Mc Swiggin

TMDSII

USERS MANUAL

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1.0 INTRODUCTION

This manual is intended to give users of the TMDSII system a summary of command and data formats used to create displays on the TMDSII monitors, see Figure 1. The individual command formats are listed and their effects on the system are described. Restrictions placed upon the user to avoid jobs which take too long are described.

The bulk of this description was written by John Fletcher of LLL in the form of preliminary specifications to the user. It has been reviewed and some minor changes have been incorporated by Data Disc, Inc.

DISPLAY INFORMATION FORMAT

Data being displayed on a TMDSII Monitor is refreshed 30 times per second from a copy of the data held on a video disk. The data are stored in the form of a square raster of 256K points (where K = 1024), 512 on a side. Each refresh cycle consists of two fields, each requiring $\frac{1}{60}$ of a second; during one field (the odd field) all odd-numbered horizontal lines are refreshed, and during the other field (the even field) all even-numbered lines are refreshed. Data are placed onto the video disk by means of a display controller which interprets the stream of bits sent to it as a sequence of commands and data. This section describes the format of the information interpreted by the controller; this information, supplied by the user program, is passed to the controller by TMDSII unaltered and unexamined.

The format for display information is oriented around the chomp. A chomp consists of two consecutive bytes, where a byte is eight bits. In a worker computer, the chomps are packed tightly without regard to word boundaries. Each chomp is regarded as a command until a particular command, block transfer, is encountered. This command includes a byte count; the immediately following chomps are regarded as containing bytes of display data equal in number to the byte count. If the byte count is odd,

the second byte of the last data chomp is ignored. The chomps following the data are again interpreted as commands until another block transfer command is encountered.

The first six bits of a command are the op code, defining the type of command. Of the 64 different op codes, only eight define legal commands for the user. Three of the remaining 56 op codes are used by the TMDSII system software to perform functions not permitted the user; the remaining 53 op codes are illegal for the system as well as the user. The eight user op codes and three system op codes are now discussed in turn. The bits of a command are numbered from 15 on the left to Ø on the right. A three-character mnemonic is suggested for each op code.

Load Control Register (LCR) selects a number of options which prevail until the next LCR command.

Bits 15 through 10 are the op code, 41 octal.

Bit 9, if set, indicates that the full raster should be erased, provided that bits 8 and 7 are clear. If bits 8 or 7 are set when bit 9 is set, all three bits are ignored, and no change is made in the options which they control. If bit 9 is clear, bits 8 and 7 are interpreted as now explained.

Bit 8, if set, indicates that the two bytes within each data (not command) chomp are to be processed in swapped order;

otherwise they are processed in normal order. Reasons for using swapped order are difficult to suggest.

Bit 7, if set, indicates that data is to be interpreted as raster bits; otherwise data is interpreted as text. The bits of a raster byte are recorded into eight successive points of a raster line. The bits of a text byte are used to select one of 256 characters from a predefined font table; the raster representation of the selected character is recorded on the video disk and displayed.

Bit 6, if set, indicates that data bits should be recorded as a negative image; that is, zeroes, rather than ones, should produce a bright point, and ones, rather than zeroes, should produce a dark point. Similarly, if erase is indicated (by bit 9), the entire raster becomes bright, rather than dark. If bit 6 is clear, recording is positive.

Bits 5 and 4 select one of four text modes, which are relevant only if data is interpreted as text. If the two bits are ØØ, standard 256-character mode is indicated in which each text byte selects of of 256 predefined characters as described above. If the two bits are Ø1, then the high-order bit of each text byte is ignored and treated as though it were zero. Thus only the first 128 characters of the full font table are accessible; these 128 characters constitute font Ø. If the two bits are 1Ø, then

the high-order bit of each text byte is ignored and treated as though it were one. Thus only the last 128 characters of the full font table are accessible; these 128 characters constitute font 1. If the predefined font table consists of a single set of 256 different characters, the latter two modes are probably not of much use. However, if it actually consists of two fonts of the same 128 characters (perhaps differing in size); then the latter two modes are quite valuable. The 256 character mode permits the two fonts to be freely intermixed. In the three modes described thus far, the maximum size of a character is 8 raster points wide and 16 points high. If bits 5 and 4 are 11, then a double-size mode is selected in which there are only 128 characters altogether, but each character can be up to 16 points wide by 16 points high. The high order bit of each text byte is used to select the character spacing. If clear, font Ø spacing is selected, if set, font 1 spacing is selected. Clearly, if the predefined font is suitable for this mode, it is probably unsuitable for the former three modes, and conversely.

Bit 3, if set, indicates that the recorded raster is to be displayed as a negative or inverted image; otherwise it is displayed uninverted. The effect of this bit should not be confused with that of bit 6, which only affects how subsequent data is to be recorded on the video disk. Bit 3 does not change the recorded raster, nor does it affect the recording of subsequent data; it does cause all recorded points to be displayed inverted,

with dark points appearing bright and conversely.

