Z A P

(Z 8 0 A N I M A T I O N P R O G R A M)

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for

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I N T R O D U C T I O N

OVERVIEW

ZAP controls all parameters of Laser Media's imaging systems. It is designed to be pre-programmed or to be played in real-time, using highly reliable and accurate digital effects. There are four levels of interaction with ZAP:

KEYS (Level-Ø) allows you to play pre-programmed logo manipulations, disco graphics, and beam effects at the touch of a key.

SETEM (Level-1) allows real-time manipulations of all imaging parameters in the ZAP system: size, color, rotations, special effects and more.

MAIN (Level-2) is a programming language which allows you to create and edit a series of commands and save them in computer memory for later execution. Several computers may be interconnected to produce complex, multiple images.

LV3 (Level-3) utilizes a development computer to create pre-compiled programs which run faster and smoother than Level-2 programs. These programs are burned onto EPROM chips or downloaded into computer memory.

DOCUMENTATION NOTES

Quotation marks are used to delimit commands from text. "45 GAIN" signifies the MAIN command **45 GAIN.** DO NOT type the quotes. Quotation marks also surround single key strokes.

Brackets may also denote a single key stroke, as in:

<CTRL>	Control key
<ESC>	Escape key
<SPACE>	Space bar
<RUB>	Rubout key
<RET>	Return key
<TAB>	Tab key
<BS>	Backspace key
<LF>	Linefeed key

The caret symbol (^) combined with a letter denotes a control character such as ^X. The <CTRL> key should be held down while striking these letter keys.

Lower case letters within a command mean that a number or letter is required by that command: "n GAIN" is one example; "g x y GXY" is another, requiring three numbers in proper sequence for Gain, X coordinate, and Y coordinate.

The number zero is differentiated from the letter O by a diagonal line, as in "Ø GAIN".

DEDICATION

This manual is the result of the combined creative energies of the following beings: Paul Rother, Allen Yates, Steve Matthews, Barbara Inatsugu, Brian Samuels, Joe Fitzpatrick, Matthew Hausle and John Goss, who, in pushing the limits of laser display to an art, have each outrun the speed of light.

TABLE OF CONTENTS

M A I N

H A R D W A R E

A P P E N D I C E S

I L L U S T R A T I O N S

S E T E M

SETEM allows real-time manipulation of all imaging parameters in the ZAP system. It can be used for the manual control of live laser light shows, but is most useful as a starting point towards full-fledged laser programming. Even seasoned LV3 programmers use SETEM to "sketch out" effects.

It is helpful to think of SETEM as a way to SET values into various registers which directly control the image ZAP displays.

ENTERING SETEM

Make sure the IMAGEN computer, the terminal, and the scanner driver amplifiers are correctly interconnected. Power the computer on first, THEN the scanner amplifiers. This procedure will prevent damage to amplifier circuits. Reverse the order when powering down your system.

If the terminal screen appears blank, check to make sure the terminal power is on. If the terminal displays an error message, press the white RESET button on the IMAGEN. The RESET button should also be used if ZAP ever "freezes-up" or crashes.

You should now see the ZAP screen displayed on the terminal: a forbidding wall of glowing, cryptic runes. Don't panic. The ZAP screen will be demystified and accessible by the end of this chapter.

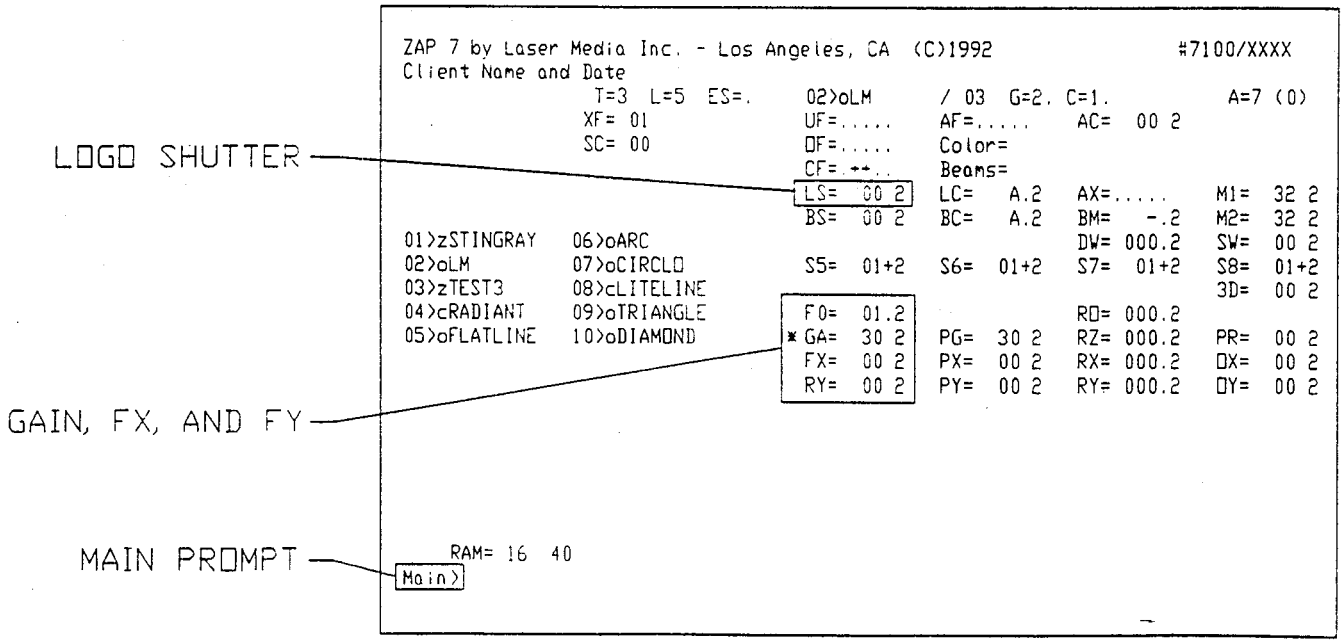


Figure 1.1 The ZAP screen with the MAIN prompt and the LS, GA, FX, and FY registers noted. The SETEM cursor (*) can be seen to the left of GA.

Direct your attention to the lower left-hand corner of the screen where you will find the "Main>" prompt. This prompt tells you that you are operating in MAIN (Level-2). To enter SETEM (Level-1), either type the command "SETEM" followed by <RET> or simply hit the "]" (right bracket) key. Enter SETEM now using one of these methods. Notice that the prompt has changed to "Setem>". To exit SETEM and return to MAIN hit <RET> or <ESC>. Practice these various ways of entering and exiting SETEM.

REGISTERS

When you are in SETEM, each letter on the keyboard will move the SETEM cursor, displayed as an blinking asterisk (*), around the various registers that control ZAP. In SETEM, try hitting various letter keys and identify the "*" cursor. Observe that by moving the cursor you are activating different registers.

Note: if your system utilizes a laser table with a beam shutter and actuators, type "BOPEN n BEAM" <RET> at the MAIN prompt (where "n" is the number of the beam position of your graphics scanner) before continuing.

LS (Logo Shutter)

Hit the "G" key. Notice that the "*" cursor moves to a register called LS. This is the register that controls the logo shutter. You must open the shutter before you can see an image. After reset, the value in the register is Ø. A properly adjusted shutter will be fully open when a value of 11Ø is placed in the LS register.

Here are two important commands for increasing or decreasing the value of the active register:

"."	(period) will increase the value of the active register in single steps.
","	(comma) will decrease the value in single steps.

Hit "." now to increase the value in the LS register. Hold the key down to increase the value quickly. If your laser is on and properly aligned, you should see the Laser Media logo (Lasermedia) begin to fade in somewhere around the number 2Ø and continue to increase in intensity until the shutter is fully open at 11Ø. The computer will beep to let you know that you have reached the maximum or minimum values allowed for a register.

Try to increase the value to 128. Try to decrease the value (using ",") to -1. (Ø and 127 are the extreme values allowed in the LS register.) As you will see, many registers have a maximum value of 127.

Other keys that affect the value in the active register are:

<SPACE> will "zero" a register. Set a value into the LS register; then try pressing the space bar.

"1" through "Ø" are "preset" keys. These can be used to quickly change the value in a register and (in some cases) arrive at special preset effects. The specific values for each preset depend on the register.

Try each of the ten preset keys and observe the value of LS.

Everything you have just learned will apply to every register on the ZAP screen. These basic principles will give you complete control over fantastic laser effects.

You may have noticed that the SETEM prompt (in the lower left-hand side of the ZAP screen) will display your last 24 key strokes, 'wrapping around' after the 24th key. This is only displayed for the user's reference.

GA (Gain or Logo Size)

Check to make sure LS is fully opened (use the preset key "Ø"). Locate the three lower left registers GA, FX and FY on the ZAP screen (see Figure 1.1). These are extremely powerful registers. They can be accessed by hitting the "Q", "A" and "Z" keys, respectively. Move the * cursor to each of these registers.

Now, move the * cursor to the GA register. This register controls gain (size) of the displayed logo. Use the single increment keys, <SPACE>, and the preset keys to change the value in the GA register, and observe the effect on the scanned logo.

Notice that the extreme values of this register are -127 and 127. Negative numbers invert the logo. Note also that the two extremes may cause the scanners to "chatter." It is a wise practice to approach these extreme values cautiously (using the single increment keys). If your scanners sound too noisy there, reduce the gain to protect them from excessive wear. Use common sense when operating the scanners at any extreme.

Another useful key is:

"-" (minus) will toggle the value of the active register between positive and negative. Try hitting "-" with different values in GA.

FX and FY (Horizontal and Vertical Positions)

In ZAP, X coordinates move a logo right to left; Y coordinates move a logo up and down. By combining these two values, you can place a logo exactly where you want it on the field of projection.

Move the * cursor to FX. Change the value of that register. Note the extreme values of -127 and 127. Also notice that if the logo gain is too large, the image will "squash" as it approaches these extremes. (Reduce GA to correct this problem.)

Move the * cursor to FY. Repeat your experiments using the commands you have learned so far.

Suppose you want to return all your registers to their original (default) values (3Ø Gain, shutter closed, FX and FY at Ø). You can activate each register, one at a time, and change their values OR you can restore their default values using:

"_" (underscore) to reset all registers to their default values. This is referred to as a 'soft reset.'

SW (Logo Scanning Speed)

Open the shutter again and increase the gain of the Laser Media logo to 75 using the preset keys.

The "L" key will activate the SW register. This register affects the speed at which the computer scans an image. You can use it to slow down the rate at which ZAP scans the digitized points of any logo.

Use "." to slowly increase the value in SW. Notice that the logo begins to flicker. Your eye is beginning to perceive the single beam of light scanning the shape of the logo at a very high speed. Slow the scanning further by increasing SW to 3Ø. Close your eyes and blink them open briefly (like a camera taking a very quick exposure). You will "catch" the piece of the logo that has been scanned in that short time. The logo is not a complete picture like a still frame from a movie; but rather a single beam of light moving fast enough to fool the eye into seeing a complete, continuous image. Slowly increase SW to its maximum. You can now clearly see how the scanners are moving the beam of light to each point of the digitized image.

Note: besides creating glittering effects and unique transitions between different logos, SW can be used to smooth rotations, create outstanding color sequences, and clean up glitching on multiple-image harmonies. However, since you are slowing down the scanning rate whenever you use SW, ZAP may execute GOBYs and other MAIN commands at higher speeds. It is a good practice to

always return SW to Ø (and the computer to normal operating speed) whenever the SW effect is not visibly in use.

SW works on an exponential scale:

SW = Ø	full	speed scanning
SW = 16	1/2	speed scanning
SW = 32	1/4	speed scanning
SW = 64	1/16	speed scanning
SW = 8Ø	1/32	speed scanning
SW = 96	1/64	speed scanning
SW = 112	1/128	speed scanning
SW = 127	really slow	scanning

LC (Logo Color)

Altering color requires that you have a full color system or, at the very least, an argon laser. Laser Media systems create color by **subtracting** certain wavelengths of light from either a white or blue-green argon light source. They do this by placing color filters in the path of the laser beam. To create red, you subtract all the green and blue from the light; to create green, subtract the red and blue. The various combinations of these filters allow for 6 distinct colors, plus white and black.

The LC register is just to the right of the LS register on the ZAP screen. The key to activate this register is just to the right of the one you used to activate LS. You used "G" to activate LS, so use the "H" key now to activate LC.

Change the value of this register by using the preset keys. Do you notice a difference? This register displays letters instead of numbers. Each letter is the equivalent of a combination of filters which create a color. Here is a list of these letters and the colors they represent:

A,H	white or brightest	(no filters)
B,I	red	(minus green and blue)
C,J	green	(minus red and blue)
D,K	blue	(minus red and green)
E,L	cyan	(minus red)
F,M	magenta	(minus green)
G,N	yellow	(minus blue)
Z	black	(all filters)

Letters H through N add an optional diffusion filter or other effect on some systems (diffusion, for example, creates a neon glow effect rather than a crisp line). In systems without this option, these letters call up the standard colors.

Letters A through J can be accessed with preset keys "1" through "1Ø". K through N and Z can be accessed using the single increment keys. <SPACE> gives you the value A, the unfiltered beam. (Letters O through Y are not currently used.)

RZ, RX and RY (Spinning Logos Around Their Center of Rotation)

These registers are slightly more complicated than those we have already seen, but they permit very powerful manipulations. RZ will spin a logo clockwise or counter-clockwise; RX will spin the logo side to side; and RY will spin it top to bottom. Remember how GA, FX and FY were accessed by the "Q", "A" and "Z" keys? RZ, RX and RY are accessed by the "E", "D" and "C" keys.

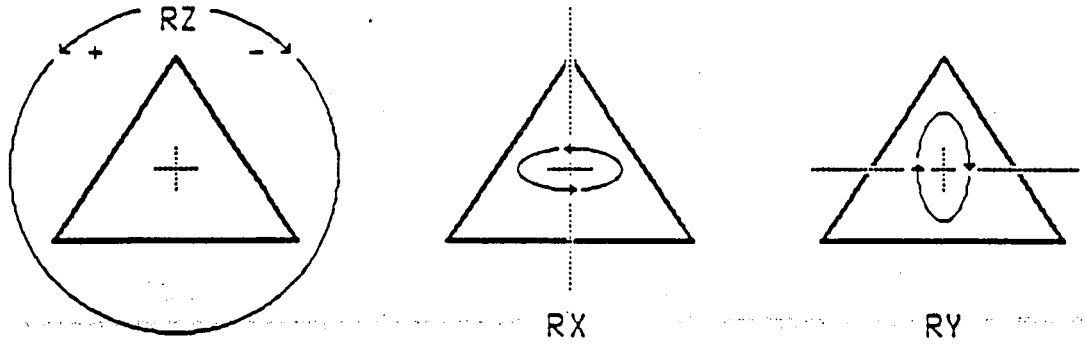


Figure 1.2 Z rotation, X rotation, and Y rotation axes

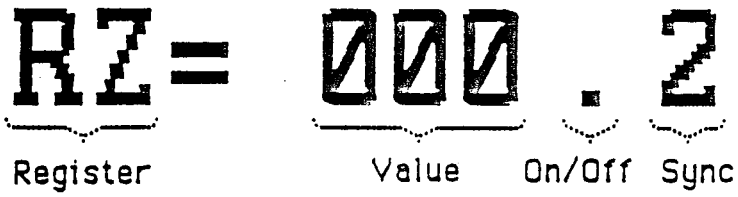


Figure 1.3 The RZ register

Note: each of these registers have three digits (currently set to zero) with extreme values of -512 and 511. However, when you increase these registers past 511 (or decrease them past -512) you will automatically 'roll over' to the opposite extreme (you are actually going around in a very large circle). Also, note that a "." follows these three decimal spaces. The "." signifies that the register is turned off. No matter what value you place in these registers, nothing will happen until you turn them on.

The commands for turning registers on and off in SETEM are:

";" (semi-colon) will turn the active register on.

"'" (apostrophe) will turn the active register off.

Turn on the RZ register now. A "+" will replace the ".", telling you the register is on. Slowly increase the value of this register to 2Ø using the single increment key.

Start/End Point Break Up

Note that the Laser Media logo is beginning to "break up" at the letter L. The logo is spinning so fast that by the time the laser beam has completely outlined the letters, the start point (hidden in the letter L) has moved. The beam must then skip to the new start point and begin to outline the logo again. Generally speaking, simple graphics work best for rotations. The fewer the points in a logo, the faster it will be outlined. The Laser Media logo is made up of 674 points. Sometimes, adding a little SW can help correct break up. However, break up is not always undesirable; it can be used intentionally to create fantastic abstract, liquid, and vibrational effects.

Changing Logos

Let's rotate a simpler logo. The ZAP ROM chip includes the CHIEF set, which is a series of standard geometric graphics and Wordfire fonts. Most likely, your system has a selection of other logos and graphics as well.

You can switch between logos in your system by using the following control characters:

^N will display the next graphic in your system.

^B will move back a graphic.

Use these commands to cycle through your system's graphics. As you do, locate the place on the ZAP screen which displays the name of the current logo (see Figure 1.4). Each graphic has a "cue" number, a prefix (in lower case), and a name (Figure 1.5). The cue number signifies the current location of the graphic or program in your system. This number may change according to the number of graphics you have and their order on EPROMS or in ZAP's memory. The prefix and the name of each graphic will never change. Prefixes identify the type of cue.

The possible prefixes are:

"o"	logo (or graphic)
"a"	animation
"c"	Wordfire font
"z"	pre-programmed LV3 TOPA cue
"w"	pre-programmed Wordfire message
"e"	KEYS program or a flight path

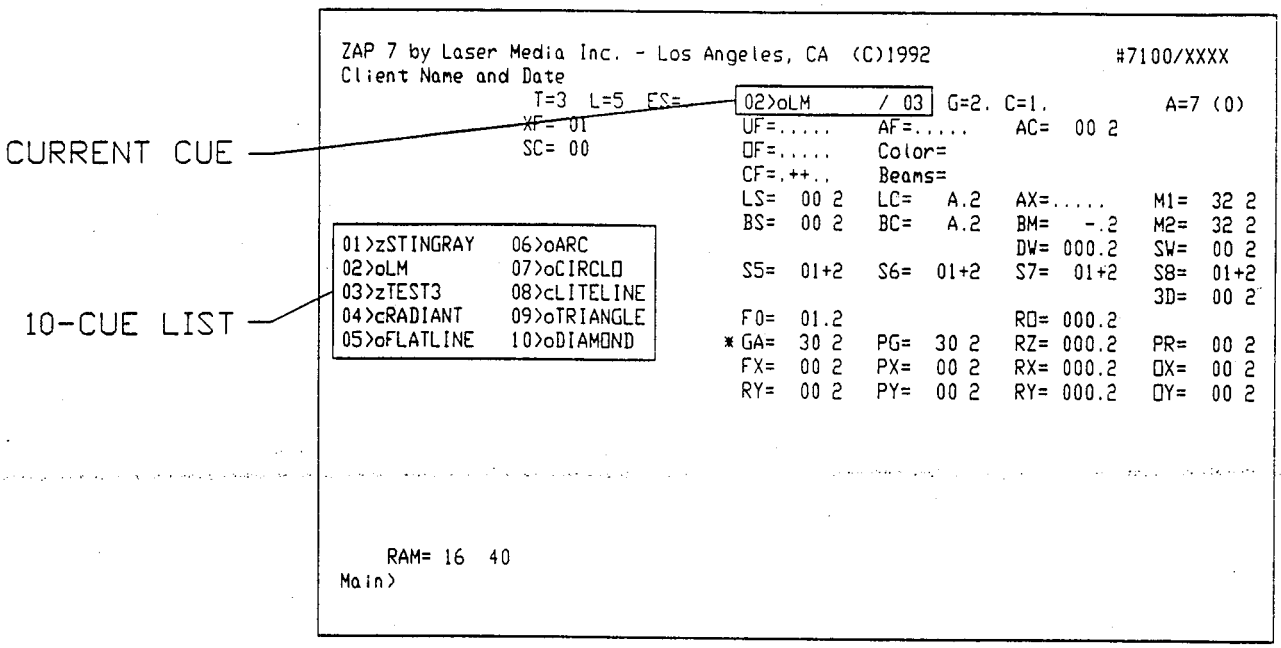


Figure 1.4 The 10-cue list (middle left) and the current cue (top middle) are noted.

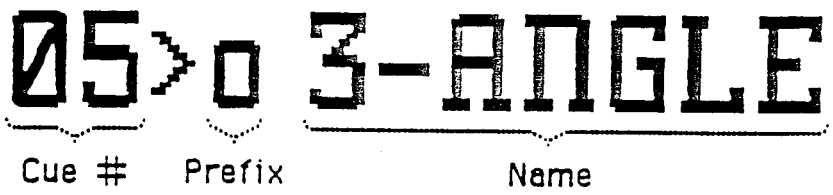


Figure 1.5 Cue number, prefix, and name

On the left side of the ZAP screen is a two column list of ten of the cues in your computer. You can page this list forward or backward using the two keys:

<LF> (linefeed) pages the cue list forward by 1Ø.

"\" (back-slash) pages the cue list back by 1Ø.

Try this now. Note that all logos, TOPAs, Wordfire fonts, etc. are displayed here, but that ^N and ^B only display logos and animations.

In addition to using ^N and ^B to cycle through logos, you can select a specific graphic from SETEM or MAIN by using its cue number or name.

<RUB> when struck will display the "ncue>" (meaning "next cue?") prompt. Type in the name (without the prefix) OR the cue number of the graphic you want and hit <RET>. The selected logo will be displayed.

Locate the logo called "TRIANGLE" by paging through the cue list. Determine its cue number. Select the graphic using <RUB>.

Rotation Effects

Remember that the "-" (minus key) will toggle the value of the register between negative and positive. Try this now (make sure RZ is turned on). It is possible to adjust the contents of rotation registers to speed up, slow down, and reverse their effects in real-time.

Turn off the rotation with "'". If the value in the register is positive, the logo will complete its rotation and then come to a stop. If the value is negative, it will immediately jump to its default position. Turn the rotation on and off several times with both positive and negative values in the register to get a feel for this difference.

Find and select the graphic called "HEART." Now, with RZ turned on at a medium speed, hit <SPACE>. What happens? When you zero a rotation, the logo will stop wherever it happens to be. To restore the logo to its default position, increase the value in the register again and THEN turn the rotation off. Practice this method of 'freezing' rotations.

With RZ turned on, try the preset keys. In rotation registers, the preset keys provide values to create special "harmonic effects." Here is a list of those values and their effects:

Key	Value	Effect
1	1Ø	slow rotation
2	32	fast rotation
3	64	16 images, "frozen 16 harmony"
4	128	7 images, "frozen 7 harmony"
5	171	6 images, "rotating 6 harmony"
6	2Ø4	5 images, "rotating 5 harmony"
7	256	4 images, "frozen 4 harmony"
8	341	3 images, "rotating 3 harmony"
9	41Ø	4 images, "rotating 4 harmony"
1Ø	-512	2 images, "frozen 2 harmony"

PG, PX, AND PY (Offsetting the Center of Rotation)

You may have noticed that most (but not all) of the logos spin around their center point. This is because they were digitized at the center of a digitizing tablet. The center of the tablet determines the center axes of rotation of the graphic. However, you can offset this center of rotation to create a wide range of rotational effects.

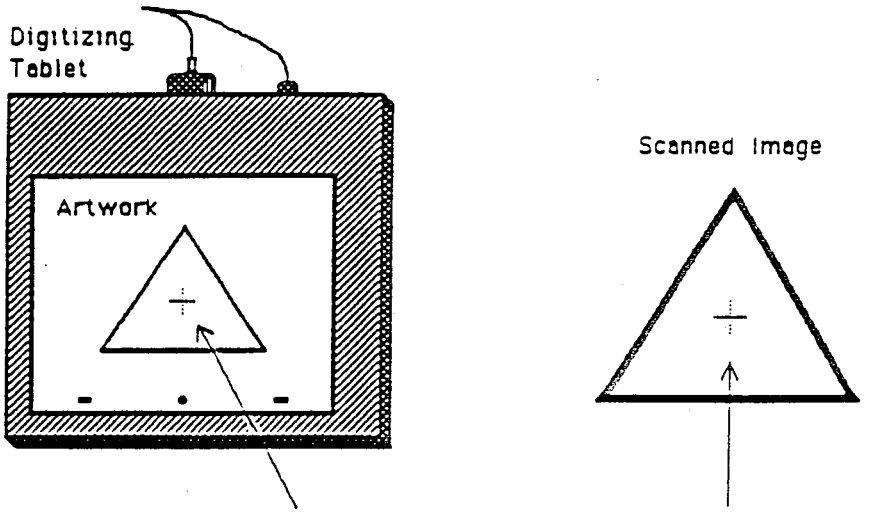


Figure 1.6 Placement of the artwork on the digitizing tablet determines the default center of rotation.

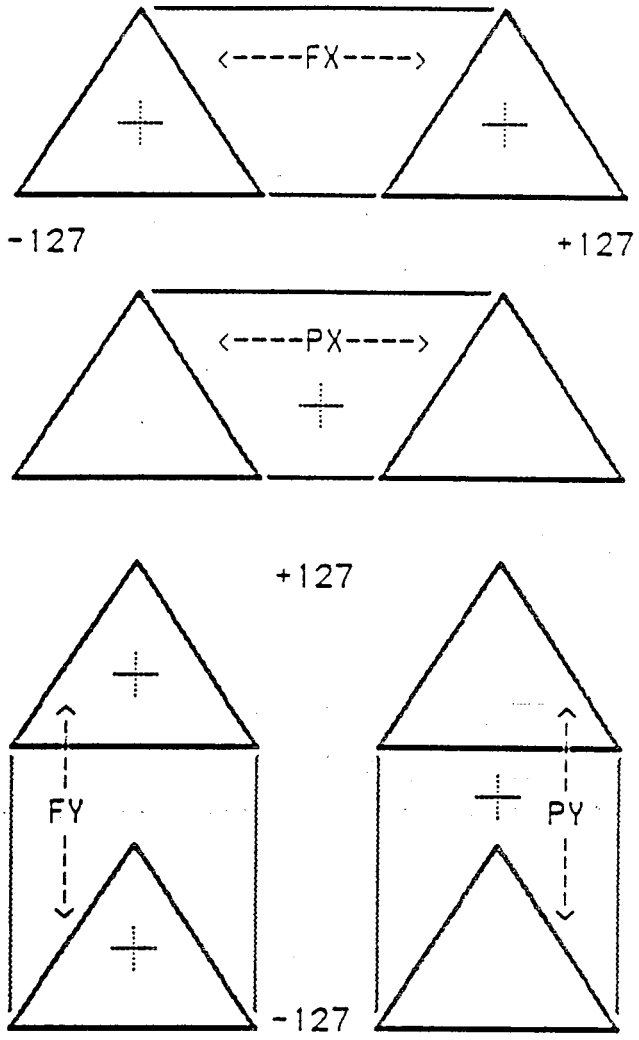


Figure 1.7 FX and FY will shift the image AND its rotation axes. PX and PY will shift the image AWAY from its rotation axes.

