Overview

The **CAT** (Computer Aided Transceiver) System in the **MARK-V FT-1000MP** provides control of frequency, VFO, memory, and other settings such as dual-channel memories and diversity reception using an external personal computer. This allows multiple control operations to be fully automated as single mouse clicks or keystroke operations on the computer keyboard.

The **MARK-V FT-1000MP** has a built-in level converter, allowing direct connection from the rear-panel **CAT** jack to the serial port of your computer without the need of any external boxes.

Each time a command instruction is being received from the computer via the **CAT** port, the "**CAT**" indicator appears in the display, then turns off afterward. You will need a serial cable for connection to the RS-232C (serial or COM port) connector on your computer. Purchase a standard serial cable (not the so-called "null modem" type), ensuring it has the correct gender and number of pins (some serial COM port connectors use a 9-pin rather than 25-pin configuration). If your computer uses a custom connector, you may have to construct the cable. In this case, refer to the technical documentation supplied with your computer for correct data connection.

Vertex Standard does not produce **CAT** System operating software due to the wide variety of personal computers and operating systems in use today. However, the information provided in this chapter explains the serial data structure and opcodes used by the **CAT** system. This information, along with the short programming examples, is intended to help you start writing programs on your own. As you become more familiar with **CAT** operation, you can customize programs later on for your operating needs and discover the true operating potential of this system.

CAT Data Protocol

Serial data is passed via the **CAT** jack on the rear panel of the transceiver at 4800 bits/sec. All commands sent from the computer to the transceiver consist of five-byte blocks, with up to 200 ms between each byte. The last byte sent in each block is the instruction opcode, while the first four bytes of each block are arguments: either parameters for that instruction, or dummy values (required to pad the block out to five bytes):

CAT 5-BYTE COMMAND STRUCTURE				
Byte 1	Byte 2	Byte 3	Byte 4	Byte 5
Argument	Argument	Argument	Argument	Instruction OPCODE

Each byte sent consists of one start bit, 8 data bits, no parity bit and two stop bits:

CAT DATA BYTE FORMAT										
Start Bit	0	B	1	1	1	1	1	1	Stop Bit	Stop Bit

There are twenty-nine instruction opcodes for the **MARK-V FT-1000MP**, listed in the table on pages 94 ~ 97. Most of these duplicate menu programming settings or options, or else emulate front panel button functions. Notice that several instructions require no specific parameters. However, every Command Block sent to the transceiver must always consist of five bytes.

The **CAT** control program you are writing must construct the 5-byte block, by selecting the appropriate instruction opcode, organizing the parameters, if any, and providing unused (dummy) argument bytes for padding the block to its required 5-byte length (the dummy bytes can contain any value). The resulting five bytes are then sent, opcode last, from the computer to the **MARK-V FT-1000MP** CPU via the serial port and **CAT** jack on the transceiver rear panel.

CONSTRUCTING AND SENDING CAT COMMANDS

Example #1: Set Main VFO-A to 14.25000 MHz;

- ❒ First determine the opcode for the desired instruction by referring to the CAT Commands Table. A good idea would be to store these opcodes within the program, so they can be looked up when the user requests the corresponding command.
- ❒ Here the instruction is "Set Main VFO Frequency," so the opcode (last byte of the block) is **0A**H.
  Note - "H" s following each byte value indicate hexadecimal (base 16) values.
- ❒ Build the four argument byte values from the desired frequency by breaking it into 2-digit blocks (BCD "packed decimal" format). Note that a leading zero is always required in the hundreds-of-MHz place (and another in the tens-of-MHz if below 10 MHz).
- ❒ Breaking 14.250.00 MHz into its BCD component, we arrive at:

10's Hz	100's Hz	1's kHz	10's kHz	100's kHz	1's MHz	10's MHz	100's MHz
0	0	0	5	2	4	1	0
00		**50**		**42**		**01**	
Byte 1		Byte 2		Byte 3		Byte 4	

- ❒ Inserting the 4-byte BCD-coded frequency (00, 50, 42, 01), the resulting 5-byte block should now look like this (again, in hex format):

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5
00	**50**	**42**	**01**	**0A**H
DATA/ARGUMENT BYTES				OPCODE

- ❒ Send these five bytes to the transceiver, in the order shown in the table above - from left-to-right: **00 50 42 01 0A**H.

Example #2: Activate a RX Clarifier Offset of +3.5 kHz.

- ❒ Clarifier settings are controlled from opcode **09**H. The first four parameter bytes determine the type of offset, direction, and frequency displacement.
- ❒ According to the example, the first byte would be **50** (500 Hz), the second **03** (3000Hz), followed by **00**H (for +offset), **81**H (TX CLAR on) and then opcode **09**H. Remember that the 1st and 2nd bytes are in BCD format.
- ❒ Completing the command byte sequence, we would send, in sequence, **50**H, **03**H, **00**H, **81**H, **09**H, to effect the Tx Clarifier offset.

