

# Stable Raster with Lightpen

I've seen a few references to getting a stable raster by triggering the light pen but couldn't find it in any tutorials. So I was curious about it and have documented here what I've found out.

It turns out to be a mostly useless technique because of the following problems:

- It's wrecked if the user presses space or joystick #1 button
- It can only be used once per frame!

But if you can live with that (for example if you check for space/button anyway to exit an intro) maybe you could use it. And you might **want** to use it because it has one big advantage:

## You can have a stable raster in less than one raster line, using only one IRQ!

You don't have to setup a stable raster, then set timers, then use them in future IRQs - just one and you're done. Also, you don't need sprites or any other DMA.

## How does it work?

It's based on the fact that you can manually trigger the light pen and read off the raster X coordinate from it, and if you do it in your IRQ routine the X coordinate will correspond to the amount your IRQ was delayed.

Here's a step-by-step explanation but see the Vic-II doc by Christian Bauer for more technical details:

1. Connect the light pen to port B of CIA A
2. In your IRQ routine, trigger light pen by writing \$ff then \$00 to \$dc01
3. Read light pen X coordinate from \$d013
4. Convert this to a value from 0 to 7
5. Use value in a clockslide

## Code Example

The following code can get a stable raster in 45 cycles but it wastes 256 bytes on a table for converting the LP X value to the clockslide value. If you set "use\_table = false" at the top to do the calculation manually, it will not need the table but will take 49 cycles.

The code shows the jitter value at the top right of the screen by incrementing a character corresponding to each jitter value, from 0 to 7.

```
; code should compile with 64tass V1.53.1590 or thereabouts

; 6502 w/ illegal instructions
.cpu "6502i"

; ---- config -----
```

```
---  
  
irq_vec      = $fffe  
nmi_vec      = $fffa  
screen       = $400  
r_interrupt  = 30  
use_table    = true  
  
; ---- code -----  
---  
  
* = $0801  
  
    ; basic stub  
    .word endbasic           ; link to next line  
    .word 2018               ; line number  
    .null $9E, format("%d", start) ; SYS token  
endbasic:  
    .byte 0,0,0             ; end of BASIC program  
  
start:  
    ; paranoia  
    cld  
  
    ; disable interrupts  
    sei  
  
    ; swap out basic and kernel roms  
    lda #%00101111  
    sta $00  
    lda #%00111101  
    sta $01  
  
    ; disable timer interrupts  
    lda #$7f  
    sta $dc0d  
    sta $dd0d  
  
    ; lock out NMI interrupts  
    lda #<nmi  
    sta nmi_vec  
    lda #>nmi  
    sta nmi_vec+1  
    lda #$00  
    sta $dd0e           ; stop timer A  
    sta $dd04           ; zero timer A  
    sta $dd05  
    lda #%10000001  
    sta $dd0d           ; enable timer A NMI  
    lda #$01
```

```
    sta $dd0e          ; start timer A, causing immediate NMI
    nop               ; some delay for paranoia sake
    nop
    jmp clear_screen

nmi:
    rti

clear_screen:
    ldx #$00
-   lda #$20
    sta $0400,x
    sta $0500,x
    sta $0600,x
    sta $0700,x
    lda #$01
    sta $d800,x
    sta $d900,x
    sta $da00,x
    lda #$06
    sta $db00,x
    inx
    bne -

    ; text
    scrpos = screen + ( 1*40) + 32
    ldx #textlen
-   lda text,x
    sta scrpos,x
    dex
    bpl -

    ; init lightpen
    lda #%00010000
    sta $dc03
    lda #$ff
    sta $dc01

    ; set the interrupt vector
    lda #<irq1
    ldx #>irq1
    sta irq_vec
    stx irq_vec+1
    ; set the initial raster interrupt location
    lda #(r_interrupt & $ff)
    sta $d012
    lda $d011
    .if r_interrupt < $100
        and #%01111111
    .else
        ora #%10000000
```

```
.endif
sta $d011
; enable raster interrupt
lda #$01
sta $d01a
; ack video interrupts
lsr $d019

; let the interrupts begin
cli

; this mainloop ensures every possible jitter value is hit at some point
mainloop:
    inc $700,x
    bne mainloop
    inx
    jmp mainloop

; ---- irq -----
---

.option allow_branch_across_page = 0

irq1:
    ; CPU takes 9 to 16 cycles

    ; skip saving registers, assume real mainloop would be simply jmp *

    ; ack (6 cycles)
    lsr $d019

    ; get raster X by triggering lightpen (6 cycles)
    lda #$00
    sta $dc01

    .if use_table
        ; use 256 byte table to shave 4 cycles off manual method (8
cycles)
        ldy $d013
        lda table_delay,y
    .else
        ; manually calc jitter value (12 cycles)
        lda $d013
        lsr
        lsr
        sbc #$08
        and #%00000111
    .endif
```

```

        ; clockslide (16 to 9 cycles)
        sta mod_clockslide0
mod_clockslide0 = *+1
        bpl *
        lda #$a9
        lda #$a9
        lda #$ad
        lda $ea

        ; ---- stable here (45 cycles w/ table, 49 cycles without) ----

        ; border
        inc $d020

        ; delay for about 10 raster lines
        ldy #$83
-       iny
        bne -

        ; now delay a bit more, increasing delay by one cycle every few
frames
        ; and restart after 31 increases
        dec cntr
        lda cntr
        lsr
        lsr
        lsr
        and #$1f          ; delay from 0 to 31

        sta mod_clockslide1
mod_clockslide1 = *+1
        bpl *
        lda #$a9          ; 0
        lda #$a9          ; 2
        lda #$a9
        lda #$a9
        lda #$a9
        lda #$a9          ; 10
        lda #$a9
        lda #$a9
        lda #$a9
        lda #$a9          ; 20
        lda #$a9
        lda #$a9
        lda #$ad
        lda $ea          ; 30

        ; border
        dec $d020

```

```
        ; display lightpen x
        ldx mod_clockslide0
        inc screen + 32,x

endirq:
        ; reset lightpen
        lda #$ff
        sta $dc01

        rti

; ----- data -----
---

cntr:   .byte 00

text:   .text "01234567"
textlen = * - text - 1

.if use_table
        ; entire page of delay values; we only really need about 4*7 values in
the table, but
        ; because of spurious lightpen readings we need to have all the other
values covered
        ; to prevent a crash
        table_delay:
            .fill $20, 0

            .page    ; no page crossing here to ensure no extra cycles
            .fill $04, 0
            .fill $04, 1
            .fill $04, 2
            .fill $04, 3
            .fill $04, 4
            .fill $04, 5
            .fill $04, 6
            .fill $04, 7
            .endp

            .fill $c0, 7
.endif
```

## Download Example

Here's a zipped prg file compiled from the above:

# lp-stable-raster.zip

From:  
<https://codebase64.org/> - **Codebase 64 wiki**

Permanent link:  
[https://codebase64.org/doku.php?id=base:stable\\_raster\\_with\\_lightpen&rev=1550290084](https://codebase64.org/doku.php?id=base:stable_raster_with_lightpen&rev=1550290084)

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