Getting started with STLINK-V3PWR firmware

Introduction

STLINK-V3PWR is a two-in-one standalone debugger probe and a source measurement unit (SMU) designed to synchronize code execution with a power consumption of STM32 applications in real time. This tool is specifically adapted for power consumption optimization (patent pending).

STLINK-V3PWR can be used as a standalone source measurement unit to supply power and measure the current consumption of the target application. The product keeps the output voltage constant during a fast current transient from a very low current to a high current.

This document describes the command interface to configure the SMU and retrieve power data from a Virtual COM port.

Related documents, available on *www.st.com*:

- User manual *Source measurement unit (SMU) and debugger/programmer for STM32 microcontrollers*(UM3097)
- User manual *Getting started with PowerShield firmware* (UM2269).

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For further information contact your local STMicroelectronics sales office.

www.st.com

1   STLINK-V3PWR COM port connection

STLINK-V3PWR appears on a host PC as a USB composite device with several USB interfaces. Two of them are Virtual COM ports:

- One is linked to the debug interface, providing access to a UART channel to the microcontroller under debug;
- One is used to control the source measurement unit (SMU) and to return power measurement data to the host PC.
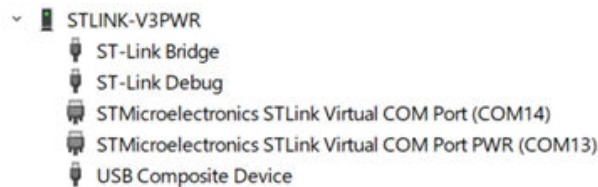
On Windows®, if no driver has been installed, the COM ports appear as COMxx in the device manager. There is no systematic rule regarding the index assignment by the system, despite at the device level the debug COM is the USB interface index 1, and the power COM is the USB interface index 4 (power COM might get a lower index than the debug COM). Their properties can distinguish them, for instance, the "MI_" value of the "Hardware Ids" (MI_01 for debug COM, MI_04 for power COM):

Figure 1. STLINK-V3PWR power COM interface enumeration on Windows®

Property

Hardware Ids

Value

USB\VID_0483&PID_3757&REV_0100&MI_04
USB\VID_0483&PID_3757&MI_04
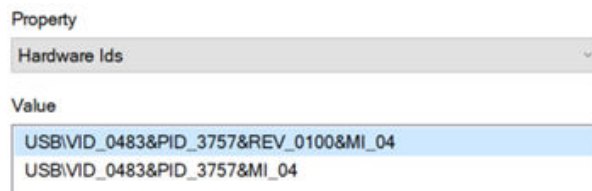
In case the driver has been previously installed (STSW-LINK009 on st.com), the detected COM ports are renamed as shown in Figure 2:

Figure 2. STLINK-V3PWR enumeration on Windows®

- STLINK-V3PWR
  - ST-Link Bridge
  - ST-Link Debug
  - STMicroelectronics STLink Virtual COM Port (COM14)
  - STMicroelectronics STLink Virtual COM Port PWR (COM13)
  - USB Composite Device

Communication with the SMU may be established through a standard terminal application, opened on the power COM port (as serial device).

1.1   Serial COM port configuration

As long as there is no real UART behind the STLINK-V3PWR power COM port, some parameters of the terminal do not affect the communication (baud rate, data length, stop bit, parity, and flow control). Conversely, the end-of-line format is important for correct communication: it must be "\r\n" (carriage return, line feed) in both directions.

Figure 3. Example of serial COM port terminal configuration

New-line

Receive: CR+LF

Transmit: CR+LF

1.2 Power interface command format

The shell always replies to a command sent.

Feedback can be either:

- Acknowledge: string "ack" is sent back with the command string. The acknowledge is followed by the command effectively applied or the command returned data.
- Error: string "err" is sent back with the command string. On the following lines, a description of the error can be sent.

The commands can take some arguments, either string or numerical values.

Numerical values of arguments can be formatted with:

- Numerical characters only (positive integers)
- Numerical characters with unit characters 'n', 'u', 'm', 'k', and 'M' for nano, micro, milli, kilo, mega
- Numerical characters with powers of ten '-xx' or '+xx' (xx: number on two digits maximum)

Example: The value '2 milliseconds' can be entered with: '2m' or '2-3', but '0,002' is not accepted.

2 Power interface commands description (API version 1)

2.1 Command list summary

When sending the "help" command to STLINK-V3PWR firmware, it returns the list of available commands and a short description for each command.

