# Optoelectronics, Inc.
# OPTOCOM™
# Serial Interface Specification

# Interface Version 1.1

**May 11, 1999**

## INTRODUCTION

This document describes the serial interface of the OPTOCOM™, a computer-controlled VHF/UHF Receiver.  The OPTOCOM™ provides a serial computer interface, as well as built-in circuitry to decode Dual-Tone Multi-Frequency (DTMF) digits, Continuous Tone-Controlled Squelch System (CTCSS) sub-audible tones, Digitally-Coded Squelch (DCS) codes, and Logic Trunked Radio (LTR) data. The OPTOCOM™ receiver, along with a personal computer and the appropriate application software, forms a complete computer-aided scanning system capable of receiving VHF/UHF signals in the range 25 - 520 MHz, 760 - 823.995 MHz, 849 - 868.995 MHz, and 894 - 1300 MHz.  AM, FM-narrowband, and FM-wideband modes are supported.

This document was written to assist the programmer in developing software applications for the OPTOCOM™.

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**ABOUT CI-5**

The serial interface on the OPTOCOM™ conforms to the Icom CI-V interface standard, with enhancements unique to Optoelectronics products.  The CI-5 interface is an asynchronous, half-duplex, Transistor Transistor Logic (TTL) serial interface connected in a wire-OR (bussed) configuration.  Several different devices can be connected to the bus simultaneously, and each device has its own unique address.  Software developers are strongly encouraged to obtain a copy of the *Icom Communication Interface - V Reference Manual* from Icom, Inc. for detailed information on the CI-V interface protocol.  The communications parameters for the serial interface are listed in Table 1 below.

**Table 1.  Communications Parameters.**

| DATA RATE | SELECTABLE |
|---|---|
| START BITS | 1 |
| DATA BITS | 8 |
| PARITY | NONE |
| STOP BITS | 1 |

On power up, the serial interface data rate is 9600 bps.  By issuing the proper command, the data rate can be changed.  Once the data rate has been changed, the new data rate remains in effect until it is changed again, or until the unit is powered down.

One important thing to note about the CI-5 interface is that, as mentioned above, it is connected in a wire-OR configuration.  This means that the transmit data signal and the receive data signal are connected together.  Therefore, when a command is transmitted by the computer, it is automatically echoed back as received data, followed by the response to the command, if any.  For example, if an eleven-byte command is transmitted to a device on the bus, which returns a six-byte response, the computer will receive a total of seventeen bytes.  This configuration allows devices on the bus to monitor their own transmissions in order to detect interface collisions.  A collision occurs when two or more devices transmit simultaneously.  If a collision occurs, the command must be re-transmitted.

The OPTOCOM™ includes a built-in CI-5 - to - RS-232C interface converter.  Its purpose is to convert the CI-5 interface voltage levels to RS-232C levels compatible with most personal computers.  This feature eliminates the need for an external interface converter box.  The RS-232C interface is available on the 9-pin female "D"-type connector located on the rear panel.  In addition, the RS-232C interface provides two optional interface signals, RTS and DCD, which can be used to significantly increase the scanning speed of the OPTOCOM™.  These signals and their functions are not a part of the Icom CI-V interface specification.  The use of these signals is described later.

For multiple-receiver applications, such as connection of one or more OPTOCOM™ receivers to one or more Icom receivers, two standard CI-5 miniature phone jacks are provided on the rear panel.  In this configuration, one or more CI-5 devices can be connected to the OPTOCOM™ by using one or both of the two CI-5 jacks provided.  If more than two additional devices are to be connected, external cabling such as common 3.5mm Y-adapters can be used to connect multiple devices.

## DTMF/CTCSS/NRZ DECODER

The OPTOCOM™ contains built-in circuitry to decode Dual-Tone Multi-Frequency (DTMF) digits, Continuous Tone-Controlled Squelch System (CTCSS) sub-audible tones, and NRZ data such as Digitally-Coded Squelch (DCS) codes, and Logic Trunked Radio (LTR) data. The DTMF/CTCSS/NRZ decoder operates continuously. However, decoding only takes place when the squelch is open, and CTCSS/NRZ decoding only takes place when FM-narrowband mode is selected.

The OPTOCOM™ is capable of decoding 16 DTMF digits. The specified maximum digit rate of the DTMF decoder is 10 digits per second. The specific DTMF digits decoded by the OPTOCOM™ are listed in Table 2 below.

**Table 2.  DTMF digits.**

| 1 | 2 | 3 | A |
|---|---|---|---|
| 4 | 5 | 6 | B |
| 7 | 8 | 9 | C |
| * | 0 | # | D |

The OPTOCOM™ is capable of decoding 52 CTCSS tones. The specified acquisition time of the CTCSS decoder is 200 milliseconds (0.2 seconds). At times it may be faster, or, if the incoming signal is weak or noisy, it may be slower. The specific CTCSS tones decoded by the OPTOCOM™ are listed in Table 3 below.

**Table 3.  CTCSS tones.**

| 60.0 | 100.0 | 151.4 | 192.8 |
|------|-------|-------|-------|
| 67.0 | 103.5 | 156.7 | 196.6 |
| 69.3 | 107.2 | 159.8 | 199.5 |
| 71.9 | 110.9 | 162.2 | 203.5 |
| 74.4 | 114.8 | 165.5 | 206.5 |
| 77.0 | 118.8 | 167.9 | 210.7 |
| 79.7 | 120.0 | 171.3 | 218.1 |
| 82.5 | 123.0 | 173.8 | 225.7 |
| 85.4 | 127.3 | 177.3 | 229.1 |
| 88.5 | 131.8 | 179.9 | 233.6 |
| 91.5 | 136.5 | 183.5 | 241.8 |
| 94.8 | 141.3 | 186.2 | 250.3 |
| 97.4 | 146.2 | 189.9 | 254.1 |

The OPTOCOM™ is capable of decoding 106 DCS codes. The specified acquisition time of the DCS decoder is 350 milliseconds (0.35 seconds). At times it may be faster, or, if the incoming signal is weak or noisy, it may be slower. The specific DCS codes decoded by the OPTOCOM™ are listed in Table 4 below.

**Table 4. DCS codes.**

| | | | | |
|---|---|---|---|---|
| 017 | 125 | 251 | 411 | 565 |
| 023 | 131 | 252 | 412 | 606 |
| 025 | 132 | 255 | 413 | 612 |
| 026 | 134 | 261 | 423 | 624 |
| 031 | 143 | 263 | 431 | 627 |
| 032 | 145 | 265 | 432 | 631 |
| 036 | 152 | 266 | 445 | 632 |
| 043 | 155 | 271 | 446 | 654 |
| 047 | 156 | 274 | 452 | 662 |
| 050 | 162 | 306 | 454 | 664 |
| 051 | 165 | 311 | 455 | 703 |
| 053 | 172 | 315 | 462 | 712 |
| 054 | 174 | 325 | 464 | 723 |
| 065 | 205 | 331 | 465 | 731 |
| 071 | 212 | 332 | 466 | 732 |
| 072 | 223 | 343 | 503 | 734 |
| 073 | 225 | 346 | 506 | 743 |
| 074 | 226 | 351 | 516 | 754 |
| 114 | 243 | 356 | 523 | |
| 115 | 244 | 364 | 526 | |
| 116 | 245 | 365 | 532 | |
| 122 | 246 | 371 | 546 | |

## PIPELINED TUNING

Perhaps the most significant feature of the OPTOCOM™ is its ability to pipeline the tuning operation. This is important because it significantly increases the maximum possible scanning speed of the receiver. By making use of this feature, scanning speeds of up to 80 channels per second are possible.

In non-pipelined computer-aided scanning systems, scanning each frequency involves three main steps performed in sequence. First, the command or commands to tune the receiver to the new frequency and/or mode must be issued. The amount of time required by this step depends on the number of bytes in the command or commands and their responses, and the serial interface data rate.

The second step involves the settling time of the receiver, once the new frequency and/or mode command or commands have been received. The receiver settling time includes the time necessary for the synthesizers to slew and re-acquire lock, the time necessary for the preselector filters to settle, and the time necessary for the squelch detection circuitry to respond. The settling time of the OPTOCOM™ receiver is 12 milliseconds (0.012 seconds) maximum.

Third, the command to request squelch status must be issued and the response returned. The amount of time required by this step is again dependent on the length of the command and its response, and the serial interface data rate.

To increase scanning speed, the overall time required for the three steps outlined above must be reduced. Receiver settling time is generally a function of the hardware architecture. Therefore, nothing much can be done to reduce the settling time, short of a fairly major re-design of the receiver hardware. The remaining area of concern is the transit time of commands and responses on the serial interface.

One obvious way to reduce the serial interface transit time is to simply increase the data rate. However, even at 19,200 bps, the practical limit of many PC-based serial ports, the collective transit time of the necessary commands and responses is several milliseconds.

The most desirable solution is to completely eliminate the serial interface transit time from impacting the scanning speed. This can be accomplished by the use of pipelining. The basic concept of the OPTOCOM™ pipelined tuning scheme is to take advantage of the otherwise wasted receiver settling time by sending the next frequency and mode to the receiver while it is still settling on the current frequency and mode. A special command, TRANSFER NEXT FREQUENCY/MODE, is provided in which the next frequency and mode are sent to the receiver, but do not take effect until commanded to do so. Therefore, the transit time of the command is totally transparent, as long as it is completed within the settling time of the receiver. This can be easily accomplished at an interface data rate of 19,200 bps. In fact, there is no advantage to increasing the data rate beyond 19,200 bps, since the limiting factor is the 12 millisecond receiver settling time.

To complete the operation, two hardware interface signals are added. First, the Request To Send (RTS) RS-232C interface signal is used as a hardware tuning command. Once the next frequency and mode have been sent to the receiver using the TRANSFER NEXT FREQUENCY/MODE command, the receiver is commanded to tune to the next frequency and mode by simply changing the state of the RTS signal. If it was previously negated, it is asserted. If it was previously asserted, it is negated. The receiver immediately begins settling on the next frequency and mode, which have now become the current frequency and mode.

Second, the Data Carrier Detect (DCD) RS-232C interface signal is used as a hardware squelch indicator. This eliminates the need to send a command over the serial interface to request squelch status, and wait for the response. The steps involved in implementing a fully pipelined computer-aided scanning system are summarized in Table 5 below.

**Table 5.  Pipelined Tuning Sequence.**

| | |
|---|---|
| **Step 1:** | Send the next frequency and mode to the receiver using the TRANSFER NEXT FREQUENCY/MODE command. |
| **Step 2:** | Change the state of the RTS interface signal to cause the next frequency and mode to become the current frequency and mode, and the receiver to begin settling. |
| **Step 3:** | While the receiver is still settling on the current frequency and mode, send the next frequency and mode to the receiver using the TRANSFER NEXT FREQUENCY/MODE command. |
| **Step 4:** | Wait for the receiver to finish settling. The total settling time, including sending the next frequency and mode, is 12 milliseconds (0.012 seconds). |
| **Step 5:** | Check the squelch status by reading the DCD interface signal. If the squelch is open, scanning is stopped. Otherwise, scanning continues. Optionally, the status of the DTMF/CTCSS/NRZ decoder can be checked, and the appropriate action taken. |
| **Step 6:** | Continuously repeat steps 2 through 5 above. |

Of course, either of the two hardware interface signals can be used without the other, but maximum scanning speed is achieved when both are used. It should be noted that the implementation of the RTS and DCD interface signals by the OPTOCOM™ is not a part of the Icom CI-V interface specification, which specifies only the serial interface protocol. If more than one OPTOCOM™ receiver is connected on the bus, then special hardware provisions must be made to provide RTS and DCD signals for each receiver. However, the details are beyond the scope of this specification. Alternatively, the appropriate serial interface commands can be used in place of the two hardware signals, but maximum scanning speed will be degraded.

