

***MM II 1201  
Graphics Tablet  
Technical Reference  
Publication 84-5000-001  
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## About This Book

This book provides the information you need to install, operate, and care for the MM® II 1201 graphics tablet. It describes the standard product configuration.

If you're new to graphics tablets or to the MM II, read through the entire book. Many aspects of this product are interrelated and interdependent. An overall understanding of it, before you start, is very helpful.

# Chapter 1

## What is the MM II and How Does It Work?

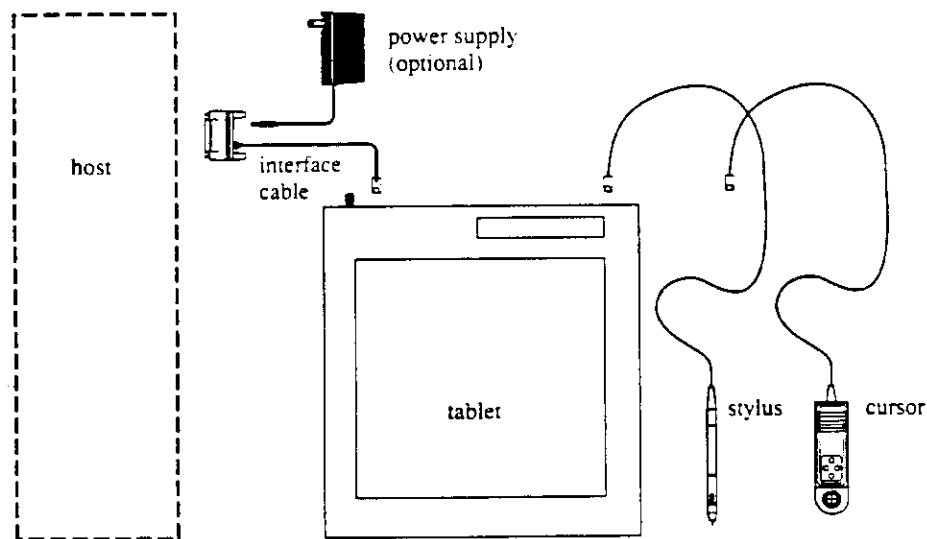
### Section A - What is the MM II?

The MM II is a graphics tablet. A graphics tablet is an input device that translates graphic information into digital information, suitable for computer manipulation. Its many uses include:

- steering a computer screen pointer
- picking locations on menus
- drawing and tracing

The components required for a functional MM II are:

- the tablet
- a stylus or cursor
- an interface cable
- a power source



The tablet is like a drawing board. The stylus and cursor are hand-held devices that you use for pointing or drawing on the tablet. The interface cable links the tablet to the host (computer). The power source can be either the host or a power supply.

## Section B - How the MM II Works

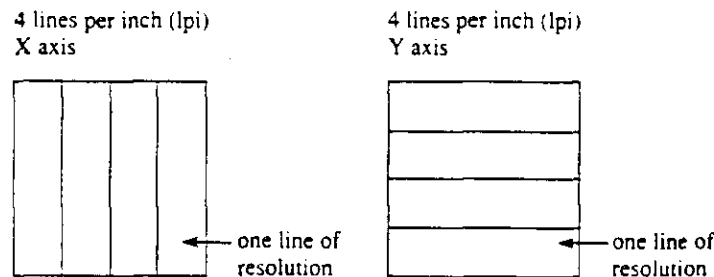
The MM II translates the stylus/cursor position on the tablet into digital information and communicates that information to the host. The stylus/cursor position is expressed as an X,Y coordinate pair. One coordinate pair is a report.

Valid reports can be collected only when the stylus/cursor is in the tablet's active area and in proximity:

- The **active area** is an 11.7-inch square area within the groove on the tablet surface.
- **Proximity** is the maximum distance above the active area that the stylus/cursor can be held and report a valid position. The proximity is approximately 1/2-inch. This means that the stylus/cursor and tablet need not be in direct contact with each other to issue reports. You can have up to a 1/2-inch of material (drawings, photos, etc.) between the tablet and stylus/cursor, and it will still issue reports.

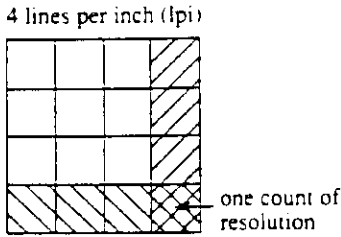
The active area and proximity, in effect, establish a three-dimensional volume within which the stylus/cursor can issue valid reports. Reports issued from outside this volume are **out-of-prox** and, therefore, do not represent the current position of the stylus/cursor.

Reports are measured in counts of resolution. Resolution is the "fineness" of detail that the tablet can distinguish. Resolution is expressed in lines per inch (lpi) or lines per millimeter (lpmm). This terminology is slightly misleading, however. Resolution should be expressed in "bands per ..." or "lanes per ..." because these "lines" have perceivable width at lower resolution settings.

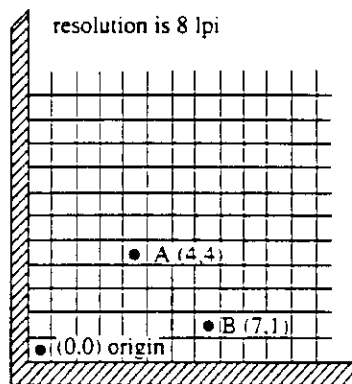
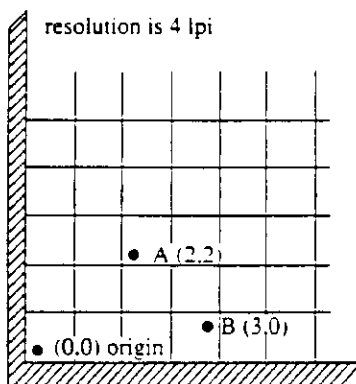


The higher the resolution, e.g. 100 lpi or 200 lpi, the narrower the bands of resolution become. Eventually, the bands become so narrow that they are easier to conceptualize as "lines" of no measurable width.

As previously stated, reports are measured in counts of resolution. As shown below, each square is one count of resolution. The tablet reports the same coordinates for any point within the square.



With different resolution settings, you can get different reports for the same tablet location. In the illustration below, points A and B are the same physical locations on the tablet, but their coordinates are different because of the resolution setting.



points	absolute coordinates	relative coordinates
A	(2,2)	
B	(3,0)	(1,-2)

points	absolute coordinates	relative coordinates
A	(4,4)	
B	(7,1)	(3,-3)

Reports are in absolute or relative coordinates. **Absolute coordinates** are coordinates measured from the the tablet's origin (0,0). **Relative coordinates** are measured "relative to" the last report location. In the illustration above, point B is issued after point A. Therefore, in relative coordinates, point B is measured relative to point A.

The tablet defaults to absolute coordinates. However, you can change to relative coordinates with the Relative Coordinates command, described in Chapter 4.

## Section C - Commands: Controlling the Tablet's Operation

You can control the MM II's operating characteristics, functions, and diagnostics with commands from the host. These are described in Chapter 4, "Operating Characteristics and Functions", and Chapter 7, "Checking the Graphics Tablet". A summary of the commands appears in Appendix D.

This book represents the commands in ASCII. For your convenience, an ASCII conversion chart appears in Appendix C.

The tablet accepts commands from the host at any rate, except as follows:

- After you turn on the tablet or issue the Reset command, wait approximately ten milliseconds before sending commands.
- Commands that require a tablet response: If you send a command to the tablet that requires a response, the tablet does so within two milliseconds. Wait until the host receives the entire response before issuing another command to the tablet.

## Section D - Changing the Tablet Set-Up

The tablet is already set up to operate with a certain:

- baud rate: 9600 or Autobaud
- report format: binary or ASCII BCD
- parity: odd parity or no parity

The standard set-up is 9600 baud, binary report format, and odd parity. Your unit may be different. (Chapter 3 explains each of these.)

You can change the set-up by altering the hardware or with commands from the host. Appendix B tells you how to change the hardware. Chapter 4 describes the commands. Read these passages, then choose the method most appropriate for your situation. Note that the tablet defaults to the hardware set-up each time you turn on the tablet or send the Reset command.

## Chapter 2

### Assembly and Installation

The standard configuration includes the items listed below. Yours may be different.

- a tablet
- a stylus or cursor
- an interface cable
- a power supply (optional)
- document clips
- an *MM II 1201 Graphics Tablet Technical Reference*

In brief, to assemble and install your MM II:

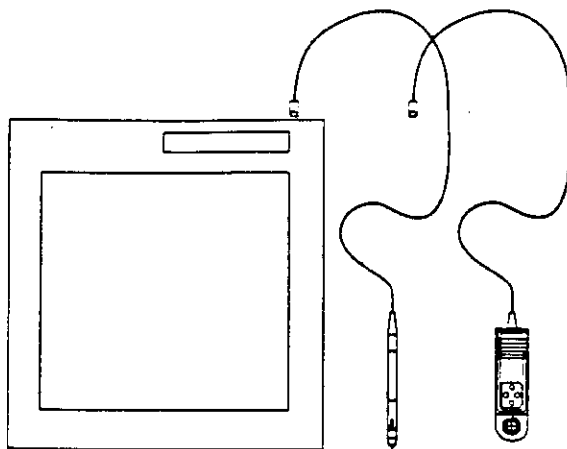
1. Connect the stylus or cursor to the tablet.
2. Connect the tablet to the host and power source.
3. Turn the tablet on.
4. Attach the document clips. (optional)

Detailed instructions follow.

*Note: Always have the computer and tablet power off when you attach or detach any part of the MM II. If the power is on, nothing serious happens to the MM II, but it might corrupt the file you are working with or cause the computer to act strangely. (This is true for any computer peripheral.)*

## 1. Connect the stylus or cursor to the tablet

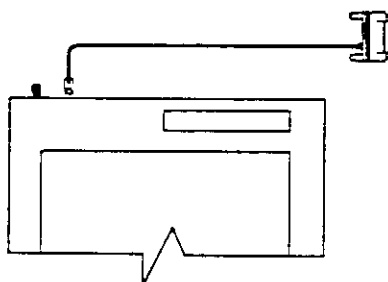
Plug the stylus or cursor into the modular socket on the top right edge of the tablet.



The cursor and stylus are interchangeable.

## 2. Connect the tablet to the host and power source

Plug the interface cable modular connector into the socket at the top left edge of the tablet.

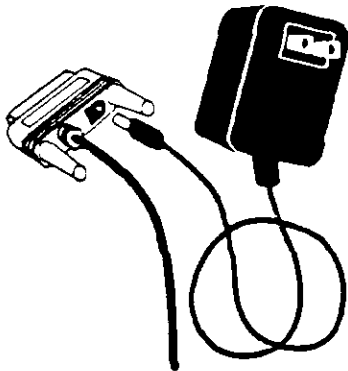


Next, plug the interface cable 25-pin D connector into the host communications port.

