the Light Pen

Inkwell Systems

CREATORS OF PENWARE™

PLEASE READ BEFORE USING THE LIGHT PEN

This package contains an INKWELL SYSTEMS' Light Pen, a copy of a computer program recorded on one or more (sides) of a magnetic diskette(s), and supporting documentation.

This material embodies proprietary rights protected under the U.S. Copyright laws and the trade secret laws of most states.

Your purchase of this package is subject to the following terms and conditions:

Purchaser acquires full title and possession of the light pen and diskette(s), and a limited, non-exclusive license to load the copy of the computer program into a personal micro processor and to make one archival or working copy of it on a spare diskette(s).

Purchaser is not authorized to make any other copy of the computer program, to transfer possession of any copy of the program to another person, to load a copy of the program on any multi-user system or use it in rendering any kind of software-related services which might result in copying by other persons, to modify and/or adapt the computer program in any way including translating, reverse engineering, decompiling or disassembling the computer program.

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LIMITED WARRANTY NOTICE

INKWELL SYSTEMS warrants the diskette(s) as free of defect in material and workmanship, and the recorded copy of the computer program as an accurate copy of the original for a period of 90 days from the date of purchase.

INKWELL SYSTEMS warrants the Light Pen Model 170-C to be free of defect in material and workmanship for a period of 90 days and warrants the Light Pen Model 184-C to be free of defect in material and workmanship for a period of ninety (90) days.

EXCLUSIVE REMEDIES

Items found defective and returned to INKWELL SYSTEMS during their warranty period will be repaired or replaced free of charge; providing that the applicable WARRANTY REGISTRATION CARD is on file at INKWELL SYSTEMS .

NOTICE: WARRANTY REGISTRATION CARD MUST BE ON FILE AT INKWELL SYSTEMS FOR WARRANTY COVERAGE, TO RECEIVE TECHNICAL SUPPORT AND TO RECEIVE PRODUCT UPDATE INFORMATION IF APPLICABLE.

EXCLUSION

The computer program is made available to you "AS IS". NO WARRANTY EITHER EXPRESSED OR IMPLIED IS MADE AS TO ITS APPLICATION OR FITNESS FOR ANY PURPOSE. IN NO EVENT WILL INKWELL SYSTEMS, ITS LICENSORS OR ASSOCIATES BE HELD LIABLE FOR ANY TYPE OF DAMAGES RESULTING FROM ANY DEFECT IN THE COMPUTER PROGRAM OR FROM ANY USE OR ATTEMPT TO USE IT.

This above limited warranty is in lieu of any other expressed or implied warranty. It gives the purchaser specific legal rights. There may be other rights which vary from state to state. Some states prohibit limitations on the extent and duration of implied warranties.

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Your Light Pen package contains the following items:

- LIGHT PEN APPLICATION DEMONSTRATION DISK (COMMODORE 64, 128, SX64 FORMAT)
- 170C OR 184C HIGH RESOLUTION LIGHT PEN
- OPERATIONS MANUAL
- WARRANTY CARD

If this package is not complete, immediately return it to the place of purchase.

The Light Pen Application Demonstration Disk contains the following programs to show possible use of the light pen in programs that you create: **FOLLOW ME!, LIGHT PEN PIANO, SYNTHESIZER,** and **WHERE AM I?**

To get started using your Light Pen, we recommend that you read the entire manual. All programs on the Demonstration Disk are accessed by typing:

LOAD "*",8 <RETURN>
RUN <RETURN>.

PLEASE NOTE: WARRANTY REGISTRATION CARD MUST BE ON FILE AT INKWELL SYSTEMS FOR WARRANTY COVERAGE AND TO RECEIVE TECHNICAL ASSISTANCE, IF REQUIRED.

PLEASE
☞ SEND IN YOUR WARRANTY CARD ☜
NOW!!