**BitBanger™ MODE**

BitBanger™ mode is a special mode in which the OptoCom™ processor inputs raw data from the on-board data slicer at a selected data rate. The data is then transmitted to the host computer via the CI-5 port at the CI-5 interface data rate, 1 byte at a time.

To use BitBanger™ mode, the host computer must first select the desired data rate at which data is to be received from the data slicer. This is accomplished using the WRITE BIT BANGER DATA RATE command. BitBanger™ mode is then enabled using the WRITE BIT BANGER MODE command. Once enabled, BitBanger™ mode is activated or deactivated by asserting or negating the DTR serial interface signal, respectively. When BitBanger™ mode is enabled and activated, all normal CI-5 operation ceases, and raw data received from the data slicer is transmitted continuously to the host computer via the serial port. When the host computer has finished receiving data from the data slicer, normal CI-5 functionality can be restored by negating the DTR serial interface signal, and/or disabling BitBanger™ mode. When BitBanger™ mode is disabled (the power-up default state), the DTR serial interface signal is ignored.

It is important to note that no CI-5 commands or responses can be exchanged while BitBanger™ mode is enabled and activated. Therefore, the burden is on the host computer software to ensure that any CI-5 activity in progress is complete before activating BitBanger™ mode. For example, if a CI-5 command has been issued, the host computer should wait until the response is received before activating BitBanger™ mode.

It is also important to note that data received from the data slicer at the BitBanger™ data rate is transmitted to the host computer at the CI-5 interface data rate with no flow control. Therefore, the host computer software must ensure that the CI-5 interface data rate is sufficient to handle the selected BitBanger™ data rate. For example, if 3600 bps is chosen as the BitBanger™ data rate, then the power-up default CI-5 interface data rate of 9600 bps will be sufficient to keep up with the incoming data. However, if 9600 bps is chosen as the BitBanger™ data rate, then the CI-5 interface data rate should be changed to at least 19,200 bps to ensure that data overflow does not occur.

**COMMAND REFERENCE**

The OPTOCOM™ recognizes 43 different commands.  The first 9 commands are standard Icom CI-V commands compatible with receivers such as the Icom R-7100.  The remaining "7F" series commands are special OPTOCOM™ commands provided to access features, such as DTMF/CTCSS/NRZ decoding, not generally found on other receivers.  The commands, along with their corresponding responses, are summarized in Table 6 below.

Following the table is a detailed description of each of the commands, including examples illustrating their use.  In the command descriptions, "ra" refers to the RECEIVE ADDRESS, and "ta" refers to the TRANSMIT ADDRESS.

The RECEIVE ADDRESS is the address of the OPTOCOM™, which can be any address in the range 80 through 8F.  Each device on the CI-5 bus must have its own unique address.  The OPTOCOM™ will not process any command in which the RECEIVE ADDRESS does not match its own currently selected address.  However, the OPTOCOM™ will process commands with a RECEIVE ADDRESS of 00, but all command responses will be suppressed.  A RECEIVE ADDRESS of 00 has special meaning.  It provides a means for a device on the CI-5 bus to transmit a command to all other devices simultaneously.  However, since several simultaneous responses would cause a collision, the responses are suppressed.

The TRANSMIT ADDRESS is the address of the device which is transmitting the command to the OPTOCOM™.  In most cases, this device is a personal computer executing application software, usually referred to as the CONTROLLER.  The standard address for the CONTROLLER is E0, but any address can be used for the TRANSMIT ADDRESS.  However, the TRANSMIT ADDRESS must be in the range 01 to EF.  Also, the OPTOCOM™ will not process any command in which the TRANSMIT ADDRESS matches its own currently selected address.

It is important to remember that the values specified are not ASCII characters, but are bytes expressed in hexadecimal notation.  For example, "FE" represents a single byte with a value of 0xFE (hexadecimal), or 254 (decimal).  It does not represent the ASCII character "F" followed by the ASCII character "E", a two-byte sequence.

**Table 6.  OPTOCOM™ CI-5 Interface Command Summary.**

| COMMAND | SUB-COMMAND | DESCRIPTION |
|---|---|---|
| 00 | - | Transfer frequency, no response. |
| 01 | - | Transfer mode, no response. |
| 02 | - | Read upper/lower-edge frequency. |
| 03 | - | Read frequency. |
| 04 | - | Read mode. |
| 05 | - | Write frequency. |
| 06 | - | Write mode. |
| 15 | 01 | Read squelch status. |
| 15 | 02 | Read signal strength. |
| 7F | 01 | Select LOCAL control (OS535 emulation) |
| 7F | 02 | Select REMOTE control (OS535 emulation) |
| 7F | 03 | Enable tape recorder. |
| 7F | 04 | Disable tape recorder. |
| 7F | 05 | Read status. |
| 7F | 06 | Read CTCSS tone. |
| 7F | 07 | Read DCS code. |
| 7F | 08 | Read DTMF digit. |
| 7F | 09 | Read identification |
| 7F | 0A | Enable speaker audio. |
| 7F | 0B | Disable speaker audio. |
| 7F | 0C | Enable 5 kHz search window. |
| 7F | 0D | Disable 5 kHz search window. |
| 7F | 0E | Transfer next frequency/mode, no response. |
| 7F | 0F | Enable search mode. |
| 7F | 10 | Disable search mode. |
| 7F | 11 | Write decode mode |
| 7F | 12 | Read LTR data |
| 7F | 13 | Write volume/squelch control |
| 7F | 14 | Read volume setting |
| 7F | 15 | Write volume setting |
| 7F | 16 | Read squelch setting |
| 7F | 17 | Write squelch setting |
| 7F | 18 | Write scan mode |
| 7F | 19 | Read memory |
| 7F | 1A | Write memory |
| 7F | 1B | Clear memory |
| 7F | 1C | Write Bit Banger Data Rate |
| 7F | 1D | Write Bit Banger Mode |
| 7F | D0 | Write CI-5 address |
| 7F | D1 | Write CI-5 data rate |
| 7F | D2 | Write CI-5 interface mode |
| 7F | D3 | Store operating parameters |
| 7F | D4 | Recall operating parameters |

**TRANSFER FREQUENCY**

**Command:**

| FE | FE | ra | ta | 00 | frequency | FD |
|----|----|----|----|----|-----------|----|

**Example:**

437.162500 MHz

| FE | FE | 80 | E0 | 00 | 00 | 25 | 16 | 37 | 04 | FD |
|----|----|----|----|----|----|----|----|----|----|----|

**Response:**

NONE

**Description:**

This command selects the operating frequency of the receiver.  However, no response is returned under any condition.

The frequency data is in the form of 5 bytes, each consisting of 2 BCD digits.  The order of the 10 BCD digits is as follows:  10 Hz digit, 1 Hz digit, 1 kHz digit, 100 Hz digit, 100 kHz digit, 10 kHz digit, 10 MHz digit, 1 MHz digit, 1 GHz digit, 100 MHz digit.  See the example shown above.

If SCAN mode is enabled, then the frequency change is not processed immediately, but is saved to take effect later when SCAN mode is disabled.

If the command length is incorrect, or if the received frequency is not in the range 25 - 520 MHz, 760 - 823.995 MHz, 849 - 868.995 MHz, or 894 - 1300 MHz, or is not an even multiple of 5 kHz or 12.5 kHz, then the command is ignored.

**TRANSFER MODE**

**Command:**

| FE | FE | ra | ta | 01 | md | FD |
|----|----|----|----|----|----|----|

md  is a BCD value representing the desired operating mode.  BCD values are encoded as follows:

    02:     AM
    05:     FM-narrowband
    06:     FM-wideband

**Example:**

FM-narrowband

| FE | FE | 80 | E0 | 01 | 05 | FD |
|----|----|----|----|----|----|----|

**Response:**

NONE

**Description:**

This command selects the operating mode of the receiver.  However, no response is returned under any condition.

The mode data is in the form of 1 byte, consisting of 2 BCD digits.  See the example shown above.

If SCAN mode is enabled, then the mode change is not processed immediately, but is saved to take effect later when SCAN mode is disabled.

If the command length is incorrect, or if the received mode data is not valid, then the command is ignored.

**READ UPPER/LOWER-EDGE FREQUENCY**

**Command:**

| FE | FE | ra | ta | 02 | FD |
|----|----|----|----|----|----|

**Example:**

| FE | FE | 80 | E0 | 02 | FD |
|----|----|----|----|----|----|

**Response:**

| FE | FE | ta | ra | 02 | lower frequency | 2D | upper frequency | FD |
|----|----|----|----|----|----|----|----|----|

**Examples:**

25.000000 - 1300.000000 MHz

| FE | FE | E0 | 80 | 02 | 00 | 00 | 00 | 25 | 00 | 2D | 00 | 00 | 00 | 00 | 13 | FD |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|

Error

| FE | FE | E0 | 80 | FA | FD |
|----|----|----|----|----|----|

**Description:**

This command instructs the unit to send the upper and lower edge of the operating frequency range.

The frequency data is in the form of 5 bytes, each consisting of 2 BCD digits. The order of the 10 BCD digits is as follows: 10 Hz digit, 1 Hz digit, 1 kHz digit, 100 Hz digit, 100 kHz digit, 10 kHz digit, 10 MHz digit, 1 MHz digit, 1 GHz digit, 100 MHz digit. See the example shown above.

If the command length is incorrect, then the command is ignored, and the error response is returned.

**READ FREQUENCY**

**Command:**

| FE | FE | ra | ta | 03 | FD |
|----|----|----|----|----|----|

**Example:**

| FE | FE | 80 | E0 | 03 | FD |
|----|----|----|----|----|----|

**Response:**

| FE | FE | ta | ra | 03 | frequency | FD |
|----|----|----|----|----|----|----|

**Examples:**
162.550000 MHz

| FE | FE | E0 | 80 | 03 | 00 | 00 | 55 | 62 | 01 | FD |
|----|----|----|----|----|----|----|----|----|----|----|

Error

| FE | FE | E0 | 80 | FA | FD |
|----|----|----|----|----|----|

**Description:**
This command instructs the unit to send the current operating frequency.

The frequency data is in the form of 5 bytes, each consisting of 2 BCD digits.  The order of the 10 BCD digits is as follows:  10 Hz digit, 1 Hz digit, 1 kHz digit, 100 Hz digit, 100 kHz digit, 10 kHz digit, 10 MHz digit, 1 MHz digit, 1 GHz digit, 100 MHz digit.  See the example shown above.

If the command length is incorrect, then the command is ignored, and the error response is returned.

**READ MODE**

**Command:**

| FE | FE | ra | ta | 04 | FD |
|----|----|----|----|----|----|

**Example:**

| FE | FE | 80 | E0 | 04 | FD |
|----|----|----|----|----|----|

**Response:**

| FE | FE | ta | ra | 04 | md | FD |
|----|----|----|----|----|----|----|

md    is a BCD value representing the currently selected operating mode.  BCD values are encoded as follows:

02:    AM
05:    FM-narrowband
06:    FM-wideband

**Examples:**

AM

| FE | FE | E0 | 80 | 04 | 02 | FD |
|----|----|----|----|----|----|----|

Error

| FE | FE | E0 | 80 | FA | FD |
|----|----|----|----|----|----|

**Description:**
This command instructs the unit to send the current operating mode.

The mode data is in the form of 1 byte, consisting of 2 BCD digits.  See the example shown above.

