Optoelectronics, Inc.
CD100™ Multicounter
Serial Interface Specification

Interface Version 1.1

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INTRODUCTION

This document describes the serial interface of the CD100™ Multicounter, a hand-held frequency counter capable of measuring the frequency of VHF and UHF transmitters and other signal sources, as well as decoding CTCSS, DCS, DTMF, and LTR data. The CD100™ is also capable of storing up to 100 frequencies and corresponding decoded data. This frequency data can then be downloaded to a personal computer for logging and analysis.

This document was written to assist the programmer in developing computer software applications for the CD100™.

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ABOUT CI-5

The serial interface on the CD100™ conforms to the Icom CI-V interface standard. However, Optoelectronics has added enhancements in the form of additional commands and features. Optoelectronics has, therefore, modified the name of this new enhanced interface to CI-5.

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 who are unfamiliar with the CI-5 interface 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.

<table>
<thead>
<tr>
<th>DATA RATE</th>
<th>9600 bps</th>
</tr>
</thead>
<tbody>
<tr>
<td>START BITS</td>
<td>1</td>
</tr>
<tr>
<td>DATA BITS</td>
<td>8</td>
</tr>
<tr>
<td>PARITY</td>
<td>NONE</td>
</tr>
<tr>
<td>STOP BITS</td>
<td>1</td>
</tr>
</tbody>
</table>

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 the computer transmits a command, it is automatically echoed back as received data, followed by the response to the command, if any. For example, if an 11-byte command is transmitted to a device on the bus, which returns a 6-byte response, the computer will receive a total of 17 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.

To connect the CD100™ to a computer, a subminiature phone jack is provided on the top panel. An external interface converter box, such as the Optoelectronics Optolinx™, is required to connect the CD100™ to an RS-232C computer interface. Its purpose is to convert the CI-5 interface voltage levels to RS-232C levels compatible with most personal computers.
The CD100™ accepts commands over the CI-5 interface when CI-5 COMMAND interface is selected from the front panel. In this section, all CI-5 command and response bytes are expressed in hexadecimal notation. The CD100™ recognizes 9 different commands, which are summarized in Table 2 below.

Following the command summary 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 CD100™, which is fixed at 9A. Each device on the CI-5 bus must have its own unique address. The CD100™ will not process any command in which the RECEIVE ADDRESS is not 9A. However, the CD100™ 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 CD100™. 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 CD100™ will not process any command in which the TRANSMIT ADDRESS matches its own address, 9A.

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 2. CD100™ CI-5 Interface Command Summary.

<table>
<thead>
<tr>
<th>COMMAND</th>
<th>SUB-COMMAND</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>03</td>
<td>-</td>
<td>Read Frequency</td>
</tr>
<tr>
<td>06</td>
<td>-</td>
<td>Write Mode</td>
</tr>
<tr>
<td>15</td>
<td>01</td>
<td>Read Squelch Status</td>
</tr>
<tr>
<td>7F</td>
<td>09</td>
<td>Read Identification</td>
</tr>
<tr>
<td>7F</td>
<td>20</td>
<td>Read Decode Measurement</td>
</tr>
<tr>
<td>7F</td>
<td>21</td>
<td>Write Decode Select</td>
</tr>
<tr>
<td>7F</td>
<td>22</td>
<td>Read Frequency Memory</td>
</tr>
<tr>
<td>7F</td>
<td>23</td>
<td>Read Decode Memory</td>
</tr>
<tr>
<td>7F</td>
<td>24</td>
<td>Clear Memory</td>
</tr>
</tbody>
</table>
READ FREQUENCY

Command:
```
FE FE ra ta 03 FD
```

Example:
```
FE FE 9A E0 03 FD
```

Response:
```
FE FE ta ra 03 frequency FD
```

Examples:
- **162.550000 MHz**
  ```
  FE FE E0 9A 03 00 00 55 62 01 FD
  ```

- **1045.725000 MHz**
  ```
  FE FE E0 9A 03 00 50 72 45 10 FD
  ```

Error
```
FE FE E0 9A FA FD
```

Description:
This command instructs the unit to send the current frequency measurement result.