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5
50H	**03**H	**00**H	**81**H	**09**H
DATA/ARGUMENT BYTES				OPCODE

You should be getting a feel for the CAT command structuring sequence, let's move to the next step; reading transceiver operational data.

DOWNLOADING MARK-V FT-1000MP DATA

On command, the **MARK-V FT-1000MP** will download some or all (1,863 bytes) of its operational data. This data block contains all current transceiver settings. In addition, the current meter indication (Tx or Rx) is read, digitized and returned as well. This provides a wealth of information in near real-time that can be processed by your program or the running application for control purposes or display readouts. By regular or intermittent requests for this data, the program (and you) can be kept continuously up-to-date on the status of the **MARK-V FT-1000MP** operating environment.

The following four commands cause the **MARK-V FT-1000MP** to download various operational and internally stored settings via the CAT port:

Status Update (**10**H) - causes the transceiver to return all or portions of its RAM table (up to 1,863 bytes).

Status Flags Request (**FA**H) - obtains only the first 6 bytes (the Status Flags), plus 2 extra "Model ID" bytes (10H and 00H).

Read Meter (**F7**H) - returns the meter deflection (0 - FFH) repeated in four bytes, followed by one "filler" byte (F7H).

Pacing Command (**0E**H) - Each byte of returned data may be delayed by an interval determined by this command (0 to 255 ms in 1-ms steps). This delay is initially zero until the Pacing command is sent (see note below).

Note: Pacing allows returned data to be read and processed by slower computers. However, set it as short as your computer will allow, to minimize the inconvenience of the delay. Sending all 1,863 bytes requires just under 5 seconds with zero-length delay selected, but over 5 minutes if the maximum delay is selected!

Parameter	Bytes Returned	Data Returned	Comment
U = 00H	1,863	All Status Updata Data	See above Box - *Pacing Command*
U = 01H	1	Memory Channel No.	Current or Last Selected Memory
U = 02H	16	Current Operating Data (VFO or Memory)	See the Tables on page 91 and 92 for 16-byte data record structures
U = 03H	32 (2 x 16)	Main VFO-A & Sub VFO-B Data	
U = 04H※	16	Memory Data	
X = 00 ~ 71H	NA	X = Memory (1~99, P1 ~ P5, Q1 ~ Q5) ※ only used when U = 04H	

STATUS UPDATE DATA ORGANIZATION

An overview of the Status Update Data that can be returned to the PC in response to one of the Status Update requests (opcodes **10**H, **FA**H, **F7**H, or **0E**H) is shown next page. The 1,863-byte block begins with six bytes, each containing one-bit state Status Flags (**A**), for a total of 48 bits, followed by one byte indicating the current (or last selected) Memory Channel (**B**), followed by 116 x 16-byte data records: one for the current Operating Data (**C**), one each for VFO-A (**D**) and VFO-B (**E**), and one for each of the 113 memories (**F**).

Of the four commands that cause Status Update to be returned, remember that only opcode 10H (with its last argument set to zero) returns all of the data (see bottom left of this page).

STATUS FLAGS (BYTES 1~ 6)

Each of the first six bytes are subdivided into 1-bit flag fields: if a bit is set (1), the function is enabled (on); and if reset (0), the function is disabled (off). These flags reflect the current states of various transceiver functions, most of which appear in the radio display as indicators or LEDs. The Status Flags command returns these bytes for use in the control program (you could replicate these indicators on the computer display, or else use them as control flags for routines, etc.). Bit offsets for all six bytes is shown on page 89.

MEMORY CHANNEL DATA (BYTE 7)

The seventh Update Data Byte contains a binary value from **00** ~ **70**H, corresponding to the current memory channel number on the display. Only this byte is returned by sending the Status Update command with the first parameter set to 1. The chart on page 90 lists the corresponding hexadecimal codes for memory channels 01 ~ 99, P1 ~ P9, and QMB memories 1 ~ 5.

16-BYTE DATA RECORDS (BYTES 8 ~ 1863)

The remainder of the operational data returned by the Status Update command consist of 16-byte data records, indicating VFO and memory-specific selections. The first of these records is for the current display, followed by the VFO-A, VFO-B, and then the 113 memory channels, from lowest to highest. Please review the table at the top left column on page 91, which outlines the structure of a 16-byte data record. Each byte is identified by its offset from the start (base address) of the record. A further breakdown of each byte offset is also provided.

Note that this same 16-byte data record format is used for the VFO and Memory Data as well, unless you are currently operating on a retuned memory ("**M TUNE**" displayed).