If the command length is incorrect, then the command is ignored, and the error response is returned.

**WRITE FREQUENCY**

**Command:**

| FE | FE | ra | ta | 05 | frequency | FD |
|----|----|----|----|----|-----------|-----|

**Example:**

162.550000 MHz

| FE | FE | 80 | E0 | 05 | 00 | 00 | 55 | 62 | 01 | FD |
|----|----|----|----|----|----|----|----|----|----|-----|

**Response:**

| FE | FE | ta | ra | FB or FA | FD |
|----|----|----|----|----------|-----|

**Examples:**

OK

| FE | FE | E0 | 80 | FB | FD |
|----|----|----|----|----|-----|

Error

| FE | FE | E0 | 80 | FA | FD |
|----|----|----|----|----|-----|

**Description:**

This command selects the operating frequency of the receiver.

The frequency data is in the form of 5 bytes, each consisting of 2 BCD digits.  The order of the 10 BCD digits is as follows:  10 Hz digit, 1 Hz digit, 1 kHz digit, 100 Hz digit, 100 kHz digit, 10 kHz digit, 10 MHz digit, 1 MHz digit, 1 GHz digit, 100 MHz digit.  See the example shown above.

If SCAN mode is enabled, then the frequency change is not processed immediately, but is saved to take effect later when SCAN mode is disabled.

If the command length is incorrect, or if the received frequency is not in the range 25 - 520 MHz, 760 - 823.995 MHz, 849 - 868.995 MHz, or 894 - 1300 MHz, or is not an even multiple of 5 kHz or 12.5 kHz, then the command is ignored, and the error response is returned.

**WRITE MODE**

**Command:**

| FE | FE | ra | ta | 06 | md | FD |
|----|----|----|----|----|----|----|

md   is a BCD value representing the desired operating mode.  BCD values are encoded as
follows:

02:     AM
05:     FM-narrowband
06:     FM-wideband

**Example:**
FM-wideband

| FE | FE | 80 | E0 | 06 | 06 | FD |
|----|----|----|----|----|----|----|

**Response:**

| FE | FE | ta | ra | FB or FA | FD |
|----|----|----|----|----------|----|

**Examples:**
OK

| FE | FE | E0 | 80 | FB | FD |
|----|----|----|----|----|----|

Error

| FE | FE | E0 | 80 | FA | FD |
|----|----|----|----|----|----|

**Description:**
This command selects the operating mode of the receiver.

The mode data is in the form of 1 byte, consisting of 2 BCD digits.  See the example shown above.

If SCAN mode is enabled, then the mode change is not processed immediately, but is saved to take effect later when SCAN mode is disabled.

If the command length is incorrect, or if the received mode data is not valid, then the command is ignored, and the error response is returned.

**READ SQUELCH STATUS**

**Command:**

| FE | FE | ra | ta | 15 | 01 | FD |
|----|----|----|----|----|----|----|

**Example:**

| FE | FE | 80 | E0 | 15 | 01 | FD |
|----|----|----|----|----|----|----|

**Response:**

| FE | FE | ta | ra | 15 | 01 | sd | FD |
|----|----|----|----|----|----|----|----|

**Examples:**

Squelch closed

| FE | FE | E0 | 80 | 15 | 01 | 00 | FD |
|----|----|----|----|----|----|----|----|

Squelch open

| FE | FE | E0 | 80 | 15 | 01 | 01 | FD |
|----|----|----|----|----|----|----|----|

Error

| FE | FE | E0 | 80 | FA | FD |
|----|----|----|----|----|----|

**Description:**

This command instructs the unit to send the current squelch status.

The squelch status data is in the form of 1 byte, consisting of 2 BCD digits. See the examples shown above.

If the command length is incorrect, then the command is ignored, and the error response is returned.

## READ SIGNAL STRENGTH

**Command:**

| FE | FE | ra | ta | 15 | 02 | FD |
|----|----|----|----|----|----|----|

**Example:**

| FE | FE | 80 | E0 | 15 | 02 | FD |
|----|----|----|----|----|----|----|

**Response:**

| FE | FE | ta | ra | 15 | 02 | sd | FD |
|----|----|----|----|----|----|----|----|

**Examples:**

- 20 dBm

| FE | FE | E0 | 80 | 15 | 02 | 00 | 20 | FD |
|----|----|----|----|----|----|----|----|----|

- 67 dBm

| FE | FE | E0 | 80 | 15 | 02 | 00 | 67 | FD |
|----|----|----|----|----|----|----|----|----|

- 137 dBm

| FE | FE | E0 | 80 | 15 | 02 | 01 | 37 | FD |
|----|----|----|----|----|----|----|----|----|

Error

| FE | FE | E0 | 80 | FA | FD |
|----|----|----|----|----|----|

**Description:**
This command instructs the unit to send the current signal strength.

The signal strength data is in the form of 2 bytes, each consisting of 2 BCD digits. The signal strength is reported in units of absolute dBm as measured at the antenna connector. The reported signal strength ranges from a maximum signal of - 20 dBm to a minimum signal of - 137 dBm. A minus sign is implied. See the examples shown above.

If the command length is incorrect, then the command is ignored, and the error response is returned.

## SELECT LOCAL CONTROL

**Command:**

| FE | FE | ra | ta | 7F | 01 | FD |
|----|----|----|----|----|----|----|

**Example:**

| FE | FE | 80 | E0 | 7F | 01 | FD |
|----|----|----|----|----|----|----|

**Response:**

| FE | FE | ta | ra | FB or FA | FD |
|----|----|----|----|----------|----|

**Examples:**

OK

| FE | FE | E0 | 80 | FB | FD |
|----|----|----|----|----|----|

Error

| FE | FE | E0 | 80 | FA | FD |
|----|----|----|----|----|----|

**Description:**

This command selects LOCAL control.  However, this command is only valid when OptoScan535™ emulation mode is enabled.

This command provides no function, other than OptoScan535™ emulation, which provides backward compatibility with legacy software written for the OptoScan535™.  OptoScan535™ emulation mode is enabled and disabled by use of the WRITE CI-5 INTERFACE MODE command.

If the command length is incorrect, then the command is ignored, and the error response is returned.

## SELECT REMOTE CONTROL

**Command:**

| FE | FE | ra | ta | 7F | 02 | FD |
|----|----|----|----|----|----|----|

**Example:**

| FE | FE | 80 | E0 | 7F | 02 | FD |
|----|----|----|----|----|----|----|

**Response:**

| FE | FE | ta | ra | FB or FA | FD |
|----|----|----|----|----------|----|

**Examples:**

OK

| FE | FE | E0 | 80 | FB | FD |
|----|----|----|----|----|----|

Error

| FE | FE | E0 | 80 | FA | FD |
|----|----|----|----|----|----|

**Description:**

This command selects REMOTE control. However, this command is only valid when OptoScan535™ emulation mode is enabled.

This command provides no function, other than OptoScan535™ emulation, which provides backward compatibility with legacy software written for the OptoScan535™. OptoScan535™ emulation mode is enabled and disabled by use of the WRITE CI-5 INTERFACE MODE command.

If the command length is incorrect, then the command is ignored, and the error response is returned.

**ENABLE TAPE RECORDER**

**Command:**

| FE | FE | ra | ta | 7F | 03 | FD |
|----|----|----|----|----|----|----|

**Example:**

| FE | FE | 80 | E0 | 7F | 03 | FD |
|----|----|----|----|----|----|----|

**Response:**

| FE | FE | ta | ra | FB or FA | FD |
|----|----|----|----|----------|----|

**Examples:**

OK

| FE | FE | E0 | 80 | FB | FD |
|----|----|----|----|----|----|

Error

| FE | FE | E0 | 80 | FA | FD |
|----|----|----|----|----|----|

**Description:**

This command enables a tape recorder connected to the TAPE PAUSE output.

The TAPE PAUSE output provides a pair of isolated relay contacts which are closed when the tape recorder is enabled, and open when the tape recorder is disabled.

If the command length is incorrect, then the command is ignored, and the error response is returned.

**DISABLE TAPE RECORDER**

**Command:**

| FE | FE | ra | ta | 7F | 04 | FD |
|----|----|----|----|----|----|----|

**Example:**

| FE | FE | 80 | E0 | 7F | 04 | FD |
|----|----|----|----|----|----|----|

**Response:**

| FE | FE | ta | ra | FB or FA | FD |
|----|----|----|----|----------|----|

**Examples:**

OK

| FE | FE | E0 | 80 | FB | FD |
|----|----|----|----|----|----|

Error

| FE | FE | E0 | 80 | FA | FD |
|----|----|----|----|----|----|

**Description:**

This command disables a tape recorder connected to the TAPE PAUSE output.

The TAPE PAUSE output provides a pair of isolated relay contacts which are closed when the tape recorder is enabled, and open when the tape recorder is disabled.

If the command length is incorrect, then the command is ignored, and the error response is returned.

**READ STATUS**

**Command:**

| FE | FE | ra | ta | 7F | 05 | FD |
|----|----|----|----|----|----|----|

**Example:**

| FE | FE | 80 | E0 | 7F | 05 | FD |
|----|----|----|----|----|----|----|

**Response:**

| FE | FE | ta | ra | 7F | 05 | s1 | s2 | s3 | s4 | FD |
|----|----|----|----|----|----|----|----|----|----|----|

**Examples:**
LTR decoding, DTMF digit pending, squelch open, LTR data active, Audio enabled, Audio present

| FE | FE | E0 | 80 | 7F | 05 | 53 | 12 | 00 | 00 | FD |
|----|----|----|----|----|----|----|----|----|----|----|

LTR decoding, DTMF digit pending, squelch open, LTR data active, Audio enabled, Audio present

| FE | FE | E0 | 80 | 7F | 05 | 53 | 12 | 00 | 00 | FD |
|----|----|----|----|----|----|----|----|----|----|----|

Error

| FE | FE | E0 | 80 | FA | FD |
|----|----|----|----|----|----|

**Description:**
This command instructs the unit to send the current operating status.

It should be noted that when OptoScan535™ emulation mode is enabled, the status data conforms to the OptoScan535™ format, instead of the format described in this document. This provides backward compatibility with legacy software written for the OptoScan535™. OptoScan535™ emulation mode is enabled and disabled by use of the WRITE CI-5 INTERFACE MODE command.

The status data is in the form of 4 bytes, each consisting of 6 status bits and 2 unused bits which are always cleared. The unused bits ensure that the status data always appears as valid BCD digits. See the examples shown above.

If the command length is incorrect, then the command is ignored, and the error response is returned.

The current operating status contains all pertinent information about the receiver and DTMF/CTCSS/NRZ decoder, including squelch status. Therefore, the READ SQUELCH STATUS command is optional. The following is a discussion of the use of the status bits contained in the READ STATUS command. Note that the DTMF/CTCSS/NRZ decoder is only enabled when the squelch is open, and the CTCSS/NRZ decoder is only enabled when narrowband FM mode is selected. Therefore, the appropriate status bits should be checked frequently while the squelch is open.

**s1, bit 0:  VOLUME/SQUELCH CONTROL.**  This bit indicates the current volume/squelch control status.  The volume/squelch control status is encoded as follows:

| s1, bit 0 | VOLUME/SQUELCH CONTROL |
|-----------|------------------------|
| 0 | LOCAL |
| 1 | REMOTE |

When LOCAL volume/squelch control is selected, the volume and squelch settings are controlled by the front panel VOLUME and SQUELCH controls.  When REMOTE volume/squelch control is selected, the volume is controlled by the WRITE VOLUME SETTING command, the squelch is controlled by the WRITE SQUELCH SETTING command, and the front panel VOLUME and SQUELCH controls are ignored.

