

2. COMMANDS

Command	Port	Bit							
		7	6	5	4	3	2	1	0
SEEK	163	0	0	0	0	drive	X	X	
	167	low byte of cylinder address							
WRITE SECTOR	163	0	0	1	0	drive	buffer		
	167	head	sector						
READ SECTOR (FORMATTED)	163	0	0	1	1	drive	buffer		
	167	head	sector						
READ BUFFER	163	0	1	0	1	X	X	buffer	
	167	byte count							
WRITE BUFFER	163	0	1	0	0	X	X	buffer	
	167	byte count							

If the byte read from port 167 in the WRITE BUFFER and READ BUFFER commands is zero, the byte count is assumed to be 256.

READ STATUS	163	0	1	1	0	drive	X	X	
	167	status word address							
SET IV BYTE	163	1	0	0	0	X	X	X	X
	167	IV byte address							

This command reads port 167 twice. The first byte read is the address of the IV byte to be set. The second byte read is the data to be deposited in the selected IV byte.

READ UNFORMATTED	163	1	0	1	0	drive	buffer
	167	head		sector			
FORMAT	163	1	1	0	0	drive	X X
	167	head		X	X	X	X X
INITIALIZE	163	1	1	1	0	X	X X X X

3. ERROR FLAGS

Port 161

Bit	1 means: ¹	Error may occur in:
0	Drive not ready	Any command except INITIALIZE and SET IV BYTE
1	Illegal Sector	SEEK, READ SECTOR, WRITE SECTOR, FORMAT and READ UNFORMATTED commands
2	CRC error in sector read	READ SECTOR, READ UNFORMATTED ² commands
3	CRC error in header read	SEEK, READ SECTOR, WRITE SECTOR and FORMAT commands
4	Header has wrong sector	Same as in bit 3
5	Header has wrong cylinder	Same as in bit 3 ³
6	Header has wrong head	Same as in bit 3
7	Write Protect	Same as in bit 1 ⁴

NOTES

1. All bits of port 161 are ones on the first read after the controller is turned on.
2. Always occurs on an unformatted read of a formatted sector.
3. Occurs spuriously when one of these commands is issued for a drive different from the one specified in the last seek. This spurious error is ignored by the write logic.
4. Only relevant during a Write Sector command. If a sector is write-protected, data may not be written into it. The Write Sector command is ignored and the error flag is set.

Error	Explanation
Drive not ready	Something has caused the drive to go off line. Check the drive number switch and the ready light.
CRC error in sector read	A Cyclical Redundancy Check exception was detected while the 256 data bytes of a sector were being read.
CRC error in header read.	A Cyclical Redundancy Check exception was detected while the header of a sector was being read. If the error persists, the sector is probably unusable. Reformat the disk
Header has wrong sector	The header did not contain the expected sector number. Indicates an anomaly in disk rotation. Try again.
Header has wrong cylinder	The header did not contain the expected cylinder address. Indicates a head positioning error. Try again.
Header has wrong head #	The header did not contain the expected head number. Indicates a problem in the drive electronics.
Write protect.	A command was issued for a write-protected sector. If the command was a Write Sector command, it is ignored. Other commands are executed normally.

OBJ LOC	OBJECT WORD	SOURCE NBR	SOURCE LINE	COMMENT
0000	.....	0001	*	
0000	.....	0002	**	VERSION 4.0 OF TCS CONTROLLER FIRMWARE
0000	.....	0003	**	THIS VERSION INCLUDES HEADER SUPPORT
0000	.....	0004	**	MODIFIED FROM V3.27 BY H. ROUSSO
0000	.....	0005	**	
0000	.....	0006	*	
0000	.....	0007	**	INITIALIZATION (ENTERED BY CONTROLLER RESET)
0000	.....	0008	*	
0000	.....	0009		ORG 0
0000	.....	0010	START	EQU *
0000	11000001 11111111	0011	XMIT	R1,255 INIT DRIVE INTERFACE TO FALSE
0001	11000111 00010011	0012	XMIT	IVL,19 TRACK 0
0002	00000001 00010111	0013	MOVE	R1,IV
0003	11000111 00010010	0014	XMIT	IVL,18
0004	00000001 00010111	0015	MOVE	R1,IV
0005	11000111 00010001	0016	XMIT	IVL,17
0006	00000001 00010111	0017	MOVE	R1,IV
0007	11010111 00100000	0018	XMIT	IV(7,1),0 SELECT DRIVE ZERO
0010	11000111 00010010	0019	XMIT	IVL,18
0011	11010100 00100000	0020	XMIT	IV(4,1),0 SLOW SEEK TO TRACK 0
0012	11010101 00100000	0021	XMIT	IV(5,1),0
0013	11010101 01000011	0022	XMIT	IV(5,2),3
0014	11000111 00000001	0023	XMIT	IVL,1
0015	11000000 00010101	0024	XMIT	AUX,21 SET 2,4,6 OUT; 3,5,7 IN
0016	00000000 00010111	0025	MOVE	AUX,IV
0017	11000111 00000100	0026	XMIT	IVL,4 RESET HANDSHAKE LINES
0020	00000001 00010111	0027	MOVE	R1,IV
0021	11000111 00010101	0028	XMIT	IVL,21 WAIT FOR SEEKS TO FINISH
0022	10110111 10010010	0029	NZT	IV(7,4),*
0023	.....	0030	*	END OF INITIALIZATION
0023	.....	0031	*/PAGE/	
0023	.....	0032	*	
0023	.....	0033	**	GET COMMAND FROM ALTAIR
0023	.....	0034	*	
0023	.....	0035	COMM	EQU *