PG, PX and PY are accessed by the "W", "S" and "X" keys. PG controls "position" gain. Think of it as the "strength" of the offset effect. If PG is Ø, no offset occurs. If PG is a small number, a small displacement occurs. If PG is close to its extremes of -127 and 127, a much greater effect occurs. PG always defaults to 3Ø (a small effect) when the computer resets.

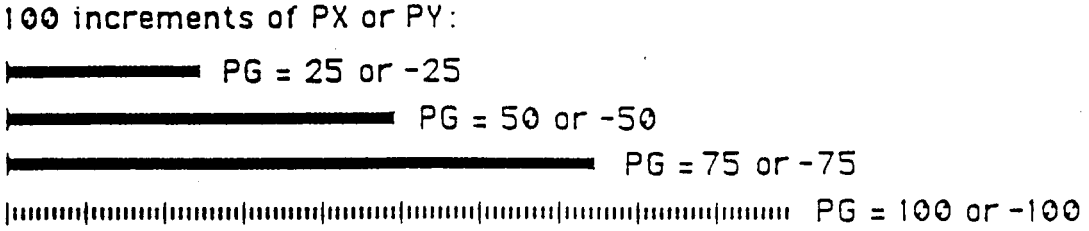


Figure 1.8 The value in PG determines the strength of PX, PY offset.

Here is an exercise to demonstrate these registers:

1. Set PG to 5Ø using the preset keys.

2. Turn off RZ and turn on RY with a value of 1Ø.

3. Use the "TRIANGLE" graphic again at 3Ø gain. Notice that the triangle is spinning around its center on the Y axis.

4. Now, move the SETEM cursor to PY. Use the single increment keys to increase and decrease the value of PY. What happens? You are shifting the center of rotation on the Y axis. Increase the value until the triangle is rotating around its base.

6. Decrease the value until it is rotating around its point.

7. Return the active cursor to RY and play with the preset keys and "-". Also, use FX and FY to move the rotating graphic around. Notice that FX and FY move both the graphic AND its center of rotation (see Figure 1.6).

After experimenting, perform a soft reset using "_" (underscore). The registers will return to their default values.

Refining Rotations

Rotate the triangle on the Z axis. Offset its center of rotation so that it will rotate exactly on one of its points. Play with the preset keys to find a pleasing harmony on the Z axis. You will create something that looks like a pinwheel.

Next, turn on RX or RY. Use the preset keys and the single increment keys to embellish your rotation.

There are two more ways to improve your effect. You may notice some "glitching" of the image. This is a problem similar to breakup. Correct this by adding just enough SW so that the glitching disappears. Rotations are also much smoother and easier on the scanners if the graphics rotate around their start/end points. To find the start/end point, first stop all rotations, then locate the point using these control characters:

"^G" to grow a logo from its start point.

"^C" to collapse a logo into its start point.

Try these effects. Locate the start/end point of the triangle. Now, turn the RZ rotation on at a low value and adjust PX and PY until the start point is at the very center of the rotation (if it wasn't already). Notice how the scanners immediately quiet down. They don't have to work so hard jumping from one end point to the next start point. This is the key to making silky-smooth rotations.

Synchronization of Registers

Each register may be linked to various "syncs" that control the speed of changes within that register. Syncs affect the speed of shutter fades, changes in size, color, and rotation velocity. Syncs can also be used to synchronize the speeds of different registers so that they will perform their effects in unison.

You may have noticed that following the values in each register is a one digit slot currently displaying the numeral "2". This tells you that the register is set to Sync 2 (see Figure 1.3).

Here is a list of all available syncs:

Sync Ø - no change, "dead sync".
Sync 1 - changes every time <TAB> is struck.
Sync 2 - changes with each complete scan of the current graphic (low point logos will scan faster than high point logos).
Sync 3 - changes every 1Øth of a second.
Sync 4 - changes as fast as possible (constant).
Sync 5 - variable (S5 register).
Sync 6 - variable (S6 register).
Sync 7 - variable (S7 register).
Sync 8 - variable (S8 register).

Variable syncs have extreme values of 1 and 99.

Reset the computer and rotate "TRIANGLE" on the Z axis at a velocity of 3Ø. Change the graphic and notice that more complex graphics (which have a higher number of points) will rotate more slowly. This is because RZ is set to Sync 2 and Sync 2 is based on the time it takes to complete one scan of the logo. Logos with more points take longer to scan.

To change the sync of a register:

> activate that register with the * cursor, then hit <SHIFT> plus the appropriate number key for the sync you want to assign.

Set RZ to Sync 3 now by hitting "#". Note that the register now displays 3 in the sync slot and the graphic moves one degree of rotation every 1Øth of a second. When you change graphics they will now all rotate at the same speed.

Set RZ to Sync Ø. This is another way to freeze a graphic in mid-rotation.

Set RZ to Sync 1. The rotation will advance every time you hit <TAB>. This is useful for live effects being controlled by an operator.

Set RZ to Sync 4. This sync moves as fast as possible. Change the velocity of rotation with the preset keys and observe the "spaghetti" effects caused by Sync 4 (which can often be used creatively).

S5, S6, S7, and S8 (Variable Syncs)

Syncs 5 through 8 can be customized to create flexible timings. They are activated by the "Y", "U", "I" and "O" keys.

Let's say you want RZ to rotate one degree every 3Øth of a second. Move the SETEM cursor to S5 (Sync 5) and set it to Sync mode 3 (every 1Øth of a second). Now, change the value of S5 to 3 (3 x .1Ø = every 3Øth of a second). Set RZ to Sync 5 and the rotation will now occur every 3Øth of a second. Increase the value in S5 to 1Ø (1Ø x .1Ø = 1) and RZ will now rotate at one second intervals.

If Sync 2 moves a little too fast, create a custom sync that will change at every 2 logo scans instead of every single scan. Use S6, which should be set to Sync 2 by default, and increase its value to 2 (2 x 1 logo scan = 2 logo scans). Set RZ to Sync 6. Graphics will now rotate at every second scan. Play with the value in S6.

If Sync 4 moves a little too fast, slow it down by creating a custom sync. Set Sync 7 to Sync 4, then increase its value.

Note: a variable sync may only be set to a sync with a number lower than itself (Sync 5 may be set to Sync Ø through 4, Sync 8 may be set to Sync Ø through 7).

RO, PR, OX, and OY (Orbiting Logos Around a Central Point)

RO stands for rotation orbit. It is activated by the "T" key. RO is similar to PG in that no effect will take place until this register is turned on and a value is assigned to it. OX and OY determine the width and height of the orbit. PR adds a perspective effect to the orbit. PR, OX and OY are activated by striking "R", "F" and "V".

Reset the computer using the underscore key. Call up the "HEARTY" logo. Use the preset keys to give OX a value of 1ØØ and OY a value of 5Ø. Then turn RO on and slowly increase its value using ".". The "-" (minus key) can be used to reverse the direction of rotation. The preset keys provide the standard harmonic effects. Add just enough SW to eliminate break up.

Now, move the active cursor to PR. Increase the value using ".". A perspective effect is created. Increase PR to 127 using the preset keys. The perspective effect recedes into the distance. Toggle the value to negative using "-" and the effect will occur in the foreground. Positive values in PR create receding rotations and negative values create advancing rotations.

Note: as a rule, FX and FY may not be used during RO effects. Zero FX and FY when using RO. PX and PY may be used instead to position the effect and add interesting offset rotational effects.

HIDDEN REGISTERS

RZP, RXP, RYP, and ROP

In addition to the visible registers on the ZAP screen, there are four hidden registers associated with RZ, RX, RY and RO. These are "position" registers (signified by the added letter "P") and can be used to accurately assign a specific degree of rotation to a graphic. The position registers may be used INSTEAD of the regular rotation registers (which simply turn rotations on and off at a given speed). They may not be used simultaneously with their corresponding rotation register (i.e. RZ should not be used when RZP is being used). If you use a position register, check to make sure its corresponding rotation register is set off and zeroed.

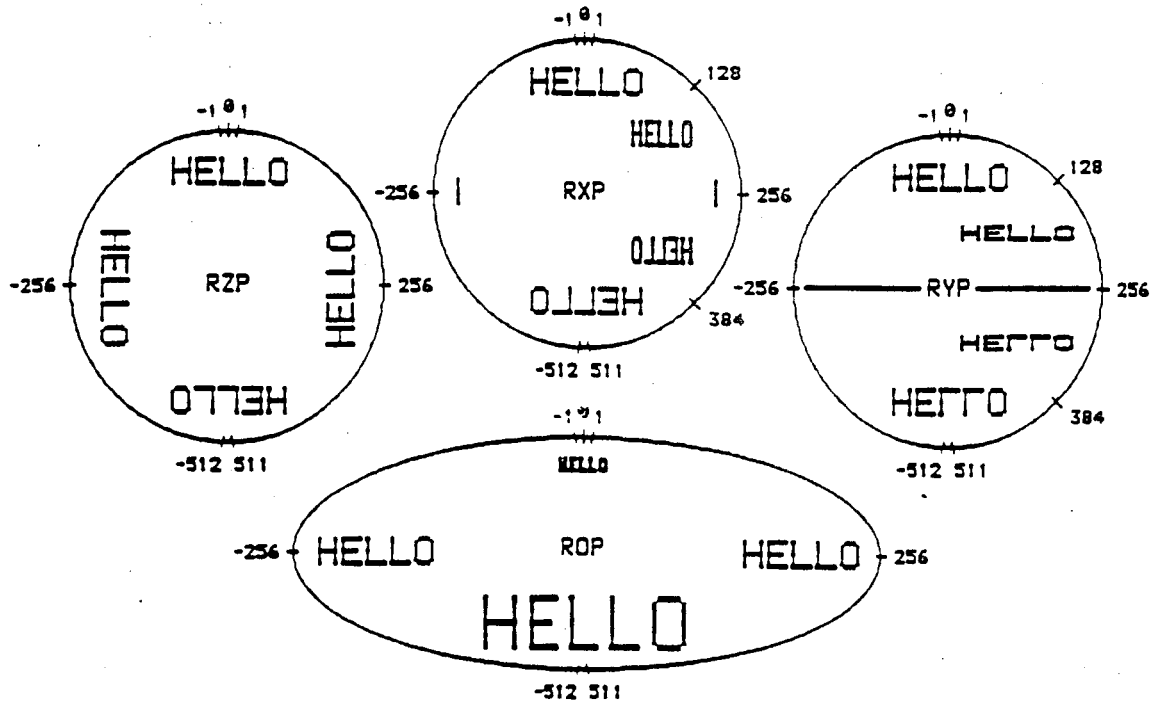
To access these registers from SETEM use:

">"	(greater-than) to move the * cursor forward through all registers including the hidden ones.
"<"	(less-than) to move the * cursor backwards.
"E" "<"	to activate RZP.
"D" "<"	to activate RXP.
"C" "<"	to activate RYP.
"T" "<"	to activate ROP.

Move the * cursor to RZP (make sure RZ is off and zeroed). Use the single increment keys to increase and decrease the value in RZP: At Ø the graphic is displayed in its normal position; at 256 and -256 the graphic is rotated by 9Ø degrees; and at 511 or -512 the logo is upside-down.

Try the RXP and RYP registers. At 256 or -256 the graphic is rotated flat on its X or Y axis. Remember, these axes can be shifted using PG, PX and PY so the logo can flatten to any point or edge. Also remember, RZP will rotate the X and Y axis.

To use ROP, you must also place values into PR, OX and/or OY.



ADDITIONAL REGISTERS

There are still more registers that may be accessed in SETEM. These are described below:

BS, BC, and BM (Beam Shutter, Beam Color, and Beam Control)

These registers are roughly equivalent to LS and LC, except that they control laser optical tables used in large shows and presentations.

BS, the beam shutter, usually controls the light to the whole optical table. It is activated by the "B" key.

BC, beam color, will display the current beam color in use. Beam color must be selected in MAIN.

BM assigns beam positions and colors. It is activated by the "M" key. This register usually displays a "-" (hyphen). This signifies a "clear" position in which the laser beam bypasses all optical effects. Preset keys supply beam positions 1 through 1Ø and <SPACE> provides "-", the clear position. This register can also display letters signifying color sequences which may be assigned in MAIN.

DW (Dynamic Loop Speed)

DW (activated by the "?" key) is a delay register similar to SW, except that while SW slows ZAP's image scan speed, DW slows the dynamic update cycle which controls execution of of MAIN commands, GOBYs, TOPAs, and color/beam sequences.

This register is intended for use with registers in sync mode 4 (update as fast as possible), although higher DW values may also slow updates for registers in sync mode 2 (depending on the point count of the graphic). It is intended primarily for controlling the speed of color chops and locks which run at sync mode 4 in 'no update' mode. More information on the use of this register can be found in the Color Effects section in the MAIN chapter of this manual.

DW has a range of 0 to 255, and can be turned off or on. Turning the register on extends the delay induced by DW. Note that turning the register off DOES NOT disable the delay, but only shuts off the 'extended delay' feature.

M1 and M2 (Motor Speeds)

M1 and M2 (keys "J" and "K") affect the motor speed of special effects on the optical table such as lumia or rotating diffraction. Values range from -127 to 127, but usually Ø is a dead-stop and a medium number (3Ø) is maximum speed.

3D (3D Depth)

The 3D register ("/" key) is used to set the 3D depth value in systems equipped to display three-dimensional images using polarizing filters.

3D works exactly like the M1 and M2 outputs.

FP (Flight Paths)

Flight paths are digitized much in the same way a graphic is created -- using a digitizing tablet and a mouse. These paths are used exclusively in LV3 programming for creating smooth and complex movements. FP is activated by the "P" key. Its extremes are 1 and 99. It controls the speed at which a flight path is executed.

Flags

See MAIN, page 3.28 and Appendix H for a description of Flag registers. Use "<" or ">" to access "flag" registers. The preset keys will produce the following effects:

1	-bit 1 off	5	-bit 3 off	9	-bit 5 off
2	-bit 1 on	6	-bit 3 on	Ø	-bit 5 on
3	-bit 2 off	7	-bit 4 off		
4	-bit 2 on	8	-bit 4 on		

XF (Firework) and SC (Scene)

Near the upper left corner of the SETEM screen are the XF and SC 'registers'. XF displays the most recent value sent to the Firework output via the MAIN command 'XFIRE' (described in the next chapter). SC displays the number of the most recently saved or recalled scene (also described in the next chapter).

These displays are not actually registers, and therefore they cannot be directly addressed from SETEM or MAIN. They are only used to display information.

K E Y S

KEYS allows someone who knows very little about the Laser Media system to play the terminal keyboard as a real-time visual instrument. Each key will produce an effect which has been pre-programmed in LV3. Before using KEYS, you should read and understand the SETEM chapter of the ZAP manual. Appendix C contains a complete listing of KEYS commands.

KEYS programs are stored on separate chips, which may or may not be part of your system. If you do not have KEYS, skip this chapter. If you wish to purchase KEYS, contact your Laser Media representative.

The most enjoyable way to learn KEYS is by experience, so turn on some music and have fun!

KEYS is currently made up of the following programs:

Disco KEYS

"DK1" mandalas of simple geometric shapes which rotate off-center.

"DK2" mandalas specifically designed for spinning around their center.

"DK3" glittery designs which use SW (slow scanning).

"DK4" designs which use RO (rotation orbits).

"DK5" simple effects which can be used with other KEYS routines.

Video Emulator KEYS

"VEK" mimics effects available on digital video systems: zoom-ins and outs, spin-ins and outs, fades, and various other "reveals." These effects are great for use with client or club logos.

Shiva Emulator KEYS

"SEK" can replace the Laser Media "Shiva" display unit to allow beam play, rhythmic sequencing, and color effects.

ENTERING THE KEYS PROGRAM

"KON"	turns KEYS on and activates the "[" key.
"["	(left bracket) enters KEYS mode (just as "]" enters SETEM). Use <RET> or <ESC> to exit KEYS.
"KEYS"	enter KEYS (same as "[").
"KOFF"	turns KEYS off and disables "[" to prevent accidental activation of KEYS.

Before entering KEYS, you may type the name of the KEYS program ("DK1" to "DK5", "VEK", or "SEK") that you wish to enter directly. Once in KEYS, use <RUB> (see SETEM, page 9) to change KEYS programs or to select specific graphics to manipulate.

THE PERMANENT FORMAT

All KEYS programs have these functions in common:

"A" through "Z"	each letter recalls a pre-programmed effect.
"1" through "Ø"	call their corresponding beam position on the laser table (Ø = beam 1Ø).
"-"	(minus) "clear beam" position.
"!" through "&"	(<SHIFT> "1" through "7") beam positions 11 through 20, respectively.
"*", "(" and ")"	call BM colors green, cyan, and blue, respectively.
"/"	recall saved LC sequence by number (1 - 8).
","	(comma) LC on.
"."	LC off.
"?"	recall saved BM sequence by number (1 - 8).
"<"	BM on.
">"	BM off.
"="	update the ZAP screen. Note: KEYS does not update changes on the ZAP screen, so use "=" if you wish to see the true values of the registers.
";"	toggle routine pause/resume.
":"	resume routine.

ENTERING THE KEYS PROGRAM

"KON"	turns KEYS on and activates the "[" key.
"["	(left bracket) enters KEYS mode (just as "]" enters SETEM). Use <RET> or <ESC> to exit KEYS.
"KEYS"	enter KEYS (same as "[").
"KOFF"	turns KEYS off and disables "[" to prevent accidental activation of KEYS.

Before entering KEYS, you may type the name of the KEYS program ("DK1" to "DK5", "VEK", or "SEK") that you wish to enter directly. Once in KEYS, use <RUB> (see SETEM, page 9) to change KEYS programs or to select specific graphics to manipulate.

THE PERMANENT FORMAT

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"!" through "&"	(<SHIFT> "1" through "7") beam positions 11 through 20, respectively.
"*", "(" and ")"	call BM colors green, cyan, and blue, respectively.
"/"	recall saved LC sequence by number (1 - 8).
","	(comma) LC on.
"."	LC off.
"?"	recall saved BM sequence by number (1 - 8).
"<"	BM on.
">"	BM off.
"="	update the ZAP screen. Note: KEYS does not update changes on the ZAP screen, so use "=" if you wish to see the true values of the registers.
";"	toggle routine pause/resume.
":"	resume routine.

"'"	(apostrophe) toggle syncs on/off.
"""	(quote) trip all syncs at once.
<TAB>	calls the next cell of specially designed KEYS graphics. This is one of the most powerful KEYS controls.
<SPACE>	stops a KEYS routine.
<BS>	stops a routine and reloads a program.
^Y	LS fade open.
^U	LS fade closed.
^K	BS open.
^L	BS close.
^W	set SETEM * cursor to the active KEYS register.
^D	increase the value in the active register by one (same as "." in SETEM).
^S	decrease the value in the active register by one (same as "," in SETEM.)
^A	"zero" the active register.
^E	turn active register on.
^R	turn active register off.

THE GENERAL FORMAT

Most KEYS programs have these functions in common:

QWERTY

These keyboard letters each recall a specific KEYS routine.

ASDFGH

These letters each modify or reverse the effect of the QWERTY key above it. For example, if "Q" caused a logo to become larger, then "A" might shrink it; if "R" created a spinning pattern, then "F" would modify the pattern in a pleasing way.

ZXCV -

These letters change the size and location of the image in the projection area. "Z" places the image in the center, at its correct size (use "Z" to re-center and re-size the image if it gets too large or extends beyond the scanning limits).

Special Functions

"I"	resets a routine (use "I" to escape if you turn on a routine you don't like).
"O"	LS open.
"P"	LS close.
"L"	toggle LS to fade open or closed, depending on its current condition.
"K"	creates a small color sequence and sets LC to Sync 4.
"N"	next cue.
"B"	back a cue.
"M"	fade and shrink logo.

DISCO KEYS

All of the Disco KEYS follow the general format except "DK5", which adds effects only.

Each of the QWERTY keys calls up a ø speed animation file containing special graphics, creates an interesting design, and opens the shutter. Be sure to use the <TAB> with these files to see all the special graphics available to you.

VIDEO EMULATOR KEYS

Use <RUB> to select the graphic you wish to manipulate with "VEK".

SHIVA EMULATOR KEYS

"SEK" can replace the "Shiva" control device to sequence and create beam effects on a beam projection system. To do this, your computer must have a "beam card."

Using "SEK" requires a little more experience and knowledge of ZAP than the previous KEYS programs. At this point you should read and understand the MAIN chapter to understand "SEK" fully.

Whenever "SEK" is recalled, the following registers are set: "S5 4 SSYNC 2Ø ! S6 4 SSYNC 2Ø ! BM 5 SSYNC BS 6 SSYNC"

Letters "Q" through "I" recall beam programs which you enter from MAIN using BPROG (see MAIN, pages 1Ø - 11) to match the beam configuration of your laser table.

Letters "A" through "J" call BC colors white, red, green, blue, cyan, or magenta.

Other commands are:

"O"	BS open.
"P"	BS close.
"L"	hold to fade BS out.
"K"	hold to fade BS on.
"M"	activate "X" and "Z" so they can be used to synchronize your beam sequences to music.
"X"	speed a beam sequence. The terminal will beep when you reach a limit.
"Z"	slow a beam sequence.
"N"	synchronize a beam sequence to the <TAB> key. Each time <TAB> is pressed, the sequence will advance (use this function to play beam sequences manually).
"B"	cause the current beam to flash (the speed may be altered by adjusting the value in S6).

L I G H T P L A Y T H E M E B O A R D S

LIGHT PLAY allows someone who knows very little about the Laser Media system to play the terminal keyboard as a real-time visual instrument. Each key will produce an effect which has been pre-programmed in LV3. Before using LIGHT PLAY, you may wish to read SETEM, KEYS, and Appendix C of the new ZAP 6249 manual.

LIGHT PLAY boards are designed for ease of use in a variety of laser display environments. Each board contains pre-programmed graphics and animations relating to a specific theme. The following is a list of LIGHT PLAY boards available now or in the near future. Key assignment instruction sheets are included at the end of this chapter. LIGHT PLAY boards are available for sale or rental. Please contact your Laser Media representative for more information.

The most enjoyable way to learn LIGHT PLAY is to turn on some music and have fun!

LIGHT PLAY is currently made up of the following programs:

Wild Winter

"XMAS-LP" Christmas and holiday graphics.

"YEAR-LP" New Years and party graphics.

For Lovers Only

"LOVE-LP" Sexy, romantic images.

Rock Shots

"ROCK-LP" Musical instruments and effects.

Everyone's a Winner

"JOCK-LP" Sports images and animations.

ENTERING LIGHT PLAY

"KON" turns KEYS on and activates the "[" key.

"[" (left bracket) enters KEYS mode (just as "]" enters SETEM). Use <RET> or <ESC> to exit KEYS.

"KEYS" enter KEYS (same as "[").

"KOFF" turns KEYS off and disables "[" to prevent accidental activation of KEYS.

Before entering KEYS, you may type the name of the LIGHT PLAY program ("LOVE-LP" or "ROCK-LP") that you wish to enter directly. Once in KEYS, use <RUB> to change KEYS programs or to select specific graphics to manipulate.

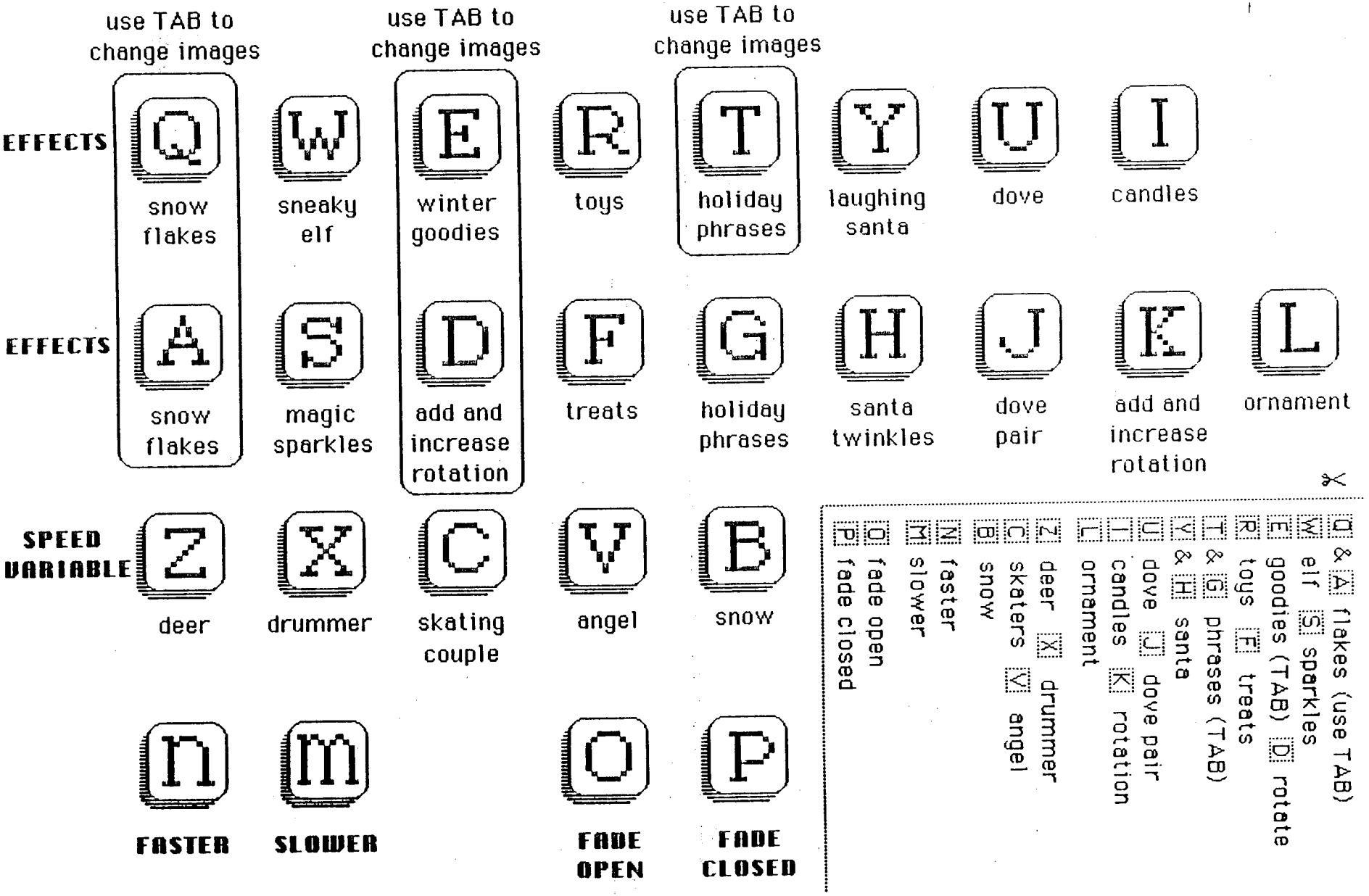
THE PERMANENT FORMAT

All LIGHT PLAY programs have these functions in common:

"A" through "Z"	each letter recalls a pre-programmed effect.
"1" through "Ø"	call their corresponding beam position on the laser table (Ø = beam 1Ø).
"-"	(minus) "clear beam" position.
"!" through "&"	(<SHIFT> "1" through "7") LC colors white, red, green, blue, cyan, magenta, or yellow.
"*", "(" and ")"	call BM colors green, cyan, and blue, respectively.
"/"	recall saved LC sequence by number (1 - 8).
","	(comma) LC on.
"."	LC off.
"?"	recall saved BM sequence by number (1 - 8).
"<"	BM on.
">"	BM off.
"="	update the ZAP screen. Note: KEYS does not update changes on the ZAP screen, so use "=" if you wish to see the true values of the registers.
";"	toggle routine pause/resume.
":"	resume routine.
"'"	(apostrophe) toggle syncs on/off.
"""	(quote) trip all syncs at once.
<TAB>	calls the next cell of specially designed KEYS graphics. This is one of the most powerful KEYS controls.
<SPACE>	stops a KEYS routine.
<BS>	stops a routine and reloads a program.
^Y	LS fade open.
^U	LS fade closed.
^K	BS open.
^L	BS close.
^W	set SETEM * cursor to the active KEYS register.
^D	increase the value in the active register by one (same as "." in SETEM).
^S	decrease the value in the active register by one (same as "," in SETEM.)
^A	"zero" the active register.
^E	turn active register on.
^R	turn active register off.