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 examples shown above.

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

Command:

FE | FE | ra | ta | 06 | ms | FD

\( ms \) is a BCD value representing the selected operating mode. BCD values are encoded as follows:

<table>
<thead>
<tr>
<th>BCD</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>00</td>
<td>TEST mode</td>
</tr>
<tr>
<td>01</td>
<td>MEMORY mode</td>
</tr>
<tr>
<td>02</td>
<td>CLEAR MEMORY mode</td>
</tr>
<tr>
<td>03</td>
<td>INTERFACE mode</td>
</tr>
<tr>
<td>04</td>
<td>RECEIVER mode</td>
</tr>
<tr>
<td>05</td>
<td>APO mode</td>
</tr>
<tr>
<td>06</td>
<td>FREQ DISPLAY mode</td>
</tr>
</tbody>
</table>

Examples:

TEST mode

FE | FE | 9A | E0 | 06 | 00 | FD

CLEAR MEMORY mode

FE | FE | 9A | E0 | 06 | 02 | FD

Response:

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

Examples:

OK

FE | FE | E0 | 9A | FB | FD

Error

FE | FE | E0 | 9A | FA | FD

Description:

This command selects the operating mode.

The mode select 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 mode select code 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  9A  E0  15  01  FD
```

**Response:**
```
FE  FE  ta  ra  15  01  sd  FD
```

**Examples:**
- Squelch closed
  
  ```
  FE  FE  E0  9A  15  01  00  FD
  ```

- Squelch open
  
  ```
  FE  FE  E0  9A  15  01  01  FD
  ```

- Error
  
  ```
  FE  FE  E0  9A  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 IDENTIFICATION

Command:

```
FE FE ra ta 7F 09 FD
```

Example:

```
FE FE 9A E0 7F 09 FD
```

Response:

```
FE FE ta ra 7F 09 id sv iv FD
```

Example:

```
FE FE 9A E0 7F 09 43 44 31 13 11 FD
```

Error

```
FE FE E0 9A FA FD
```

Description:

This command instructs the unit to send the identification information.

The identification data is in the form of 5 bytes, each consisting of 2 digits. The first 6 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.

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

Command:
```
FE FE ra ta 7F 20 FD
```

Example:
```
FE FE 9A E0 7F 20 FD
```

Response:
```
FE FE ta ra 7F 20 ds decode data FD
```

\( ds \) is a BCD value representing the selected decode measurement. BCD values are encoded as follows:

- 00: CTCSS decode
- 01: DCS decode
- 02: DTMF decode
- 03: LTR decode

Examples:
- CTCSS decode, 103.5 Hz, CTCSS active
  ```
  FE FE E0 9A 7F 20 00 10 35 01 FD
  ```
- DCS decode, 732, DCS inactive
  ```
  FE FE E0 9A 7F 20 01 07 32 00 FD
  ```
- DTMF decode, “A”
  ```
  FE FE E0 9A 7F 20 02 10 FD
  ```
- DTMF decode, DTMF buffer empty
  ```
  FE FE E0 9A 7F 20 02 99 FD
  ```
- LTR decode, AREA = 1, GOTO = 11, HOME = 03, ID = 176, FREE = 08, LTR active
  ```
  FE FE E0 9A 7F 20 03 01 11 03 01 76 08 01 FD
  ```
- Error
  ```
  FE FE E0 9A FA FD
  ```

Description:
This command instructs the unit to send the current decode measurement.

The decode select is in the form of 1 byte, consisting of 2 BCD digits, and specifies the type of decode measurement data returned. The decode data is in the form of from 1 to 7 bytes, each 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.
WRITE DECODE SELECT

Command:

```
FE FE ra ta 7F 21 ds FD
```

\(ds\) is a BCD value representing the selected decode measurement. BCD values are encoded as follows:

<table>
<thead>
<tr>
<th>BCD Value</th>
<th>Decode Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>00</td>
<td>CTCSS decode</td>
</tr>
<tr>
<td>01</td>
<td>DCS decode</td>
</tr>
<tr>
<td>02</td>
<td>DTMF decode</td>
</tr>
<tr>
<td>03</td>
<td>LTR decode</td>
</tr>
</tbody>
</table>

Examples:

- **DCS decode**
  ```
  FE FE 9A E0 7F 21 01 FD
  ```

- **LTR decode**
  ```
  FE FE 9A E0 7F 21 03 FD
  ```

Response:

```
FE FE ta ra FB or FA FD
```

Examples:

- **OK**
  ```
  FE FE E0 9A FB FD
  ```

- **Error**
  ```
  FE FE E0 9A FA FD
  ```

Description:

This command selects the decode measurement.