INKWELL SYSTEMS OFFERS YOU A 15 DAY, MONEY BACK GUARANTEE. IF YOU ARE NOT PLEASED WITH THIS PRODUCT, RETURN IT TO YOUR PLACE OF PURCHASE. IF YOU PURCHASED THIS PRODUCT DIRECTLY FROM INKWELL SYSTEMS, PLEASE CONTACT THE FACTORY FOR AN RMA# (RETURN MERCHANDISE AUTHORIZATION). YOUR MONEY WILL BE REFUNDED. NO REFUNDS WILL BE GIVEN FOR MERCHANDISE OVER 15 DAYS OLD. MERCHANDISE RETURNED TO THE FACTORY WITHOUT AN RMA # IS SUBJECT TO ADDITIONAL SHIPPING/HANDLING CHARGES.

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If you do experience any problems with your INKWELL SYSTEMS Light Pen or Demonstration Disk, please follow these instructions:

1) Disk: 90 Day Warranty

DURING WARRANTY PERIOD: Contact factory for RMA # (Return Merchandise Authorization) *before* returning the diskette to Inkwell Systems. **Then** return damaged disk. You will receive a replacement at no charge if the original diskette is found to be damaged.

AFTER WARRANTY EXPIRES: Contact factory for RMA # (Return Merchandise Authorization) *before* returning the diskette to Inkwell Systems. **Then** return damaged disk and $15.00 ($15.00 US in Canada and Mexico, $20.00 for other foreign countries). You will be sent a replacement. This charge includes replacement and shipping/handling charges.

2) THE LIGHT PEN MODEL 170-C: 90 Day Warranty

DURING WARRANTY PERIOD: Contact Factory for RMA # (Return Merchandise Authorization) *before* returning the pen. Upon receipt, any pen found defective in materials or workmanship will be repaired or replaced free of charge.

AFTER WARRANTY EXPIRES: Contact factory for RMA # (Return Merchandise Authorization) *before* returning The Light Pen to Inkwell Systems. **Then** return damaged light pen and $55.00 ($55.00 US in Canada and Mexico, $65.00 other foreign countries). Your pen will be repaired or replaced and be returned to you with a new One Year Warranty. This charge includes repair or replacement and shipping and handling charges.

3) THE LIGHT PEN MODEL 184-C: 90 Day Warranty

DURING WARRANTY PERIOD: Contact Factory for RMA # (Return Merchandise Authorization) before returning the pen. Upon receipt, any pen found defective in materials or workmanship will be replaced and returned to you free of charge.

AFTER WARRANTY EXPIRES: Due to the sealed construction on this model of light pen, we do not repair them. Replacements can be purchased directly through your local Inkwell Systems Dealer.

WELCOME TO *The Light Pen*

Congratulations on your purchase of The Light Pen! Inkwell Systems is very pleased that you have chosen this data entry device for your computer system.

The following pages contain a technical discussion regarding light pens: how they work, how your system works with relationship to The Light Pen and what information will be needed to create a program for it.

Also included in this package is The Light Pen Demonstration Disk which will run on a Commodore 64, 64C, SX64 or 128 computer and shows the many things a light pen can accomplish when programmed correctly. These programs range from menu selections through panel controls. Also included on the disk is a program to enable you to determine the exact location of the light pen on the screen for use in your own programs.

As stated above, the following pages are technical in nature and are written for those individuals who wish to create a program for The Light Pen. Inkwell Systems wishes to advise you that unless you plan to use The Light Pen with programs compatible with light pens already available on the market you will need to create your own programs for use with The Light Pen. The Demonstration disk included is just for demonstration purposes and by no means is "useful" software.

QUESTIONS? Check with your nearest Flexidraw Dealer, or contact:

Customer Service
INKWELL SYSTEMS
1050-R Pioneer Way
El Cajon, CA 92020
619/440-7666
FAX: 619/440-8048

DO'S AND DON'TS

Do: Store The Light Pen in a cool dry place.

Do: Occasionally wipe your screen with a damp cloth or your hand to reduce dust and static electricity which may effect the operation of The Light Pen.