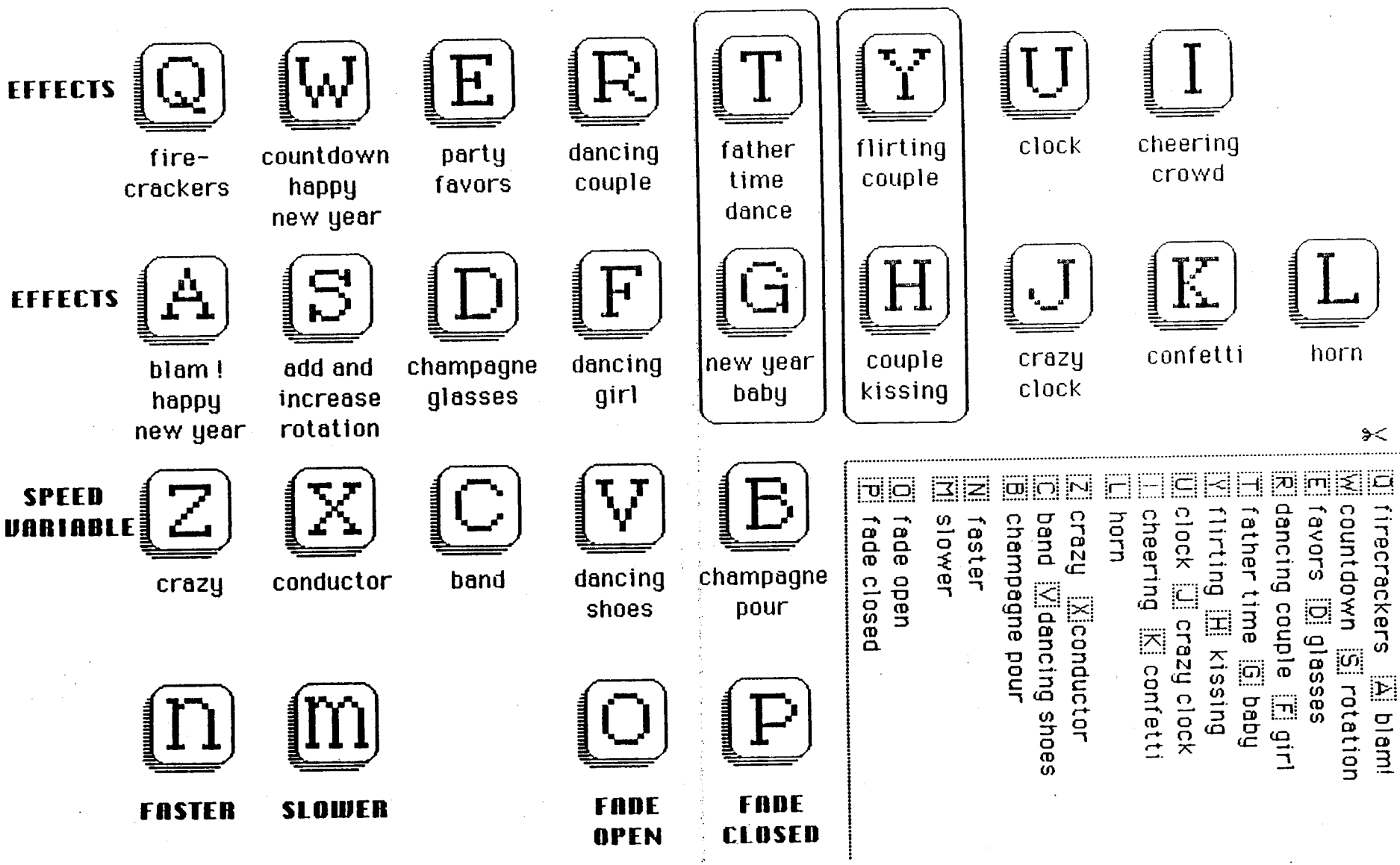
LIGHT PLAY "Wild Winter" Theme: Christmas

Cue name: "XMAS-LP"



LIGHT PLAY "Wild Winter" Theme: New Years

Cue name: "YEAR-LP"



M A I N

HELP

The Nevercom contains a "help" file which can be accessed at any time by the operator. If you are searching for a command or have forgotten its correct spelling, the help file will be of use.

"HELP" will call up the help file in the cue list area (middle left) of the ZAP screen.

<LF> will page the file forward.

"BHELP" will toggle the file back a page/forward a page.

"\" (backslash) will call the next help chapter.

Note: as each page of the help file is accessed, any graphic being displayed will suffer a slight glitch (the graphic being scanned is probably stored on a different bank-selected memory card than the help file). This glitching may occur whenever the operator uses commands which access bank-select RAM (see note on page 3.6).

LISTING

"LIST" will display all cues stored in the computer in the cue list area of the ZAP screen. <LF> and "\" will page this cue list forward and backward.

"LST" will display all cues in full screen format. <RET> will restore the ZAP screen; <ESC> will put you into MAIN with the cue list still displayed. <SPACE> will cycle the list and call additional pages if there are more cues than can be displayed on one screen. (See SETEM, pages 1.7 - 1.8 for a description of cue numbers, prefixes and names).

"ALST" will display only animations.

"LLST" will display only logos.

"GLST" will display all graphic cues, both logos and animations.

"XLST" will display TOPA cues, KEYS programs, and Wordfire fonts.

"GLST" will list all graphic cues, both logos and animations.

"XLST" will list TOPA cues, KEYS programs, and Wordfire fonts.

"MLIST" will display the contents of your computer's allotted memory lines (MAINlines), starting with line 1. <SPACE> will page forward through this list by 1Ø lines. "-" (minus) will page backwards. <RET> and <ESC> function as described above.

"n MLIST" will display the computer's allotted MAINlines, starting will line "n". <SPACE>, "-", <RET>, and <ESC> function as previously described.

"SLST" will list all available scenes (described later) by name and number. <RET>, <ESC>, and <SPACE> work as described in the "LST" command above.

"INITS" will redisplay (initialize) the ZAP screen if you used <ESC> to exit any of the previous list modes.

RAM

When the ZAP screen appears after the computer has been turned on or reset, it will display two sets of numbers in the lower left hand corner above the "MAIN>" prompt. The first number tells how many Kilobytes ("K") of RAM (computer memory) you have available in your system (typically 16); the second number tells you how many MAINlines have been allotted from this amount (1Ø MAINlines = 1K RAM). The unallotted K is used for transmitting TOPA programs or downloading. Because different users have different needs, memory allocation can be set by each user. LV3 programmers will want a lot of room for TOPAs, while Level-2 programmers will want maximum K allotted for MAINlines.

"?RAM" will display your system's RAM status.

"n ALLOT" assigns "n" lines for MAINline memory. "n" should be a multiple of 1Ø. 1Ø MAINlines = 1K. A system with 16K of RAM could have all of that K allotted for MAINlines by using the command "16Ø ALLOT". A LV3 programmer would be likely to use "1Ø ALLOT" to leave a large amount of RAM for TOPA transmission.

ALLOT always assigns MAINline RAM in groups of 10 lines (the minimum number of MAINlines is 10). If you try to ALLOT more MAINlines than your system has RAM, ZAP will simply ALLOT as many as possible (no warning is given).

PROGRAMMING

By stringing commands together, Level-2 programmers can create a complex series of effects. SETEM is used to "sketch" these effects and to note the values and condition of each effected register. This information is then programmed using MAIN commands. Here are a few commands to begin with:

"R"	is a "soft" reset. All registers will return to their "normal" (default) state, as they were when you first turned the computer on.
"O"	LS open.
"P"	LS close.
"n !"	(called "set") will set a value "n" into a given register.
"n THS"	will instruct the computer to wait "n" tenths of a second before executing the next command.
"T"	will instruct the computer to wait until <TAB> is struck to execute the next command.

Here is a simple program. Commands have been spaced for clarity, though a single space is sufficient to separate commands. Remember, DO NOT type the quotes and DO NOT confuse zero and "O":

"R TRIANGLE GA 1ØØ ! T O 2Ø THS P"

Hit <RET> to execute this line of commands.

First the computer performs a soft reset and cleans-up any stray values that may have been in the registers from a previous program. Then it calls up the graphic "TRIANGLE" and increases its size by setting the value 1ØØ into the GA register. Next it waits until <TAB> is hit. When <TAB> is struck, the computer opens LS, waits 2 seconds, and then closes LS.

SAVING

^F will recall whatever you last typed before you hit <RET>. If you hit <RET> without typing anything, "nothing" will be saved into this temporary buffer.

Use ^F to recall your previous line and execute it again by hitting <RET>. ^F is only a temporary way to save a line. When you type and execute your next commands or hit <RET>, the old commands will be lost (unless you have saved them in RAM as a MAINline).

Find out how many lines are currently allotted for MAINlines by using "?RAM" or "MLIST". Then retype the previous line of commands, but do not hit <RET>. Instead, use:

^X to save the currently typed commands into memory. The computer will display the prompt "Save>" asking for a MAINline number. Type the line number you wish to save the program to and hit <RET>. Your current commands will be saved onto that line. You can then either hit <ESC> to return to MAIN or <RET> to execute the line.

Note: be careful not to save over a previously saved MAINline, unless you wish to replace it. Use "MLIST" to locate free space for saving. Use "n MLIST" to make sure your commands were properly saved.

Save the previous simple program on MAINline 1 by using ^X. Use "MLIST" to make sure you've successfully saved it.

Note: it is always a good practice to COPY IMPORTANT PROGRAMS ONTO PAPER as soon as you've finished them and before you power your system down. It is the only foolproof way of saving program code. Even with ZAP's nonvolatile memory, there is some risk of losing MAINLines due to a program crash. (Level-3 programming provides disk saving and program printing capabilities.)

EXECUTING

"n IR" will recall line "n" from memory and execute it. This command may also be written into programs and can be used to create infinite loops.

Hot Keys

^Q, ^W, ^E, ^R, ^T, ^Y, or ^U will recall MAINlines 1, 2, 3, 4, 5, 6, or 7. By saving "IR" commands on these lines, an operator can conveniently recall programmed sections of a show or special effects from other locations in MAINline memory.

Type "1 IR" or hit ^Q to recall and execute the program you just saved.

EDITING

^V will append (add) a given MAINline to your current commands. The computer will display the "APPEND>" prompt asking for a MAINline number. Select a number and hit <RET>. The information stored on that line of memory will be added to the commands (if any) at the "MAIN>" prompt. This can be used as a simple editor, as the <BS> key will allow you to erase back from the end of the line.

"WE" will move your cursor into the Word Edit buffer so you can recall, edit, and save command lines. <RET> or <ESC> will return you to the "MAIN>" prompt. See Appendix E for a complete listing of Word Edit commands.

Enter Word Edit and use the commands described in Appendix E to revise the previous line of code to look like this:

"R TRIANGLE GA 5Ø ! T O 3Ø THS P TRIANGLE GA 75 ! O"

Save your corrected code onto line 2 of memory using ^X before you exit Word Edit. If you forget to do this, re-enter Word Edit using the "WE" command and then use ^X to save your altered commands.

"MLIST" should now display both programs in memory. Execute the revised program by using "2 IR" or "^W".

MAINLINE MANAGEMENT

MAINlines can have a maximum length of 11Ø characters (including spaces). Shorter lines are easier to edit and revise. Break your programs up into small, logical chunks. Keep your code simple and clean and it will be easier to debug.

"-->"	(minus minus greater than) at the end of a line will direct the computer to the beginning of the next MAINline during execution. Use this command to continue a program from one line to the next.
"n +IR"	will skip "n" lines ahead of the current MAINline and continue execution. Use this command to skip ahead to a specific MAINline.
"s d MCOPY"	will copy a single MAINline from source line number "s" to destination line number "d".
"s d MGCOPY"	will move a group of 1Ø MAINlines from the source line number "s" to destination line number "d". Moving MAINlines in memory means that you may have to adjust your specific "IR" recalls, but not your "-->" or "+IR commands.

NOTE: closing the shutter before using the "IR" or "-->" commands will prevent any glitching of the sort mentioned on page 3.1.

COMMANDS

"n GAIN"	will set the value "n" into the GA register (a shorter way of saying "GA n !").
"g x y GXY"	will set a number "g" into GA, "x" into FX, and "y" into FY (a shorter way of saying "GA n ! FX n ! FY n !").
"n !+"	(called "set on") will set a value "n" into a given rotation register and turn the register on.
";" or "SON"	(semi-colon) will turn on a given register.
"'" or "SOFF"	(apostrophe) will turn a rotation register off.
"ROFF"	will turn off and zero a given rotation register and its corresponding hidden position register. Use this command on rotation registers only!

"GRSP n !" will set a value "n" (Ø -9) into the G (growth speed) register. 9 is the fastest speed possible; Ø is no growth at all and can be used to "freeze" a growth in progress.

"CLSP n !" will set the same values (Ø - 9) into the C (collapse speed) register. Avoid speed 9 when using collapse (see page 3.31).

"G" will grow a logo from its start point.

"C" will collapse a logo into its start point. Note: the computer becomes very sluggish if it collapses completely. Growing out again or changing cues will solve this problem.

"(" (left paren). ZAP will treat everything that follows this command, until it meets ")" or the end of a line, as a comment only. Note that you must have a space between "(" and the beginning of the comment.

")" (right paren) end comment. Note: you don't need to use a space before ")".

Sample Program

```
"R  CIR-RAS  8Ø GAIN  GRSP 2 ! ( SET-UP) -->"
"T  G  O  4Ø THS  GRSP Ø !  ( GROW ON & FREEZE HALF WAY
              THROUGH) -->"
"RZ 64 !+  5Ø THS  SOFF  T  GRSP 9 !  ( TURN RZ ON, THEN OFF,
              FINISH GROWTH) -->"
"T  P  DIAMOND  4Ø -6Ø 3Ø GXY  O ( CHANGE LOGO & LOCATION)"
```

Type, save, and execute this four-line program. Note that the program requires three <TAB>s to execute.

GOBY AND GOBW

These are two of the most useful commands in ZAP. They will increment or decrement values in any register: to fade LS open or closed; to smoothly change the speed of rotations; to increase or decrease the values in several registers at once and wait until an assigned value in a particular register is reached before moving on to execute the next command.

"d n GOBY" ("go by") will increment or decrement a given register's value to destination number "d" in steps of "n", and the computer will go on to perform the next commands SIMULTANEOUSLY.

"d n GOBW" ("go by wait") will increment or decrement a given register's value to destination number "d" in steps of "n", but the computer will WAIT until the value "d" is reached in the register before it moves on to the next command.

Here is an example:

```
"R  TRIANGLE  Ø GAIN  ( SET-UP) -->"
"T  LS 127 3 GOBY  GA 1ØØ 1 GOBW Ø 2 GOBW  P  ( LOGO FADES
 ON & GAINS UP, THEN GAINS DOWN)"
```

When <TAB> is hit, the computer will slowly fade open the shutter (from Ø to 127 in steps of 3 = 43 steps). At the same time it will increase Gain to 1ØØ (from Ø to 1ØØ in steps of 1 = 1ØØ steps) and then wait until the value in the GA register is 1ØØ. Then it will decrease the value in GA back to Ø (from 1ØØ to Ø in steps of 2 = 5Ø steps, twice as fast) and wait until the value in GA is Ø. Then the shutter will close.

Type, save, and execute these lines.

As you execute the program, watch the affected registers on the ZAP screen.

Here is another example:

```
"R  TRIANGLE  Ø 1ØØ 1ØØ GXY ( SET-UP)  -->"
"T  LS 127 3 GOBY  GA 1ØØ 1 GOBY  FX Ø 1 GOBY  FY Ø 1 GOBW
 ( FADE ON, GAIN UP, & MOVE CENTER) -->"
"RZ SON 256 1 GOBW  15 THS  GA Ø 3 GOBY  LS Ø 3 GOBY
 ( ROTATES TO 4 HARMONY, GAIN DOWN & FADE OUT)"
```

Here are some simplified MAIN commands that make use of GOBYs:

"LFOPEN" (logo fade open) will slowly fade LS open (same as "LS 127 1 GOBY").

"LFCLOSE" (logo fade close) will slowly fade LS closed (same as LS Ø 1 GOBY).

If you are programming an argon system, "WHITE" will give you the brightest cyan, "YELLOW" will give you the brightest green, and "MAGENTA" will give you the brightest blue. This is because the "CYAN", "GREEN", and "BLUE" commands all cause a "minus red" filter to drop in front of the laser beam. (An argon laser contains no red, so you don't need to subtract any red light from the beam.)

If you are programming a red-only system, "WHITE" (no filters) will give you the brightest possible beam as opposed to the "RED" command which will cause "minus blue" and "minus green" filters to drop in front of the beam.

"NOCOLORS" turns color output off and removes all color filters from the beam path. All color commands in the program will be ignored. This command turns on "flag" number 4 in the CF (color flag) register. For a complete listing of flags and their effects, see Appendix H.

"COLORS" restores color output (turns CF flag 4 off).

If you are running a full-color program and your argon or krypton laser goes down, you can use "NOCOLORS" to save the show. This will cause the program to run with the brightest possible beam (no color filters).

If you want to test a full-color Level-2 program on an argon or red-only system, simply insert "NOCOLORS" at the start of the program and "COLORS" at the end.

Note: when a TOPA program starts, it will set CF in a predetermined way, ignoring the "NOCOLORS" command. To test or run a TOPA program, wait until the TOPA program has started, then use "NOCOLORS."

Color and Beam Sequencing

Color sequences can create beautiful effects and are easy to use. Both color and beam sequences use letters to assign colors: white = A, red = B, green = C, blue = D, cyan = E, magenta = F, yellow = G, and black = Z (see SETEM, page 1.5, and Appendix G for more information).

"CS> abc" puts a color sequence "abc" into the Color register and turns LC on. Color sequences can be a maximum of 24 letters long.

"BS> anbncn" puts a color sequence "abc" into the BC register and a beam sequence "nnn" into the BM register and turns BM on. Letters and/or numbers can be used with beam sequences. Colors should precede beam numbers. Using "-" in a beam sequence provides the 'no beam' position (see SETEM, page 1.17 for more information). Beam sequences can contain a maximum of 24 characters.

Note: "CS>" and "BS>" automatically turn on their respective registers. Sequences have no effect unless their registers are turned on. Setting BC on or off, however, has no effect on beam sequences. Single color commands, such as "RED" and "GREEN", will have no effect unless the LC register is turned off. Likewise, assigning a single beam to the BM register will have no effect unless the register is turned off. Use "LC SOFF" or "BM SOFF" to turn these registers off before selecting single colors or beams. Alternately, although it is not a suggested practice, you can use a single character color or beam sequence such as "CS> F", "BS> E1", or "BS> -" (which leaves the register on).

"CPROG" (same as the "}" key) will put you into color program mode. This will allow you to quickly test a sequence of letters. <RET> will execute the sequence.

"BPROG" (same as the "{" key) will put you into beam program mode. This will allow you to enter a sequence of letters and numbers to control beam color and positions. <RET> will execute the sequence.

Using ^X in either of these modes will save a color or beam sequence in a special place in memory, numbered 1 to 8. Eight sequence saves are allowed for both "CPROG" and "BPROG". These settings are saved even if the system is powered down. (Executing a "NEWBUF" command clears all eight beam and color sequence programs.) See Appendix G for a complete listing of color and beam program mode commands.

"n CR" will recall color sequence "n" (1 - 8) from temporary memory.

"n BR" will recall beam sequence "n" (1 - 8).

Color Effects

Combine color sequences, syncs, DW and SW to create color "chopping" or "locking" effects. To make color chopping effects, where multiple colors flow through a logo, set LC to Sync 4 (fast sync) and adjust DW and/or SW to get an effect you like. For example:

"NOU" turns off all screen updates
"n SSYNC" assigns Sync "n" to a given register.

"R NOU LM 1ØØ GAIN CS> CGBFDE 4 SSYNC SW 3 ! 0"

The "NOU" command is necessary to allow ZAP to run at its optimal speed (see page 3.23 for a description of this command). When done, use the MAIN command "K" to cancel the NOU.

SW can be adjusted up or down to refine the effect, then changed in your program using "WE". Remember: adding SW will slow down ZAP's scan rate, so be sure to zero SW as soon as the effect is no longer needed (see SETEM, pages 1.4 - 1.5 to review the SW register). Note: with NOU active, the changes you make in SETEM will not be displayed. Use the '=' key to update the screen.

As another example, using only DW to create a slow color effect, try the following:

"R NOU LM 1ØØ GAIN CS> GBF 4 SSYNC DW 110 ! 0"

Again, to refine the effect, adjust DW in SETEM. When DW is used instead of SW for sync-4 color chop or color lock effects, the 'flicker' which can be seen in high-point logos at mid-to-high SW values can be avoided. Remember to reset DW to 0 and turn the register off when it is not in use!

Note that color chops appear to change depending on what ZAP is doing. Color chops must be tested under the same conditions as they will be used!

A color locking effect can be created when you use color sequences and harmonic rotations. To create three stars of different colors:

* rotate a star graphic at a three harmony using RO and OX (see SETEM, page 1.10 for harmonic effects);
* assign the same number of colors to your sequence as you've used in your harmony (three);
* set LC to Sync 2 (logo scans).

Your program should look something like this:

"STARØ 3Ø GAIN OX 1ØØ ! RO 341 !+ CS> EFG SW 9 ! O"

Adjust the SW to get the best possible harmony and color lock and then correct your program in Word Edit.

Here is a simple program to cycle through all colors:

"R LM 1ØØ GAIN CS> ABCDEFGZ 5 SSYNC S5 3 SSYNC 1Ø ! O"

The colors will change every second because LC has been set to a custom sync (see SETEM, pages 1.13 - 1.15). If you want the colors to change whenever you hit <TAB>, set LC to Sync 1 (Tab sync). Try this.

ANIMATIONS

Animations are a sequence of cells (called TOPfiles by digitizers), which have been loaded together in a specified order (called COMfiles) to be played at a specified speed. You can manipulate these files in a variety of ways. Use "ALST" to locate the animations in your computer.

"DASP" (default animation speed) will display an animation at the speed it was created. The default speed is located in parentheses in the A (animation) register (upper right on the ZAP screen).

"RASP" (reverse default animation speed) will display an animation at the default speed (same as DASP) but will run the animation backwards, last cell to first.

"EASS" will stop a running animation on its last cell.

"n ASP" (animation speed) will display an animation at speed "n" (n = Ø - 9). At speed Ø, the animation will freeze (unless triggered by <TAB>, ^I, or ^Z); speed 1 is slow (approximately 9 scans per image), and speed 9 is fast (approximately 1 scan per image). Scan cycles per frame increase as speed decreases.

"NC?" will display the number of cells in the current animation.

"NP?" will display the number of points in a logo, cell, or first cell of an animation.

"n CELL" will display cell number "n" and freeze animation. <TAB>, ^I, or ^Z will not trigger a Ø speed animation when the "CELL" command is active.

Animation Sequencing

"|" (vertical bar) will put the keyboard into animation play mode, display the number of cells in the current animation, and the number of points in the current cell. This keystroke is the same as the MAIN command "APLAY". Change graphics by using ^N, ^B, and <RUB>. <RET> or <ESC> will bring you back into MAIN.

In "APLAY" mode, the following keys will display their equivalent animation cells:

1=1	B=12	M=23	X=34	i=45	t=56
2=2	C=13	N=24	Y=35	j=46	u=57
3=3	D=14	O=25	Z=36	k=47	v=58
4=4	E=15	P=26	a=37	l=48	w=59
5=5	F=16	Q=27	b=38	m=49	x=6Ø
6=6	G=17	R=28	c=39	n=5Ø	y=61
7=7	H=18	S=29	d=4Ø	o=51	z=62
8=8	I=19	T=3Ø	e=41	p=52	
9=9	J=2Ø	U=31	f=42	q=53	
Ø=1Ø	K=21	V=32	g=43	r=54	
A=11	L=22	W=33	h=44	s=55	

"." (period) will call the next cell.

"," (comma) will move back a cell.

Cells number 63 to 127, if they exist, are accessible by using the "CELL" command. The AC (animation cell) register will always display the number of the cell you are currently viewing.

Some animation cues contain many different images loaded at speed Ø and must be sequenced by the programmer to be viewed correctly. Use "APLAY" to select the cells you wish to use and to determine their order. Then create a sequence using their equivalent numbers and letters as shown above. See Appendix E for other special characters that can be used in animation sequences.

"n ASEQ" will display an animation sequence of numbers and letters stored in the Wordfire display buffer at speed "n" (Ø - 9). See page 3.15 for a description of Wordfire buffers and Appendix E for Word Edit commands related to these buffers.

These sequences can be stored on MAINlines and recalled into the display buffer using the "n WR" command (see page 3.16).

Animation sequences give the programmer great freedom to manipulate graphics: run animations at varying speeds, pause on certain frames, move them backwards as well as forwards, and create other advanced effects. Remember our example of three stars of different colors on page 3.12? By using a 9 speed animation sequence, along with SW and "NOU" (page 3.21), you can display multiple images of different colors and similar point size on the screen at one time using only one scanner (page 3.24).

Another way to sequence animations is to use the AC register and "go by waits." For example, "AC 3 SSYNC 21 1 GOBW Ø 1 GOBW" would run 21 frames of a given animation forward and then backwards at 1Ø frames per second.