OBJ LOC	OBJECT WORD	SOURCE NBR	SOURCE LINE	COMMENT
0023	11000111 00000100	0036	XMIT IVL,4	STROBE CONTROLLER READY
0024	11010111 00100000	0037	XMIT IV(7,1),0	
0025	11010111 00100001	0038	XMIT IV(7,1),1	
0026	11000111 00000101	0039	XMIT IVL,5	
0027	10110110 00110111	0040	NZT IV(6,1),*	WAIT FOR COMMAND
0030	11000111 00000011	0041	XMIT IVL,3	GET HIGH COMMAND BYTE
0031	00010010 01100000	0042	MOVE IV(2,3),AUX	GET COMMAND CLASS
0032	00010111 10100001	0043	MOVE IV(7,5),R1	GET COMMAND SUBTYPE
0033	11000111 00000111	0044	XMIT IVL,7	
0034	00010111 00000010	0045	MOVE IV,R2	AND ANY PARMS
0035	11000111 00000100	0046	XMIT IVL,4	
0036	11010110 00100000	0047	XMIT IV(6,1),0	SEND COMMAND ACK
0037	11010110 00100001	0048	XMIT IV(6,1),1	
0040	11000111 00000010	0049	XMIT IVL,2	CLEAR ERROR WORD
0041	11000110 00000000	0050	XMIT R6,0	
0042	00000110 00010111	0051	MOVE R6,IV	
0043	11001001 00000001	0052	XMIT R11,1	SET UP RETURN VECTOR
0044	10000000 00100101	0053	XEC AUX,COMTAB	
0045	.....	0054	COMTAB EQU *	
0045	11100000 00101101	0055	JMP SEEK	SEEK CYL (FORMATTED)
0046	11100000 01000010	0056	JMP SECTOR	TRANSFER SECTOR (FORMATTED)
0047	11100000 01001101	0057	JMP BUFFER	TRANSFER BUFFER
0050	11100000 01110010	0058	JMP STATUS	READ STATUS
0051	11100000 01111110	0059	JMP SETBYTE	SET IV BYTE
0052	11100000 10001000	0060	JMP READUN	READ SECTOR (UNFORMATTED)
0053	11100000 10010001	0061	JMP FORMAT	FORMAT DISK
0054	11100000 00000000	0062	JMP START	UNIMPLEMENTED
0055	.....	0063	*/PAGE/	
0055	.....	0064	*	
0055	.....	0065	** EXECUTE SEEK COMMAND	
0055	.....	0066	*	
0055	11000000 11111111	0067	SEEK XMIT AUX,255	MOVE COMPLEMENT
0056	11000111 00010011	0068	XMIT IVL,19	
0057	01100010 00010111	0069	XOR R2,IV	SEND LOW ORDER CYL ADDR
0060	11000111 00010010	0070	XMIT IVL,18	

OBJ LOC	OBJECT WORD	SOURCE NBR	SOURCE LINE	COMMENT
0061	01100001 00110111	0071	XOR R1,IV(7,1)	AND CYL MSB
0062	11000010 00000000	0072	XMIT R2,0	SELECT HEAD# 0
0063	11100001 10110000	0073	JMP SELECT	
0064	11000000 00000001	0074	SEEK1 XMIT AUX,1	FOR INCREMENT
0065	11000111 00010110	0075	XMIT IVL,22	GET SECTOR COUNTER
0066	00110111 10100010	0076	ADD IV(7,5),R2	... PLUS 1
0067	11000000 00011000	0077	XMIT AUX,24	CHECK FOR WRAPAROUND
0070	01100010 00000000	0078	XOR R2,AUX	
0071	10100000 00111011	0079	NZT AUX,SEEK2	NO WRAP AROUND
0072	11000010 00000000	0080	XMIT R2,0	WRAP TO SECTOR 0
0073	11000111 00010010	0081	SEEK2 XMIT IVL,18	
0074	11010101 00100000	0082	XMIT IV(5,1),0	STROBE...
0075	11100000 00111110	0083	NOP	...(DELAY)
0076	11010101 00100001	0084	XMIT IV(5,1),1	...SEEK LINE
0077	11000111 00010101	0085	XMIT IVL,21	WAIT FOR SEEKS TO SETTLE
0100	10110111 10000000	0086	NZT IV(7,4),*	
0101	11100000 11001010	0087	JMP READHED	
0102	.....	0088	*	
0102	.....	0089	*/PAGE/	
0102	.....	0090	*	
0102	.....	0091	** EXECUTE READ/WRITE DISK SECTOR	
0102	.....	0092	** BEFORE READING OR WRITING, CHECK HEADER:	
0102	.....	0093	** COMPARES CYL ADDR (INTERFACE IV BYTES 18,19);	
0102	.....	0094	** SECTOR (R2);	
0102	.....	0095	** HEADER CRC.	
0102	.....	0096	** ERROR STATUS GOES INTO IV BYTE 2, BITS 2,3,4.	
0102	.....	0097	** IF HEADER ERROR, WILL NOT DO WRITE	
0102	.....	0098	** BUT WILL READ SECTOR ANYWAY	
0102	.....	0099	*	
0102	11001001 00000010	0100	SECTOR XMIT R1,2	RETURN VECTOR
0103	11000111 00000001	0101	SECT1 XMIT IVL,1	SELECT BUFFER (READUN JMPS HERE)
0104	00000001 01010001	0102	MOVE R1,IV(1,2)	
0105	11100001 10110000	0103	JMP SELECT	
0106	.....	0104	SECT2 EQU *	
0106	00000001 00000110	0105	MOVE R1,R6	STORE R/W BIT

OBJ LOC	OBJECT WORD	SOURCE NBR	SOURCE LINE	COMMENT
0107	11100000 11001010	0106	JMP READHED	CHECK HEADER
0110	.....	0107	EQU * SECT3	
0110	11000000 00000001	0108	XMIT AUX,1	R/W MASK BIT
0111	01000110 01000001	0109	AND R6(2),R1	SHIFT AND MASK
0112	10000001 01001011	0110	XEC R1,*+1	0 = WRITE, 1 = READ
0113	11100001 10000010	0111	JMP WRITSUB	
0114	11100001 00011111	0112	JMP READSUB	
0115	.....	0113	*/PAGE/	
0115	.....	0114	*	
0115	.....	0115	** EXECUTE TRANSFER BUFFER COMMAND	
0115	.....	0116	** THIS ROUTINE TRANSFERS A BUFFER FROM OR TO THE ALTAIR	
0115	.....	0117	*	
0115	.....	0118	BUFFER EQU *	
0115	11000111 00000001	0119	XMIT IVL,1	NOTE: NOT CALLABLE
0116	00000001 01010001	0120	MOVE R1,IV(1,2)	SELECT BUFFER
0117	11000000 11111111	0121	XMIT AUX,255	GET 2'S COMPLEMENT OF BYTE COUNT
0120	01100010 00000010	0122	XOR R2,R2	
0121	11000000 00000001	0123	XMIT AUX,1	
0122	00100010 00000010	0124	ADD R2,R2	
0123	01000001 10000001	0125	AND R1(4),R1	GET DIRECTION
0124	11000011 00000000	0126	XMIT R3,0	INITIALIZE WS PTR
0125	10100001 01100100	0127	NZT R1,RDBUFF	IF NONZERO, MUST BE READ
0126	.....	0128	WRBUFF EQU *	
0126	11000111 00000100	0129	XMIT IVL,4	
0127	11010000 00100000	0130	XMIT IV(0,1),0	STROBE...
0130	11010000 00100001	0131	XMIT IV(0,1),1	...DATA READY LINE
0131	.....	0132	WRB1 EQU *	
0131	00000011 00001111	0133	MOVE R3,IVR	SELECT WS LOC
0132	11000111 00000101	0134	XMIT IVL,5	
0133	10110000 00111011	0135	NZT IV(0,1),*	WAIT ON ALTAIR DATA STROBE
0134	11000111 00000111	0136	XMIT IVL,7	
0135	00010111 00011111	0137	MOVE IV,WS	
0136	00100011 00000011	0138	ADD R3,R3	MOVE WS PTR
0137	00100010 00000010	0139	ADD R2,R2	INCREMENT BYTE COUNT
0140	11000111 00000101	0140	XMIT IVL,5	MAKE SURE DATA STROBE RESET