The tablet can obtain power from the computer or from the MM II power supply. *Caution: Never power the tablet from both simultaneously. Pin 9 and the power supply socket are connected inside the 25-pin D connector. Therefore, power applied to one, also exists on the other. Ensure that nothing is attached to the source not in use.*

- Power from the host: The host must supply +12 VDC at 250 mA, less than 50 mV ripple, +/- 10% regulation, and a rise time less than 100 milliseconds. Once you connect the tablet to the computer, the installation is complete.

- Power from the MM II power supply: Plug the power supply barrel connector into the interface cable D connector.

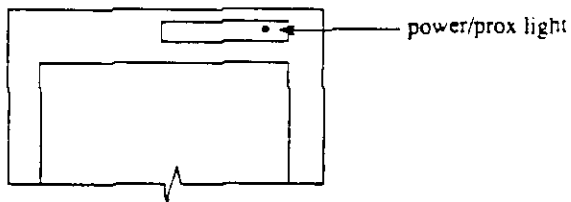


Next, plug the power supply into a standard electrical outlet. *Use only an MM II power supply. Substituting a different power supply could permanently damage the tablet.*

### 3. Turn the tablet on

To turn the tablet on, press the on/off switch. (Pressing it again, turns the tablet off.)

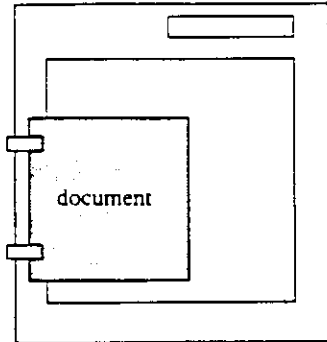
on/off switch



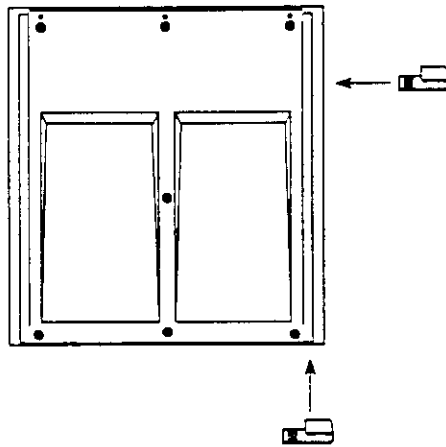
The power/prox light serves two purposes. First, it lets you know that the tablet is on and receiving power. Second, it is a proximity indicator. The light remains lit when the stylus/cursor is in-prox. It blinks when the stylus/cursor is out-of-prox. If the light blinks when the stylus/cursor is in-prox, one of two problems exists. Either, the stylus/cursor is not connected to the tablet, or it is malfunctioning. (Service information appears in Chapter 8.)

#### 4. Attach the document clips (optional)

The MM II comes with document clips. These are to steady documents on the tablet.



The clips attach to rails on the tablet underside. To attach them, you can push them straight on or slide them up from the bottom.



Position the clips where they are comfortably out of your way. To remove the clips, slide them to the bottom of the tablet.

## Chapter 3 Interfacing with the Host

For successful communication between the MM II and its host, they must have the same hardware interface, baud rate, communications protocol, and report format.

### Section A - Hardware Interface

The hardware interface consists of one cable terminated with a 25-pin male D connector. (If the computer requires a different connector, contact your Summagraphics representative for information about adapters.)

The interface accommodates RS-232-C and TTL. (Do not use both at the same time.)

#### *RS-232-C/TTL Interface - 25-Pin D Connector Pin Assignments*

Pin	Wire Name	Description
1	GND	protective, frame ground
2	TXD	transmits data to host (RS-232-C only)
3	RXD	receives data from host (RS-232-C or TTL)
7	signal ground	return for data
9	+12 VDC	power to tablet from host
11	TXD	transmits data to host (TTL only)

Pin 9 is for powering the tablet from the host. The host must supply +12 VDC at 250 mA, less than 50 mV ripple, +/-10% regulation, and a rise time less than 100 milliseconds.

#### *Caution:*

*a) Never power the tablet from the power supply and host simultaneously.*

*b) Pin 9 and the power supply socket are connected inside the 25-pin D connector. Therefore, power applied to one, also exists on the other. Ensure that nothing is attached to the source not in use.*

## RS-232-C Interface

The RS-232-C lines are configured as DTE (Data Terminal Equipment). The signal levels comply with standard signal levels for data transmission:

### *RS-232-C Signal Levels\**

RS-232-C Interface	Interchange Voltage	
	-3V to -12V	+3V to +12V
Binary states	1	0
Signal condition	Mark	Space

\*The source is the *EIA Standard RS-232-C: Interface Between Data Terminal Equipment and Data Communication Equipment Employing Serial Binary Data Interchange*, by the Engineering Department of the Electronic Industries Association (Washington, D.C.: EIA, 1969).

## TTL Interface

The computer port must provide full duplex, asynchronous, serial communications. The signal levels for data transmission are:

### *TTL Signal Levels*

TTL Interface	Interchange Voltage	
	0V to +0.8V	+2.4V to +5V
Binary states	1	0
Signal condition	Mark	Space

## Section B - Baud Rate

The MM II is available with 9600 baud or Autobaud. The standard setting is 9600 baud. (To change the setting, refer to "Changing the Tablet Set-Up", Chapter 1.)

**Autobaud** automatically matches the tablet baud rate to the host baud rate. The tablet supports 75 to 19,200 baud. After turning on the tablet, the first character it must receive from the host is an ASCII space, <SP>. The tablet uses this to identify the host baud rate and to set its own accordingly.

## Section C - Communication Protocol

The MM II communication protocol is:

- number of start bits: 1
- number of data bits: 8
- number of stop bits: 1
- parity: odd or none. (The standard product has odd parity.) To change the parity setting, refer to "Changing the Tablet Set-Up", Chapter 1.

## Section D - Report Formats

Your MM II is set up to use one of the following report formats:

- binary
- ASCII BCD

To change the format, refer to "Changing the Tablet Set-Up", Chapter 1.

The reports are in counts of resolution, not in inches or millimeters. (Counts of resolution is described in Chapter 1.)

## Binary Report Format

### *Binary Format for Absolute Coordinates*

MSB	6	5	4	3	2	1	LSB	Transmission Sequence
7							0	
PH	PR	T	Sx	Sy	Fc	Fb	Fa	1st byte
0	X6	X5	X4	X3	X2	X1	X0	2nd byte
0	X13	X12	X11	X10	X9	X8	X7	3rd byte
0	Y6	Y5	Y4	Y3	Y2	Y1	Y0	4th byte
0	Y13	Y12	Y11	Y10	Y9	Y8	Y7	5th byte

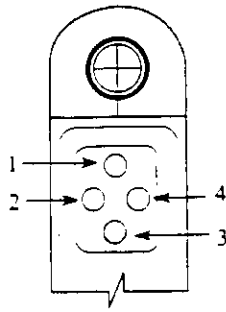
### *Binary Format for Relative Coordinates*

MSB	6	5	4	3	2	1	LSB	Transmission Sequence
7							0	
PH	PR	T	Sx	Sy	Fc	Fb	Fa	1st byte
0	X6	X5	X4	X3	X2	X1	X0	2nd byte
0	Y6	Y5	Y4	Y3	Y2	Y1	Y0	3rd byte

#### Key:

- LSB is the least significant bit. MSB is the most significant bit.
- Fa, Fb, and Fc are the flag bits. They identify the status of the stylus and cursor buttons:

Stylus Buttons	Cursor Buttons	Fc	Fb	Fa
none pressed	none pressed	0	0	0
tip button pressed	1 pressed	0	0	1
barrel button pressed	2 pressed	0	1	0
tip and barrel pressed	3 pressed	0	1	1
	4 pressed	1	0	0
	1+2	0	1	1
	1+3	1	0	0
	1+4	1	0	1
	2+3	1	0	1
	2+4	1	1	0
	1+2+3	1	1	0
	1+2+4	1	1	1
	2+3+4	1	1	1
	1+2+3+4	1	1	1



- $S_x$  and  $S_y$  are the X and Y coordinate signs. 1 is positive. 0 is negative. In absolute coordinates, the sign is always positive. In relative coordinates, the sign can be positive or negative.
- T is the Tablet Identifier. Your choice of 1 or 0. Command controlled.
- PR is the proximity bit. 0 is in-prox. 1 is out-of-prox.
- PH is the phasing bit, which is always 1.
- $X_0, X_1, \text{etc.}$  and  $Y_0, Y_1, \text{etc.}$  are the X and Y coordinate bits.

## ASCII BCD Report Format

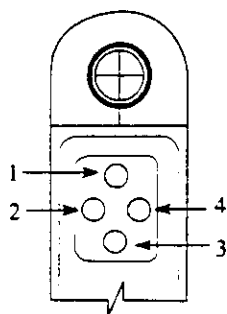
The ASCII BCD format depends on the coordinate system and resolution:

Resolution	Absolute Coordinates	Relative Coordinates
1 to 508 lpi (20 lpmm)	XXXX.YYYY,F<CR><LF>	S0XXX,S0YYY,F<CR><LF>
1000 lpi or 40 lpmm	XXXXX.YYYYY,F<CR><LF>	S00XXX,S00YYY,F<CR><LF>

Key:

- X is an X coordinate digit, where each digit is an ASCII character from 0 to 9
- , is an ASCII comma
- Y is a Y coordinate digit, where each digit is an ASCII character from 0 to 9
- F is the stylus and cursor flag character, identifying the button status:

Stylus Buttons	Cursor Buttons	F
none pressed	none pressed	0
tip button pressed	1 pressed	1
barrel button pressed	2 pressed	2
tip and barrel pressed	3 pressed	3
	4 pressed	4
	1+2	3
	1+3	4
	1+4	5
	2+3	5
	2+4	6
	1+2+3	6
	1+2+4	7
	2+3+4	7
	1+2+3+4	7



- <CR> is an ASCII carriage return character.
- <LF> is an ASCII line feed character.

## Chapter 4 Operating Characteristics and Functions

The MM II has a variety of operating characteristics and functions that you can control with commands from the host. For example, you can define:

- report flow
- tablet resolution
- tablet origin location

The tablet accepts commands from the host at any rate, except in a few situations. These are listed in Chapter 1, Section C, "Commands: Controlling the Tablet's Operation".

So that the MM II is operable upon arrival at your facility, it is set to predefined default settings. The unit defaults to these each time you turn on the tablet or issue the Reset command. A summary of the defaults appears in the Reset command section and in Appendix D.