WORD EDIT

Wordfire

Wordfire allows you to type a line of words and display it with the laser.

Wordfire can be created in real-time in Word Edit or the message can be saved on a MAINline and recalled during program execution. See Appendix E for a complete listing of Word Edit commands.

First, find out which Wordfire fonts you have in your computer by using the "XLST" command. Current fonts available are "LITELINE", "RADIANT", and "LIVEWIRE". Fonts can also be customized to include foreign alphabet characters and special symbols.

To select a font, simply type its cue name at the MAIN prompt and hit <RET>. Note: switching from one Wordfire font to another may crash your scanning. If this bug occurs, call up a logo with the shutter closed before switching to the next Wordfire font.

Use "WE" to set up and test a Wordfire sequence or to play Wordfire in a live situation. There are two "buffers" in Word Edit, each 169 characters long: the edit buffer and the display buffer. This dual buffer system will allow you to display text out of the top (display) buffer while you enter or edit text down in the lower (edit) buffer. In Word Edit mode type a message in the edit buffer, then use:

* ^E to "exchange" the message from the edit buffer into the active buffer;
* ^Q to start Wordfire;
* ^K and ^L to decrease or increase the travel speed;
* ^T to put all available characters into the edit buffer (so that you can test the characters and symbols available for each font.

Then, from MAIN:

* type your tested message;
* use ^X to save it to a specified MAINline.

Use the following commands in your program to recall and execute the message:

"TRSP n !" will set a value "n" (Ø - 9) into T (travel speed) register. 9 is as fast as possible; Ø is no speed and can be used to freeze a message in progress.

"LTSP n !" will set a value "n" (Ø - 9) into L (letter spacing) register. 9 will space the letters as wide apart as possible; Ø will space them as close together as possible. Up to 11 letters or symbols can be visible at one time, depending on the letter spacing.

"n WR" will recall a Wordfire message or animation sequence stored on MAINline "n" into the active Wordfire buffer.

"WFIRE" will start Wordfire.

Special Characters

"{" (left brace) will pause Wordfire when it hits screen left, until <TAB>, ^I, or ^Z is struck.

"}" (right brace) will pause Wordfire when it enters on screen right, until <TAB>, ^I, or ^Z is struck.

"^" (caret) may be used within a Wordfire message or animation sequence to trip Sync 6.

"n WSYNC" will wait until Sync "n" is tripped before moving on to the next command.

The "^" special character is one of the most powerful and useful features of Wordfire messages or animation sequences. But, it can be tricky to use. First, set Sync 6 to Sync Ø (dead sync). Then, use the "^" character at a place in your message or animation sequence where you want a special action to take place (shutter close, freeze Wordfire, change animation sequence, etc.). We recommend using two carets, "^^", to make absolutely sure Sync 6 will be tripped, especially when using a fast travel or animation speed. Recall the message or sequence into the active buffer by using "n WR". Start execution with "WFIRE" or "n ASEQ". Then use a short time wait command like "1 THS" followed by "6 WSYNC". The time wait is used to let previous carets can run through the active buffers without accidentally tripping Sync 6. "6 WSYNC" will wait until the caret enters the active buffer to execute the next commands (your special effect).

Here is an example using the caret to freeze a phrase as soon as it enters on screen right:

```
1)  "R  NOU LITELINE 8Ø GAIN TRSP 6 !  LTSP 3 !  S6 Ø  SSYNC
     ( SET-UP) -->"
2)  "3 WR  T  WFIRE O  1 THS 6 WSYNC  TRSP Ø !  K"
3)  ". . . Welcome to the wonderful world of  LASERS ^^"
```

Other special characters can be used in color, beam, and animation sequences as pause points or trigger syncs:

"!" will wait for <TAB>, ^I, or ^Z to be struck before resuming the sequence.

"%" will wait for Sync 5 to trip.

"&" will wait for Sync 7 to trip.

TIMING

Generally speaking, there are two kinds of timing that go on in ZAP: 1) the computer's clock and 2) image scans. Trying to coordinate these two "world views" takes quite a bit of diplomacy. Programmers rely mostly on their own eyes to spot discrepancies and bugs in ZAP's execution of their code. As you progress, your eye will become acutely aware of limitations of tenth-of-a-second timings and scanning idiosyncrasies.

You may wonder why some things never play the same way twice. The "n THS" command, for example, may be slightly off because ZAP takes time to change the assigned number into its own internal binary representation and to determine what the "THS" command is. This in itself may take a 1/1Ø of a second.

Sometimes the computer moves too fast for itself, resulting in extra Wordfire or animation cycles, missed cues or delayed events; sometimes it moves too slowly, resulting in extra Wordfire or animation cycles, missed cues or delayed events. Most of these problems can be solved by patience and manipulation of timing.

You have already learned how to delay the execution of commands by using "T", "THS", and "GOBW". Additional timing words are:

"n SCANS" will make the computer wait "n" scan cycles of the current image. The number of points in an image, as well as SW, will effect the time it takes to make one complete scan of an image (see SETEM, pages 1.4 - 1.5 for more information on logo scanning). At speed 9, each frame of an animation is scanned approximately one time. Scanning increases as speed decreases, so that at speed 1 each frame is scanned approximately 9 times. Use this as a guide to determine scan wait commands.

"E" will wait one single scan of the logo.

"W" will wait the shortest amount of computer time possible.

"EXTW" will wait for a cue from a slide programmer or other relay closure (see Hardware, page 4.8 for specifics).

"TIME" will display (from left to right): absolute time (clock); offset time (from zero); relative time (from last display of "TIME"); and relative logo scans (in that same period). "TIME 99 THS TIME" will give you the number of scans per second of a current cell or logo in tenths of seconds. See Figure 3.1.

"SYNC" will read the current timecode number from a tape, set the Host computer's clock to that number, and leave the clock "phase-locked" to the speed of the timecode signal.

"SOFT" will cause the Host computer's clock to run phase-locked to the speed of the timecode signal.

"HARD" will set the Host computer's clock to its own internal clock speed (absolute time).

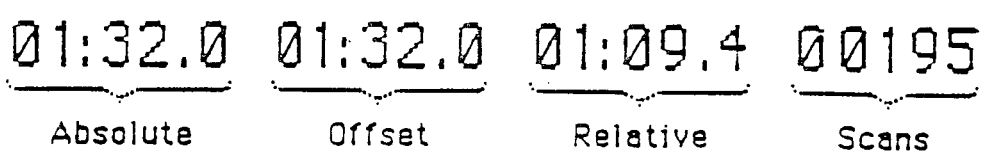


Figure 3.1 The times displayed on the bottom right of the ZAP screen

When ZAP is internally synced, it runs off a crystal oscillator. This is "HARD" sync. Absolute time is reset to zero when the system is turned on, and continues counting. If there is a timecode card in the computer connected to a timecoded tape, the "SYNC" command will sample a timecode number off the tape and set the absolute time to match that number. The computer is now in "SOFT" sync, and the clock is phase-locked to timecode (the clock will match the speed of timecode, but an actual number was read only once when "SYNC" was first used).

If there is a splice in the tape, ZAP will remain in "SOFT" sync if timecode is present. If the timecode signal drops out for some reason, ZAP returns to internal "HARD" sync. If timecode returns, ZAP will return to "SOFT". Needless to say, continuous, unedited timecode is necessary for professional performance.

Timecode Testing

To program or run a timecode show, you must first make sure that timecode is being properly received. The output level of your tape recorder on the timecode channel should be set at -3db. Run the tape. If timecode is being received you will see a "+" appear in the TC (timecode) register in the upper left of the ZAP screen. Stop the tape and the "+" should disappear (if the "+" remains on constantly, even after resetting the computer, you have a hardware problem). Play the tape again and type in the following command:

"TSY" - will test the phase of the timecode signal.

The timecode card can be set for even or odd phase. As a rule, all Laser Media tapes are first created in even phase and play back in odd. But, there may be exceptions, especially if you create or copy your own timecode tapes. When timecode is read in the wrong phase, the program will speed through all its cues or may not start at all. "TSY" will repeatedly sample and display timecode. It is the same as "999 DO SYNC LOOP". If timecode is reading in the correct phase, the numbers displayed should be incrementing upwards. If the phase is wrong, these numbers will jump all over the place. To correct phase, simply change the even/odd (C3/C4) switch on the timecode card (see Hardware, page 4.19 for information on the timecode card and creating timecode tapes). Once you see that timecode is incrementing smoothly, hit <ESC> to return to MAIN.

Programming with Timecode

Rewind the tape to a point 5 seconds before you want the first effect to appear and zero the tape deck's meter. This will be your TAPE START POINT. Type in the command "SYNC", start the tape and THEN hit <RET>.

"`" (back-tick) when struck will display the current times (same as the "TIME" command).

Hit the "`" at the moment you want the first effect to occur. Subtract two seconds from the absolute time (left number) and this will be your PROGRAM START POINT. (ZAP needs a second or two to cue all computers, do house-cleaning, and set up your first effect.)

"RTIME" resets all times to zero.

"NOW" resets the offset time to zero.

"m s t STIME" will set absolute time to a given time in minutes, seconds, and tenths of seconds.

"m s t WAMST" (wait absolute minutes, seconds, tenths) will wait until a given absolute time to execute the commands which follow.

"m s t WMST" (wait minutes, seconds, tenths) will wait until a given offset time to execute the commands which follow.

There are many different ways to use and effect the clocks. Here is an easy way to use timecode:

```
"R  SYNC  1 45 Ø9 WAMST  RTIME  ( WAIT FOR PROGRAM START
 POINT & ZERO ALL CLOCKS) -->"
"Ø Ø2 Ø WMST  LFOPEN ( FIRST EFFECT)"
```

This program will first sync the absolute time to timecode. At 1:45:Ø9 (the program start point) it will reset absolute and offset time to zero. Two seconds later it will execute the first effect.

Offset time is a timing device used to time events from a given zero point. You could just as easily use the command "NOW" instead of "RTIME" to zero only the offset clock. The "WMST" uses offset time.

"COUNTER" is a utility which will allow you to display up to 72 timings on the screen. Hit any key to set offset time to zero and then hit other keys to display timings relative to that zero point.

"COUNTOFF" is similar, but does not reset offset time.

"m s t OFFSET" will zero offset time at "mst" in absolute time.

"SYNC m s t OFFSET COUNTOFF" can be used to determine "WMST" offset timings for a timecode program.

Screen Updates

ZAP's slowest chore is to update the ZAP screen as registers are changing. The link to the terminal screen cannot handle data as fast as ZAP can process it, so ZAP has to actually slow down to update the terminal screen correctly. You may notice hesitations in your program when you are using multiple GOBYs or when you turn rotations off. This is because ZAP is pausing to update these changes on the terminal display. You have the option of shutting off the screen updates to let ZAP run at its maximum speed:

"NOU" (no update) - will turn off all screen updates, "freezing" screen information at the point where you use this command. Then ZAP will run its fastest, providing smooth GOBYs, rotations, and beautiful color sequences. Use this command at the beginning of a program (right after the soft reset) or whenever you are testing a color sequence to be used in a program that uses "NOU".

"SAME" will momentarily update the ZAP screen.

"UPDA" will restore ZAP screen updating.

"K" does an "UPDA SAME" on all computers. Insert "K" at the end of any program using "NOU" on the Host computer. This will restore the ZAP screen in case you forget. Use "INITS" to restore accurate Word Edit display.

"NOU" is a powerful command, essential to the optimum performance of ZAP, but it is easy to forget that "NOU" has been used - you may "tear your hair out" trying to figure why your SETEM cursor isn't moving or why the word edit buffer is not changing. "K" is your answer. Any operator using a Laser Media system should know how to turn "NOU" off and on and how to restore the ZAP screen.

SCENES

There are 64 'scenes' in ZAP available for programming (with the option of allocating RAM for an additional 64) as well as a special 'full screen' mode for editing scene values. Although most editing of scenes is done in SETEM, this section is presented here so that the user has had time to become familiar with the registers and effects ZAP can be used to create. These effects can now be stored as scenes.

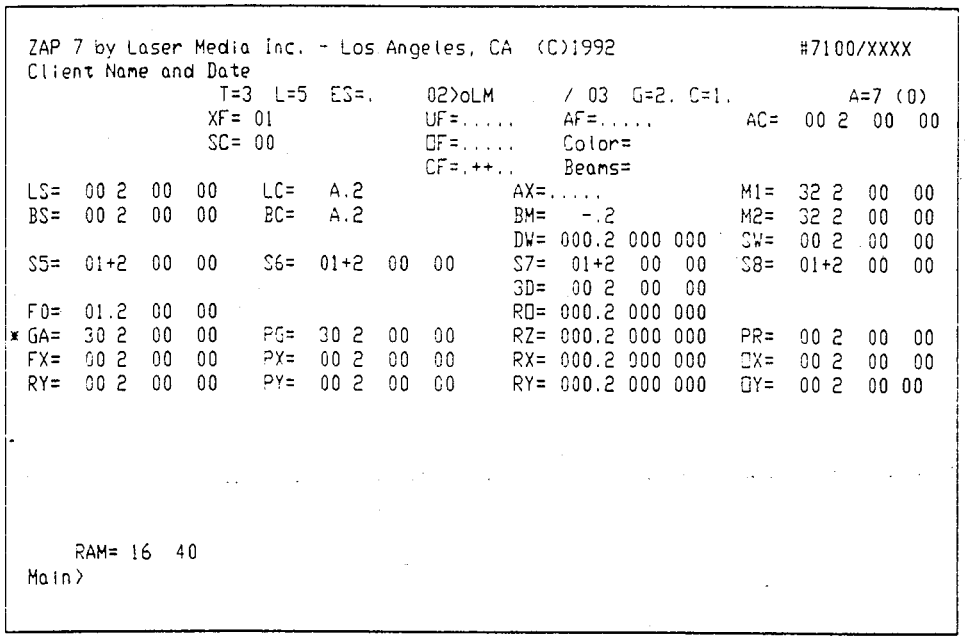


Figure 3.2 SETEM screen in full screen mode

Full Screen Mode

Normally, all of ZAP's registers are displayed with a single value. Additionally, most registers also have a sync number and some have an on/off flag (see page 1.6 of the SETEM chapter for an example).

However, most registers also have two hidden values, for a total of three numbers per register. The displayed value is the register's current value. The two other (hidden) numbers are the step and final values. Normally, these numbers are not displayed, and are only accessible through certain MAIN commands. But a special screen mode is used for programming scenes which displays ZAP's registers in an expanded form. To access this mode, use the following commands:

From MAIN:

"FULL" turns on the expanded display, showing current, step, and final values for most registers.

"HALF" returns the ZAP screen to its default display, showing only current values for each register.

From SETEM:

":" (colon) acts as a toggle between full and half screen display modes.

Note: after a RESET or INITS, the ZAP screen always returns to the default (non-expanded) display.

Enter full-screen mode now. In this mode, each register is displayed as usual (though shifted to the left), with the current, on/off flag, and sync value. Additionally, for all scene-saved registers, the two normally hidden numbers are also displayed after the register's sync, separated by spaces. These numbers are the register's step and final values, respectively.

An excellent way to demonstrate the relationship of these three values is to execute a GOBY from MAIN. In full-screen mode, both SETEM and MAIN function normally, with the exception of the 10-cue list/help window, which is disabled. Locate the GA register on the display, and observe its three values (which, after a soft reset, are 30, 0, and 0). Then, from MAIN, execute the following:

```
GA 1 SSYNC 10 ! 50 5 GOBY
```

Now observe the GA register's three values again. Note that the current value has been set to 10 and the sync to 1. Now look at the second and third numbers. The second number (GA's step value) has been set to 5, which is the increment of the GOBY command. The third number (GA's final value) is now 50, also set by the GOBY. Now press <TAB> and watch what happens. You will see the GA register's current value increase in steps of 5 until it reaches 50. The register's step and final values will not change.

Programming Scenes

Scenes are programmed in SETEM, with the ZAP display in full screen mode. This allows the programmer to set not only the current values of registers, but also the step and final values.

Setting the current value of a register in full screen mode is exactly the same as in the normal display mode. However, by using the following commands, the step and final values may also be set:

^K sets the register's step value to the current value and restores the register's original current value.

^L sets the register's final value to the current value and restores the original current value.

To demonstrate this, enter SETEM and perform a soft reset using the "_" key, and enter full screen mode by pressing the ":" key. As an example, let's program a scene in which a graphic will be displayed off-center, and PG will ramp from 30 to 100 in steps of 2. Select the "TRIANGLE" logo and open LS. Then move the SETEM cursor to PX and set the current value to 10. Do the same for PY. You should now see the triangle shifted slightly up and to the right. Now, move the cursor to PG. Clear the current value by pressing <SPACE> and increment it twice. Then press ^K to set the register's step value. You should see the step value be set equal to 2, and the current value return to 30 (its value before it was changed). Set PG's final value to 100 in the same way, this time using ^L instead of ^K. The register display should now look like this:

"PG= 30 2 02 100"

After all current, step, and final register values have been set, the scene can be saved, recalled, and tested, all from within SETEM. The commands for these actions are:

^X saves a scene. ZAP first displays the "Save>" prompt, requesting the number of the scene to save. Next, ZAP requests a scene name with the "Name>" prompt. Scene names can be up to 5 characters long.

^F recalls a scene. ZAP requests a scene number with the "Recall>" prompt.

^Q activates all waiting GOBYs.

" (double quote) displays the list of all scenes by number and name (same as the MAIN command "SLST").

First, press the " (double quote) key to display the list of scenes and select an unused location (one without a name). Return to the ZAP screen by pressing <RETURN>, then save the scene by pressing ^X. Type the scene number and name as requested. Then, use " again to show that the scene was saved.

Perform a soft reset using the "_" key. Then, test the scene by first recalling it (using ^F) and activating the GOBYs (using ^Q). You will see the saved PX, PY, PG, and LS values return (as well as the TRIANGLE logo, if it was changed), and PG will begin moving toward 100 in steps of 2.

If we wanted to change the step rate of PG from 2 to 3, we can edit the scene by recalling it but not activating the GOBYs. Recall the scene using ^F again, but do not type ^Q. Instead, move the SETEM cursor back to PG, and change the step value to 3 using the method described above. Then, re-save the scene by typing ^X. This time, instead of re-typing the number and name, simply hit ^X two more times, and the last-used number and name (displayed at the SC 'register' near the upper-left of the screen) will be supplied automatically.

Other scene-related SETEM commands are listed in Appendix B.

Saved Information

A scene saves most, but not all, of the ZAP registers' values. For the following registers, full information is stored, including current, step, and final values; as well as sync and on/off status:

GA, FX, FY, PG, PX, PY, RO, RZ, RX, RY, SW, DW, LS, BS, S5, S6, S7, S8, AC, M1, M2, 3D

For the four visible/hidden register pairs (RZ & RZp, RX & RXp, RY & RYp, RO & ROp) values are only saved for the active register of the pair. For example, if RZ is off, the start, step, final, and sync values would be saved for RZp. If RZ is on, the information for RZ would be saved instead.

Current values and syncs (if any) are stored for the following registers:

A, AF, AX, LC, BC, BM

Finally, the current cue name is stored, as well as the scene name.

Recalling Scenes

Scenes can be recalled from MAIN, in MAINlines, or in TOPAs. They can be recalled as complete scenes, or as 'fades' to specific final values. The recall commands are as follows:

"n SR" (Scene Recall) recalls scene "n" and activates all GOBYs. ZAP then immediately moves on to the next command.

"n SRW" (Scene Recall Wait) recalls scene "n" and activates all GOBYs, but ZAP then waits for ALL GOBYs TO COMPLETE before continuing on to the next command.

"n SRNG" (Scene Recall No GOBYs) recalls scene "n" but does not activate any GOBYs. ZAP then immediately moves on to the next command.

"n SF" (Scene Fade) recalls scene "n" as a 'fade' scene. This means that only step and final values are recalled. Thus, all current register values and the current cue are 'faded' to the recalled final values. ZAP immediately continues on to the next command.

"n SFW" (Scene Fade Wait) recalls scene "n" as a fade scene. ZAP waits for ALL GOBYS TO COMPLETE before continuing.

"n SFNG" (Scene Fade No GOBYs) recalls scene "n" as a fade scene, but does not activate any GOBYs. ZAP immediately continues.

"FADE" activates all waiting GOBYs left by a "n SRNG" or "n SFNG" command. ZAP immediately continues.

"FADEW" activates all waiting GOBYs. ZAP waits for ALL GOBYS TO COMPLETE before continuing.

In any of the above commands which require the number of a scene, the name of the scene may be used instead.

Loading a complete scene from memory will cause ZAP to wait for a moment as the screen is updated (this is not the case for scene fades). While some scenes can be used this way, the delay will be too long for most situations. Therefore, when scenes are used, the MAIN command "NOU" should be executed first. This will eliminate the screen-update pause.

Allocating Scene Memory

ZAP 7.1 has 24K of RAM used for both MAINlines and scenes. The default settings are 16K allotted for MAINlines for a maximum of 160 lines, and 8K allotted for scenes for a total of 64.

If many MAINlines are needed or if large LV3 TOPAs are to be used, the default allocation will work best. However, if you would instead like to allocate more RAM for scenes and you can do without the additional MAINlines and TOPA space, an optional allocation is allowed.

"MAXSCN" allocates 16K of RAM for scenes, giving a total of 128. This leaves only 8K for MAINlines, for a maximum of 80 lines.

"MINSCN" allocates only 8K of RAM for scenes for a total of 64. This leaves 16K for MAINlines, for a maximum of 160 lines. This is the default setting.

The "MAXSCN" command first checks to ensure that no more than 80 MAINlines are currently allocated. If more than 80 lines are allocated (whether or not they are in use) the memory will not be re-allocated as scene memory. The "MINSCN" command, however, does not make any check. ZAP will reboot after changing memory allocation, and the allocation will be remembered beyond system power-down.

When ZAP is in its default (MINSCN) mode, you will be allowed to list, save, recall, etc. up to 64 scenes, and ALLOT up to a maximum of 160 MAINlines. In MAXSCN mode, you will be allowed to list, save, recall, etc. up to 128 scenes, but you will only be able to ALLOT up to 80 MAINlines.

Scene Play Mode

Scene Play mode (similar to Animation Play mode) can be used to view and display scenes in real time. Use the main command "SPLAY" to enter Scene Play mode. ZAP will display the "SPLAY>" prompt. In this mode, scenes can be displayed using the key assignments noted in appendix F.

There are three recall modes which can be toggled on and off from inside SPLAY. As with the MAIN commands SR and SF, scenes recalled in SPLAY mode can be recalled as complete scenes or as scene fades. Also, scenes and scene fades can be recalled with GOBYs either active or inactive. Finally, if 128 scenes are allocated rather than the default 64, all key assignments can be mapped to the second set of 64 scenes as noted in appendix F. To toggle these modes, use the following control keys:

^F will toggle SCENE/FADE mode. In SCENE mode, keys recall complete scenes. In FADE mode, all scenes are recalled as scene fades.

^G toggles GOBYs ACTIVE/INACTIVE. In ACTIVE mode, all GOBYs are immediately active upon recalling a scene or scene fade. In INACTIVE mode, GOBYs are not immediately activated.

^K toggles between 64-scene blocks 0 (numbers 1-64) and block 1 (numbers 65-128). Will only toggle if ZAP is in MAXSCN mode.

A status line at the bottom of the ZAP screen will display the state of the BLOCK number, SCENE/FADE and GOBY ACTIVE/INACTIVE modes. Default settings (after powerup or a hard reset) are BLOCK 00, in SCENE mode with GOBYs ACTIVE.

Once a scene has been recalled, the GOBYs can be activated or deactivated using the following keys:

^Q starts all waiting GOBYs left by a recall in INACTIVE mode or by the ^W command.

^W immedately halts all GOBYs.

SPECIAL EFFECTS

Growth & Collapse

Sometimes ZAP moves too fast to trigger these effects (see pages 3.17). If growth or collapse fail to work, try adding an "E" or "1 THS" before "G" or "C". Also, changing cues resets growth and collapse effects to prevent a half grown image from accidentally appearing. This is not true when changing cells within an animation, however. Remember: when an image is collapsed to a point, the computer becomes sluggish.

Segues

There are hundreds of ways to change from one logo to another. Creating interesting segues is one of the most common challenges for the programmer.

One dazzling and simple transition is to increase SW until a logo is reduced to sparkling points, change logos, and then decrease SW back to zero. First, set SW to Sync 3 (1/10 second Sync) so that SW won't slow down the speed of the "go by wait":

```
"R NOU LOGO1 O 1Ø THS  SW 3 SSYNC 8Ø 2 GOBW LOGO2 Ø 2 GOBW K"
```

Another standard transition is made by flattening a logo on one of its axes using RXP or RYP, changing logos, and then unflattening it:

```
"R NOU LOGO1  O 1Ø THS  RYP 4 SSYNC 256 3 GOBW LOGO2 Ø 3  GOBW K"
```

Grid

"s p GRID" will calculate and produce a scanned grid. "s" determines the line spacing; "p" is the point spacing and determines the speed of the grid scanning. The standard use of this command is "1Ø 1Ø GRID".

Since this effect is being created by the computer and not a digitizing artist, it will need some SW to straighten out corners which normally would be "weighted" with digitized points. Increase the SW to create broad, sweeping scans for stunning laser fans and raster-type patterns. This effect works particularly well with color sequences.

Brian's Effect

Brian Samuels always has a trick or two up his disk sleeve. He'll create something like this in a few seconds and then laugh madly as you try to imagine how he'd managed to discover it:

```
"R  SW 65 !  100 100 GRID  RZ 343 !+  RX 344 !+
 T  O  T  RZ 256 !  RX 2 !  T  RY -6 !+"
```

Play with the various rotation registers.

SW Sparkle

To create sparkling logos use:

```
"SW 4 SSYNC  999 DO SW 12Ø !  W Ø !  W  LOOP"
```

Using a two-letter color sequence set to Sync 4 will display the logo in one color and the sparkles in the other. Adjust the high SW value to vary the type of sparkle.

High Point Logos

The logos "CIR-RAS" and "STARPOP" may look like animations, but they are, in fact, single images with many, many points. Special effect logos such as these may be created by using a large number of points when digitizing. They appear to animate because they scan so slowly. Try slowing their scan rate even further with SW.

High point logos can be very effective when designed for growth effects.

Color chopping can hide annoying flicker on high point logos.

RO Effects

Set RO to Sync 4 for spaghetti effects (see SETEM, page 1.14). If you use small numbers in either PR, OX, or OY, and harmonies in RO, you can create wiggling, fracturing, undulating, and waving effects (especially with Wordfire). If you want to make a logo look like it's under water or shaking, experiment with these registers. Use DW to refine the effect.

Position "Shocking"

Remember we said (in SETEM, page 1.15) that the position registers (RZP, RXP, RYP, and ROP) cannot be used simultaneously with their equivalent rotation registers (RZ, RX, RY,and RO)? Well, here is a very particular exception to that rule.

