Note: Due to its very low-level nature and several restrictions Aaronia no longer supports programming the Spectran directly over USB. If you want to integrate a Spectran device in your own software it is recommended to use the RSA network protocol. This document is only provided as a reference.

USB Communication

The SPECTRAN uses byte parallel transport via USB. The communication can be established via the FTD2XX library form Future Technology Devices International Ltd.
To avoid misuse, the PC has to identify itself with the verify command. Because the state of the USB communication may be unknown, it's recommended to try the verify command at least twice. Each command start with the command id followed by some parameters. The Spectran responds with a suitable status if the command is accepted. Three commands differ from that: There is no response to wrong VERIFY commands, there is no response to the LOGOUT command and the AMPFREQDAT, which carries current measurement data, is sent without request. Word (2 Bytes) values are transferred in low byte first, high byte last, which matches the normal Intel Little Endian order.

VERIFY
This is a sequence of 5 bytes, starting with the command UCMD_IDREQ, followed by UIDREQ_CODE1 - UIDREQ_CODE4. The expected answer is 5 bytes starting with UST_IDACK followed by UIDACK_CODE1 – UIDACK_CODE4

Send:

0x01	0xA5	0x5A	0xF1	0x1F

Receive:

0x01	0x51	0x1A	0xF5	0xAF

If the send command doesn't match, nothing is sent back and the communication time-outs.

LOGOUT
Send this sequence to resets the verified state in the SPECTRAN. The SPECTRAN won't accept any commands but VERIFY. Therefore it won't send back any data to a custom application which accidentally communicates with it.

Send:

0x02

Receive:

Nothing

FILEREAD
The UCMD_FILEREAD command reads a file block. The command is followed by 2 bytes file-id and 2 bytes offset. The offset is in words, not bytes. The Command responds with UST_FILESTAT followed by a status byte. If the status byte is USFT_DONE, the command
is followed by UST_FTREADDAT, 1 byte data length in words (not bytes) and data.

Send:

0x10	id	id	offset	offset

Receive:

0x10	status

Receive

0x12	Len	data	....

The status value UFST_DONE indicates successful execution of the request, read requests are followed by a UST_FTREADDAT command response. The status value UFST_NOTFND indicates that the file doesn't exist, the status value UFST_FSFULL indicates full file system (for write commands only), the status command UFST_ACCERR indicates a general SPECTRAN internal error.

FILEWRITE

UCMD_FILEWRITE appends a block of data to a file. For an update, the file must be deleted first and then completely written. The length of the command must not exceed the maximum buffer size as returned by FTMAXSIZE, currently 256 bytes.

Send:

0x11	id	id	len	data	....

Receive:

0x10	status

Status indicates write success or error as described in FILEREAD.

FTMAXSIZE

Use this command to query the maximum block size for one transfer command. The returned value indicates the buffer size in words, not bytes.

Send:

0x13

Receive:

0x11	Len

FILEDEL

UCMD_FILEDEL deletes a file.

Send:

0x12	id	id

Receive:

0x10	Status

Status indicates delete success or error as described in FILEREAD.

GETSTPVAR

UCMD_GETSTPVAR reads a SPECTRAN environment variable. The value is casted as 4 byte float variable in little endian format (Intel x86).

Send:

0x20	Id	Id

Receive:

0x20	Status	val	val	val	val

SETSTPVAR

UCMD_SETSTPVAR sets a SPECTRAN environment variable. The value is casted as 4 byte float variable in little endian format (intel x86).

Send:

0x21	id	id	val	val	val	val

Receive:

0x21	Status

Status indicates success by USST_DONE and failure by USST_FAILED.