OBJ LOC	OBJECT WORD	SOURCE NBR	SOURCE LINE	COMMENT
0141	10010000 00100001	0141	XEC IV(0,1),*	
0142	10100010 01011001	0142	NZT R2,WRB1	
0143	11100000 00010011	0143	JMP COMM	
0144	.....	0144	*	
0144	.....	0145	** READ BUFFER	
0144	.....	0146	*	
0144	.....	0147	RDBUFF EQU *	
0144	11000111 00000100	0148	XMIT IVL,4	STROBE...
0145	11010001 00100000	0149	XMIT IV(1,1),0	...
0146	11010001 00100001	0150	XMIT IV(1,1),1	...DATA READY LINE
0147	.....	0151	RDB1 EQU *	
0147	00000011 00001111	0152	MOVE R3,IVR	SET WS PTR
0150	11000111 00000110	0153	XMIT IVL,6	
0151	00011111 00010111	0154	MOVE WS,IV	WRITE BYTE TO ALTAIR
0152	00100011 00000011	0155	ADD R3,R3	MOVE WS PTR
0153	00100010 00000010	0156	ADD R2,R2	MOVE BYTE CTR
0154	11000111 00000101	0157	XMIT IVL,5	
0155	10010001 00101101	0158	XEC IV(1,1),*	
0156	10110001 00101110	0159	NZT IV(1,1),*	WAIT ON STROBE TO GO LOW
0157	10010001 00101111	0160	XEC IV(1,1),*	THEN HIGH AGAIN
0160	10100010 01100111	0161	NZT R2,RDB1	NOT DONE - BRANCH
0161	11100000 00010011	0162	JMP COMM	
0162	.....	0163	*/PAGE/	
0162	.....	0164	*	
0162	.....	0165	** EXECUTE THE STATUS TRANSFER COMMAND	
0162	.....	0166	*	
0162	.....	0167	STATUS EQU *	
0162	11001001 00000101	0168	XMIT R11,5	GET RETURN VECTOR
0163	00000010 00000011	0169	MOVE R2,R3	SAVE IV-BYTE ADDRESS
0164	11000010 00000000	0170	XMIT R2,0	SET UP HEAD# 0 FOR SELECT
0165	11100001 10110000	0171	JMP SELECT	SELECT HEAD,DRIVE
0166	.....	0172	STAT1 EQU *	
0166	00000011 00000111	0173	MOVE R3,IVL	SELECT STATUS WORD
0167	00010111 00000010	0174	MOVE IV,R2	READ IT
0170	11000111 00000110	0175	XMIT IVL,6	

OBJ LOC	OBJECT WORD	SOURCE NBR	SOURCE LINE	COMMENT	
0171	00000010	00010111	0176	MOVE R2,IV	SEND IT TO ALTAIR
0172	11000111	00000100	0177	XMIT IVL,4	
0173	11010001	00100000	0178	XMIT IV(1,1),0	STROBE...
0174	11010001	00100001	0179	XMIT IV(1,1),1	...DONE
0175	11100000	00010011	0180	JMP COMM	
0176	.....	.....	0181	*/PAGE/	
0176	.....	.....	0182	*	
0176	.....	.....	0183	** EXECUTE SET IV BYTE DATA COMMAND	
0176	.....	.....	0184	*	
0176	.....	.....	0185	SETBYTE EQU *	
0176	11000111	00000100	0186	XMIT IVL,4	SEND RDY FOR DATA FLAG
0177	11010000	00100000	0187	XMIT IV(0,1),0	
0200	11010000	00100001	0188	XMIT IV(0,1),1	
0201	11000111	00000101	0189	XMIT IVL,5	WAIT FOR ALTAIR DATA STROBE
0202	10110000	00100010	0190	NZT IV(0,1),*	
0203	11000111	00000111	0191	XMIT IVL,7	GET DATA VALUE
0204	00010111	00000011	0192	MOVE IV,R3	
0205	00000010	00000111	0193	MOVE R2,IVL	SELECT DESIRED IV BYTE
0206	00000011	00010111	0194	MOVE R3,IV	
0207	11100000	00010011	0195	JMP COMM	END OF COMMAND
0210	.....	.....	0196	*/PAGE/	
0210	.....	.....	0197	*	
0210	.....	.....	0198	** EXECUTE UNFORMATTED SECTOR READ	
0210	.....	.....	0199	*	
0210	.....	.....	0200	READUN EQU *	
0210	11001001	00000100	0201	XMIT R11,4	RETURN PARM
0211	11100000	01000011	0202	JMP SECT1	DO COMMON STUFF & RETURN HERE
0212	.....	.....	0203	READU1 EQU *	
0212	11000100	00011000	0204	XMIT R4,24	LOW ORDER FOR 257+CRC
0213	11000011	00001000	0205	XMIT R3,8	HIGH ORDER FOR 257+CRC
0214	11000000	00000001	0206	XMIT AUX,1	READ MODE
0215	11100001	11001100	0207	JMP DDSET	
0216	11100001	11101010	0208	READU2 JMP SECTW	
0217	.....	.....	0209	READU3 EQU *	
0217	11000001	01010000	0210	XMIT R1,80	COUNT FOR 1/2 PREAMBLE

OBJ LOC	OBJECT WORD	SOURCE NBR	SOURCE LINE	COMMENT
0220	11100001 00100101	0211	JMP RDS11	JUMP TO READ SUBROUTINE
0221	.....	0212	*/PAGE/	
0221	.....	0213	*	
0221	.....	0214	**	EXECUTE THE FORMAT DISK COMMAND
0221	.....	0215	**	
0221	.....	0216	**	FORMATS THE SELECTED HEAD # WITH HEADER INFORMATION:
0221	.....	0217	**	PREAMBLE, SYNC BYTE (ALL 1'S),
0221	.....	0218	**	CYL ADDR (2 BYTES, MSB FIRST),
0221	.....	0219	**	HEAD+SECTOR # (1 BYTE)
0221	.....	0220	**	HEADER CRC (2 BYTES),
0221	.....	0221	**	HEADER GAP
0221	.....	0222	**	
0221	.....	0223	**	AFTER WRITING, GOES BACK AND CHECKS HEADER.
0221	.....	0224	**	ERROR STATUS LOADED INTO IV BYTE 2
0221	.....	0225	*	
0221	.....	0226	FORMAT EQU *	
0221	11001001 00000011	0227	XMIT R11,3	RETURN PARM FOR SELECT
0222	11100001 10110000	0228	JMP SELECT	SELECT DRIVE
0223	.....	0229	FORMS EQU *	
0223	11001001 00000010	0230	XMIT R11,2	RETURN VECTOR FOR WRITHEd
0224	.....	0231	FORM0 EQU *	
0224	11000000 11111111	0232	XMIT AUX,255	INIT CYL ADDR TO ZERO
0225	11000111 00010011	0233	XMIT IVL,19	
0226	00000000 00010111	0234	MOVE AUX,IV	
0227	11000111 00010010	0235	XMIT IVL,18	
0230	00000000 00010111	0236	MOVE AUX,IV	
0231	11010100 00100000	0237	XMIT IV(4,1),0	SET RESTORE
0232	11010101 00100000	0238	XMIT IV(5,1),0	SET CYL STROBE
0233	11100000 10011100	0239	NOP	
0234	11010101 01000011	0240	XMIT IV(5,2),3	RESET CYL STROBE, RESTORE
0235	11000111 00010101	0241	FORM05 XMIT IVL,21	WAIT FOR SEEK TO SETTLE
0236	10110111 10011110	0242	NZT IV(7,4),*	
0237	11000110 00000000	0243	XMIT R6,0	INITIALIZE SECTOR #
0240	.....	0244	FORM1 EQU *	
0240	00000110 00000010	0245	MOVE R6,R2	READHEd WANTS SECTOR # R2