Status Update Data Organization

1863-Byte Status Updata Data (sent L-to-R)

Status Flags	Memory Channel No.	Operating Data	VFO-A Data	VFO-B Data	Memory Data
6 byte	1 byte	16 byte	16 byte	16 byte	16 bytes (x 113 memories = 1808 bytes total)
(A)	(B)	(C)	(D)	(E)	(F)

6-Byte Status Flags Record Table

Bit Offset	STATUS FLAG BYTE #1 CONTENTS
0	Split Frequency Operation
1	Dual Receive Operation
2	Antenna Tuning In Progress
3	CAT System Activated
4	SUB VFO-B In-Use (Rx/Tx LED on)
5	Keypad Entry In Progress
6	Main Receiver Muted
7	PTT Keyed (Tx Active)

Bit Offset	STATUS FLAG BYTE #2 CONTENTS
0	5-sec. MEM CHK Timer Active
1	Memory Checking In Progress
2	Dual VFO Tracking Active
3	Quick Memory Bank Selected
4	Memory Tuning Active
5	VFO Operation
6	Memory Operation
7	General Coverage Reception

Bit Offset	STATUS FLAG BYTE #3 CONTENTS
0	FAST Tuning Active
1	Antenna Tuner (ATU) In-Line
2	SUB VFO-B Locked
3	MAIN VFO-A Locked
4	Squelch Closed
5	Scan Direction (Up/Down)
6	Scan Paused
7	Auto Memory Write Scanning Active

Bit Offset	STATUS FLAG BYTE #4 CONTENTS
0	2nd IF 455 kHz Filter Selection Active
1	1st IF 8.2 MHz Filter Selection Active
2	N/A
3	N/A
4	PTT Keyed via CAT Command
5	General Coverage TX Inhibit
6	Key Release Timer Active
7	Tx Inhibit

Bit Offset	STATUS FLAG BYTE #5 CONTENTS
0	RTTY TX Idle
1	N/A
2	N/A
3	Grouped Memory Mode Active
4	ANT B Selected
5	RX ANT Selected
6	PMS Tuning Active
7	AM Synchronous Mode Active

Bit Offset	STATUS FLAG BYTE #6 CONTENTS
0	Sub Receiver Audio Muted
1	Main Receiver Audio Muted
2	Dual VFO Tracking
3	N/A
4	N/A
5	VFO Channel Stepping
6	Tuner Wait (while tuning)
7	AM Synchronous Mode Active

Selecting Update Data to Download

As mentioned before, there are four opcodes that cause the **MARK-V FT-1000MP** to report (update) its operating status by downloading all or a portion of its 1,863 data bytes. These opcodes are shaded in the **CAT** Commands table (pages 94 ~ 97).

Status Update (Opcode **10**H) - The 1st and 4th parameters of this command allow selecting different portions of Status data to be returned, as follows ("X" is the 1st parameter, "U" is the 4th):

Read Flags (Opcode **FA**H) -This command can be set to retrieve all six Status Flag bytes, or else five bytes - three Status Flag Bytes, plus two transceiver ID bytes. The Status Flag Bytes are described on the preceding page, and in the Record Tables on the previous page.

The transceiver ID bytes are used in programs to distinguish the **MARK-V FT-1000MP** from other models, which have different, unique values returned in this situation. The constant values of **03**H and **93**H are returned by the **MARK-V FT-1000MP** (and only the **MARK-V FT-1000MP**), as shown:

Flag Byte 1	Flag Byte 2	Flag Byte 3	ID Byte 1 (03H)	ID Byte 2 (93H)

Read Meter Data (Opcode **F7**H) - Sending this command returns a digitized meter deflection indication, between **00** and **FF**H (usually around **F0**H maximum). Four copies of this value are returned, along with one padding byte (**F7**H), as follows:

Meter Byte	Meter Byte	Meter Byte	Meter Byte	F7H

During reception, the signal strength deflection is returned. During transmission, the parameter represented by the reading returned depends on the setting of the **METER** switch.

1-Byte Memory Channel Number Data Structure

This identifies the current or last-selected memory channel 1 ~ 99, P1 ~ P5 or QMB 1 ~ 5 for operation. The table below translates hexadecimal codes into corresponding memory channel numbers. Please read the note in the box at the page bottom.

