Chapter 6 2-Player Cautions

6.1 PROGRAM PROCESS TIMING

The process timing for Game Boy programs is shown in Figure 1-6-1. This program processing is done during a 15 msec period from the instant when the hardware reads the video RAM (V-RAM) data and starts drawing the LCD screen, until the LCD is drawn. When the program is short (less than 15 msec), a loop called the V-blank wait is executed to wait until the hardware completes the LCD drawing. When the LCD is finished, the V-blank flag is set high, and the CPU executes a V-blank interrupt. While the hardware is drawing the LCD screen, the CPU cannot transmit screen data to the V-RAM, and the next set of screen data must be input to the V-RAM between the time the screen is completed and the time the hardware starts to draw the next screen. This operation is performed during the V-blank interrupt, which is only 1msec long. Since this operation must be completed in 1msec, it is common that only those processes which need to be run during V-blank (those associated with screen drawing) are executed during this period. If this operation exceeds 1 msec (process overflow), screen disturbances will result.

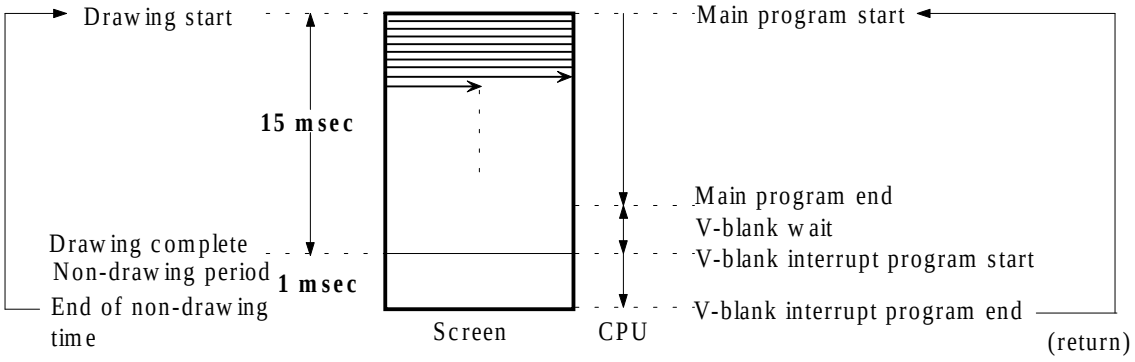

Figure 1-6-1 LCD Timing and CPU Processing

6.2 SCREEN DISTURBANCES AND PROCESS OVERFLOW

Two types of process overflow can occur in this situation. Figure 1-6-2, illustration (a) shows the normal process timing. The first type of process overflow, shown in illustration (b), is caused by a main program which is too long and cannot be executed in 15 msec. Since the V-blank interrupt still occurs at 15msec, the main program gets interrupted and must be executed after V-blank. If the V-blank interrupt process requires the allowed 1 msec, the main program will overflow to the next frame and will deprive the next process of its execution time. The second type of process overflow, shown in illustration (c), is caused

by a V-blank process which is too long and cannot be executed in 1msec. The V-blank interrupt, following the main program and V-blank wait, exceeds the time limit and causes an overflow.

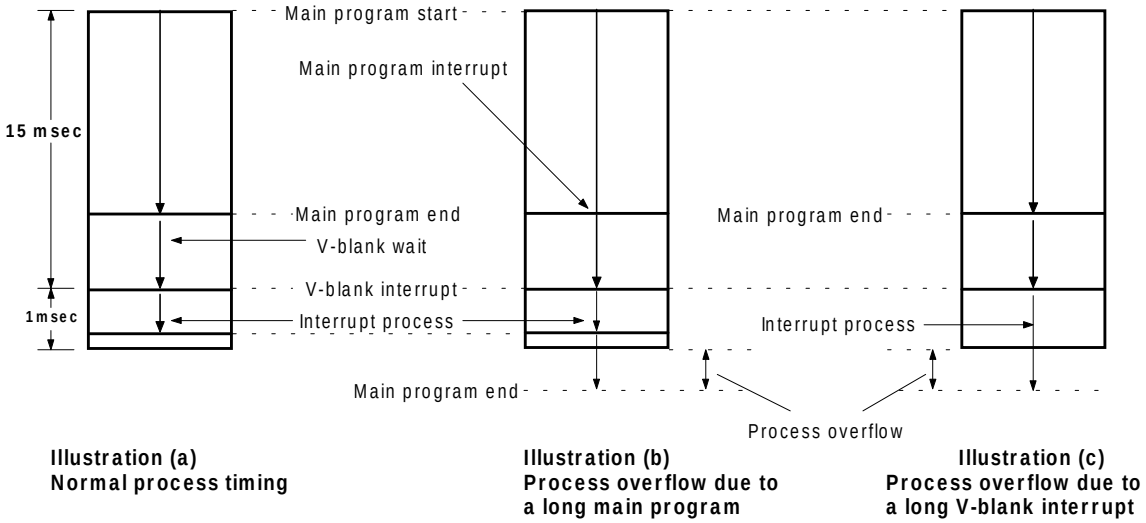

Figure 1-6-2 Process Overflow Conditions

Screen disturbances are caused by these V-blank process overflows. To obtain an understanding of how this type of overflow causes screen disturbances, an understanding of Game Boy operation is required.