Table 1. List summary as displayed by the firmware when entering the "help" command

STLINK-V3PWR commands	
Command	**Description**
help	Displays the list of commands
echo <arg1>	Loopback to check the functionality of communication Rx and Tx. <arg1>: String of characters
whoami	Check STLINK-V3PWR device availability; can be used to scan which serial port is connected to STLINK-V3PWR. Response: "STLINK-V3PWR" with board unique ID
version	Get the STLINK-V3PWR firmware revision. Response: "V3PWR V<main>.J<dbg>.B<bdg>.P<pwr>"
apiver	Get the STLINK-V3PWR API version. Response: '<apiVer>'
range	Get STLINK-V3PWR current measurement range. Response: <current min> <current max>
status	Get STLINK-V3PWR status. Response: 'ok' or 'error: <error description>'
htc	Host takes control
hrc	Host releases control
volt <arg1> (<arg2>)	Set or get a power supply voltage level. Unit: V. <arg1>: Optional. String among the list: {'vout', 'vaux'}. Restrict the command to the specified signal. Default value for the 'get' command: 'vout'. Applied to both signals by default for the 'set' command. <arg2>: Set voltage: Numerical value in the range [1600m; 3600m] by steps of 100m. Default value: 3300m Get voltage: string 'get'
freq <arg1>	Set the sampling frequency. Unit: Hz. <arg1>: Numerical value among the list: {100k(*), 50k(*), 20k, 10k, 5k, 2k, 1k, 500, 200 100, 50, 20, 10, 5, 2, 1} Default value: 10kHz (*): available only in bin_hexa format
acqtime<arg1>	Set acquisition time. Unit: s. <arg1>: For limited acquisition duration: Numerical value in the range: [100u; 100] For infinite acquisition duration: Numerical value "0" or string "inf" Default value: 10 s
output<arg1>	Set the output type. Current: instantaneous current. Energy: integrated energy, reset after each sample sent (integration time set by parameter 'freq'. Limited to 10 kHz max (⇔ 100 μs min)). <arg1>: String among the list: {'current', 'energy'}

STLINK-V3PWR commands	
Command	**Description**
	Default value: 'current'
format <arg1>	Set a measurement data format.
	Data format 1: ASCII, decimal basis.
	The format is readable directly, but the sampling frequency is limited to 20 kHz.
	Decoding: 6409-07 $\Leftrightarrow$ 6409 x 10^-7 = 640.9 µA
	Data format 2: Binary, hexadecimal basis.
	Format optimizing data stream size.
	Decoding: 52A0 $\Leftrightarrow$ (2A0)16 x 16^-5 = 640.9 µA
	<arg1>: String among the list: {'ascii_dec', 'bin_hexa'}
	Caution: ascii_dec available only for freq <= 20k
	Default value: 'ascii_dec'
trigsrc<arg1>	Set a trigger source to start measurement acquisition.
	trigger source software (immediate trig after software starts)
	trigger from external signal rising or falling edge on TRIGIN input pin.
	<arg1>: String among the list: {'sw', 'hw', 'd7'} (d7 for compatibility with PowerShield, same as 'hw')
	Default value: 'sw"
trigdelay	Set a trigger delay between the target power-up and measurement acquisition start. Unit: s. Resolution: 1 ms
	<arg1>: Numerical value in the range [0; 16383m]
	Default value: 0
currthres<arg1>	Set the current threshold to trigger an event. Unit: A.
	The event is triggered when the threshold is exceeded: signal generated on TRIGOUT pin.
	<arg1>: Numerical value in the range [100n; 500m] or value '0' for threshold disable
	Default value: 0
pwr (<arg1>) <arg2> (<arg3>)	Set a target power supply connection:
	–Automatic: On the first run, power on when acquisition starts. Then, the power state depends on the 'pwrend' command.
	–Manual: Force power state.
	Note: *This can be used during acquisition. To perform successive power off and on, it is preferable to use the 'targrst' command.*
	Optionally, power status can be sent at the beginning and end of the acquisition data stream.
	<arg1>: Optional. String among the list: {'vout', 'vaux'}. Restrict the command to the specified signal, default value for the 'get' command: 'vout'. Applied to both signals by default for the 'set' command.
	<arg2>: Set pwr: String among the list: {'auto', 'on', 'off'} Default value: 'auto'
	Get pwr: String 'get' (response: state 'on' or 'off')
	<arg3>: Optional. String among the list: {'nostatus', 'status'}
	Default value: 'nostatus'
pwrend<arg1>	Set a target power supply state after acquisition: keep unchanged or switch power-off.
	<arg1>: String among the list: {on, off}
	Default value: 'on'
	Note: *'on' means kept unchanged. A signal remains off if it is already off during the acquisition.*
start	Starts acquisition (measurement of current or energy depending on configuration).