OBJ LOC	OBJECT WORD	SOURCE NBR	SOURCE LINE	COMMENT
0241	10001001 10100000	0246	XEC R11,*-1	
0242	11100001 01001000	0247	JMP WRITHED	WRITE HEADER
0243	11100000 11001010	0248	JMP READHED	READ HEADER
0244	.....	0249	FORM20 EQU *	
0244	11000111 00000010	0250	XMIT IVL,2	CHECK FOR HEADER READ ERROR
0245	11000000 00000111	0251	XMIT AUX,7	ERROR MASK
0246	01010100 01100000	0252	AND IV(4,3),AUX	
0247	10100000 11000111	0253	NZT AUX,FORM61	IF ERROR, STOP READING
0250	.....	0254	FORM21 EQU *	
0250	11000000 00000001	0255	XMIT AUX,1	INCREMENT VALUE
0251	00100110 00000110	0256	ADD R6,R6	INCREMENT SECTOR #
0252	11000000 00011000	0257	XMIT AUX,24	CHECK IF LAST SECTOR+1
0253	01100110 00000000	0258	XOR R6,AUX	
0254	10100000 10100000	0259	NZT AUX,FORM1	REPEAT IF MORE
0255	11000111 00010011	0260	XMIT IVL,19	LOAD CYL LSB'S INTO R2
0256	11000000 11111111	0261	XMIT AUX,255	COMPLEMENT
0257	01110111 00000010	0262	XOR IV,R2	
0260	11000111 00010010	0263	XMIT IVL,18	CHECK CYL MSB
0261	10110111 00110110	0264	NZT IV(7,1),FORM3	IF FALSE, IGNORE CYL LSB
0262	11000000 10010101	0265	XMIT AUX,149	CYL ADDR 405 (8 LSB)
0263	01100010 00000000	0266	XOR R2,AUX	CHECK FOR LAST CYL ADDR
0264	10100000 10110110	0267	NZT AUX,FORM3	IF NOT LAST, INC CYL ADDR
0265	11100000 11000100	0268	JMP FORM6	CHECK MODE
0266	.....	0269	FORM3 EQU *	
0266	11000000 00000001	0270	XMIT AUX,1	
0267	00100010 00000010	0271	ADD R2,R2	INC CYL ADDR
0270	10101000 10111010	0272	NZT OVF,FORM4	CHECK OVERFLOW
0271	11100000 10111100	0273	JMP FORM5	NO OVERFLOW = LOAD LSB
0272	.....	0274	FORM4 EQU *	
0272	11000111 00010010	0275	XMIT IVL,18	OVERFLOW,...
0273	11010111 00100000	0276	XMIT IV(7,1),0	...SET CYL MSB TRUE
0274	11000111 00010011	0277	FORM5 XMIT IVL,19	
0275	11000000 11111111	0278	XMIT AUX,255	SEND CYL LSB TO INTERFACE
0276	01100010 00010111	0279	XOR R2,IV	COMPLEMENT
0277	11000111 00010010	0280	XMIT IVL,18	PULSE CYL STROBE

OBJ LOC	OBJECT WORD	SOURCE NBR	SOURCE LINE	COMMENT
0300	11010101 00100000	0281	XMIT IV(5,1),0	
0301	11100000 11000010	0282	NOP	
0302	11010101 00100001	0283	XMIT IV(5,1),1	
0303	11100000 10011101	0284	JMP FORM05	NEXT TRACK, SECTOR 0
0304	11000000 00000011	0285	FORM6 XMIT AUX,3	FINISHED ALL CYLS
0305	01101001 00000000	0286	XOR R11,AUX	READING OR WRITING ?
0306	10100000 11001000	0287	NZT AUX,FORM7	1 - FINISHED WRITING
0307	.....	0288	FORM61 EQU *	
0307	11100000 00010011	0289	JMP COMM	FINISHED READING - RETURN
0310	.....	0290	FORM7 EQU *	
0310	11001001 00000011	0291	XMIT R11,3	RETURN VECTOR FOR READ MOCE
0311	11100000 10010100	0292	JMP FORM0	GO BACK & READ HEADERS
0312	.....	0293	*/PAGE/	
0312	.....	0294	*	
0312	.....	0295	** READ HEADER SUBROUTINE	
0312	.....	0296	**	
0312	.....	0297	** THIS READS THE HEADER AND COMPARES THE CYL ADDR	
0312	.....	0298	** WITH THAT STORED IN INTERFACE IV BYTES 18 AND 19,	
0312	.....	0299	** COMPARES SECTOR # WITH R2 (5 LSB),	
0312	.....	0300	** AND CHECKS THE HEADER CRC.	
0312	.....	0301	** ERROR STATUS IS STORED IN IV BYTE 2, BITS 2-4	
0312	.....	0302	** BIT 2 - CYL ADDR,	
0312	.....	0303	** BIT 3 - SECTOR #,	
0312	.....	0304	** BIT 4 - HEADER CRC	
0312	.....	0305	*	
0312	.....	0306	READHED EQU *	
0312	00001001 00000101	0307	MOVE R11,R5	SAVE RETURN VECTOR
0313	11000100 00110000	0308	XMIT R4,48	LOW ORDER 4 HEADER+CRC
0314	11000011 00000000	0309	XMIT R3,0	HIGH ORDER 4+CRC
0315	11001001 00000011	0310	XMIT R11,3	RETURN VECTOR
0316	11000000 00000001	0311	XMIT AUX,1	READ MODE
0317	11100001 11001100	0312	JMP DDSET	
0320	11100001 11101010	0313	READH1 JMP SECTW	
0321	11000001 01010000	0314	READH2 XMIT R1,80	COUNT FOR 1/2 PREAMBLE (40 US)
0 2	11000000 11111111	0315	XMIT AUX,255	

