STC-TSQ11
Tape Cartridge Drive Controller Manual

Σ Sigma Information Systems

STC-TSQ11
Tape Cartridge Drive Controller Manual

ANAHEIM, CALIFORNIA - JULY 1987

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Section 1 - General Information

1.1 INTRODUCTION

This manual provides the necessary information to install and operate the STC-TSQ11 tape cartridge controller manufactured by Sigma Information Systems, Anaheim, California.

The material in this manual is arranged into the following sections:

Section 1 - GENERAL INFORMATION. This section contains a brief general description of the STC-TSQ11. Features and specifications are included for the controller.

Section 2 - INSTALLATION. This section describes the switch and jumper selections necessary to configure the STC-TSQ11.

Section 3 - PROGRAMMING CONSIDERATIONS. This section defines the register formats and describes the command codes for the STC-TSQ11. Command packet definitions are included.

Section 4 - APPLICATION NOTES. This section provides examples for operating the STC-TSQ11. Bootstrap programs and system software commands are included.

Appendices - APPENDIX A contains a brief description of the STC-TSQ11 register formats and APPENDIX B provides a complete list of address switch settings.

1 2 GENERAL DESCRIPTION

The STC-TSQ11 dual-wide controller interfaces a QIC 2 cartridge tape drive to the *DEC Q-bus range of computer systems. The STC-TSQ11 emulates DEC's TSV05/TS11 1/2" magnetic tape controller and is compatible with operating systems designed for the DEC subsystem.

Sigma's controller, when coupled with any QIC 2 cartridge tape unit, yields a low cost, effective mass storage tape subsystem that is ideally suited for winchester disk drive backup. The STC-TSQ11 also can control a streaming 1/4 inch tape drive for file oriented transfers. Thus, the product can be used to exchange files between computer systems using low cost, durable media, and for producing bootable tapes. This is ideal for software distribution as well as diagnostic or support purposes.

Data is stored on industry standard cartridge with up to 60MBs of storage When data is transferred to the tape in a file structured mode, the operating system defines a small block length (512 bytes) and inserts file marks, thereby reducing tape capacity.

1 3 FEATURES

The STC-TSQ11 controller is designed to provide compatibility with the DEC TS11 tape subsystem. When using the Kennedy 6500, or equivalent 1/4" streaming drive, the STC-TSQ11 has the following features:

- Provides compact, high capacity backup for LSI-11 systems.
- Compatible with TS11/TSV05 software.
- Operates in streaming or start/stop modes while performing file-by-file operations.
- Maximum throughput is ensured with an on-board 8K byte data buffer and block mode DMA (direct memory access).
- Streams at 1 MB per 12 seconds.
- Stores up to 60 MBs of data per cartridge (DC 600A).
- Includes on-board boot function.
- LSI-11 compatibility supports full 22-bit addressing and DMA transfers.

*DEC and Q bus are registered trademarks of Digital Equipment Corporation

1.4 SPECIFICATIONS

Power Requirements:	+5V @ 3.5 amps
Device Address:	17772520 standard with switch selectable alternates from 17760000 to 7777760 in octal 20 increments
Interrupt Vector:	224 (octal) standard with switch selectable alternate at 204
Priority Level:	Level 4
Booting:	Via MS boot commands or internal boot
Operating System:	Compatible with RT11, RSX11M, RSTS/E, UNIX, TSX+
Media:	Compatible with ANSI standard *3M or equivalent tape cartridges: e.g., 450 foot DC300XLP or 600 foot DC600A.
Cabling:	Requires standard 50-conductor ribbon cable (not included) to tape cartridge drive
Dimensions:	Standard dual-wide Q bus module
Installation:	Plugs directly into any Q bus backplane slot
Temperature	
Operating:	5°C to 45°C
Storage:	-16°C to 60°C
Humidity:	10% t 95% noncondensing

**3M is a registered trademark of Minnesota Mining and Manufacturing Company.

NOTES

Section 2 - Installation

2.1 UNPACKING AND INSPECTION

The STC-TSQ11 is shipped in a special packing carton designed to keep the module from vibrating and to give it maximum protection during shipment. The packing carton should be retained in case the unit requires reshipment.

Unpack the STC-TSQ11 and visually inspect for physical damage. If any damage has occurred, contact the factory immediately.

2.2 FACTORY CONFIGURATIONS

The STC-TSQ11 is shipped with switch and jumper configurations as shown in Figure 2-1. Verify that these configurations are correct. If other configurations are required, refer to the appropriate paragraphs in this section.

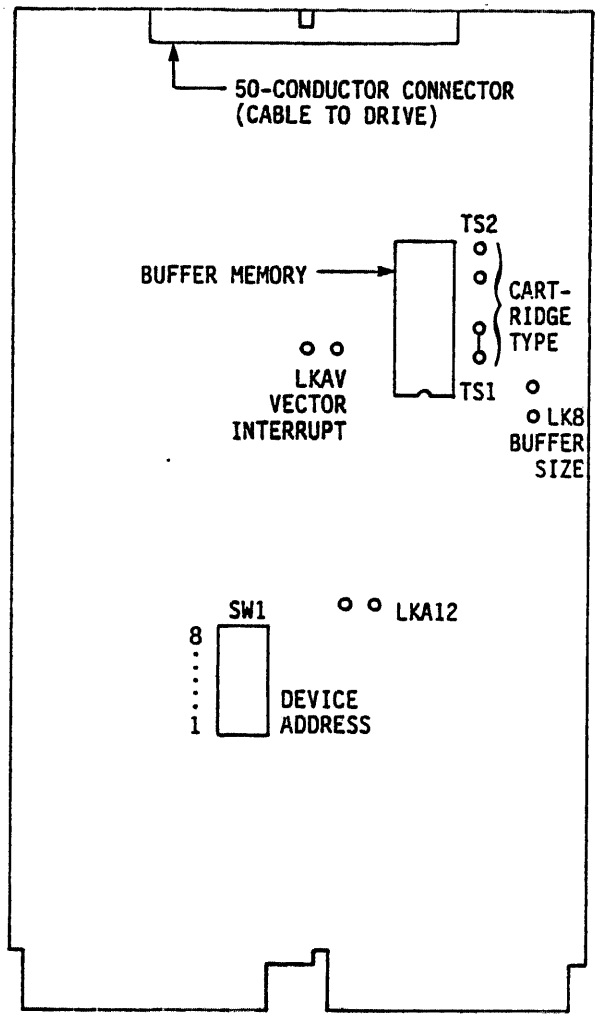


FIGURE 2-1: FACTORY CONFIGURATION

2.3 DEVICE ADDRESSING

The device address is determined by setting switch SW1 and by installing or removing jumper A12 to determine address bits A00 through A15. Address selection is shown in Figure 2-2. Notice that A15 through A13 and A03 through A00 are fixed, and A12 (the most significant bit) is set by jumper A12.

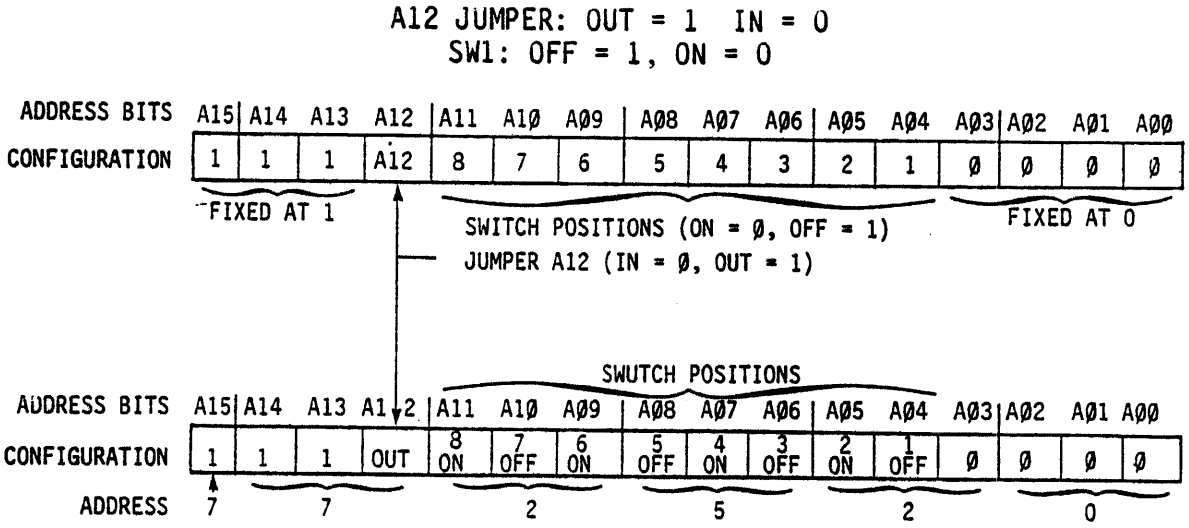


FIGURE 2-2: DEVICE ADDRESS SELECTION

A complete table of address configurations is listed in Appendix B.

2 4 INTERRUPT VECTOR SELECTION

The interrupt vector generated by the STC-TSQ11 is factory set to 224 (octal). An optional vector at 204 is selected by installing jumper AV Figure 2-1) as shown in Table 2-1.

INTERRUPT VECTOR	JUMPER AV
224	OUT
204	IN

TABLE 2-1: INTERRUPT VECTOR SELECTION

2 5 CARTRIDGE TYPE

The STC-TSQ11 has jumpers in order to accommodate different tape lengths (i e , capacities) without pre-recording the tape. Cartridge type (450 foot DC 300XL or 600 foot DC600A) are defined by jumpers TS1 and TS2 as shown in Table 2-2.

TS1	TS2	CARTRIDGE TYPE	ABSOLUTE CAPACITY
IN	IN	DC 600 XTD	144 MBytes Archive 2150 (18 tracks)
OUT	IN	DC 300 XL	42 MBytes 9 track drive
IN	OUT	DC 600 A	59 MBytes 9 track drive
OUT	OUT	DC 600 A	118 MBytes 15 track drive

TABLE 2-2: CARTRIDGE TYPE SELECTION

2.6 BUFFER SIZE

The STC-TSQ11 has an 8K buffer memory. Special applications requiring 16K or 32K buffer memory can be implemented when jumper LK8 is installed. Consult the factory if an upgraded memory buffer is required.

2.7 INSTALLATION INTO THE SYSTEM

The STC-TSQ11 is a dual-wide controller module that installs directly into any LSI-11 backplane. A 50-conductor connector requires a ribbon cable to interface the controller to a cartridge tape drive.

Section 3 - Programming Considerations

3.1 INTRODUCTION

The functions listed below are compatible with the TSV05 and make up the STC-TSQ11 Command Set. These commands utilize "command packets" stored in the computer system memory to operate the tape drive and transfer data. Some commands have various sub-commands, termed "modes." The interface device registers are used to initiate command packet processing and retrieve basic status. This section describes register manipulation and provides an overview of packet protocol (the format used to transfer commands and data).

3.2 REGISTERS

The STC-TSQ11 uses the four TSV05 device registers which occupy only two LSI-11 bus word locations: a Data Buffer (TSDB), a Bus Address Register (TSBA), a Status Register (TSSR) and an Extended Data Buffer (TSDBX).

Data Buffer (TSDB)

The TSDB is an 18-bit register that is parallel loaded from the LSI-11 bus or from the STC-TSQ11 controller itself. A 16-bit portion of this register is used as a word buffer register. It is written into by the CPU to initiate and operate, and it is written into by the controller logic itself to store data to be transmitted to LSI-11 bus memory during a DMA cycle.

Bus Address Register (TSBA)

The TSBA is an 18-bit register (22-bits when the high byte of the TSSR is written to) that is parallel loaded from the TSDB every time the TSDB is loaded. TSDB bits 15-02 load into TSBA bits 15-02, TSDB bits 1 and 0 load into TSBA bits 17 and 16, and zeroes are modulo-4 address. TSBA bits 17 and 16 are displayed in TSSR bits 09 and 08, respectively. TSDB can be extended to 22 bits by first loading TSDB bits 18-22 into the high byte of TSSR. The extended feature switch must be ON or else bits 18-22 are ignored. The TSBA register is incremented or decremented by two for DMA word transfers, or by one for DMA byte transfers.

Status Register (TSSR)

The TSSR is a 16 bit register that can only be updated from the STC-TSQ11 internal logic.