The decode select code 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 decode select code is not valid, then the command is ignored, and the error response is returned.
**READ FREQUENCY MEMORY**

**Command:**
```
FE FE ra ta 7F 22 memory FD
```

**Examples:**
- Memory location 0
  ```
  FE FE 9A E0 7F 22 00 00 FD
  ```
- Memory location 63
  ```
  FE FE 9A E0 7F 22 00 63 FD
  ```
- Memory location 99
  ```
  FE FE 9A E0 7F 22 00 99 FD
  ```

**Response:**
```
FE FE ta ra 7F 22 frequency FD
```

**Examples:**
- 162.550000 MHz
  ```
  FE FE E0 9A 7F 22 00 00 55 62 01 FD
  ```
- 1045.725000 MHz
  ```
  FE FE E0 9A 7F 22 00 50 72 45 10 FD
  ```

**Error**
```
FE FE E0 9A FA FD
```

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

The specified memory location data is in the form of two bytes, each consisting of two BCD digits. The specified memory location must be in the range 0 to 99. The frequency data is in the form of five bytes, each consisting of two BCD digits. The order of the ten BCD digits is as follows: 10 Hz digit, 1 Hz digit, 1 kHz digit, 100 Hz digit, 10 kHz digit, 100 kHz digit, 10 MHz digit, 1 MHz digit, 1 GHz digit, 100 MHz digit. 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.
READ DECODE MEMORY

Command:

| FE | FE | ra | ta | 7F | 23 | memory | FD |

Examples:

Memory location 0

| FE | FE | 9A | E0 | 7F | 23 | 00 | 00 | FD |

Memory location 99

| FE | FE | 9A | E0 | 7F | 23 | 00 | 99 | FD |

Response:

| FE | FE | ta | ra | 7F | 23 | ds | decode data | FD |

*ds* is a BCD value representing the selected decode measurement. BCD values are encoded as follows:

- 00: CTCSS decode
- 01: DCS decode
- 02: DTMF decode
- 03: LTR decode

Examples:

CTCSS decode, 103.5 Hz

| FE | FE | E0 | 9A | 7F | 23 | 00 | 10 | 35 | FD |

DCS decode, 732

| FE | FE | E0 | 9A | 7F | 23 | 01 | 07 | 32 | FD |

DTMF decode, “0123*#C”

| FE | FE | E0 | 9A | 7F | 23 | 02 | 00 | 01 | 02 | 03 | 14 | 15 | 12 | 16 | 16 | 16 | FD |

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

| FE | FE | E0 | 9A | 7F | 23 | 03 | 01 | 11 | 03 | 01 | 76 | 08 | FD |

Error

| FE | FE | E0 | 9A | FA | FD |

Description:

This command instructs the unit to send the decode measurement stored in the specified memory location.

The specified memory location data is in the form of two bytes, each consisting of two BCD digits. The specified memory location must be in the range 0 to 99. The decode select is in the form of 1 byte, consisting of 2 BCD digits, and specifies the type of decode measurement data returned. The decode data is in the form of from 2 to 10 bytes, each consisting of 2 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.
CLEAR MEMORY

Command:

| FE | FE | ra | ta | 7F | 24 | FD |

Example:

| FE | FE | 9A | E0 | 7F | 24 | FD |

Response:

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

Example:

OK

| FE | FE | E0 | 9A | FB | FD |

Error

| FE | FE | E0 | 9A | FA | FD |

Description:
This command clears all frequency and decode memory locations.

Once this command is executed, all memory locations are set to zero. This command has the same effect as clearing the memory from the front panel.

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