**s1, bit 1:  DTMF PENDING.**  This bit indicates whether or not one or more DTMF digits are waiting in the 31-digit DTMF buffer.  The DTMF buffer status is encoded as follows:

| s1, bit 1 | DTMF |
|-----------|------|
| 0 | BUFFER EMPTY |
| 1 | PENDING |

If the DTMF PENDING bit is set, one or more READ DTMF DIGIT commands should be issued to read the new digits.  The DTMF PENDING bit is automatically cleared when the last digit is read from the DTMF buffer.  The READ DTMF DIGIT command will always return the next DTMF digit in the order received.  In other words, the DTMF buffer works like a FIFO.  Once the DTMF buffer is empty, the READ DTMF DIGIT command will return a "99" code to indicate that the buffer is empty.  This feature eliminates the need to check the DTMF PENDING bit after each digit has been read from the buffer.

**s1, bit 2:  DTMF OVERRUN.**  This bit indicates whether or not one or more new DTMF digits have been received after the DTMF buffer is full.  It is an indication that one or more DTMF digits have been lost.  The DTMF buffer overrun status is encoded as follows:

| s1, bit 2 | DTMF |
|-----------|------|
| 0 | NORMAL |
| 1 | OVERRUN |

Any digits received after the DTMF buffer becomes full are discarded.  The DTMF OVERRUN bit is cleared when a READ DTMF DIGIT command is issued.  The maximum supported DTMF digit rate is approximately 10 digits per second.  Therefore, the DTMF PENDING bit should be checked at least every 2 to 3 seconds to avoid losing digits.

**s1, bit 3:  UNUSED.**  This bit will always be zero.

**s1, bit 4: SQUELCH.**  This bit indicates the current squelch status. The squelch status is encoded as follows:

| s1, bit 4 | SQUELCH STATUS |
|-----------|----------------|
| 0 | Squelch closed |
| 1 | Squelch open |

This bit provides that same information as the READ SQUELCH STATUS command.

**s1, bit 5: CTCSS ACTIVE.** This bit indicates whether or not a valid CTCSS tone is currently being received. The CTCSS tone status is encoded as follows:

| s1, bit 5 | CTCSS |
|-----------|----------|
| 0 | INACTIVE |
| 1 | ACTIVE |

If the CTCSS ACTIVE bit is set, a READ CTCSS TONE command should be issued to read the CTCSS tone. The READ CTCSS TONE command will always return the most recent CTCSS tone, even if the tone is no longer being received, so the command should only be issued while the CTCSS ACTIVE bit is set. Note that the CTCSS ACTIVE bit does not function the way the DTMF PENDING bit does. The CTCSS ACTIVE bit is only set while a valid CTCSS tone is being received. It does not indicate the previous occurrence of a CTCSS tone.

**s1, bit 6: NRZ ACTIVE.** This bit indicates whether or not valid NRZ data, such as DCS or LTR, is currently being received. The NRZ data status is encoded as follows:

| s1, bit 6 | NRZ |
|-----------|----------|
| 0 | INACTIVE |
| 1 | ACTIVE |

If the NRZ ACTIVE bit is set, the appropriate command should be issued to read the NRZ data, based on the state of the NRZ MODE bits. Note that the NRZ ACTIVE bit does not function the way the DTMF PENDING bit does. It is only set while valid NRZ data is being received. It does not indicate the previous occurrence of NRZ data.

**s1, bit 7: UNUSED.** This bit will always be zero.

**s2, bit 0: TAPE CONTROL.** This bit indicates the current tape recorder control status. The tape recorder control status is encoded as follows:

| s2, bit 0 | TAPE CONTROL |
|-----------|----------|
| 0 | DISABLED |
| 1 | ENABLED |

The tape recorder is enabled using the ENABLE TAPE RECORDER command. The tape recorder is disabled using the DISABLE TAPE RECORDER command.

**s2, bit 1: SPEAKER CONTROL.** This bit indicates the current speaker audio control status. The speaker audio control status is encoded as follows:

| s2, bit 1 | SPEAKER CONTROL |
|-----------|----------|
| 0 | DISABLED |
| 1 | ENABLED |

The speaker audio is enabled using the ENABLE SPEAKER AUDIO command. The speaker audio is disabled using the DISABLE SPEAKER AUDIO command.

**s2, bit 2: 5 KHZ SEARCH WINDOW.** This bit indicates the current 5 kHz search window control status. The 5 kHz search window control status is encoded as follows:

| s2, bit 2 | 5 KHZ SEARCH WINDOW |
| --- | --- |
| 0 | DISABLED |
| 1 | ENABLED |

The 5 kHz search window is enabled using the ENABLE 5 KHZ SEARCH WINDOW command. The 5 kHz search window is disabled using the DISABLE 5 KHZ SEARCH WINDOW command.

**s2, bit 3: UNUSED.** This bit will always be zero.

**s2, bit 4: AUDIO STATUS.** This bit indicates the current audio status. The audio status is encoded as follows:

| s2, bit 4 | AUDIO STATUS |
| --- | --- |
| 0 | NO AUDIO PRESENT |
| 1 | AUDIO PRESENT |

This bit is set when audio is present on the current frequency, and cleared when no audio is present. It provides a means to skip over dead carrier signals.

**s2, bit 5: SEARCH MODE.** This bit indicates the current search mode status. The search mode status is encoded as follows:

| s2, bit 5 | SEARCH MODE |
| --- | --- |
| 0 | DISABLED |
| 1 | ENABLED |

The search mode is enabled using the ENABLE SEARCH MODE command. The search mode is disabled using the DISABLE SEARCH MODE command.

**s2, bit 6: SCAN MODE.** This bit indicates the current scan mode status. The scan mode status is encoded as follows:

| s2, bit 6 | SCAN MODE |
| --- | --- |
| 0 | DISABLED |
| 1 | ENABLED |

The scan mode is enabled or disabled using the WRITE SCAN MODE command.

**s2, bit 7: UNUSED.** This bit will always be zero.

**s3, bit 0: FREQUENCY RECEIVED.** This bit indicates the current frequency command status. The frequency command status is encoded as follows:

| s3, bit 0 | FREQUENCY COMMAND |
|---|---|
| 0 | NOT RECEIVED |
| 1 | RECEIVED |

This bit is set upon successful reception of a valid TRANSFER FREQUENCY or WRITE FREQUENCY command. It provides a means to determine if a frequency command transmitted by the controller was executed by the receiver. This bit is automatically cleared after a READ STATUS command.

**s3, bit 1: MODE RECEIVED.** This bit indicates the current mode command status. The mode command status is encoded as follows:

| s3, bit 1 | MODE COMMAND |
|---|---|
| 0 | NOT RECEIVED |
| 1 | RECEIVED |

This bit is set upon successful reception of a valid TRANSFER MODE or WRITE MODE command. It provides a means to determine if a mode command transmitted by the controller was executed by the receiver. This bit is automatically cleared after a READ STATUS command.

**s3, bit 2: PIPELINE RECEIVED.** This bit indicates the current pipeline command status. The pipeline command status is encoded as follows:

| s3, bit 2 | PIPELINE COMMAND |
|---|---|
| 0 | NOT RECEIVED |
| 1 | RECEIVED |

This bit is set upon successful reception of a valid TRANSFER NEXT FREQUENCY/MODE command. It provides a means to determine if a pipelined frequency/mode command transmitted by the controller was executed by the receiver. This bit is automatically cleared after a READ STATUS command.

**s3, bit 3: UNUSED.** This bit will always be zero.

**s3, bit 4: DATA AVAILABLE.** This bit indicates the current overall decoder data status. The decoder data status is encoded as follows:

| s3, bit 4 | DECODER DATA |
|---|---|
| 0 | NOT AVAILABLE |
| 1 | AVAILABLE |

This bit is set upon reception of any new decoder data that is different from the previous data, or if the decoder status changes, such as a CTCSS tone no longer being received. It provides the same information as the DATA AVAILABLE (CTS) signal on the RS-232 interface. This bit is automatically cleared after a READ STATUS command.

**s3, bit 5: RESERVED.** This bit is reserved for future use.

**s3, bit 6: RESERVED.** This bit is reserved for future use.

**s3, bit 7: UNUSED.** This bit will always be zero.

**s4, bits 0 - 2: DECODE MODE.** These three bits collectively indicate the currently selected decode mode. The various decode modes are encoded as follows:

| s4, bit 2 | s4, bit 1 | s4, bit 0 | DECODE MODE |
|---|---|---|---|
| 0 | 0 | 0 | CTCSS/DCS DECODE |
| 0 | 0 | 1 | LTR DECODE |
| 0 | 1 | 0 | Reserved |
| 0 | 1 | 1 | Reserved |
| 1 | 0 | 0 | Reserved |
| 1 | 0 | 1 | Reserved |
| 1 | 1 | 0 | Reserved |
| 1 | 1 | 1 | Reserved |

The decode mode is an indication of the type of NRZ data available when the NRZ ACTIVE bit is set.

**s4, bit 3: UNUSED.** This bit will always be zero.

**s4, bit 4: RESERVED.** This bit is reserved for future use.

**s4, bit 5: RESERVED.** This bit is reserved for future use.

**s4, bit 6: RESERVED.** This bit is reserved for future use.

**s4, bit 7: UNUSED.** This bit will always be zero.

**READ CTCSS TONE**

**Command:**

| FE | FE | ra | ta | 7F | 06 | FD |
|----|----|----|----|----|----|----|

**Example:**

| FE | FE | 80 | E0 | 7F | 06 | FD |
|----|----|----|----|----|----|----|

**Response:**

| FE | FE | ta | ra | 7F | 06 | sd | FD |
|----|----|----|----|----|----|----|----|

**Examples:**

82.5 Hz

| FE | FE | E0 | 80 | 7F | 06 | 08 | 25 | FD |
|----|----|----|----|----|----|----|----|----|

103.5 Hz

| FE | FE | E0 | 80 | 7F | 06 | 10 | 35 | FD |
|----|----|----|----|----|----|----|----|----|

Error

| FE | FE | E0 | 80 | FA | FD |
|----|----|----|----|----|----|

**Description:**
This command instructs the unit to send the most recent CTCSS tone, provided that CTCSS/DCS decode mode is selected.

The CTCSS data is in the form of 2 bytes, each consisting of 2 BCD digits. The order of the 4 BCD digits is as follows: 100 Hz digit, 10 Hz digit, 1 Hz digit, 0.1 Hz digit. See the examples shown above. A complete list of the CTCSS tones decoded by the OPTOCOM™ is given in Table 3.

It should be noted that this command will always return the most recent CTCSS tone, even if the tone is no longer being received. Therefore, the CTCSS ACTIVE bit should be checked to determine whether or not a CTCSS tone is currently being received. The CTCSS ACTIVE bit is accessed through the READ STATUS command. If the frequency, mode, or decode mode is changed, the CTCSS tone is cleared.

If the command length is incorrect, or if CTCSS/DCS decode mode is not selected, then the command is ignored, and the error response is returned.