When a rotation is turned on, you have very little control over what position the rotating image will be. By placing a value into the equivalent position register while a logo is rotating, you can temporarily "shock it" to that assigned position. This is useful if you want a logo to begin rotating at a specific point as you open the shutter. Try the following example to observe this effect in action:

```
"R NOU CIRCLE OX 1ØØ ! OY 75 ! RO 3Ø !+ O ( SET-UP) -->"
"4 DO T ROP 1ØØ ! LOOP 4 DO  T ROP -100 ! LOOP 4 DO T ROP
 511 ! LOOP K"
```

9-Speed Animations

By using carefully created animation files in which each cell has the same number of points and plenty of blanked points at the start and end, you can display several images on the screen with only one scanner. Generally, these types of cells are made up of 13Ø to 2ØØ points, including blanked points "fore and aft."

Each cell of your special animation may be a different image or they may be separate parts of a logo that you want to break apart or fly in from various directions to form a logo. This effect can be created with 9 speed animations or 9 speed animation sequences.

Set your rotation harmony to match the number of cells in the animation sequence (a three harmony for three cells, a five harmony for five cells). Adjust SW until you've locked-in discreet images (this will take some adjustment).

Color sequences set to Sync 2, which use the same number of letters as the number of cells in your sequence, will color each image differently (see the previous example on page 3.12). To get REALLY complex, you can alternate cells in the animation sequence to animate each of your harmonic images. If you have a 5 harmony, you might use 25 cells in your animation sequence to give each of the 5 displayed images five animation cell movements.

PROGRAMMING WITH "KEYS"

When programming MAINlines for a show, KEYS routines can be used to save space.

"n KEY" will execute key "n" of a given KEYS program (see Appendix C). Keys "A" through "Z" are accessed by numbers 1 through 26. Numbers 27-31 are "[", "\", "]", "^", and "_", respectively. This command must be followed by a wait command to allow the KEYS program to execute.

To use these commands, first call up the name of the graphic and the specific KEYS program ("DK1" to "DK5", "SEK", or "VEK") you wish to use. Here is an example: (Note: KEYS programs cause the terminal to beep when they are accessed.)

```
"R  NOU  KON  LM  VEK  T  18 KEY  O  2Ø THS  19 KEY  15 THS  K"
```

Here is another:

```
"R  NOU  KON  DK4  T  17 KEY  O  3Ø THS  23 KEY  3Ø THS
 24 KEY  UPDA"
```

"UPDA" was used this time because "K" would have caused a noticeable hesitation in the execution of the routine.

PROGRAMMING FOR FILM

In most film shoot situations, laser effects are required to expose acceptably at "live action" speed. This means that laser graphics must have an effective exposure time of 1/48 of a second per frame of film (assuming the film speed is 24 fps with a 18Ø° shutter). The critical factor in filming graphics is the scanning rate of the image. Ideally, two or more scans of the image per frame is desirable, which means a minimum of 1ØØ scans per second. The "TIME n SCANS TIME" command can provide this information (see page 3.18).

Even at 1ØØ scans per second, there is some perceptible intensity variation which will appear to travel through the graphic. Therefore, a rate between 2ØØ and 3ØØ scans per second is ideal.

Test shots should be taken to determine correct exposure, depending on the shooting situation. Expect to be close to wide open (f.2 - 2.8) to get good saturation.

The exposure can be one to two scans per frame in a single frame exposure of graphics, depending, once again, on the conditions (projection surface, laser power, ambient light, etc.).

MULTIPLE COMPUTERS

ZAP computers can be linked together to create multiple or complex effects (see Hardware, page 4.10 - 4.14 for configuring instructions). Once your computers are interconnected, you can use a variety of commands to communicate from the Host to the Slaves:

"n SETSIO" will set the serial I/O option (n = Ø, 1, or 2) and establish communication between computers. Note: if ZAP cannot locate the additional DUAL UART cards needed for multiple-computer systems, an error message is displayed.

"TAB" will execute a <TAB> (trip Sync 1).

"+DTAB" will send all <TAB>s struck on the Host to the Slaves as well.

"-DTAB" will turn off <TAB> sends to the Slaves.

There are also a variety of ways to "SEND" commands to the Slave computers. (See Appendix D for a list of these commands.)

Before programming a multi-scanner show, be sure to register all of your computers' scanning standards ("NNST") so that each is square, the same size, and their centers are superimposed. To do this, adjust each scanner amplifier's X and Y gain and offset (see Hardware, page 4.26 for adjustment instructions).

"NN" will call up the standard (same as "NNST 1ØØ GAIN O").

"NNN" will call up the standard on all computers.

"BB" will call up the blanking standard (same as "BBST 1ØØ GAIN O".

"BBB" will call up the blanking standard on all computers.

As a rule, check shutter adjustment (Hardware, page 4.16) and blanking (see LM22SDA manual, page 1Ø) before beginning programming. This is especially critical in multi-computer set-ups.

RUNNING A TIMECODE SHOW

Preparation

Plug the timecode card into the Host computer and connect the RCA end of the timecode cable marked TC IN into the channel 4 output on the back of the Tascam.

1. Play the module audio tape in the Tascam. Find a particularly loud section and adjust the audio playback levels on the Tascam. Tracks 1 & 2 should be set high, but not so high that the red peak indicator lights are blinking frequently. These lights warn that the output is distorting. If there are test tones on the tape, adjust channels 1 and 2 accordingly. If not, find a good level and make sure both channels are adjusted to the same value. Do not adjust the speaker volume by changing the Tascam outputs.

2. Adjust the timecode level on the Tascam. Track 4 should always play back at -3 on the V.U. meter.

   Note: whenever you change a tape, always make sure that track 4 is set to -3db and that tracks 1 & 2 are set as high as possible without peaking frequently. BE SURE THE DBX IS SWITCHED TO "OFF."

3. Adjust the speaker volume with the amplifier volume control so that the tape will play back at the desired level.

4. Rewind the tape to a point AT LEAST 5 seconds before the audio begins. Push the reset meter button on the Tascam to zero the counter. Depress the STOP button just to the right of the RESET button. This will cause the Tascam to automatically stop at the zero point on the counter when you rewind the tape, leaving the tape properly cued up for the show.

5. Play the tape. Type the command "TSY" on the Host computer, followed by <RET>. This is a test to see if the timecode is reading properly. In the lower left corner of the ZAP screen, you will see numbers which should be incrementing smoothly. If the numbers are randomly skipping around you must flip the top switch (C3/C4) on the timecode card. After flipping this switch, the numbers should increment smoothly. Hit <ESC> to end this test.

6. Reset all computers with "~".

7. Once the computers have reset, type the module cue name on the Host terminal followed by <RET>. The cursor should display a highlighted W, signifying that it is now waiting for timecode.

Running the Module

1. Start the tape. The Host computer will cue up and start the Slaves.

2. After you have tested the module, rewind your cassette tape to the zero point. It will stop automatically and be cued up for your show.

3. Repeat previous steps 6 and 7.

TOPA CONTROL

<ESC>	will exit a TOPA program.
"ETOPA"	will freeze a TOPA cue.
"L"	will freeze TOPAs on all computers.
"TWAIT"	will wait for completion of a TOPA before executing the next command (be aware, however, that many TOPAs will reset the computer after they complete, overriding this command).
"PAUSE"	TOPA pause.
"RESUME"	TOPA resume.
"TFF"	will toggle TOPA pause/resume.

FLAGS

Flags are a convenient way to group together miscellaneous on/off functions. Five on/off switches (or bits) are grouped together into one set of flags. Some of these flags are currently undefined, but may be assigned a function in the future. See Appendix H for a complete listing of flag registers and their effects.

MAIN commands can turn these flags on or off, but it is also possible to control flags individually or in groups by assigning values to these registers (see Appendix H).

MATH AND STACK FUNCTIONS

ZAP can be used as a calculator. It operates by a FILO (first in/last out) math stack. This is called "postfix notation" and is the same type of system Hewlett-Packard calculators use. Numbers are placed on this stack; the operation to be performed is given, followed by the command to print the answer. A command to add would be "3 4 + ?"; "1Ø24 9 - ?" would be a command to subtract.

More complicated operations can be done by utilizing the stack. This system was patterned after FORTH (a computer language). It is possible to take advantage of this math operation in conjunction with Do Loops. By pushing the index "I" from the loop onto the stack and multiplying ("*") or dividing ("/") it, you can use the result to control certain commands, such as "CELL" or "GAIN". Random numbers may also be used. See Appendix D for math and stack commands.

Further reading on math and stack functions may be done in chapters one and two of Starting FORTH by Leo Brodie, (Prentice-Hall, 1981).

PROGRAMMING TIPS

* By now, you will have noticed that ZAP is very obedient, but rather literal-minded. It is up to you to do all the thinking, to anticipate problems, and to find solutions in advance. ZAP will try to do everything you command it to do.

* Check the scanning standard, blanking standard, and shutter adjustment before programming or running a module.

* If you forget commands, consult the help file.

* Do not forget (because ZAP doesn't) which registers you've affected and in what condition you've left them. Be sure to "clean house" before moving on to the next effect.

* Do all your set-up commands before you open the shutter.

* Use SW only when necessary and "zero it" between uses. Assign SW last, just before opening the shutter.

* Use comments and keep your code clean.

* "If it looks complex, it's not done." If your code isn't clean and simple, you haven't found the easiest way to get the effect. Keep trying.

TROUBLESHOOTING

It may be comforting to know that it is not possible to destroy ZAP or the computer by entering incorrect commands. If the computer freezes up, reset it. If the terminal freezes, try turning it off, then on again.

Sometimes you may accidentally hit ^1 which will print garbage on the ZAP screen, or ^4 which will beep on each key stroke. See Appendix A for a list of these Esprit control keys.

The most common problems with programs are typos and errors in logic. Check your code carefully for spelling mistakes or extra characters.

***"I DON'T SEE ANYTHING ON THE PROJECTION AREA." Troubleshoot the problem one step at a time and isolate the problem:

Is your laser turned on?
Is the shutter open?
Is a color command being used with the wrong color laser?
Are the scanner driver amplifiers turned on?

***"THE WORD EDIT BUFFER AND SETEM AREN'T DISPLAYING CORRECTLY."

Is the screen updating?
Is "NOU" on? (a common problem)

***"THE PROGRAM OR MODULE IS BEHAVING ERRATICALLY."

Is your timecode phase correct?
Is there a constant "+" in the ES or TC register?
Is the DBX switch set to "off?"

***"COLLAPSE OR GROWTH DOESN'T SEEM TO WORK."

Are you changing a logo after the command?
Try putting a time wait before "G" or "C"?
Is your growth or collapse speed set to Ø?

***"WORDFIRE WON'T DISPLAY."

Is your travel speed set to Ø?

TRIVIA

ZAP displays 14,286 points per second.

ZAP spends 71% of its time displaying points and 29% doing everything else.

UPGRADES AND BUGS

ZAP upgrades are made throughout the year to add new commands or correct bugs that have been discovered. Contact your Laser Media representative for information on recent changes. This manual is based on ZAP #7100.

If you think you have discovered a bug in ZAP, please isolate the problem and contact Laser Media.

At this writing, there are five known problems:

***A slight glitch in the scanned graphic may be seen when the help file is accessed or paged. While this problem is most noticable when the help file is used, other commands which use the CPU card's ROM and RAM (such as SLST, MLIST, etc.) may also cause a slight 'blip' in the image.

***The MAIN Recall command ^F should only be used before typing anything at the MAIN prompt, or it will not recall the previous command correctly. Also, pressing ^F repeatedly (without pressing <RETURN>) has been known to crash ZAP.

***It is possible to overflow the MAIN stack. This is easily done, for example, with a loop that leaves numbers on the stack each iteration. This can crash ZAP and may even induce the loss of MAINLines or saved scenes.

***Changing from one Wordfire font to another (especially to a customized font) may crash the scanning. If this occurs, try calling another logo (with the shutter closed) before switching to the new font. (Note: calling another logo after scanning has crashed will restore scanning to normal.)

***There is no range-checking for GOBYs executed from MAIN or in a TOPA. This will not cause any major problems, but it may produce unexpected results.

H A R D W A R E

This section is included as a reference only. If you plan to enact an option discussed here, don't hesitate to consult Laser Media first. If service is needed and you have some technical background, minor repair may be attempted using this guide. All adjustments are preset at Laser Media before the equipment leaves the factory. These procedures are included here for you in case something should need readjustment or a replacement part is installed.

Laser Media will not take responsibility for any changes made to a Laser Media system by the owner, or for the attachment of any external device to a Laser Media system.

If a problem arises, first find out if the difficulty is in the hardware or software. To determine if the problem is in the software, perform the following procedure:

* Hit the tilde (~) key. If that doesn't work
* Hit the IMAGEN reset button. If that doesn't work
* Turn the terminal power off, wait 1Ø seconds, turn the terminal back on again and hit the IMAGEN reset button. If that doesn't work
* Turn all power off, wait 1Ø seconds and power back on again. If that doesn't work
* YOU HAVE A HARDWARE PROBLEM.

If you are having a problem or would like further information on connection of external equipment, please contact Laser Media:

LASER MEDIA, INC.
6383 Arizona Circle
Los Angeles, CA 9ØØ45

Phone: (31Ø) 338-92ØØ
FAX : (31Ø) 338-9221
Telex: 288898 LSMED UR

BASIC LASER MEDIA IMAGING SYSTEM

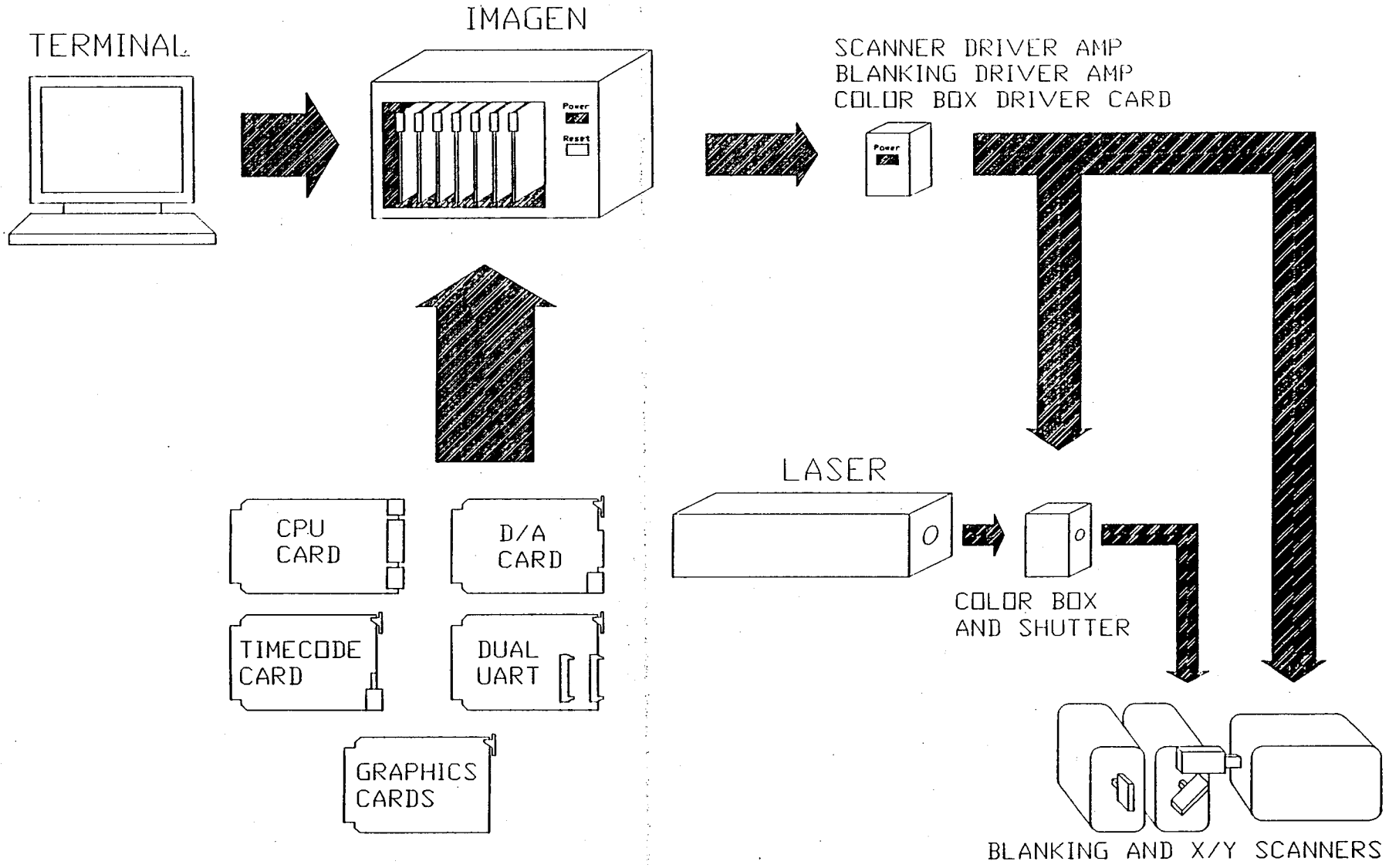


Figure 4.1 Diagram of a basic Laser Media system

THE TERMINAL

The terminal is your interface with ZAP. It is connected through serial port A of connector JP4 on the LM65ZAP CPU card. This port is configured for 96ØØ baud, no parity, eight data bits, and one stop bit. The terminal is DTE (data terminal equipment), so port A of the CPU is hard-wired as DCE (data computer equipment). Only three wires are needed for proper communication.

D-25		Data Direction
2	-TD (transmit data)	to computer
3	-RD (receive data)	to terminal
7	-Ground	

Terminal Installation

Configuration switch Settings for the Esprit II terminal:

```
1 2 3 4 5 6 7 8 9 Ø    1 2 3 4 5 6 7 8 9 Ø
- - ^ ^ ^ ^ - - ^ ^    ^ ^ ^ ^ - - - - - -
```

^ = up
- = down

The terminal is pre-configured by Laser Media to work with the IMAGEN. However, options such as keyclick and cursor style can be reconfigured to your own personal tastes. Refer to the terminal manual for instructions on altering the settings.

Control and Function Keys

The eight keys above the numeric key-pad on the Esprit II terminal are not implemented in ZAP and will have unpredictable actions (usually a reset). In addition, ^1 through ^Ø are not meant to be used with this system, but sometimes they are hit by mistake. See Appendix A for a list of these control keys and their effects.

On the new Esprit Opus 2 terminal, control keys and function keys have been reprogrammed by Laser Media as various ZAP commands. See appendix A for a list of these keys and their functions. These keys may be reprogrammed by following the instructions in the Esprit manual.

Troubleshooting

If your keyboard freezes, turn the terminal off, wait 5-1Ø seconds, and turn it back on. If the terminal still does not work, check the keyboard connection.

THE IMAGEN

The IMAGEN (see Figure 4.1) is Laser Media's computer chassis (power supply and card cage). The "power" and "reset" buttons are located on the front of the unit.

Troubleshooting

Make sure that 1) all cards are completely "seated" (firmly pushed in) in the IMAGEN; 2) all EPROMS are firmly seated on their cards; and 3) the copper bus contact area of each board is clean. Using an eraser to clean the front and back of these contact areas may help if you seem to have intermittent card problems.

THE CPU CARD

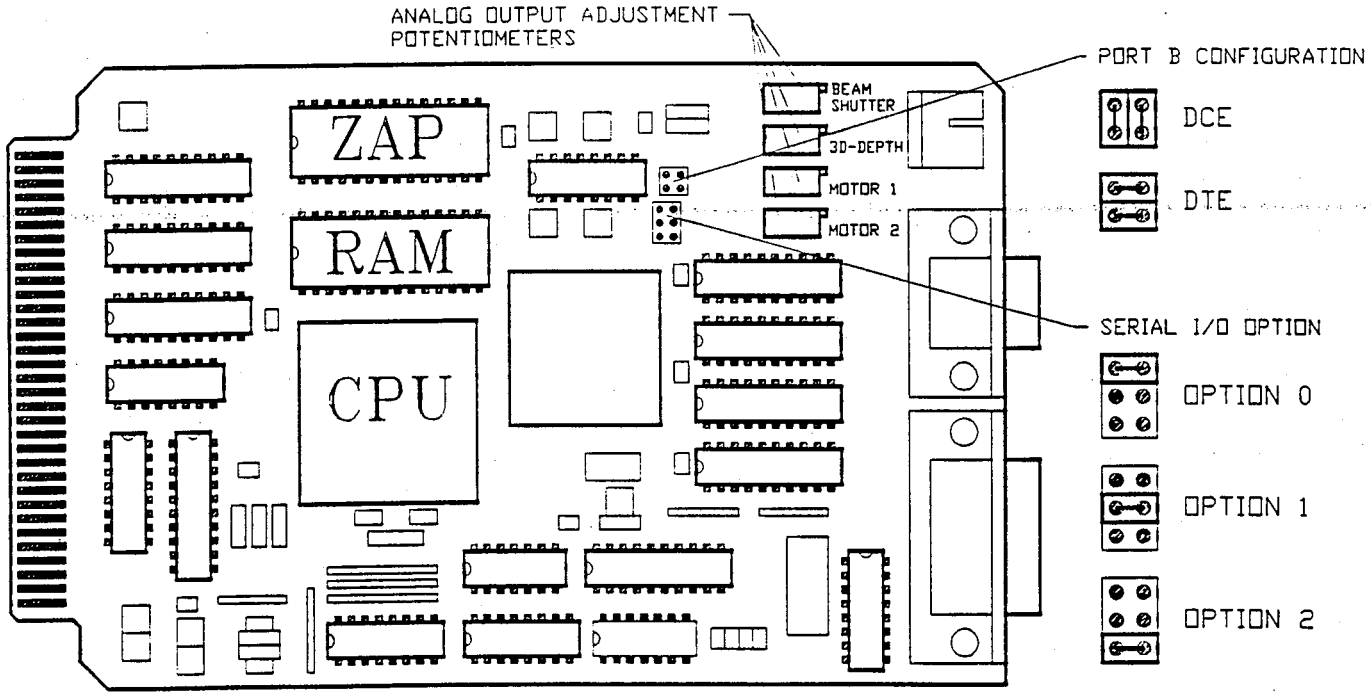


Figure 4.2 The CPU card

The LM65ZAP CPU (Central Processing Unit) card is the brain and clock of ZAP. All image and data processing is done on this card and all other cards are peripheral devices to the CPU. ZAP resides on a single EPROM as shown in Figure 4.2.

Most of the IMAGEN's normal functions are performed by the CPU card. This includes generation of the TTL-level and variable-voltage table control signals, communication with the terminal and a LV3 computer or slave, and accepting of external cues and signals. Also, all non-volatile RAM is located on the CPU card.

Battery Backed RAM

All of ZAP's non-volatile RAM is located on a single DALLAS 32K battery-backed RAM chip located directly below the ZAP ROM. This RAM is used to store all ZAP's MAINlines, Scene data, and Beam and Color programs. Part of the RAM is also used as ZAP's run-time 'scratch pad' and program memory.

This RAM contains 16K of memory used for MAINlines and LV3 programs (TOPAs), 8K of Scene data, and 8K of run-time program memory for ZAP. The battery back-up is rated for 10 years of data retention.

As the non-volatile RAM chip does not need any external supply to maintain data, it can be removed and transferred to another CPU card or 'backed up' to a data file using an EPROM burner (make sure it is configured for DALLAS 1230Y SRAM first!) without losing any MAINlines or Scenes. Note that as the pins on this IC are fairly thin and fragile, they must be removed and installed with great care.

Although it is rare, it is still possible to crash ZAP in such a way that ZAP 'forgets' how many MAINlines were allocated. If this occurs, ZAP will erase the first 10 lines and ignore the rest. Use the MAIN command 'TOLLA' to restore any lines after line 11. The first 10 lines will be permanently lost, so it is a good idea to use this area for non-critical programming. Also, if a RAM chip is inserted backwards or a pin is bent, all data (MAINlines and Scenes) may be lost. Remember, the only foolproof way of saving a program is to copy it down on paper.

Two-Channel SIO

The first two serial communication channels used by an IMAGEN computer come from the CPU card. The first channel, called Port 1, is used for communication with a terminal. The second channel, called Port 2, can be connected to an LV3 computer, a Slave IMAGEN, a Host Imagen, or not connected at all.

Both ports use 3 lines for communication; one to transmit data, one to receive data, and a ground. All six lines are found on the 6-pin male MOLEX connector JP4 at the upper right corner of the card.

The RS232 standard uses pins 2 and 3 of the D-25 connector for transmitting and receiving data. Whether pin 2 is to be used for transmitting or receiving depends on your point of view. Either way, it is necessary for the two pieces of equipment to have opposing points of view, or else both pieces of equipment will try to transmit on the same pin. The names for these two views are DTE and DCE.

DTE (Data Terminal Equipment:

pin 2 - Transmit (output)
pin 3 - Receive (input)

DCE (Data Computer Equipment:

pin 2 - Receive (input)
pin 3 - Transmit (output)

The top three pins, numbered 1-3, are used for serial port 1 (labeled 'TERMINAL' at the connector). Pin 1 is grounded, pin 2 is the transmit line, and pin 3 the receive line (DTE). This port cannot be configured.

The lower three pins, numbered 4-6, are used for serial port 2 (labeled 'AUX'). As this port can be used to communicate with several different devices, the port's transmit and receive lines (at connector pins 4 and 5) can be switched by changing the orientation of the jumpers J4 and J5, changing between DTE and DCE configuration. For DTE, install the two jumpers HORIZONTALLY as shown on the card. For DCE, install the two jumpers VERTICALLY (this is the default setting). In either configuration, pin 4 remains grounded.

Projector TTL Output

All of the projector's beam positions are generated on the CPU card. There are ten beam positions in all, and they can be found on the female D25 PROJECTOR connector JP3 at the following pins:

Pin	Signal
1	Beam 1
2	Beam 2
3	Beam 3
4	Beam 4
5	Beam 5
6	Beam 6
7	Beam 7
8	Beam 8
9	Beam 9
10	Beam 10
13 & 25	Reference ground

These outputs are controlled by the various MAIN commands, such as "n BEAM" and beam sequences. All outputs are TTL level, active high.

Auxiliary TTL Output

Five auxiliary output bits are available for accessories or for interfacing ZAP to external devices. The electrical considerations are the same as noted above for the External Cue signal, except that these signals are not momentary. All auxiliary outputs are reset (low) when the computer is reset. The outputs can be found on the female D25 PROJECTOR connector JP3 at the following pins:

Pin	Signal
11	AUX 1
21	AUX 2
22	AUX 3
23	AUX 4
24	AUX 5
13 & 25	Reference ground

These output bits are normally controlled via the AX flags, but they may be programmed into beam sequences (for use as beam positions) as well. A "+" on a flag represents a high TTL output, while a "." represents a low TTL output.