Memory Channel Data (Hex Codes)

Ch.	Hex	Ch.	Hex	Ch.	Hex	Ch.	Hex
01	00H	31	1EH	61	3CH	91	5AH
02	01H	32	1FH	62	3DH	92	5BH
03	02H	33	20H	63	3EH	93	5CH
04	03H	34	21H	64	3FH	94	5DH
05	04H	35	22H	65	40H	95	5EH
06	05H	36	23H	66	41H	96	5FH
07	06H	37	24H	67	42H	97	60H
08	07H	38	25H	68	43H	98	61H
09	08H	39	26H	69	44H	99	62H
10	09H	40	27H	70	45H	P1	63H
11	0AH	41	28H	71	46H	P2	64H
12	0BH	42	29H	72	47H	P3	65H
13	0CH	43	2AH	73	48H	P4	66H
14	0DH	44	2BH	74	49H	P5	67H
15	0EH	45	2CH	75	4AH	P6	68H
16	0FH	46	2DH	76	4BH	P7	69H
17	10H	47	2EH	77	4CH	P8	6AH
18	11H	48	2FH	78	4DH	P9	6BH
19	12H	49	30H	79	4EH	Q1	6CH
20	13H	50	31H	80	4FH	Q2	6DH
21	14H	51	32H	81	50H	Q3	6EH
22	15H	52	33H	82	51H	Q4	6FH
23	16H	53	34H	83	52H	Q5	70H
24	17H	54	35H	84	53H		
25	18H	55	36H	85	54H		
26	19H	56	37H	86	55H		
27	1AH	57	38H	87	56H		
28	1BH	58	39H	88	57H		
29	1CH	59	3AH	89	58H		
30	1DH	60	3BH	90	59H		

Important Note!

The Hex Memory Channel Codes for returned memory data shown above (Byte 7) ***are different*** than those used in upload command data (opcodes)!

The memory channel hex codes used as argument (parameter) bytes for opcodes are offset by one (that is, one value greater) from their returned data counterparts. Therefore the channel hex codes used in opcodes **02**H, **03**H, and **0D**H would range from **01**H ~ **71**H.

When constructing command block bytes, ensure that the correct memory channel hex code is used!

16-Byte Data Record Structure

The following tables outline the 16-byte data record structure common to the Operating Data, VFO-A, VFO-B and Memory Data records. The table below shows assignments for each of the 16-bytes in the Operating Data Record.

Byte	16-Byte Data Record Assignment
0	Band Selection
1	Operating Frequency
2	
3	
4	
5	Clarifier Offset
6	
7	Operating Mode
8	IF Filter Offset
9	VFO/MEM Operating Flags
A ~ F	Not Used

Band Selection - The 0.1~30 MHz transceiver operating range is divided into 28 bands, represented in hexadecimal format in the table below. Data read in this record after downloading is in binary format, and must be converted to hexadecimal, then translated to the corresponding band.

Hex Code	Band	Hex Code	Band
01H	0.1 ~ 0.5 MHz	0FH	10.5 ~ 12.0 MHz
02H	0.5 ~ 1.5 MHz	10H	12.0 ~ 14.0 MHz
03H	1.5 ~ 1.8 MHz	11H	14.0 ~ 14.5 MHz
04H	1.8 ~ 2.0 MHz	12H	14.5 ~ 15.0 MHz
05H	2.0 ~ 2.5 MHz	13H	15.0 ~ 18.0 MHz
06H	2.5 ~ 3.0 MHz	14H	18.0 ~ 18.5 MHz
07H	3.0 ~ 3.5 MHz	15H	18.5 ~ 21.0 MHz
08H	3.5 ~ 4.0 MHz	16H	21.0 ~ 21.5 MHz
09H	4.0 ~ 6.5 MHz	17H	21.5 ~ 22.0 MHz
0AH	6.5 ~ 7.0 MHz	18H	22.0 ~ 24.5 MHz
0BH	7.0 ~ 7.5 MHz	19H	24.5 ~ 25.0 MHz
0CH	7.5 ~ 8.0 MHz	1AH	25.0 ~ 28.0 MHz
0DH	8.0 ~ 10.0 MHz	1BH	28.0 ~ 29.0 MHz
0EH	10.0 ~ 10.5 MHz	1CH	29.0 ~ 30.0 MHz

The Band Selection data byte is divided into two 4-bit fields, representing the first and second value of the band number hex code. The Bit 0 and Bit 1 of the first field are used as flags for the memory mask and scan skip feature. A bit value of "1" means enabled, and "0" for disabled. Each value of the hex code is entered into its respective field in 4-bit binary format. The table below outlines the Data Byte field, and show an example of how the 24.5 ~ 25.0 MHz band would be read as:

Band Selection Data Byte (0)							
Bit 0*	Bit 1**	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7
Field 1				Field 2			
0*	0**	0	1	1	0	0	1
*Mem Mask	**Scan Skip	0001 = 1		1001 = 9			
"0" = Off "1" = On		19H = 24.5 ~ 25.0 MHz (refer to band chart)					

Operating Frequency - Likewise, the current operating frequency is similarly coded, this time into four bytes comprised of eight fields, from MSB to LSB. For example, a read binary value of 0000 0000 0001 0101 1011 1110 0110 1000 is 15BC68 (HEX) = 14.250.00 MHz as follows:

Operating Frequency Data Bytes (1-4)							
Byte 1		Byte 2		Byte 3		Byte 4	
Field 1 MSB	Field 2	Field 3	Field 4	Field 5	Field 6	Field 7	Field 8 LSB
0 0 0 0	0 0 0 0	0 0 0 1	0 1 0 1	1 0 1 1	1 1 1 0	0 1 1 1	1 0 0 0
0	0	1	5	B	C	6	8
0015BC68 (HEX) = 1,425,000 = 14.250.00 MHz							

Clarifier Offset - Clarifier offset is written using 16-bit binary data in two bytes. Negative offsets are expressed in binary 2s-complement format, with a leading bit flag value* of "1." Although frequency resolution below 10 Hz cannot be viewed, absolute Clarifier offsets down to 0.625 Hz can be read from downloaded data.

Arithmetic conversion must be done on the binary value to arrive at the actual frequency offset (multiplying the 16-bit binary offset by 0.625). For example, a binary value of 0011 1110 0110 1111 (3E6FH or 15,983) multiplied by 0.625 results in an offset of +9989.375 Hz.

16-Byte Data Record Structure

A value of 1011 1110 0110 1111 (the 2-s complement of the previous example) produces a minus offset of -9989.375 Hz. See the byte chart below for a breakdown of the conversion process.

Clarifier Offset Data Bytes (5-6)															
Byte 5								**Byte 6**							
1*	0	1	1	1	1	1	0	0	1	1	0	1	1	1	1
1* ("–" flag) 011 1110 0110 1111 = (–) 3E6F (HEX) = (–)15,983 (–)15,983 x 0.625 = (–) 9989.375 Hz															
***Note -** Remember that the first bit is a flag: "0" for positive offsets, "1" for negative offsets, and is not included in calculations.															

Operating Mode - The operating mode is expressed as a three-bit binary code in offsets 5 ~ 7. Bit 0 contains a User Mode flag, while Bits 1~4 contain "dummy" values (unused).

Operating Mode Byte (7)							
Bit 0*	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7
User Mode	N/A - "dummy bytes				Mode Data (3-bit Code)		
0	X	X	X	X	**0**	**1**	**0**
0XXXX010 = CW operation, User Mode Off							
0 = off 1 = on	Bits 1 ~ 3 are "dummy bits" - any 1/0 combination may appear in here, but is insignificant.				LSB 000 USB 001 CW 010 AM 011 FM 100 RTTY 101 PKT 110		

IF Filter Selection - The first data bit (Bit 0) contains a flag indicating normal or alternate reception mode (see table). The remainder of the data byte contains 2 x 4-bit fields separated by a dummy bit. The first field holds the 3-bit binary code for the 8.2 MHz 2nd IF filter selection, while the second holds the 455 kHz 3rd IF selection. Codes are listed in the bottom of the table below.

IF Filter Selection Byte (8)							
Bit 0*	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7
RX Mode	**8.2 MHz 2nd IF** Thru 000 2.4k 001 2.0k 010 500 011 250 100			X	**455 kHz 3rd IF** 6.0k 000 2.4k 001 2.0k 010 500 011 250 100		
Mode*	**CW**	**AM**	**RTTY**	**PKT**			
0	USB	ENV	LSB	LSB			
1	LSB	SYNC	USB	FM			

VFO/MEM Indicators - Five flags indicate the status of Clarifier (Rx & Tx), Repeater Offset (+/-), and Antenna Selection (A/B/RX). Bits 0 and 1 are not used (dummy values).

Clarifier, RPT, ANT Status Byte (9)							
Bit 0*	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7
TX CLAR	RX CLAR	+RPT	–RPT	ANT SELECT		X	X
Note: for all flag bits, 1 = On, 0 = Off for ANT SELECT: 00 = ANT-A, 01 = ANT-B, 10 = RX ANT							

Coding Examples

Although Vertex Standard does not provide CAT control software (owing to the large variety of computers and operating systems used by our customers), the following are a few examples of critical CAT I/O functions, in Basic. Note that all variations of Basic may not support some of the commands, in which case alternate algorithms may need to be developed to duplicate the functions of those shown.

Sending a Command

After "opening" the computer's serial port for 4800-baud, 8 data bits and 2 stop bits with no parity, as I/O device #2, any CAT command may be sent. However, if you determine that your computer may need extra time to process data returned from the transceiver, you should send the Pacing command first. Here is an example of the Pacing command setting a 2-ms delay:

PRINT #2,
CHR$(0);CHR$(0);CHR$(0);CHR$(2);CHR$(&HE);

Notice that the instruction opcode is sent last, with the first (MSB) parameter sent just before it, and the LSB parameter (or dummies) sent first. This means that the parameters are sent in the reverse order from that in which they appear in the CAT Commands table. Also note that in this and the following examples, we are sending zeros as dummy bytes; this is not necessary, however. If you decide to send commands through a 5-byte array, the values of the dummy parameters need not be cleared. Also note the semicolon at the end of the line, to prevent Basic from sending extra bytes to "end the line" (the CAT system control system is based on binary streams, not text streams).