**READ DCS CODE**

**Command:**

| FE | FE | ra | ta | 7F | 07 | FD |
|----|----|----|----|----|----|----|

**Example:**

| FE | FE | 80 | E0 | 7F | 07 | FD |
|----|----|----|----|----|----|----|

**Response:**

| FE | FE | ta | ra | 7F | 07 | sd | FD |
|----|----|----|----|----|----|----|----|

**Examples:**
023

| FE | FE | E0 | 80 | 7F | 07 | 00 | 23 | FD |
|----|----|----|----|----|----|----|----|----|

732

| FE | FE | E0 | 80 | 7F | 07 | 07 | 32 | FD |
|----|----|----|----|----|----|----|----|----|

Error

| FE | FE | E0 | 80 | FA | FD |
|----|----|----|----|----|----|

**Description:**
This command instructs the unit to send the most recent DCS code, provided that CTCSS/DCS decode mode is selected.

The DCS data is in the form of 2 bytes, each consisting of 2 BCD digits. The order of the 4 BCD digits is as follows: unused digit (always 0), 100's digit, 10's digit, 1's digit. See the examples shown above. A complete list of the DCS codes decoded by the OPTOCOM™ is given in Table 4.

It should be noted that this command will always return the most recent DCS code, even if the code is no longer being received. Therefore, the NRZ ACTIVE bit should be checked to determine whether or not a DCS code is currently being received. The NRZ ACTIVE bit is accessed through the READ STATUS command. If the frequency, mode, or decode mode is changed, the DCS code is cleared.

If the command length is incorrect, or if CTCSS/DCS decode mode is not selected, then the command is ignored, and the error response is returned.

**READ DTMF DIGIT**

**Command:**

| FE | FE | ra | ta | 7F | 08 | FD |
|----|----|----|----|----|----|----|

**Example:**

| FE | FE | 80 | E0 | 7F | 08 | FD |
|----|----|----|----|----|----|----|

**Response:**

| FE | FE | ta | ra | 7F | 08 | sd | FD |
|----|----|----|----|----|----|----|----|

| sd | is a BCD value representing the next DTMF digit. BCD values are encoded as follows:

| | | | | | |
|---|---|---|---|---|---|
| 00: | "0" | 08: | "8" | 99: | DTMF Buffer Empty |
| 01: | "1" | 09: | "9" | | |
| 02: | "2" | 10: | "A" | | |
| 03: | "3" | 11: | "B" | | |
| 04: | "4" | 12: | "C" | | |
| 05: | "5" | 13: | "D" | | |
| 06: | "6" | 14: | "*" | | |
| 07: | "7" | 15: | "#" | | |

**Examples:**

"3"

| FE | FE | E0 | 80 | 7F | 08 | 03 | FD |
|----|----|----|----|----|----|----|----|

"A"

| FE | FE | E0 | 80 | 7F | 08 | 10 | FD |
|----|----|----|----|----|----|----|----|

DTMF Buffer Empty

| FE | FE | E0 | 80 | 7F | 08 | 99 | FD |
|----|----|----|----|----|----|----|----|

Error

| FE | FE | E0 | 80 | FA | FD |
|----|----|----|----|----|----|

**Description:**
This command instructs the unit to send the next DTMF digit waiting in the 31-digit DTMF buffer.

The DTMF data is in the form of 1 byte, consisting of 2 BCD digits. The BCD digits are encoded as shown above. Each issuance of the READ DTMF DIGIT command causes the next digit in the DTMF buffer to be sent in the order it was received, in a First-In-First-Out (FIFO) fashion. Once the DTMF buffer is empty, the READ DTMF DIGIT command returns the DTMF Buffer Empty code. See the examples shown above. If the frequency, mode, or decode mode is changed, the DTMF buffer is cleared.

If the command length is incorrect, then the command is ignored, and the error response is returned.

**READ IDENTIFICATION**

**Command:**

| FE | FE | ra | ta | 7F | 09 | FD |
|----|----|----|----|----|----|----|

**Example:**

| FE | FE | 80 | E0 | 7F | 09 | FD |
|----|----|----|----|----|----|----|

**Response:**

| FE | FE | ta | ra | 7F | 09 | id | sv | iv | FD |
|----|----|----|----|----|----|----|----|----|----|

**Examples:**

OPTOCOM™, software version 1.4, interface version 1.1

| FE | FE | E0 | 80 | 7F | 09 | 50 | 54 | 43 | 14 | 11 | FD |
|----|----|----|----|----|----|----|----|----|----|----|----|

Error

| FE | FE | E0 | 80 | FA | FD |
|----|----|----|----|----|----|

**Description:**

This command instructs the unit to send the identification data.

It should be noted that when OptoScan535™ emulation mode is enabled, the OptoScan535™ identification data is sent, instead of the OPTOCOM™ identification data described in this document. This provides backward compatibility with legacy software written for the OptoScan535™. OptoScan535™ emulation mode is enabled and disabled by use of the WRITE CI-5 INTERFACE MODE command.

The identification data is in the form of 5 bytes, each consisting of 2 BCD digits. The first 6 BCD digits uniquely identify the device. The next 2 BCD digits indicate the current software version. The last 2 BCD digits indicate the current interface version. See the example shown above.

If the command length is incorrect, then the command is ignored, and the error response is returned.

**ENABLE SPEAKER AUDIO**

**Command:**

| FE | FE | ra | ta | 7F | 0A | FD |
|----|----|----|----|----|----|----|

**Example:**

| FE | FE | 80 | E0 | 7F | 0A | FD |
|----|----|----|----|----|----|----|

**Response:**

| FE | FE | ta | ra | FB or FA | FD |
|----|----|----|----|----------|----|

**Examples:**
OK

| FE | FE | E0 | 80 | FB | FD |
|----|----|----|----|----|----|

Error

| FE | FE | E0 | 80 | FA | FD |
|----|----|----|----|----|----|

**Description:**
This command enables the speaker audio.

The speaker audio can be enabled and disabled under software control to facilitate selective scanning. This feature allows the software to mute the speaker audio unless a certain CTCSS tone, or DCS code, or DTMF digit sequence is detected on a particular frequency.

If SCAN mode is enabled, then the speaker audio change is not processed immediately, but is saved to take effect later when SCAN mode is disabled.

If the command length is incorrect, then the command is ignored, and the error response is returned.

**DISABLE SPEAKER AUDIO**

**Command:**

| FE | FE | ra | ta | 7F | 0B | FD |

**Example:**

| FE | FE | 80 | E0 | 7F | 0B | FD |

**Response:**

| FE | FE | ta | ra | FB or FA | FD |

**Examples:**
OK

| FE | FE | E0 | 80 | FB | FD |

Error

| FE | FE | E0 | 80 | FA | FD |

**Description:**
This command disables the speaker audio.

The speaker audio can be enabled and disabled under software control to facilitate selective scanning. This feature allows the software to mute the speaker audio unless a certain CTCSS tone, or DCS code, or DTMF digit sequence is detected on a particular frequency.

If SCAN mode is enabled, then the speaker audio change is not processed immediately, but is saved to take effect later when SCAN mode is disabled.

If the command length is incorrect, then the command is ignored, and the error response is returned.

**ENABLE 5 KHZ SEARCH WINDOW**

**Command:**

| FE | FE | ra | ta | 7F | 0C | FD |
|----|----|----|----|----|----|----|

**Example:**

| FE | FE | 80 | E0 | 7F | 0C | FD |
|----|----|----|----|----|----|----|

**Response:**

| FE | FE | ta | ra | FB or FA | FD |
|----|----|----|----|----------|----|

**Examples:**
OK

| FE | FE | E0 | 80 | FB | FD |
|----|----|----|----|----|----|

Error

| FE | FE | E0 | 80 | FA | FD |
|----|----|----|----|----|----|

**Description:**
This command enables the 5 kHz search window.

The search mode can be enabled by the software when a limit search is conducted.  When search mode is enabled, a squelch open indication is only given if the currently recieved signal is centered on the receiver's tuned frequency.  This provides more selective squelch operation, which helps prevent the receiver from stopping 5 or 10 kHz away from the actual transmitter frequency.  In addition, the 5 kHz search window can be enabled to make the squelch indication even more selective.  When 5 kHz channel spacing is used, the 5 kHz search window should be enabled.  When 12.5 kHz or wider channel spacing is used, the 5 kHz search window should be disabled.  When the search mode is disabled, the setting of the 5 kHz search window has no effect.

If SCAN mode is enabled, then the 5 kHz search window change is not processed immediately, but is saved to take effect later when SCAN mode is disabled.

If the command length is incorrect, then the command is ignored, and the error response is returned.

**DISABLE 5 KHZ SEARCH WINDOW**

**Command:**

| FE | FE | ra | ta | 7F | 0D | FD |
|----|----|----|----|----|----|----|

**Example:**

| FE | FE | 80 | E0 | 7F | 0D | FD |
|----|----|----|----|----|----|----|

**Response:**

| FE | FE | ta | ra | FB or FA | FD |
|----|----|----|----|----------|----|

**Example:**

OK

| FE | FE | E0 | 80 | FB | FD |
|----|----|----|----|----|----|

Error

| FE | FE | E0 | 80 | FA | FD |
|----|----|----|----|----|----|

**Description:**

This command disables the 5 kHz search window.

The search mode can be enabled by the software when a limit search is conducted.  When search mode is enabled, a squelch open indication is only given if the currently recieved signal is centered on the receiver's tuned frequency.  This provides more selective squelch operation, which helps prevent the receiver from stopping 5 or 10 kHz away from the actual transmitter frequency.  In addition, the 5 kHz search window can be enabled to make the squelch indication even more selective.  When 5 kHz channel spacing is used, the 5 kHz search window should be enabled.  When 12.5 kHz or wider channel spacing is used, the 5 kHz search window should be disabled.  When the search mode is disabled, the setting of the 5 kHz search window has no effect.

If SCAN mode is enabled, then the 5 kHz search window change is not processed immediately, but is saved to take effect later when SCAN mode is disabled.

If the command length is incorrect, then the command is ignored, and the error response is returned.

**TRANSFER NEXT FREQUENCY/MODE**

**Command:**

| FE | FE | ra | ta | 7F | 0E | frequency | md | dm | of | FD |
|----|----|----|----|----|----|-----------|----|----|----|----|

md  is a BCD value representing the desired operating mode.  BCD values are encoded as follows:

02:  AM
05:  FM-narrowband
06:  FM-wideband

dm  is a BCD value representing the desired decode mode.  BCD values are encoded as follows:

00:  CTCSS/DCS DECODE mode
01:  LTR DECODE mode
02:  Reserved
03:  Reserved
04:  Reserved
05:  Reserved
06:  Reserved
07:  Reserved

of  is a binary value representing various operating flags.  Individual bits are encoded as follows:

bit 0:  0 = audio enabled, 1 = audio disabled
bit 1:  0 = search mode disabled, 1 = search mode enabled
bit 2:  0 = 5 kHz search window disabled, 1 = 5 kHz search window enabled
bit 3:  Unused.  Always 0.
bit 4:  Reserved
bit 5:  Reserved
bit 6:  Reserved
bit 7:  Unused.  Always 0.

**Examples:**
435.162500 MHz, FM-narrowband, LTR DECODE mode, audio disabled, search mode enabled, 5 kHz search window enabled

| FE | FE | 80 | E0 | 7F | 0E | 00 | 25 | 16 | 35 | 04 | 05 | 01 | 07 | FD |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|

99.500000 MHz, FM-wideband, CTCSS/DCS DECODE mode, audio enabled, search mode disabled, 5 kHz search window disabled

| FE | FE | 80 | E0 | 7F | 0E | 00 | 00 | 50 | 99 | 00 | 06 | 00 | 00 | FD |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|

**Response:**
NONE

**Description:**
This command selects the next operating frequency and operating mode of the receiver. However, no response is returned under any condition.