Analog Table Signals

There are four adjustable analog signals generated on the CPU card which are run to the laser table. These are the beam shutter, motors 1 and 2, and the 3D Depth signals. The voltage range of these signals is adjustable through the four potentiometers located on the upper right corner of the card as noted in figure 4.2 above. Standard adjustment yields a full range of +/-5 Volts at maximum register values.

All four signals can be found on the female D25 PROJECTOR connector JP3 at the following pins:

Pin	Signal
14	3D Depth
15	Beam Shutter
16	Motor 1
17	Motor 2

Also, there are three 4-level beam color signals and one 4-level option signal. These are not adjustable, and are used to control the three beam color flags (CYAN, MAGENTA, and YELLOW) and an additional option. The three color signals are found on the following pins of the PROJECTOR connector JP3:

Pin	Signal
18	Cyan
19	Magenta
20	Yellow

The option signal is not routed to the table; instead, it can be found at pin 4 of the JOYSTICK connector JP1.

External Sync Input

The External Sync input is wired from pin 9 of the 10-pin JOYSTICK header JP1 on the CPU card to pin 5 of the male D9 connector on the IMAGEN front panel. To use this input, an external relay should used to connect pins 5 (sync input) and 8 (ground).

Internally, this signal is pulled high, thus the relay only serves to pull pin 5 low. A low pulse of about 1/1Ø second will trigger the sync (which is tripped on the falling edge only).

The "EXTW" command is used to halt programs until an external sync input is provided.

External Cue Output

The external cue output is a momentary (1/4 sec.) relay closure. The word to trigger the relay is "ECUE". This relay can be used to trigger an external device, such as a slide-projector, lighting console, audio tape deck, a third-party's computer, or any other special effect machine.

The output can be found on pin 12 of the CPU's female D25 PROJECTOR connector JP3. Reference ground is wired to pins 13 and 25 of the same connector. At pin 12, the output signal is a high (normally low) TTL pulse. Although there is full TTL drive capability, there is not enough power to drive a relay directly. We strongly caution against connecting this output directly to anything other than Laser Media equipment. A 2N2222 or other similar transistor can be used to amplify the TTL level to drive a relay, which in turn can be used to trigger other equipment.

Firework Output

The firework output was originally designed for use with fireworks, but can be used for any kind of momentary action devices, such as strobes, chimes, relay start/stops, etc. Sixty-four devices can be connected to this output through the use of decoding logic, such as four 74LS154s.

The XFIRE signals are found on the following pins:

Pin	Signal
1	XF4
2	XF3
3	XF2
4	XF1
5	XF0
7	Latch Enable
8	Latch Enable
9	XF5
6	Reference ground

The firework number minus 1 (set with the MAIN command "n XFIRE") is encoded in binary on signals XF0 through XF5, with XF0 as the LSB and XF5 the MSB. Pins 7 and 8 carry a latch enable pulse (both high) to signal a new XFIRE value.

Troubleshooting

Problems with the CPU card are usually obvious - ZAP doesn't run. But if this is the case, before blaming the CPU card, check that the IMAGEN has power, that the terminal is properly connected, and that all the pins of the ZAP ROM and RAM chips on the CPU card are socketed correctly (not bent).

The functionality of the CPU card is broken down into several different subsections. If there seems to be a specific problem with ZAP, while all other areas work as expected, it may be that only one particular chip has failed.

If ZAP does not recognize any graphic cards (which are known to work correctly) and/or ZAP does not scan properly, the problem could be with the card's bus control and buffer chips (U1-U3, U17 and U18; located along the left edge of the card). In particular, the data buffer (U3) is sensitive to live insertion and withdrawal from the bus, and may burn out if this occurs.

If the ZAP screen comes up but ZAP won't accept input from the terminal (after ensuring that the keyboard is connected, and that turning the terminal off, waiting 10 seconds, then back on does not solve the problem), or if nothing appears at the terminal at all but otherwise ZAP seems to be running correctly, the 2-channel serial MAX232 chip (U9, top center of the board) may be at fault.

If any of the TTL-level table signals (beam positions, AUX flags) do not work correctly, and the table connectors and cables check out OK, try checking the three table signal buffers U13, U15, and U16 (right side of the board, just behind the XFIRE and PROJECTOR 'D' connectors).

If ZAP does not recognize the joystick or external cue inputs (and your system is wired for these options), check the input signal buffer U14 (middle right side of the board, just above the JOYSTICK connector).

If any of the three 4-level color signals (CYAN, MAGENTA, and YELLOW) are nonfunctional, check the TLO84 U8 (lower edge of the card, directly below the CPU).

Finally, if any of the MOTOR1, MOTOR2, Beam Shutter or 3D analog signals is not working correctly, check the D/A converter U10 and its associated TLO84s U6 and U7 (lower edge of the card, just left of center).

THE DUAL UART CARD

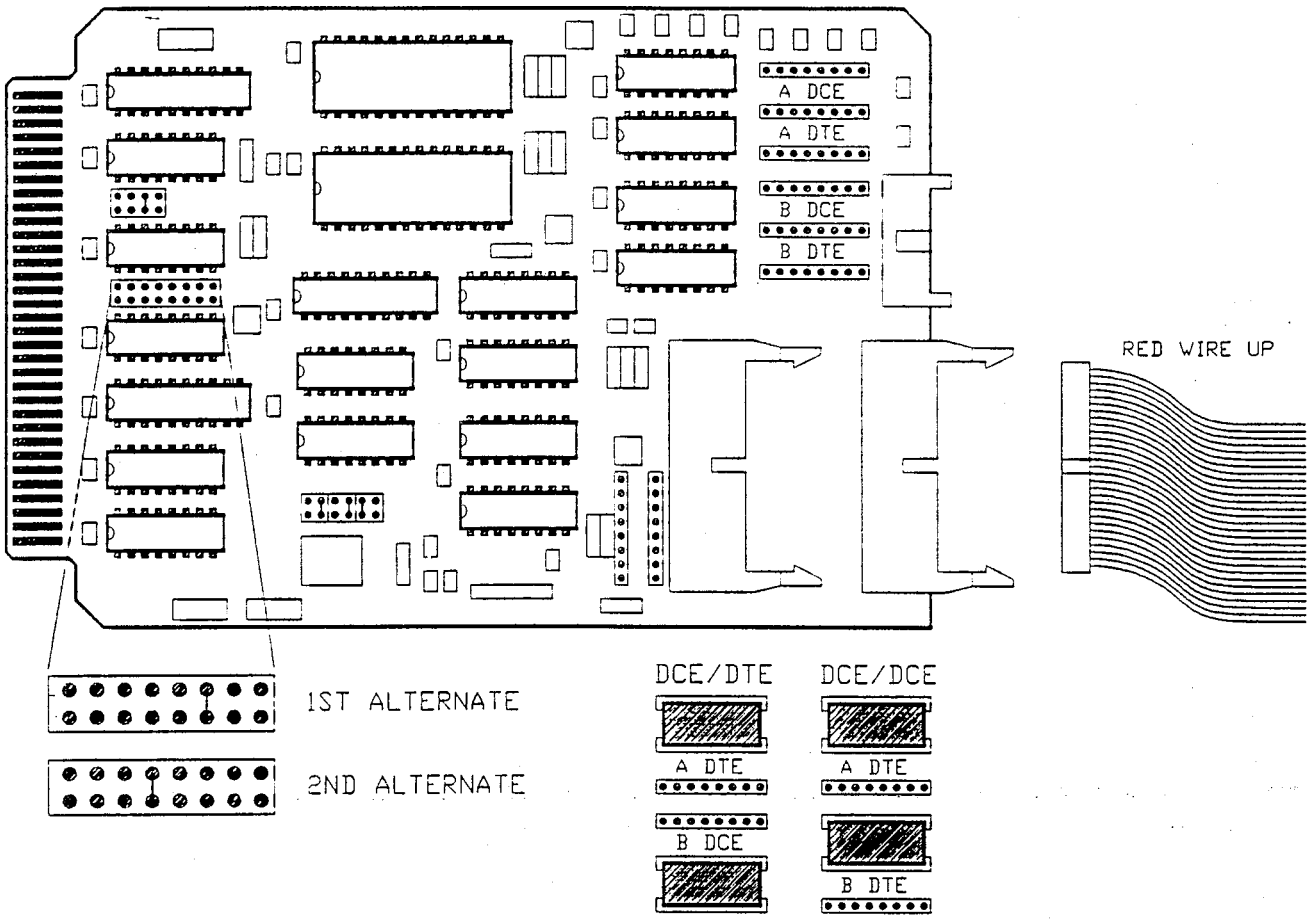


Figure 4.3 The Dual Uart card. On the left are shown the card address options; on the right are the DCE/DTE and DCE/DCE configurations.

These cards each contain two RS232 communication ports, which can be used to link the Host IMAGEN and Slave computers. Only systems operating in a Host/Slave setup need any Dual UART cards.

Host/Slave Interface

Slave computers are connected through serial ports A and B on the Dual UART cards. These ports are both configured for 96ØØ baud, and can be set as DCE (data computer equipment) or DTE (data terminal equipment). Three wires are used for communication:

D-25		Data Direction
2	-TD (transmit data)	to Host (not connected on some systems)
3	-RD (receive data)	to Slave
7	-Ground	

Serial I/O Options

The serial I/O option determines how the the Host computer will communicate with the LV3 programming computer and/or the Slave computers. Note that the serial I/O options apply to the Host only; Slave computers are ALWAYS set to option Ø and will NEVER need any Dual UART cards.

There are three options for the Host:

Option Ø: This is the "normal" operating mode in which there is either a single ZAP computer, a ZAP with an LV3 programming computer, or a Host and Slave ZAP with no LV3 computer. No Dual UART cards are needed in this system.

Option 1: This option is used to interface a Host and Slave ZAP to an LV3 programming computer or to create a ZAP triad (a Host, Slave 1, and Slave 2), with or without an LV3 programming computer. One Dual UART card must be present in the Host computer and configured as the First Alternate (see figure 4.3).

Option 2: This option is for a four computer show, with or without an LV3 programming computer. For this option, the Host computer requires two Dual UART cards, one configured as the First Alternate and one as the Second Alternate (see figure 4.3).

Each of these options, and the associated Dual UART port connections, are shown in figure 4.4. Use this figure as a guide for configuring any multiple-computer system.

There are two operations involved in setting the Serial I/O option:

1. Setting the serial I/O option on the Host computer.
2. Configuring the Dual UART card(s).

1. Setting the Serial I/O Option

There are two methods for setting the serial I/O options:

(A) From MAIN, enter the command "n SETSIO". "n" is the desired option number. This command must be used every time computer is powered-up or reset. This method is used for a temporary operating set-up only.

(B) The option can be set automatically by jumpering the pins labeled 'OPTION n' on the Host CPU card. Connecting one of the three option jumpers J1-J3 (noted in figure 4.2) will cause ZAP to boot up in that serial I/O mode.

2. Configuring the Dual Uart Cards

Configuring the Serial I/O card is a two part operation:

(A) The Dual UART card address must be set.
(B) The DTE/DCE jumpering must be set.

Setting the Dual Uart Card Address

Dual Uart card address is set at the "SY" jumpering strip. "SY" is located on the middle left side of the card (see Figure 4.3). When a single Dual UART card is needed in the Host (option 1), it is addressed as the "1st Alternate." When there is a second Dual UART card (option 2), it is addressed as the "2nd Alternate."

Jumpering for DTE/DCE

As noted above, any two pieces of equipment communicating with each other must have opposing configurations. Thus, to communicate through a Dual UART card to a CPU card's second port (which is normally configured as DTE), the UART port must be configured as DCE.

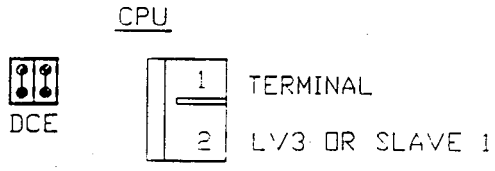
On the Dual UART card, DTE or DCE is selected by covering up the letters of the option in effect. Thus, if you can read DTE, that channel is set to the DCE configuration (see Figure 4.3).

Troubleshooting

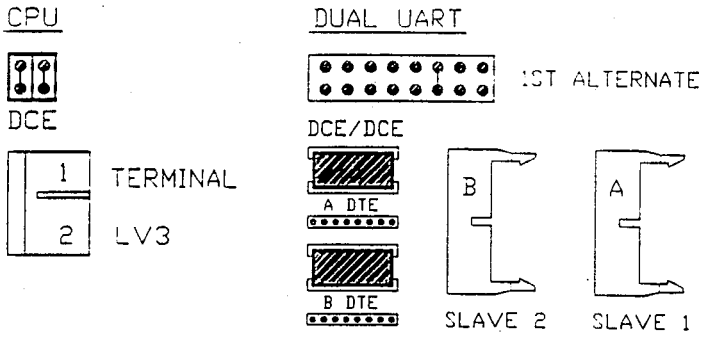
It's easy to get mixed up here. Make sure that the slave is configured as option 1 and that the host output runs into serial port B of the CPU card. Also make sure that the Host is configured to the correct serial I/O option (by jumpers or with the "n SETSIO" command, and that the output to the slave comes from the appropriate port (see figure 4.4). Finally, make sure that the Host and Slave computers are not both using DTE or DCE. If the Host computer is set to option 1 or 2 but ZAP is unable to find the appropriate Dual UART card or cards (if the card is missing or nonfunctional), an error message will be displayed.

HOST

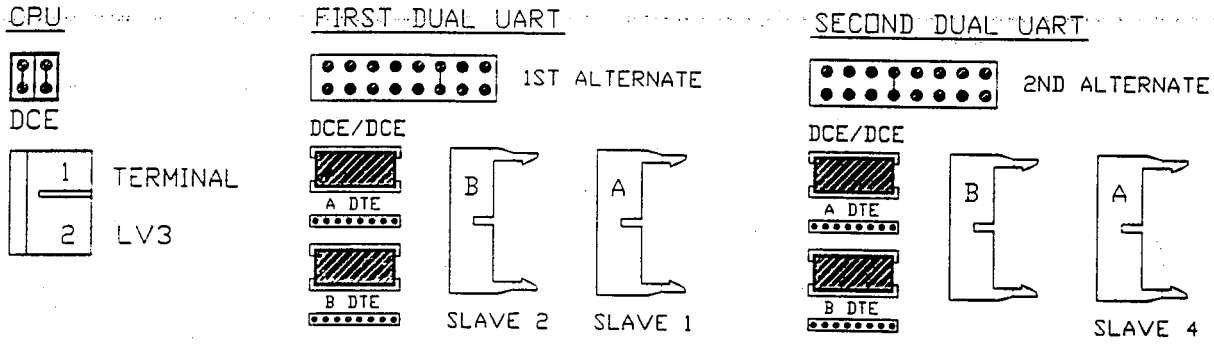
OPTION 0: Host IMAGEN alone, with LV3 computer, or with one slave IMAGEN.



OPTION 1: Host IMAGEN with one or two slave IMAGENs, with or without LV3 computer.

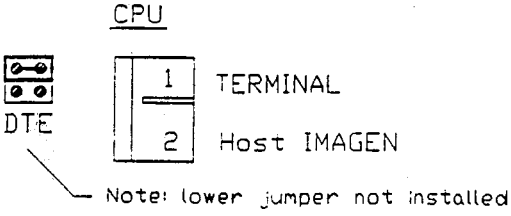


OPTION 2: Host IMAGEN with three slave IMAGENs, with or without LV3 computer.



SLAVE

Systems with only the host and one slave (host CPU configured as Option 0):



All other slaves:

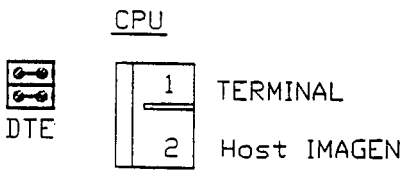


Figure 4.4 Dual Uart card option configurations. Slave computers are always option Ø.

THE D/A CARD

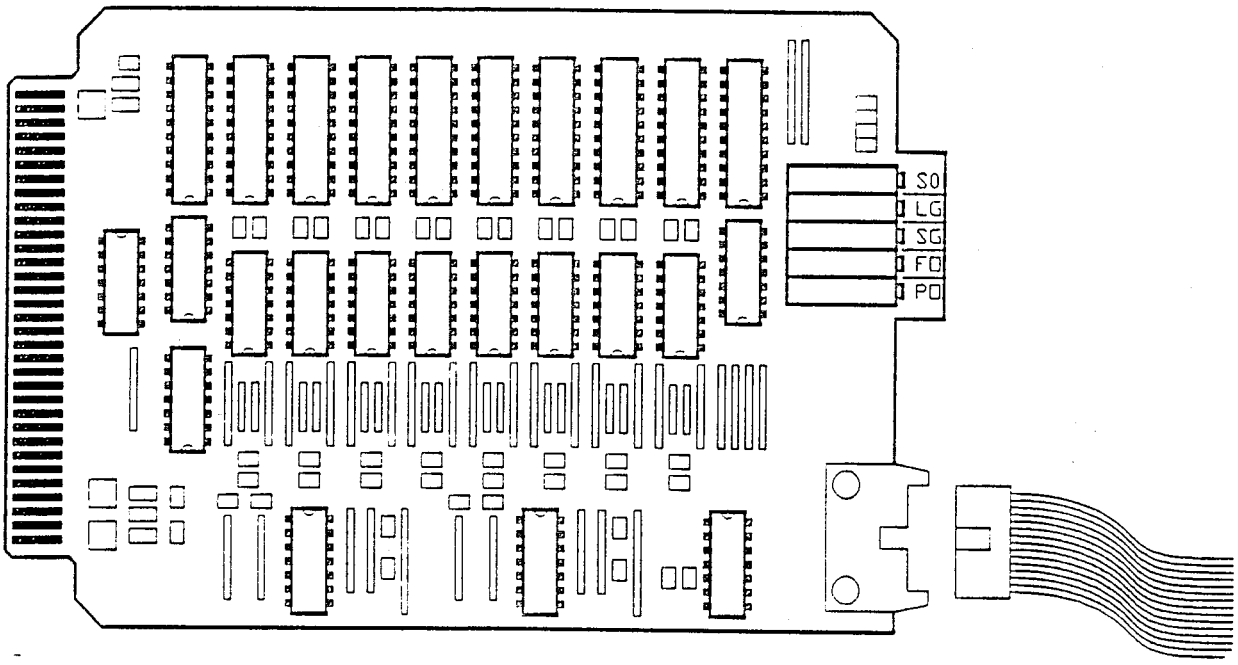


Figure 4.5 The D/A card with its IMAGEN connecting cable

The D/A (Digital to Analog) card converts binary numbers into DC voltages which drive the scanners, the logo shutter, and the logo color filters.

There are trimpots for adjustments located on the right side of the card (see Figure 4.5). These trimpots are:

S O	Shutter Offset
- -	Not Used
L G	Logo Gain
S G	Shutter Gain
F O	Final Offset Gain
P O	Pre-rotation Offset Gain
D	Diffusion Offset
B	-Blue (yellow) Offset
G	-Green (magenta) Offset
R	-Red (cyan) Offset

D-9 Connector Outputs:

Pin	Output	Ø Volts	7.5 Volts
1	Signal Ground		
2	X (horizontal	± 1Ø volts	
3	Y (vertical)	± 1Ø volts	
4	Blanking	Normal	Blanked
5	Option	Inactive	Active
6	Shutter	Closed	Open
7	-Blue (yellow)	White	Cyan
8	-Green (magenta)	White	Magenta
9	-Red (cyan)	White	Yellow

Procedure for Adjusting Shutter

The shutter should be adjusted to begin opening at about 2Ø and be fully open at about 11Ø. Failure to have a properly adjusted shutter will result in poor fades and incorrect play for pre-programmed shows.

"Down" means counter clockwise. The trimpots are 2Ø turn trimpots, and when fully down (or up), they will audibly "click".

1. Turn SG (shutter gain) all the way down.

2. Adjust SO (shutter offset) so that the shutter just barely opens (be sure to do this in a completely dark environment for correct results); then back off a little until the shutter is just barely closed.

3. Set LS to 1ØØ.

4. Turn up SG (shutter gain) until the shutter opens completely.

5. Now, use the preset keys in LS to display the numeric range from close (2Ø) to open (11Ø).

6. If this range of fading is greater than 9Ø steps, SG should go up; if the range is less than 8Ø, SG should come down.

7. Repeat steps 5 and 6 until you have a correctly adjusted shutter.

NOTE: Realize that SG is a function of the size of the beam. A small HeNe laser will use a small amount of SG, whereas a high-powered argon laser with a fat beam will take more SG to fade correctly.

Procedure for Matching Offsets

Graphic gains should be adjusted so the "TEST3" command produces the standard shown in Figure 4.6. This calibration assures that programs transferred from one system to another will have matching offsets.

1. Turn PO (pre offset) and FO (final offset) down.
2. Turn LG (logo gain) up until image is maximum size.
3. Back off on LG until it is about 8Ø% maximum.
4. Adjust PO until the lines line up.
5. Adjust FO until the lines line up.

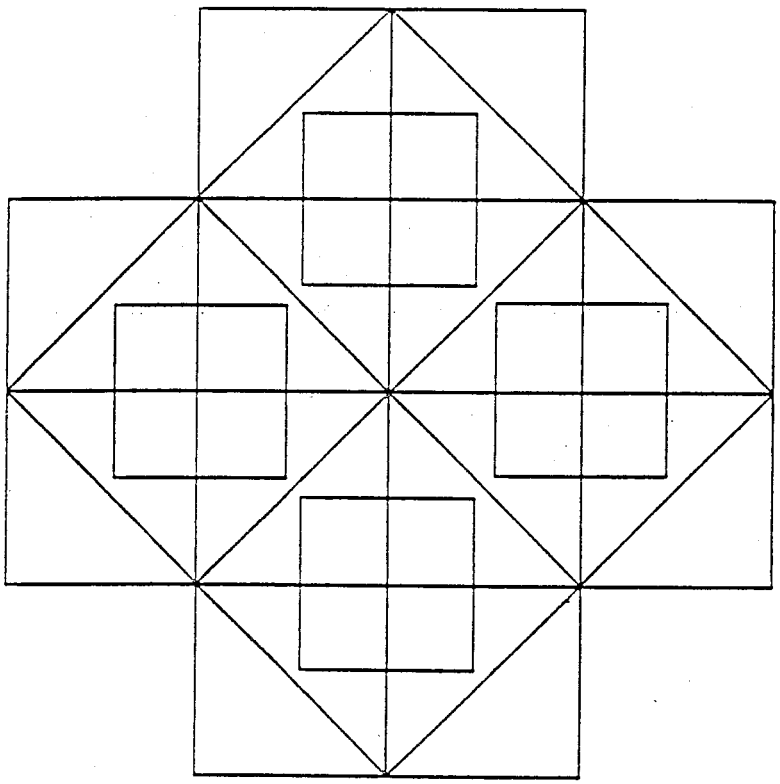


Figure 4.6 The Offset Standard

Troubleshooting

Incorrect color assignment may be caused by a D/A card problem. If "TEST3" cannot be accurately adjusted, or if the logo shutter does not smoothly close and open, then the D/A card may be at fault.

THE TIME CODE CARD

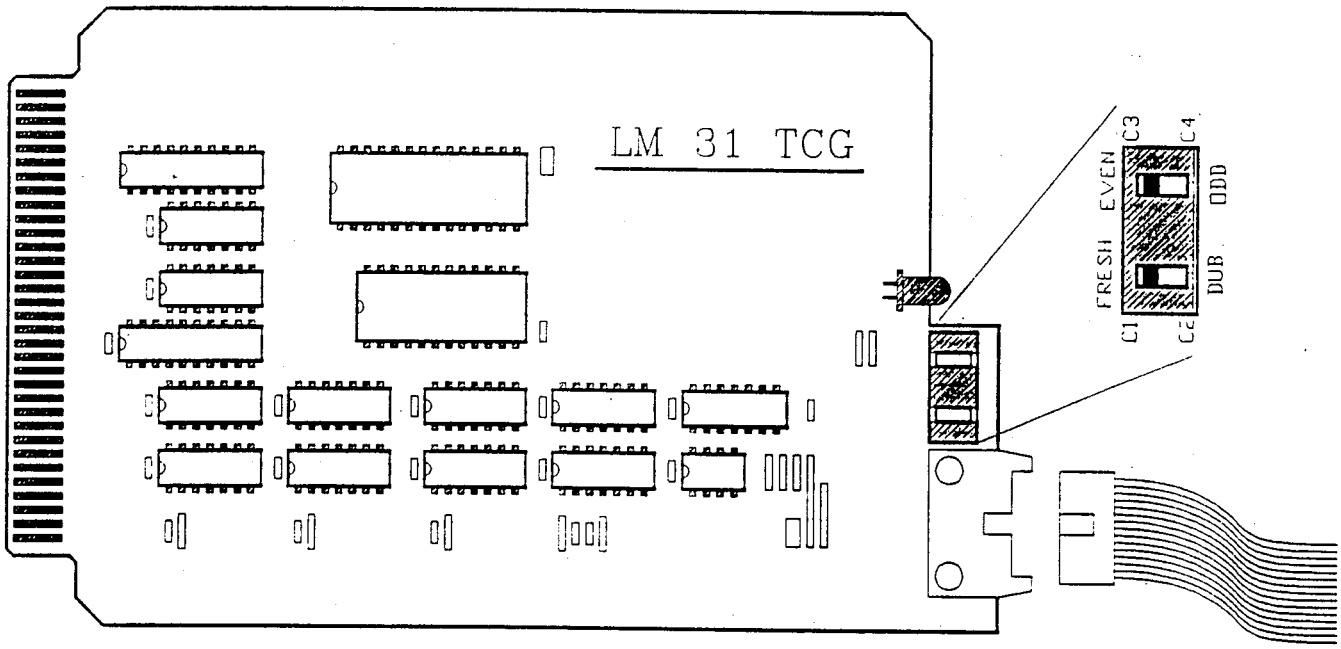


Figure 4.7 The timecode card with its phase (C3/C4) and generation (C1/C2) switches and its signal input/output cable.

The timecode card is used to generate, regenerate, and read Laser Media's timecode signal.

Generating Timecode

Timecode is a square wave synchronization signal that is recorded on a channel of the soundtrack tape. The ZAP computer can be synced to the pre-recorded timecode, providing perfect soundtrack/audio synchronization. The first step is to record the timecode onto the soundtrack tape. You must have a timecode card in the ZAP computer to proceed.

1. Timecode is usually recorded on track #4 of a four track audio master tape. Audio is recorded on channels 1 and 2, with track 3 used as a buffer between audio and timecode.

2. The first step is to make the necessary connections. Connect the timecode card output to the channel 4 record input on the audio deck, and the channel 4 output of the audio deck to the timecode card input (for playback). Put the C3/C4 switch (see Figure 4.7) on C3 (even phase) and the C1/C2 switch on the C1 position (fresh timecode). Note: be sure to turn off any noise reduction system on your recording tape deck. Noise reduction systems may distort timecode.