STLINK-V3PWR commands	
Command	**Description**
stop	Stop acquisition. If the acquisition is set to a finite duration, it may be aborted before the number of samples initially requested is received.
targrst<arg1>	Reset the target by disconnecting the power supply during a configurable duration. Unit: s. *Note:* *This can be performed during acquisition to monitor target transient current consumption during its power-up.* <arg1>: Numerical value in the range [10m; 1] or value "0" to leave the target off
temp<arg1> (<arg2>)	Get the temperature of the temperature sensor on the STLINK-V3PWR board, in units: Degrees Celsius or Fahrenheit. <arg1>: String among the list: {'degc', 'degf'} Default value: 'degc' <arg2>: Optional: 'refresh' to force a new sampling of the temperature value, instead of the startup one

2.2 Compatibility with PowerShield command set

To minimize the porting effort of X-NUCLEO-LPM01A and STM32L562E-DK users, the STLINK-V3PWR power API is compatible with the one described in UM2269, for similar functionalities. Some modifications are required because of different functionalities and they are described below.

Table 2. PowerShield commands not available on STLINK-V3PWR

Command	Behavior on STLINK-V3PWR
acqmode<arg1>	Error: Obsolete command
funcmode<arg1>	No impact on STLINK-V3PWR
lcd	Error: Obsolete command
psrst	Error: Obsolete command

Table 3. PowerShield commands aliased on STLINK-V3PWR

Command	Behavior on STLINK-V3PWR
powershield	whoami
reset	psrst (obsolete)
rst	psrst (obsolete)

2.3 Command description

Table 4. "help" command

Argument	(none)
Description	Displays the list of commands

Table 5. "echo" command

Argument	1. String of characters (maximum: 35 characters)
Description	Loopback to check the functionality of communication Rx and Tx

Table 6. "whoami" command

Argument	(none)
Description	Check STLINK-V3PWR device availability. It can be used to scan which serial port is connected to the STLINK-V3PWR power COM. Response: "STLINK-V3PWR" with board unique ID (24-digit serial number as shown at USB device level). Example of shell feedback: `ack STLINK-V3PWR 002300463130510636383730`

Table 7. "version" command

Argument	(none)
Description	Gets STLINK-V3PWR firmware revision. Response: "V3PWR V<main>.J<dbg>.B<bdg>.P<pwr>" Example of shell feedback: `ack version: V3PWR V4.J3.B1.P4`

Table 8. "apiver" command

Argument	(none)
Description	Gets STLINK-V3PWR COM power API version (changes in case of evolution in the API). Example of shell feedback: `ack apiver: 1`

Table 9. "range" command

Argument	(none)
Description	Get STLINK-V3PWR current measurement range. Response: <current min> <current max> Example of shell feedback: `ack range: 100-9 500-3`

Table 10. "status" command

Argument	(none)
Description	Gets STLINK-V3PWR status. Response: "ok" or "error: <error description>" In case of an error, running this command clears the STLINK-V3PWR state machine error and restores the normal state of LEDs (AUX and OUT).

Table 11. "htc" command

Argument	(none)
Description	The host takes control. No side effects on STLINK-V3PWR. Provided for compatibility with the PowerShield API.

Table 12. "hrc" command

Argument	(none)
Description	The host releases control. If an acquisition is in progress, the command stops it and cuts off OUT and AUX outputs. Otherwise, no side effects on STLINK-V3PWR. Provided for compatibility with the PowerShield API.

Table 13. "volt" command

Argument	1. Optional. String among the list: {'vout', 'vaux'}. Restrict the command to the specified signal
	2. Set voltage: Numerical value in the range [1600 m; 3600 m] by steps of 100 m
	Get voltage: String 'get'
Description	Set or get a power supply voltage level. Unit: V.
	If no signal is explicitly mentioned in the 'volt get' command, the OUT voltage is returned.
	If no signal is explicitly mentioned with a numerical value, the numerical value is assigned to the OUT and AUX signals.
	At STLINK-V3PWR power-up, the default OUT and AUX reference voltage is 3300m (and outputs are off)

Table 14. "freq" command

Argument	1. Numerical value among the list:
	{100k, 50k, 20k, 10k, 5k, 2k, 1k, 500, 200, 100, 50, 20, 10, 5, 2, 1}
Description	Set the sampling frequency. Unit: Hz.
	At STLINK-V3PWR power-up, the default sampling frequency is 10 kHz.
	Maximum value in ascii_dec format: 20 kHz.

Table 15. "acqtime" command

Argument	1. For limited acquisition duration:
	–Numerical value in the range: [100u; 100]
	For infinite acquisition duration:
	–Numerical value '0' or string 'inf'
Description	Set acquisition time. Unit: s
	At STLINK-V3PWR power-up, the default acquisition time is 10 s.