Do: Adjust the Color, Brightness, and Contrast controls of your television or monitor for the best possible display.

Do: Occasionally use a twisted piece of tissue paper to remove any dust that has accumulated inside the tip of the light pen.

Do: Contact your Inkwell Systems Dealer if you have any questions.

Don't: Drop or bang the light pen on a hard surface.

Don't: Store your light pen or disks in the sun or any place where there is excessive heat.

Don't: Take The Light Pen apart. If you suspect a problem contact your local dealer or Inkwell Systems Customer Service for assistance.

Don't: Use The Light Pen Model 170-C on a CRT screen that is not smooth. Use of the pen's nose tip switch on a textured screen could damage the screen surface and/or The Light Pen.

Don't: **Return Merchandise to Inkwell Systems without FIRST obtaining an RMA# as described in the *The Light Pen Contents and Warranty* section of this manual.**

HARDWARE REQUIREMENTS

The Light Pen is joystick Port 1 compatible with Commodore 64, 64C, SX64, and 128 computers. To program for The Light Pen you will need:

- A COMPUTER WITH SUITABLE LIGHT PEN INTERFACE
- COMPATIBLE DISK DRIVE
- TV OR MONITOR SUITABLE FOR USE WITH THE LIGHT PEN
  (See the *About Phosphor* section in this manual)
- COMPATIBLE DISKETTES

To run The Light Pen Demonstration Disk you will need:

- COMMODORE 64, 64C, SX 64, or 128 MICROCOMPUTER
- COMPATIBLE DISK DRIVE
- TV OR MONITOR SUITABLE FOR USE WITH THE LIGHT PEN

HOW TO USE *The Light Pen* WITH COMMODORE COMPUTERS

- **170-C Light Pen:** Insert The Light Pen in Control Port 1 which is located on the right side of the Commodore 64, 64C and 128 computers and in the rear of the SX64 portable. Press the tip of The Light Pen to the CRT to perform the functions the software dictates. (HINT...For a "second switch" you can program the <Control Key> or the <Back Arrow> key.)

- **184-C Light Pen:** Install The Light Pen as above. While it is not necessary for the tip of this pen to be placed directly on the screen to position objects or the make selections, it is recommended that you use the pen no more than six inches away from the screen for optimum operation. To activate the touch switches, simply lay your finger gently on the switch. It activates using the moisture in your skin as a conductor. Each switch can be programmed to perform different functions...i.e. the right and left button on a mouse. (HINT: If you have extremely dry skin, we recommend using hand lotion before using The Light Pen for best results. We have also noticed that you may get a jumpy cursor if you operate the 184-C close to a megawatt radio station).

TO USE *The Light Pen* WITH OTHER PERSONAL COMPUTERS

The Light Pen may be adapted for use on other personal computers which have a Light Pen Port. To do so, you must read through their respective manuals to determine where and how to connect The Light Pen to the computer.

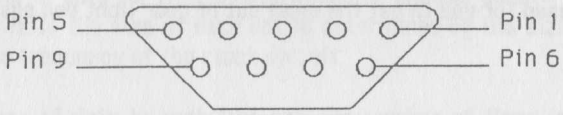
The Light Pen comes packaged with a 9 position "D" Subminiature connector wired as follows:

MODEL 184-C

Pin 1: Not Connected
2: Not Connected
3: Black Switch 2
4: Not Connected
5: Yellow Switch 1
6: Green Video
7: Red +5V
8: Shield Ground
9: Not Connected

MODEL 170-C

Pin 1: Not Connected
2: Not Connected
3: Black Switch
4: Not Connected
5: Not Connected
6: Green Video
7: Red +5V
8: Yellow Ground
9: Not Connected



"D" Subminiature Connector

Other computers will require the "D" Subminiature connector to be removed and a different style connector to be purchased and installed. It is recommended that only those with technical background attempt modifications themselves. Inkwell Systems recommends that any modifications be made by a reliable computer dealer/repair station.