Using the same example as on page 87, the following command could be used to set the frequency of the display to 14.25000 MHz:

PRINT #2,
CHR$(&H00);CHR$(&H50);CHR$(&H42);CHR$(&H01);
CHR$(&HA);

Notice here that the BCD values can be sent just by preceding the decimal digits with "&H" in this example. However, in an actual program, it may be preferable to convert the decimal frequency variable in the program to an ASCII string, and then to convert the string to characters through a lookup table.

If you send a parameter that is out of range for the intended function, or not among the specified legal values for that function, the **MARK-V FT-1000MP** should do nothing. Therefore, you may wish to alternate your sending regular commands or command groups with the Read Flags or short-form Update commands, allowing the transceiver to let the computer know if everything sent so far has been accepted and acted upon as expected.

Bear in mind that some commands specify "binary," as opposed to BCD formatted parameters. You can send binary parameters without going through the character/hex string conversion process. For example, the CH parameter in the Command table is a binary value. You could have the **MARK-V FT-1000MP** recall memory channel 50 (decimal) by the following:

PRINT#2,
CHR$(0);CHR$(0);CHR$(0);CHR$(49);CHR$(2);

Note that we must send 49 to get channel 50, since the channel numbers in the command start from 0, while those on the display start with 1.

Reading Returned Data

The reading process is easily done through a loop, storing incoming data into an array, which can then be processed after the entire array has been read. To read the meter:

FOR I=1 TO 5
MDATA(I) = ASC(INPUT$(1,#2))
NEXT I

Recall from above that the meter data consists of four identical bytes, followed by a filler byte, so we really only need to see one byte to get all of the information this command offers. Nevertheless, we must read all five bytes (or 1, 16, or 1,863, in the case of the Update data). After reading all of the data, we can select the bytes of interest to us from the array (MDATA, in the above example).

Opcode Command Chart (1)

Command or Key	Parameter Bytes				Opcode	Parameter Description
	1st	2rd	3rd	4th	5th	
SPLIT	–	–	–	T	**01**H	Split Tx/Rx operation ON (T = **01**H) or OFF (T = **00**H)
Recall Memory	–	–	–	X	**02**H	Recalls memory number X: **01**H ~ **71**H, corresponding to memories 1 ~ 99, P1 ~ P9, and QMB 1 ~ QMB 5.
VFO/MEM	–	–	K	X	**03**H	Enter (K = **00**H), Mask (K = **01**H) or Un-Mask (K = **02**H), memory channel X (**01**H ~ **71**H).
LOCK	–	–	–	P	**04**H	Tuning knob Lock/Unlock: P = **00**H: Main Dial Lock P = **01**H: Main Dial Unlock P = **02**H: Sub Dial Lock P = **03**H: Main Dial Unlock
A/B	–	–	–	V	**05**H	Select VFO-A (V = **00**H), or VFO=B (V = **02**H).
[M►B]	–	–	–	X	**06**H	Copy memory X (**01**H ~ **71**H) to last-used VFO.
UP (▲)	–	–	U	V	**07**H	Step VFO-A/B (V = **00**H/**01**H) *up* by 100 kHz/1 MHz (U = **00**H/**01**H).
DOWN (▼)	–	–	D	V	**08**H	Step VFO-A/B (V = **00**H/**01**H) *down* by 100 kHz/1 MHz (D = **00**H/**01**H).
CLAR	C1	C2	C3	C4	**09**H	Clarifier offset direction & frequency in BCD C1 = Hz offset (C1 = **00**H ~ **99**H) C2 = kHz offset (C2 = **00**H ~ **09**H) C3 = Hz offset (C3 = **00**H/**FF**H) Clarifier On/Off/Reset: C4 = RX CLAR ON/OFF (C4 = **00**H/**01**H) TX CLAR ON/OFF (C4 = **80**H/**81**H) CLAR CLEAR (C4 = **FF**H)
Set Main VFO-A Operating Freq.	F1	F2	F3	F4	**0A**H	New operating frequency in BCD format (F1 ~ F4) see text for formatting example.
MODE	–	–	–	M	**0C**H	Select Operating Mode M: LSB: M = **00**H USB: M = **01**H CW: M = **02**H CW (R): M = **03**H AM: M = **04**H AM(Sync): M = **05**H FM: M = **06**H FM-W: M = **07**H RTTY (L): M = **08**H RTTY (U): M = **09**H PKT (L): M = **0A**H PKT (F): M = **0B**H
Pacing	–	–	–	N	**0E**H	Add N-millisecs (**00**H ~ **FF**H) delay between each byte of all downloaded data returned from the transceiver
PTT	–	–	–	T	**0F**H	Transmitter ON (T = **01**H) or OFF (T = **00**H)
Status Update	X	–	–	U	**10**H	Instructs the radio to return 1, 16, 32, or 1863 bytes of Status Updata data. X is significant only when U = 1 ~ 4. X = 00H ~ 71H: desired memory channel (1 ~ 99, P1 ~ P9, or QMB 1 ~ QMB 5) U = 00H All 1863 byte U = 01H 1-byte Memory Channel Number U = 02H 16-byte Operating Data U = 03H 2 x 16-byte VFO (A & B) Data U = 04H 1 x 16-byte Memory Data