AMPFREQDAT

UST_AMPFREQDAT is somewhat special because it has no request. It's sent by HF Spectran as long as the environment Variable USBMEAS is set. The data is total 16 bytes separated as follows:

- Time unsigned int (4 bytes)
Internal timestamp value.
- Frequency unsigned int (4 bytes)
The frequency in Hz / 10. A value of 1000 means 10 kHz.
- Minval Float (4 bytes)
The minimum (when using MinMax detector) or RMS value in dBm measured for the current point.
- Maxval Float (4 bytes)
The maximum (when using MinMax detector) or RMS value in dBm measured for the current point.

Send:

Nothing

Receive:

0x22	time	time	time	time	freq	freq	freq	freq	min	min	min	min	max	max	max	max

Explanation of Minval, Maxval and Pulsemode:

Each measurement point is captured multiple times before it's displayed. If the Pulsemode setting is on, and the maximum value during the time is high enough, then the value is reported even if the signal isn't detected during the whole period, so minval is low or -120 dBm. If the Pulsemode setting is off, the value is suppressed and MinVal and MaxVal are identical. As long as the input is continuous, it's better to leave the setting off. If the signal changes very fast (time slot signals), it's recommended to turn the setting on. On HF V4 devices Pulsemode is replaced by MinMax detector setting.

PHYFREQDAT

UST_PHYFREQDAT is somewhat special because it has no request. It's sent by NF Spectran as long as the environment Variable USBMEAS is set. The data is total 18 bytes separated as follows:

- Time unsigned int (4 bytes)
Internal timestamp value.
- Sensor unsigned short int (2 bytes)
Sensor ID that recorded the value and also determines the phyiscal unit of the measurement data:
    - 0-2 means magnetic sensor X/Y/Z axis, value in Tesla
    - 3-5 means static sensor X/Y/Z axis, value in Tesla
    - 6 means electric sensor, value in Volt/meter
    - 7 means analog input, value in Volt
- Frequency unsigned int (4 bytes)
The frequency in Hz * 10. A value of 1000 means 100 Hz.
- Minval Float (4 bytes)
The minimum measured value for the current point.
- Maxval Float (4 bytes)
The maximum measured value for the current point.

Send:

Nothing

Receive:

0x23	time	time	time	time	sens	sens	freq	freq	freq	freq	min	min	min	min	max	max	max	max

Other commands

The SPECTRAN flash update is done also via USB command. The start command is 0xE0, which activates a special flash mode. The detailed Flash procedure is outside the scope of this document.

