100mS), to check if the pen is detected within proximity of the digitizer active area. If this is found, the Dwakeup signal toggles LOW again and the Pen Input System returns to the full-power operating mode. This may be used as an interrupt to wake-up the entire system from a low power / standby mode when the pen returns to proximity.
Reset	Input, active LOW: Resets and disables the Pen Input System when LOW, and restores operation to the power-up state when toggled back HIGH. It is pulled high by the control card, so it may be left disconnected if the hardware reset is unused.
VCCD	Input, Regulated DC Power: Typically 3.3VDC, +/-10%. Minimum = 2.7 VDC. Although the FPI Pen Input System can operate on DC voltages up to 5.5 VDC, it is not recommended to use a DC input voltage above 3.6 VDC, in order to ensure good margins regarding these capacitors.
DGND	Input, Power / Signal Ground: Direct or "quiet" connection to system ground in preferred.
RC1	PSC Processor Control Pin
RB6	PSC Processor Control Pin
RB7	PSC Processor Control Pin
PGM / MCLR	PSC Processor Control Pin

3.2.7 PSC to Host Interface: Output Data Format

Each x, y coordinate pair is transferred as a default 5-byte data packet (can be downloaded to an 8-byte packet, but final three bytes are all 0). The PSC default mode will send data only when the pen is in proximity (with Px bit =1). The standard Data Format is described below.

FPI Standard Pen-Based System Format, 1016 PPI (40 PPMM)
(19,200 Baud, 8 Data Bits, No parity, 1 stop bit)

BYTE	B7	B6	B5	B4	B3	B2	B1	B0
1 (Status)	1	Pc	Px	0	Ts	0	S2	S1
2 (Xdata)	0	X6	X5	X4	X3	X2	X1	X0
3 (Xdata)	0	X13	X12	X11	X10	X9	X8	X7
4 (Ydata)	0	Y6	Y5	Y4	Y3	Y2	Y1	Y0
5 (Ydata)	0	Y13	Y12	Y11	Y10	Y9	Y8	Y7
6 (Optional)	0	0	0	0	0	0	0	0
7 (Optional)	0	0	0	0	0	0	0	0
8 (Optional)	0	0	0	0	0	0	0	0

Notes:

Byte 1	Status as follows:
B7 (1): Always 1	1= Packet Sync Bit
B6 (Pc): Switch Status Change (typically unused by host)	1= Changing 0= No change in switch status
B5 (Px): Proximity	1= In Proximity 0= Out Of Proximity
B4 (0): Always 0	(Unused at this time)
B3 (Ts): Test Data	1= "Test" data 0= Normal position data
B2 (0): Reserved	Typically 0, but reserved for a third pen switch.
B1 (S2): Sw2 Status (if used)	1= Side Switch Enabled 0= Side Switch Disabled
B0 (S1): Pen Tip Status	1= Pen tip (Sw1) Down / Enabled 0= Pen tip UP (disabled)
Byte 2 & 3	14 bit X position data @ 1016 PPI (40 PPMM)
Byte 4 & 5	14 bit Y position data @ 1016 PPI (40 PPMM)
Byte 6,7,8 (optional) Not normally sent.	If the eight-byte format is enabled ('B' command), these three bytes are sent as all 0's. (Default is the 5-byte format, so bytes 6,7, & 8 are not normally sent)

3.2.8 Digitizer Origin and Maximum Coordinates

The default "origin" of the digitizer assembly (where X=0 and Y=0) is the lower-left corner of the LCD. This assumes the LCD is operating in "landscape" mode. In this configuration, the 'X' coordinates increase as the pen moves from left to right, and the 'Y' coordinates increase as the pen moves from bottom to top.

The default configuration supplies the output points at 1016 PPI (40 PPMM). X coordinates range from 0 to 8980, while the Y coordinates range from 0 to 6700.

3.2.9 Interface: PSC Download Commands

The Pen System is capable of receiving download commands. These commands allow for power management, subsystem and system test, and for control of features. The PSC Download Commands are listed in detail in the Appendix.