OBJ LOC	OBJECT WORD	SOURCE NBR	SOURCE LINE	COMMENT
0323	00100001 00000001	0316	ADD R1,R1	
0324	10100001 11010011	0317	NZT R1,*-1	
0325	11000111 00100101	0318	XMIT IVL,37	START TRANSFER
0326	11010001 00100001	0319	XMIT IV(1,1),1	
0327	11000111 00100100	0320	XMIT IVL,36	WAIT ON DATA READY
0330	10010111 00111000	0321	XEC IV(7,1),*	
0331	11000111 00100101	0322	XMIT IVL,37	STROBE IT OUT (SYNC BYTE)
0332	11010110 00100001	0323	XMIT IV(6,1),1	
0333	11010110 00100000	0324	XMIT IV(6,1),0	
0334	11000111 00100100	0325	XMIT IVL,36	WAIT ON DATA READY
0335	10010111 00111101	0326	XEC IV(7,1),*	
0336	11000111 00100001	0327	XMIT IVL,33	READ HEADER CYL MSB
0337	00010111 00100001	0328	MOVE IV(7,1),R1	
0340	11000000 00000001	0329	XMIT AUX,1	INVERT CONTROLLER CYL MSB
0341	11000111 00010010	0330	XMIT IVL,18	
0342	01110111 00100000	0331	XOR IV(7,1),AUX	
0343	01100001 00000000	0332	XOR R1,AUX	COMPARE
0344	11000111 00000010	0333	XMIT IVL,2	SELECT IV BYTE 2
0345	11100000 11100110	0334	NOP	ALIGN ADDR. REF. BELOW
0346	00000000 00110010	0335	MOVE AUX,IV(2,1)	SET BIT 2 IF ERROR
0347	11000111 00100101	0336	XMIT IVL,37	STROBE IT OUT
0350	11010110 00100001	0337	XMIT IV(6,1),1	
0351	11010110 00100000	0338	XMIT IV(6,1),0	
0352	11000111 00100100	0339	XMIT IVL,36	WAIT ON DATA READY
0353	10010111 00101011	0340	XEC IV(7,1),*	
0354	11000111 00100001	0341	XMIT IVL,33	READ HEADER CYL LSB
0355	00010111 00000001	0342	MOVE IV,R1	
0356	11000000 11111111	0343	XMIT AUX,255	INVERT CONTRL. CYL LSB
0357	11000111 00010011	0344	XMIT IVL,19	
0360	01110111 00000000	0345	XOR IV,AUX	
0361	01100001 00000000	0346	XOR R1,AUX	COMPARE
0362	10100000 11110100	0347	NZT AUX,READH3	
0363	11100000 11110110	0348	JMP READH4	EQUAL
0364	.....	0349	EQU *	
0364	11000111 00000010	0350	XMIT IVL,2	SET...

OBJ LOC	OBJECT WORD	SOURCE NBR	SOURCE LINE	COMMENT
0365	11010010 00100001	0351	XMIT IV(2,1),1	...IV BYTE 2 BIT 2 TO 1
0366	.....	0352	EQU *	
0366	11000111 00100101	0353	XMIT IVL,37	STROBE IT OUT
0367	11010110 00100001	0354	XMIT IV(6,1),1	
0370	11010110 00100000	0355	XMIT IV(6,1),0	
0371	11000111 00100100	0356	XMIT IVL,36	WAIT ON DATA READY
0372	10010111 00111010	0357	XEC IV(7,1),*	
0373	11000000 00011111	0358	XMIT AUX,31	MASK FOR 5 BIT SECTOR
0374	01000010 00000010	0359	AND R2,R2	
0375	11000111 00100001	0360	XMIT IVL,33	READ HEADER SECTOR
0376	01010111 00000000	0361	AND IV,AUX	
0377	01100010 00000000	0362	XOR R2,AUX	COMPARE SECTOR #
0400	10100000 00000010	0363	NZT AUX,READH5	NOT EQUAL
0401	11100001 00000100	0364	JMP READH6	
0402	11000111 00000010	0365	XMIT IVL,2	SET IV BYTE 2
0403	11010011 00100001	0366	XMIT IV(3,1),1	... BIT 3 TO 1
0404	.....	0367	EQU *	
0404	11000000 00000111	0368	XMIT AUX,7	HEAD# MASK
0405	11000111 00010001	0369	XMIT IVL,17	SELECT SELECT CTL BYTE
0406	01010011 01100001	0370	AND IV(3,3),R1	MASK OUT CONTRL. HEAD#
0407	11000111 00100001	0371	XMIT IVL,33	SELECT DATA BYTE
0410	01010010 01100000	0372	AND IV(2,3),AUX	MASK OUT HEADER HEAD#
0411	01100001 00000001	0373	XOR R1,R1	COMPARE
0412	10100001 00001100	0374	NZT R1,READH7	NOT EQUAL
0413	11100001 00001110	0375	JMP READH8	
0414	11000111 00000010	0376	XMIT IVL,2	SET IV BYTE 2...
0415	11010001 00100001	0377	XMIT IV(1,1),1	... BIT 1 FOR HEAD# ERROR
0416	11000111 00100100	0378	XMIT IVL,36	CHECK FOR END OF TRANSFER
0417	10010110 00101111	0379	XEC IV(6,1),*	
0420	11000001 00010100	0380	XMIT R1,20	WAIT 10 US FOR CRC
0421	11000000 11111111	0381	XMIT AUX,255	
0422	00100001 00000001	0382	ADD R1,R1	
0423	10100001 00010010	0383	NZT R1,*-1	
0424	11000111 00100101	0384	XMIT IVL,37	STOP TRANSFER
0425	11010001 00100000	0385	XMIT IV(1,1),0	

OBJ LOC	OBJECT WORD	SOURCE NBR	SOURCE LINE	COMMENT
0426	11000111 00100100	0386	XMIT IVL,36	MOVE HEADER CRC STATUS
0427	00010101 00100010	0387	MOVE IV(5,1),R2	TO R2
0430	11000111 00000010	0388	XMIT IVL,2	MOVE IT TO IV BYTE 2, BIT 4
0431	00000010 00110100	0389	MOVE R2,IV(4,1)	
0432	00000101 00001001	0390	MOVE R5,R11	RESTORE RETURN VECTOR
0433	10001001 00011011	0391	XEC R11,*	RETURN TO CALLER
0434	11100000 00010011	0392	JMP COMM	RETURN 1 = SEEK
0435	11100000 01001000	0393	JMP SECT3	RETURN 2 = SECTOR
0436	11100000 10100100	0394	JMP FORM20	RETURN 3 = FORMAT
0437	.....	0395	*/PAGE/	
0437	.....	0396	*	
0437	.....	0397	**	
0437	.....	0398	*	READ SECTOR SUBROUTINE
0437	.....	0399	READSUB EQU *	
0437	11000100 00011000	0400	XMIT R4,24	LOW ORDER FOR 257+CRC
0440	11000011 00001000	0401	XMIT R3,8	HIGH ORDER
0441	11001001 00000001	0402	XMIT R11,1	RETURN VECTOR
0442	11100001 11001100	0403	JMP DDSET	
0443	11010010 00100001	0404	RDS1 XMIT IV(2,1),1	READ MODE
0444	11000001 00010100	0405	XMIT R1,20	COUNT 1/2 HEADER GAP (10 US)
0445	.....	0406	RDS11 EQU *	
0445	11000000 11111111	0407	XMIT AUX,255	
0446	00100001 00000001	0408	ADD R1,R1	
0447	10100001 00100110	0409	NZT R1,*-1	
0450	11000111 00100101	0410	XMIT IVL,37	START TRANSFER
0451	11010001 00100001	0411	XMIT IV(1,1),1	
0452	11000111 00100100	0412	XMIT IVL,36	WAIT ON DATA READY
0453	10010111 00101011	0413	XEC IV(7,1),*	
0454	11000111 00100101	0414	XMIT IVL,37	STROBE IT OUT (SYNC BYTE)
0455	11010110 00100001	0415	XMIT IV(6,1),1	
0456	11010110 00100000	0416	XMIT IV(6,1),0	
0457	11000000 00000001	0417	XMIT AUX,1	
0460	.....	0418	RDS2 EQU *	
0460	11000111 00100100	0419	XMIT IVL,36	READ TRANSFER STATUS
0461	10010111 01010001	0420	XEC IV(7,2),*	WAIT LOOP & BRANCH TABLE