Extended Data Buffer (TSDBX)

The TSDBX is a Write-Only hardware byte register located at the fourth byte address of the I/O register block. This address corresponds to the high-order byte of the TSSR register. The TSDBX is used to specify the most significant four bits of a 22-bit command pointer address, and also to allow an automatic tape boot sequence to be performed.

3.2.1 Bus Address Register (TSBA) - READ ONLY

The Bus Address Register (TSBA) is a Read-Only hardware register located at the first I/O register address. In normal operating mode, it displays the low-order 16 bits of the memory address used by the controller to access system main memory. In Maintenance Mode, it displays data from the Wraparound tests invoked by writing into TSDB.

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
A15	A14	A13	A12	A11	A10	A09	A08	A07	A06	A05	A04	A03	A02	A01	A00

Address Bits 15 through 00 normally reflect the low-order 16 bits of the 22-bit address used by the controller to access LSI-11 bus memory. They can be loaded by:

1. The CPU writing a word into TSDB to define the address of the Command Buffer for the next operation. TSDB 15:02 are copied into TSBA 15:02, and TSBA 01:00 are set to 0.

2. The CPU writing into the high byte (DATOB) of TSDB (for a maintenance function). TSDB bits 15-08 are copied into both bytes of TSBA. Data for bits 07-00 is TSDB 15:08. TSDB bits 08 and 09 are copied into TSSR bits 08 and 09 (A16,A17).

3. The CPU writing into the low byte (DATOB) of TSDB (for a maintenance function). TSDB bits 07-00 are copied to TSBA 07:00. TSBA 15:08 is then loaded from TSDB bits 07:00.

4. The CPU writing a word (DATO) into TSDB in Maintenance Mode. (Maintenance mode is achieved as a result of 2 or 3.)

5. The STC-TSQ11 controller specifying bits 15-00 of a DMA address. TSBA is not modified by Initiliaze.

3.2.2 Data Buffer (TSDB) - WRITE ONLY

The TSDB is, externally, a 16-bit Write-Only register that is parallel loaded from the LSI-11 Bus. Internally, it is a 22-bit register. It can be loaded from the CPU by four different types of transfers. Two transfers are for maintenance purposes (DATOB to high byte and DATOB to low byte); these place the controller into Maintenance Mode, which can be cleared only by an Initialize, and causes the internal "Data Wraparound" functions. The third is for maintenance purposes (DATO word when in Maintenance Mode.) The fourth is for normal operation (DATO word when not in Maintenance Mode) to specify a Command Pointer. The 4-bit extension to TSDB is written at the high byte of the TSSR location.

The STC-TSQ11 controller will respond whenever the TSDB location is written to, but will be loaded only when the SSR bit in the TSSR register is set; if SSR is clear, the RMR bit in TSSR will be set. Writing into TSDB clears SSR. After a DATO or DATOB to TSDB (for maintenance data "wraparound"), SSR momentarily clears then sets when the data "wraparound" has been performed. An Initialize should be performed (i.e., write into TSSR) in order to use the controller again for normal operation. Note that entering Maintenance Mode (by performing a DATOB to either byte of the TSDB) causes the NBA (Need Buffer Address) bit in TSSR to be set and automatic running of the ideal-time On-Line Microdiagnostics to be inhibited.

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
P15	P14	P13	P12	P11	P10	P09	P08	P07	P06	P05	P04	P03	P02	P17	P16

DATA BUFFER FORMAT (TSDB) - COMMAND POINTER

BIT	SIGNAL	DESCRIPTION
15-02 01-00	P15:P02 P17:P16	COMMAND POINTER BITS 17-02. When the TSDB is written as a word, and SSR = 1, and the controller is not in Maintenance Mode, the data is loaded into bits 17-02 of both the TSBA Output File register (for reading onto the LSI-11 bus) and into an internal TSBA register and command processing commences. TSBA bits 01-00 are cleared to 0 (modulo-4 address). In addition, the Extended TSDB Register (TSDBX) is loaded into TSBA bits 21-18; TSDBX must be loaded before TSDB.

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
A15	A14	A13	A12	A11	A10	A09	A08	A07	A06	A05	A04	A03	A02	A01	A00

DATA BUFFER FORMAT (TSDB) - MAINTENANCE MODE

BIT	SIGNAL	DESCRIPTION
15-08	M15:M08	MAINTENANCE DATA BITS 15-08. For wraparound to TSBA. If the wraparound is correct, M15:M08 appears in both bytes of TSBA. A DATOB to TSDB places the controller into maintenance mode. NOTE: DATOB to high byte.
07-00	M07:M00	MAINTENANCE DATA BITS 07-00. For wraparound to TSBA. If the wraparound is correct. M07:M00 appears in both TSBA 07:00 and in TSBA 15:08. A DATOB to TSDB places the controller into maintenance mode. NOTE: DATOB to Low Byte
15-00	M15:M00	MAINTENANCE DATA BIT 15:00. This function can be used for specifying the address used in the Low-Byte Data Wrap test. Bits 15-12 are reserved for future maintenance functions and should be written to 0. NOTE: DATO Word in Maintenance Mode.

3.2.3 Status Register (TSSR) - READ/WRITE

The TSSR is a 16-bit register. Although defined as a Read/Write register its contents cannot be modified by the LSI-11 bus. It can be read to examine status, but writing into it initializes the controller. A DATOB to the high byte of the TSSR, however, loads the extended TSDBX. The contents of the register are modified by the controller. If the initialize diagnostic fails, this register has alternate bit definitions.

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
SC	///		SCE	RMR	NXM	NBA	A17	A16	SSR	OFL	FC1	FC0	TC2	TC1	TC0

BIT	NAME	DESCRIPTION
15	SC	SPECIAL CONDITION. When set, indicates that either an error was detected or an exception condition (Tape Mark on Read, Reverse Motion at BOT, etc.) occurred. Also set by error bits in TSSR (RMR and NXM). Indicates that the Termination Class bits are nonzero (unless RMR is the only error). Cleared by Initialize unless a self-test error is detected, in which case SC is set.
14	-	Not used.
13	SCE	SANITY CHECK ERROR. Set when the controller detects an internal failure, which is serious enough to inhibit transmission of a Message Buffer.
12	RMR	REGISTER MODIFICATION REFUSED. Set when the TSDB is written from the LSI-11 bus and Subsystem Ready (SSR) is not set. Causes the Special Condition (SC) bit to be set but no Termination Class because RMR can be set if TSDB is written while an ATTN message is being output. If ATTN is not enabled, RMR setting indicates a fatal controller problem or a software bug.
11	NXM	NONEXISTENT MEMORY. Set when trying a DMA transfer to/from a memory location that does not exist (no response in 12 usec). May occur when fetching a Command Packet, fetching/storing data, or storing a Message Packet. Can cause termination Class Codes 4 and 5 (bits 03-01).
10	NBA	NEED BUFFER ADDRESS. When set, indicates that a Message Buffer address is needed. Set by Initialize and by performing DATOB to TSDB (i.e., to enter Maintenance Mode). Cleared during Write Characteristics command with a valid address. If NBA=1, any command other than Write Characteristics terminates the operation with Function Reject.

09-08 A17:A16 ADDRESS BITS 17-16. Displays bits 17 and 16 of the TSBA register that holds a Command Pointer or DMA address. Loaded from TSDB bits 01-00 when TSDB is written.

07 SSR SUB-SYSTEM READY. When set, indicates that the controller is not busy and is ready to accept new command pointer. Cleared by writing TSDB. Also cleared by Initialize, then set by the controller if the basic microdiagnostics are successfully passed.

06 OFL OFF-LINE. When set, indicates that the transport is off-line and unavailable for any tape motion commands. This bit does not indicate the current status of the Tape transport (updated on command completions). Can cause termination Class Codes 1 and 3 (bits 03-01).

05-04 FC1:FC0 FATAL TERMINATION CLASS CODE. Used to indicate the type of fatal error which has occurred. The code is valid only when the SC bit is set and the Termination Class Code (TC) bits are all set (111); they are clear otherwise. Can cause termination Class Code 7 (bits 03-01). The FC codes are:

0 Internal diagnostic failure.
See the Error Code byte (XST3) for the failed function. Initialize must be issued for the controller to accept further commands.
1 Reserved
2 Not used
3 Reserved

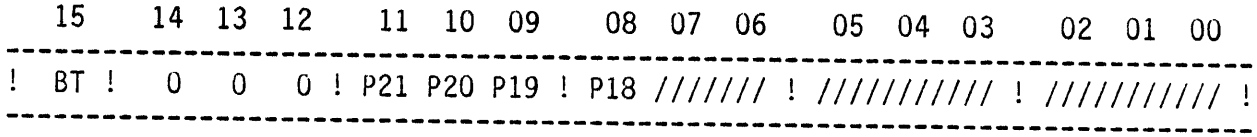
03-01 TC2:TC0 TERMINATION CLASS CODE. This 3-bit field acts as a word offset value whenever an error or exception condition occurs on a command. Each of the 8 possible values of this field represents a class of errors or exceptions. The conditions in each class have similar significance and recovery procedures (as applicable). The codes are:

0 Normal Termination
1 Attention Condition
2 Tape Status Alert
3 Function reject
4 Recoverable Error - tape position is one record down tape from start of function.
5 Recoverable Error - tape not moved
6 Unrecoverable Error - tape position lost
7 Fatal Controller Error - see Fatal Termination Class Codes (bits 05-04)
0 Not used

3.2.4 Extended Data Buffer (TSDBX) - WRITE ONLY

The Extended Data Buffer Register (TSDBX) is a Write-Only hardware byte register located at the fourth byte address of the STC-TSQ11 1/0 register block. This address corresponds to the high order byte of the TSSR register. The TSDBX is used to specify the most significant four bits of a 22-bit command pointer address, and also to allow an automatic tape boot sequence to be performed. TSDBX can be written only by a byte-access (DATOB) cycle addressed to the high byte of TSSR.

Once written, the contents of the least significant four bits of TSDBX are transferred to bits 18 through 21 of the internal TSBA (Bus Address) register for use as a command pointer. The low order 18 bits of the command pointer are specified by writing into the TSDB register, which starts operation and then clears TSDBX. Therefore, a subsequent load of the TSDB only will specify a 22-bit command pointer address with the high-order four bits equal to zero. For the TSDBX register to be properly written, the SSR (Subsystem Ready) bit in TSSR must be set. If it is not, the RMR (Register Modification Refused) bit will be set and no modification to TSDBX will occur. When the TSDBX is written, the SSR bit is not cleared. Therefore, RMR should be checked before TSDB is written. Writing the TSDB will begin processing on TSDBX. If the Boot bit is not set, the command pointer to the 22-bit TSDB will be retrieved, and command processing will begin. If the Boot bit is set, SSR will remain clear until the boot sequence is complete or until an error occurs.



BIT	NAME	DESCRIPTION
15	BT	BOOT COMMAND BIT. When written to 1, with SSR=1, causes the tape to be rewound to BOT, the first tape record to be skipped, and the second record (only the first 512 bytes of it) to be loaded into CPU memory space starting at location 0.
14-12	-	RESERVED. Should always be written as 0.
11-08	P21:P18	COMMAND POINTER BITS 21-18. When the TSDBX is written, and SSR=1, the data is loaded into bits 21-18 of the internal TSBA register. TSDBX is cleared after TSDB is written and is also cleared by Initialize.

3.2.5 Extended Status Register 0 (XST0)

The Extended Status Register 0(XST0) appears as the fourth word in the Message Buffer stored by the STC-TSQ11 upon completion of a command or an Attention (ATTN).

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
TMK	RLS	LET	RLL	WLE	NEF	ILC	ILA	MOT	ONL	IE	VCK	PED	WLK	BOT	EOT

BIT	NAME	CODE DESCRIPTION
15	TMK	TAPE MARK DETECTED. Set whenever a Tape Mark is detected during a Read, Space, or Skip command, and also as a result of the Write Tape Mark or Write Tape Mark Retry commands. Can cause termination Class Code 2 (TSSR bits 03-01).
14	RLS	RECORD LENGTH SHORT. This bit indicates that either the record length was shorter than the byte count on Read operations, a Space Record operation encountered a tape mark or BOT before the position count was exhausted, or a Skip Tape Marks command was terminated by encountering BOT or a double tape mark (if that operational mode is enabled, see LET) prior to exhausting the position counter. Can cause termination Class Code 2 (TSSR bits 03-01).
13	LET	LOGICAL END OF TAPE. Set only on the Skip Tape Marks command when either two contiguous tape marks are detected, or when moving off of BOT and the first record encountered is a tape mark. The setting of this bit does not occur unless this mode of termination is enabled through use of the Write Characteristics command. Can cause termination Class Code 2 (TSSR bits 03-01).
12	RLL	RECORD LENGTH LONG. When set, indicates that the record read on a Read was longer than the byte count specified. Can cause termination Class Code 2 (TSSR bits 03-01).
11	WLE	WRITE LOCK ERROR. When set, indicates a write operation was issued but the tape does not contain a write enable ring. Can cause termination Class Codes 3 and 6 (TSSR bits 03-01).
10	NEF	NON-EXECUTABLE FUNCTION. When set, indicates that a command was not be executed for one of the following conditions: The command specified reverse tape direction but the tape was already at BOT. Any motion command when the Volume Check bit is set.