### Section A - Controlling the Report Flow

The primary functions that control the report flow are Point, Remote Request, Stream, and Switch Stream modes. The secondary functions are Report Rate, Increment Mode and Axis Update. These are described below, but first, a few notes:

- Reports in binary have a proximity bit. (Refer the "Report Formats" section for bit definitions.)
- Each report has flag bits. These identify the stylus/cursor buttons that are activated when the report was issued. (Refer the "Report Formats" section for bit definitions.)

#### Point Mode

---

ASCII command: B

---

In Point Mode, the tablet issues one report when you press a stylus/cursor button. If the stylus/cursor is out-of-prox, the last valid report is issued for each button press.

## Remote Request Mode

---

ASCII mode command:	D
ASCII trigger command:	P

---

In Remote Request Mode, the tablet issues one report each time the host sends a trigger command. Issue the mode command once. Thereafter, send only a trigger command for each report. After you send the trigger command, the tablet issues the report within ten milliseconds.

You can issue reports with the trigger even if the MM is in Point, Stream, or Switch Stream mode. However, the reverse is not true: pressing a stylus/cursor button when the MM is in Remote Request Mode does not issue a report.

When the stylus/cursor is out-of-prox, the tablet issues the last valid report each time it receives a trigger.

## Stream Mode

---

ASCII command:	@
----------------	---

---

In Stream Mode, the tablet issues reports continuously, whether a stylus/cursor button is pressed or not. The Report Rate, described below, controls the number of reports issued per second.

If the stylus/cursor is out-of-prox and no buttons are pressed, the last valid report is transmitted three times. If a button is pressed, the last valid report is issued continuously.

## Switch Stream Mode

---

ASCII command:	A
----------------	---

---

In Switch Stream Mode, the tablet issues reports continuously while you press a stylus/cursor button. The Report Rate, described below, controls the number of reports issued per second.

If the stylus/cursor is out-of-prox and a button is pressed, the last valid report is issued continuously.

## Report Rate

	ASCII command
Report Rate equal to:	
maximum throughput	Q
maximum throughput + 2	R
maximum throughput + 8	S
maximum throughput + 32	T

The Report Rate function is an adjunct to Stream and Switch Stream modes. Use it to define the number of reports the tablet issues each second. Maximum throughput is the default.

### Maximum Report Throughput

Baud Rate	Binary Report Format Absolute Coordinates (reports per second)	Binary Report Format Relative Coordinates (reports per second)	ASCII BCD* Report Format (reports per second)
19,200	166	200	94
9600	116	157	55
4800	70	102	30
2400	39	60	16
1200	20	33	8
600	10.6	17	4
300	5.4	8.4	2
150	3.7	4.1	1

\*Approximate rates. Throughput can vary with coordinate system and resolution setting.

## Increment Mode

Command Sequence: <mode command><increment value>

	ASCII command
mode command	I
increment value	<SP> to 2

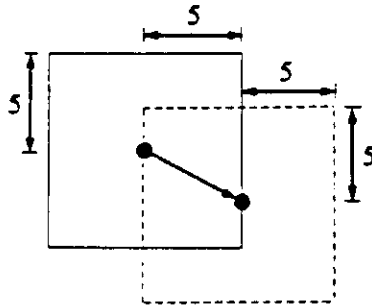
Increment Mode is an adjunct to Remote Request, Stream, and Switch Stream modes. It is useful for reducing redundant data output.

In Increment Mode, the tablet sends a report only when the stylus/cursor has traveled a minimum distance in the X or Y direction. This minimum distance is the increment. The increment applies to both axes and is measured in counts (of resolution). Its limits are 0 to 95 counts.

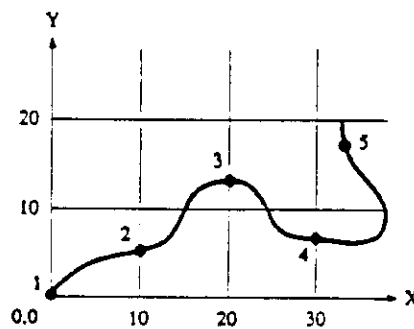
Note: When using Increment Mode, we recommend using a resolution setting of 50 lpi or higher.

### How Increment Mode Works

The last report issued becomes the center of an imaginary square. The square's sides measure twice the increment value. The stylus/cursor can move anywhere inside the imaginary square without the tablet issuing a report. When the stylus/cursor touches the square, the increment is met, and the tablet transmits a report. This point becomes the center of a new imaginary square. The process repeats. The following illustration shows the imaginary square created around a report point. The increment is five.



The following example shows the reports issued as the stylus/cursor travels across the tablet. The increment is ten. We have assumed that the first point collected is the origin (0,0).



The points issued are:

Point	Report	Description
1	(0,0)	First point collected in Increment Mode.
2	(10,5)	The increment is met along the X axis. The tablet reports the actual Y location.
No point is transmitted between points 2 and 3 because the stylus/cursor did not move ten counts in either the X or Y direction.		
3	(20,13)	The increment is met along the X axis. The tablet reports the actual Y location.
4	(30,7)	The increment is met along the X axis. The tablet reports the actual Y location.
5	(32,17)	The increment is met along the Y axis. The tablet reports the actual X location.

### How to Use Increment Mode

Send the mode command, then the increment value. The increment value is in counts (of resolution) and can be a decimal whole number from 0 to 95. (The default is zero.) Add 32

(decimal), a required offset, to the desired increment, then convert the sum into your preferred number base. For example, if the desired increment value is 10 (decimal),

$$\begin{array}{rcccc}
 \text{desired increment} & + & 32 & = & \text{increment value} & = & \text{increment value} & = & \text{increment value} \\
 & & & & \text{in decimal} & & \text{in hexadecimal} & & \text{in ASCII} \\
 10 & & + & 32 & = & 42_{\text{decimal}} & = & 2A_{\text{hexadecimal}} & = & * \text{ASCII}
 \end{array}$$

To disable Increment Mode, set the increment to zero with the ASCII space character, <SP>.

As we said above, the increment value is in counts. The length of a count can vary depending on the resolution and measurement system the tablet is using. Therefore, the increment length can vary:

Resolution	Measurement System	Increment Value (in Counts)	Length of One Count	Increment Length
50 lpi	U.S.	5	0.02 inches	0.1 inches
200 lpi	U.S.	5	0.005 inches	0.025 inches

### Checking the Increment

You can confirm the increment setting with the zi command. Refer to the section "Z Commands" later in this chapter.

### Combining Increment Mode with Other Modes

- **Point Mode and Increment Mode:** Invalid combination. Point Mode overrides Increment Mode.
- **Remote Request Mode and Increment Mode:** When the tablet receives a (Remote Request) trigger from the host, it issues a report. If the increment has not been met when the tablet receives this trigger, the tablet reissues the last report. If the increment has been met when the tablet receives this trigger, the tablet issues an updated report.
- **Stream Mode and Increment Mode:** The tablet issues a report when the increment is met. It can issue reports up to the established Report Rate. Also, when you press a stylus/cursor button, the tablet reissues the last valid report twice, once when the button is pressed, and again when it is released. (The difference between these reports is the button flag. The flag is set when the button is pressed. It is zero when the button is released.)
- **Switch Stream Mode and Increment Mode:** If the increment has not been met, the tablet issues one report when a button is pressed. If the increment has been met and a button is pressed, the tablet can issue reports up to the established Report Rate.

## Axis Update Mode

Command Sequence: <mode command><update value>

	ASCII command
mode command	G
update value	<SP> to z

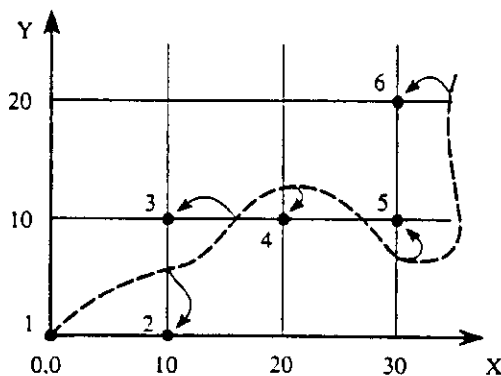
Axis Update Mode is an adjunct to Remote Request, Stream, and Switch Stream, and is particularly useful if you are using a grid on the tablet, and you want reports sent only at intersection points.

In Axis Update Mode, the unit sends a report only when the stylus/cursor has moved a certain distance in the X or Y direction. This distance is the update. The update applied to the X or Y axis is measured in counts (of resolution). Its limits are 0 to 95 counts.

Note: When using Axis Update Mode, we recommend using a resolution setting of 10 or higher.

### How Axis Update Mode Works

Every time the stylus/cursor returns to proximity, the tablet uses the first reportable point. From that reference point, an imaginary grid emanates with grid intervals equal to the update. Each time the stylus/cursor crosses a grid line, the tablet sends a report. Unlike Incremental Mode, when the update has been met for one axis, the tablet repeats the last report for the other axis. The following example shows the reports issued as the stylus/cursor travels across a grid. The update is ten. We have assumed that the initial reference point is the origin (0,0).



The points issued are:

Point	Report	Description
1	(0,0)	Reference point, the first point collected in Axis Update Mode.
2	(10,0)	X update was met. Y was not. Last Y value repeated.
3	(10,10)	Y update was met. X was not. Last X value repeated.
4	(20,10)	X update was met. Y was not. Last Y value repeated.
No point is issued between points 4 and 5 because the same report is not issued consecutively.		
5	(30,10)	X update was met. Y was not. Last Y value repeated.
6	(30,20)	Y update was met. X was not. Last X value repeated.

### How to Use Axis Update Mode

Before sending the mode command, place the stylus/cursor on the tablet at one of your desired grid intersection points. Send the mode command, then the update value. The update value is in counts (of resolution) and can be a decimal whole number from 0 to 95. (The default is zero.) Add 32 (decimal), a required offset, to the desired update value, then convert the sum into your preferred number base. For example, if the desired update value is 10 (decimal),

$$\begin{array}{r}
 \text{desired} \\
 \text{update}
 \end{array}
 + 32 = \begin{array}{r}
 \text{update value} \\
 \text{in decimal}
 \end{array} = \begin{array}{r}
 \text{update value} \\
 \text{in hexadecimal}
 \end{array} = \begin{array}{r}
 \text{update value} \\
 \text{in ASCII}
 \end{array}$$

$$10 + 32 = 42_{\text{decimal}} = 2A_{\text{hexadecimal}} = * \text{ASCII}$$

To disable Axis Update Mode, set the update to zero with the ASCII space character, <SP>.

As mentioned above, the update value is in counts. The length of a count can vary depending on the resolution and measurement system the tablet is using. Therefore, the update length can vary. For example:

Resolution	Measurement System	Update Value (in Counts)	Length of One Count	Update Length
50 lpi	U.S.	5	0.02 inches	0.1 inches
200 lpi	U.S.	5	0.005 inches	0.025 inches

### Combining Axis Update Mode with Other Modes

- Point Mode and Axis Update Mode: Invalid combination. Point Mode overrides Axis Update Mode.
- Remote Request Mode and Axis Update Mode: When the tablet receives a (Remote Request) trigger from the host, it issues a report. If the update has not been met when the tablet receives this trigger, the tablet reissues the last report. If the update has been met when the tablet receives this trigger, the tablet issues an updated report.