OBJ LOC	OBJECT WORD	SOURCE NBR	SOURCE LINE	COMMENT
0462	11100001 00110101	0421	JMP RDS3	DATA READY
0463	11100001 00111101	0422	JMP RDS4	END OF TRANSFER
0464	11100001 00110101	0423	JMP RDS3	DATA READY & END OF TRANSFER
0465	.....	0424	EQU *	
0465	00000001 00001111	0425	MOVE R1,IVR	
0466	11000111 00100001	0426	XMIT IVL,33	TRANSFER TO WS
0467	00010111 00011111	0427	MOVE IV,WS	
0470	00100001 00000001	0428	ADD R1,R1	MOVE WS PTR
0471	11000111 00100101	0429	XMIT IVL,37	STROBE IT OUT
0472	11010110 00100001	0430	XMIT IV(6,1),1	
0473	11010110 00100000	0431	XMIT IV(6,1),0	
0474	10100001 00110000	0432	NZT R1,RDS2	NOT DONE - CONTINUE
0475	.....	0433	EQU *	
0475	11000001 00010100	0434	XMIT R1,20	WAIT 10 US FOR CRC
0476	11000000 11111111	0435	XMIT AUX,255	
0477	00100001 00000001	0436	ADD R1,R1	
0500	10100001 00111111	0437	NZT R1,*-1	
0501	11000111 00100101	0438	XMIT IVL,37	STOP TRANSFER
0502	11010001 00100000	0439	XMIT IV(1,1),0	
0503	11000111 00100100	0440	XMIT IVL,36	MOVE SECTOR CRC STATUS
0504	00010101 00100010	0441	MOVE IV(5,1),R2	
0505	11000111 00000010	0442	XMIT IVL,2	TO IV BYTE 2, BIT 5
0506	00000010 00110101	0443	MOVE R2,IV(5,1)	
0507	11100000 00010011	0444	JMP COMM	RETURN
0510	.....	0445	*/PAGE/	
0510	.....	0446	*	
0510	.....	0447	**	WRITE HEADER SUBROUTINE
0510	.....	0448	**	(USED ONLY WITH FORMAT COMMAND)
0510	.....	0449	**	WRITES PREABLE (26 BYTES OF ZEROS),
0510	.....	0450	**	SYNC BYTE (ALL ONES),
0510	.....	0451	**	CYL ADDR (2 BYTES, MSB FIRST),
0510	.....	0452	**	HEAD+SECTOR # (1 BYTE),
0510	.....	0453	**	HEADER CRC (2 BYTES),
0510	.....	0454	**	HEADER GAP (13 BYTES, ALL ZEROS)
0510	.....	0455	**	

OBJ LOC	OBJECT WORD	SOURCE NBR	SOURCE LINE	COMMENT
0510	.....	0456	** R6 = SECTOR #	
0510	.....	0457	*	
0510	.....	0458	WRITHED EQU *	
0510	11000100 00100000	0459	XMIT R4,32	LOW ORDER FOR HEADER
0511	11000011 00000000	0460	XMIT R3,0	HIGH ORDER
0512	11001001 00000101	0461	XMIT R11,5	RETURN VECTOR
0513	11000000 00000000	0462	XMIT AUX,0	WRITE MODE
0514	11100001 11001100	0463	JMP DDSET	
0515	11100001 11101010	0464	WRITH1 JMP SECTW	
0516	11000111 00010010	0465	WRITH2 XMIT IVL,18	START WRITE
0517	11010011 00100000	0466	XMIT IV(3,1),0	
0520	11000000 11111111	0467	XMIT AUX,255	
0521	11000111 00100010	0468	XMIT IVL,34	
0522	00000000 00010111	0469	MOVE AUX,IV	WRITE SYNC BYTE
0523	11000111 00100101	0470	XMIT IVL,37	STROBE IT IN
0524	11010110 00100001	0471	XMIT IV(6,1),1	
0525	11010110 00100000	0472	XMIT IV(6,1),0	
0526	11000100 10100000	0473	XMIT R4,160	DELAY 80 US FOR PREAMBLE
0527	00100100 00000100	0474	ADD R4,R4	
0530	10100100 01010111	0475	NZT R4,*-1	
0531	11000111 00100101	0476	XMIT IVL,37	START TRANSFER
0532	11010001 00100001	0477	XMIT IV(1,1),1	
0533	11000000 00000001	0478	XMIT AUX,1	CYL ADDR MSB MASK
0534	11000111 00010010	0479	XMIT IVL,18	
0535	01010111 00000001	0480	AND IV,R1	
0536	01100001 00000001	0481	XOR R1,R1	
0537	11000111 00100010	0482	XMIT IVL,34	TRANSFER CYL ADDR MSB
0540	00000001 00010111	0483	MOVE R1,IV	
0541	11000111 00100101	0484	XMIT IVL,37	STROBE IT IN
0542	11010110 00100001	0485	XMIT IV(6,1),1	
0543	11010110 00100000	0486	XMIT IV(6,1),0	
0544	11000000 11111111	0487	XMIT AUX,255	INVERT CYL LSB
0545	11000111 00010011	0488	XMIT IVL,19	
0546	01110111 00000001	0489	XOR IV,R1	
0547	11000111 00100010	0490	XMIT IVL,34	TRANSFER CYL ADDR LSB