Any write command when the tape does not contain a write enable ring (also causes write Lock Status - WLE).

Can cause termination Class Code 3 (TSSR bits 03-01).

09 ILC ILLEGAL COMMAND. Set when a command is issued and a Command field contains codes which are not supported. Can cause termination Class Code 3 (TSSR bits 03-01).

08 ILA ILLEGAL ADDRESS. Set when a command specifies an address more than 22 bits, or an odd address when an even one is required. Can cause termination Class Code 3 (TSSR bits 03-01).

07 MOT MOTION. Tape is moving. Indicates that the transport is asserting Formatter Busy or Rewinding status.

06 ONL ON LINE. When set, indicates that the transport is on-line and operable. A change in this bit can cause a Termination Class 1 if ATTENTIONS are enabled. If ONL is clear and a motion command is issued, it can cause a Termination Class 3. See TSSR bits 03-01.

05 IE INTERRUPT ENABLE. Reflects the state of Interrupt Enable bit supplied on the last command.

04 VCK VOLUME CHECK. When set, indicates that the transport has been either powered down or is off-line. Cleared by the Clear Volume Check (CVC) bit in the Command Headed word. This bit can cause a Termination Class of 3.

03 PED PHASE-ENCODED DRIVE. Always Set. Indicates that the transport is capable of reading and writing only phase encoded data.

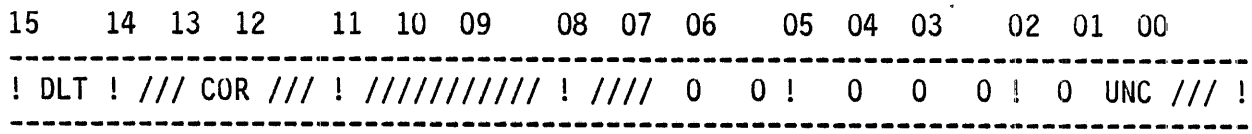
02 WLK WRITE LOCKED. When set, indicates that the tape does not have a write enable ring installed (tape is write protected). Can cause termination Class Code 3 (TSSR bits 03-01).

01 BOT BEGINNING OF TAPE. When set, indicates that the tape is positioned at the load point as denoted by the BOT reflective strip on the tape. Can cause termination Class Code 3 (TSSR bits 03-01).

00 EOT END OF TAPE. This bit is set whenever the tape is positioned at or beyond the End of Tape reflective strip. Does not reset until the tape passes over the strip in the reverse direction under program control. If the controller is read buffering (pre-reading records from tape automatically) and the EOT strip is seen, this will not be sent until the program actually requests the record associated with the EOT. Can cause termination Class Code 2 (TSSR bits 03-01).

3.2.6 Extended Status Register 1 (XST1)

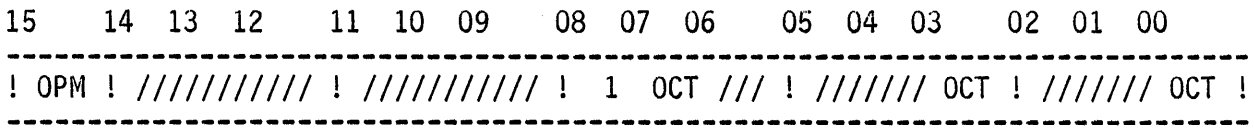
The Extended Status register 1 (XST1) appears as the fifth word in the Message Buffer stored by the STC-TSQ11 upon completion of a command or on an Attention (ATTN).



BIT	NAME	DESCRIPTION
15	DLT	DATA LATE. Always zero. Can cause termination Class Code 4 (TSSR bits 03-01).
14	-	Not used.
13	COR	CORRECTED ERROR. Always zero. Can cause termination Class Code 4 (TSSR bits 03-01).
12-08	-	Not used.
07-02		Always set to 0
01	UNC	UNCORRECTABLE DATA OR HARD ERROR. Set in response to the transport asserting Hard Error, during a read or write to indicate that one of the following has occurred: False preamble detection False postamble detection Multichannel dropout Parity error without associated channel dropouts (could result from bad write Data Interface circuit in the controller) Loss of data envelope prior to postamble detection Excessive skew Can cause termination Class Code 4 (TSSR bits 03-01).
00	-	Not Used.

3.2.7 Extended Status Register 2 (XST2)

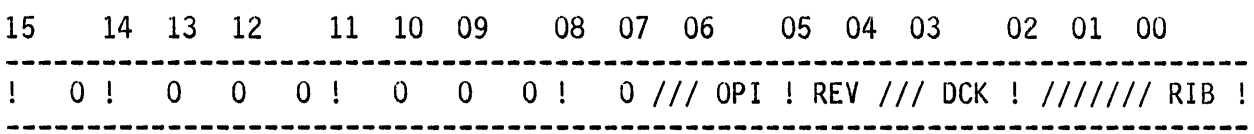
The Extended Status Register 2 (XST2) appears as the sixth word in the Message Buffer stored by the STC-TSQ11 upon completion of a command or on an Attention (ATTN).



BIT	NAME	DESCRIPTION
15	OPM	OPERATION IN PROGRESS. Indicates tape has moved.
14-09	-	Not used.
08,03,00	OCT	OCTAL 211. Always set after Set Characteristics Command.
07,06-04 02,01	-	Not used.

3.2.8 Extended Status Register 3 (XST3)

Extended Status Register 3 appears as the seventh word in the Message Buffer upon completion of a command or on an Attention (ATTN).



BIT	CODE	DESCRIPTION
15-08	-	Not used. Always zeros.
07	-	Not used.
06	OPI	OPERATION INCOMPLETE. Set when Read, Space, or Skip operation has moved about 25 feet of tape without detecting any data of the tape.

05	REV	REVERSE. Set when the current operation caused reverse tape motion (includes the Retry commands as well as simple reverse Read, space, etc.). Cleared when operation is forward or rewind.
04	-	Not used.
03	DCK	DENSITY CHECK. Set when a PE identification Burst (IDB) is not detected while moving off of BOT. A Read, Space of Skip will complete (if no other errors occur) to allow tapes with the IDB wrong to be read.
02-01	-	Not used.
00	RIB	REVERSE INTO BOT. When set, indicates that a Read, Space, Skip or Retry command already in progress has encountered the BOT marker when moving tape in the reverse direction. Tape motion is halted at BOT.

3.2.9 Extended Status Register 4 (XST4)

Extended Status Register 4 (XST4) appears as the eighth word in the Message Buffer upon completion of a command or on Attention (ATTN).

The STC-TSQ11 does not use the XST4. Bits 15-00 are always zeros.

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

3.3 COMMAND PACKET DEFINITIONS

Table 3-1 lists the Command Set for the STC-TSQ11.

COMMAND	DESCRIPTION
GET STATUS	Get Status (update the Extended Status registers in the message buffer in memory)
READ	Read Next (Forward)
WRITE	Write Next (Forward)
FORMAT	Write Tape Mark
CONTROL	Message Buffer Release Rewind and Unload Clean Tape (handle as a NO-OP) Rewind with Immediate Interrupt
INITIALIZE	Controller/Drive Initialize
SET CHARACTERISTICS	Load Message Buffer Address and Set Device Characteristics
POSITION	Space Records Forward Skip Tape Marks Forward Skip Tape Marks Reverse Rewind

TABLE 3-1: ASSIGNED COMMAND SET FOR STC-TSQ11

The CPU issues a command to the STC-TSQ11 by first building a Command Packet in CPU memory space (on a modulo-4 address boundary) then writing the address of the packet into the STC-TSQ11 TSDB hardware register. The address written is the Command Pointer. If the STC-TSQ11 is ready to accept a command, writing of the Command Pointer initiates command processing, in which the controller fetches the Command Packet and executes the command encoded within the packet.

Logically, a Command Packet can be composed of one, two, three, or four 16-Bit words, depending upon the type of command and the amount of information it needs to proceed with execution. The following paragraphs describe each command in detail and its specific Command Packet format.

Certain bits of the Header Word and other words within the Command Packet are not defined for all commands. When building the Command Packet, the software should set these undefined bits to zero. If any bit is undefined or reserved with respect to a particular command and the bit is not zero, the command will not be executed and will be terminated with a Function Reject (See TSSR bits 03-01 - Termination Class 3).

The header (Word 1) of the command packet for the commands listed in Table 3-1 is shown below.

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
WORD 1	ACK	CVC	OPP	SWB	--COMMAND MODE--			IE	HDR TYPE		----COMMAND CODE----					

BIT	NAME	FUNCTION
15	ACK	ACKNOWLEDGE. This bit is set for issuing a command when the CPU owns the Message Buffer. Informs the STC-TSQ11 that the Message Buffer is available for message packets. This passes ownership of the Message Buffer to the STC-TSQ11. If the CPU has released ownership of the Message Buffer to the STC-TSQ11 for Attentions and has not yet received an ATTN message, this bit should be 0.

Bits 14 through 12 are dependent on the command packets described in paragraphs 3.3.1 through 3.3.8.

BIT	NAME	DESCRIPTION
14	CVC	CLEAR VOLUME CHECK. When set, causes the Volume Check condition. Set when the transport is cleared to go from Off-Line to On-Line, allowing tape operations to be executed on the transport.
13	OPP	OPPOSITE. When set, reverses execution sequence of reread commands (e.g. Reread Next, Previous)
12	SWB	SWAP BYTES. When set, instructs the STC-TSQ11 to alter the sequence of storing and retrieving tape data bytes from CPU memory. When SWB=0 (DEC protocol), the 1st byte in a word is the least significant byte (bits 7-0). When SWB=1 (industry standard protocol) the first byte of a word is to be bits 15 through 8.

11-08 COMMAND MODE Extension field to Command Code field. Allows further specification of device commands. (Table 3-2)

07 IE Interrupt Enable. 0 = Disable, 1 = Enable

06,05 HDR TYPE HEADER TYPE. Defines header type. Must be zero (1-word header).

04-00 COMMAND CODE Defines major command category. Used with Command Mode field to specify the command. See Table 3-2.

COMMAND CODE	COMMAND NAME	COMMAND MODE	MODE NAME
00001	READ	0000	Read Next (Forward)
00100	SET CHARACTERISTICS	0000	Load Message Buffer address and set device characteristics
00101	WRITE	0000	Write Data (Next)
00110	WRITE SUBSYSTEMS	0000	Enter Maintenance Mode and load test functions into memory (diagnostic use only - not for normal programming operations)
01000	POSITION	*0000	Space Records Forward
		*0001	Space Records Reverse
		*0010	Skip Tape Marks Forward
		*0011	Skip Tape Marks Reverse
		*0100	Rewind
01001	FORMAT	*0000	Write Tape Mark
		*0001	Erase
01010	CONTROL	*0000	Message Buffer Release
		*0001	Rewind and Unload
		*0010	Clean Tape function
		*0100	Rewind with Immediate interrupt
01011	INITIALIZE	*0000	Controller/Drive Initialize
01111	GET STATUS	*0000	Get Status (output END status message)

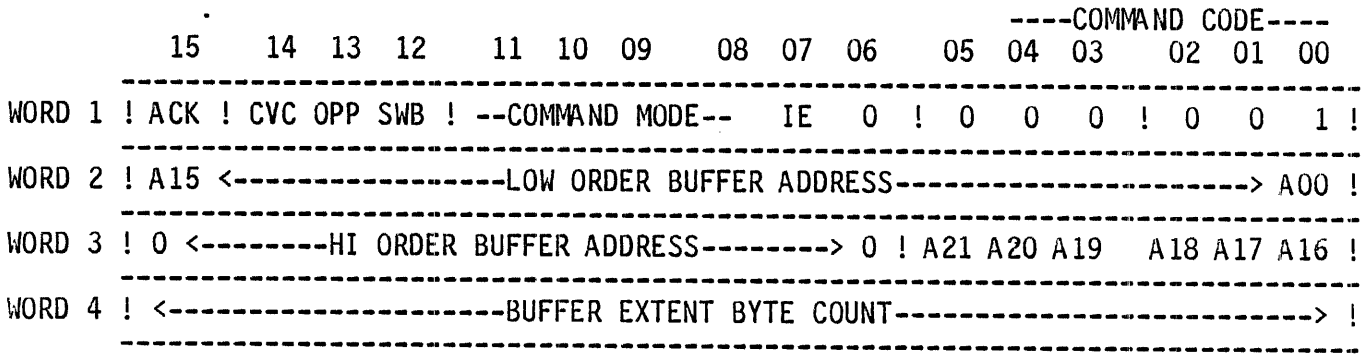
*1-word Command Packet

TABLE 3-2: COMMAND CODE AND MODE

3.3.1 Read Command Packet (Command Code 00001)

The command packet for a Read is shown below. The four normal modes of operation include two modes (Reread Previous and Next) that are further controlled by the OPP bit in the packet header word.