3. Rewind the tape to the beginning (before the beginning of the audio), put the deck in record, set the record level at -3db. Reset the computer, then type in the command "LAYDOWNTC" <RET>. This command resets timecode to "ØØ 25 ØØ". It's a good idea to lay 3Ø seconds or more of timecode before and after your audio, to allow extra time for playback and programming. If you listen to the timecode track through an audio system, you will hear a continuous non-timecode tone if the system has just been turned on or reset. After the "LAYDOWNTC" word has been used, you should hear timecode (a series of "chirping" sounds, with a chirp dropping out every 25.6 seconds). The maximum length for a timecode recording is 1ØØ minutes. Once the recording is complete, hit <ESC> to escape from "LAYDOWNTC".

4. Next is playback level calibration. Rewind the tape and place the deck in play. Now, turn the playback level up and down while watching the "TC" parameter on the Esprit terminal. When the timecode level is in range, a "+" will appear after the "TC" symbol (-3db is the standard playback level).

5. Now, type "TSY" into the Esprit terminal. This command repeatedly syncs ZAP absolute time to the timecode of the tape and displays that time in tenths of seconds. If timecode is being properly read, the numbers displayed will be smoothly incrementing upwards. If not, flip the phase switch C3/C4 on the timecode card. This switch inverts the phase of the incoming timecode. This may be necessary because some tape decks reverse the phase of the playback signal. By raising and lowering the playback level, determine the maximum and minimum levels for good timecode and set the level in the middle range. Timecode will not work with poor levels or incorrect phase adjustment.

Regenerating Timecode

When making a copy of a soundtrack/timecode tape, you should regenerate the timecode track through the timecode card. This is because the added distortion of second generation recording can cause the timecode to be unreliable. No ZAP commands are needed for this operation. To make a timecode dub, follow this procedure:

1. Connect the timecode channel of the playback deck to the timecode card input and the timecode card output to the record deck input.

2. Make sure the level on the playback deck is correctly set and the phase inversion switch on the timecode card (C3/C4) is also correctly set by using "TSY" to make sure you are reading timecode in the correct phase. Once you have verified the phase, reset the computer. You should now make sure that ZAP is reading the timecode.

3. Set the C1/C2 switch to C2. This puts the output of the timecode card into dub (regenerate) mode. Now the output signal of the timecode card is a "cleaned-up" copy of the input timecode.

4. Set the level on the record deck to -3db and you are ready to make a timecode dub.

Be sure to dub the audio channels in sync with the timecode.

Troubleshooting

Make sure you are recording timecode and not non-timecode tone. Reset the computer and type in "LAYDOWNTC" if you have any doubts. You will then hear the distinctive "chirping" - make sure you have properly connected the timecode signal input and output RCA cables. Timecode will not read or write if these cables are reversed. Make sure you are reading timecode in the proper phase by using the "TSY" command. Try to keep all your tape dubs in one phase. All of Laser Media's tapes play in the "even" (C3) position.

GRAPHICS CARDS

The Mega Card

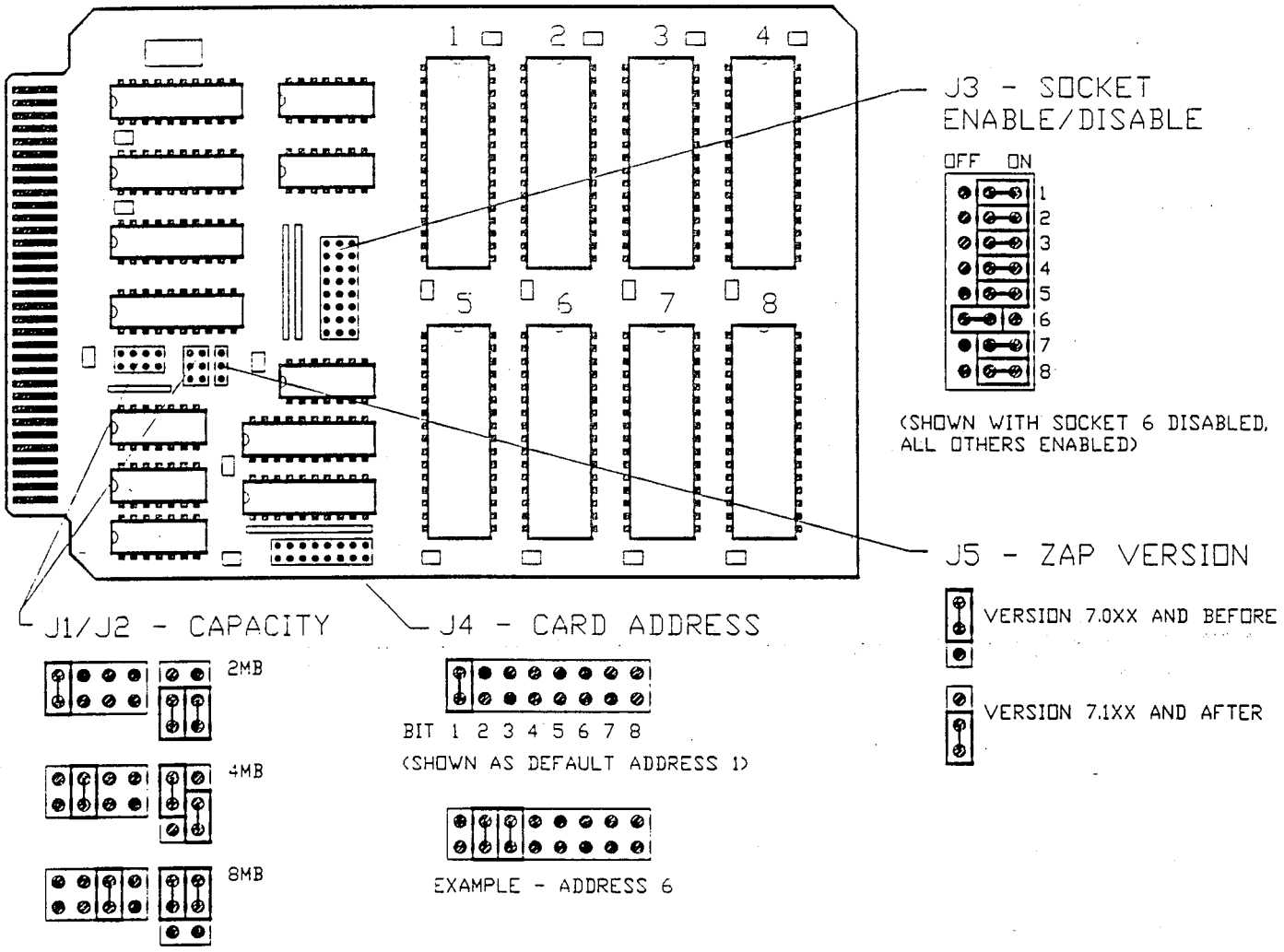


Figure 4.8 The Mega card with address and chip enable jumpers noted.

The Mega card is the standard graphic memory card for the IMAGEN system. ZAP 7.1 may access up to 256 separate Mega cards, but only one MEGA card at a time.

Configuring the Mega card

The Mega card can be configured to accept EPROMs of 2Mb, 4Mb, or 8Mb in size. Both jumpers J1 and J2 must be configured as noted in figure 4.8 for the type of EPROM that will be used. Note that only one type of EPROM may be present on any single Mega card; EPROM sizes may not be mixed.

To allow for the use of Fat cards in the same system as a Mega card, each EPROM socket can be individually disabled using jumper J3. If a socket is disabled, ZAP will not read the EPROM in that socket. ZAP will not be bothered by an empty socket which is not disabled, unless a Fat card occupies the same bank (see "Mega Card Systems With Fat Cards" below).

Jumper J4 is used to configure a system for one or more Mega cards. If an IMAGEN is to have only one Mega card, jumper J4 should be set to '1' (see figure 4.8), making the single Mega card active at boot-up. However, if more than one Mega card will be used in a system, each card must be given a separate address by jumpering J4. Jumper J4 is simply an 8-bit card address, with the LSB closest to the bus connector. This address is used with the MAIN command "n SHOW". Therefore, a card with no jumpers will be enabled by the MAIN command "0 SHOW", and a card with one jumper over the two far right pins would be addressed as "128 SHOW".

Jumper J5 is only used if a MEGA card is to be used with ZAP versions before 7.1 which do not support the 'SHOW' command. For ZAP version 7.1 and later, J5 should be on the lower two pins.

Troubleshooting

ALWAYS power the computer down when removing or adding Mega cards. If this is not done, the bus buffers (U1-U3) may be damaged. Check for bent EPROM legs if graphics are glitched or absent. DO NOT INSERT EPROMS BACKWARDS! THEY WILL NOT SURVIVE! The notch on each chip corresponds to the notch on the socket (towards the top edge of the Mega card).

If a Mega card does not seem to be reading graphics correctly, and the EPROMs are known good and inserted properly, it is likely that the card is not jumpered correctly.

If graphics are missing or duplicated, check that jumpers J1 and J2 are set correctly for the size of EPROM installed on the card. Also ensure that only EPROMs of that one capacity are used.

If all graphics on one EPROM are not found, check that all EPROM pins are socketed correctly, that the EPROM is oriented correctly (notch pointing toward the top edge of the card), and that the socket is enabled ('on') at jumper J3.

Finally, if some graphics are glitched, many not found, and odd entries show up in the cue list, make sure that all Mega cards in the system have different addresses at J4, and that J5 is enabled for all cards (as shown in figure 4.8).

The Fat Card

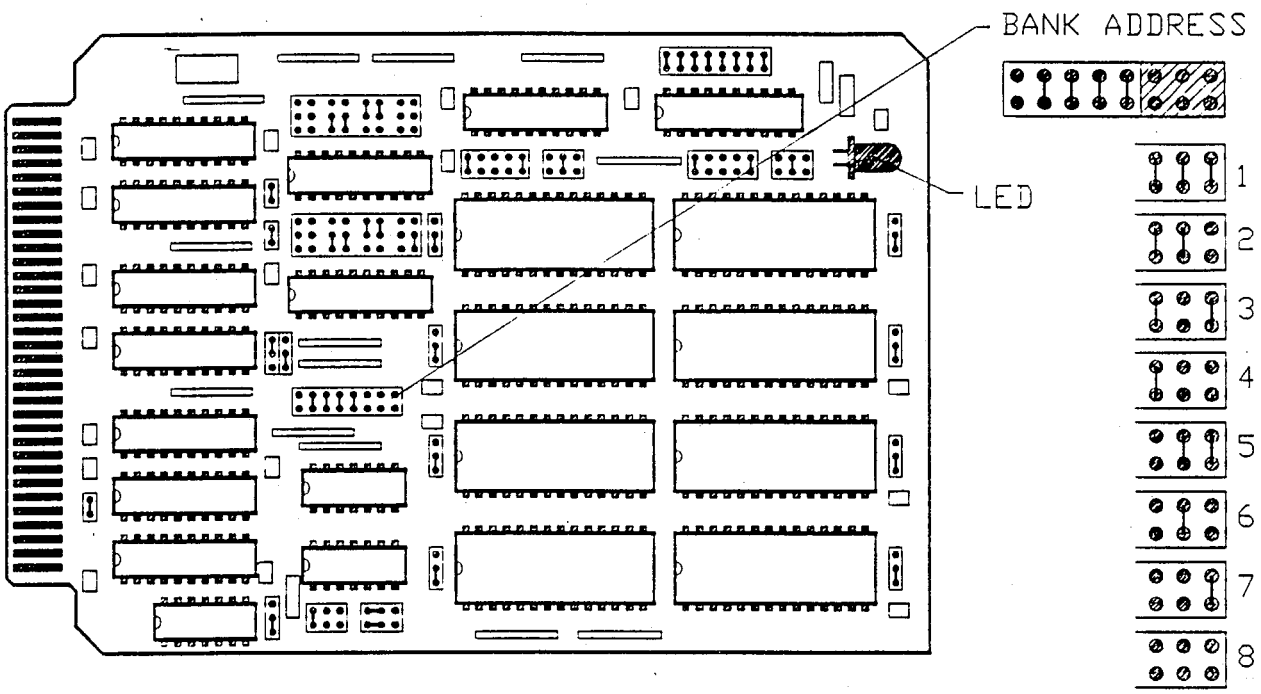


Figure 4.9 The Fat card with its eight possible jumpering options. The LED will light when the board is accessed by ZAP or the "SEEBS" command.

In systems where a large amount of volatile RAM is required, or if for any other reason 32K EPROMs or RAMs must be used, one or more FAT cards may share the IMAGEN memory space with a Mega ROM card, or possibly FAT cards alone may be used.

A single FAT card can be used to hold up to 256K of memory, either RAM or ROM (cards must be jumpered to support the type of memory used; consult the Pro-Log STD-7000 7710 512K Memory Card User's Manual or Laser Media Inc. for information). When using FAT cards in a system with a Mega ROM card, each FAT card will take the place of one EPROM socket on the Mega card. When using only FAT cards in a system, each card must occupy a separate address.

Fat Card Only Systems

When using more than one fat board at a time in a single IMAGEN, you must make sure that each board is jumpered differently. Check the three pin positions noted in Figure 4.9. The eight possible jumpering options are noted on the right side of the figure. There are eight possible ways to jumper these boards, therefore, a maximum of eight fat boards may be used in one computer.

Use the command "SEEBS" to test for duplicate jumpering. If the LEDs on any two boards light up simultaneously, neither will read correctly.

Mega Card Systems With Fat Cards

In a system which employs both Mega and Fat cards, one socket on the Mega card must be disabled for each Fat card used. The section on the MEGA card above shows the jumper location and describes its use.

The sockets on the Mega card are numbered 1-8, corresponding to the 8 possible memory banks used by ZAP. To use a Fat card, first jumper the Fat card to one of the eight possible banks as shown in figure 4.9. Jumpering works as inverted binary, with the MSB closest to the bus. (Alternately, to determine which bank a Fat card occupies, the SEEBS command can be used. Simply note the number SEEBS displays when the LED on the Fat card lights. This will be the Fat card's bank number.) Then, disable the corresponding socket on the Mega card (and on all additional Mega cards, if any) using the jumper J3.

Note that no matter what density the Mega card is configured for (2, 4, or 8MB), the always-256K Fat card will be read correctly.

Troubleshooting

ALWAYS power the computer down when removing or adding Fat cards. Make sure to use only 32K EPROMs on fat boards. Check for bent EPROM legs if graphics are glitched or absent. DO NOT INSERT EPROMS BACKWARDS! THEY WILL NOT SURVIVE! The notch on each chip corresponds to the notch on the socket (toward the bus for Fat cards).

If a Fat card does not read correctly when used with a Mega card, check that the Mega card socket corresponding to the Fat card bank address is disabled. Use "SEEBS" to determine the Fat card bank address, then disable the corresponding socket on the Mega board(s) at J3.

APPENDIX A
IMMEDIATE ACTION KEYS

All Modes

~	-(called "tilde") hard reset (entire system)
_	-(underscore) soft reset ("zeros" shutters, beams, gains, rotations, offsets, and stops TOPAs)
<RET>	-enter command, return to MAIN prompt
^M	-<RET>
<ESC>	-abort command, return to MAIN prompt
<LF>	-page cue list or HELP file forward
^J	-<LF>
\	-page cue list back or next chapter of HELP file
<DEL>	-select a cue scene, or scene fade by name or number. To select a cue, type the cue name or number. To select a scene, type "." (period) and the scene name or number (no space). To select a scene fade, type "," (comma) and the scene name or number (no space).
<TAB>	-trip Sync 1, advance animation, release Wordfire
^I	-<TAB>
^Z	-advance animation, release Wordfire
^O	-LS open
^P	-LS close
`	-(backtick) display absolute time, offset time, relative time, and relative logo scans (from the last display)
^H	-<BS>

All Modes Except Word Edit

]	-enter SETEM
[	-enter KEYS mode if KEYS is turned on
{	-enter BPROG
}	-enter CPROG
|	-enter APLAY
^G	-start growth
^C	-start collapse
^N	-next cue
^B	-back a cue

Main Mode Only

^S	-increment
^D	-decrement
/	-(slash) will toggle MAINline pause while program is executing or waiting.
=	-end "do-loop" in progress and execute next command
^Q	-recall and execute MAINline 1
^W	-recall and execute MAINline 2
^E	-recall and execute MAINline 3
^R	-recall and execute MAINline 4
^T	-recall and execute MAINline 5
^Y	-recall and execute MAINline 6
^U	-recall and execute MAINline 7

All Modes Except List Screens, APLAY and SPLAY

^X	-save
^V	-append or recall

Esprit Terminal Keys

^1	-disable monitor (screen garbage mode)
^2	-enable monitor (correct screen garbage)
^3	-enter/exit line mode
^4	-toggle key beep on/off
^5	-select static cursor
^6	-select slow blinking cursor
^7	-select fast blinking cursor
^8	-select block cursor
^9	-select underline cursor
^Ø	-terminal RAM test (reset or initialize to correct)

A P P E N D I X B
S E T E M

*** Cursor Movement**

Key	Register/Effect
G	-LS - logo shutter
H	-LC - logo color
Q	-GA - gain (size)
A	-FX - X movement (left to right)
Z	-FY - Y movement (up and down)
W	-PG - P gain (PX and PY strength)
S	-PX - X axis offset
X	-PY - Y axis offset
E	-RZ - rotation Z axis
D	-RX - rotation X axis
C	-RY - rotation Y axis
R	-PR - perspective
F	-OX - orbit X axis
V	-OY - orbit Y axis
T	-RO - rotation orbit
Y	-S5 - Sync 5
U	-S6 - Sync 6
I	-S7 - Sync 7
O	-S8 - Sync 8
P	-FP - flight path speed
J	-M1 - motor 1 speed
K	-M2 - motor 2 speed
L	-SW - scanning speed
B	-BS - beam shutter
N	-BC - beam color
M	-BM - beam assignment
/	-3D - 3D Depth
?	-DW - Dynamic Loop Wait
>	-move * cursor forward through all registers
<	-move * cursor backward
E <	-RZP - RZ position
D <	-RXP - RX position
C <	-RYP - RY position
F <	-ROP - RO position
`E	-AC - animation cells
`R	-AF - animation flags
`T	-ANSP - animation speed

Value Changing

,	-decrement in single steps
-	-reverse or oppose a value
<SPACE>	-zero a register
1	-preset
2	-preset
3	-preset
4	-preset
5	-preset
6	-preset
7	-preset
8	-preset
9	-preset
Ø	-preset

Turning Registers On and Off

;	-turn register on
'	-turn register off

Assigning Syncs

!	-Sync 1 - Tab sync
@	-Sync 2 - Logo scans
#	-Sync 3 - 1Øth of a second
$	-Sync 4 - fast as possible (constant)
%	-Sync 5 - variable
^	-Sync 6 - variable
&	-Sync 7 - variable
*	-Sync 8 - variable
)	-Sync Ø - dead sync

Changing Logos

^N	-Next logo
^B	-Back a logo
^J	-page the cue list forward by ten cues
<LF>	-page the cue list forward by ten cues
\	-page the cue list backwards

Scene Saves, Recalls, and Programming

`X	-save current settings as a scene (ZAP prompts for number and name)
`F	-recall scene (ZAP prompts for number)
`V	-recall scene as a scene fade - only step and finally values are restored (ZAP prompts for number)
`A	-begin a GOBY waiting at current register
`Q	-start all GOBYs
`S	-halt the GOBY at the current register
`W	-halt all GOBYs in progress
`K	-set step value to current value and restore current
`L	-set final to current and restore current
`H	-swap current and final values

Miscellaneous

=	-update screen
:	-toggle between full and half screen mode
"	-display scene list (same as MAIN command SLST)

Exiting SETEM

<RET>	-return to MAIN
<ESC>	-escape to MAIN

A P P E N D I X C
K E Y S

The Permanent Format

A through Z -pre-programmed KEYS routines

1	-beam 1
2	-beam 2
3	-beam 3
4	-beam 4
5	-beam 5
6	-beam 6
7	-beam 7
8	-beam 8
9	-beam 9
0	-beam 10
-	-(minus) "clear beam" position
!	-white
@	-red
#	-green
$	-blue
%	-cyan
^	-magenta
&	-yellow
*	-BM green
(	-BM cyan
)	-BM blue
/	-recall LC sequence (1 - 8)
,	-(comma) LC on
.	-(period) LC off
?	-recall BM sequence (1 - 8)
<	-BM on
>	-BM off
=	-update the ZAP screen
;	-toggle routine pause/resume
:	-resume routine
'	-(apostrophe) toggle syncs on/off
"	-(quote) trip all syncs
<TAB>	-calls the next cell of specially designed KEYS graphics
<SPACE>	-stops a KEYS routine
<BS>	-stops a routine and reloads the program

`Y	-LS fade open
`U	-LS fade closed
`K	-BS open
`L	-BS close
`W	-set SETEM * cursor to the active KEYS register
`D	-increase the value in the active register by one
`S	-decrease the value in the active register by one
`A	-"zero" the active register
`E	-active register on
`R	-active register off

The General Format

Q	-start a specific KEYS routine
W	-start a specific KEYS routine
E	-start a specific KEYS routine
R	-start a specific KEYS routine
T	-start a specific KEYS routine
Y	-start a specific KEYS routine
A	-modify or reverse "Q"
S	-modify or reverse "W"
D	-modify or reverse "E"
F	-modify or reverse "R"
G	-modify or reverse "T"
H	-modify or reverse "Y"
Z	-re-center and re-size image
X	-change size and location of image
C	-change size and location of image
V	-change size and location of image
O	-LS open
P	-LS close
L	-toggle LS to fade open/closed
M	-fade and shrink logo
K	-LC color sequence
N	-next cue
B	-back a cue
I	-resets a routine

Shiva Emulator KEYS

O	-BS open
P	-BS close
L	-hold to fade BS out
K	-hold to fade BS on
M	-activate "X" and "Z"
X	-speed a beam sequence
Z	-slow a beam sequence
N	-synchronize a beam sequence to the <TAB> key
B	-flashing beam (adjust speed with S6)

Key Number Assignment for MAIN Programming

Corresponding numbers and keys for using the "n KEY" command.

Number	Letter
Ø	reset KEYS program
1	A
2	B
3	C
4	D
5	E
6	F
7	G
8	H
9	I
1Ø	J
11	K
12	L
13	M
14	N
15	O
16	P
17	Q
18	R
19	S
2Ø	T
21	U
22	V
23	W
24	X
25	Y
26	Z
27	[
28	\
29	]
3Ø	^ (caret)
31	_ (underscore)

APPENDIX D
MAIN COMMANDS

Programming Set Up

NNST	-the scanning standard
NN	-scanning standard test (same as "R NNST 1ØØ GAIN O"
NNN	-performs "NN" on all computers
BBST	-the blanking standard
BB	-blanking standard test (same as "R BBST 1ØØ GAIN O")
BBB	-performs "BB" on all computers
TEST3	-the offset standard
BBOF	-turn blanking off (CF flag 2 off)
BBON	-turn blanking on (CF flag 2 on)
RTOF	-turn retracing off (CF flag 3 off)
RTON	-turn retracing on (CF flag 3 on)
SEEBS	-(see Bank Select) will light the LED on each Fat board in your computer, according to its jumpering. Used to test for duplicate jumpering.
n SETSIO	-set serial I/O option (n = Ø - 2)
BEEPOFF	-turns error beep off (film shoots, audience situations)
BEEPON	-turns error beep on
LM	-Laser Media logo

MAINlines and Memory

?RAM	-displays total RAM available and MAINlines allotted
n ALLOT	-allots "n" lines of memory for MAINlines (n=1Ø-24Ø in multiples of 1Ø; 1Ø MAINlines = 1K RAM)
n TOLLA	-same as ALLOT, but does not clear existing MAINlines. Used by programmers to recover un-allotted memory.
MLIST	-full screen listing of MAINline memory (1Ø lines per page)
n MLIST	-lists MAINlines, beginning with line "n"
s d MCOPY	-copy source MAINline number "s" to destination line number "d"
s d MGCOPY	-moves 1Ø MAINlines in memory, starting with source line number "s" to destination line number "d"
n IR	-recall and execute MAINline "n"
n IRECALL	-same as "IR"
n +IR	-skip ahead "n" lines and execute
—›	-execute next MAINline (same as "1 + IR")
NEWBUF	-clear save buffers: SETEM, color, and beam saves only. Use with caution!

n IRECALL	-same as "IR"
n +IR	-skip ahead "n" lines and execute
-->	-execute next MAINline (same as "1 + IR")
NEWBUF	-clears all eight color and and beam sequence saves. Use with caution!

Screen Updates

NOU	-shut off all screen updates (except error and TOPA messages)
NOUP	-turn off register updates
UPDA	-restore screen updating
SAME	-display correct screen values
K	-performs "UPDA SAME" on all computers
SUPPW	-suppress Level-2 wait messages
DISPW	-enable Level-2 wait messages
INITS	-re-initialize (clean-up) screen
HALF	-puts SETEM display in half-screen mode (default)
FULL	-puts SETEM display in full-screen mode

Cue Words

"name"	-display cue called "name"
n CUE	-display cue "n"
N	-next cue
B	-back a cue
QUERY	-will ask for a cue name or number before continuing execution. Same as <DEL> described in appendix A.
LIST	-lists all cues on middle left of ZAP screen. Use <LF> and "\" to page through list.
LST	-full screen cue listing
GLST	-full screen list of all graphics
LLST	-full screen list of all logos
ALST	-full screen list of all animations
XLST	-full screen list of all TOPAs and Wordfire fonts
n KEY	-execute KEYS routine key "n" of a given KEYS program
n KEYW	-same as "n KEY TWAIT"
REFIND	-causes ZAP to search for all graphics in the system
n SHOW	-switches to Mega card number "n" (defaults to card 1 on power-up). ZAP displays the LM logo upon execution and REFINDs all graphics. NOTE: works only with LM69MEG cards Rev. A and above.