HARD DISK CONTROLLER FIRMWARE LISTING -- VERSION 4.3

10 APR 78

PAGE # 15

25

OBJ LOC	OBJECT WORD	SOURCE NBR	SOURCE LINE	COMMENT
0550	00000001 00010111	0491	MOVE R1, IV	
0551	11000111 00100101	0492	XMIT IVL, 37	STROBE IT IN
0552	11010110 00100001	0493	XMIT IV(6, 1), 1	
0553	11010110 00100000	0494	XMIT IV(6, 1), 0	
0554	11000000 00000111	0495	XMIT AUX, 7	MASK FOR HEAD#
0555	11000111 00010001	0496	XMIT IVL, 17	SELECT SELECT CTL BYTE
0556	01010011 01100000	0497	AND IV(3, 3), AUX	MASK OUT HEAD#
0557	00000000 01100000	0498	MOVE AUX(3), AUX	MOVE TO 3 MSB
0560	00100110 00000001	0499	ADD R6, R1	ADD IN WITH SECTOR#
0561	11000111 00100010	0500	XMIT IVL, 34	TRANSFER SECTOR#/HEAD#
0562	00000001 00010111	0501	MOVE R1, IV	
0563	11000111 00100101	0502	XMIT IVL, 37	STROBE IT IN
0564	11010110 00100001	0503	XMIT IV(6, 1), 1	
0565	11010110 00100000	0504	XMIT IV(6, 1), 0	
0566	11000111 00100100	0505	XMIT IVL, 36	WAIT UNTIL CRC TRANSFERRED
0567	10010110 00110111	0506	XEC IV(6, 1), *	
0570	11000000 11111111	0507	XMIT AUX, 255	DELAY FOR HEADER GAP
0571	11000100 01010000	0508	XMIT R4, 80	
0572	00100100 00000100	0509	ADD R4, R4	
0573	10100100 01111010	0510	NZT R4, *-1	
0574	11000111 00010010	0511	XMIT IVL, 18	STOP WRITING
0575	11010011 00100001	0512	XMIT IV(3, 1), 1	
0576	11000111 00100101	0513	XMIT IVL, 37	
0577	11010001 00100000	0514	XMIT IV(1, 1), 0	STOP TRANSFER
0600	11001001 00000010	0515	XMIT R11, 2	TRANSFER VECTOR WITHIN FORMAT
0601	11100000 10101000	0516	JMP FORM21	RETURN TO FORMAT
0602	.....	0517	*/PAGE/	
0602	.....	0518	*	
0602	.....	0519	**	SUBROUTINE TO WRITE SECTOR
0602	.....	0520	**	APPENDS SYNC BYTE +256 DATA BYTES +CRC BYTES TO HEADER
0602	.....	0521	*	
0602	.....	0522	WRITSUB EQU *	
0602	11000111 00000010	0523	XMIT IVL, 2	CHECK FOR HEADER ERROR
0603	11000000 00011011	0524	XMIT AUX, 27	HD#/SECT/CRC/WPROT
060	01010100 10000000	0525	AND IV(4, 4), AUX	

OBJ LOC	OBJECT WORD	SOURCE NBR	SOURCE LINE	COMMENT
0605	10100000 10001011	0526	NZT AUX,WRERR	IF ERROR, DON'T WRITE
0606	11000100 00001000	0527	XMIT R4,8	GET...
0607	11000011 00001000	0528	XMIT R3,8	...LENGTH
0610	11001001 00000010	0529	XMIT R11,2	GET RETURN VECTOR
0611	11000000 00000000	0530	XMIT AUX,0	WRITE MODE
0612	11100001 11001100	0531	JMP DDSET	
0613	11100000 00010011	0532	JMP COMM	
0614	.....	0533	WRERR WRS1 EQU *	
0614	11000111 00010010	0534	XMIT IVL,18	START WRITE
0615	11010011 00100000	0535	XMIT IV(3,1),0	
0616	11000001 11111111	0536	XMIT R1,255	WRITE SYNC BYTE
0617	11000111 00100010	0537	XMIT IVL,34	
0620	00000001 00010111	0538	MOVE R1,IV	
0621	11000111 00100101	0539	XMIT IVL,37	STROBE IT IN
0622	11010110 00100001	0540	XMIT IV(6,1),1	
0623	11010110 00100000	0541	XMIT IV(6,1),0	
0624	11000000 11111111	0542	XMIT AUX,255	WAIT HEADER GAP TIME
0625	11000100 00100001	0543	XMIT R4,33	
0626	00100100 00000100	0544	ADD R4,R4	
0627	10100100 10010110	0545	NZT R4,*-1	
0630	11000000 00000001	0546	XMIT AUX,1	
0631	11000111 00100101	0547	XMIT IVL,37	
0632	11010001 00100001	0548	XMIT IV(1,1),1	START TRANSFER
0633	.....	0549	WRS2 EQU *	
0633	00100001 00000001	0550	ADD R1,R1	MOVE WS PTR
0634	00000001 00001111	0551	MOVE R1,IVR	
0635	11000111 00100010	0552	XMIT IVL,34	
0636	00011111 00010111	0553	MOVE WS,IV	TRANSFER BYTE
0637	11000111 00100101	0554	XMIT IVL,37	
0640	11010110 00100001	0555	XMIT IV(6,1),1	STROBE IT IN
0641	11010110 00100000	0556	XMIT IV(6,1),0	
0642	11000111 00100100	0557	XMIT IVL,36	TEST NEXT
0643	.....	0558	*	
0643	10010111 01000011	0559	WRS3 XEC IV(7,2),*	WAIT LOOP & BRANCH TABLE
0644	11100001 10011011	0560	JMP WRS2	DATA READY

HARD DISK CONTROLLER FIRMWARE LISTING -- VERSION 4.3 10 APR 78 PAGE # 17

OBJ LOC	OBJECT WORD	SOURCE NBR	SOURCE LINE	COMMENT
0645	11100001 10100111	0561	JMP WRS4	TRANSFER END
0646	11100001 10100111	0562	JMP WRS4	TRANSFER END & MORE DATA
0647	.....	0563	EQU *	
0647	11000000 11111111	0564	XMIT AUX,255	DELAY FOR POSTAMBLE
0650	11000100 00101000	0565	XMIT R4,40	
0651	00100100 00000100	0566	ADD R4,R4	
0652	10100100 10101001	0567	NZT R4,*-1	
0653	11000111 00010010	0568	XMIT IVL,18	STOP WRITING
0654	11010011 00100001	0569	XMIT IV(3,1),1	
0655	11000111 00100101	0570	XMIT IVL,37	STOP TRANSFER
0656	11010001 00100000	0571	XMIT IV(1,1),0	
0657	11100000 00010011	0572	JMP COMM	RETURN TO COMMAND
0660	.....	0573	*/PAGE/	
0660	.....	0574	*	
0660	.....	0575	** SELECT DRIVE SUBROUTINE	
0660	.....	0576	*	
0660	00000001 01000001	0577	SELECT MOVE R1(2),R1	GET DRIVE # IN 2 LOW BITS
0661	11000000 00000011	0578	XMIT AUX,3	MASK OFF REST OF R1
0662	01000001 00000000	0579	AND R1,AUX	
0663	11000111 00010001	0580	XMIT IVL,17	SELECT SELECT CTL WORD
0664	10000000 11000101	0581	XEC AUX,SELTAB	SET THE BITS
0665	11000000 00000100	0582	XMIT AUX,4	INVERSION MASK
0666	01100010 10100000	0583	XOR R2(5),AUX	GET HEAD#
0667	00000000 01110011	0584	MOVE AUX,IV(3,3)	SEND TO INTERFACE
0670	11000111 00010101	0585	XMIT IVL,21	GET WRITE PROTECT BIT...
0671	00010010 00100000	0586	MOVE IV(2,1),AUX	
0672	11000111 00000010	0587	XMIT IVL,2	...AND MOVE TO ERR BYTE
0673	00000000 00110000	0588	MOVE AUX,IV(0,1)	...HIGH BIT
0674	.....	0589	*	
0674	.....	0590	*	
0674	11000111 00010101	0591	XMIT IVL,21	CHECK FOR DRIVE READY
0675	10110000 00111111	0592	NZT IV(0,1),SELRET	
0676	11100001 11001001	0593	JMP ERROR	
0677	10001001 10111111	0594	SELRET XEC R11,*	RETURN
0700	11100000 00110100	0595	JMP SEEK1	RETURN 1 - SEEK