COMMAND MODE	DESCRIPTION
0000	Read Next (Forward)
0001	Read Previous (Reverse)
0010	Reread Previous
OPP = 0	Space Reverse, Read Forward
OPP = 1	Read Reverse, Space Forward
0011	Reread Next
OPP = 0	Space forward, Read Reverse
OPP = 1	Read Forward, Space Reverse



Word 1 is the Header Word (Section 3.3). Word 2 and Word 3 specify the address of the data buffer in CPU memory space where the data read from tape is to be deposited. Notice that Word 3 bits 15-06 must be zero; if not all zeros, the command is aborted with Function Reject termination with Illegal Address (ILA) error status. Word 3 specifies the number of bytes expected in the tape record to be read. A byte count of 0 specifies that 65,536 (64K) bytes are expected.

3.3.2 Set Characteristics Command Packet (Command Code 001000)

The Set Characteristics Command Packet defines the location and size of the message buffer in the CPU memory and some specific controls for executing other commands. When done, this command clears the Need Buffer Address (NBA) in TSSR. If the command is rejected because an illegal address was specified, NBA will be set.

		---COMMAND MODE---										----COMMAND CODE----					
	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
WORD 1	ACK	CVC	0	0	0	0	0	0	IE	0	0	0	0	1	0	0
WORD 2	A15	<---------- LOW-ORDER CHARACTERISTIC DATA ADDRESS ---------->														A00
WORD 3	0	<-HI ORDER CHARACTERISTICS DATA ADDRESS->						0	A21	A20	A19	A18	A17	A16		
WORD 4	<----------BUFFER BYTE COUNT---------->															

Word 1 is the header word (section 3.3). Words 2 and 3 define the address of the characteristics data buffer, which must reside on an even address boundary in CPU memory. Notice that Word 3 bits 15-06 must be zeros. Word 4 specifies the number of bytes of the data buffer, which must be at least a count of 6 to allow the first three characteristic data words to be fetched. If byte count is less than 7, Word 1 will not be fetched, and the current values of the Characteristic Mode bits stored in the controller are retained.

The Set Characteristics Data format is shown below.

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
WORD 1	A15	<----------LOW ORDER MESSAGE BUFFER ADDRESS---------->														A00
WORD 2	0	<----HI ORDER MESSAGE BUFFER ADDRESS---->						0	A21	A20	A19	A18	A17	A16		
WORD 3	<---------LENGTH OF MESSAGE BUFFER (AT LEAST 16 BYTES LONG)---------->															
WORD 4	0	<-------MUST BE ZEROS-------->						0	ESS	ENB	EAI	ERI	0	0	0	0

NAME	FUNCTION
ERI	ENABLE MESSAGE BUFFER RELEASE INTERRUPTS to the CPU. If this bit is 0, interrupts will not be generated when a Message Buffer Release command is received by the coupler; only Subsystem Ready (SSR) will be reasserted. If this bit is 1, an interrupt will be generated.

EAI ENABLE ATTENTION INTERRUPTS. When this bit is 0, attention conditions such as offline and online will not result in interrupt to the CPU. If this bit is 1, interrupts will be generated once the coupler owns the message buffer.

ENB ENABLE SKIP TAPE MARKS STOP AT BOT. This bit is meaningful only if the ESS bit is set. If the drive is at BOT when a Skip Tape Marks command is issued and the first record seen is a tape mark, then the transport will set LED (XSTAT0) and stop after the first tape mark. If ENB is clear, the drive will not set LET but just count the tape mark and continue.

ESS ENABLE SKIP TAPE MARKS STOP. When set, the transport stops during a Skip Tape Mark command when a double tape mark (two contiguous tape marks) is detected. If cleared, the Skip Tape Marks command will terminate only on Tape Mark Count Exhausted or if BOT is detected.

3.3.3 Write Command Packet (Command Code 00101)

The Write Command Packet is shown below.

		---COMMAND MODE---											----COMMAND CODE----					
		15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
WORD 1	!	ACK	CVC	0	SWB	0	0	0	0	IE	0	0	0	0	1	0	1
WORD 2	!	A15 <----------LOW ORDER BUFFER ADDRESS----------> A00															
WORD 3	!	0 <--------HI ORDER BUFFER ADDRESS--------> 0											A21	A20	A19	A18	A17	A16
WORD 4	!	<----------BUFFER EXTENT BYTE COUNT---------->																

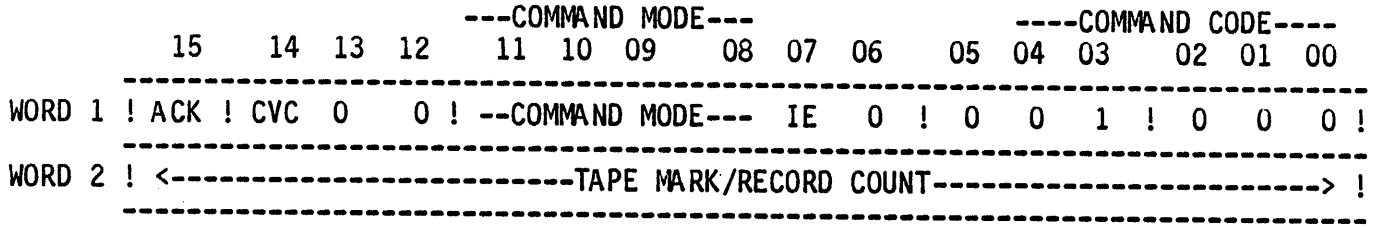
Word 1 is the Command Packet Header (Section 3.3). Words 2 and 3 specify the address of the data buffer in the CPU memory space where the data to be written onto tape is stored. Notice that Word 3 bits 15-06 must be zero or the command will be aborted with Function Reject termination with Illegal Address (ILA) error status. Word 4 defines the number of bytes available in the data buffer and the number of bytes to be written onto tape. A byte count of 0 specifies that 65,536 (64K) bytes are to be written.

If a Write command is executed at or beyond the EOT marker, the data will be written by a Tape Status Alert (TSA) termination will occur. EOT will remain set until passed in the reverse direction.

3.3.4 Position Command Packet (Command Code 01000)

This command causes the tape to space records forward or reverse, skip tape marks forward or reverse, or to rewind to BOT. There are four Command Modes for the Position Command Packet shown below.

COMMAND MODE	FUNCTION
0000	Space Records Forward
0001	Space Records Reverse
0010	Skip Tape Marks Forward
0011	Skip Tape Marks Reverse
0100	Rewind (Record Count Ignored)



Word 1 is the Command Packet Header (Section 3.3). Word 2 is a 16-bit positive integer that specifies the mark/record count. Word 2 must be exact for Skip Tape Mark and Space Record command modes.

A Space Records operation automatically terminates when a tape mark is traversed. Record Length Short (RLS) is also set if record count was not decremented to zero.

A Skip Tape Marks command terminates when it encounters a double tape mark and the Enable Skip Stop mode is specified (ESS bit set) in the Set Characteristics Data Buffer. Termination will also occur if a tape mark is the first record off BOT and ESS and ENB bits are set in the Set Characteristics Data Buffer. Record Length Short (RLS) is set if the record count is not decremented to zero.

A Space Records Reverse or Skip Tape Marks Reverse that runs into BOT set Reverse Into BOT (RIB) and causes a tape status alert termination. If the tape is positioned between BOT and the first record and a space reverse or skip reverse is done, RIB will set and the residual frame count will equal the specified count in the original command.

3.3.5 Format Command Packet (Command Code 01001)

This command writes/rewrites a tape mark or erases tape. There are three Command Modes for the Format Command Packet shown below.

COMMAND MODE	FUNCTION
0000	Write Tape Mark
0001	Erase
0010	Write Tape Mark Retry (Space Reverse, Erase, Write Tape Mark)

		---COMMAND MODE---							----COMMAND CODE----					
	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
WORD 1	ACK	CVC	0	0	--COMMAND MODE---				IE	0	0	0	1	0	0	1
WORD 2	<----------NOT USED---------->															

Word 1 is the Header Command Word (Section 3.3). Word 2 is present (fetched by the controller), but is not used in the command.

Executing a Format command at or beyond EOT will cause a Tape Status Alert Termination. The EOT bit will remain set until the EOT marker is passed in the reverse direction.

A Write Tape Mark or Erase command issued at BOT will cause the PE Identification Burst (IDB) to be written on the tape. If, during this operation, the IDB is not received from the transport, the Density Check (DCK) error will be set and Tape Position Lost termination will occur.

The Write Tape Mark Retry causes a space reverse (over the previous record), followed by an erase of 3.75" of tape and then by a Write Tape Mark (which erases 3.75" more of tape before writing the file mark). If the tape is positioned at BOT when the Write Tape Mark Retry command is issued, the operation will be aborted with Function Reject termination and the Nonexecutable Function (NEF) error bit will be set.

3.3.6 Control Command Packet (Command Code 01010)

There are four modes associated with the Control Command Packet shown below:

COMMAND MODE	FUNCTION
0000	Message Buffer Release
0001	Rewind and Unload
0010	NO-OP
0100	Rewind with Immediate Interrupt

		---COMMAND MODE---								----COMMAND CODE----					
	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
WORD 1	ACK	CVC	0	0	--COMMAND MODE---				IE	0	0	0	1	0	0	1
WORD 2	<----------NOT USED---------->															

The Message Buffer Release command (with ACK bit set) lets the controller own the Message Buffer so it can update the status in the message buffer area on an Attention (ATTN).

The Rewind and Unload command rewinds the tape completely onto the supply reel and places the transport offline. When this command is executed, termination (and an interrupt if IE is set) will occur immediately.

The NO-OP command causes immediate termination with no tape motion.

The Rewind with Immediate Interrupt command rewinds the tape to BOT. Termination response to the CPU occurs at the start of the rewind rather that when the tape reaches BOT, as in a normal Rewind command. This command is used in a multi-transport system to select another unit after issuing a rewind. If a transport is rewinding and another tape motion command is issued to it, the new controller will wait until the tape has been rewound to BOT before proceeding with the new command. During execution of a Rewind with Immediate Interrupt, the Motion (MOT) bit in XSTO is set if a Get Status command is performed.

3.3.7 Drive Initialize Command Packet (Command Code 01011)

The Drive Initialize Command Packet is shown below.

		---COMMAND MODE---										----COMMAND CODE----					
		15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
WORD 1	!	ACK	!	CVC	0	0	!	0	0	0	!	0	IE	0	!	0	0	1	!	0	1	1	!
WORD 2	!	<----------NOT USED---------->															!

If there are no microdiagnostic errors, this command is treated as a NO-OP. If error exist, the command is the same as a write into the TSSR register. In either case, IFEN to the Tape Transport is pulsed to stop runaway commands.

3.3.8 Get Status Command Packet (Command Code 01111)

The Get Status Command Packet is shown below;

		---COMMAND MODE---										----COMMAND CODE----					
		15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
WORD 1	!	ACK	!	CVC	0	0	!	0	0	0	!	0	IE	0	!	0	0	1	!	1	1	1	!
WORD 2	!	<----------NOT USED---------->															!

This command deposits a message packet in the Message Buffer area to update the Extended Status registers. However, since the transport automatically updates the Extended Status registers after the end of any command (except Message Buffer Release), this command only needs to be used when the transport has been idle for some time, or when a status register update is desired without performing a tape motion command, or to read the unit number of the currently selected tape transport (deposited in bits 02-00 of the Extended Status Register 2).