SPECTRAN Environment Variables

<table>
<tr><th>ID</th><th>Name</th><th>Unit</th><th>Description</th></tr>
<tr><td>0x01</td><td>STARTFREQ</td><td>HF / HF-V4 / NF</td><td>Start frequency of the sweep in MHz.</td></tr>
<tr><td>0x02</td><td>STOPFREQ</td><td>HF / HF-V4 / NF</td><td>Stop frequency of the sweep in MHz. If the Span is 0, the display changes from frequency domain to time domain.</td></tr>
<tr><td>0x03</td><td>RESBANDW</td><td>HF / HF-V4 / NF</td><td>Resolution bandwidth
<table>
<tr><th>HF</th><th>HF-V4</th><th>NF</th></tr>
<tr><td>0: Full</td><td>0: Full</td><td>0: 10 MHz</td></tr>
<tr><td>1: 3 MHz</td><td>1: 3 MHz</td><td>1: 3 MHz</td></tr>
<tr><td>2: 1 MHz</td><td>2: 1 MHz</td><td>2: 1 MHz</td></tr>
<tr><td>3: 300 kHz</td><td>3: 300 kHz</td><td>3: 300 kHz</td></tr>
<tr><td>4: 100 kHz</td><td>4: 100 kHz</td><td>4: 100 kHz</td></tr>
<tr><td></td><td>5: 30 kHz</td><td>5: 30 kHz</td></tr>
<tr><td></td><td>6: 10 kHz</td><td>6: 10 kHz</td></tr>
<tr><td></td><td>7: 3 kHz</td><td>7: 3 kHz</td></tr>
<tr><td></td><td>8: 1 kHz</td><td>8: 1 kHz</td></tr>
<tr><td></td><td>100: 120 kHz</td><td>9: 300 Hz</td></tr>
<tr><td></td><td>101: 9 kHz</td><td>10: 100 Hz</td></tr>
<tr><td></td><td>102: 200 Hz</td><td>11: 30 Hz</td></tr>
<tr><td></td><td>103: 5 MHz</td><td>12: 10 Hz</td></tr>
<tr><td></td><td>104: 200 kHz</td><td>13: 3 Hz</td></tr>
<tr><td></td><td>105: 1.5 MHz</td><td>14: 1 Hz</td></tr>
<tr><td></td><td></td><td>15: 0.3 Hz</td></tr>
</table></td></tr>
<tr><td>0x04</td><td>VIDBANDW</td><td>HF / HF-V4 / NF</td><td>Video bandwidth, the values are the same as RESBANDW.</td></tr>
<tr><td>0x05</td><td>SWEEPTIME</td><td>HF / HF-V4 / NF</td><td>Sweep time in milliseconds.
HF: 10 to 600000ms
HFv4: 10 to 600000ms
NF: 10 to 240000ms</td></tr>
<tr><td>0x06</td><td>ATTENFAC</td><td>HF / HF-V4 / NF</td><td>Attenuation factor
-10=AUTO
0=OFF
and Range 1 to 30 dBm. The Value is positive and is 'subtracted'.</td></tr>
<tr><td>0x07</td><td>REFLEVEL</td><td>HF / HF-V4 / NF</td><td>Reference level from -20 to 70dB</td></tr>
<tr><td>0x08</td><td>DISPRANGE</td><td>HF / HF-V4 / NF</td><td>Display range from 10 to 100dB</td></tr>
<tr><td>0x09</td><td>DISPUNIT</td><td>HF / HF-V4 / NF</td><td>Display unit
HF: 0=dBm 1=dBµV 2=V/m 3=A/m
NF: 0=Tesla 1=Gauss 2=A/m</td></tr>
<tr><td>0x0A</td><td>PULSEMODE</td><td>HF</td><td>Pulse mode - 1 is on, 0 is off.</td></tr>
<tr><td>0x0A</td><td>DETMODE</td><td>HF-V4</td><td>Detector Mode 0=RMS 1=MIN/MAX</td></tr>
<tr><td>0x0A</td><td>SENSMODE</td><td>NF</td><td>Sensor Mode (1D / 2D)
0=MAGNETIC X / XY
1=MAGNETIC Y / YZ
2=MAGNETIC Z / ZX
3=STATIC X / XY
4=STATIC Y / YZ
5=STATIC Z / ZX
6=ELECTRIC
7=ANALOG</td></tr>
<tr><td>0x0B</td><td>DEMODMODE</td><td>HF-V4 / NF</td><td>Demodulator mode
HF: 0=OFF 1=AM 2=FM</td></tr>
<tr><td>0x0C</td><td>SPECPROC</td><td>HF / HF-V4 / NF</td><td>Spectrum processing mode program number. This program is called after a sweep has completed. The default setting is program 150, which evaluates the current markers and calculates current Field Power (See disassembly of the program).</td></tr>
<tr><td>0x0D</td><td>ANTTYPE</td><td>HF / HF-V4</td><td>Antenna type
0=HL7025
1=HL7040
2=HL7060
3=HL6080
4=H60100</td></tr>
<tr><td>0x0D</td><td>DIMMODE</td><td>NF</td><td>0=1D
1=2D
2=3D</td></tr>
<tr><td>0x0E</td><td>CABLETYPE</td><td>HF / HF-V4</td><td>Cable Type.
-1=NONE
0=1m standard cable</td></tr>
<tr><td>0x0E</td><td>SAMPPROC</td><td>NF</td><td>0=PEAK
1=MIN/MAX</td></tr>
<tr><td>0x0F</td><td>RECVCONF</td><td>HF / HF-V4</td><td>Receiver configuration
0=Spectrum
1=Broadband</td></tr>
<tr><td>0x0F</td><td>UNITSCALE</td><td>NF</td><td>Divider used to scale display values
-1=Auto</td></tr>
<tr><td>0x1E</td><td>CENTERFREQ</td><td>HF / HF-V4 / NF</td><td>Centre Frequency of the sweep in MHz. The value modifies STARTFREQ and STOPFREQ with centre +/- Span/2.</td></tr>
<tr><td>0x1F</td><td>SPANFREQ</td><td>HF / HF-V4 / NF</td><td>Modifies STOPFREQ as STARTFREQ + SPANFREQ.</td></tr>
<tr><td>0x10</td><td>PREAMPEN</td><td>HF-V4</td><td>Internal Pre-amplifier
0=OFF
1=ON</td></tr>
<tr><td>0x11</td><td>SWPDLYACC</td><td>HF-V4</td><td>Sweep delay for accuracy mode. 1 enables and 0 disables the delay.</td></tr>
<tr><td>0x12</td><td>SWPFRQPTS</td><td>HF-V4</td><td>Sweep frequency points request</td></tr>
<tr><td>0x13</td><td>REFOFFS</td><td>HF-V4</td><td>Manual calibration value in +- dB</td></tr>
<tr><td>0x20</td><td>USBMEAS</td><td>HF / HF-V4 / NF</td><td>Measurement data to USB mode
0=OFF
1=ON</td></tr>
<tr><td>0x21</td><td>USBSWPRST</td><td>HF / HF-V4 / NF</td><td>Reset current sweep. If this variable is not 0, the current sweep is aborted and restarted with current values of STARTFREQ and STOPFREQ.</td></tr>
<tr><td>0x22</td><td>USBSWPID</td><td>HF / HF-V4 / NF</td><td>USB sweep identification request</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
</table>