SETEM Related

SETEM_ -enter SETEM

Register Assignment (* cursor movement, invisible in MAIN)

Register		Range
TRSP	-Wordfire travel speed	Ø - 9
LTSP	-Wordfire letter spacing	Ø - 9
ANSP	-animation speed	Ø - 9
GRSP	-growth rate speed	Ø - 9
CLSP	-collapse rate speed	Ø - 9 (avoid setting t
AF	-animation flags	32 - 63
OF	-option flags	32 - 63
UF	-update flags	32 - 63
CF	-color chop flags	32 - 63
AX	-auxiliary output flags	32 - 63
AC	-animation cell	1 - 127
XF	-fire works	1 - 64
SW	-scanning speed	Ø - 127
LS	-logo shutter	Ø - 127
LC	-logo color	1(A) - 26(Z)
BS	-beam shutter	Ø - 127
BC	-beam color	1(A) - 26(Z)
BM	-beam assignment	Ø(-) - 1Ø(Ø)
M1	-motor 1 speed	-127 - +127
M2	-motor 2 speed	-127 - +127
S5	-sync 5	Ø - 99
S6	-sync 6	Ø - 99
S7	-sync 7	Ø - 99
S8	-sync 8	Ø - 99
FP	-flight path	Ø - 99
GA	-gain	-127 - +127
FX	-X movement	-127 - +127
FY	-Y movement	-127 - +127
PG	-P gain	-127 - +127
PX	-X axis offset	-127 - +127
PY	-Y axis offset	-127 - +127
PR	-perspective	-127 - +127
OX	-orbit X axis	-127 - +127
OY	-orbit Y axis	-127 - +127

RZ	-Rotation Z axis	-512 - +511
RZP	-RZ position	-512 - +511
RX	-Rotation X axis	-512 - +511
RXP	-RX position	-512 - +511
RY	-Rotation Y axis	-512 - +511
RYP	-RY position	-512 - +511
RO	-Rotation orbit	-512 - +511
ROP	-RO position	-512 - +511
3D	-3D depth	-127 - +127
DW	-dynamic loop delay	0 - 255

SSAME -link SETEM cursor and MAIN cursor
-SSAME -turn off SSAME option

Value Changing and Register Manipulation

n ! -set value "n" into a given register
n SCUR -same as "!"
n !+ -set value "n" into a given register and turn the register on

; -turn on a given register
SON -same as ";"
' -(apostrophe) turn off a given register
SOFF -same as "'"
ROFF -turn off a given rotation/position register pair and "zero" them

GET -get value of current register and put it on the stack

d n GOBY -move to value "d" in steps of "n" and perform the next commands simultaneously
d n GOBW -move to value "d" in steps of "n" and wait for completion

n GAIN -set GA to "n"
g x y GXY -set GA to "g", FX to "x", and FY to "y"
x y PXY -set PX to "x", and PY to "y"

INC -increment a given register by one
DEC -decrement a given register by one

n SGTO -set final value
n SINC -set step value

Scene Related

SLST -full screen list of all scenes by number and name.
n SCLEAR -clear scene number "n" to default values
s d SCOPY -copy source scene number "s" to destination scene number "d"

n SR	-recall scene number "n" (n is the scene number or the 5-character scene name)
n SRW	-recall scene number "n" and wait for all GOBYs to complete before continuing
n SRNG	-recall scene "n" but do not initiate GOBYs
n SF	-recall scene number "n" as a scene fade (recall only step and final values)
n SFW	-recall scene "n" as a scene fade and wait for all GOBYs to complete before continuing
n SFNG	-recall scene "n" as a scene fade but do not initiate GOBYs
FADE	-start all waiting GOBYs left by a SRNG or SFNG
FADEW	-start all waiting GOBYs and wait for all GOBYs to complete before continuing
MINSC	-allocate 16K of RAM for MAINlines (160 lines) and 8K for scenes (64 scenes). (Default setting)
MAXSC	-allocate 8K of RAM for MAINlines (80 lines) and 16K for scenes (128 scenes).

Shutter

O	-open logo shutter (same as "LS 127 !")
LOPEN	-same as "O"
P	-close logo shutter (same as "LS Ø !")
LCLOSE	-same as "P"
LFOPEN	-(logo fade open) same as "LS 127 1 GOBY"
LFCLOSE	-(logo fade close) same as "LS Ø 1 GOBY"
BOPEN	-open beam shutter (same as "BS 127 !")
BCLOSE	-close beam shutter (same as "BS Ø !")
BFOPEN	-fade beam shutter open (same as "BS 127 1 GOBY")
BFCLOSE	-fade beam shutter closed (same as "BS Ø 1 GOBY")

Beams

n BEAM	-assign beam position "n" to BM. (n = Ø - 1Ø, Ø = clear position)
n BEAMOFF	-disable beam "n". Generally used for safety purposes such as a misalligned mirror. Use "ALL" instead of "n" to disable all beams.
n BEAMON	-re-enable beam "n". Use "ALL" to re-enable all beams.
BEAM?	-show status of which beams are enabled/disabled

NOTE: in the above commands, "n" is a beam number 1 through 1Ø (Ø). AUX flags and ECUE (external cue out) can also be disabled. AUX 1 through 5 are referenced as n= 11 through 15. ECUE is referenced as n= 16. The "BEAM?" status displays AUX 1 through 5 as "abcde" and ECUE as "x".

Beam commands, like flags, can set multiple enables on or off with a single command. Beams 1 through 1Ø are referenced as 1, 2, 4, 8, 16, 32, 64, 128, 256, 512, respectively for this purpose. to turn a group of positions off, add up these (powers of 2) position numbers, plus 1Ø24 more to get "n".

For example, if you want to disable positions 1, 4, and 9: add 1 (1) + 8 (4) + 256(9) which is 265. Then add 1Ø24 more which is 1289. The command "1289 BEAMOFF" will disable beams 1, 4, and 9. To re-enable them, enter "1289 BEAMON or more simply "ALL BEAMON".

Color and Beam Sequences

"WH" or "WHITE"	-no color filters
"RED"	-minus green and minus blue
"GR" or "GREEN"	-minus red and minus blue
"BL" or "BLUE"	-minus red and minus green
"CYAN"	-minus red
"MAG" or "MAGENTA"	-minus green
"YEL" or "YELLOW"	-minus blue
"BLACK"	-all color filters

BCY	-BC cyan
BGR	-BC green
BBL	-BC blue

CS> abc	-enter color sequence "abc" and turn LC on
CPROG	-enter color program mode to test and save color sequences
n CR	-recall saved color sequence "n" and turn LC on (n = 1 - 8)
n CRECALL	-same as "CR"
BS> anbncn	-enter color and beam sequence "anbncn" and turn BM on (n = Ø - 9 and "-", Ø = position 1Ø, "-" is the clear position
BPROG	-enter beam program mode to test and save color and beam sequences.
n BR	-recall saved beam sequence "n" and turn BM on (n = 1 - 8)
n BRECALL	-same as "BR"
CCON	-enable color blanking (for use with color modulation systems and color blanked logos only)
CCOF	-disable color blanking
NOCOLORS	-disable colors and color sequences; display with brightest beam (for testing or loss of laser color)
COLORS	-enable colors and color sequences

Time Words

n THS	-waits "n" tenths of seconds
n SCANS	-waits "n" logo scans
E	-wait one logo scan
T	-wait for a <TAB>
TW	-same as "T" but will display a Level-2 wait message even if "SUPPW" is used
W	-wait shortest time increment possible
n DO...LOOP	-execute the inclusive commands "n" times
IREL	-resets the Do loop leave flag (obscure)
d n GOBW	-move to value "d" in steps of "n" and wait for completion
n WSYNC	-wait for sync "n" to trip
TWAIT	-wait for TOPA cue or KEYS routine to finish
GCWAIT	-wait for growth or collapse to complete
n KEYW	-execute KEYS routine key "n" and then "TWAIT"
WEXT	-wait for external cue (relay closure or push button signal)
EXTW	-like "WEXT" except switch must open again before next closure will be accepted. Used to prevent accidental triggering if the button is held down or held too long.
TIME	-display absolute time, offset time, relative (from last display) time and relative logo-scans in lower right of ZAP screen
NOW	-zero offset time
RTIME	-zero all times
m s t WMST	-wait until "mst" in offset time
m s t WAMST	-wait until "mst" in absolute time
m s t STIME	-set absolute time to mst
m s t OFFSET	-set offset time to zero at "mst" in absolute time
COUNTER	-a utility used to time up to 72 events. Does a "NOW" to mark zero offset time.
COUNTOFF	-same as "COUNTER" but it does not reset offset time.
AA	-retard time 12 seconds
SS	-retard time 5 seconds
A	-retard time 1 second
S	-retard time 1/10 second
D	-advance time 1/10 second
F	-advance time 1 second
DD	-advance time 5 seconds
FF	-advance time 12 seconds
LAYDOWNTC	-prepare timecode signal for recording
TSY	-test for correct timecode phase
SOFT	-put clock into phase with timecode
HARD	-put clock into absolute mode (its internal crystal)

SYNC	-read a time from tape, set absolute time and go into "SOFT"
MUSIC	-turn on music option flag (obscure)
SILENT	-turn off music option flag (obscure)
?RESYNC	-send absolute time to all other computers

Sync Related

n SSYNC	-set a given register to Sync "n"
n TSYNC	-trip Sync "n"
n WSYNC	-wait for Sync "n" to trip
SSFF	-toggle sync on/off
SSONE	-trip all syncs at once
SSOFF	-return syncs to their normal condition

Animation Words

DASP	-run animation at default speed
RASP	-run animation backwards at default speed
EASS	-stop animation on its last cell (re-trigger with <TAB> or ^Z
n ASP	-run animation at speed "n" (n = Ø to 9)
n CELL	-display cell "n" and freeze animation
n ASEQ	-display the sequence in the display buffer at speed "n" (n = Ø to 9)
NC?	-display number of cells in current animation
NP?	-display number of points in current cell
APLAY	-enter Animation Play mode

Word Edit Related

WE	-enter Word Edit mode
WEDIT	-same as "WE"
"n WR"	-recall MAINline "n" into display buffer
n WRECALL	-same as "WR"
WFIRE	-start Wordfire display of message in display buffer
WEXCH	-exchange edit and display buffer
WAPPEND	-append edit buffer
WHICH	-display current font character set when Wordfire is active

TOPA Related

ETOPA	-freeze TOPA
L ~	-"ETOPA" on all computers
PAUSE	-TOPA pause
RESUME	-resume TOPA
TFF	-toggle TOPA pause/resume
TWAIT	-wait for TOPA cue or KEYS routine to finish
DTOPAS	-delete all TOPAs stored on CPU nonvolatile RAM (RAM bank 1, used by LV3)

KEYS Related

KON	-KEYS on
KOFF	-KEYS off
KEYS	-enter KEYS
n KEY	-execute KEYS routine key "n" of a given KEYS program (see Appendix C)
n KEYW	-same as "n KEY TWAIT"

Multiple Computer Words

In a multiple computer system:

Host is computer ø
Slaves are computer 1, 2, 4, and 8

SEND	-send rest of line to Slave 1
2SEND	-send rest of line to Slave 2
4SEND	-send rest of line to Slave 4
7SEND	-send rest of line to all Slave computers
SEND1	-send the next word to Slave 1
2SEND1	-send the next word to Slave 2
4SEND1	-send the next word to Slave 4
7SEND1	-send the next word to all Slave computers
SENDTILL	-send all (until an <ESC>) to Slave 1
2SENDTILL	-send all (until an <ESC>) to Slave 2
4SENDTILL	-send all (until an <ESC>) to Slave 4
7SENDTILL	-send all (until an <ESC>) to all Slave computers
1RESYNC	-send absolute time to Slave 1
2RESYNC	-send absolute time to Slave 2
4RESYNC	-send absolute time to Slave 3
7RESYNC	-send absolute time to all computers
+DTAB	-<TAB>s will echo on all Slave computers
-DTAB	-turn off <TAB> echo
SESC	-send an <ESC> to all Slave computers
n SETSIO	-set serial I/O option (n = ø - 2)

Math and Stack

stack input	operation	stack output	where
n2 n1	+	s	s = n2 + n1
n2 n1	*	q	q = n2 * n1
n2 n1	-	d	d = n2 - n1
n2 n1	/	q	q = n2 / n1
n2 n1	/MOD	r q	q = n2 / n1 , r = remainder
n	RN	r	r = random number from Ø to n
n	?		prints top of stack
n	??	n	prints and leaves top of stack
n	DUP	n n	dups top of stack
n2 n1	SWAP	n1 n2	swaps top 2 items on stack
n	DROP		drops top of stack
n2 n1	OVER	n2 n1 n2	dups second item on stack
n2 n1	MAX	r	leaves only the larger of n1 and n2 on stack
n2 n1	MIN	r	leaves only the smaller of n1 and n2 on stack

Random number example: "256 RN" will return a random number between -127 and 127; "1Ø24 RN" will return a random number between -512 and 511; "2Ø RN 1Ø +" will return a random number between 1Ø and 3Ø.

I -push the inner most loop index onto the stack
II -push the second loop index onto the stack
III -push the outer most loop index onto the stack

Note: the index in what ZAP counts with. The first time through index = Ø, last time index = n - 1.

Miscellaneous

G -start growth effect
C -start collapse effect

GET -push value of current register onto the stack

Z -advance animation set to speed Ø; release Wordfire

RESET -hard (system) reset. Clears everything to their default settings.
R -soft reset. Clears registers to default settings and stops sequencing and TOPAs in progress.
SRESET -same as "R"

POWERUP	-hard reset, as though the IMAGEN had just been turned on. Like RESET, except it forces ZAP to re-check hardware jumpers and clear volatile buffers.
FCUE	-sets the default first cue (displayed after a hard reset) to the current cue
HELP	-access help file from beginning. Use <LF> and "\" to review.
NHELP	-next help chapter
BHELP	-toggle back a page/forward a page
s p GRID	-creates a grid pattern with lines spaced by "s" and containing "p" points per line
BEEP	-good for debugging or waking up a sleeping operator
ECUE	-cues an external device such as a slide projector or lighting console
n XFIRE	-cue external firework output "n" (n = 1 - 64). Data bits 6 and 7 act as momentary latch pulses.
n OUT	-place data 'n' on the XFIRE port (n = 0 - 255). Data is latched.
n JSTEP	-sets joystick input step (increment)
VER	-displays the ZAP version number
OK	-turns on operator OK flag (obscure)
(	-(followed by a space) start comment
)	-end comment

A P P E N D I X E
W O R D E D I T M O D E

Word Edit is used to edit MAINlines, Wordfire messages and animation sequences. The two buffers -- edit and display -- are 158 characters long. Remember, though, that you can only save 11Ø characters into memory.

Edit Cursor Movement

^a	-back a word
^s	-back a character
^d	-forward a character
^f	-forward a word
^b	-to beginning
^n	-to end

Delete

^g	-delete character under cursor
^h <BS>	-delete character to left of cursor
^u	-delete to end
^y	-delete to beginning

Saves and Recalls

^x	-save line to "n"
^x^x	-save to same line previously accessed
^v	-append line to edit buffer
^c	-recall entire line
^t	-put entire character set into edit buffer (to test Wordfire fonts)

Buffers

^w	-push edit line into display buffer
^r	-copy display line into edit buffer
^e	-exchange edit and display buffer lines

Wordfire

^q	-start Wordfire
^z	-release Wordfire pause
^k	-decrease travel speed
^l	-increase travel speed

Special Characters

^ -trip Sync 6 when this character is reached
{ -Wordfire pause when this character reaches screen left
} -Wordfire pause when this character reaches screen right
! -animation, color, or beam sequence wait for <TAB> or ^I
% -animation, color, or beam sequence wait for Sync 5
& -animation, color, or beam sequence wait for Sync 7

APPENDIX F
ANIMATION AND SCENE PLAY MODES

In "APLAY" mode, the following keys will display their equivalent animation cells:

1=1	B=12	M=23	X=34	i=45	t=56
2=2	C=13	N=24	Y=35	j=46	u=57
3=3	D=14	O=25	Z=36	k=47	v=58
4=4	E=15	P=26	a=37	l=48	w=59
5=5	F=16	Q=27	b=38	m=49	x=6Ø
6=6	G=17	R=28	c=39	n=5Ø	y=61
7=7	H=18	S=29	d=4Ø	o=51	z=62
8=8	I=19	T=3Ø	e=41	p=52	
9=9	J=2Ø	U=31	f=42	q=53	
Ø=1Ø	K=21	V=32	g=43	r=54	
A=11	L=22	W=33	h=44	s=55	

Changing Cells

. -(period) will call the next cell.
, -(comma) will move back a cell.

In "SPLAY" mode with the BANK toggle set to 00, the keys shown in the table above will recall their equivalent scenes (numbers 1 through 64). With the BANK toggle set to 01, the keys are remapped to the second set of 64 scenes (numbers 65 through 128), as shown in the following table:

1=65	B=76	M=87	X=98	i=1Ø9	t=12Ø
2=66	C=77	N=88	Y=99	j=11Ø	u=121
3=67	D=78	O=89	Z=1ØØ	k=111	v=122
4=68	E=79	P=9Ø	a=1Ø1	l=112	w=123
5=69	F=8Ø	Q=91	b=1Ø2	m=113	x=124
6=7Ø	G=81	R=92	c=1Ø3	n=114	y=125
7=71	H=82	S=93	d=1Ø4	o=115	z=126
8=72	I=83	T=94	e=1Ø5	p=116	
9=73	J=84	U=95	f=1Ø6	q=117	
Ø=74	K=85	V=96	g=1Ø7	r=118	
A=75	L=86	W=97	h=1Ø8	s=119	

Changing Scenes

. -(period) will move forward one scene.
, -(comma) will move backward one scene.

APPENDIX G
COLOR AND BEAM PROGRAMMING

CPROG, BPROG (Color and Beam Sequence Programming)

Color and beam sequences can contain up to 24 characters. For colored beams, enter color character and then beam position number. There are 8 save and recall buffers for each mode.

Entering:

Letter	Function
A-Z	-color
1-Ø	-beam position 1 to 1Ø (BPROG only)
-	-clear beam position (BPROG only)
;<=>?	-activate AUX1-5 respectively (BPROG only)
:	-activate CUE (BPROG only)
!	-wait for <TAB> or ^I
%	-wait for Sync 6
&	-wait for Sync 7
^	-trip Sync 6

Immediate Action:

Key	Function
<BS>	-delete last entry
^X	-save edit line
^V	-append saved edit line
^W	-push edit line up into sequence
^R	-pull sequence down into edit line
;	-turn sequencing on (CPROG only)
'	-(apostrophe) turn sequencing off (CPROG only)
<RET>	-push edit line up, start sequencing, and return to MAIN

Letter	Number	Color	
A	1	white	(all flags out)
B	2	red	
C	3	green	
D	4	blue	
E	5	cyan	
F	6	magenta	
G	7	yellow	

(Letters H-N call the following colors with an option such as diffusion, if implemented on the system)

H	8	white	(with option if implemented)
I	9	red	(with option)
J	1Ø	green	(with option)
K	11	blue	(with option)
L	12	cyan	(with option)
M	13	magenta	(with option)
N	14	yellow	(with option)
Z	26	black	(all flags in)

Smoothest Order for Color Programs

Letter	Color	Red	Green	Blue
E	cyan	x		
D	blue	x	x	
F	magenta		x	
B	red		x	x
G	yellow			x
C	green	x		x

i.e. EDFBGC EDFBGC ... (down the chart)
CGBFDE CGBFDE ... (up the chart)
DFBGC DFBGC ... (skip cyan)
EDBGC EDBGC ... (skip magenta)
DBGC DBGC ... (skip cyan and magenta)

A P P E N D I X H
F L A G S

AF **-animation flags**

bit 1 + =manual speed control (ANSP)
bit 2 + =stop at end of sequence (wait for <TAB> or ^z)
bit 3 + =use display buffer for animation sequencing
bit 4 + =use display buffer for animation sequencing
bit 5 + =reverse animation order, last cell first

OF **-option flags**

bit 1 + =SETEM cursor to follow MAIN cursor
bit 2 + =send tabs to computer 1 (dual tab)
bit 3 + =suppress Level-2 wait messages
bit 4
bit 5 + =MUSIC (. =SILENT)

UF **-screen update flags**

bit 1 + =no beam/color sequencing update
bit 2 + =no dynamic changes ("GOBY")
bit 3 + =no update at end of "GOBYs"
bit 4 + =no "!" updates
bit 5 + =no miscellaneous updates: Wordfire messages, color or beam sequences

CF **-color chop flags**

bit 1 + =no logo color chopping
bit 2 + =no blanking
bit 3
bit 4 + =no colors or color sequences
bit 5

AX **-auxiliary output flags**

bit 1 + =AUX1 active
bit 2 + =AUX2 active
bit 3 + =AUX3 active
bit 4 + =AUX4 active
bit 5 + =AUX5 active

Turning Single Flags On/Off

When in SETEM, use the numerical keys 1 through Ø to turn flags on or off. From MAIN use "!" to turn bits (flags) on/off. I.e. "AF 4 !" to turn on AF bit 2 (to stop at the end of an animation sequence):

Bit	Off	On
bit 1	1	2
bit 2	3	4
bit 3	5	6
bit 4	7	8
bit 5	9	Ø

Turning Multiple Flags On/Off

Add up the numbers from the chart below, plus 32:

Bit	Off	On
bit 1	Ø	1
bit 2	Ø	2
bit 3	Ø	4
bit 4	Ø	8
bit 5	Ø	16

To turn all flags on : "63 !"
To turn all flags off: "32 !"

To turn only flags 2 and 5 on (Ø + 2 + Ø + Ø + 16 + 32 = 5Ø): "5Ø !"

APPENDIX I
ADVANCED TOPICS

TIMING, SW, AND DW

All of the jobs that ZAP must do are broken down into two separate processes: scanning and everything else. Scanning consists mostly of displaying points, one at a time. Everything else includes such things as running TOPAs and MAINlines, updating the screen, and changing all registers with GOBYs or rotations.

To perform these two tasks simultaneously, ZAP has two main program loops it runs. The first loop is the scan loop, which is responsible for displaying points. This loop is interrupt-driven, and is executed every time ZAP receives a NMI (non-maskable interrupt), which occurs once every 70 microseconds (written "70us", 1us=1/1,000,000 second). For each interrupt, the scan loop is run once, displaying one point. This generally takes about 50us, leaving 20us free.

The remaining 20us left after running the scan loop and before the next NMI is received is spent executing the second loop, known as the dynamic update loop. This loop performs all the other tasks ZAP must accomplish, one at a time, first to last and back to first again. This loop checks for sync triggers, updates all GOBYs, executes MAINlines and TOPAs, communicates with the terminal and slaves, and all other housekeeping. Note that unlike the scan loop, the dynamic loop is not based on a fixed time interval; therefore, if ZAP has a lot to do (for example, during a scene with many GOBYs and rotations), it will take more time to do it than if there is little dynamic action occuring (like just after a reset). In particular, screen updates take much of ZAP's dynamic loop time.

However, this timing can be changed. The two registers used to change ZAP's scan and dynamic loop rates are SW and DW.

SW

SW slows the scan speed by extending the time between non-maskable interrupts. At SW=0, interrupts occur every 70us. At SW=16, interrupts only occur every 140us, deviding the scan rate in half. Thus, at SW=0 ZAP spent about 71% of its time displaying points (50/70) and only 29% handling dymanic tasks (20/70). But at SW=16, ZAP spends only 36% of its time scanning and 64% running the dynamic loop.

Therefore, increasing SW has two direct effects: fewer points are scanned in a given time, and the dynamic loop is executed more quickly (because ZAP has more free time to devote to it). While the lower scan speed is very noticable, the increase in the dynamic update speed is not as intrusive, except in the case of registers performing GOBYs, rotations, or sequences at sync 4 (free run), because that sync is triggered each time through the dynamic loop (which occurs more often at nonzero SW values).

DW

The DW register not as powerful as SW, but can be very useful in some situations.

SW effected the timing distribution, altering the amount of time ZAP spent doing points or dynamic updates. DW, on the other hand, does not effect the scan rate at all. It simply adds another task to ZAP's dynamic update loop, thereby slowing it down slightly, the delay dependant on the value in DW. As noted above, a slight change in speed in the dynamic update loop is generally not very noticable, except in the case of rotations, GOBYs, and sequences executed at sync 4. It is for these cases that DW can be used to adjust the update speed in fine increments.

DW was created specifically for use with color sequences. To create a sequence of colors flowing slowly through a graphic, the color sequence is entered and CS is set to sync 4 (with ZAP in NOU mode). Then, instead of having to slow scan speed by raising SW to achieve the desired effect, DW can be used to change the color chop rate. Also, DW has a much finer resolution for adjusting sync 4-speed sequences than SW.

SW and DW can be used together; for example, between low SW values and the full range of DW, color lock can often be achieved without sacrificing much scan speed. However, note that as SW increases, ZAP has more time to cycle through the dynamic loop, which means that the delay induced by DW has less and less effect.

G L O S S A R Y

ANGSTROM	- A measurement of the wavelength of light. 1 angstrom = 1,ØØ,ØØØ,ØØØ,ØØØ meters; 1Ø angstroms = 1 nanometer.
ARGON	- An inert gas; atomic element number 18.
BIT	- The smallest piece of information a computer can handl A bit is either on or off; high or low; one or zero.
BLANKING	- A technique using a very fast mirror to deflect the laser beam causing specific sections of an image to appear blank (undrawn).
BUFFERS	- An area of computer memory set aside for special data.
BURN	- Programming data onto an EPROM, where the data remains until it is erased with ultra-violet light.
BYTE	- A block of eight bits. There are 256 (2 to the 8th) possible combinations. The byte is the basic unit of measurement for memory (usually in Kilobytes).
CELL	- A single frame of an animation cue.
COMFILE	- A series of TOPfiles organized for viewing, burning, or downloading.
CUE	- Any pre-compiled program or digitized image stored on EPROM or in computer memory.
EPROM	- An IC which is plugged into a computer card. Laser Media currently uses several sizes of EPROMs to store IMAGEN graphics and programs.
FONT	- A stylized character set or group of icons.
FORTH	- Language of the elite.
HENE	- An abbreviation for a Helium-Neon (red) laser.
KRYPTON	- An inert gas; atomic element number 36.
K	- Abbreviation for Kilobytes, used as a unit of measurement of computer memory. 1K bytes = 1,Ø24 bytes.
LASER	- Acronym for "Light Amplification by Stimulated Emission of Radiation".
LOGO	- A general term referring to a scanned image, such a corporate logo or other graphic.

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LM	- An acronym for Laser Media, as well as the command to call the Laser Media logo.
MANDALA	- A circular design containing concentric geometric forms and images, which symbolize the universe, totality, or wholeness in Hinduism and Buddhism.
NEON	- An inert gas; atomic element number 1Ø.
NEVERCOM	- The Nevercom contains basic geometric graphics, Wordfire fonts, and the help file. It comes with each LM system and should "NEVER" leave the computer.
PHASE-LOCKED	- Synchronized to timecode pulses.
RAM	- An acronym for "Random Access Memory." This stands for "read/write" memory.
ROM	- Read Only Memory. An EPROM, once burned, is often referred to as ROM.
ROUTINE	- A specific pre-programmed KEYS event.
RS232	- The serial connection between computers and/or terminals (such as the Esprit).
SEGUE	- (pronounced seg-way) The visual transition from one image to another.
SHIVA	- A beam control unit which can be used instead of the ZAP computer (also, the Hindu god of destruction and reproduction).
START/END POINT	- The assigned place on an image where each scanning cycle begins and ends.
TIMECODE	- An audio clock track which keeps ZAP in perfect sync with music.
TOPA	- A pre-programmed Level-3 cue.
TOPFILE	- A graphic data source file used to create and edit each image or cell.

ZAP - An acronym for "The Z8Ø Animation Program." ZAP controls all Laser Media computers.

Z8Ø - An 8-bit micro-processor.