3.4 MESSAGE PACKET FORMAT

The message packet format is shown below. This format is used for all messages, whether at the end of a command or for an Attention.

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
WORD 1	ACK	0	0	0	---CLASS CODE----			0	0		0	----MESSAGE TYPE----				
WORD 2	0	0	0	0	0	0	C	C	0	0	0	0	1	1	0	0
WORD 3	RBPCR															
WORD 4	XST0															
WORD 5	XST1															
WORD 6	XST2															
WORD 7	XST3															
WORD 5	XST4															

WORD 1

BIT	CODE	DESCRIPTION
15	ACK	ACKNOWLEDGE. This bit is set by the transport to tell the CPU that the Command Buffer is available for pending or subsequent command packets. An ATTN message will not set this bit since the controller does not own the Command Buffer.
14-12	RESERVED	Reserved for future expansion. Must be set as zeros.
11-08	C	CLASS CODE FIELD. These bits define the class of failure determined for the rest of the message buffer when the Message Type field is not indicating a normal END message. The codes are:

ATTN	0000	On or off line
ATTN	0001	Microdiagnostic failure
FAIL	0000	Not used.
FAIL	0001	Illegal Command (ILC), Illegal Address (ILA), or Need Buffer Address (NBA) on a tape motion command.

	FAIL 0010	Write Lock error on Non-executable function.
	Fail 0011	Microdiagnostic Error.

07-05 - PACKET FORMAT. Specifies a one-word message. Must be zeros.

04-00 - MESSAGE TYPE. Indicates the general type of message contained in the buffer. This field is related to the Termination Class Code in the TSSR register as follows:

MESSAGE TYPE	TERMINATION CLASS CODE	DEFINITION
10000	0,2	End
10001	3	Fail
10010	4,5,6,7	Error
10011	1.7	Attention

WORD 2

15-08 RESERVED Reserved for future expansion. Appears as zeros.

07-00 - DATA FIELD LENGTH. Specifies how many bytes of information (Word 3 through Word 8) follow this word in the message packet. Must be binary value of 00001100 (decimal 12), indicating the packet contains the RBPCR plus five extended status registers.

WORD 3

RESIDUAL BYTE/RECORD/FILE COUNT REGISTER. After a Read command, this word contains the difference between the number of bytes specified in the command and the number of bytes actually transferred from tape; i.e., how much the tape record fell short of the expected length. After a Space Records or Skip Tape Marks command, this register contains the difference between the number of records or tape marks specified in the Count word of the command and the number of records or files actually skipped. Note that spacing and skipping operations can terminate before the count is exhausted for many reasons (tape mark, BOT, etc.).

WORD 3 THROUGH WORD 8

See Paragraphs 3.2.5 through 3.2.9 for descriptions of Extended Status Registers 0 through 4 (XST0 through XST4).

Section 4 - Application Notes

4.1 INTRODUCTION

This section provides application notes and examples for operating the STC-TSQ11 tape cartridge drive controller.

4.1.1 Drive Types

The operation of the STC-TSQ11 has been verified with tape drives from the following manufactures:

Archive	(Scorpion)
Cipher	(540 CT)
Kennedy	(6500)
Northern Telecom	
Tandberg	(TDC 3319)
Wangtek	(Series 5000 Version E upward)

4 1 2 Compatibility

The STC-TSQ11 has shown no faults or restrictions using standard DEC handlers or commands. It emulates a TSV05 subsystem and has been used with the DEC operating system listed below.

RT11	(Version 4 and Version 5)
RSTS	(Version 8 and Version 9)
RSX	(11/11M/11M+)
MUMPS	(Version 2 and Version 3)
XXDP+	

NOTE

While the STC-TSQ11 subsystem can be used to generate and load XXDP+ bootable cartridges it will NOT run the TSV05 diagnostic programs. A modified version of the TSV05 Data Reliability program is available for diagnostic purposes. A driver is supplied for operation with Micro VMS.

The STC-TSQ11 subsystem operates with all the file transfer utilities in the above DEC operating systems (including operation with DOS or ANSI file labeling).

The S & H supplied operating system, TSX-11, is also supported by the STC-TSQ11.

4.1.3 Features

The STC-TSQ11 can perform many functions not normally possible with 5 1/4 inch tape sub-systems. e.g.

Creation of Bootable Tape Cartridges
Appending data to existing Tape information
Multi-volume operation with the following DEC back-up/ restore utilities

RSTS	SAVRES
RSX	BRU, DSC, PIP, FILEX
RT11	COPY, BUP, FILEX
VMS	COPY, BACKUP

4.2 TAPE CAPACITIES

Absolute tape capacities are approximately as follows:

CARTRIDGE TYPE	LENGTH	ABSOLUTE CAPACITY
DC 600A*	(600 Feet)	59 Mbytes
DC 300XL	(450 Feet)	40 Mbytes

*(do not use with Cipher 540CT)

When used under different operating systems these capacities vary depending on the block length and file structure that the system writes. The following is a guide to the capacities that may be achieved:

OPERATING SYSTEM	BACKUP/RESTORE UTILITY	FILE/ UTILITY	TOTAL TAPE CAPACITY DC300XLP	DC600A
RT11	BUP†		37 MB	49 MB
RT11		COPY,PIP*	17 MB	22 MB
RSTS/E	SAVRES		31 MB	42 MB
RSTS/E		PIP (ANSI)	17 MB	22 MB
		(DOS)	18 MB	24 MB
RSX 11	BRU,DSC		40 MB	57 MB
RSX 11		PIP,FILEX	15 MB	20 MB

† Backup under BUP must be limited to a single tape volume (up to RT11 Ver. 5.1).

* When using COPY for multiple file transfer use the /POS:-1 switch to stop excessive tape positioning between files e.g.

```
COPY DKn:*.* MSO:/POS:-1
```

NOTE

In many system configurations this will allow the tape to stream much of the time.

4.3 HINTS ON OPERATION

This section covers some useful hints on operation such as cartridge insertion and removal. Cautionary information is included.

4.3.1 After Writing a Tape

The 8K memory buffer is utilized during write and read operations. At the end of any tape write operation there may be residual information in this buffer. When the controller detects that there have been no commands it will 'time-out' and write out these residual contents.

```
**********
* CAUTION *
**********
```

It is very important to wait a few seconds (up to 10) after the last Write command to ensure that all data has been written out.

4.3.2 Cartridge Insertion/Removal

When the tape system is idling, the STC-TSQ11 controller polls the tape drive at approximately 2 seconds intervals. This may be observed by flashes on the Drive Select light. This process enables the controller to detect when a tape cartridge is inserted or removed from the drive.

```
**********
* CAUTION *
**********
```

Do not confuse the 2 second flash with the Error Code from some tape drives (e.g. Kennedy 6500)

After inserting a tape cartridge, wait at least 3 seconds to allow the drive to be polled. When the controller sees that a cartridge has been inserted it will try to Rewind it to BOT before indicating to the system that the tape is READY. If the tape needs to be rewound, allow the rewind sequence to complete (i.e. wait until tape movement stops) before requesting a system tape operation.

After removing a cartridge, it is important to wait until the drive has been polled (or at least 3 seconds) before inserting another cartridge.

NOTE

It is essential to follow the above procedure during a Multi-Volume cartridge changeover.

4.3.3 System Offline Command

If the operating system gives an Offline command (or a Rewind Offline Command) when the cartridge has been rewound to BOT, the controller will not allow the tape system to become Ready again until the cartridge has been removed and a new one inserted, or the same cartridge has been removed and replaced.

This occurs if the User requests a 'DISMOUNT MS', at the end of each cartridge in a Multi-Volume operation, or at the end of the backup utilities (BRU, DSC, SAVRES, BUP, etc.).

4.4 SYSTEM SOFTWARE COMMAND EXAMPLES

This chapter contains operating systems together with any restrictions on the use of the commands. Operating systems and utilities covered are:

RSX	BRU DSC PIP
RSTS/E	SAVRES BACKUP PIP FILEX
RT11/TSX	BUP PIP DUP BINCOM/SRCCOM INIT/FILE (For Bootable Tape) MSBOOT

The following examples are guidelines and, as such, are not meant to be only valid utilities available. Refer to the appropriate operating system manuals for full information.

NOTE

In the following examples, **bolded** letters are keyboard entries.

4 4 1 RSX11

BRU Backup/Restore Utility

BRU is the main RSX11 security copy and distribution utility. It can be used for Device. Account and individual file saves, or transfers. Before using BRU it is essential to establish the following:

- o Devices to be used must have been allocated to the user
- o If any specified disk is already mounted, the BRU directive must contain a /MOU switch.
- o Ensure that any disk, account or file that is to be BRU'd is not being used elsewnere.
- o The task BRU must be installed using the directive:
  >INS BRU

To BRU a complete disk to tape

>BRU/REW/mou/ver/SY: MS0:

To restore a tape generated by the command above to another disk

>BRU/REW/ini/ver MS0: DKn:

To BRU an account, but label the backup set in preparation for a subsequent append command

>BRU/REW/mou/BAC:1 DKn:[1,2] MS0:

To append an account to the tape above

>BRU/mou/APP/BAC:2 DKn:[1,54] MS0:

To restore the tape generated above to a different disk, which does not have these accounts on it

>BRU/REW/UFD/BAC:1/noinit/ver MS0: DKm:

And the second set

>BRU/REW/UFD/BAC:2/noinit/ver MS0: DKm:

To get a directory of a BRU tape

>BRU/REW/DIR MS0:

DSC Disk Save and Compress

This is an older utility that allows the user to create a tape which can then be restored to a disk to create a compressed copy of the original data.

To create a DSC tape

```
>INS DSC

>DSC MS0:/RW/ver=DKn:
```

To restore the tape generated by the directive above

```
>DSC DKn:/ver=MS0:/RW
```

To compare a tape with a disk

```
>DSC DKn:=MS0:/RW/CMP
```

PIP Peripheral Interchange Program

This is the general purpose file interchange utility

NOTE

The tape subsystem may be used under PIP only if the RSX system has been SYSGEN'd with ANSI support.

All tapes must be INITialized with a volume label before use -

As ANSI labeling supports multi-volume operation it is essential to have INITialized a second, or more, volume if it is possible that a PIP tape generation will exceed one tape.

To INITialize a tape

```
>ALL MSO:

>INIT MSO:LABEL

>MOU MSO:LABEL
```

Creating a PIP copy of all files in an account

```
>PIP MSO:=SY:[1,1]
```

Copying selective files to tape

```
>PIP MSO:=SY:*.TSK
```

Tape directory

```
>PIP MSO: /RW/LI
```

Copy complete account from tape to disk

```
>PIP DKn:[1,2]=MSO:*.HLP/RW
```

FLX - Format Conversation and Interchange Utility

This utility allows the user to create tapes in the correct format for transfer, by tape, to another operating system. Tapes must be initialized in the chosen transfer format

```
>FLX MSO:/ZE/DO          (DOS Format)
```

Copy selective files to tape

```
>FLX MSO:/DO=SY:*.BAS/RS
```

Copy files from tape to disk

```
>FLX DKn:[1,54]/RS=MSO:*.BAS/DO/RW
```

4 4 2 RSTS/E

SAV/RES Save Restore Utility

SAVRES is the main RSTS device archiving utility. It is normally used for creating security copies of disks and for restoring the disks in the event of a system failure. Tapes created under SAV/RES are bootable for subsequent stand alone disk creation.

There are two versions of SAVRES; one is run at option level and the other is run under timesharing. The following description refers to the option level program although the other version looks almost identical. This example shows a SAVE (disk to tape) operation from an RL02 with a pack ID of "PACKID"

```
Option:      SA <CR>

SAV/RES Function:   SA <CR>

From RSTS Disk?  DLO: <?CR>

***  Pack ID/Default Save Set Name is "PACKID"

To device?  MSO:<CR>

***  Save Set Name is "PACKID"

Expiration Date <1-Jan-85>?  <LF>

Verify (Yes or No)  Y<CR>

Proceed (Yes or No) Y<CR>

***  Initializing first SAVE volume

***  Begin SAVE from DLO: to MSO: at <time>

***  Begin VERIFY pass from DLO: to MSO: at <time>
```

When it has finished SAVRES gives a list of errors encountered together with timing information. The most important part of this information is that concerning the numbers of errors found (and, if a verify was requested, the number of bad compares). Both of these should be zero.