Table 16. "output" command

Argument	1. String among the list: {'current', 'energy'}
Description	Set the output type.
	current: instantaneous current.
	energy: integrated energy in Joules for one sample duration. The reference voltage is multiplied by the measured current with a 10μs accuracy. Each 10μs energy contribution is cumulated during the period defined by the sampling frequency.
	At STLINK-V3PWR power-up, the default output type is 'current'.

Table 17. "format" command

Argument	1. String among the list: {'ascii_dec', 'bin_hexa'}
Description	Set a measurement data format.
	Data format 1: ASCII, decimal basis.
	–Format readable directly, but sampling frequency limited to 20 kHz. Decoding: 6409-07 ⇔ 6409 x 10^-7 = 640.9 µA
	Data format 2: Binary, hexadecimal basis.
	–Format optimizing the data stream size.
	Decoding: 52A0 ⇔ (2A0)16 x 16^-5 = 640.9 µA
	At STLINK-V3PWR power-up, the default data format is 'ascii_dec'.
	Refer to Section 2.4: Data stream format

Table 18. "trigsrc" command

Argument	1. String among the list: {'sw', 'hw'}
Description	Set a trigger source to start measurement acquisition: trigger source software (immediate trig after software starts), trigger from external signal rising or falling edge on TRIGIN pin.
	Note: *Trigger from an external signal also requires the "start" command (similar software start) to arm the trigger. Then the following triggers are effective without any command.*
	The "stop" command disarms the trigger (acquisition stop after acquisition time elapsed does not disarm the trigger).
	Note: parameter 'd7' is accepted for compatibility with PowerShield, and is equivalent to 'hw'

Table 19. "trigdelay" command

Argument	1. Numerical value in the range [0; 16383 m]
Description	Set a trigger delay between target power-up and start measurement acquisition. Unit: s. Resolution: 1 ms.
	This command allows the voltage and current to stabilize before starting current acquisition.
	At STLINK-V3PWR power-up, the default trig delay is 0.

Table 20. "currthres" command

Argument	1. Numerical value in the range [100n; 500m]
Description	Set the current threshold to trigger an event. Unit: A.
	The TRIGOUT pin level reflects the actual current value compared to the programmed threshold. The TRIGOUT pin is set when the current exceeds the threshold and released when the current is below the threshold.
	At STLINK-V3PWR power-up, the default threshold is 0.

Table 21. "pwr" command

Argument	1. Optional. String among the list: {'vout', 'vaux'}. Restrict the command to the specified signal. Default value for the 'get' command: 'vout'; applies to both signals by default for the 'set' command
	2. Set pwr: String among the list: {'auto', 'on', 'off'} Default value: 'auto'
	Get pwr: String 'get' (response: state 'on' or 'off')
	3. Optional. String among the list: {'nostatus', 'status'} Default value: 'nostatus'
Description	Set or get a target power supply connection.
	If no signal is explicitly mentioned in the 'pwr get' command, the OUT voltage is returned.
	If no signal is explicitly mentioned with 'pwr auto', 'pwr on', or 'pwr off', the action applies to both OUT and AUX signals.
	–Automatic first run, power on when acquisition starts.
	Then, the power state depends on the 'pwrend' command.
	–Manual: Force power state (on or off).
	Note: *It can be used during acquisition. To perform successive power off and on, it is preferable to use the 'targrst' command.*
	Optionally, power status can be sent at the beginning and end of the acquisition data stream.

Table 22. "pwrend" command

Argument	1. String among the list: {on, off}
	Default value: "on"
Description	Defines the target power supply state after current measurement acquisition.
	power-off applies to both OUT and AUX signals. power-on lets both signals unchanged (may be on or off, depending on their state during acquisition)

Table 23. "start" command

Argument	(none)
Description	Start acquisition (measurement of current or energy depending on configuration).

Table 24. "stop" command

Argument	(none)
Description	Stop acquisition. If the acquisition is set to a finite duration, it might be aborted before the number of samples initially requested are received.