3.3 Environmental Specification

3.3.1 Temperature and Humidity

Sensor Grid Assembly and PSC Daughtercard

Operating Conditions	-5°C to +60°C
Guaranteed Accuracy	+20°C ± 20°C
Storage Range	-20°C to +80°C
Relative Humidity	5% to 95% (w/o condensation)

3.3.2 Drop/Shock

Shall meet the overall unit/system requirements.

3.3.3 ESD

12000 Volts, Pulsed

3.3.4 Altitude

Operating	10,000 feet (3048 m)
Non-Operating	40,000 feet (12,192 m)

4.0 PEN SYSTEM PERFORMANCE SPECIFICATION

4.1 System Performance

4.1.1 Resolution

The output resolution of the position reports shall be set to 1016 points per inch (PPI), or 40 points per millimeter (PPMM).

4.1.2 Accuracy

The Absolute Accuracy of the Pen System with the Pen in the vertical position shall be ± 0.01 inch (0.25 mm) maximum to within 0.50 inches (12.7 mm) of active area edge. Accuracy at the edge of the active area is somewhat reduced due to the compressed edges and metal bezel of the LCD.

The pen input subsystem is optimized for accuracy when using the Toshiba LTM10C321K LCD, and assuming a writing surface height of approximately 1.5mm above the LCD glass. (The final Pen Based Computer System is assumed to have an additional glass or Plexiglas surface above the LCD surface, since writing directly on the LCD can distort or damage it). However, additional metal bezels or EMI coatings applied around the top surface of the LCD in the final system will affect the digitizer accuracy performance. In these cases, optimum accuracy is achieved after FPI corrects for system effects in a representative production unit. This optimization must be implemented in the FPI PSC firmware code.

4.1.3 Dynamic (Traverse) Error (Relative to Static)

Error at 19.7 inches / sec (500 mm /sec)	± 0.022 inch (0.56 mm)

4.1.4 Output Data Rate (Conversion Rate)

The maximum Output Data Conversion Rate shall be set to output 133.3 conversion pairs per second (CPS). A conversion rate of 100 CPS, and output rates at one half to one ninth the maximum (in integer divisions) is available with download commands (see the appendix).

4.1.5 Pen Slew Rate

The Input Pen Slew Rate shall be at least 50 inches (1270 mm) per second.

4.1.6 Proximity

The Pen Proximity shall be at least 0.500 inches (12.70 mm) above the top surface, at the center of the tablet's active area.

4.1.7 Jitter and Noise Performance

The Jitter and Noise Instability shall be ± 0.002 inch (0.051 mm) RMS maximum with filtering and nominal background noise. It may increase somewhat at the edges.

4.1.8 Bandwidth

Input Filter Bandwidth	≤ 10 Hz, 3DB

4.2 Diagnostics

Download Test commands are included in the appendix. These commands can be used to evaluate the pen input subsystem with and without a pen. FPI engineering can assist with generation of diagnostic test sequences using the existing download command set.

5.0 MISCELLANEOUS REQUIREMENTS

5.1 Integration Requirements

5.1.1 Sensor Grid Assembly Cleaning Instructions

When cleaning the Sensor Grid Assembly, aqueous cleaning solutions shall not be used if they are allowed to degrade the conductive adhesive contact between the EM shield to PCB ground plane via copper tape. It is not a requirement that the Sensor Grid Assembly have shiny surfaces (i.e. finger prints are acceptable), therefore excessive cleaning steps are not recommended.

5.1.2 Attachment of Digitizer to Toshiba LCD

The mounting screws that attach the LCD Timing/Control Board to the back of the LCD panel must be loosened slightly to provide for a complete insertion of the FPI Digitzer Assembly into the pocket area behind the Timing/Control Board. The Digitizer Assembly must be inserted until it touches the mechanical stop located behind the Timing/Control Board. The mounting screws may be re-tightened after the Digitizer Assembly has been installed properly.