It should be noted that when OptoScan535™ emulation mode is enabled, the frequency/mode data conforms to the OptoScan535™ format, instead of the format described in this document. This provides backward compatibility with legacy software written for the OptoScan535™. OptoScan535™ emulation mode is enabled and disabled by use of the WRITE CI-5 INTERFACE MODE command.

The frequency data is in the form of 5 bytes, each consisting of 2 BCD digits. The order of the 10 BCD digits is as follows: 10 Hz digit, 1 Hz digit, 1 kHz digit, 100 Hz digit, 100 kHz digit, 10 kHz digit, 10 MHz digit, 1 MHz digit, 1 GHz digit, 100 MHz digit. The mode data is in the form of 1 byte, consisting of 2 BCD digits. The decode mode data is in the form of 1 byte, consisting of 2 BCD digits. The operating flag data is in the form of 1 byte, consisting of 6 operating flag bits and 2 unused bits which are always cleared. The unused bits ensure that the operating flag data always appears as valid BCD digits. See the examples shown above.

This command allows the software to make use of the OPTOCOM™ pipelined tuning feature. The next frequency, mode, decode mode, and operating flag data specified by this command are stored by the OPTOCOM™. However, the new parameters do not take effect until a transition is detected on the RTS interface signal. This feature allows the next frequency and mode to be sent to the receiver while waiting for the receiver to settle on the current frequency and mode.

If the command length is incorrect, or if the received frequency is not in the range 25 - 520 MHz, 760 - 823.995 MHz, 849 - 868.995 MHz, or 894 - 1300 MHz, or is not an even multiple of 5 kHz or 12.5 kHz, or if the received mode, decode mode, or operating flag data is not valid, then the command is ignored.

**ENABLE SEARCH MODE**

**Command:**

| FE | FE | ra | ta | 7F | 0F | FD |
|----|----|----|----|----|----|----|

**Example:**

| FE | FE | 80 | E0 | 7F | 0F | FD |
|----|----|----|----|----|----|----|

**Response:**

| FE | FE | ta | ra | FB or FA | FD |
|----|----|----|----|----------|----|

**Examples:**

OK

| FE | FE | E0 | 80 | FB | FD |
|----|----|----|----|----|----|

Error

| FE | FE | E0 | 80 | FA | FD |
|----|----|----|----|----|----|

**Description:**
This command enables the search mode.

The search mode can be enabled by the software when a limit search is conducted.  When search mode is enabled, a squelch open indication is only given if the currently recieved signal is centered on the receiver's tuned frequency.  This provides more selective squelch operation, which helps prevent the receiver from stopping 5 or 10 kHz away from the actual transmitter frequency.  In addition, the 5 kHz search window can be enabled to make the squelch indication even more selective.  When 5 kHz channel spacing is used, the 5 kHz search window should be enabled.  When 12.5 kHz or wider channel spacing is used, the 5 kHz search window should be disabled.  When the search mode is disabled, the setting of the 5 kHz search window has no effect.

If SCAN mode is enabled, then the search mode change is not processed immediately, but is saved to take effect later when SCAN mode is disabled.

If the command length is incorrect, then the command is ignored, and the error response is returned.

**DISABLE SEARCH MODE**

**Command:**

| FE | FE | ra | ta | 7F | 10 | FD |
|----|----|----|----|----|----|----|

**Example:**

| FE | FE | 80 | E0 | 7F | 10 | FD |
|----|----|----|----|----|----|----|

**Response:**

| FE | FE | ta | ra | FB or FA | FD |
|----|----|----|----|----------|----|

**Examples:**
OK

| FE | FE | E0 | 80 | FB | FD |
|----|----|----|----|----|----|

Error

| FE | FE | E0 | 80 | FA | FD |
|----|----|----|----|----|----|

**Description:**
This command disables the search mode.

The search mode can be enabled by the software when a limit search is conducted.  When search mode is enabled, a squelch open indication is only given if the currently recieved signal is centered on the receiver's tuned frequency.  This provides more selective squelch operation, which helps prevent the receiver from stopping 5 or 10 kHz away from the actual transmitter frequency.  In addition, the 5 kHz search window can be enabled to make the squelch indication even more selective.  When 5 kHz channel spacing is used, the 5 kHz search window should be enabled.  When 12.5 kHz or wider channel spacing is used, the 5 kHz search window should be disabled.  When the search mode is disabled, the setting of the 5 kHz search window has no effect.

If SCAN mode is enabled, then the search mode change is not processed immediately, but is saved to take effect later when SCAN mode is disabled.

If the command length is incorrect, then the command is ignored, and the error response is returned.

## WRITE DECODE MODE

### Command:

| FE | FE | ra | ta | 7F | 11 | dm | FD |

dm is a BCD value representing the desired decode mode.  BCD values are encoded as follows:

- 00: CTCSS/DCS DECODE mode
- 01: LTR DECODE mode
- 02: Reserved
- 03: Reserved
- 04: Reserved
- 05: Reserved
- 06: Reserved
- 07: Reserved

### Examples:

CTCSS/DCS DECODE mode

| FE | FE | 80 | E0 | 7F | 11 | 00 | FD |

LTR DECODE mode

| FE | FE | 80 | E0 | 7F | 11 | 01 | FD |

### Response:

| FE | FE | ta | ra | FB or FA | FD |

### Examples:

OK

| FE | FE | E0 | 80 | FB | FD |

Error

| FE | FE | E0 | 80 | FA | FD |

### Description:

This command selects the decode mode.  However, this command is not valid when OptoScan535™ emulation mode is enabled.

The decode mode data is in the form of 1 byte, consisting of 2 BCD digits.  See the examples shown above.

If SCAN mode is enabled, then the decode mode change is not processed immediately, but is saved to take effect later when SCAN mode is disabled.

If the command length is incorrect, or if the received decode mode data is not valid, or if OptoScan535™ emulation mode is enabled, then the command is ignored, and the error response is returned.

**READ LTR DATA**

**Command:**

| FE | FE | ra | ta | 7F | 12 | FD |
|----|----|----|----|----|----|----|

**Example:**

| FE | FE | 80 | E0 | 7F | 12 | FD |
|----|----|----|----|----|----|----|

**Response:**

| FE | FE | ta | ra | 7F | 12 | ad | gd | hd | id | fd | FD |
|----|----|----|----|----|----|----|----|----|----|----|----|

**Examples:**

AREA = 0, GOTO = 05, HOME = 17, ID = 23, FREE = 07

| FE | FE | E0 | 80 | 7F | 12 | 00 | 05 | 17 | 00 | 23 | 07 | FD |
|----|----|----|----|----|----|----|----|----|----|----|----|----|

AREA = 1, GOTO = 11, HOME = 03, ID = 176, FREE = 08

| FE | FE | E0 | 80 | 7F | 12 | 01 | 11 | 03 | 01 | 76 | 08 | FD |
|----|----|----|----|----|----|----|----|----|----|----|----|----|

Error

| FE | FE | E0 | 80 | FA | FD |
|----|----|----|----|----|----|

**Description:**
This command instructs the unit to send the most recent LTR data, provided that LTR decode mode is selected. However, this command is not valid when OptoScan535™ emulation mode is enabled.

The LTR data is in the form of 6 bytes, each consisting of 2 BCD digits. The order of the 12 BCD digits is as follows: unused digit (always 0), AREA code digit, GOTO repeater 10's digit, GOTO repeater 1's digit, HOME repeater 10's digit, HOME repeater 1's digit, unused digit (always 0), ID code 100's digit, ID code 10's digit, ID code 1's digit, FREE repeater 10's digit, FREE repeater 1's digit. See the examples shown above.

It should be noted that this command will always return the most recent LTR data, even if the data is no longer being received. Therefore, the NRZ ACTIVE bit should be checked to determine whether or not LTR data is currently being received. The NRZ ACTIVE bit is accessed through the READ STATUS command. If the frequency, mode, or decode mode is changed, the LTR data is cleared.

If the command length is incorrect, or if LTR decode mode is not selected, or if OptoScan535™ emulation mode is enabled, then the command is ignored, and the error response is returned.

**WRITE VOLUME/SQUELCH CONTROL**

**Command:**

| FE | FE | ra | ta | 7F | 13 | vs | FD |

vs　is a BCD value representing the desired volume/squelch control mode.  BCD values are encoded as follows:

00:　　LOCAL VOLUME/SQUELCH CONTROL mode
01:　　REMOTE VOLUME/SQUELCH CONTROL mode

**Examples:**
LOCAL VOLUME/SQUELCH CONTROL mode

| FE | FE | 80 | E0 | 7F | 13 | 00 | FD |

REMOTE VOLUME/SQUELCH CONTROL mode

| FE | FE | 80 | E0 | 7F | 13 | 01 | FD |

**Response:**

| FE | FE | ta | ra | FB or FA | FD |

**Examples:**
OK

| FE | FE | E0 | 80 | FB | FD |

Error

| FE | FE | E0 | 80 | FA | FD |

**Description:**
This command selects the volume/squelch control mode.

The volume/squelch control mode data is in the form of 1 byte, consisting of 2 BCD digits.  See the examples shown above.  If LOCAL VOLUME/SQUELCH CONTROL mode is selected, then the front panel volume and squelch controls are active.  If REMOTE VOLUME/SQUELCH CONTROL mode is selected, then the front panel volume and squelch controls are ignored, and the volume and squelch settings are controlled using the WRITE VOLUME SETTING and WRITE SQUELCH SETTING commands, respectively.

If the command length is incorrect, or if the received volume/squelch control mode data is not valid, then the command is ignored, and the error response is returned.

**READ VOLUME SETTING**

**Command:**

| FE | FE | ra | ta | 7F | 14 | FD |

**Example:**

| FE | FE | 80 | E0 | 7F | 14 | FD |

**Response:**

| FE | FE | ta | ra | 7F | 14 | vs | FD |

**Examples:**
29

| FE | FE | E0 | 80 | 7F | 14 | 29 | FD |

37

| FE | FE | E0 | 80 | 7F | 14 | 37 | FD |

Error

| FE | FE | E0 | 80 | FA | FD |

**Description:**
This command instructs the unit to send the current active volume setting.

The volume setting data is in the form of 1 byte, consisting of 2 BCD digits. The order of the 2 BCD digits is as follows: 10's digit, 1's digit. The volume setting data is in the range 0 - 99, with 0 representing minimum volume, and 99 representing maximum volume. See the examples shown above.

It should be noted that the volume setting data returned depends on whether LOCAL VOLUME/SQUELCH CONTROL or REMOTE VOLUME/SQUELCH CONTROL is selected. If LOCAL VOLUME/SQUELCH CONTROL is selected, then the current setting of the front panel volume control is returned. If REMOTE VOLUME/SQUELCH CONTROL is selected, then the current volume setting selected by the WRITE VOLUME SETTING command is returned.

If the command length is incorrect, then the command is ignored, and the error response is returned.

**WRITE VOLUME SETTING**

**Command:**

| FE | FE | ra | ta | 7F | 15 | vs | FD |
|----|----|----|----|----|----|----|----|

**Examples:**

07

| FE | FE | 80 | E0 | 7F | 15 | 07 | FD |
|----|----|----|----|----|----|----|----|

55

| FE | FE | 80 | E0 | 7F | 15 | 55 | FD |
|----|----|----|----|----|----|----|----|

**Response:**

| FE | FE | ta | ra | FB or FA | FD |
|----|----|----|----|----------|----|

**Examples:**

OK

| FE | FE | E0 | 80 | FB | FD |
|----|----|----|----|----|----|

Error

| FE | FE | E0 | 80 | FA | FD |
|----|----|----|----|----|----|

**Description:**
This command writes the volume setting.

The volume setting data is in the form of 1 byte, consisting of 2 BCD digits. The order of the 2 BCD digits is as follows:  10's digit, 1's digit.  The volume setting data must be in the range 0 - 99, with 0 representing minimum volume, and 99 representing maximum volume.  See the examples shown above.