Table 25. "targrst" command

Argument	1. Numerical value the [10 m; 1] or value "0" to let the target power down.
Description	Target the power cycle by disconnecting the power supply during a configurable duration. Unit: s.
	Note: *It can be performed during acquisition to monitor the target transient current consumption during its power-up.*

Table 26. "temp" command

Argument	1. String among the list: {'degc', 'degf'}
	Default value: 'degc'
	2. Optional: 'refresh' to force a new sampling of the temperature value, instead of the startup one
Description	Gets the temperature from the temperature sensor on the STLINK-V3PWR board, in units: Celsius or Fahrenheit degrees.
	Note: *The reported temperature approximates the ambient temperature, measured on the board surface inside the casing, at STLINK-V3PWR power up. It is recommended to leave the STLINK-V3PWR unplugged for several minutes between measurement sessions if temperature reliability is important. The temperature increase during a measurement session might be monitored by the 'temp refresh' command. The temperature is also internally automatically monitored to trigger automatic calibration. To limit the impact of such a temperature increase (and conversely to the previous note), it is recommended to let the OUT signal on for several minutes before starting the measurement.*

Table 27. "calib" command

Argument	(none)
Description	Performs board self-calibration.
	Note: *Calibration is automatically done after a change in OUT voltage order, or when temperature shifts of more than 5°C since the previous calibration.*

2.4 Data stream format

Measurement data contain the main information: current or energy (depending on configuration).

Note: *Information on voltage is not sent. The effective voltage is assumed to be close to the ordered voltage (tolerance approximately ±1%).*

Note: *Timing information is not sent and must be deduced from the data count. For example, if the acquisition frequency is set at 10 kHz, the first data corresponds to 10 μs, the second data to 20 μs, the third data to 30 μs, and so on. In case of overflow at STLINK-V3PWR level, measured data are skipped (and definitively lost) until the host flushes the already acquired data. When the flow to the host restarts after the overflow, timestamp metadata is sent before the first new record, allowing the host application to compute the overflow duration.*

2.4.1 Data format 1: ASCII, decimal basis

2.4.1.1 Measurement data of current or energy

Format intended when STLINK-V3PWR is used with a COM port terminal: Data are formatted in ASCII characters and values are in decimal basis.

Note: *Due to higher data size in ASCII format and to data bandwidth constraints, this data format can be used with a sampling up to 20 kilosamples per second.*

Each measurement data is formatted on eight ASCII characters:

Table 28. ASCII character description

Byte on serial port	Byte number	Description
ASCII [0; 9]	1	Current measurement digit 4
ASCII [0; 9]	2	Current measurement digit 3
ASCII [0; 9]	3	Current measurement digit 2
ASCII [0; 9]	4	Current measurement digit 1
ASCII {'-';'+'}	5	Current measurement power of 10 sign
ASCII [0; 1]	6	Current measurement power of 10 value
ASCII [0; 9]	7	Current measurement power of 10 value
ASCII '\r'	8	Carriage return
ASCII '\n'	9	Line feed

Example of data stream and corresponding conversion to decimal values:

6409-7: $(6409)_{10} \times 10^{-7} = 640.9 \ 10^{-6} = 640.9 \ \mu A$

2.4.1.2 Metadata inserted into data stream

Metadata is inserted into the data stream to provide other information.

Data must be filtered in the data stream to isolate measurement data (current or energy values) versus metadata.

Differentiator of measurement data versus metadata:

- Measurement data begin with a number in ASCII format (the first byte corresponding to decimal values from 48 to 57).
- Metadata begins with a letter in ASCII format (the first byte corresponding to a decimal value other than a number, described above).

2.4.1.2.1 Metadata: Timestamp

A timestamp (recordID of the next data) is sent after a buffer overflow at the STLINK-V3PWR level or after an automatic calibration, which might result in losing records in the middle of an acquisition sequence.

It can be used to resynchronize the display after data loss.

Timestamp format: ASCII, decimal format

Maximum value: UINT32_MAX (4 294 967 295)

Table 29. Timestamp, format 1: ASCII characters description

Byte on serial port	Byte number	Description
ASCII '\r'	1	Carriage return
ASCII '\n'	2	Line feed
ASCII 'R'	3	Timestamp tag characters
ASCII 'e'	4	Timestamp tag characters
ASCII 'c'	5	Timestamp tag characters
ASCII 'I'	6	Timestamp tag characters
ASCII 'D'	7	Timestamp tag characters
ASCII ' '	8	Timestamp tag characters
ASCII [0; 9]	9	RecordID digit 0 (highest decade)
ASCII [0; 9]	10	RecordID digit 1 if value >9
ASCII [0; 9]	11	RecordID digit 2 if value >99
…	…	…
ASCII '\r'	x	Carriage return
ASCII '\n '	x+1	Line feed

2.4.1.2.2 Metadata: Error

An error message can be sent as a stream of ASCII characters.