Figure 1-6-3, illustration (a), simply illustrates the connection between the CPU, V-RAM and LCD screen (LCD controller). Note that the CPU V-RAM connection and the V-RAM LCD screen (LCD controller) connection share the same data bus. This bus carries screen data from the V-RAM to the LCD screen (LCD controller) while the CPU is processing the main program (illustration (b)). During the 15 msec period, the CPU cannot read or write to the V-RAM. This data transmission must take place during the 1-msec V-Blank (illustration (c)). During V-blank, the V-RAM does not send screen data to the LCD screen (LCD controller), and the CPU can send the next set of screen data to the V-RAM.

When a process overflow occurs, data transmission (shown in illustration (d)) continues past the 1-msec limit, and clashes with the data from the V-RAM to the LCD screen (LCD controller). This is what causes the disturbances on the screen.

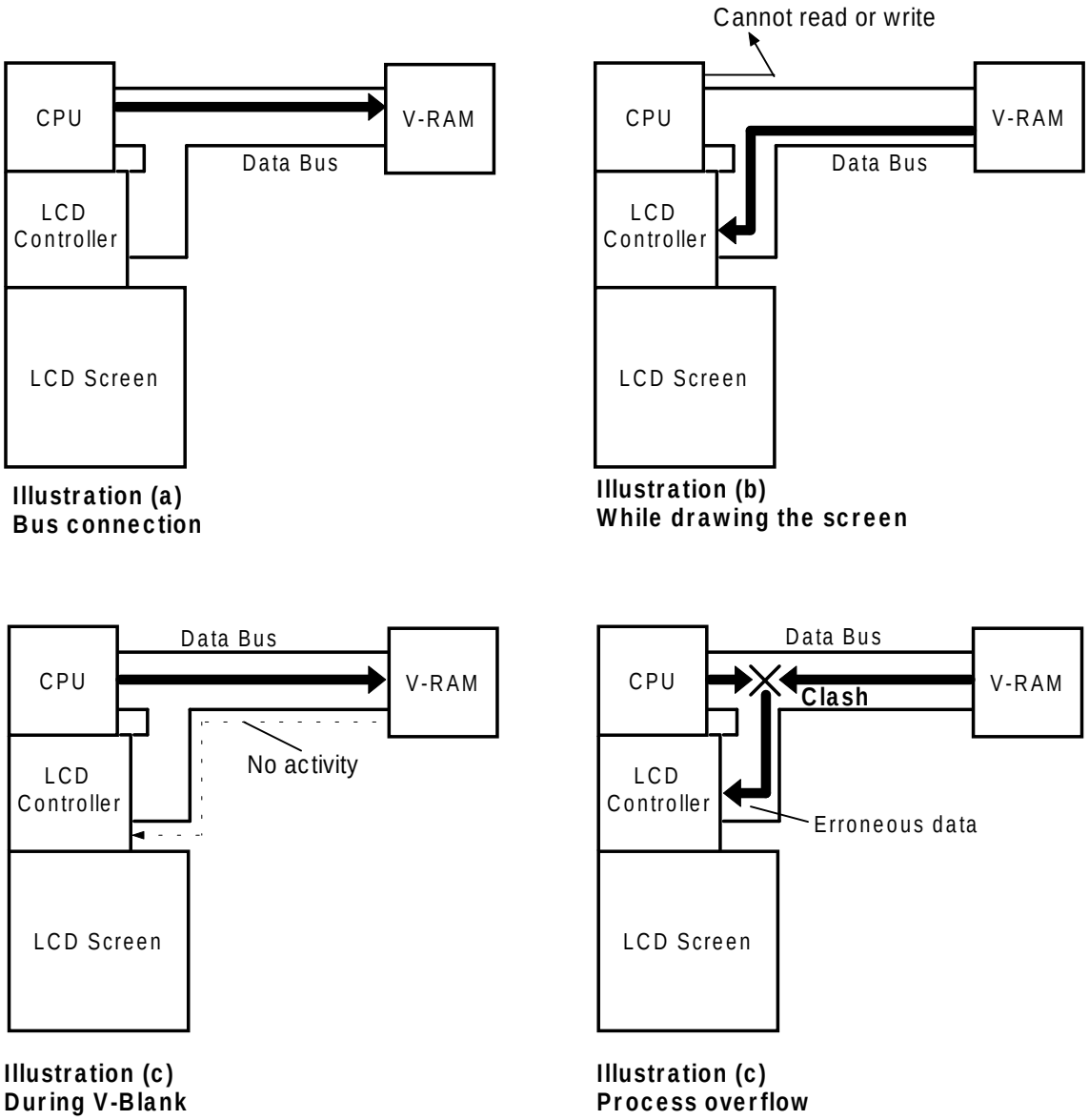

Figure 1-6-3 Communication of CPU, V-RAM, and LCD

6.3 COMMUNICATION AND PROCESS TIME

Even though communication tends to cause screen disturbances, these disturbances are not directly caused by communication itself. The screen can be disturbed without communication depending on how one programs one's games. The reason that communication tends to cause screen disturbances is that the interrupt process which comes after the communication (SIO interrupt) sometimes get executed in V-blank, and causes a process overflow.