The SAV/RES tape created by the above operation can be used to restore or create a RSTS disk. The first volume of the backup is bootable and can be used to bring up a RSTS system to OPTION level to allow the user to invoke SAV/RES.

The example below is for a RESTORE operation from a tape SAVED from a RSTS RL02 disk with pack ID of "PACKID".

Option: **SA <CR>**

SAV/RES Function: **RE <CR>**

From device ? **MS0: <CR>**

*** Save Set Name / default pack ID is "PACKID"

To RSTS DK: Disk? **DKn <CR>**

*** Pack will be reinitialized
Mount it anyway <NO> ? **Y <CR>**

*** Pack ID is PACKID

Verify (Yes or No) <NO> ? **Y <CR>**

Proceed (Yes or No) <NO> ?**Y <CR>**

The restore will now proceed and when completed the User should check that no errors have occured.

PIP - Peripheral Interchange Program

PIP is the general purpose copying program for RSTS (and other operating systems). It permits fully file structured storage and retrieval on any supported device. Before it can be run the RT11 Run Time System (RTS) must be present in the system and, if it is not the default RTS, it must be "added" using UTILITY. PIP always requests input from the operator with a * prompt.

Two types of magtape format are used by RSTS:

ANSI — which requires a volume label and produces tapes that interchange with other operating systems (RSX, RT11) ANSI labeling will also allow Multi-Volume operation, but note that the second and subsequent volumes must have been initalized before they are required for use.

DOS — does not require labeling and is a more compact tape format.

The default for the tape labeling is set under DEFAULT at OPTION level.

A blank tape must be INITialsed before files can be copied to it, using the command:

***MSO:/ZE<CR>** (for DOS format)

or

***MSO:LABEL/ZE<CR>** (for ANSI format)

PIP responds with a confirmation message

Really zero MSO:/PARITY:ODD/DENSITY:1600? **Y<CR>** (DOS format)

or

Really zero MSO:LABEL/PARITY:ODD/DENSITY:1600? **Y<CR>** (ANSI format)

The parameters listed in this confirmation refer to the TSV05 and should not be changed.

File Copy Operations

File copy operations are carried out in exactly the same way as for a TSV05. This example copies a single file called FILNAM .EXT from the user's account to tape.

***MSO:=FILNAM.EXT<CR>**

This example copies all of the files with extension .SAV to tape.

***MSO:=*.SAV/<CR>**

This example copies the file FILNAM.EXT from tape to the users account with the new name NEWNAM.EXT.

***NEWNAM.EXT=MSO:FILNAM.EXT<CR>**

(This is the type of command which would be used to copy the Sigma backup program onto the user's disk when it has been distributed on cartridge)

4 4 3 RT11 and TSX+

TSX+ (the operation system from S & H Computer Systems Inc.) uses RT11 handlers and a similar command structure to RT11. This description deals specifically with RT11.

Under RT11 certain operations involving utility programs may be started in one of two ways. Either the utility can be run and commands supplied via the Command String Interpreter (CSI), or commands in a more readily comprehensible form may be entered directly in response to the monitor prompt.

PIP Peripheral Interchange Program

PIP is RT11's file structure copy program. Before files can be transferred to a file structured device it must be initialized (see DUP below). Use of the /POS:-1 switch where possible will prevent unnecessary rewinds and therefore speed up most multiple file transfers considerably.

Monitor Commands	CSI Commands
To copy a single file to tape	
.COPY FILNAM.EXT MSO:	**.RUN PIP** ***MSO:=FILNAM.EXT**
To copy all .SAV files to tape	
.COPY *.SAV MSO:/POS:-1	**.RUN PIP** ***MSO:=*.SAV/M:-1**
To copy a single file from tape to the system disk	
.COPY MSO:FILNAM.EXT SY:	**.RUN PIP** ***SY:=MSO:FILNAM.EXT**
To copy the entire tape to the system disk	
.COPY/sys MSO:*.* SY:	**.RUN PIP** **SY:=MSO:*.***

NOTE

Since the /VERIFY switch under COPY operations (equivalent to /V under PIP) introduces a large amount of extra repositioning of the tape, it is recommended that verification of tape files be done under BINCOM or SRCCOM.

BINCOM and SRCCOM

BINCOM is a binary compare program which compares files word for word. SRCCOM is an ASCII compare program which will search intelligently for pieces of matching data. BINCOM is more thorough for checking files which have been copied without any conversion and is recommended for use instead of PIP's/V option.

Monitor Commands	CSI Commands
To compare two files	
DIFF/BIN MSO:FILI.EXT,DK:FIL2.EXT	**.RUN BINCOM** ***MSO:FIL1.EXT,DK:FIL2.EXT**

DUP Device Utility Program

DUP is designed for data transfer and device maintenance usually at device rather than file structure level. However, it can be used for generating files which are an image of a device and in this way it makes a useful backup/restore utility.

To initialize a tape

INIT MSO:	**.RUN DUP**
MSO:/Initialize; are you sure ?**Y**	***MSO:/Z**

To copy a complete device (e.g. DK:) to a single tape file

COPY DK:/DEV MSO:DK.DSK/FIL	**.RUN DUP** ***MSO:DK.DSK=DK:*.*/I**

This operation may be repeated to permit backup of multiple volumes on a single tape.

To restore a complete device from a single tape file

```
.COPY MSO:DK.DSK/FIL DK:/DEV
```

```
.RUN DUP
*DK:*.*=MSO:DK.DSK/I
```

BUP Backup Utility Program

BUP is used for copying large single volumes to sets of smaller volumes. It is useful when the system contains (disk) devices which have greater capacity than a single tape cartridge.

Monitor Commands	CSI Commands

To initialize a tape for use with BUP

```
.INIT/BACK MSO:
```

```
.RUN BUP
*MSO:/Z
```

To copy a complete disk (DK:) to tape

```
.BACKUP/DEVICE DK: MSO:
```

```
.RUN BUP
*MSO:=DK:/I
```

To restore a tape (created by the command above) to a disk

```
.BACKUP/RESTORE/DEVICE MSO: DK:
```

```
.RUN BUP
*DK:=MSO:/I/X
```

To list the directory of a backup volume

```
.DIR/BACKUP MSO:
```

```
.RUN BUP
*MSO:/L
```

MSBOOT Magtape Bootstrap

It is possible under RT11 to generate a bootable tape that can be used to distribute the system. The following command file may be used to create a bootable RT11 tape that contains the RT11SJ monitor, all of he device handlers and certain vital utilities. The file can be altered to include more programs or to exclude unwanted handlers. Certain restrictions are placed on the position of particular files. These are commented in the file and must be observed. The example shows the tape being built from device SY: but this may be altered as required.

INIT/NOQ/FILE:MBOT16.BOT MSO:

MSBOOT and MDUP must come next

COPY MSBOOT.BOT,MDUP.%% MSO:/POS:-1

Monitor files come next

COPY/SYS SWAP.SYS,RT11%%.SYS MSO:/POS:-1

TT Handler must come immediately after monitor

COPY/SYS (TT,D%,M%,%%X).SYS MSO:/POS:-1/NOREPLACE

System utilities PIP, DUP and DIR must follow in that order

COPY (PIP,DUP,DIR).SAV MSO:.POS:-1

Then any other programs in any order

COPY (DLFB4B,ODT,IND,BUP).SAV MSO:/POS:-1

End of Distribution Command File

To use a tape generated by this command file, the tape must first be booted using a standard hardware bootstrap or a toggle-in bootstrap as described elsewhere in this manual. When the tape had been successfully booted it will respond with the sign-on message prompt as follows:

```
MSBOOT V05-00
*
```

Next the user must invoke the magtape specific version of DUP by typing

```
*MDUP.MS
*
```

When MDUP has been loaded it signs on as follows:

```
MDUP V05.01
```

A response of

***DLO:/Z**

initializes the disk to RT11 format. **ALL PREVIOUS DATA IS LOST.**

The minimal system is now copied using the command

***DLO:A=MSO:**

NOTE

Filespec A is only a dummy but must be inserted.

Once MDUP has copied a sufficient system to the disk it will attempt to boot it. The user may now copy the remaining contents of the tape using PIP or a COPY command.

NOTE

The version numbers of MDUP and MSBOOT will not necessarily be as shown above.

4.5 CREATION OF A BOOTABLE XXDP+ CARTRIDGE

We assume that the XXDP+ files are being taken from a DEC RL02 distribution pack and that therefore the system being used has an RL02 Disk system and Sigma STC-TSQ11 Cartridge Tape System.

NOTE

If the XXDP+ source is an RX02 floppy wherever DL0: appears change it to DY0:)

```
.R UPD2
UPD2.BIC
CHUP2D0 XXDP+ UPD2 UTILITY
RESTART:003714
*ZERO MS0:(CR)
USER DATA ON MS0 WILL BE DESTROYED!
PROCEED ? (Y/N/CR=N) (CR)
*LOAD HMMSC1.SYS (CR)
HMMSC1.SYS
*SAVE MS0:HMMSC1.SAV (CR)
*PIP MS0:=HDMSC1.SYS (CR)
*PIP MS0:=UPD2.BIC (CR)
```

This has created a bootable tape. The user may now add all the files pertinent to his "TARGET" system, using similar PIP statements.

Some essential files are:

```
Device handlers    (HDxxxn.SYS)
Device diagnostics (Zxxyyn.BIN)
```

Some useful files are:

HUDICO.SYS - Directory Utility
HELP.TXT - Help file

4.6 BACKUP/RESTORE AND BOOTSTRAP PROGRAMS

The CTSBAK program is written in MARCO-11 and runs under RT11. It comprises a kernel that contains the operation control and monitor, together with the interface to a section that contains the device handlers and disk drive parameters. Thus it is fairly simple to add or remove support for other disk types. The program creates or restores an image copy of the disk on the tape, thereby allowing the tape system to stream continuously and providing a HIGH SPEED utility for security or distribution backups. The incorporated VERIFY facility, also carried out at streaming speed, should give the user complete confidence of the integrity of the tapes created.

Some of the features of the CTSBAK program are listed below.

Creates a 'Bootable' cartridge tape

Can be called a simply by any operation system

Self generating (writes itself at the front of each tape)

Supports multi-volume tapes for larger disks.

Currently supports DL, DU, DM, DR, DP disk devices.

Supports multiple DL copies (up to four) on a single tape

Supports Backup, Restore, Verify or Boot.
(Can specify automatic verification.)

Streams at the rate of 1 Mbyte per 12 seconds !

Has tape ID facility - up to 40 characters.

Has a Tape Test facility that allows the User to check the operation of the tape subsystem.

4 6 1 Running CTSBAK

When the program is invoked it will present the User with a Menu of disk types:

```
 STC-TSQ11/TS-11 Backup Restore Utility

Configured for:      General Purpose use
           on:       Date

1   Disk type   DL     DEC RL01/02
2   Disk type   AL     4 X RL02 on a 40 MB winch
3   Disk type   BL     2 X RL02 on a 20 MB winch
4   Disk type   DU     DEC MSCP  (RD51/52)
5   Disk type   DM     RK06/07
6   Disk type   DP     RP02
7   Disk type   DR     RM02/03
8               TS     Tape Test

Select Disk Type:  XX  (CR)
Enter Disk unit number: n (CR)

1. Backup disk to tape
2. Restore tape to disk
3. Verify disk with tape
4. Boot selected disk

Select option for XXn:
```

The user should select the appropriate task which will request further details as it proceeds.

If the program is used to backup a disk, it will start by writing the contents of the system memory to tape, this will create a bootable tape that can then be used to bring up a new system or to restore a system in the event of a failure.

4.6.2 Booting a CTSBAK Tape

1) From standard DEC hardware bootstraps
2) From standard DEC bootstrap commands where available, e.g. under RSTS or XXDP+
3) From the following simple ODT toggle in routine:

```
1000/       112737
1002/          200
1004/       172523
1006/       105737
1010/       172522
1012/       100375
1014/         5007

1000G
```

This routine may be complied as a program that can be called by the operating system being used.