Table 30. Error, format 1: ASCII characters description

Byte on serial port	Byte number	Description
ASCII '\r'	1	Carriage return
ASCII '\n '	2	Line feed
ASCII 'e'	3	Error tag characters
ASCII 'r'	4	Error tag characters
ASCII 'r'	5	Error tag characters
ASCII 'o'	6	Error tag characters
ASCII 'r'	7	Error tag characters
ASCII ':'	8	Error tag characters
ASCII ' '	9	Error tag characters
ASCII char	10	Message content: ASCII character
ASCII char	...	Message content: ASCII character
ASCII char	x	Message content: ASCII character
ASCII char	x + 1	Message content: ASCII character
ASCII '\r'	x + 2	Carriage return (end tag)
ASCII '\n'	x + 3	Line feed (end tag)

2.4.1.2.3 Metadata: End of acquisition

Metadata is sent when the acquisition is completed: Acquisition time is reached or the user sends the "stop" command and the host receives all data in the Tx buffer.

Table 31. End of acquisition, format 1: ASCII characters description

Byte on serial port	Byte number	Description
ASCII '\r'	1	Carriage return
ASCII '\n '	2	Line feed
ASCII 'e'	3	End of acquisition tag characters
ASCII 'n'	4	End of acquisition tag characters
ASCII 'd'	5	End of acquisition tag characters
ASCII '\r'	6	Carriage return
ASCII '\n '	7	Line feed

2.4.1.2.4 Metadata: Power to target connection

Metadata is sent as the acknowledgment and data of the "pwr get" command.

Metadata is also sent at the beginning (after metadata acquisition starts) and end (before metadata acquisition ends) of each acquisition if the second parameter of the "pwr" command is set to the "status" argument (optional).

Power to target connection status is coded on two or three characters:

"off" <=> power off (power supply disconnected from target)

"on" <=> power on (power supply connected to target)

Metadata is sent when the acquisition is completed: Acquisition time is reached or the user sends the "stop" command, and the host receives all the data in the Tx buffer.

Table 32. Power to target, format 1: ASCII characters description

Byte on serial port	Byte number	Description
ASCII '\r'	1	Carriage return
ASCII '\n '	2	Line feed
ASCII 'p'	3	Power to target tag characters
ASCII 'w'	4	Power to target tag characters
ASCII 'r'	5	Power to target tag characters
ASCII ' '	6	Power to target tag characters
ASCII char	7	Power to target connection status characters
ASCII char	8	Power to target connection status characters
ASCII char	...	Power to target connection status characters
ASCII '\r'	x	Carriage return
ASCII '\n '	x+1	Line feed

2.4.1.2.5 **Metadata: Summary**

After the end of the acquisition, a summary is displayed between the "summary beg" and "summary end" tags.

Description and data are sent in ASCII: acquisition mode, sampling frequency, acquisition time, number of samples, number of calibrations (if >0), current min, current max

Table 33. Summary, format 1: ASCII characters description

Byte on serial port	Byte number	Description
ASCII '\r'	1	Carriage return
ASCII '\n '	2	Line feed
ASCII 's'	3	Summary tag characters
ASCII 'u'	4	Summary tag characters
ASCII 'm'	5	Summary tag characters
ASCII 'm'	6	Summary tag characters
ASCII 'a'	7	Summary tag characters
ASCII 'r'	8	Summary tag characters
ASCII 'y'	9	Summary tag characters
ASCII ' '	10	Summary tag characters
ASCII 'b'	11	Summary tag characters
ASCII 'e'	12	Summary tag characters
ASCII 'g'	13	Summary tag characters
ASCII '\r'	14	Carriage return
ASCII '\n '	15	Line feed
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
ASCII '\r'	-	Carriage return
ASCII '\n '	-	Line feed
ASCII 's'	-	Summary tag characters
ASCII 'u'	-	Summary tag characters
ASCII 'm'	-	Summary tag characters
ASCII 'm'	-	Summary tag characters
ASCII 'a'	-	Summary tag characters
ASCII 'r'	-	Summary tag characters
ASCII 'y'	-	Summary tag characters
ASCII ' '	-	Summary tag characters
ASCII 'e'	-	Summary tag characters
ASCII 'n'	-	Summary tag characters
ASCII 'd'	-	Summary tag characters
ASCII '\r'	-	Carriage return
ASCII '\n '	-	Line feed

Figure 4. Example of summary in ASCII format

```
summary beg
Acquisition mode:     CURRENT
Sampling frequency: 10000 Hz
Acquisition time:     1000 ms
Number of samples:   10000 samples
Current min:          0 nA
Current max:          52 nA
summary end
```

2.4.2 Data format 2: Binary, hexadecimal basis

2.4.2.1 Measurement data of current or energy

Format intended when STLINK-V3PWR is used with a dedicated host software, able to decode raw binary data.

This data format is optimized to have the lowest data width per measurement data.

Each measurement data is formatted on two bytes (binary value, not ASCII):

- Data size of two-byte characters compresses data size as much as possible (it allows the user to transmit a data stream of 100 kilosamples per second on the USB).
- Each data is coded in hexadecimal: 12 bits of data and four bits of negative power of 16.