Modifications to The Light Pen which result in a pen malfunction will void the Warranty and it is urged that the connector modifications be carefully inspected to prevent serious damage to the computer and/or The Light Pen when installed.

Inkwell Systems is not responsible for any damage to a computer system by a modified light pen.

WHAT IS A LIGHT PEN?

A light pen is a hand-held electro-optical pointing device which, when touched to or aimed closely at a connected monitor or TV screen, will allow the computer to determine where on that screen the pen is aimed.

The software and light pen driver may process this location information in various ways, but the job of the pen itself is simply to make a time measurement which will be translated into X and Y coordinates representative of a position on the CRT (cathode ray tube, i.e., TV or monitor).

There are two parts to a light pen system: the hardware (the light pen and computer system to which it is attached) and the software (which can range from simple to complex).

The hardware determines the resolution and accuracy which is attainable with the system. The software determines the usefulness of the light pen and the sophistication level and speed at which it performs.

The light pen is a real-time interactive device and its performance should be on par with the operator. Programs which are written primarily in a high level language, such as interpreted BASIC, are usually so slow that the usefulness of the light pen system is greatly diminished. It is suggested that machine code be used for you to get the most out of your light pen system.

HOW A TV/MONITOR WORKS

To understand how a light pen works, you must first understand how the video output is displayed on your TV or monitor (CRT).

In your computer system there is a special chip (sometimes called a video chip) which handles everything associated with video output including colors, characters, sprites, graphics, screen organization and the light pen.

To illuminate your CRT, the electron beam located inside the CRT will start in the upper left corner of the screen and sweep (paint) from left to right until a horizontal sync pulse (generated by a counter chip) is encountered. At this time the electron beam gun is turned off and quickly returns to the left side just below the previous starting point. It will continue to paint in this fashion for a given number of times until a vertical sync pulse (generated by another counter chip) is encountered, at which time it returns to the top-most, left-most position to begin the process all over again.

The left to right scan is called a line. The series of lines from top to bottom is called a frame. Each line consists of a series of phosphor dots and these dots are called pixels.

The number of dots per line is determined by another counter chip called a dot counter, while the size of each dot is determined by the size and type of CRT and by the frequency of the clock circuit.

The number of dots in each line and the number of lines in each frame are referred to as resolution; i.e. 320 X 200 resolution simply says there are 320 dots per line and 200 lines per frame. The larger the numbers, the higher the resolution. The higher the resolution, the smaller the dots are in size and the closer the lines appear on the screen.

All of the previous information has described physically what is happening to the CRT. What this means simply is that the electron beam is actually drawing a picture on the CRT, line by line, by turning on and off pixels. This entire picture (frame) is being painted on the CRT 60 times a second. Sometimes this painting action is called "refreshing" the screen.

ABOUT PHOSPHOR

Perhaps the most critical element in the performance of a light pen is the type of phosphor used in the CRT. For optimum efficiency, it is recommended that a fast persistence phosphor be used with The Light Pen.

Since The Light Pen uses its photo detector to determine when the electron beam strikes a pixel within its field of view, it is important that there be adequate contrast between an "on" and "off" pixel. The greater the light the pixel gives off, and the faster it goes from on to off, the more accurate The Light Pen will perform.

If the phosphor dots glow and become black very quickly, the phosphor is said to have a short persistence. Most TV's and monitors have this rating.

If the phosphor dots turn on and slowly turn off, it is said that the CRT has a long persistence phosphor. Another common term for this is an "easy on the eye" CRT or one that reduces operator fatigue.

On a long persistence phosphor CRT it is sometimes easy to see the difference. The images seem to streak or "ghost" on the screen when you move them; i.e. the cursor on a word processing program will leave a trail as you move it from left to right.

It is important to know the CRT resolution and to determine if it has a slow or fast persistence phosphor when making a decision as to what type of light pen to use.

On color TV's and monitors, it is recommended that the color "clear red" not be used in conjunction with pen operation. The red phosphor emits such a low level of light over a long period of time, that the photo detector may not see the on-off contrast and the pen may appear not to function properly. This can be overcome by introducing another color, preferably blue with the red, which will give the light pen adequate contrast to "on" and "off" pixels.