Bits 2 and 1 select among three recording modes. If the two bits are ØØ, the mode is unchanged and retains its previous value. If the two bits are Ø1, additive mode is selected. In this mode, only ones are recorded on the video disk (as bright or dark points as determined by bit 6); raster points corresponding to zeroes in the data are unaffected. If the two bits are 1Ø, replacement mode is selected. In this mode, all bits are recorded on the video disk; thus a character of text data records not just the character itself but the entire rectangle determined by the font size, making some points bright and others dark. If the two bits are 11, line replacement mode is selected. In this mode, every raster line on which data is recorded is first erased (to dark or bright as determined by bit 6). For example, if a single character is recorded, all preceding and following character positions in the same row of characters become blank.

Bit Ø, if set, indicates that successive characters of text data are to be placed below, rather than to the right, of preceding characters; otherwise characters progress in normal left to right fashion. This step-down mode must not be used in connection with raster data.

Load Font Ø Size (LF0) and Load Font 1 Size (LF1)

set the size of the indicated font. In 256-character mode, the

high-order bit of each text byte determines which font size is used; therefore the two sizes should be set the same if the font table contains one set of 256 characters. An entry in the font table consists of a 8 by 16 or a 16 by 16 raster; a rectangle from the upper left corner of this raster is determined by the font size, and only bits from this rectangle are recorded when the entry is selected by a text data byte. A font usually has a size with which it is intended to be used, and the unused bits to the right and below in the font entry are normally set to zero. Thus, using a larger size than intended increases the intercharacter spacing; using a smaller size may turncate the character. The size selected by a LF0 or LF1 command prevails until the next such command for the same font.

Bits 15 through 10 are the op code, 56 octal for LF0, 57 octal for LF1.

Bits 9 and 8 are unused.

Bits 7 through 4 define a number one less than the height of the font, which may therefore vary from 1 to 16. However, a height of one, besides being somewhat foolish, can lead to difficulty.

Bits 3 through Ø define a number one less than the width of the font, which may therefore vary from 1 to 16. Widths

greater than eight will be treated modulo 8 unless double-size character mode is also used.

Load X-Coordinate (LDX) and Load Y-Coordinate (LDY) set the raster position to be used as the starting point for subsequent data. The selected point defines the left end of the next raster byte or the upper left corner of the next character. The X-coordinate (abscissa) is numbered from Ø on the left to 511 on the right; the Y-coordinate (ordinate) is numbered from 511 at the top to Ø at the bottom.

Bits 15 through 10 are the op code, 66 octal for LDX, 67 octal for LDY.

Bits 9 is unused.

Bits 8 through Ø define the coordinate.

Block Transfer (BXF) signals the beginning of data bytes and indicates their number. Whether the bytes are raster or text is determined by a preceding LCR command. Raster bytes are recorded on a single horizontal line beginning at the current X,Y position. If part of a byte extends beyond column 511, it is truncated. A byte should not begin beyond column 511; therefore the byte count for raster data should never exceed 64. After all the data is recorded, the X-coordinate reverts to the same value as before the BXF command, and the Y-coordinate is

decremented by one. Thus a succession of BXF commands effect the recording of successive raster lines beginning at the same X-coordinate.

Text bytes select entries from the font table which are recorded on as many lines as are determined by the font size. Successive characters follow to the right with a spacing determined by the font width (or, in step-down mode, follow below with a spacing determined by the font height). If characters extend beyond column 511, or below line Ø, they are truncated. If, as a result of stepping to the right, a character is about to begin in a column beyond 511, the X-coordinate is automatically reset to its value after the last LDX command and the Y-coordinate is decremented by the height of the last character recorded (stepping down below line Ø should not be allowed to occur); thus several rows of characters beginning at the same X-coordinate may be recorded with one BXF command (in contrast to the situation with raster data, which requires a BXF command for every line). When all text data associated with a BXF command has been recorded, the X-coordinate is reset to its value after the last LDX command and the Y-coordinate is decremented by the height of the last character recorded (or, in step-down mode, the X-coordinate is incremented by the width of the last character recorded, while the Y-coordinate is reset to its value after the last LDY command). The character generator cannot process more than 128 characters per display line. This

restriction is of significance only if a font width of four or less, is selected.

Bits 15 through 1Ø are the op code, 46 octal.

Bits 9 through Ø define the byte count. The command is followed by data chomps equal in number to half this count, rounded up to the next integer; the second byte of the last chomp is unused if the count is odd. If the count is zero, the command has the effect of a carriage return and line feed. The X value becomes whatever it was set to by the last LDX command and the Y value is incremented by an amount corresponding to the height currently specified by font Ø.