Data accuracy: Decimation error of base 16 is data ±0.20% worst case.

Table 34. Serial byte 1 (sent first)

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
neg pow16 bit3	neg pow16 bit2	neg pow16 bit1	neg pow16 bit0	value bit11	value bit10	value bit9	value bit8

Table 35. Serial byte 2 (sent last)

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
value bit7	value bit6	value bit5	value bit4	value bit3	value bit2	value bit1	value bit0

Example of measurement data sent on serial port and corresponding conversion to decimal values:

52A0: $(2A0)_{16} \times 16^{-5} = (672)_{10} / 16^5 = 640.9 \times 10^{-6} = 640.9 \ \mu A$

3145: $(145)_{16} \times 16^{-3} = (325)_{10} / 16^3 = 793.5 \times 10^{-4} = 79.35 \ mA$

Note: *The power of 16 is typically in the range of [-10; -3], allowing a current range of [0.2 nA; 999 mA].*

Note: *The negative power of 16 is limited to the range {0 (`0x0`); 14 (`0xE`)}. Value 15 (`0xF`) is reserved as an information tag (refer to time stamp description).*

2.4.2.2 Metadata inserted into data stream

Metadata is inserted into the data stream to provide other information.

Data must be filtered in the data stream to isolate measurement data (current or energy values) versus metadata.

Differentiator of measurement data versus metadata:

- Metadata
    - Metadata start: two consecutive bytes starting by `0xF` (measurement data can have only one of the bytes having this value): `0xF0` and `0xFx` (value depending on metadata type, refer to Table 38)
    - Metadata stop: two consecutive bytes at value `0xFF`.
- Measurement data: All other data

2.4.2.2.1 Metadata: Error

An error message (voltage drop) can be sent as a stream of ASCII characters.

Table 36. Metadata error

Byte on serial port	Byte number	Description
`0xF0`	1	Metadata beginning tag
`0xF1`	2	Metadata ASCII error message tag
ASCII char	3	Message content: ASCII character
ASCII char	...	Message content: ASCII character
ASCII char	x	Message content: ASCII character
ASCII char	x + 1	Message content: ASCII character
'\r'	x + 2	Message content: ASCII value of carriage return, for indication in case of data stream watched in terminal
'\n'	x + 3	Message content: ASCII value of line feed, for indication in case of data stream watched in terminal
`0xFF`	x + 4	Metadata end tag (1/2)
`0xFF`	x + 5	Metadata end tag (2/2)

2.4.2.2.2 Metadata: Information

Similar to the error message, with a different metadata tag.

Table 37. Metadata information

Byte on serial port	Byte number	Description
`0xF0`	1	Metadata beginning tag
`0xF2`	2	Metadata ASCII information message tag
ASCII char	3	Message content: ASCII character
ASCII char	...	Message content: ASCII character
ASCII char	x	Message content: ASCII character
ASCII char	x + 1	Message content: ASCII character
'\r'	x + 2	Message content: ASCII value of carriage return, for indication in case of data stream watched in terminal
'\n'	x + 3	Message content: ASCII value of line feed, for indication in case of data stream watched in terminal
`0xFF`	x + 4	Metadata end tag (1/2)
`0xFF`	x + 5	Metadata end tag (2/2)

2.4.2.2.3 Metadata: Timestamp

A timestamp (recordID of the next data) is sent after a buffer overflow at the STLINK-V3PWR level or after an automatic calibration, which might result in losing records in the middle of an acquisition sequence.

It can be used to resynchronize the display after data loss.

Table 38. Metadata timestamp

Byte on serial port	Byte number	Description
`0xF0`	1	Metadata beginning tag
`0xF3`	2	Metadata timestamp message tag
x	3	RecordId byte 0 (LSByte)
x	4	RecordId byte 1
x	5	RecordId byte 2
x	6	RecordId byte 3 (MSByte)
x	7	Timestamp cause (OR-ed flags): 0xCx: after calibration 0xxF: after overflow
`0xFF`	8	Metadata end tag (1/2)
`0xFF`	9	Metadata end tag (2/2)

Note: *The timestamp value is coded on four bytes and sent in little-endian format. Maximum value = 4294967295, corresponding to approximately 11 hours at 100 kilosamples per second.*

2.4.2.2.4 Metadata: End of acquisition

Metadata is sent when the acquisition is completed: Integration time is reached or the user sends the "stop" command, and the host receives all the data in the Tx buffer.

Table 39. Metadata end of acquisition

Byte on serial port	Byte number	Description
`0xF0`	1	Metadata beginning tag
`0xF4`	2	Metadata end of acquisition tag
`0xFF`	3	Metadata end tag (1/2)
`0xFF`	4	Metadata end tag (2/2)

2.4.2.2.5 Metadata: Summary

Metadata is sent immediately after the end of metadata acquisition.