## Section B - Setting the Resolution

Resolution is the "fineness" of detail that the tablet can distinguish. Resolution is expressed in lines per inch (lpi) or lines per millimeter (lpm). (A detailed definition of resolution appears in Chapter 1.) Two resolution functions are available, Predefined Resolution and Definable Resolution.

Each time you turn on the tablet or issue the Reset command, the tablet defaults to a resolution of 500 lpi.

### Resolution, Predefined

	ASCII command
Resolution setting of:	
1 lpi	l (lowercase L)
2 lpi	n
4 lpi	p
100 lpi	d
200 lpi	e
10 lpm (254 lpi)	f
400 lpi	g
500 lpi	h
20 lpm (508 lpi)	i
1000 lpi	j
40 lpm (1016 lpi)	q

Use these commands to set the tablet to one of the predefined resolutions listed above.

X axis resolution, low byte	—	00 to FF
X axis resolution, high byte	—	00 to 17
Y axis resolution, low byte	—	00 to FF
Y axis resolution, high byte	—	00 to 17

The purpose of the Definable Resolution function is to let you match the tablet resolution to the resolution of another two-dimensional device, e.g. a computer screen. With Definable Resolution, you can:

- define the resolution of each tablet axis, independent of one another
- define the resolution to be any value from 1 to 508 lpi.

Here is how to use Definable Resolution:

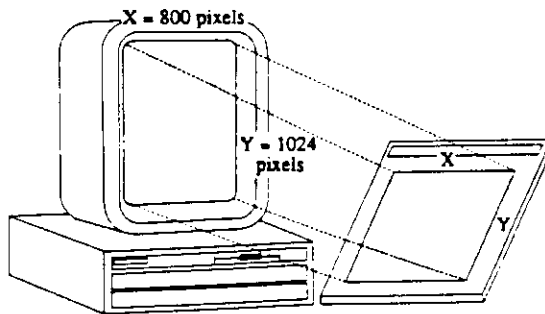
1. Determine the resolution that you desire for the entire length of the (tablet) axis:

- If the other device's resolution is expressed in "units per ...", such as 37 lines per inch, multiply that number by the tablet axis length. Example:

*other device's resolution x length of tablet axis = desired axis resolution*

*37 lpi x 11.7 inches = 432.9 = rounded to 433 ... is the desired axis resolution*

- The other device may have a resolution expressed as the overall axes values, such as 800 by 1024 pixels.



In this case, ensure that the length of the corresponding tablet axis divides evenly into the other device's resolution. If it doesn't, the tablet truncates the resolution value to a whole number.

Example: Matching the MM II to a vertical (portrait) screen with a resolution of 800 (X) by 1024 (Y) pixels:

*other device's resolution / tablet axis length*

800 pixels / 11.7 inches = 68.37 ... X axis

1024 pixels / 11.7 inches = 87.52 ... Y axis

The tablet would truncate these values to 68 and 87. Therefore, round them high to 69 and 88. (This ensures that the entire screen is addressable from the tablet.) Multiply the rounded values by the tablet axis length to derive the desired resolution for the overall axis.

69 x 11.7 inches = 807.3 = rounded to 808 ... is the desired X axis resolution

88 x 11.7 inches = 1029.6 = rounded to 1030 ... is the desired Y axis resolution

2. Convert the desired axis resolution to a hexadecimal number. Example:

808<sub>decimal</sub> = 328<sub>hexadecimal</sub>

1030<sub>decimal</sub> = 406<sub>hexadecimal</sub>

If the number is less than four digits, pack the left side with zeros. For example, 328 becomes 0328; 406 becomes 0406.

Separate the hexadecimal number into two two-digit parts, the most significant byte (high byte) and the least significant byte (low byte). Example:

0328 = 03<sub>high byte</sub> 28<sub>low byte</sub>

0406 = 04<sub>high byte</sub> 06<sub>low byte</sub>

3. Now, you are ready to send the Definable Resolution command sequence to the tablet. In our example of the 800 by 1024 portrait screen, the command sequence is:

<i>command</i>	<i>X low byte</i>	<i>X high byte</i>	<i>Y low byte</i>	<i>Y high byte</i>
72	28	03	06	04

Note: To change the resolution of only one axis, send zeros as the other axis's resolution.

4. To verify the new resolution settings, use the Send Configuration command.

## Section C - Other Functions

### Absolute and Relative Coordinates (Delta Mode)

	ASCII command
relative coordinates	E
absolute coordinates	F

These commands change the tablet's coordinate system. Absolute coordinates are measured from the tablet's origin (0,0). Relative coordinates are measured "relative to" the last report location. (Refer to Chapter 1 for details.)

The tablet defaults to absolute coordinates.

When you change to relative coordinates, the lower left corner of the tablet becomes the active area origin. Stylus/cursor movement up and to the right is positive. Movement down and to the left is negative. (You can change the origin location to the upper left corner with the Origin command. Stylus/cursor movement down and to the right is positive; up and to the left is negative.)

Also, when the tablet is using relative coordinates, reports issued out-of-prox are zero.

### Origin

	ASCII command
Origin location:	
upper left	b
lower left	c

Use the Origin command to define the location of the tablet's origin (0,0). It can be the lower or upper left corner of the active area. The default is the lower left.

When the origin is in the upper left corner, Y coordinates are positive, not negative. This departure from the standard Cartesian coordinate system is to aid in the compatibility between the MM II and terminals with a screen origin in the upper left corner.

## Reset (to Defaults)

ASCII command: <NUL>

The Reset command runs the Self Test diagnostic function and returns the MM II to the defaults:

- Axis Update: 0, Axis Update Mode off
- Coordinate system: absolute
- Increment: 0, Increment Mode off
- Origin: lower left corner
- Report Mode: Switch Stream
- Report Rate: maximum throughput
- Resolution: 500 lpi
- Tablet Identifier: 0

After the tablet receives the Reset command, there is a ten millisecond delay before it is ready to receive further data from the host.

## Send Configuration

ASCII command: a

Send Configuration sends a status report to the host. Among other things, it identifies the resolution of each axis. This is especially helpful for verifying a Definable Resolution setting. The report format is:

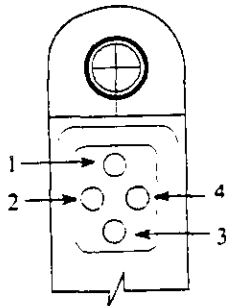
MSB							LSB	Transmission
7	6	5	4	3	2	1	0	Sequence
1	PR	T	1	1	Fc	Fb	Fa	Flag byte
0	b6	b5	b4	b3	b2	b1	b0	X low byte
0	b13	b12	b11	b10	b9	b8	b7	X high byte
0	b6	b5	b4	b3	b2	b1	b0	Y low byte
0	b13	b12	b11	b10	b9	b8	b7	Y high byte

Key:

- LSB is least significant bit. MSB is most significant bit.

- Fa, Fb, and Fc are the flag bits. They identify the status of the stylus and cursor buttons:

Stylus Buttons	Cursor Buttons	Fc	Fb	Fa
none pressed	none pressed	0	0	0
tip button pressed	1 pressed	0	0	1
barrel button pressed	2 pressed	0	1	0
tip and barrel pressed	3 pressed	0	1	1
	4 pressed	1	0	0
	1+2	0	1	1
	1+3	1	0	0
	1+4	1	0	1
	2+3	1	0	1
	2+4	1	1	0
	1+2+3	1	1	0
	1+2+4	1	1	1
	2+3+4	1	1	1
	1+2+3+4	1	1	1



- T is the Tablet Identifier, which is 1 or 0.
- PR is the proximity bit. 0 is in-prox. 1 is out-of-prox.
- b0 through b13 is the maximum X or Y value at the set resolution.

The configuration report *does not* express the resolution in lines per inch or lines per millimeter. Rather, the resolution is expressed as the total number of counts over the length of the axis.

Example: The resolution setting is 200 lpi. The X and Y axes are 11.7-inches long. Therefore, the resolution is 2340 for each axis. The Send Configuration report is:

MSB	7	6	5	4	3	2	1	LSB	0	Transmission Sequence
	1	0	0	1	1	0	0	0	0	Flag byte
	0	0	1	0	0	1	0	0	0	X low byte
	0	0	0	1	0	0	1	0	0	X high byte
	0	0	1	0	0	1	0	0	0	Y low byte
	0	0	0	1	0	0	1	0	0	Y high byte

	ASCII command
Tablet Identifier equal to:	
zero	0 (zero)
one	1

Use this command to set a bit in the binary report format to a one or a zero. This can be helpful in a dual-tablet configuration to distinguish between the reports coming from one tablet versus the other.

### Transmission Control

	ASCII command
Stop Transmission (XOFF)	<DC3>
Resume Transmission (XON)	<DC1>

The Stop Transmission and Resume Transmission commands act as software gates, controlling data transmission from the MM II to the host. They control data flow, regardless of the report collection mode (Stream, Point, etc.). Stop Transmission and Resume Transmission are equivalents of the protocols XOFF and XON.

Stop Transmission places the tablet on standby. It is useful for systems that do not constantly use the tablet. End the standby state by sending the Resume Transmission command.

While on standby, the tablet can buffer up to ten commands, which it executes after receiving the Resume Transmission command.

If you issue Stop Transmission while data is being transmitted, no data is lost. The MM II severs the data transmission at the end of the byte. When you issue the Resume Transmission command, the tablet resumes operation.

**Note:** The Reset command does not cancel Stop Transmission.

## Commands:

	ASCII command
Autobaud	z<SP><SP>
ASCII BCD report format	za
binary report format	zb
8 data bits, no parity	z8
8 data bits, odd parity	z9
increment confirmation	zi
firmware identification	z?
stylus/cursor identification	zt

The z commands include a variety of functions. Some can be used to override the set-up jumpers inside the tablet. To void a z command, send the Reset command or re-power the tablet.

- **Autobaud:** This command overrides set-up jumper AA. It changes the default baud rate to Autobaud, described in Chapter 2. The character <SP> is an ASCII space.

After issuing z<SP>, ensure that the host port is set to the baud rate you want. Only then can you issue the second <SP>. The tablet responds with an ASCII <ACK> at the new baud rate.