Load Data (LDD) defines a single data byte. The effect of this command is the same as a BXF with a count of one, followed by the data byte.

Bits 15 through 1Ø are the op code, 4Ø octal.

Bits 9 and 8 are unused.

Bits 7 through Ø define a data byte.

Idle (IDL) is a no-operation.

Bits 15 through 1Ø are the op code, ØØ octal.

Bits 9 through Ø are unused.

These eight types of commands, LCR, LFØ, LF1, LDX, LDY, BXF, LDD and IDL, are the only ones legal for the user. The three types mentioned next are used by the system.

Load Font Address (LFA) is used to load the font table. It defines a character entry within the table. The operation of the first BXF command following an LFA is modified. The count in that command (which should not exceed 128) indicates how many sets of 16 data chomps follow it. Each set of 16 chomps constitutes two font table entries: The high-order bytes of the 16 chomps are an entry for font Ø; the low-order bytes are an entry for font 1. Both entries are for the same character (or for characters having codes differing by 128, in the 256-character mode). In double-size mode, each set of 16 chomps defines a single entry. The first 16-chomp set is loaded into the table at the entry defined by the LFA command; subsequent sets are loaded into succeeding entries.

Bits 15 through 1Ø are the op code, 60 octal.

Bits 9 through 7 are unused.

Bits 6 through Ø define the font table entry.

Clear System (CLS) initializes the video disk controller.

Bits 15 through 1Ø are the op code, 77 octal.

Bits 9 through Ø are unused.

Load Channel Address (LCA) selects one of up to 256 channels on the video disks on which subsequent data is to be recorded. In the initial configuration only 96 channels will be implemented. Each channel holds the refresh data for one displayed picture. All display information must be presented to the controller twice, one to record the odd field and once to record the even field; the LCA command selects the field as well as the channel. (The user program need send display information for a given picture or change in a picture only once; TMDSII will then present it to the controller twice. Each user is assigned one channel while he is using the subnetwork.)

Bits 15 through 1Ø are the op code, 62 octal.

Bits 9 and 8 select the field. If the bits are ØØ, the field retains its previous selection; if they are Ø1, the even field is selected; if they are 1Ø, the odd field is selected; if they are 11, the field selection is changed from its previous value to the opposite selection (i.e. is toggled).

Bits 7 through Ø define the channel.

All other op codes are illegal; the op codes LFA, CLS, and LCA are illegal for users. Commands having illegal op codes are treated as no-operations, but a record is made by the controller that an illegal op code has been processed.

The controller has a 128 character buffer. This allows some freedom from the restriction that data must be organized sequentially. The 128 characters may be presented to the buffer in any order and still be displayed properly. The restriction is that characters in excess of 128 must not appear on the screen above or to the left of the last displayed character.

Some commands can be imbedded within a job without confusing the processor. These commands are LDX, LDY, LCR, IDL, and, of course, BXF and LDD. The processor will process data following these commands according to the parameters they specify. LFØ and LF1 should not normally be altered within a job because they are not processed until the 128 character buffer is empty and subsequent data are delayed. This delay may be large enough to cause the data to fall behind which results in a bad list indication. If care is taken to allow a few lines of space i.e. change Y to a new value a few lines below the last displayed value, then LFØ and LF1 commands may be imbedded in the job also.

FUNCTION	MODE	MNEMONIC	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
LOAD CONTROL REGISTER	ALL	LCR	1	0	0	0	0	1	Generator Mode *			I *	Char. Mode *		D *	Disc Mode *		V *
LOAD CHANNEL ADDRESS	EXEC	LCA	1	1	0	0	1	0	Field *		X	X	Channel Address					
NO-OP	ALL	IDL	0	0	0	0	0	0	X	X	X	X	X	X	X	X	X	X
LOAD FONT Ø SIZE	ALL	LFØ	1	0	1	1	1	0	X	X	Height - 1				Width - 1			
LOAD FONT 1 SIZE	ALL	LF1	1	0	1	1	1	1	X	X	Height - 1				Width - 1			
LOAD FONT ADDRESS	EXEC	LFA	1	1	0	0	0	0			Character Start Address							
BLOCK TRANSFER	ALL	BXF	1	0	0	1	1	0	Byte Count									
CLEAR SYSTEM	EXEC	CLS	1	1	1	1	1	1	X	X	X	X	X	X	X	X	X	X
LOAD DATA	ALL	LDD	1	0	0	0	0	0	X	X	Data Byte							
LOAD X	ALL	LDX	1	1	0	1	1	0	X	X	Address							
LOAD Y	ALL	LDY	1	1	0	1	1	1	X	Y	Address							

*See text for code assignments

X = Don't care.

FIGURE 1

COMMAND SUMMARY