5.1.3 System Updates

FPI engineering must approve system updates if the updates impact the performance of the Pen Input Subsystem. Updates that impact Pen Input Subsystem performance include, but are not limited to, LCD update or change, housing material change, changes or additions to shielding in the housing, significant changes to the writing surface height, incorporation of significant noise sources into the system design. All updates must be evaluated by FPI prior to incorporation to determine whether the Pen Input Subsystem may operate in the new environment and/or whether a design update is required for the FPI subsystem. If deemed necessary, the FPI evaluation may require the delivery of a prototype unit with the proposed updates from the customer to FPI engineering.

5.2 Shipping Requirements

FPI shall mark the component PCB assemblies (sensor grids) with a label (or labels) that includes the FPI part number, the date code and customer required information, packaged individually in electrostatically shielded bags. The component assemblies shall be placed in individual or bulk containers and the master or shipping container marked with the required information on the exterior of such containers, in the format specified by the customer.

APPENDIX: PSC Download Command Definitions

These are the commands supported by the Pen System controller subsystem. They may be accessed by communicating directly to the Pen System microcontroller. Additional information about the Download Commands may be obtained from the FPI Engineering Department.

CTRL-Q (11H)	=	XON: Handshake - Send Position Data (default)
CTRL-S (13H)	=	XOFF: Handshake - Stop Sending Position Data, but continue to respond to commands
0	=	Set Conversion & Output Rate to 100 CPS
1	=	Set Conversion & Output Rate to Maximum: 133.3 CPS (default)
2 through 9	=	Set Conversion Rate to Maximum (133.3 CPS), but divide the output rate as selected (2=Max/2, 3=Max/3, etc.)
@	=	Software RESET
A	=	ACK (Enable position data output after receiving an XOFF or any command that disables it)
B	=	Enable 8-Byte Packet (Pad Last 3 Bytes with '0's: See section 3.2.7)
Cn	=	Factory tests: n = 0 to 4 (Not used by the OEM, listed for reference only)
D	=	Factory test, DO NOT USE!
F	=	Send MAX Line #, DATA, and FREQUENCY Information (disables position output data)
G	=	Send REF and all X and Y Line Data (disables position output data)
J	=	Send X and Y Tablet Extents (Maximum position coordinates)
K	=	Send Status: Date Code, Type, and Rev. Information (disables position output data)
L	=	Enable 5-Byte (standard) Data Packet (Default configuration: See section 3.2.7)
M	=	(Same as ‘G’ command)
N	=	Send Unaveraged Data (disables digital filter: resume digital filter with 'V' command)
O	=	Send Position Data only when In Proximity (Default)
P	=	Send “Last” Position Data when Out-of-Proximity (with Proximity Bit = 0)
R	=	If 'P' Previously received, stop sending Out-of-Proximity data until next time In-Prox
S	=	Stop/Sleep
T	=	Send Reference and “Open” line TEST Data (disables position output data)
V	=	Send Filtered/Averaged Data (Default Condition)
W	=	Standby / Wakeup Mode (Low Power: Pen Down in Active Area returns to full ON)
/An	=	Output and/or adjust the AGC setting; where n = 'R', 'L00' to 'L88'
/En	=	Output X & Y MAX line data and/or Frequency Count in place of X & Y position data, where n = ’0’ to ‘3’

DETAILED DESCRIPTION OF PSC DOWNLOAD COMMANDS:

General note regarding all returned TEST data: Any requested Test or Status information is always sent using one or more of the 5 (or 8) byte packet(s) as defined in section 3.2.7. However, the 14 bit X & Y "position" information are re-assigned to represent TEST mode data (one specific 14 bit TEST data information returned in place of the X position, and another one for Y). Some or all of the "Status" bits may also be re-assigned to indicate other TEST information. The "synchronization" bit (Bit7 of the first byte of each packet) is always SET, but the below definitions for TEST data does not include this. For example, when STATUS (Byte 1) is listed as '8' for the Test Command example, the actual first byte of the data packet is binary 10001000. TEST data referred to as sent in bytes 2&3 (X position for normal packets) and 4&5 (Y position for normal packets) should be decoded the same as the position data (concatenate the two bytes to make one 14 bit word from each of the two byte register pairs). The resulting 14 bit data for each is the returned "count", "amplitude" data, or other status information as described below.