4.6.3 Universal Toggle in Tape Bootstrap Routine

Toggle in Bootstrap routine which is suitable for all known bootable tape formats.

```
1000        012701
1002        172522
1004        112761
1006        000200
1010        000001
1012        105711
1014        100376
1016        010704
1020        062704
1022        000030
1024        005000
1026        005007
1030        046523
```

Start by:

```
1000G
```

NOTES

```
  15    14  13  12    11  10  09    08  07  06    05  04  03    02  01  00
-------------------------------------------------------------------------
! A15 ! A14 A13 A12 ! A11 A10 A09 ! A08 A07 A06 ! A05 A04 A03 ! A02 A01 A00 !
-------------------------------------------------------------------------
```

BUS ADDRESS BIT FORMAT (TSBA) - READ ONLY

```
  15    14  13  12    11  10  09    08  07  06    05  04  03    02  01  00
-------------------------------------------------------------------------
! P15 ! P14 P13 P12 ! P11 P10 P09 ! P08 P07 P06 ! P05 P04 P03 ! P02 P17 P16 !
-------------------------------------------------------------------------
```

DATA BUFFER FORMAT (TSDB) - COMMAND POINTER - WRITE ONLY

```
  15    14  13  12    11  10  09    08  07  06    05  04  03    02  01  00
-------------------------------------------------------------------------
! A15 ! A14 A13 A12 ! A11 A10 A09 ! A08 A07 A06 ! A05 A04 A03 ! A02 A01 A00 !
-------------------------------------------------------------------------
```

DATA BUFFER FORMAT (TSDB) - MAINTENANCE MODE - WRITE ONLY

```
  15    14  13  12    11  10  09    08  07  06    05  04  03    02  01  00
-------------------------------------------------------------------------
! /// ! /////// RMR ! NXM NBA A17 ! A16 SSR OFL ! FC1 FC0 TC2 ! TC1 TC0 A00 !
-------------------------------------------------------------------------
```

STATUS REGISTER FORMAT (TSSR) - READ/WRITE

```
  15    14  13  12    11  10  09    08  07  06    05  04  03    02  01  00
-------------------------------------------------------------------------
!  BT !   0   0   0 ! P21 P20 P19 ! P18 /////// ! /////////// ! /////////// !
-------------------------------------------------------------------------
```

EXTENDED DATA BUFFER FORMAT (TSDBX) - WRITE ONLY

```
  15    14  13  12    11  10  09    08  07  06    05  04  03    02  01  00
-------------------------------------------------------------------------
! TMK ! RLS LET RLL ! WLE NEF ILC ! ILA MOT ONL !  IE VCK PED ! WLK BOT EOT !
-------------------------------------------------------------------------
```

EXTENDED STATUS REGISTER 0 FORMAT (XST0)

```
  15    14  13  12    11  10  09    08  07  06    05  04  03    02  01  00
-------------------------------------------------------------------------
! DLT ! /// COR /// ! /////////// ! ///   0   0 !   0   0   0 !  0  UNC /// !
-------------------------------------------------------------------------
```

EXTENDED STATUS REGISTER 1 FORMAT (XST1)

```
  15    14  13  12    11  10  09    08  07  06    05  04  03    02  01  00
-------------------------------------------------------------------------
! OPM ! XXXXXXXXXXX ! XXXXXXXX  1 ! XXX OCT XXX ! XXXXXXX OCT ! XXXXXXX OCT !
-------------------------------------------------------------------------
```

EXTENDED STATUS REGISTER 2 FORMAT (XST2)

NOTES

*JUMPER A12 OUT (X = 7) - JUMPER A12 IN (X = 6)

ADDRESS	-----SW1 SWITCH POSITIONS----- 8	7	6	5	4	3	2	1
*7X7760	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
7X7740	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON
7X7720	OFF	OFF	OFF	OFF	OFF	OFF	ON	OFF
7X7700	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON
7X7660	OFF	OFF	OFF	OFF	OFF	ON	OFF	OFF
7X7640	OFF	OFF	OFF	OFF	OFF	ON	OFF	ON
7X7620	OFF	OFF	OFF	OFF	OFF	ON	ON	OFF
7X7600	OFF	OFF	OFF	OFF	OFF	ON	ON	ON
7X7560	OFF	OFF	OFF	OFF	ON	OFF	OFF	OFF
7X7540	OFF	OFF	OFF	OFF	ON	OFF	OFF	ON
7X7520	OFF	OFF	OFF	OFF	ON	OFF	ON	OFF
7X7500	OFF	OFF	OFF	OFF	ON	OFF	ON	ON
7X7460	OFF	OFF	OFF	OFF	ON	ON	OFF	OFF
7X7440	OFF	OFF	OFF	OFF	ON	ON	OFF	ON
7X7420	OFF	OFF	OFF	OFF	ON	ON	ON	OFF
777400	OFF	OFF	OFF	OFF	ON	ON	ON	ON
7X7360	OFF	OFF	OFF	ON	OFF	OFF	OFF	OFF
7X7340	OFF	OFF	OFF	ON	OFF	OFF	OFF	ON
7X7320	OFF	OFF	OFF	ON	OFF	OFF	ON	OFF
7X7300	OFF	OFF	OFF	ON	OFF	OFF	ON	ON
7X7260	OFF	OFF	OFF	ON	OFF	ON	OFF	OFF
7X7240	OFF	OFF	OFF	ON	OFF	ON	OFF	ON
7X7220	OFF	OFF	OFF	ON	OFF	ON	ON	OFF
7X7200	OFF	OFF	OFF	ON	OFF	ON	ON	ON
7X7160	OFF	OFF	OFF	ON	ON	OFF	OFF	OFF
7X7140	OFF	OFF	OFF	ON	ON	OFF	OFF	ON
7X7120	OFF	OFF	OFF	ON	ON	OFF	ON	OFF
7X7100	OFF	OFF	OFF	ON	ON	OFF	ON	ON
7X7060	OFF	OFF	OFF	ON	ON	ON	OFF	OFF
7X7040	OFF	OFF	OFF	ON	ON	ON	OFF	ON
7X7020	OFF	OFF	OFF	ON	ON	ON	ON	OFF
7X7000	OFF	OFF	OFF	ON	ON	ON	ON	ON
7X6760	OFF	OFF	ON	OFF	OFF	OFF	OFF	OFF
7X6740	OFF	OFF	ON	OFF	OFF	OFF	OFF	ON
7X6720	OFF	OFF	ON	OFF	OFF	OFF	ON	OFF
7X6700	OFF	OFF	ON	OFF	OFF	OFF	ON	ON
7X6660	OFF	OFF	ON	OFF	OFF	ON	OFF	OFF
7X6640	OFF	OFF	ON	OFF	OFF	ON	OFF	ON
7X6620	OFF	OFF	ON	OFF	OFF	ON	ON	OFF
7X6600	OFF	OFF	ON	OFF	OFF	ON	ON	ON

ADDRESS	-----SW1 SWITCH POSITIONS----- 8	7	6	5	4	3	2	1
7X6560	OFF	OFF	ON	OFF	ON	OFF	OFF	OFF
7X6540	OFF	OFF	ON	OFF	ON	OFF	OFF	ON
7X6520	OFF	OFF	ON	OFF	ON	OFF	ON	OFF
7X6500	OFF	OFF	ON	OFF	ON	OFF	ON	ON
7X6460	OFF	OFF	ON	OFF	ON	ON	OFF	OFF
7X6440	OFF	OFF	ON	OFF	ON	ON	OFF	ON
7X6420	OFF	OFF	ON	OFF	ON	ON	ON	OFF
7X6400	OFF	OFF	ON	OFF	ON	ON	ON	ON
7X6360	OFF	OFF	ON	ON	OFF	OFF	OFF	OFF
7X6340	OFF	OFF	ON	ON	OFF	OFF	OFF	ON
7X6320	OFF	OFF	ON	ON	OFF	OFF	ON	OFF
7X6300	OFF	OFF	ON	ON	OFF	OFF	ON	ON
7X6260	OFF	OFF	ON	ON	OFF	ON	OFF	OFF
7X6240	OFF	OFF	ON	ON	OFF	ON	OFF	ON
7X6220	OFF	OFF	ON	ON	OFF	ON	ON	OFF
X66200	OFF	OFF	ON	ON	OFF	ON	ON	ON
7X6160	OFF	OFF	ON	ON	ON	OFF	OFF	OFF
7X6140	OFF	OFF	ON	ON	ON	OFF	OFF	ON
7X6120	OFF	OFF	ON	ON	ON	OFF	ON	OFF
7X6100	OFF	OFF	ON	ON	ON	OFF	ON	ON
7X6060	OFF	OFF	ON	ON	ON	ON	OFF	OFF
7X6040	OFF	OFF	ON	ON	ON	ON	OFF	ON
7X6020	OFF	OFF	ON	ON	ON	ON	ON	OFF
7X6000	OFF	OFF	ON	ON	ON	ON	ON	ON
7X5760	OFF	ON	OFF	OFF	OFF	OFF	OFF	OFF
7X5740	OFF	ON	OFF	OFF	OFF	OFF	OFF	ON
7X5720	OFF	ON	OFF	OFF	OFF	OFF	ON	OFF
7X5700	OFF	ON	OFF	OFF	OFF	OFF	ON	ON
7X5660	OFF	ON	OFF	OFF	OFF	ON	OFF	OFF
7X5640	OFF	ON	OFF	OFF	OFF	ON	OFF	ON
7X5620	OFF	ON	OFF	OFF	OFF	ON	ON	OFF
7X5600	OFF	ON	OFF	OFF	OFF	ON	ON	ON
7X5560	OFF	ON	OFF	OFF	ON	OFF	OFF	OFF
7X5540	OFF	ON	OFF	OFF	ON	OFF	OFF	ON
7X5520	OFF	ON	OFF	OFF	ON	OFF	ON	OFF
7X5500	OFF	ON	OFF	OFF	ON	OFF	ON	ON
7X5460	OFF	ON	OFF	OFF	ON	ON	OFF	OFF
7X5440	OFF	ON	OFF	OFF	ON	ON	OFF	ON
7X5420	OFF	ON	OFF	OFF	ON	ON	ON	OFF
7X5400	OFF	ON	OFF	OFF	ON	ON	ON	ON

Appendix B - Address Switch Settings

*JUMPER A12 OUT (X = 7) - JUMPER A12 IN (X = 6)

ADDRESS	----SW1 SWITCH POSITIONS---- 8	7	6	5	4	3	2	1
*7X5360	OFF	ON	OFF	ON	OFF	OFF	OFF	OFF
7X5340	OFF	ON	OFF	ON	OFF	OFF	OFF	ON
7X5320	OFF	ON	OFF	ON	OFF	OFF	ON	OFF
7X5300	OFF	ON	OFF	ON	ON	OFF	ON	ON
7X5260	OFF	ON	OFF	ON	OFF	ON	OFF	OFF
7X5240	OFF	ON	OFF	ON	OFF	ON	OFF	ON
7X5220	OFF	ON	OFF	ON	OFF	ON	ON	OFF
7X5200	OFF	ON	OFF	ON	OFF	ON	ON	ON
7X5160	OFF	ON	OFF	ON	ON	OFF	OFF	OFF
7X5140	OFF	ON	OFF	ON	ON	OFF	OFF	ON
7X5120	OFF	ON	OFF	ON	ON	OFF	ON	OFF
7X5100	OFF	ON	OFF	ON	ON	OFF	ON	ON
7X5060	OFF	ON	OFF	ON	ON	ON	OFF	OFF
7X5040	OFF	ON	OFF	ON	ON	ON	OFF	ON
7X5020	OFF	ON	OFF	ON	ON	ON	ON	OFF
7X5000	OFF	ON	OFF	ON	ON	ON	ON	ON
7X4760	OFF	ON	ON	OFF	OFF	OFF	OFF	OFF
7X4740	OFF	ON	ON	OFF	OFF	OFF	OFF	ON
7X4720	OFF	ON	ON	OFF	OFF	OFF	ON	OFF
7X4700	OFF	ON	ON	OFF	OFF	OFF	ON	ON
7X4660	OFF	ON	ON	OFF	OFF	ON	OFF	OFF
7X4640	OFF	ON	ON	OFF	OFF	ON	OFF	ON
7X4620	OFF	ON	ON	OFF	OFF	ON	ON	OFF
7X4600	OFF	ON	ON	OFF	OFF	ON	ON	ON
7X4560	OFF	ON	ON	OFF	ON	OFF	OFF	OFF
7X4540	OFF	ON	ON	OFF	ON	OFF	OFF	ON
7X4520	OFF	ON	ON	OFF	ON	OFF	ON	OFF
7X4500	OFF	ON	ON	OFF	ON	OFF	ON	ON
7X4460	OFF	ON	ON	OFF	ON	ON	OFF	OFF
7X4440	OFF	ON	ON	OFF	ON	ON	OFF	ON
7X4420	OFF	ON	ON	OFF	ON	ON	ON	OFF
7X4400	OFF	ON	ON	OFF	ON	ON	ON	ON
7X4360	OFF	ON	ON	ON	OFF	OFF	OFF	OFF
7X4340	OFF	ON	ON	ON	OFF	OFF	OFF	ON
7X4320	OFF	ON	ON	ON	OFF	OFF	ON	OFF
7X4300	OFF	ON	ON	ON	OFF	OFF	ON	ON
7X4260	OFF	ON	ON	ON	OFF	ON	OFF	OFF
7X4240	OFF	ON	ON	ON	OFF	ON	OFF	ON
7X4220	OFF	ON	ON	ON	OFF	ON	ON	OFF
7X4200	OFF	ON	ON	ON	OFF	ON	ON	ON