- **ASCII BCD report format:** This command overrides set-up jumper AB. It causes the tablet to use the ASCII BCD report format.
- **Binary report format:** This command overrides set-up jumper AB. It causes the tablet to use the binary report format.
- **8 data bits, no parity:** This command overrides set-up jumper AC. It programs the UART to use an 8-bit frame: 8 data bits, no parity. After the command is executed, the tablet responds with an ASCII <ACK>.
- **8 data bits, odd parity:** This command overrides Jumper AC. It programs the UART to use a 9-bit frame: 8 data bits, odd parity. After the command is executed, the tablet responds with an ASCII <ACK>.
- **Increment confirmation:** This command lets you confirm the current Increment Mode value. The tablet transmits two ASCII hexadecimal characters followed by an ASCII carriage return: XX<CR>.
- **Firmware identification:** This command sends a character string to the host that identifies the tablet firmware version. The string is:

MM2 12x12 Tablet by Summagraphics Firmware Version x.xx<CR>

where x.xx is the firmware version and <CR> is an ASCII carriage return.

- **Transducer identification:** This command sends a character string to the host that identifies which transducer (stylus or cursor) is attached to the tablet. The string is one of the following:

CSR4<CR> ... for a four-button cursor

CSR16<CR> ... for a 16-button cursor

STYLUS<CR> ... for a stylus

where <CR> is an ASCII carriage return.

## Section D - Reserved Commands

*Do not use the ASCII commands zh, zd, or zf or their equivalents. They are reserved for factory use. If you issue a reserved command by mistake, clear it by re-powering the tablet.*

## Chapter 5

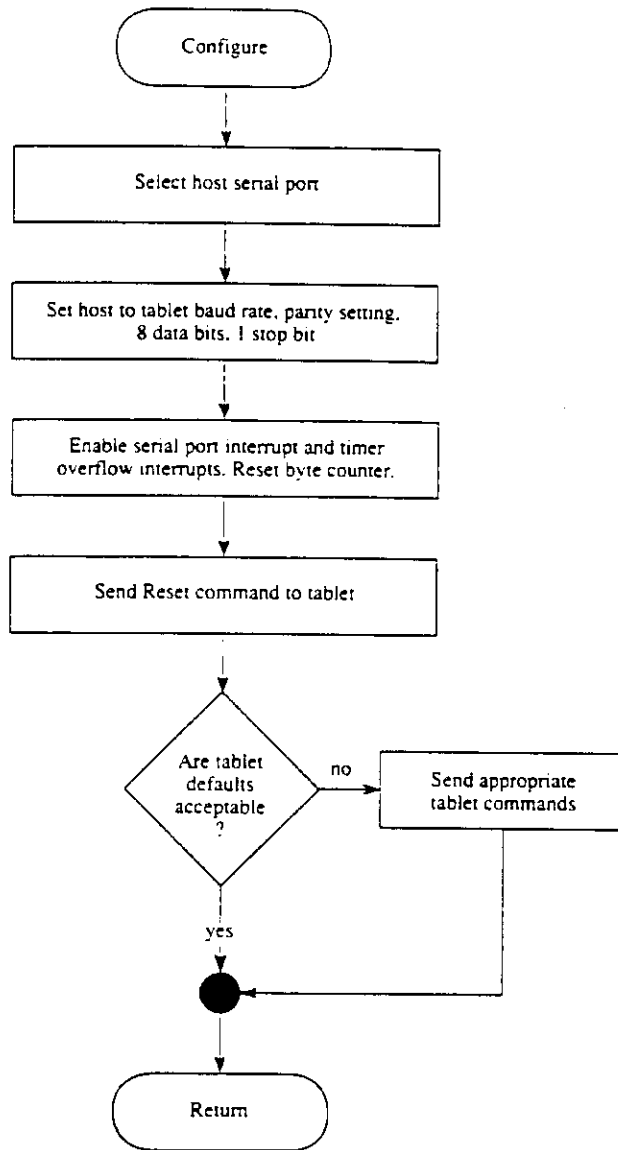
### Guidelines for Writing a Device Driver

For your computer to make use of the data being sent to it from the tablet, your software (system or application) must contain a tablet device driver. The driver must be written for your specific MM II configuration. The **device driver** is a program that collects and decodes the tablet data. This chapter provides guidelines for writing such a driver.

The driver usually sits between the application and the serial interface. The driver should be able to: 1) receive reports and status information from the tablet via the serial interface; 2) transmit this data to the application; 3) receive high level commands from the application that control the tablet. A typical driver should be able to:

- Configure the host and tablet
  - configure the host communications port (port address, baud rate, etc.)
  - configure the tablet (resolution, report mode, etc.)
- Collect reports from the tablet
  - assemble the report: collect the data bytes into an array
  - check for errors
- Process reports from the tablet
  - decode the report
  - filter reports, if required by the application
  - notify the application, if applicable, that a report is ready to be issued to the application
- Process errors
  - parity errors
  - short report errors after timeout
  - long report errors
  - missing report errors after timeout
  - host buffer full errors (automatic XON/XOFF support)

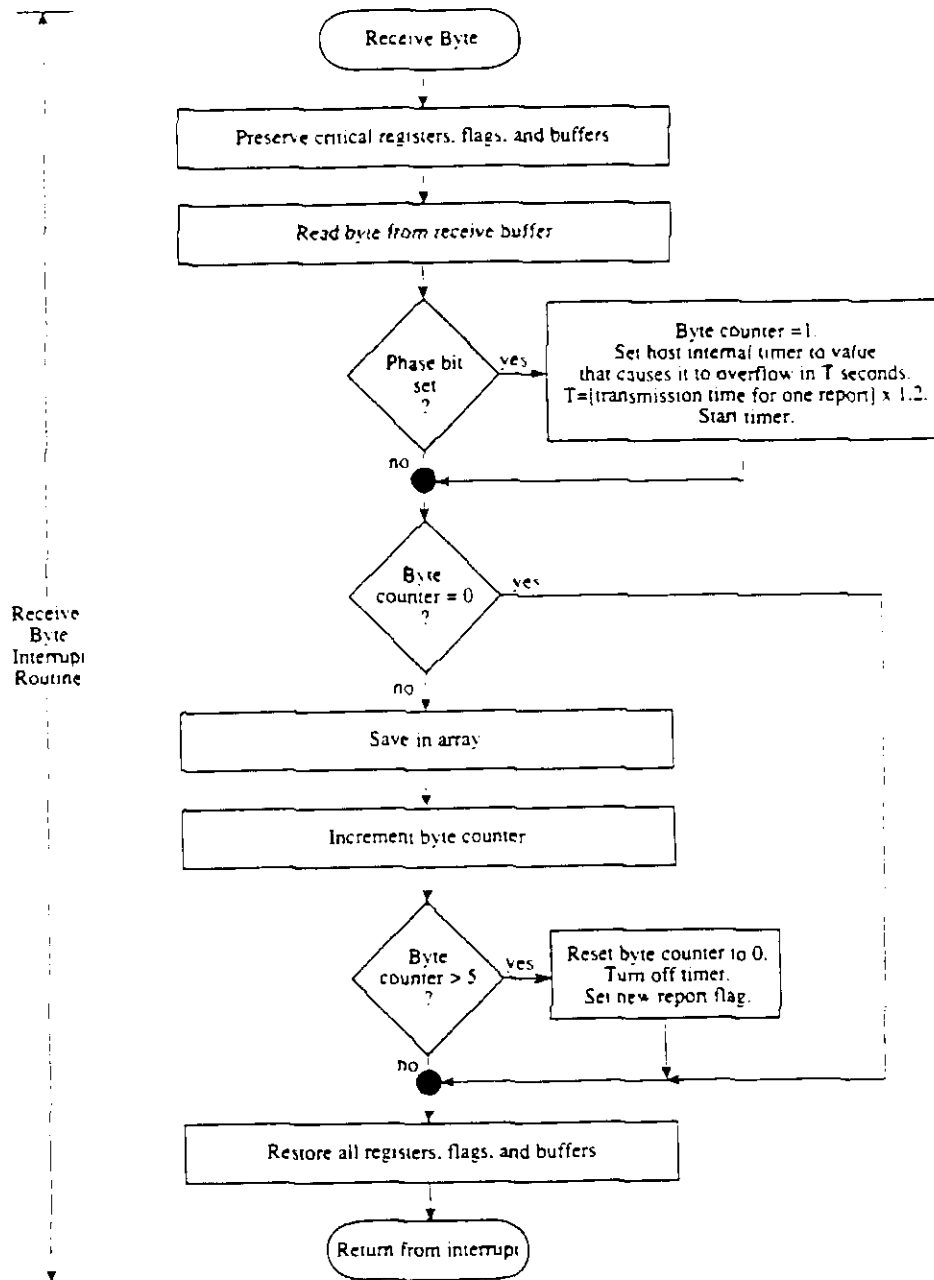
*The following flowcharts are for an MM II using absolute coordinates and the binary report format.*



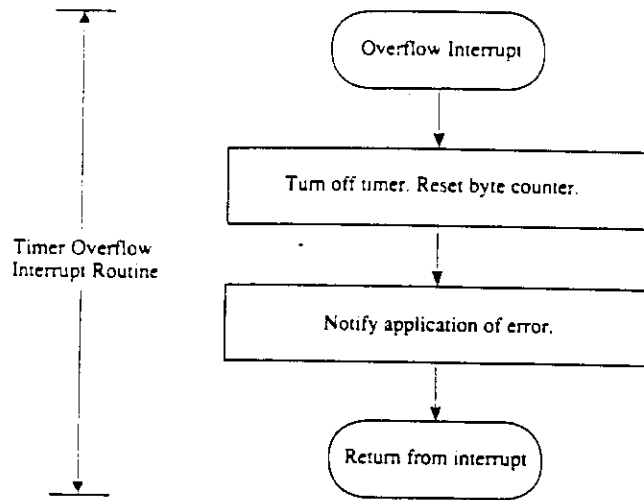
Collect reports from the tablet

- assemble the reports: collect the data bytes into an array
- check for errors

(cont.)