ACKNOWLEDGE Command (ASCII A)

The ACKNOWLEDGE command enables position data output data after receiving any test mode command that disables position output data, or after an XOFF. The resulting output will be standard X and Y data in the previously selected format.

STOP Command (ASCII S)

If a STOP command (ASCII S) is received, the unit will turn the analog electronics OFF (no output) and execute a STOP instruction that stops the clock oscillator to reduce power consumption to an absolute minimum. The unit will not respond to a pen signal or any commands while in STOP mode. The only way to exit this mode is by the reassertion of the HARDWARE RESET (Power-On Reset).

WAKEUP Command (ASCII W)

The WAKE UP command (ASCII W) is used to place the PSC into a "lower" power Standby mode. If a WAKE UP command is received, the unit will turn the analog electronics OFF, raise the DWAKEUP signal line (set HIGH), go into STANDBY (low-power) mode, and set an internal counter for sample timing which allows the unit to wake up approximately every 100 milliseconds to scan for a pen signal. If no pen signal is detected, the unit returns to a low power mode.

Upon finding a pen signal, the unit will return to its previous full power operating mode, and activate (logic LOW) the DWAKEUP line to the host system. This may be used as an interrupt to wake-up the entire system from a low power / standby mode when the pen returns to proximity.

SEND NON-AVERAGED DATA Command (ASCII N)

If a SEND NON-AVERAGED DATA command (ASCII N) is received, NO digital filtering is applied to the position data prior to output.

SEND AVERAGED DATA Command (ASCII V)

If a SEND AVERAGED DATA command (ASCII V) is received, the position data is digitally filtered prior to output. (Default configuration)

TEST Command (ASCII T)

The TEST command can be performed any time after initialization. If a TEST command (ASCII T) is received, the unit will output the data from the reference line, and test (open) line. The two output data packets (same as first two in the PEN/GRID Test) are as follows:

BYTE 1	BYTES 2 & 3	BYTES 4 & 5
Status = 8	0	Ref Line Amplitude
Status = 8	1	Open Line Amplitude

After transmitting the test data, no further data is sent until another command is received.

PEN/GRID TEST Commands (ASCII G, ASCII M)

If a PEN/GRID TEST command (ASCII G, ASCII M) is received, the unit reads the level for each grid loop (grid line) and transmits the resulting signal level. The PSC will scan all the grid lines and test lines (Refer to the TEST Command). Multiple data packets (58) will then be output, each one containing the following TEST data for each line:

BYTE 1	BYTES 2 & 3	BYTES 4 & 5
Staus	Line Number	Amplitude

where;

Status:	'8' for the test lines (first 2 packets); see ASCII T
Line Number:	'0' & '1' for the first two packets (REF & TEST)
Status:	'9' for X Grid Loops (next 32 packets)
Line Number:	'0' to '31' (X grid line number)
Status:	'10' for Y Grid Loops (final 24 packets)
Line Number:	'0' to '23' (Y grid line number)
Amplitude:	Measured Line Signal Amplitude in ADC Counts. Measured values vary with signal, but are between 0 & 769

After transmitting the test data, no further data is sent until another command is received.

OUTPUT AMPLITUDE DATA and/or FREQUENCY COUNT command (ASCII /En)

This set of commands allow for different data to be sent in place of the standard X & Y "position" data. When enabled, the output data is sent with the same timing as the "Normal" data (typically only when the pen is within proximity), but modifies the data content of each packet sent. Depending on the command parameter ('0' to '3'), the X and/or Y position data is replaced with the amplitude data of the grid line that has the maximum signal (in A/D counts ranging from 0 to 769), or a count that represents the measured frequency from the pen (1 count = 2.4 kHz). This mode remains active until another command is sent to modify the action:

Commands	BYTE 1	BYTES 2 & 3	BYTES 4 & 5
/E0 (Default)	Status	X Position	Y Position
/E1	Status	X Position	Frequency Count
/E2	Status	Max. X Amplitude	Max. Y Amplitude
/E3	Status	Max. X Amplitude	Frequency Count

PEN FREQUENCY TEST Command (ASCII F)

If a PEN FREQUENCY TEST command (ASCII F) is received, the unit reads the received pen frequency based on the X grid loop with the largest reported signal level. The Pen Frequency is read during a 10 mS "window" time. One data packet is output as follows:

BYTE 1	BYTES 2 & 3	BYTES 4 & 5
Max Line #	Data	Frequency

Where:

Max Line #: X Grid Loop with Maximum Reported Signal Level (0 to 31)
{NOTE: If pen is out of proximity, then this is the number of the "maximum" line, but with Bit 6 SET}

Data: Signal Level: A/D Count of Maximum Line; 0 to 769

Frequency: Measured Frequency (x100 Hz);
e.g. 4831 corresponds to 483.1 kHz

After transmitting the test data, no further data is sent until another command is received.

SEND STATUS Command (ASCII K)

If a SEND STATUS command (ASCII K) is received, the unit will output the status information in three packets as follows:

BYTE 1	BYTES 2 & 3	BYTES 4 & 5
Status = 8	MMDD	YYYY
Status = 8	ID Number	Revision
Status = 15	Correction Rev #	Unassigned

Where;

Status: '8' for all except Last STATUS Packets
'15' for the Last STATUS Packet

MMDD: Month and Day (e.g. 513 = May 13, 103 = Jan 3, 1003 = Oct 3)

YYYY: Year (e.g. 2001)

ID Number: Product or Customer ID Number
Assigned by FPI

Revision: Internal Firmware Revision Number
Assigned by FPI

Correction Rev #: Internal Firmware Number for Correction Revision
Assigned by FPI

Unassigned: Unused (0)

After transmitting the test data, no further data is sent until another command is received.

SELECT / SEND AGC LEVELS Command (ASCII /An)

If a SELECT / SEND AGC LEVELS command (ASCII /An) is received, the unit will respond in the following manner:

Three bits of gain control are used to provide eight gain settings. These AGC levels, referred to as AGC levels 7 through 0, are automatically adjusted by the Pen System Controller Processor during normal operation to assure optimum signal levels are received by the Pen Signal Receiver (PSR). The maximum AGC (Gain) level is a 7, while the minimum gain level is 0.

In order to test for absolute amplitude data from any or all grid lines, the AGC level must be known, or fixed to some known level. This command allows for both. Note that any AGC status is sent as one data packet in the data format defined in section 3.2.7.

/AL*xy* = Load X & Y AGC level: Fix or force them to some known value, or allow the firmware to automatically select them (default=auto select).
{Does not output data or change the data output mode.}

where,

x = X AGC level, ASCII ‘0’ to ‘8’
y = Y AGC level, ASCII ‘0’ to ‘8’
Note: ASCII '0' to '8' selects the following for X & Y:
0 - 7 = select fixed AGC level 0 to 7, respectively
8 = enables "automatic" level selection (default)

/AR = Read the current X & Y AGC levels.

Responds with one data packet, with the bytes configured as follows:

Status byte: 8 = X & Y AGC levels are automatically selected
9 = X AGC level is fixed, Y AGC is automatically selected
10 = X AGC level is automatically selected, Y AGC is fixed
11 = X & Y AGC levels are fixed

X Data: Current X AGC Level (7 to 0)
Y Data: Current Y AGC Level (7 to 0)

After transmitting the above data, no further data is sent until another command is received.

SEND TABLET EXTENTS (ASCII J)

If a SEND TABLET EXTENTS command is received, the unit will send the largest X and Y coordinates which can be output for this firmware and grid. This defines the dimensions of the active area in counts for the default (1016 lpi) output resolution. The format of the response is as follows:

BYTE 1	BYTES 2 & 3	BYTES 4 & 5
Status = 15	X Extent	Y Extent