HOW *The Light Pen* WORKS

The Light Pen contains a lens and a photo detector located in its tip. When the electron beam strikes the phosphor within the pen's field of view, the light emitted by the phosphor is focused through the lens and onto the photo detector. This action causes an increase in signal current and is transmitted to the computer.

The Light Pen contains a properly selected lens and photo detector as well as an aperture to enable it to detect the flash of the passage of the beam while ignoring the residual glow of the phosphor. When the flash is detected, the photo detector sends a signal to the computer and the position of the beam is kept track of by the horizontal and vertical counters which relay this information to a register. (See the *HARDWARE BACKGROUND FOR PROGRAMMING A LIGHT PEN* section in this manual).

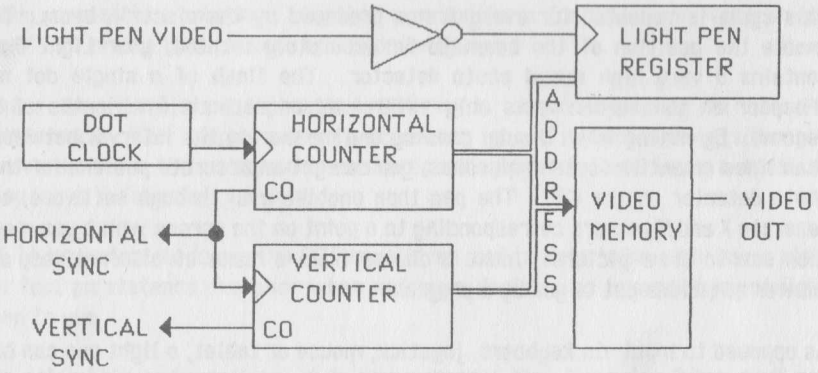
This cycle is repeated for every frame produced by the electron beam. To enable the position of the beam to be accurately located, your Light Pen contains a very high speed photo detector. The flash of a single dot of phosphor on the screen lasts only several micro seconds (millionths of a second). By noting when a scan goes by and measuring the interval between scan lines or entire screen refreshes, you can get an accurate position of the photo detector on the CRT. The pen then enables you, through software, to generate X and Y vectors corresponding to a point on the screen which you may then use to draw pictures, make a choice from a menu of alternatives, or answer questions put to you by a program.

As opposed to input via keyboard, joystick, mouse or tablet, a light pen can be a dramatically friendly peripheral. Imagine needing merely to point the pen at the screen in order to make a choice, or to draw a picture on the CRT as simply as with a crayon on paper. There are many diverse possibilities a light pen affords. You are only limited by your imagination.

HARDWARE BACKGROUND FOR PROGRAMMING *The Light Pen*

In the long run, a basic understanding of the relation of the hardware functions to the video and light pen portion of the computer will allow for better programming.

In very simple terms, the video generation circuit may be thought of as two counters, horizontal and vertical, driven by an oscillator called the *dot clock*. The counters in turn are used to access the screen memory which holds the image to be displayed.



The screen random access memory (RAM), which is addressed by the horizontal and vertical counters, determines whether each dot (pixel) will be "on" or "off", depending on the state of each corresponding bit in the screen RAM.

The output of the photo detector is amplified and that signal is compared to a threshold voltage. When the threshold is exceeded, an output pulse is generated and is gated by the computer, latching the address information of the screen RAM (horizontal and vertical counters) into a buffer to be read by the computer. In this way, the location of the pen on the screen is determined by the computer.

PROGRAMMING TIPS

To best program for your light pen, Inkwell Systems advises reading your computer manual and corresponding Programmer's Reference Guide thoroughly.

The following are general programming guidelines plus some specific information relating to the Commodore 64 family of computers. It assumes that the programmer has an understanding of Commodore 64 BASIC and at least a familiarity with the principles of 6502 machine language.