Opcode Command Chart (2)

Command or Key	Parameter Bytes				Opcode	Parameter Description
	1st	2rd	3rd	4th	5th	
Electronic Keyer	K1	K2	K3	K4	**70H**	Activates remote control and contest keyer functions. K1 = **00**H (fixed value) K2 = keyer function: **00**H = Message 0 **01**H = Message 1 **02**H = Message 2 **03**H = Message 3 **04**H = CQ/ID Message **05**H = Contest Number **06**H = Decrement Contest Number **07**H = Increment Contest Number **08**H = Message Playback m/o Tx **09**H = Write Message into Memory K3 = **01**H (fixed value) K4 = **1B**H (fixed value)
EDSP Enhanced Digital Signal Plocessing	–	–	P1	P2	**75H**	EDSP Settings, where P2 is: RX EDSP OFF (**30**H), P1 = **00**H AM EDSP Demodulation On (**31**H), P1 = **00**H USB EDSP Demodulation (**32**H), with audio response of 100 Hz ~ 3.1 kHz (P1 = **00**H) or 300 Hz ~ 2.8 kHz (P1 = **10**H) LSB EDSP Demodulation (**33**H), with audio response of 100 Hz ~ 3.1 kHz (P1 = **00**H) or 300 Hz ~ 2.8 kHz (P1 = **10**H) AF Filter Off (**40**H), P1 = **00**H AF LPF On (**41**H), where P1 = [FCUTOFF (Hz)]/20 (HEX format) AF HPF On (**42**H), where P1 = [FCUTOFF (Hz)]/20 (HEX format) CW 240 Hz BWF (**45**H), where P1 = FCENTER (BCD format) CW 120 Hz BWF (**46**H), where P1 = FCENTER (BCD format) CW 60 Hz BWF (**47**H), where P1 = FCENTER (BCD format) Data Mode AF Filter On (**48**H), where P1 = FSK (**10**H), SSTV (**20**H), Packet (**30**H), or FAX (**40**H) Random Noise Filter (**4A**H) Off/On (P1 = **00**H/**1Y**H) Audio Notch Filter (**4B**H) Off/On (P1 = **00**H/**10**H) Noise Reducer (**4E**H), where P1 = Off (**00**H), NR A (**10**H), NR B (**20**H), NR C (**30**H), NR D (**40**H) TX EDSP Off (**B0**H) USB EDSP Modulation (**B2**H), with audio response of: 100 Hz ~ 3.1 kHz (P1 = **10**H), 50 Hz ~ 3.1 kHz (P1 = **20**H), 200 Hz ~ 3.1 kHz (P1 = **30**H), 300 Hz ~ 3.1 kHz (P1 = **40**H) LSB EDSP Modulation (**B3**H), with audio response of: 100 Hz ~ 3.1 kHz (P1 = **10**H), 150 Hz ~ 3.1 kHz (P1 = **20**H), 200 Hz ~ 3.1 kHz (P1 = **30**H), 300 Hz ~ 3.1 kHz (P1 = **40**H), TX Audio EDSP (**C1**H), where P1 = Off (**00**H), Bank 1 (**10**H), Bank 2 (**20**H), Bank 3 (**30**H), Bank 4 (**40**H)

Opcode Command Chart (3)