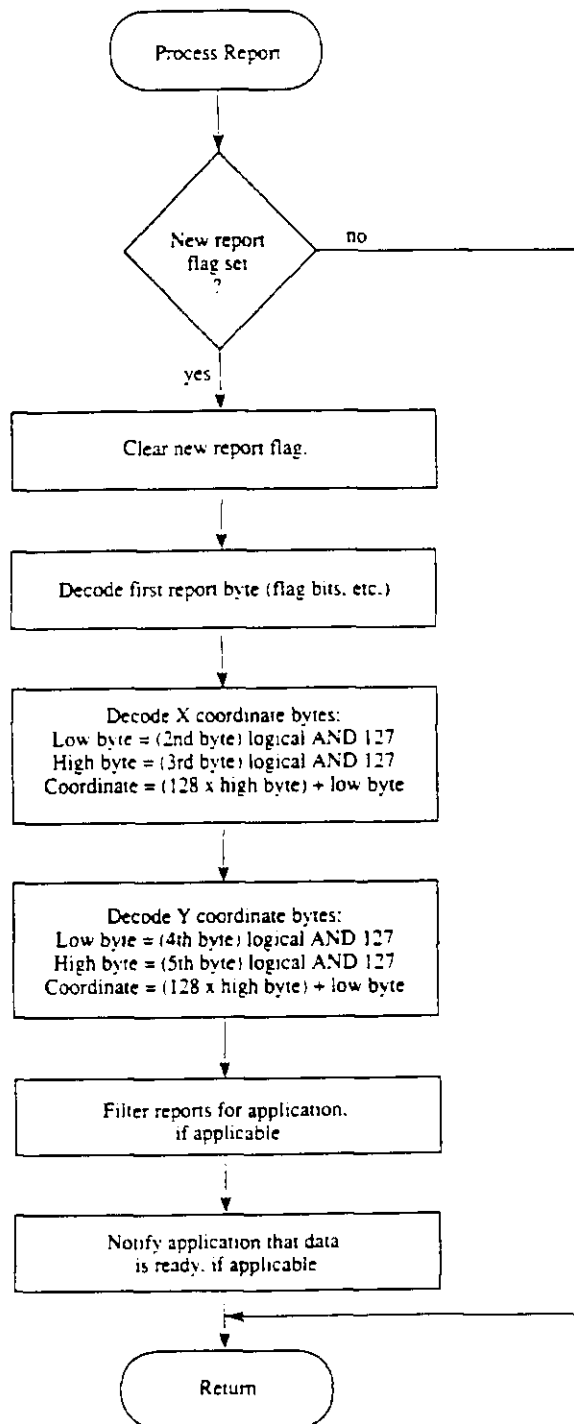


(cont.)



*Process reports from the tablet*

- *decode the report*
- *filter reports, if required by the application*
- *notify the application, if applicable, that a report is ready to be issued to the application*



## Chapter 6

### Using the MM II

Using the MM II is easy. Just think of it as a sketch pad. However, you'll get the most from your tablet if you follow these guidelines:

- You can tape things down to the tablet, like pictures and drawings. Tape doesn't bother the tablet. You can even stack materials up to 1/2-inch high between the tablet and stylus/cursor.
- After turning on the tablet, wait ten milliseconds before starting an application that uses it.
- Keep the stylus/cursor in the active area of the tablet and in proximity. (Note: When the stylus/cursor is in proximity, the tablet power/prox light is on. When the stylus/cursor is out-of-prox, the light blinks.)
- Stylus or cursor—which to use? For freehand drawing, the stylus tends to feel more natural. For tracing, the cursor gives you more control and precise sighting. Also, the cursor has multiple buttons to which your application or program can assign specific functions.
- The cursor and stylus are interchangeable. However, before changing from one to the other, turn off the tablet. (This allows the tablet's internal software to re-initialize for each device.)
- Stylus: The stylus has two buttons, the barrel button and the refill tip. To activate, just press.
- Cursor: The cursor is most accurate when held parallel with the tablet surface. To activate a cursor button, press it.
- When you turn off the computer, turn off the tablet.
- The unit is affected by conductive materials. Don't trace through metal or metallized paper. Don't use metal objects, such as rulers, on the tablet. However, with the cursor, you can trace through some conductive materials, such as, X-rays or drawings in pencil or conductive ink.

## Chapter 7

### Checking the Graphics Tablet

This chapter describes various ways that the tablet can be checked. If it fails any of the tests, have it serviced. (Service information appears in Chapter 8.)

#### Section A - Power/Prox Light

The power/prox light on the tablet serves two purposes. First, it lets you know that the tablet is on and receiving power. Second, it is a proximity indicator. The light remains lit when the stylus/cursor is in-prox. It blinks when the stylus/cursor is out-of-prox.

If the light blinks when the stylus/cursor is in-prox, one of two problems exists. Either, the stylus/cursor is not connected to the tablet, or it is malfunctioning.

#### Section B - A Quick Functional Check

Here is a quick functional check that you can perform. Its purpose is to ensure that the interface is working and that all parts of the tablet active area are being read by the stylus/cursor.

1. Connect the tablet to a "dumb" terminal. The terminal must be set up to communicate in full duplex at 9600 baud. The terminal's data protocol must be a 9-bit frame: odd parity and eight data bits.
2. On the terminal, enter the command string:

```
za@
```

The tablet is now in Stream Mode sending reports in an ASCII format.

3. Starting at the lower left corner of the tablet, run the stylus/cursor across the tablet's active area. You should see reports on the terminal in the following ASCII format:

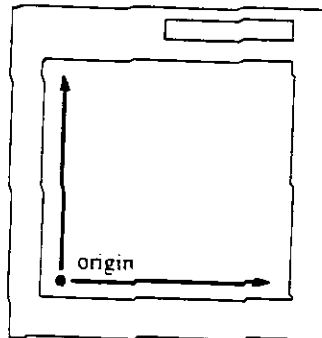
XXXX,YYYY,F

where, XXXX,YYYY are the X and Y coordinates. F is the stylus/cursor flag:

Stylus Buttons	Cursor Buttons	F
not pressed	none pressed	0
up button pressed	1 pressed	1
barrel button pressed	2 pressed	2
tip and barrel pressed	3 pressed	3
	4 pressed	4

The X and Y coordinates should increase as you slide the stylus/cursor up and right, as shown below.

When stylus/cursor moves vertically, X is constant, Y increases.



When stylus/cursor moves horizontally, Y is constant, X increases.

## Section C - Diagnostic Functions

### Code Check

ASCII command: x

Code Check identifies the tablet's firmware version. It does this by issuing a number, called the checksum, to the host. Each firmware version has a unique checksum.

We recommend that you record the checksum when the unit first arrives and periodically thereafter. The checksum should always be the same. A change indicates a change in the firmware.

The checksum is in a six byte format:

.HHHH

where HHHH is a hexadecimal number in ASCII. This is the format, regardless of the report format being used by the tablet.

## **Echo**

---

ASCII command: **k**

---

Use Echo to ensure that the interface between the tablet and host is operating correctly. The tablet echoes (retransmits) characters back to the host that were sent from the host. The tablet echoes the characters, one by one, as it receives them. If the interface is working properly, the sent character matches the echoed character.

Note that character sequences are passed through, not acted upon by the tablet. Therefore, commands issued while Echo is in effect are ignored by the tablet.

To abort the Echo function, issue the Reset command or re-power the tablet.

## **Self Test**

---

ASCII command: **t**

---

Self Test checks the following:

- analog circuitry
- stylus/cursor status
- digital circuitry

The tablet performs the self test each time it is turned on, and each time the Reset or Self Test command is issued. The test results are stored in the tablet. You can access them with the Send Test Results command.

## Send Test Results

ASCII command: `w`

Send Test Results transmits the most recent Self Test results to the host. The results are transmitted as one byte:

MSB							LSB
7	6	5	4	3	2	1	0
T	0	0	0	PR	D	C	A

- A analog circuitry test; pass = 1, fail = 0
- C stylus/cursor connection and coil test; pass = 1, fail = 0
- D digital circuitry test; pass = 1, fail = 0
- PR stylus/cursor proximity; in-prox = 1, out-of-prox = 0
- T total test result (based on A, C, and D); pass = 1, fail = 0

If the test result is a Hex 8FH or 87H, the tablet passed the tests. Another result means that the tablet failed.

## Chapter 8

### Operating Environment, Care, and Service

#### Section A - Operating Environment

Operate the MM II within these temperature and humidity ranges:

+45 degrees to +110 degrees Fahrenheit  
+7 degrees to +43 degrees Celsius  
8% to 80% relative humidity, non-condensing

Acceptable non-operating conditions are:

-45 degrees to +145 degrees Fahrenheit  
-43 degrees to +63 degrees Celsius  
8% to 80% relative humidity, non-condensing

Extremes in environment can cause degradation of operation. Be careful. Extreme temperatures can occur in some rather surprising places — atop a TV set, in direct sunlight, or in a car on a hot or cold day.

#### Section B - Service

You should have no problems with your MM II . However, if a problem arises, try one or more of the following:

- Check the hardware connections and ensure that the tablet is turned on. The power/prox light should be lit.
- Ensure that the computer is working.
- If possible, perform the tests described in Chapter 7.
- If applicable, check that the device driver is installed in your system or application software.
- Turn off the computer and the tablet. Turn them on again.

When contacting Customer Service, please have ready the unit serial number. The serial number is located on the bottom of the tablet. If it is necessary to return the unit, Customer Service will give you a Return Authorization Number. Write this number on the outside of the package and on all accompanying paperwork.

*Do not ship equipment to Summagraphics without obtaining instructions and a Return Authorization Number from the Customer Service Department.*

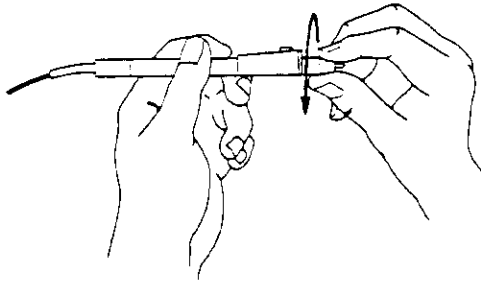
## Section C - Care and Cleaning

The MM II requires minimal care and cleaning. However, the following guidelines are important:

- Disconnect the unit from its power source before cleaning.
- Using a soft, damp (not wet), lint-free cloth, wipe the case clean with a mild detergent solution.
- Never disassemble any part of the MM II, except to change the stylus refill.
- Never immerse in liquid.
- Never bang or drop it.
- Never scratch or mar the tablet surface.
- **Cursor:** The transparent part of the cursor that encases the cross hair is called the paddle. Do not scratch or mar. To clean the paddle, wipe with a lint-free cloth dampened with water. Do not use spray cleaner or any other type of cleaner or solvent.
- Many of the connectors look like those used for telephone equipment. *Caution: Do not plug MM II connectors into foreign objects. Do not plug foreign objects into the MM II. Doing so would produce unpredictable results and could destroy the tablet.*

## Section D - Changing the Stylus Refill

To change the stylus refill, unscrew the cap and pull the refill straight out.



Insert the new refill and screw on the cap.

# Appendix A - Specifications

## Physical Description

Approximate physical dimensions:

- Width = 16 inches (406 mm)
- Length = 17 inches (432 mm)
- Maximum height = 1.3 inches (33 mm)

Weight: 7 lbs. (3.2 kg) maximum

## Power Supply Specifications

The MM II power supply is specified as:

- Input: 120 VAC +7%, -13%, 58 to 62 Hz
- Output: +12 VDC at 250 mA, less than 50 mV ripple, +/-10% regulation, rise time less than 100 milliseconds.

## Operating Specifications

The following specifications are provided to aid in your understanding and use of the product. For detailed specifications, contact Summagraphics Corporation.

Accuracy...+/- 0.025 inches (1.27mm) or better  
Accuracy is how closely a point's actual location is determined.