- As discussed in previous chapters, the electron beam "paints" the picture on the screen, and the VIC-II video controller chip keeps track of where the beam is on the screen. This chip monitors both the horizontal (X) and vertical (Y) positions.

- When the electron beam strikes the phosphor within the pen's field of view, the pen sends a pulse back to the VIC-II chip, which then saves the current X and Y positions of the electron beam on the screen in the two light pen registers. These registers are located at memory location 53267 (D013HEX) for the X location and 53268 (D014 HEX) for the Y location.

- The Light Pen Model 170-C nose tip switch is configured to look like a joystick switch to the computer. It may be checked by looking at bit 2 of memory location 56321 (DC01 HEX). When the switch is closed, this bit will be zero (0).

- Some means of visual feedback is important for interaction with the operator. Without this, it is difficult to know whether the light pen is aimed properly. There are several ways this feedback may be accomplished. The symbol the light pen sees may be flashed, intensified, displayed in inverse video, or marked with a cursor. Audio feedback, if available, is also an excellent means of acknowledging proper pen placement.

- There are two basic operational modes that are used with a light pen: the pick mode and the track mode.

In the pick mode, the operator places the pen tip over the area desired and actuates the switch. The operator then places the pen tip over another area and again actuates a switch. Each actuation of the switch will cause the software to perform some task, i.e., if drawing a straight line between two points, the line starts at the first switch actuation and ends at the second switch actuation.

PROGRAMMING TIPS

In the track mode, a target (such as a crosshair) is generated and displayed with its center located at the last point seen. As the pen is moved on the screen (or the second switch touched on Model 184-C), each new point is retained as part of the line and the target is kept centered as long as the switch is depressed.

- To overcome a light pen's inability to register location over a dark area, the CRT may be flashed (the entire screen is turned on) for one frame after the switch has been actuated. This will provide maximum signal for the pen while being unnoticeable to the operator (as long as the number of flashes per second is kept low).

- If a color CRT is being used, the color red is equivalent to black due to the red phosphor's long persistence. The blue phosphors have good response characteristics so the screen should be flashed with blue (or white) for maximum light pen response.

- Under certain conditions, such as an extremely noisy CRT, a noisy power supply, picture jitter, etc., the output from the light pen may vary with time for a given location. One way to control this is to require two or more consecutive hits to be made at the same location before the location is considered valid. This suggestion is especially important if there is no control of the environment or system with which the light pen is used.

The Light Pen DEMONSTRATION DISK: GETTING STARTED

Set up your Commodore 64, 64C, SX64 or 128 computer, disk drive and TV or monitor as described in their respective owner's manuals.

With the power OFF, disconnect anything connected to the joystick ports on the computer. Install The Light Pen by inserting the connector into the joystick port marked "Control Port 1" located on the right side near the front of the computer (or in the rear of the SX64). That is all there is to it!

Turn on the computer first, then the monitor and finally the disk drive. At this time you are ready to begin programming, running the Demonstration Disk or using The Light Pen with your favorite light pen compatible software.

LOADING *The Light Pen* DEMONSTRATION DISK

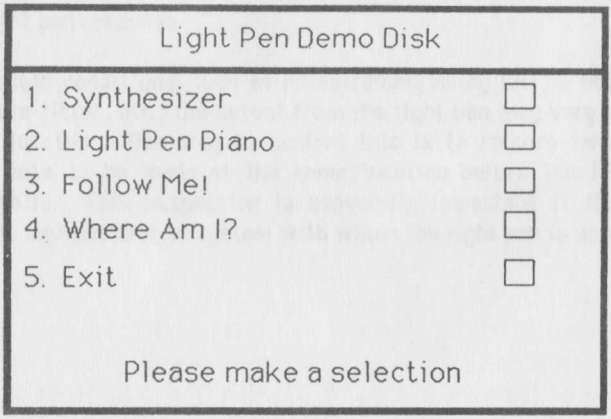
Follow the instructions in the *GETTING STARTED* section of this manual to ready your computer system and The Light Pen.