OBJ LOC	OBJECT WORD	SOURCE NBR	SOURCE LINE	COMMENT
0701	11100000 01000110	0596	JMP SECT2	2 = SECTOR
0702	11100000 10010011	0597	JMP FORMS	3 = FORMAT
0703	11100000 10001010	0598	JMP READU1	4 = READ UNFORMATTED
0704	11100000 01110110	0599	JMP STAT1	5 = STATUS
0705	.....	0600	SELTAB EQU *	
0705	11010111 10001110	0601	XMIT IV(7,4),14	DRIVE 1
0706	11010111 10001101	0602	XMIT IV(7,4),13	DRIVE 2
0707	11010111 10001011	0603	XMIT IV(7,4),11	DRIVE 3
0710	11010111 10000111	0604	XMIT IV(7,4),7	DRIVE 4
0711	.....	0605	*	
0711	11000111 00000010	0606	ERROR XMIT IVL,2	BIT 7 OF IV-BYTE 2 ...
0712	11010111 00100001	0607	XMIT IV(7,1),1	... SET FOR "DRIVE NOT READY"
0713	11100000 00010011	0608	JMP COMM	
0714	.....	0609	*/PAGE/	
0714	.....	0610	*	
0714	.....	0611	** DDSET -- SET UP DISK DATA BOARD	
0714	.....	0612	*	
0714	.....	0613	DDSET EQU *	
0714	11000111 00100101	0614	XMIT IVL,37	SET UP DISK DATA CONTROLS
0715	00000000 00110010	0615	MOVE AUX,IV(2,1)	SET READ/WRITE MODE
0716	11010001 01000010	0616	XMIT IV(1,2),2	SET CRCAPE, NO START
0717	11010111 10000000	0617	XMIT IV(7,4),0	SET SMS, NO ACK, CLEAR
0720	11010100 00100001	0618	XMIT IV(4,1),1	RESET CLEAR
0721	11000111 00100011	0619	XMIT IVL,35	SELECT CONTROL BYTE
0722	11010011 10001111	0620	XMIT IV(3,4),15	RESET LOAD STROBES
0723	00000100 10010111	0621	MOVE R4,IV(7,4)	
0724	11010011 00100000	0622	XMIT IV(3,1),0	NIBBLE 1
0725	11010011 00100001	0623	XMIT IV(3,1),1	
0726	00000100 10000100	0624	MOVE R4(4),R4	ROTATE TO GET NEXT
0727	00000100 10010111	0625	MOVE R4,IV(7,4)	
0730	11010010 00100000	0626	XMIT IV(2,1),0	NIBBLE 2
0731	11010010 00100001	0627	XMIT IV(2,1),1	
0732	00000011 10010111	0628	MOVE R3,IV(7,4)	
0733	11010001 00100000	0629	XMIT IV(1,1),0	NIBBLE 3
0734	11010001 00100001	0630	XMIT IV(1,1),1	

OBJ LOC	OBJECT WORD	SOURCE NBR	SOURCE LINE	COMMENT
0735	00000011 10000011	0631	MOVE R3(4),R3	ROTATE TO GET NEXT
0736	00000011 10010111	0632	MOVE R3,IV(7,4)	
0737	11010000 00100000	0633	XMIT IV(0,1),0	NIBBLE 4
0740	11010000 00100001	0634	XMIT IV(0,1),1	
0741	11000111 00100101	0635	XMIT IVL,37	LEAVE SETUP FOR R/W MODE SELECT
0742	11010100 00100000	0636	XMIT IV(4,1),0	SET CLEAR
0743	11010100 00100001	0637	XMIT IV(4,1),1	RESET CLEAR
0744	10001001 11100100	0638	XEC R11,*	RETURN TO CALLER
0745	11100001 00100011	0639	JMP RDS1	RETURN 1 - READSUB
0746	11100001 10001100	0640	JMP WRS1	2 - WRITSUB
0747	11100000 11010000	0641	JMP READH1	3 - READHD
0750	11100000 10001110	0642	JMP READU2	4 - READ UNFORMATTED
0751	11100001 01001101	0643	JMP WRITH1	5 - WRITHED
0752	.....	0644	*/PAGE/	
0752	.....	0645	*	
0752	.....	0646	**	SECTOR WAIT SUBROUTINE
0752	.....	0647	*	
0752	.....	0648	SECTW EQU *	
0752	11000011 00011000	0649	XMIT R3,24	COUNT DOWN 24 SECTOR PULSES
0753	11000111 00010110	0650	XMIT IVL,22	WAIT ON SECTOR PULSE...
0754	10110000 00101100	0651	SECTWO NZT IV(0,1),*	...TO GO LOW
0755	10010000 00101101	0652	XEC IV(0,1),*	...AND THEN HIGH
0756	11000000 00011111	0653	XMIT AUX,31	GET 5 BIT MASK
0757	01000010 00000000	0654	AND R2,AUX	MASK OFF SECTOR
0760	01110111 10100000	0655	XOR IV(7,5),AUX	COMPARE TO SECTOR COUNTER
0761	10100000 11110110	0656	NZT AUX,SECTW1	IF DIFF., TRY AGAIN
0762	10001001 11110000	0657	XEC R11,*-2	RETURN TO CALLER
0763	11100000 11010001	0658	JMP READH2	3 - READHD
0764	11100000 10001111	0659	JMP READU3	4 - READUN
0765	11100001 01001110	0660	JMP WRITH2	5 - WRITHED
0766	.....	0661	*	
0766	11000000 11111111	0662	SECTW1 XMIT AUX,255	DECREMENT SECTOR COUNT
0767	00100011 00000011	0663	ADD R3,R3	
0770	10100011 11101100	0664	NZT R3,SECTWO	MORE TO GO ?
0771	11000111 00000010	0665	XMIT IVL,2	SET BIT 6 OF IV-BYTE ?

OBJ LOC	OBJECT WORD	SOURCE NBR	SOURCE LINE	COMMENT	
0772	11010110 00100001	0666	XMIT	IV(6,1),1	... FOR "BAD SECTOR" ERROR
0773	11100000 00010011	0667	JMP	COMM	