The Game Boy communication is initiated by one of the Game Boys. One communication takes 1 msec, but the CPU executes the program normally during communication because the hardware automatically executes the communication once it is initiated. When the communication is complete, an interrupt called SIO interrupt can start. This interrupt prepares the next communication data and processes the data received. The SIO interrupt timing is not resolute since communication executed by hardware may occur anytime (The Game Boy initiating the communication has some control). Figure 1-6-4 show three possible process sequences. Illustration (a) show the case where the SIO interrupt timing is not a problem, while illustrations (b) and (c) show instances where the SIO interrupt timing causes an overflow.

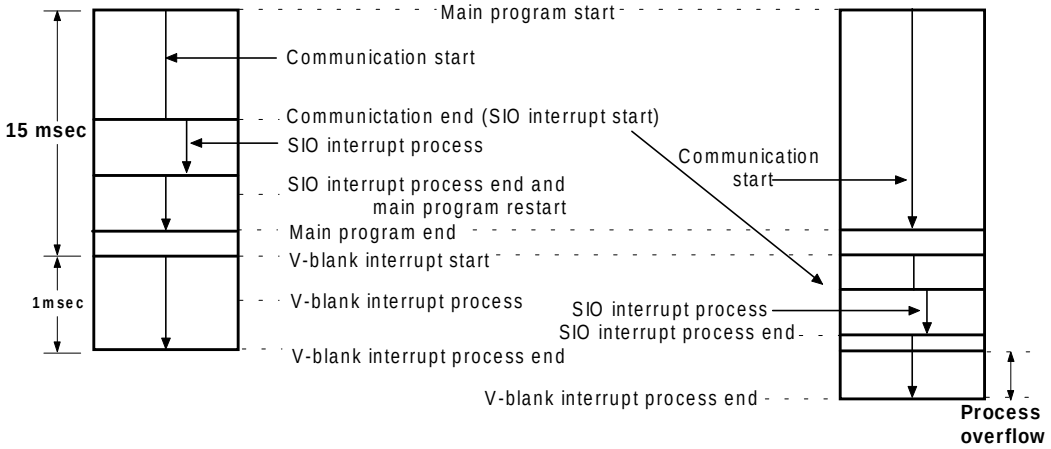

Illustration (a)
SIO interrupt process in the main program

Illustration (b)
SIO interrupt process in the V-blank interrupt

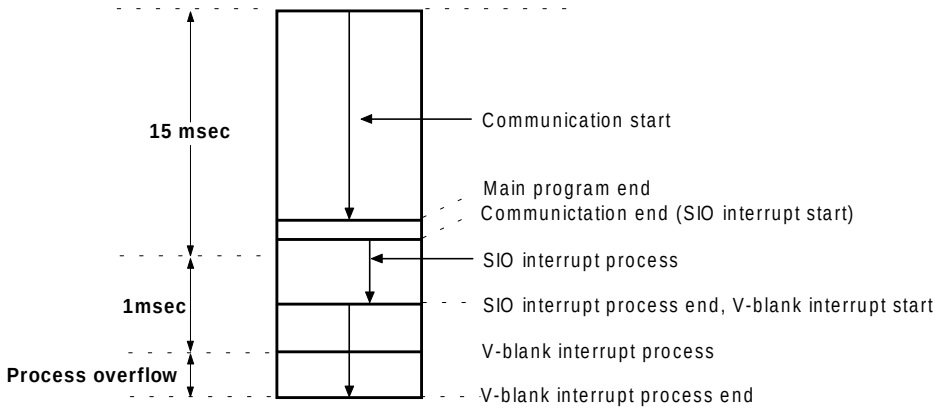

Illustration (c)
SIO interrupt process delays start of V-blank interrupt

Figure 1-6-4 SIO Interrupt Timing

If the SIO interrupt occurs during V-blank, as in Illustration (b), the V-blank interrupt process is interrupted (if multiple interrupts, or "EI", are permitted) and the remaining portion is executed after the SIO interrupt process is done. The execution time for the V-blank interrupt is delayed by the SIO interrupt. This can cause and overflow (Figure 1-6-4) and screen disturbances. If communication occurs only once during one frame, do not authorize multiple interrupts (EI) during the V-blank process. If communication occurs more than once per frame, however, multiple interrupts (EI) must be allowed during the V-blank, since inhibiting multiple interrupts disturbs communication. (Note that multiple interrupts are automatically inhibited once the interrupt process begins.)