It should be noted that the volume setting data applies only to REMOTE VOLUME/SQUELCH CONTROL mode.  If LOCAL VOLUME/SQUELCH CONTROL mode is selected, then the volume setting data is stored until REMOTE VOLUME/SQUELCH CONTROL mode is selected.

If the command length is incorrect, or if the received volume setting data is not in the range 0 - 99, then the command is ignored, and the error response is returned.

## READ SQUELCH SETTING

**Command:**

| FE | FE | ra | ta | 7F | 16 | FD |
|----|----|----|----|----|----|----|

**Example:**

| FE | FE | 80 | E0 | 7F | 16 | FD |
|----|----|----|----|----|----|----|

**Response:**

| FE | FE | ta | ra | 7F | 16 | ss | FD |
|----|----|----|----|----|----|----|----|

**Examples:**

26

| FE | FE | E0 | 80 | 7F | 16 | 26 | FD |
|----|----|----|----|----|----|----|----|

83

| FE | FE | E0 | 80 | 7F | 16 | 83 | FD |
|----|----|----|----|----|----|----|----|

Error

| FE | FE | E0 | 80 | FA | FD |
|----|----|----|----|----|----|

**Description:**
This command instructs the unit to send the current active squelch setting.

The squelch setting data is in the form of 1 byte, consisting of 2 BCD digits.  The order of the 2 BCD digits is as follows:  10's digit, 1's digit.  The squelch setting data is in the range 0 - 99, with 0 representing minimum squelch, and 99 representing maximum squelch.  See the examples shown above.

It should be noted that the squelch setting data returned depends on whether LOCAL VOLUME/SQUELCH CONTROL or REMOTE VOLUME/SQUELCH CONTROL is selected.  If LOCAL VOLUME/SQUELCH CONTROL is selected, then the current setting of the front panel squelch control is returned.  If REMOTE VOLUME/SQUELCH CONTROL is selected, then the current squelch setting selected by the WRITE SQUELCH SETTING command is returned.

If the command length is incorrect, then the command is ignored, and the error response is returned.

**WRITE SQUELCH SETTING**

**Command:**

| FE | FE | ra | ta | 7F | 17 | ss | FD |
|----|----|----|----|----|----|----|----|

**Examples:**

0

| FE | FE | 80 | E0 | 7F | 17 | 00 | FD |
|----|----|----|----|----|----|----|----|

31

| FE | FE | 80 | E0 | 7F | 17 | 31 | FD |
|----|----|----|----|----|----|----|----|

**Response:**

| FE | FE | ta | ra | FB or FA | FD |
|----|----|----|----|----------|----|

**Examples:**

OK

| FE | FE | E0 | 80 | FB | FD |
|----|----|----|----|----|----|

Error

| FE | FE | E0 | 80 | FA | FD |
|----|----|----|----|----|----|

**Description:**

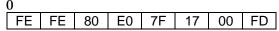This command writes the squelch setting.

The squelch setting data is in the form of 1 byte, consisting of 2 BCD digits. The order of the 2 BCD digits is as follows:  10's digit, 1's digit.  The squelch setting data must be in the range 0 - 99, with 0 representing minimum squelch, and 99 representing maximum squelch.  See the examples shown above.

It should be noted that the squelch setting data applies only to REMOTE VOLUME/SQUELCH CONTROL mode.  If LOCAL VOLUME/SQUELCH CONTROL mode is selected, then the squelch setting data is stored until REMOTE VOLUME/SQUELCH CONTROL mode is selected.

If the command length is incorrect, or if the received squelch setting data is not in the range 0 - 99, then the command is ignored, and the error response is returned.

**WRITE SCAN MODE**

**Command:**

| FE | FE | ra | ta | 7F | 18 | sm | FD |
|----|----|----|----|----|----|----|----|

sm   is a BCD value representing the desired scan mode.  BCD values are encoded as follows:

      00:     SCAN mode disabled
      01:     SCAN mode enabled

**Examples:**
SCAN mode disabled

| FE | FE | 80 | E0 | 7F | 18 | 00 | FD |
|----|----|----|----|----|----|----|----|

SCAN mode enabled

| FE | FE | 80 | E0 | 7F | 18 | 01 | FD |
|----|----|----|----|----|----|----|----|

**Response:**

| FE | FE | ta | ra | FB or FA | FD |
|----|----|----|----|----------|----|

**Examples:**
OK

| FE | FE | E0 | 80 | FB | FD |
|----|----|----|----|----|----|

Error

| FE | FE | E0 | 80 | FA | FD |
|----|----|----|----|----|----|

**Description:**
This command enables or disables SCAN mode. However, this command is not valid when OptoScan535™ emulation mode is enabled.

The scan mode data is in the form of 1 byte, consisting of 2 BCD digits. See the examples shown above.

When SCAN mode is enabled, the memories are scanned repetitively, from memory location 0 to the first empty memory location. If memory location 0 is empty, then SCAN mode cannot be enabled.

If the command length is incorrect, or if the received scan mode data is not valid, or if memory location 0 is empty, or if OptoScan535™ emulation mode is enabled, then the command is ignored, and the error response is returned.

**READ MEMORY**

**Command:**

| FE | FE | ra | ta | 7F | 19 | ml | FD |
|----|----|----|----|----|----|----|----|

**Examples:**

Memory location 0

| FE | FE | 80 | E0 | 7F | 19 | 00 | FD |
|----|----|----|----|----|----|----|----|

Memory location 47

| FE | FE | 80 | E0 | 7F | 19 | 47 | FD |
|----|----|----|----|----|----|----|----|

Memory location 99

| FE | FE | 80 | E0 | 7F | 19 | 99 | FD |
|----|----|----|----|----|----|----|----|

**Response:**

| FE | FE | ta | ra | 7F | 19 | frequency | md | dm | of | FD |
|----|----|----|----|----|----|-----------|----|----|----|----|

md  is a BCD value representing the desired operating mode.  BCD values are encoded as follows:

02:     AM
05:     FM-narrowband
06:     FM-wideband

dm  is a BCD value representing the desired decode mode.  BCD values are encoded as follows:

00:     CTCSS/DCS DECODE mode
01:     LTR DECODE mode
02:     Reserved
03:     Reserved
04:     Reserved
05:     Reserved
06:     Reserved
07:     Reserved

of  is a binary value representing various operating flags.  Individual bits are encoded as follows:

bit 0:   0 = audio enabled, 1 = audio disabled
bit 1:   0 = search mode disabled, 1 = search mode enabled
bit 2:   0 = 5 kHz search window disabled, 1 = 5 kHz search window enabled
bit 3:   Unused.  Always 0.
bit 4:   0 = squelch delay disabled, 1 = squelch delay enabled
bit 5:   Reserved
bit 6:   Reserved
bit 7:   Unused.  Always 0.

**Examples:**

315.575000 MHz, AM mode, CTCSS/DCS decode mode, audio enabled, search mode disabled, 5 kHz search window disabled, squelch delay enabled

| FE | FE | E0 | 80 | 7F | 19 | 00 | 50 | 57 | 15 | 03 | 02 | 00 | 10 | FD |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|

1045.712500 MHz, FM-narrowband mode, LTR decode mode, audio disabled, search mode enabled, 5 kHz search window disabled, squelch delay disabled

| FE | FE | E0 | 80 | 7F | 19 | 00 | 25 | 71 | 45 | 10 | 05 | 01 | 03 | FD |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|

memory location empty

| FE | FE | E0 | 80 | 7F | 19 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | FD |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|

Error

| FE | FE | E0 | 80 | FA | FD |
|----|----|----|----|----|----|

**Description:**
This command instructs the unit to send the frequency and associated data stored in the specified memory location.

The specified memory location data is in the form of 1 byte, consisting of 2 BCD digits. The specified memory location must be in the range 0 to 99.

The frequency data is in the form of 5 bytes, each consisting of 2 BCD digits. The order of the 10 BCD digits is as follows: 10 Hz digit, 1 Hz digit, 1 kHz digit, 100 Hz digit, 100 kHz digit, 10 kHz digit, 10 MHz digit, 1 MHz digit, 1 GHz digit, 100 MHz digit. The mode data is in the form of 1 byte, consisting of 2 BCD digits. The decode mode data is in the form of 1 byte, consisting of 2 BCD digits. The operating flag data is in the form of 1 byte, consisting of 6 operating flag bits and 2 unused bits which are always cleared. The unused bits ensure that the operating flag data always appears as valid BCD digits. See the examples shown above.

If the command length is incorrect, or if the specified memory location is not in the range 0 to 99, then the command is ignored, and the error response is returned.

**WRITE MEMORY**

**Command:**

| FE | FE | ra | ta | 7F | 1A | ml | frequency | md | dm | of | FD |
|----|----|----|----|----|----|----|-----------|----|----|----|----|

`md` is a BCD value representing the desired operating mode. BCD values are encoded as follows:

    02:    AM
    05:    FM-narrowband
    06:    FM-wideband

`dm` is a BCD value representing the desired decode mode. BCD values are encoded as follows:

    00:    CTCSS/DCS DECODE mode
    01:    LTR DECODE mode
    02:    Reserved
    03:    Reserved
    04:    Reserved
    05:    Reserved
    06:    Reserved
    07:    Reserved

`of` is a binary value representing various operating flags. Individual bits are encoded as follows:

    bit 0:    0 = audio enabled, 1 = audio disabled
    bit 1:    0 = search mode disabled, 1 = search mode enabled
    bit 2:    0 = 5 kHz search window disabled, 1 = 5 kHz search window enabled
    bit 3:    Unused. Always 0.
    bit 4:    0 = squelch delay disabled, 1 = squelch delay enabled
    bit 5:    Reserved
    bit 6:    Reserved
    bit 7:    Unused. Always 0.

**Examples:**
Memory location 23, 315.575000 MHz, AM mode, CTCSS/DCS decode mode, audio enabled, search mode disabled, 5 kHz search window disabled, squelch delay enabled

| FE | FE | E0 | 80 | 7F | 1A | 23 | 00 | 50 | 57 | 15 | 03 | 02 | 00 | 10 | FD |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|

Memory location 67, 1045.712500 MHz, FM-narrowband mode, LTR decode mode, audio disabled, search mode enabled, 5 kHz search window disabled, squelch delay disabled

| FE | FE | E0 | 80 | 7F | 1A | 67 | 00 | 25 | 71 | 45 | 10 | 05 | 01 | 03 | FD |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|

**Response:**

| FE | FE | ta | ra | FB or FA | FD |
|----|----|----|----|----------|----|

**Examples:**
OK

| FE | FE | E0 | 80 | FB | FD |
|----|----|----|----|----|----|

Error

| FE | FE | E0 | 80 | FA | FD |
|----|----|----|----|----|----|

**Description:**
This command writes the frequency and associated data to the specified memory location.

The specified memory location data is in the form of 1 byte, consisting of 2 BCD digits. The specified memory location must be in the range 0 to 99.