ID	Name	Unit	Description
0x23	USBRUNPROG	HF-V4	Run SPECTRAN program - FID_FACTSETUP 97 reset to factory defaults - FID_INICALREQ 98 (re)run initial boot calibration - FID_POWEROFF 99 switch unit off additional P-Code programs can be run by their file ID as well
0x30	LOGFILEID	HF / HF-V4 / NF	Log. file id. Write log file data to this file (see Program 200).
0x31	LOGSAMPCNT	HF / HF-V4 / NF	Number of Samples to write to log file. After each interval, this number is decremented and then the program 200 is called.
0x32	LOGTIMEIVL	HF / HF-V4 / NF	If the sweep is finished before this interval is reached, the log event isn't generated.
0x41	SPECDISP	HF / HF-V4 / NF	Spectrum display mode 0=Limits Mode 1=Spectrum Mode
0x42	PEAKDISP	HF / HF-V4 / NF	Peak display mode. 0 shows the Frequency of the markers in field 4-6 of the display and the power in Fields 10-12, 1 is visa versa.
0x43	MARKMINPK	HF / HF-V4 / NF	Minimum Power to be treated as a marker.
0x44	RDOUTIDX	HF / HF-V4 / NF	The display shows a vertical line at this pixel column and reports the value at this as marker. The value -1 disables this feature.
0x45	MARKCOUNT	HF / HF-V4 / NF	Marker count
0x46	LEVELTONE	HF-V4	Peak level audio tone enable / disable
0x47	BACKBBEN	HF-V4	Background BB detector enable / disable
0x48	DISPDIS	HF-V4	Display update disable / enable
0x49	SPKVOLUME	HF / HF-V4 / NF	Internal Speaker volume. Floating point range from 0.0 to 1.0
0x60	RBWFSTEP	HF / HF-V4 / NF	RBW frequency in MHz, read only. The RBW can be set up by the RESBANDW var.
0x61	ANTGAIN	HF / HF-V4 / NF	Nominal antenna gain in dB.
0x80	PEAK1POW	HF / HF-V4 / NF	Peak 1 power (Read only).
0x81	PEAK2POW	HF / HF-V4 / NF	Peak 2 power (Read only).
0x82	PEAK3POW	HF / HF-V4 / NF	Peak 3 power (Read only).
0x84	PEAK1FREQ	HF / HF-V4 / NF	Peak 1 freq. (Read only). HF/MHz NF/kHz
0x85	PEAK2FREQ	HF / HF-V4 / NF	Peak 2 freq. (Read only).
0x86	PEAK3FREQ	HF / HF-V4 / NF	Peak 3 freq. (Read only).
0x90	MAXPEAKPOW	HF / HF-V4 / NF	Global maximal peak power
0xC0	STDTONE	HF / HF-V4 / NF	Output standard speaker tone. Set a duration value from 1 to 9999
0xC1	MENUSEL	NF	