When the SIO interrupt process starts prior to the V-blank interrupt, as shown in illustration (c), the V-blank interrupt process does not begin until the SIO interrupt process ends. (Other interrupts are inhibited during an interrupt process, unless multiple interrupt authorization, EI, is given.) This results in an overflow equal in time to the delay of the V-blank interrupt. Of concern is that the delay forced on the V-blank interrupt process in illustration (c) can occur due to any interrupt process, and not only an SIO interrupt.

The events described in Illustrations (b) and (c), above, are the cause of screen disturbances.

6.4 CAUTIONS

6.4.1 CAUTION #1

The most important thing is not to create process overflows. Make the V-blank process as short as possible. Consolidate all the V-RAM related tasks (redrawing or adding the background, etc.) immediately after the DMA transmission, which starts as soon as V-blank starts. Move the tasks which are not related to the V-RAM transmission but must be done during V-blank to the very end of the V-blank process (Figure 1-6-5). Slight overflows will not disturb the screen as long as V-RAM tasks have been completed.

6.4.2 CAUTION #2

The user can avoid an interrupt process from delaying the V-blank interrupt process with judicious use of multiple interrupt (EI) authorization or V-blanks interrupts only authorization, when using other interrupts. Also, inhibit multiple interrupts during the V-blank interrupt process. Communication disturbances may occur, however, when multiple interrupts are authorized during the SIO interrupt process or inhibited during the V-blank interrupt process. Read Countermeasure 3 before using this approach. When multiple interrupts cannot, for some reason,

be authorized during the interrupt process, screen disturbances can be avoided by making the V-blank process time plus the interrupt process time 1 msec of less. To avoid screen disturbances when you want to authorize multiple interrupts during the V-blank interrupt process, make the V-blank process time plus all interrupt process time 1 msec or less.

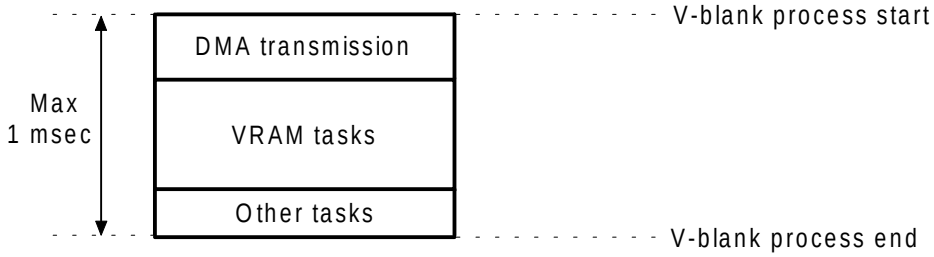

Figure 1-6-5 Recommended Program Placement in V-Blank

6.4.3 CAUTION #3

6.4.3.1 ONE COMMUNICATION PER FRAME

If communication occurs only once per frame in a game using communications, inhibit multiple interrupts during the V-blank, and authorize multiple interrupts (EI) or V-blank interrupts only during the SIO interrupt process. No problems or communication disturbances should occur as long as there are no process overflows and the first precaution in this section is exercised.

6.4.3.2 TWO OR MORE COMMUNICATIONS PER FRAME

If communication occurs more than once per frame, the communication structure requires that multi-interrupts os SIO interrups only be allowed during the V-blank process, and that multi-interrupts be inhibited during the SIO interrupt process. This will avoid communication disturbances. In this case, control the timing of each interrupt precisely and make the V-blank and SIO interrupt processes as short as possible. If the V-blank and SIO interrupt process time exceeds 1 msec, the screen will be disturbed. As indicated in caution #1, the V-blank process should be programmed as indicated in the figure above. The procedure described in caution #1 is very effective when the sum of the V-blank and SIO processes is close to 1 msec.

6.4.4 CAUTION #4

When using interrupts other than communications in a communication game, try to ensure that those interrupts are not excecuted during V-blank. If they must be excecuted during V-blank, make sure that the total process time for V-blank, SIO interrupt and other interrupt processes is less than 1 msec.

****

Credits:

Game Boy 2-Player Cautions (version 1.0) was brought to you by NoComply, F.H.
Document Reproduced by F.H (anyone have any SNES docs for release???)
****