Table 40. Metadata summary

Byte on serial port	Byte number	Description
`0xF0`	1	Metadata beginning tag
`0xF5`	2	Metadata summary tag
x	3	Current min byte 1 (MSB)
x	4	Current min byte 0 (LSB)
x	5	Current max byte 1 (MSB)
x	6	Current max byte 0 (LSB)
`0xFF`	7	Metadata end tag (1/2)
`0xFF`	8	Metadata end tag (2/2)

2.4.2.2.6 Metadata: Acknowledgment and data of the "target reset (target power down)" command

Metadata is sent (in binary format) after a command from the host is received (in format ASCII), only when the acquisition is ongoing or the trigger is armed.

Table 41. Metadata target power down

Byte on serial port	Byte number	Description
0xF0	1	Metadata beginning tag
0xF6	2	Metadata target power down tag
0xFF	3	Metadata end tag (1/2)
0xFF	4	Metadata end tag (2/2)

2.4.2.2.7 Metadata: Acknowledgment and data of the "Voltage get" command

Metadata is sent (in binary format) after a command from the host is received (in ASCII format), only when the acquisition is ongoing or the trigger is armed.

Voltage in mV is coded on two bytes in the unsigned format:

- 0x0CE4 ⇔ 3300 mV
- 0x0708 ⇔ 1800 mV

Table 42. Metadata acknowledgment and data "voltage get" command

Byte on serial port	Byte number	Description
0xF0	1	Metadata beginning tag
0xF7	2	Metadata voltage tag
x	3	Voltage value in mV, byte 1 (MSB)
x	4	Voltage value in mV, byte 0 (LSB)
0xFF	5	Metadata end tag (1/2)
0xFF	6	Metadata end tag (2/2)

2.4.2.2.8 Metadata: Acknowledgment and data of the "Temperature" command

Metadata is sent (in binary format) after a command from the host is received (in ASCII format), only when the acquisition is ongoing or the trigger is armed.

Temperature is coded on two bytes in signed format (the unit degC or degF depends on the command parameter):

0x000A ⇔ +10

0xFFFD ⇔ -3

Table 43. Metadata temperature

Byte on serial port	Byte number	Description
0xF0	1	Metadata beginning tag
0xF8	2	Metadata temperature tag
x	3	Temperature value byte 1 (MSB)
x	4	Temperature value byte 0 (LSB)
0xFF	5	Metadata end tag (1/2)
0xFF	6	Metadata end tag (2/2)

2.4.2.2.9 Metadata: Acknowledgment and data of the "pwr get" command

Metadata is sent (in format binary) after a command from the host is received (in format ASCII), only when the acquisition is ongoing or the trigger is armed.

Metadata is also sent at the beginning (after metadata acquisition starts) and end (before metadata acquisition ends) of each acquisition if the second parameter of the "pwr" command is set to the "status" argument (optional).

Power to target connection status is coded on one byte:

- 0x0 <=> power off (power supply disconnected from target)
- 0x1 <=> power on (power supply connected to target)

Table 44. Metadata power to target connection

Byte on serial port	Byte number	Description
0xF0	1	Metadata beginning tag
0xF9	2	Metadata power to target connection tag
x	3	Power to target connection
0xFF	4	Metadata end tag (1/2)
0xFF	5	Metadata end tag (2/2)

2.4.2.2.10 Metadata: Acknowledgment and data of the "pwr on" command

Metadata is sent (in format binary) after a command from the host is received (in format ASCII), only if the acquisition is ongoing or the trigger is armed.

Table 45. Metadata ack power on

Byte on serial port	Byte number	Description
0xF0	1	Metadata beginning tag
0xFA	2	Metadata power on ack tag
0xFF	3	Metadata end tag (1/2)
0xFF	4	Metadata end tag (2/2)

2.4.2.2.11 Metadata: Acknowledgment and data of the "pwr off" command

Metadata is sent (in format binary) after a command from the host is received (in format ASCII), only if the acquisition is ongoing or the trigger is armed.

Table 46. Metadata ack power off

Byte on serial port	Byte number	Description
0xF0	1	Metadata beginning tag
0xFB	2	Metadata power off ack tag
0xFF	3	Metadata end tag (1/2)
0xFF	4	Metadata end tag (2/2)

2.4.2.2.12 Metadata reserved

Metadata reserved for potential future usage:

- {0xF0; 0xFC, 0xFD, 0xFE}

Revision history

Table 47. Document revision history

Date	Revision	Changes
03-Apr-2024	1	Initial release.

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