SPECTRAN Assembler

The SPECTRAN has a build in Stack Interpreter. The LCS File manager Utility contained in the LCS Software from http://www.aaronia.de can assemble and upload programs. Programs are stored in the EEPROM of the SPECTRAN and identified by a file number.

Some special file numbers are listed in the following table:

100-109	Key 0 to 9
110	Dot-Key
110	Shift-Key
120-123	Key- up, down, left, right
130	Clear-Key
131	Enter-Key
150	Executed after each completed Sweep, depending on display mode, the current power for the maximum marker is calculated
170	Called by program 150. If the SPECTRAN is in DECT-Mode, this program shifts the DECT-Channel

Each Assembler op code can have multiple parameters which are retrieved from the stack. To add 5+4, first the constant 5 must be loaded on the stack, then the constant 4 and then the add op code must be executed. The add op code will take the last two values from the stack and replace it with the result of the operation. Only floating point variables are used. Labels are alphanumeric names followed by a colon. The names T1, T2 and T3 reference the last three stack elements, where T1 is the top of stack.

The assembler has the following sections:

- Read/Write 256 memory variables
- Read/Write environment variables to control the sweep or evaluate sweep results
- Load constant values
- Jump to Labels / Call subroutines
- Math including Add, Sub, Mul, Div, Modulo, Logarithm, Power
- Output Values

Op code Reference

Name	Pop / Push	Description
Memory / IO Access		
LDSHCO	0/1	Load a constant from range -128 to 127 on the stack, needs less space than LDCONST. Parameters: the value
LDCONST	0/1	Load a float constant on the stack. Parameters: the float value or hexadecimal value
CHSIGN	1/1	Change the sign of the topmost stack variable.
SWAP	2/2	Exchange the 2 topmost stack values. Useful when operands are not in the expected order.
DUP	1/2	Duplicate the last value on the stack.
LOADSET	0/1	Load an environment variable on the stack. Parameters: the name or the index of the variable.
STORESET	1/0	Store the topmost stack value in the environment variable. Parameters: the name or the index of the variable.
SETUP	0/0	Setup multiple environment variables at once. The number of Parameters is not fixed. Syntax: Setup <name>:value <name>:value … Example: SETUP STARTFREQ:4000 STOPFREQ:5000 RESBANDW:1 VIDBANDW:1 SWEEPTIME:1000 ATTENFAC:-10 REFLEVEL:10 DISPRANGE:100 PULSEMODE:0
LOADVAR	0/1	Load a variable from memory on the stack. Parameters: the number of the variable 0-255
STOREVAR	1/0	Save the topmost stack variable to memory Parameters: the number of the variable 0-255
Control opcodes		
NOP	0/0	Do nothing, useful in hex mode
JUMP	0/0	Jump to a label that's close to the current location, can jump only 127 bytes, that's mostly about 40 instructions. Parameters: The target label.
AJUMP	0/0	Jump to a label, no matter how far it is. Parameters: the name of the label
ACALL	0/0	Call a sub routine, the subroutine must be finished by RET. Parameters: The target label.
RET	0/0	Return from a subroutine.
STOP	0/0	Stop program execution. At the end of a program is an implicit STOP.
CHAIN	1/0	Execute the program with the number of the topmost stack variable. The execution doesn't return.
JUMPGE	2/0	Jump if the T1 is greater or equal than T2. Parameters: The target label.
JUMPLT	2/0	The opposite of JUMPGE Parameters: The target label.
JUMPEQ	2/0	Jump if the T1 and T2 differ. Parameters: The target label.
JUMPNZ	1/0	Jump if T1 is different from zero. Parameters: The target label.
JUMPZ	1/0	Jump if the topmost stack variable is zero. Parameters: The target label.
Math opcodes		
ADD	2/1	
SUB	2/1	
MUL	2/1	
DIV	2/1	
POW	1/1	Raise power on top of stack
SQUARE	1/1	Square top of stack
SQRT	1/1	Square root top of stack
EXP	1/1	Exp. top of stack
LOG	1/1	Log. top of stack
LOG10	1/1	Log. 10 top of stack
SIN	1/1	sin top of stack
COS	1/1	cos top of stack
IMOD	2/1	Integer modulo T2 by T1
LOGNOT	1/1	Logical not
CHECKRNG	3/1	Check if T3 is between T2 and T1
MAX	2/1	Build maximum of T1 and T2
File Operations		
FILEREAD	2/2	Read value from file T1 at offset T2 (words, not bytes). Returns: T1 = state (1 OK, 0 No Data, -1 = Error) T2: If state is 1, the value
FILEWRITE	2/1	Write (append) value T2 to file with id T1. Returns: T1 = state (1 OK, 0 File system full, -1 Error)
FILEDEL	1/1	Delete file with id T1