ADDRESS	-----SW1 SWITCH POSITIONS---- 8	7	6	5	4	3	2	1
7X4160	OFF	ON	ON	ON	ON	OFF	OFF	OFF
7X4140	OFF	ON	ON	ON	ON	OFF	OFF	ON
7X4120	OFF	ON	ON	ON	ON	OFF	ON	OFF
7X4100	OFF	ON	ON	ON	ON	OFF	ON	ON
7X4060	OFF	ON	ON	ON	ON	ON	OFF	OFF
7X4040	OFF	ON	ON	ON	ON	ON	OFF	ON
7X4020	OFF	ON	ON	ON	ON	ON	ON	OFF
7X4000	OFF	ON	ON	ON	ON	ON	ON	ON
7X3760	ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF
7X3740	ON	OFF	OFF	OFF	OFF	OFF	OFF	ON
7X3720	ON	OFF	OFF	OFF	OFF	OFF	ON	OFF
7X3700	ON	OFF	OFF	OFF	OFF	OFF	ON	ON
7X3660	ON	OFF	OFF	OFF	OFF	ON	OFF	OFF
7X3640	ON	OFF	OFF	OFF	OFF	ON	OFF	ON
7X3620	ON	OFF	OFF	OFF	OFF	ON	ON	OFF
7X3600	ON	OFF	OFF	OFF	OFF	ON	ON	ON
7X3560	ON	OFF	OFF	OFF	ON	OFF	OFF	OFF
7X3540	ON	OFF	OFF	OFF	ON	OFF	OFF	ON
7X3520	ON	OFF	OFF	OFF	ON	OFF	ON	OFF
7X3500	ON	OFF	OFF	OFF	ON	OFF	ON	ON
7X3460	ON	OFF	OFF	OFF	ON	ON	OFF	OFF
7X3440	ON	OFF	OFF	OFF	ON	ON	OFF	ON
7X3420	ON	OFF	OFF	OFF	ON	ON	ON	OFF
7X3400	ON	OFF	OFF	OFF	ON	ON	ON	ON
7X3360	ON	OFF	OFF	ON	OFF	OFF	OFF	OFF
7X3340	ON	OFF	OFF	ON	OFF	OFF	OFF	ON
7X3320	ON	OFF	OFF	ON	OFF	OFF	ON	OFF
7X3300	ON	OFF	OFF	ON	OFF	OFF	ON	ON
7X3260	ON	OFF	OFF	ON	OFF	ON	OFF	OFF
7X3240	ON	OFF	OFF	ON	OFF	ON	OFF	ON
7X3220	ON	OFF	OFF	ON	OFF	ON	ON	OFF
7X3200	ON	OFF	OFF	ON	OFF	ON	ON	ON
7X3160	ON	OFF	OFF	ON	ON	OFF	OFF	OFF
7X3140	ON	OFF	OFF	ON	ON	OFF	OFF	ON
7X3120	ON	OFF	OFF	ON	ON	OFF	ON	OFF
7X3100	ON	OFF	OFF	ON	ON	OFF	ON	ON
7X3060	ON	OFF	OFF	ON	ON	ON	OFF	OFF
7X3040	ON	OFF	OFF	ON	ON	ON	OFF	ON
7X3020	ON	OFF	OFF	ON	ON	ON	ON	OFF
7X3000	ON	OFF	OFF	ON	ON	ON	ON	ON

*JUMPER A12 OUT (X = 7) - JUMPER A12 IN (X = 6)

ADDRESS	-----SW1 SWITCH POSITIONS----- 8	7	6	5	4	3	2	1	ADDRESS	-----SW1 SWITCH POSITIONS----- 8	7	6	5	4	3	2	1
*7X2760	ON	OFF	ON	OFF	OFF	OFF	OFF	OFF	7X1560	ON	ON	OFF	OFF	ON	OFF	OFF	OFF
7X2740	ON	OFF	ON	OFF	OFF	OFF	OFF	ON	7X1540	ON	ON	OFF	OFF	ON	OFF	OFF	ON
7X2720	ON	OFF	ON	OFF	OFF	OFF	ON	OFF	7X1520	ON	ON	OFF	OFF	ON	OFF	ON	OFF
7X2700	ON	OFF	ON	OFF	OFF	OFF	ON	ON	7X1500	ON	ON	OFF	OFF	ON	OFF	ON	ON
7X2660	ON	OFF	ON	OFF	OFF	ON	OFF	OFF	7X1460	ON	ON	OFF	OFF	ON	ON	OFF	OFF
7X2640	ON	OFF	ON	OFF	OFF	ON	OFF	ON	7X1440	ON	ON	OFF	OFF	ON	ON	OFF	ON
7X2620	ON	OFF	ON	OFF	OFF	ON	ON	OFF	7X1420	ON	ON	OFF	OFF	ON	ON	ON	OFF
7X2600	ON	OFF	ON	OFF	OFF	ON	ON	ON	7X1400	ON	ON	OFF	OFF	ON	ON	ON	ON
7X2560	ON	OFF	ON	OFF	ON	OFF	OFF	OFF	7X1360	ON	ON	OFF	ON	OFF	OFF	OFF	OFF
7X2540	ON	OFF	ON	OFF	ON	OFF	OFF	ON	7X1340	ON	ON	OFF	ON	OFF	OFF	OFF	ON
7X2520	ON	OFF	ON	OFF	ON	OFF	ON	OFF	7X1320	ON	ON	OFF	ON	OFF	OFF	ON	OFF
7X2500	ON	OFF	ON	OFF	ON	OFF	ON	ON	7X1300	ON	ON	OFF	ON	OFF	OFF	ON	ON
7X2460	ON	OFF	ON	OFF	ON	ON	OFF	OFF	7X1260	ON	ON	OFF	ON	OFF	ON	OFF	OFF
7X2440	ON	OFF	ON	OFF	ON	ON	OFF	ON	7X1240	ON	ON	OFF	ON	OFF	ON	OFF	ON
7X2420	ON	OFF	ON	OFF	ON	ON	ON	OFF	7X1220	ON	ON	OFF	ON	OFF	ON	ON	OFF
7X2400	ON	OFF	ON	OFF	ON	ON	ON	ON	7X1200	ON	ON	OFF	ON	OFF	ON	ON	ON
7X2360	ON	OFF	ON	ON	OFF	OFF	OFF	OFF	7X1160	ON	ON	OFF	ON	ON	OFF	OFF	OFF
7X2340	ON	OFF	ON	ON	OFF	OFF	OFF	ON	7X1140	ON	ON	OFF	ON	ON	OFF	OFF	ON
7X2320	ON	OFF	ON	ON	OFF	OFF	ON	OFF	7X1120	ON	ON	OFF	ON	ON	OFF	ON	OFF
7X2300	ON	OFF	ON	ON	OFF	OFF	ON	ON	7X1100	ON	ON	OFF	ON	ON	OFF	ON	ON
7X2260	ON	OFF	ON	ON	OFF	ON	OFF	OFF	7X1060	ON	ON	OFF	ON	ON	ON	OFF	OFF
7X2240	ON	OFF	ON	ON	OFF	ON	OFF	ON	7X1040	ON	ON	OFF	ON	ON	ON	OFF	ON
7X2220	ON	OFF	ON	ON	OFF	ON	ON	OFF	7X1020	ON	ON	OFF	ON	ON	ON	ON	OFF
7X2200	ON	OFF	ON	ON	OFF	ON	ON	ON	7X1000	ON	ON	OFF	ON	ON	ON	ON	ON
7X2160	ON	OFF	ON	ON	ON	OFF	OFF	OFF	7X0760	ON	ON	ON	OFF	OFF	OFF	OFF	OFF
7X2140	ON	OFF	ON	ON	ON	OFF	OFF	ON	7X0740	ON	ON	ON	OFF	OFF	OFF	OFF	ON
7X2120	ON	OFF	ON	ON	ON	OFF	ON	OFF	7X0720	ON	ON	ON	OFF	OFF	OFF	ON	OFF
7X2100	ON	OFF	ON	ON	ON	OFF	ON	ON	7X0700	ON	ON	ON	OFF	OFF	OFF	ON	ON
7X2060	ON	OFF	ON	ON	ON	ON	OFF	OFF	7X0660	ON	ON	ON	OFF	OFF	ON	OFF	OFF
7X2040	ON	OFF	ON	ON	ON	ON	OFF	ON	7X0640	ON	ON	ON	OFF	OFF	ON	OFF	ON
7X2020	ON	OFF	ON	ON	ON	ON	ON	OFF	7X0620	ON	ON	ON	OFF	OFF	ON	ON	OFF
7X2000	ON	OFF	ON	ON	ON	ON	ON	ON	7X0600	ON	ON	ON	OFF	OFF	ON	ON	ON
7X1760	ON	ON	OFF	OFF	OFF	OFF	OFF	OFF	7X0560	ON	ON	ON	OFF	ON	OFF	OFF	OFF
7X1740	ON	ON	OFF	OFF	OFF	OFF	OFF	ON	7X0540	ON	ON	ON	OFF	ON	OFF	OFF	ON
7X1720	ON	ON	OFF	OFF	OFF	OFF	ON	OFF	7X0520	ON	ON	ON	OFF	ON	OFF	ON	OFF
7X1700	ON	ON	OFF	OFF	OFF	OFF	ON	ON	7X0500	ON	ON	ON	OFF	ON	OFF	ON	ON
7X1660	ON	ON	OFF	OFF	OFF	ON	OFF	OFF	7X0460	ON	ON	ON	OFF	ON	ON	OFF	OFF
7X1640	ON	ON	OFF	OFF	OFF	ON	OFF	ON	7X0440	ON	ON	ON	OFF	ON	ON	OFF	ON
7X1620	ON	ON	OFF	OFF	OFF	ON	ON	OFF	7X0420	ON	ON	ON	OFF	ON	ON	ON	OFF
7X1600	ON	ON	OFF	OFF	OFF	ON	ON	ON	7X0400	ON	ON	ON	OFF	ON	ON	ON	ON

*JUMPER A12 OUT (X = 7) - JUMPER A12 IN (X = 6)

ADDRESS	-----SW1 SWITCH POSITIONS----- 8	7	6	5	4	3	2	1
*7X0360	ON	ON	ON	ON	OFF	OFF	OFF	OFF
7X0340	ON	ON	ON	ON	OFF	OFF	OFF	ON
7X0320	ON	ON	ON	ON	OFF	OFF	ON	OFF
7X0300	ON	ON	ON	ON	OFF	OFF	ON	ON
7X0260	ON	ON	ON	ON	OFF	ON	OFF	OFF
7X0240	ON	ON	ON	ON	OFF	ON	OFF	ON
7X0220	ON	ON	ON	ON	OFF	ON	ON	OFF
7X0200	ON	ON	ON	ON	OFF	ON	ON	ON

ADDRESS	-----SW1 SWITCH POSITIONS----- 8	7	6	5	4	3	2	1
7X0160	ON	ON	ON	ON	ON	OFF	OFF	OFF
7X0140	ON	ON	ON	ON	ON	OFF	OFF	ON
7X0120	ON	ON	ON	ON	ON	OFF	ON	OFF
7X0100	ON	ON	ON	ON	ON	OFF	ON	ON
7X0060	ON	ON	ON	ON	ON	ON	OFF	OFF
7X0040	ON	ON	ON	ON	ON	ON	OFF	ON
7X0020	ON	ON	ON	ON	ON	ON	ON	OFF
7X0000	ON	ON	ON	ON	ON	ON	ON	ON