Intan Technologies RHA2000-EVAL evaluation board USB protocol

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The Intan Technologies RHA2000-EVAL evaluation board uses an FTDI FT2232H chip to provide a USB interface to a PC. Detailed information on this chip may be found at:

http://www.ftdichip.com/Products/ICs/FT2232H.htm

The FT2232H chip supports two independent FIFO channels. The channel used by the RHA2000-EVAL board is factory-configured with the name "Intan I/O Board 1.0 A". (FTDI provides software routines to open a device by its name.)

The RHA2000-EVAL board is controlled by sending one-byte ASCII command characters over the USB interface. The following table summarizes the valid commands:

ASCII character	Hex equivalent	Command
S	0x53	Start USB data transfer from amplifiers
s	0x73	Stop USB data transfer from amplifiers
I	0x49	Command board to send 3-byte ID/version number
F	0x46	Enable amplifier fast settle
f	0x66	Disable amplifier fast settle
Z	0x5A	Enable impedance check mode
z	0x7A	Disable impedance check mode
R	0x52	Reset to amplifier channel 0 (impedance check mode only)
N	0x4E	Step to next channel (impedance check mode only)

To read data from the board, send an 'S' to initiate data transfer and then read the stream of bytes coming from the board. A complete sequence of single A/D samples from all 16 amplifiers uses 16 x 3 = 48 bytes in the following three-byte format (MSB is on the left; LSB is on the right):

Byte 1

1	ADC6	ADC5	ADC4	ADC3	ADC2	ADC1	ADC0

Byte 2

1	ADC13	ADC12	ADC11	ADC10	ADC9	ADC8	ADC7

Byte 3

0	0	CH3	CH2	CH1	CH0	ADC15	ADC14

ADC0 through ADC15 comprise the 16-bit A/D converter sample from a particular amplifier channel. (ADC15 is the MSB; ADC0 is the LSB.) The A/D full-scale range is 2.5V. The "zero" level of RHA2116 amplifiers is around 1.225V, although this can vary from one channel to another due to built-in offset voltages. The use of a software high-pass filter is recommended to remove these offsets. (See the RHA2116 datasheet for more information.) With the RHA2116 amplifier gain of 200 taken into account, each A/D step corresponds to an electrode-referred voltage of $(2.5V/200)/2^{16}$ = 0.19073 µV.

CH0 through CH3 encode information that varies with the channel number. The following table shows the values for these bits depending on the channel:

Amplifier Channel	CH3	CH2	CH1	CH0
0	0	0	0	0
1	0	0	0	AUX1
2	0	0	0	AUX2
3	0	0	0	AUX3
4	0	0	0	AUX4
5	0	0	0	AUX5
6	0	0	0	AUX6
7	X	X	X	X
8	X	X	X	X
9	X	X	X	X
10	X	X	X	X
11	X	X	X	X
12	X	X	X	X
13	X	X	X	X
14	X	X	X	X
15	1	1	1	1

AUX1 through AUX6 are bits corresponding to the Port J3 auxiliary TTL inputs shown on page 6 of the RHA2000-EVAL datasheet. Any bits listed as 'X' are not specified and should not be used. Note that channels 0 and 15 are unambiguously marked (0000 and 1111, respectively). It is recommended that interface software first watch for a byte that begins with '001111xx'. This must correspond to Byte 3 of channel 15. The next 48 bytes will comprise a complete 16-channel data frame starting with channel 0 and proceeding through channel 15.

Each amplifier channel is sampled at 25 kS/s, which gives a data rate of 25,000 x 16 x 3 = 1.2 MByte/s.

In our experience, the FTDI occasionally drops bytes, requiring any interface software to frequently look for a '001111xx' byte at the end of each 48-byte data frame to ensure synchronization is maintained. When sync is lost, the software must search for this byte again.