Name	Pop / Push	Description
Display Commands		
CLRFLD	0/0	Clear Field Parameters: 1. The field Id
PRINTSTR	0/0	Print a string Parameters: 1. The field Id 2. The string
PRINTINT	1/0	Print Integer Parameters: 1. The field Id
PPIXTEXT	0/0	Print Text in main pixel display Parameters: 1. Flag: Invert text. 2. The row/col of the text. The row is in the high byte of the value, the easiest way to encode row/col is to use hex values. The Row/Col are expressed in Text cells, not pixels. 3. The string.
PPIXDBL	1/0	Print a String value. The Parameters are the same as PPIXTEXT. Some string elements are interpreted special: #: print the number here. The number of #'s behind a dot interprets the precision, leading #'s count the minimum number of digits +/-: print the sign here. Using +, there will be a sign if the value is positive, using - there is once a sign, when the value is negative, otherwise it's a Space. .,: Decimal dot.
PPICXBAR	1/0	Print a bar The T1 can contain a value from 0.0 to 1.0 Parameters: 1. The text-row of the bar from 0 to 2
PPIXDOT	0/3	Draw a dot. Parameters are Mode, X, Y where mode is 0=Pixel On 1=Pixel ON 2=Invert Pixel(XOR)
PPIXLINE	0/5	Draw a line. Parameters are Mode, X1, Y1, X2, Y2 where mode is 0=Pixel On 1=Pixel ON 2=Invert Pixel(XOR)
PPXRECT	0/5	Draw a rectangle. Parameters are Mode, X1, Y1, X2, Y2 where mode is 0=Pixel On 1=Pixel ON 2=Invert Pixel(XOR)

Field Id's	
0	The main pixel field
1	The circle power bar at top.
2	The medium sized display below the power bar, 6 chars
3	The big size display below, 4 chars
4-6	The marker fields are divided in 3 Sections: a medium sized 4 digit field, a very small 3 digit field beside and a small size 6 digit field below. The Id's 4-6 are the three 4 digit fields.
7-9	The Id's 7-9 are the 3 digit fields.
10-12	The Id's 10-12 are the 6 digit fields.
< 0	If the field ID is small than 0, the sign is changed and the operation is executed but the field isn't reset before. The field 0 isn't reset anyway.