Active Area...11.7 inches by 11.7 inches (287 mm by 287 mm) approximately  
The area of the tablet that senses the stylus/cursor location and where valid reports are obtained.

Jitter...stylus or cursor: +/-1 count of resolution  
Jitter is the difference in values collected by the graphics tablet for the same point (for example, 200, 201, 202). Jitter can be caused by electrical noise from environmental sources or from the tablet's analog-to-digital conversion circuitry. Noise affects the signal that identifies a point. Jitter is measured as one unit of the resolution.

Proximity...0.5 inches (12.7mm) approximately  
Proximity is the maximum distance the stylus/cursor can be held above the active area and report a valid position.

Resolution...up to 1016 lpi (40 lpmm)

Resolution is the "fineness" of detail that the tablet can distinguish. Resolution is expressed in lines per inch (lpi) or lines per millimeter (lpmm).

## Appendix B - Changing the Set-Up Jumpers

This appendix describes how to change the set-up jumpers inside the tablet that control certain operational defaults:

- baud rate: 9600 or Autobaud
- report format: binary or ASCII BCD
- parity: odd or none

*Caution: Performing the procedure described in this appendix is done at your own risk. We take no responsibility for any damage that could occur.*

*An alternative to changing the jumpers is to use the z commands, described in Chapter 4.*

In brief, to change the set-up jumpers:

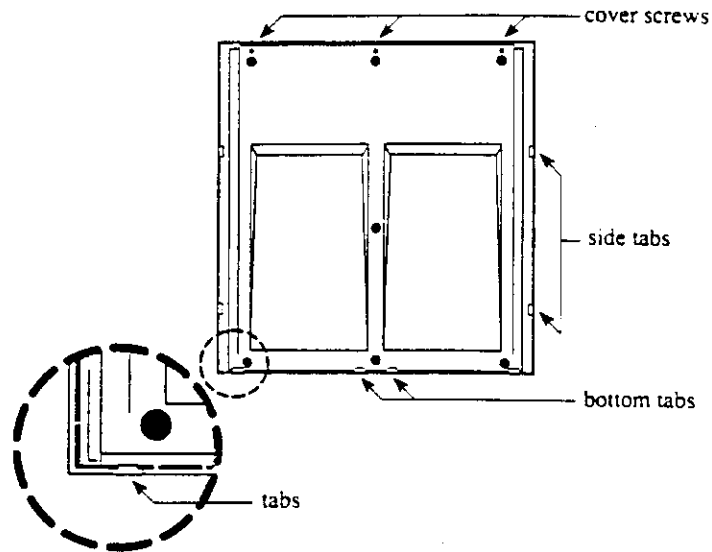
1. Disassemble the tablet.
2. Change the jumper caps.
3. Reassemble the tablet.

Detailed instructions follow.

### **Disassembling the Tablet**

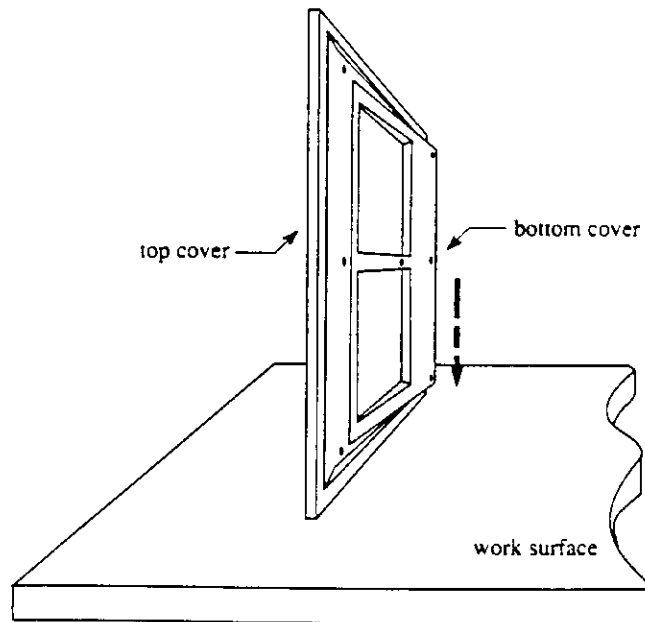
1. *Ensure that the tablet is turned off and all cables are removed.*
2. Turn the tablet upside-down on a clean, smooth surface that will not mar it. The bottom cover should be facing you.

- Using a Phillips head screwdriver, remove the three cover screws. (A magnetic screwdriver is helpful because the screws are recessed.) Lay the screws aside.

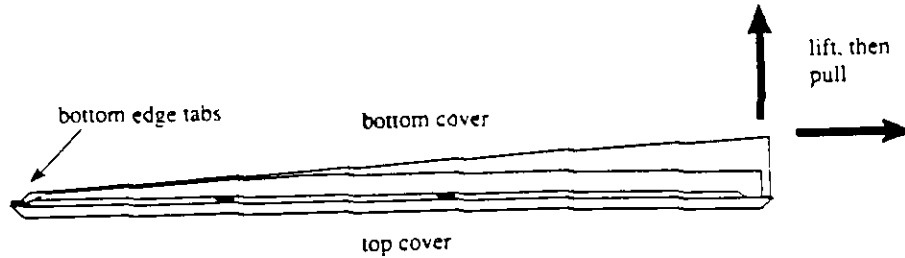


Notice that the bottom and top covers are held together by tabs on the bottom cover.

- Turn the tablet on its side. Tap it gently against the work surface. This shifts the bottom cover enough to loosen the tabs from their slots at the upper edge.

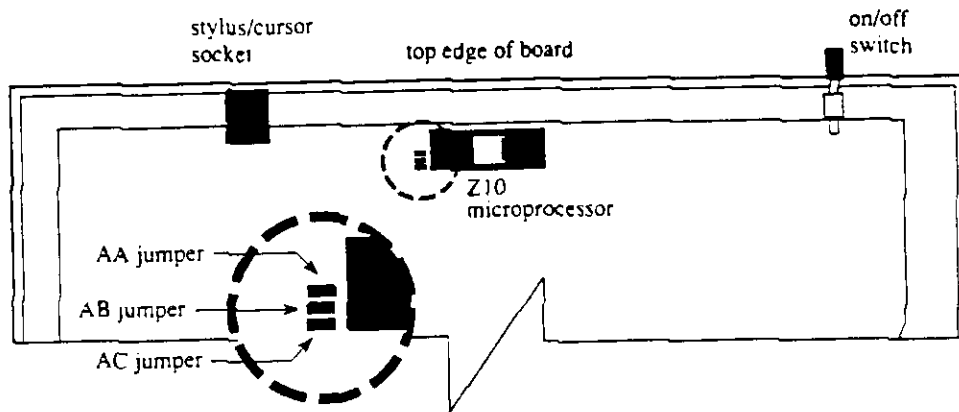


3. Lay the tablet upside down on the work surface. Grasp the side of the tablet that is still held together. Flex the top cover away from the tabs until they snap loose. Do the same at the bottom edge.



When the bottom cover is free, remove and set aside. The printed circuit board is now visible. Do not remove the board from the cover. It protects delicate shielding below.

8. The jumper locations are shown here:

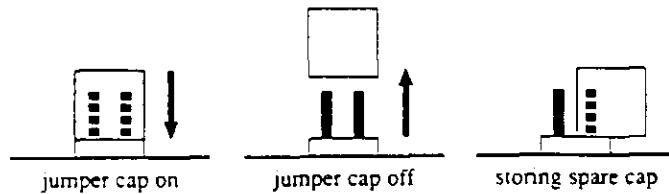


### Changing Jumpers

Change the jumper caps as you wish.

Configuration	Board Label	Jumper
9600 baud	AA	attached
Autobaud	AA	removed
binary report format	AB	attached
ASCII BCD report format	AB	removed
8 data bits, odd parity	AC	attached
8 data bits, no parity	AC	removed

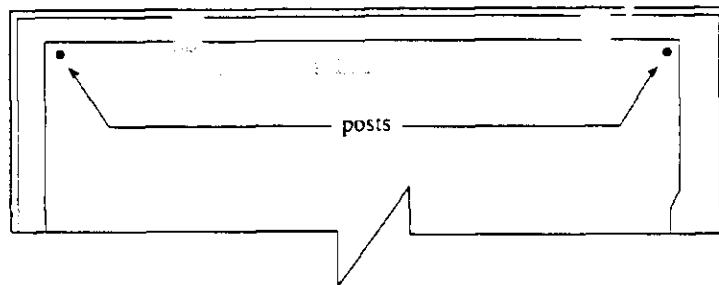
The jumper caps are black plastic sleeves, open at two ends. To remove a cap, pull straight up. To attach a cap, push straight down onto the two jumper pins. Both ends of the cap are the same, so it doesn't matter which way you attach it.



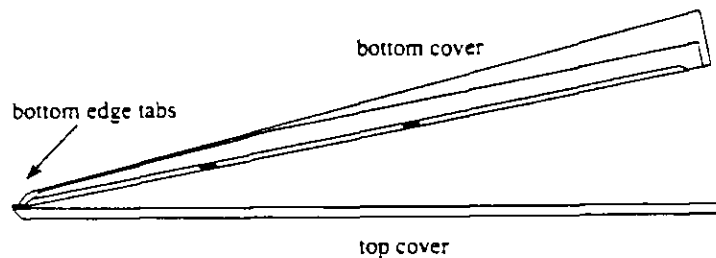
A cap is "attached" when it straddles both pins. It is "removed" when it is on no pins or only one pin. Therefore, a handy way of storing a spare cap is to stick it on only one pin.

### Reassembling the Tablet

1. Ensure that the printed circuit board has not shifted or lifted out of position. It should be held gently in place by the two posts at the top edge.



4. Hold the bottom cover upside-down over the top cover. Slide the bottom edge of the bottom cover into the top cover so that the tabs fit into the slots.



5. Snap the bottom cover down against the top cover. The bottom and side tabs should be seated in the slots.
6. Replace the three cover screws. Gently tighten, but *do not over tighten*. Too much pressure can strip the screw threads. Ensure that there is no gap between the top and bottom covers.