Command or Key	Parameter Bytes				Opcode	Parameter Description
	1st	2rd	3rd	4th	5th	
TUNER	–	–	–	T	**81**H	Switch Antenna Tuner ON (T = **01**H) or OFF (T = **00**H)
Tuner Start	–	–	–	–	**82**H	Start Antenna Tuning
Dual Operation	–	–	–	D	**83**H	Switch Dual Receive ON (D = **01**H) or OFF (D = **00**H)
[**RPT**]	–	–	–	R	**84**H	Switch Simplex Operation (R = **00**H), Minus Shift (R = **01**H), or Plus Shift (R = **02**H) for Repeater Operation
[A►B]	–	–	–	–	**85**H	Copy Data Display in VFO-A or VFO-B.
Set SUB VFO-B Operating Freq.	F1	F2	F3	F4	**8A**H	Enter new operating frequency in F1 ~ F4, in BCD format: see text for example.
BANDWIDTH 2nd & 3rd IF Filter Selection	X1	–	–	X4	**8CH**	Select filter bandwidth for selected IF (see below): **VFO-A** / **VFO-B** / **IF (VFO-A)** THRU: X4 = **04** / 6.0 kHz: X4 = **84** / Both: X1 = **00** 2.4 kHz: X4 = **00** / 2.4 kHz: X4 = **80** / 8.2 MHz: X1 = **01** 2.0 kHz: X4 = **01** / 2.0 kHz: X4 = **81** / 455 kHz: X1 = **02** 500 Hz: X4 = **02** / 500 Hz: X4 = **82** 250 Hz: X4 = **03** / 250 Hz: X4 = **83**
MEM. Channel Scan Skip	–	–	S	X	**8D**H	Tag memory channels 1 through 99 (X = **01**H ~ **6C**H), to be skipped (S = **01**H) or included (S = **00**H) while scanning.
Step VFO-A UP/DOWN	–	–	–	T	**8E**H	Step frequency of VFO-A UP (T = **00**H) or DOWN (T = **01**H)
CTCSS Encoder Tone Frequency Select	E	E	E	E	**90**H	Select one of 33 CTCSS subaudible tones where E = **00**H ~ **20**H E = **00**H 67.0 Hz / E = **0B**H 118.8 Hz / E = **16**H 173.8 Hz E = **01**H 71.9 Hz / E = **0C**H 123.0 Hz / E = **17**H 179.9 Hz E = **02**H 77.0 Hz / E = **0D**H 127.3 Hz / E = **18**H 186.2 Hz E = **03**H 82.5 Hz / E = **0E**H 131.8 Hz / E = **19**H 192.8 Hz E = **04**H 88.5 Hz / E = **0F**H 136.5 Hz / E = **1A**H 203.5 Hz E = **05**H 94.8 Hz / E = **10**H 141.3 Hz / E = **1B**H 210.7 Hz E = **06**H 100.0 Hz / E = **11**H 146.2 Hz / E = **1C**H 218.1 Hz E = **07**H 103.5 Hz / E = **12**H 151.4 Hz / E = **1D**H 225.7 Hz E = **08**H 107.2 Hz / E = **13**H 156.7 Hz / E = **1E**H 233.6 Hz E = **09**H 110.9 Hz / E = **14**H 162.2 Hz / E = **1F**H 241.8 Hz E = **0A**H 114.8 Hz / E = **15**H 167.9 Hz / E = **20**H 250.3 Hz
Read Meter & Panel Controls	–	–	–	–	**F7**H	Instruct radio to return digitized indications of various meter level readings and front panel control settings (4 repeated bytes, and **F7**H) selected by: M = **00**H Main S-Meter / M = **87**H TUN Meter M = **01**H Sub S-Meter / M = **F0**H Shuttle Jog Dial M = **80**H PO Meter / M = **F1**H CW Pitch Setting M = **81**H ALC Meter / M = **F2**H Remote Control A/D Level M = **83**H IC Meter / M = **F3**H SHIFT Setting M = **84**H VCC Meter / M = **F4**H WIDTH Setting M = **85**H SWR Meter / M = **F5**H EDSP Contour Selection M = **86**H MIC Meter / M = **F6**H EDSP NR Selection
Repeater Offset	X1	X2	X3	X4	**F9**H	Set offset for RPT shift, valid values are 0 ~ 500 kHz in 1-kHz step. Use BCD format for X2 ~ X4. X1 is 10’s & 100’s of Hz / X2 is 1’s & 10’s of kHz X3 is must be **00**H, **01**H, or **02**H / X4 is must be **00**H

Opcode Command Chart (4)

Command or Key	Parameter Bytes				Opcode	Parameter Description
	1st	2rd	3rd	4th	5th	
Read Internal Status Flags	–	–	–	F	**FA**H	Instructs radio to return either five or six status flag bytes. **5-Byte Format (F = 00H)**: Status Flag Byte #1, Status Flag Byte #2, Status Flag Byte #3, *ID Byte #1 (**03**H), *ID Byte #2 (**93**H) **6-Byte Format (F = 01H)**: Status Flag Byte #1, Status Flag Byte #2, Status Flag Byte #3, Status Flag Byte #4, Status Flag Byte #5, Status Flag Byte #6 * See page 89 for explanation of transceiver ID byte values.