The frequency data is in the form of 5 bytes, each consisting of 2 BCD digits. The order of the 10 BCD digits is as follows: 10 Hz digit, 1 Hz digit, 1 kHz digit, 100 Hz digit, 100 kHz digit, 10 kHz digit, 10 MHz digit, 1 MHz digit, 1 GHz digit, 100 MHz digit. The mode data is in the form of 1 byte, consisting of 2 BCD digits. The decode mode data is in the form of 1 byte, consisting of 2 BCD digits. The operating flag data is in the form of 1 byte, consisting of 6 operating flag bits and 2 unused bits which are always cleared. The unused bits ensure that the operating flag data always appears as valid BCD digits. See the examples shown above.

If the command length is incorrect, or if the specified memory location is not in the range 0 to 99, or if any of the memory data to be stored is invalid, then the command is ignored, and the error response is returned.

**CLEAR MEMORY**

**Command:**

| FE | FE | ra | ta | 7F | 1B | ml | FD |
|----|----|----|----|----|----|----|----|

**Examples:**
Memory location 0

| FE | FE | 80 | E0 | 7F | 1B | 00 | FD |
|----|----|----|----|----|----|----|----|

Memory location 47

| FE | FE | 80 | E0 | 7F | 1B | 47 | FD |
|----|----|----|----|----|----|----|----|

Memory location 99

| FE | FE | 80 | E0 | 7F | 1B | 99 | FD |
|----|----|----|----|----|----|----|----|

**Response:**

| FE | FE | ta | ra | FB or FA | FD |
|----|----|----|----|----------|----|

**Examples:**
OK

| FE | FE | E0 | 80 | FB | FD |
|----|----|----|----|----|----|

Error

| FE | FE | E0 | 80 | FA | FD |
|----|----|----|----|----|----|

**Description:**
This command clears the specified memory location.

The specified memory location data is in the form of 1 byte, consisting of 2 BCD digits. The specified memory location must be in the range 0 to 99.

If memory location 0 is cleared, and SCAN mode is enabled, then SCAN mode is disabled.

If the command length is incorrect, or if the specified memory location is not in the range 0 to 99, then the command is ignored, and the error response is returned.

**WRITE BIT BANGER DATA RATE**

**Command:**

| FE | FE | ra | ta | 7F | 1C | dr | FD |
|----|----|----|----|----|----|----|----|

dr  is a BCD value representing the desired data rate.  BCD values are encoded as follows:

       00:      3600 bps
       01:      9600 bps

**Examples:**
3600 bps

| FE | FE | 80 | E0 | 7F | 1C | 00 | FD |
|----|----|----|----|----|----|----|----|

9600 bps

| FE | FE | 80 | E0 | 7F | 1C | 01 | FD |
|----|----|----|----|----|----|----|----|

**Response:**

| FE | FE | ta | ra | FB or FA | FD |
|----|----|----|----|----------|----|

**Examples:**
OK

| FE | FE | E0 | 80 | FB | FD |
|----|----|----|----|----|----|

Error

| FE | FE | E0 | 80 | FA | FD |
|----|----|----|----|----|----|

**Description:**
This command selects the BitBanger™ data rate.  The power-up default data rate is 3600 bps.  See the **BitBanger™ MODE** section for more information.

The data rate data is in the form of 1 byte, consisting of 2 BCD digits.  See the examples shown above.

If the command length is incorrect, or if the received data rate data is not valid, then the command is ignored, and the error response is returned.

**WRITE BIT BANGER MODE**

**Command:**

| FE | FE | ra | ta | 7F | 1D | ms | FD |
|----|----|----|----|----|----|----|----|

ms    is a BCD value representing the desired mode. BCD values are encoded as follows:

     00:      Disabled
     01:      Enabled

**Examples:**
Disable BitBanger™ mode

| FE | FE | 80 | E0 | 7F | 1D | 00 | FD |
|----|----|----|----|----|----|----|----|

Enable BitBanger™ mode

| FE | FE | 80 | E0 | 7F | 1D | 01 | FD |
|----|----|----|----|----|----|----|----|

**Response:**

| FE | FE | ta | ra | FB or FA | FD |
|----|----|----|----|----------|----|

**Examples:**
OK

| FE | FE | E0 | 80 | FB | FD |
|----|----|----|----|----|----|

Error

| FE | FE | E0 | 80 | FA | FD |
|----|----|----|----|----|----|

**Description:**
This command enables or disables the BitBanger™ mode. The power-up default is BitBanger™ mode disabled. See the **BitBanger™ MODE** section for more information.

The mode data is in the form of 1 byte, consisting of 2 BCD digits. See the examples shown above.

If the command length is incorrect, or if the received mode data is not valid, then the command is ignored, and the error response is returned.

**WRITE CI-5 ADDRESS**

**Command:**

| FE | FE | ra | ta | 7F | D0 | security code | | | | | ad | FD |
|----|----|----|----|----|----|---|---|---|---|---|----|----|

**Examples:**
CI-5 address 83

| FE | FE | 80 | E0 | 7F | D0 | 94 | 18 | 72 | 26 | 49 | 83 | FD |
|----|----|----|----|----|----|----|----|----|----|----|----|----|

CI-5 address 8C

| FE | FE | 80 | E0 | 7F | D0 | 94 | 18 | 72 | 26 | 49 | 8C | FD |
|----|----|----|----|----|----|----|----|----|----|----|----|----|

**Response:**

| FE | FE | ta | ra | FB or FA | FD |
|----|----|----|----|----------|----|

**Examples:**
OK

| FE | FE | E0 | 80 | FB | FD |
|----|----|----|----|----|----|

Error

| FE | FE | E0 | 80 | FA | FD |
|----|----|----|----|----|----|

**Description:**
This command selects the CI-5 interface address.

The security code is in the form of 5 bytes, each consisting of 2 BCD digits. The security code is, therefore, a unique 10-digit code which must be correctly specified to change the CI-5 address. The address code is in the form of 1 byte, consisting of 2 hexadecimal digits. The address code must be in the range 80 through 8F. See the examples shown above.

Note that if the address is successfully changed, then the new address will be reflected in the response, and all subsequent commands must be sent to the new address. If the current address is unknown, and there is only one device on the CI-5 bus, then this command can be sent using address 00 (all units addressed). The CI-5 address is stored in non-volatile memory, and remains the same until the next valid address change command.

If the command length is incorrect, or if the security code or address code is not valid, then the command is ignored, and the error response is returned.

**WRITE CI-5 DATA RATE**

**Command:**

| FE | FE | ra | ta | 7F | D1 | security code | | | | dr | FD |
|----|----|----|----|----|----|----|----|----|----|----|----|

| dr | is a BCD value representing the desired CI-5 interface data rate.  BCD values are encoded as follows:

        00:     300 bps
        01:     600 bps
        02:     1200 bps
        03:     2400 bps
        04:     4800 bps
        05:     9600 bps
        06:     19200 bps
        07:     38400 bps

**Examples:**
9600 bps

| FE | FE | 80 | E0 | 7F | D1 | 38 | 69 | 84 | 12 | 76 | 05 | FD |
|----|----|----|----|----|----|----|----|----|----|----|----|----|

1200 bps

| FE | FE | 80 | E0 | 7F | D1 | 38 | 69 | 84 | 12 | 76 | 02 | FD |
|----|----|----|----|----|----|----|----|----|----|----|----|----|

**Response:**

| FE | FE | ta | ra | FB or FA | FD |
|----|----|----|----|----|----|

**Examples:**
OK

| FE | FE | E0 | 80 | FB | FD |
|----|----|----|----|----|----|

Error

| FE | FE | E0 | 80 | FA | FD |
|----|----|----|----|----|----|

**Description:**
This command selects the CI-5 interface data rate.

The security code is in the form of 5 bytes, each consisting of 2 BCD digits.  The security code is, therefore, a unique 10-digit code which must be correctly specified to change the CI-5 data rate. The data rate code is in the form of 1 byte, consisting of 2 BCD digits.  See the examples shown above.

Note that if a valid data rate change command is received, the change takes place immediately, and the response is transmitted at the new data rate.  If the CI-5 data rate is changed, the new data rate remains in effect until the unit is powered down.  The unit always powers up with a CI-5 data rate of 9600 bps.

If the command length is incorrect, or if the security code or data rate code is not valid, then the command is ignored, and the error response is returned.

**WRITE CI-5 INTERFACE MODE**

**Command:**

| FE | FE | ra | ta | 7F | D2 | security code | | im | FD |
|----|----|----|----|----|----|----|----|----|----|

im  is a BCD value representing the desired interface mode.  BCD values are encoded as follows:

      00:     OPTOCOM™ interface mode
      01:     OptoScan535™ emulation mode

**Examples:**
OPTOCOM™ interface mode

| FE | FE | 80 | E0 | 7F | D2 | 15 | 31 | 48 | 78 | 60 | 00 | FD |
|----|----|----|----|----|----|----|----|----|----|----|----|----|

OptoScan535™ emulation mode

| FE | FE | 80 | E0 | 7F | D2 | 15 | 31 | 48 | 78 | 60 | 01 | FD |
|----|----|----|----|----|----|----|----|----|----|----|----|----|

**Response:**

| FE | FE | ta | ra | FB or FA | FD |
|----|----|----|----|----------|----|

**Examples:**
OK

| FE | FE | E0 | 80 | FB | FD |
|----|----|----|----|----|----|

Error

| FE | FE | E0 | 80 | FA | FD |
|----|----|----|----|----|----|

**Description:**
This command selects the CI-5 interface mode.

The security code is in the form of 5 bytes, each consisting of 2 BCD digits.  The security code is, therefore, a unique 10-digit code which must be correctly specified to change the CI-5 interface mode.  The interface mode data is in the form of 1 byte, consisting of 2 BCD digits.  See the examples shown above.

OptoScan535™ emulation mode provides backward compatibility with legacy software written for the OptoScan535™.  The CI-5 interface mode is stored in non-volatile memory, and remains the same until the next valid interface mode change command.

If the command length is incorrect, or if the security code or interface mode data is not valid, then the command is ignored, and the error response is returned.

**STORE OPERATING PARAMETERS**

**Command:**

| FE | FE | ra | ta | 7F | D3 | FD |
|----|----|----|----|----|----|----|

**Example:**

| FE | FE | 80 | E0 | 7F | D3 | FD |
|----|----|----|----|----|----|----|

**Response:**

| FE | FE | ta | ra | FB or FA | FD |
|----|----|----|----|----------|----|

**Examples:**
OK

| FE | FE | E0 | 80 | FB | FD |
|----|----|----|----|----|----|

Error

| FE | FE | E0 | 80 | FA | FD |
|----|----|----|----|----|----|

**Description:**
This command instructs the unit to store the current operating parameters in non-volatile memory.

The operating parameters are automatically recalled from non-volatile memory on power-up.

If the command length is incorrect, then the command is ignored, and the error response is returned.

**RECALL OPERATING PARAMETERS**

**Command:**

| FE | FE | ra | ta | 7F | D4 | FD |
|----|----|----|----|----|----|----|

**Example:**

| FE | FE | 80 | E0 | 7F | D4 | FD |
|----|----|----|----|----|----|----|

**Response:**

| FE | FE | ta | ra | FB or FA | FD |
|----|----|----|----|----------|----|

**Examples:**

OK

| FE | FE | E0 | 80 | FB | FD |
|----|----|----|----|----|----|

Error

| FE | FE | E0 | 80 | FA | FD |
|----|----|----|----|----|----|

**Description:**

This command instructs the unit to recall the current operating parameters from non-volatile memory.

The operating parameters are automatically recalled from non-volatile memory on power-up.

If the command length is incorrect, then the command is ignored, and the error response is returned.

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