## Appendix C - ASCII Conversion Chart

Decimal	Binary 7 6 5 4 3 2 1 0	Octal	Hex	ASCII Character	Control Function or Character Description
0	0 0 0 0 0 0 0 0	000	00	NUL	Null
1	0 0 0 0 0 0 0 1	001	01	SOH	Start of Heading
2	0 0 0 0 0 0 1 0	002	02	STX	Start of Text
3	0 0 0 0 0 0 1 1	003	03	ETX	End of Text
4	0 0 0 0 0 1 0 0	004	04	EOT	End of Transmission
5	0 0 0 0 0 1 0 1	005	05	ENQ	Enquiry
6	0 0 0 0 0 1 1 0	006	06	ACK	Acknowledge
7	0 0 0 0 0 1 1 1	007	07	BEL	Bell
8	0 0 0 0 1 0 0 0	010	08	BS	Backspace
9	0 0 0 0 1 0 0 1	011	09	HT	Horizontal Tab
10	0 0 0 0 1 0 1 0	012	0A	LF or NL	Line Feed or New Line
11	0 0 0 0 1 0 1 1	013	0B	VT	Vertical Tab
12	0 0 0 0 1 1 0 0	014	0C	FF	Form Feed
13	0 0 0 0 1 1 0 1	015	0D	CR or RT	Carriage Return
14	0 0 0 0 1 1 1 0	016	0E	SO	Shift Out
15	0 0 0 0 1 1 1 1	017	0F	SI	Shift In
16	0 0 0 1 0 0 0 0	020	10	DLE	Data Link Escape
17	0 0 0 1 0 0 0 1	021	11	DC1	Device Control 1
18	0 0 0 1 0 0 1 0	022	12	DC2	Device Control 2
19	0 0 0 1 0 0 1 1	023	13	DC3	Device Control 3
20	0 0 0 1 0 1 0 0	024	14	DC4	Device Control 4
21	0 0 0 1 0 1 0 1	025	15	NAK	Negative Acknowledge
22	0 0 0 1 0 1 1 0	026	16	SYN	Synchronous Idle
23	0 0 0 1 0 1 1 1	027	17	ETB	End Transmission Block
24	0 0 0 1 1 0 0 0	030	18	CAN	Cancel
25	0 0 0 1 1 0 0 1	031	19	EM	End of Medium
26	0 0 0 1 1 0 1 0	032	1A	SUB	Substitute
27	0 0 0 1 1 0 1 1	033	1B	ESC	Escape
28	0 0 0 1 1 1 0 0	034	1C	FS	File Separator
29	0 0 0 1 1 1 0 1	035	1D	GS	Group Separator
30	0 0 0 1 1 1 1 0	036	1E	RS	Record Separator
31	0 0 0 1 1 1 1 1	037	1F	US	Unit Separator
32	0 0 1 0 0 0 0 0	040	20	SP	Space
33	0 0 1 0 0 0 0 1	041	21	!	Exclamation Point
34	0 0 1 0 0 0 1 0	042	22	"	Double Quote
35	0 0 1 0 0 0 1 1	043	23	#	Number or Pound
36	0 0 1 0 0 1 0 0	044	24	\$	Dollar
37	0 0 1 0 0 1 0 1	045	25	%	Percent
38	0 0 1 0 0 1 1 0	046	26	&	Ampersand
39	0 0 1 0 0 1 1 1	047	27	'	Apostrophe
40	0 0 1 0 1 0 0 0	050	28	(	Left Parenthesis
41	0 0 1 0 1 0 0 1	051	29	)	Right Parenthesis
42	0 0 1 0 1 0 1 0	052	2A	*	Asterisk
43	0 0 1 0 1 0 1 1	053	2B	+	Plus or Addition

cont.

Decimal	Binary 7 6 5 4 3 2 1 0	Octal	Hex	ASCII Character	Control Function or Character Description
44	0 0 1 0 1 1 0 0	054	2C	.	Comma
45	0 0 1 0 1 1 0 1	055	2D	-	Hyphen
46	0 0 1 0 1 1 1 0	056	2E	.	Period
47	0 0 1 0 1 1 1 1	057	2F	/	Slash
48	0 0 1 1 0 0 0 0	060	30	0	
49	0 0 1 1 0 0 0 1	061	31	1	
50	0 0 1 1 0 0 1 0	062	32	2	
51	0 0 1 1 0 0 1 1	063	33	3	
52	0 0 1 1 0 1 0 0	064	34	4	
53	0 0 1 1 0 1 0 1	065	35	5	
54	0 0 1 1 0 1 1 0	066	36	6	
55	0 0 1 1 0 1 1 1	067	37	7	
56	0 0 1 1 1 0 0 0	070	38	8	
57	0 0 1 1 1 0 0 1	071	39	9	
58	0 0 1 1 1 0 1 0	072	3A	:	Colon
59	0 0 1 1 1 0 1 1	073	3B	;	Semicolon
60	0 0 1 1 1 1 0 0	074	3C	<	Less Than
61	0 0 1 1 1 1 0 1	075	3D	=	Equals
62	0 0 1 1 1 1 1 0	076	3E	>	Greater Than
63	0 0 1 1 1 1 1 1	077	3F	?	Question Mark
64	0 1 0 0 0 0 0 0	100	40	@	Commercial At
65	0 1 0 0 0 0 0 1	101	41	A	
66	0 1 0 0 0 0 1 0	102	42	B	
67	0 1 0 0 0 0 1 1	103	43	C	
68	0 1 0 0 0 1 0 0	104	44	D	
69	0 1 0 0 0 1 0 1	105	45	E	
70	0 1 0 0 0 1 1 0	106	46	F	
71	0 1 0 0 0 1 1 1	107	47	G	
72	0 1 0 0 1 0 0 0	110	48	H	
73	0 1 0 0 1 0 0 1	111	49	I	
74	0 1 0 0 1 0 1 0	112	4A	J	
75	0 1 0 0 1 0 1 1	113	4B	K	
76	0 1 0 0 1 1 0 0	114	4C	L	
77	0 1 0 0 1 1 0 1	115	4D	M	
78	0 1 0 0 1 1 1 0	116	4E	N	
79	0 1 0 0 1 1 1 1	117	4F	O	
80	0 1 0 1 0 0 0 0	120	50	P	
81	0 1 0 1 0 0 0 1	121	51	Q	
82	0 1 0 1 0 0 1 0	122	52	R	
83	0 1 0 1 0 0 1 1	123	53	S	
84	0 1 0 1 0 1 0 0	124	54	T	
85	0 1 0 1 0 1 0 1	125	55	U	
86	0 1 0 1 0 1 1 0	126	56	V	
87	0 1 0 1 0 1 1 1	127	57	W	
88	0 1 0 1 1 0 0 0	130	58	X	
89	0 1 0 1 1 0 0 1	131	59	Y	

cont.

Decimal	Binary 7 6 5 4 3 2 1 0	Octal	Hex	ASCII Character	Control Function or Character Description
90	0 1 0 1 1 0 1 0	132	5A	Z	
91	0 1 0 1 1 0 1 1	133	5B	{	Left Square Bracket
92	0 1 0 1 1 1 0 0	134	5C	\	Back Slash
93	0 1 0 1 1 1 0 1	135	5D	}	Right Square Bracket
94	0 1 0 1 1 1 1 0	136	5E	^	Circumflex
95	0 1 0 1 1 1 1 1	137	5F	_	Underscore
96	0 1 1 0 0 0 0 0	140	60	'	Left Single Quote
97	0 1 1 0 0 0 0 1	141	61	a	
98	0 1 1 0 0 0 1 0	142	62	b	
99	0 1 1 0 0 0 1 1	143	63	c	
100	0 1 1 0 0 1 0 0	144	64	d	
101	0 1 1 0 0 1 0 1	145	65	e	
102	0 1 1 0 0 1 1 0	146	66	f	
103	0 1 1 0 0 1 1 1	147	67	g	
104	0 1 1 0 1 0 0 0	150	68	h	
105	0 1 1 0 1 0 0 1	151	69	i	
106	0 1 1 0 1 0 1 0	152	6A	j	
107	0 1 1 0 1 0 1 1	153	6B	k	
108	0 1 1 0 1 1 0 0	154	6C	l	
109	0 1 1 0 1 1 0 1	155	6D	m	
110	0 1 1 0 1 1 1 0	156	6E	n	
111	0 1 1 0 1 1 1 1	157	6F	o	
112	0 1 1 1 0 0 0 0	160	70	p	
113	0 1 1 1 0 0 0 1	161	71	q	
114	0 1 1 1 0 0 1 0	162	72	r	
115	0 1 1 1 0 0 1 1	163	73	s	
116	0 1 1 1 0 1 0 0	164	74	t	
117	0 1 1 1 0 1 0 1	165	75	u	
118	0 1 1 1 0 1 1 0	166	76	v	
119	0 1 1 1 0 1 1 1	167	77	w	
120	0 1 1 1 1 0 0 0	170	78	x	
121	0 1 1 1 1 0 0 1	171	79	y	
122	0 1 1 1 1 0 1 0	172	7A	z	
123	0 1 1 1 1 0 1 1	173	7B	[	Left Curved Bracket
124	0 1 1 1 1 1 0 0	174	7C		Vertical Line
125	0 1 1 1 1 1 0 1	175	7D	]	Right Curved Bracket
126	0 1 1 1 1 1 1 0	176	7E	~	Tilde
127	0 1 1 1 1 1 1 1	177	7F	DEL	Delete (rubout)

## Appendix D - Quick Reference of Commands and Defaults

### Command Summary

Command	ASCII	Command	ASCII
Autobaud	<SP>	Resolution, Predefined:	
Axis Update Mode:		1 lpi	l (lowercase L)
command	G	2 lpi	n
value	<SP> to z	4 lpi	p
Code Check	x (lowercase X)	100 lpi	d
Coordinate system:		200 lpi	e
absolute	F	10 lpm (254 lpi)	f
relative	E	400 lpi	g
Echo	k	500 lpi	h
Increment Mode:		20 lpm (508 lpi)	i
mode command	I	1000 lpi	j
increment value	<SP> to z	40 lpm (1016 lpi)	q
Origin:		Resume Transmission (XON)	<DC1>
upper left	b	Self Test	t
lower left	c	Send Test Results	w
Report Modes:		Send Configuration	a
Point Mode	B	Stop Transmission (XOFF)	<DC3>
Remote Request Mode:		Tablet Identifier:	
mode command	D	zero	0 (zero)
trigger command	P	one	1
Stream Mode	@	Z commands:	
Switch Stream Mode	A	Autobaud	z<SP><SP>
Report Rate:		ASCII BCD report format	za
maximum + 32	T	binary report format	zb
maximum + 8	S	8 data bits, no parity	z8
maximum + 2	R	8 data bits, odd parity	z9
maximum	Q	increment confirmation	zi
Reset	<NUL>	firmware identification	z?
Resolution, Definable:		transducer identification	zt
command	r		
X axis resol., low byte	Hex 00 to FF		
X axis resol., high byte	Hex 00 to 17		
Y axis resol, low byte	Hex 00 to FF		
Y axis resol, high byte	Hex 00 to 17		

Reserved commands: Do not use the commands zh, zd, or zf.

Axis Update: 0, Axis Update Mode on  
Coordinate System: absolute  
Increment: 0, Increment Mode off  
Origin: lower left corner  
Report Mode: Switch Stream  
Report Rate: maximum throughput  
Resolution: 500 lpi  
Tablet Identifier: 0

### Standard Product Configuration

Baud rate: 9600  
Report Format: binary  
Parity: odd

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