Insert The Light Pen Demonstration Disk and type:

LOAD "*", 8 <RETURN>

RUN <RETURN>

The following screen will appear:



Make your selection with The Light Pen.

To EXIT a program on the Demonstration Disk and choose another program, you must reboot.

PLEASE NOTE: For your convenience, a back-up copy of The Light Pen Demonstration Disk is provided on the back of the disk. For an additional copy, we suggest that an additional back-up disk be made using any one of the fine copy programs available on the market today. The Demonstration Disk is NOT copy protected.

WHERE AM I?

The *Where Am I?* demonstration is provided as a tool to determine the X and Y location of The Light Pen when the pen tip is pointed at the screen and the switch is actuated.

While the program is running, move The Light Pen to various parts of the screen. Notice that the values change. Notice also that the range of values may not be what you expect. That is because there has been programmed into the Demonstration an OFFSET to the actual pen position on the screen. This OFFSET "removes" the border area from the usable screen area the light pen sees and allows the pen to register each pixel in the X direction rather than a 2 pixel point as preset by the computer. You can see the modification if you run a listing on the program. Look for XOFFSET and YOFFSET.

By computing these offset values and changing the program to reflect these new values in this BASIC program, the X values read 0 to 320 as you move the pen from left to right and the Y values read 0 to 200 as you move the pen from top to bottom.

If you wish to determine the Character Position on the screen to which the light pen is pointing, divide the X and Y positions by 8. Character blocks are 8 pixels wide and 8 lines high. Program modification would be:

```
145 X=INT (X/8)
147 Y=INT (Y/8)
```

This new modification will allow the pen, when traveling along the X axis to register from 0 to 39. This is the character position on the line. The Y value will register from 0 to 24 as the pen travels vertically. This is the number of the text line to which the pen is pointed.

The Light Pen PIANO

This program is written entirely in BASIC and is designed to give you some insight into your own programs.

After prompting you for the parameters of a sound, the program draws a simulated piano keyboard on the screen which can then be "played" with The Light Pen. To change the sound parameters, Press <SPACE BAR>.

The Light Pen SYNTHESIZER

The Synthesizer program demonstrates the use of The Light Pen with a set of simulated slide controllers. By moving the controls up and down on the bars, you can change the frequency, pulse width, filter, cut-off frequency, and amplitude of the SID synthesizer output.

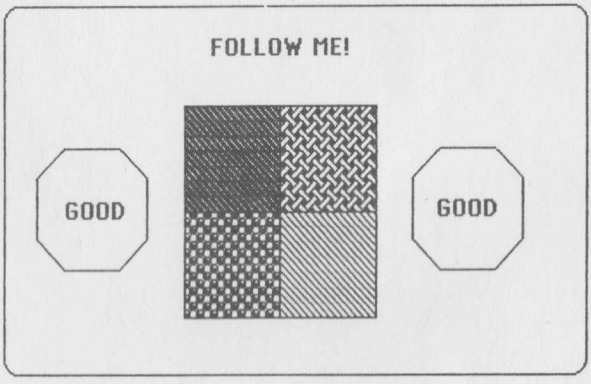
This program is written entirely in BASIC and demonstrates a simple, yet powerful application of the sprite graphics capability of the Commodore 64 using BASIC programming techniques.

FOLLOW ME!

This program will demonstrate the ease of use of a light pen for game applications. It also demonstrates the use of a flash when handling red applications on a color CRT.

After you choose Follow Me!, the program will ask if you have a color or monochrome display. For a color monitor or television, press <RETURN>. If you have a monochrome monitor or a black and white television, press "N" <RETURN>.

The game screen will appear:



The computer will create a color/tone combination. It will begin with one combination and, for each correct sequence repeated back, will add one additional sequence.

TO PLAY:

Repeat the color/tone sequence played by the computer by touching the squares with the light pen. When you make a mistake, the computer will tell you your score and play back the last sequence.

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