Standard WSA API Library

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1 Introduction

This documentation, compiled using Doxygen, describes in details the wsa_api library. The wsa_api provides functions to set/get particular settings or acquire data from the WSA. The wsa_api encodes the commands into SCPI syntax scripts, which are sent to a WSA through the wsa_lib library. Subsequently, it decodes any responses or packets coming back from the WSA through the wsa_lib. Thus, the API helps to abstract away SCPI syntax from the user.

Data frames passing back from the wsa_lib are in VRT format. This API will extract the information and the actual data frames within the VRT packet and makes them available in structures and buffers for users.

1.1 Release v1.1

- Can set various sample size. Use get max to determine the limit.
- IF gain set/get is now available.

1.2 Limitations in v1.0

The following features are not yet supported with the CLI:

- DC correction. Need Nikhil to clarify on that.
- IQ correction. Same as above.
- Automatic finding of a WSA box(s) on a network.
- Set sample sizes. 1024 size for now.
- Triggers.
- Gain calibrarion. TBD with triggers.
- USB interface method - might never be available.

1.3 How to use the library

The wsa_api is designed using mixed C/C++ languages. To use the library, you need to include the header file, wsa_api.h, in files that will use any of its functions to access a WSA, and a link to the wsa_api.lib.

2 Data Structure Index

2.1 Data Structures

Here are the data structures with brief descriptions:

wsa_descriptor (This structure stores WSA information) 2

wsa_device (A structure containing the components associate with each WSA device) 4

wsa_frame_header (This structure contains header information related to each frame read by wsa_read_frame()) 4

wsa_resp (This structure contains the response information for each query) 5

wsa_socket (**A structure containing the socket parameters used for creating TCP/IP connection for control and data acquisition**) 6

wsa_time (**This structure contains the time information. It is used for the time stamp in a frame header**) 6

3 File Index

3.1 File List

Here is a list of all files with brief descriptions:

wsa_api.cpp 7

wsa_api.h 16

wsa_error.h 27

4 Data Structure Documentation

4.1 wsa_descriptor Struct Reference

This structure stores WSA information.

Data Fields

- char prod_name [50]
- char prod_serial [20]
- char prod_version [20]
- char rfe_name [50]
- char rfe_version [20]
- char fw_version [20]
- char intf_type [20]
- uint64_t inst_bw
- uint64_t max_sample_size
- uint64_t max_tune_freq
- uint64_t min_tune_freq
- uint64_t freq_resolution
- int max_if_gain
- int min_if_gain
- float abs_max_amp [NUM_RF_GAINS]

4.1.1 Field Documentation

4.1.1.1 float abs_max_amp

An array storing the absolute maximum RF input level in dBm for each quantized RF gain setting of the RFE. Operating a WSA device at these absolute maximums may cause damage to the device.

4.1.1.2 uint64_t freq_resolution

The frequency resolution in Hz that a WSA's centre frequency can be incremented.

4.1.1.3 char fw_version

The firmware version currently in the WSA.

4.1.1.4 uint64_t inst_bw

The WSA instantaneous bandwidth in Hz.

4.1.1.5 char intf_type

The interface method to a WSA. Available: "TCPIP" ("USB" TBD).

4.1.1.6 int max_if_gain

The maximum IF gain in dB that a WSA's RFE can be set.

4.1.1.7 uint32_t max_sample_size

The maximum number of continuous I and Q data samples the WSA can capture per frame.

4.1.1.8 uint64_t max_tune_freq

The maximum frequency in Hz that a WSA's RFE can be tuned to.

4.1.1.9 int min_if_gain

The minimum IF gain in dB that a WSA's RFE can be set.

4.1.1.10 uint64_t min_tune_freq

The minimum frequency in Hz that a WSA's RFE can be tuned to.

4.1.1.11 char prod_name

WSA product name.

4.1.1.12 char prod_serial

WSA product serial number.

4.1.1.13 char prod_version

WSA product version number.

4.1.1.14 char rfe_name

WSA product name.

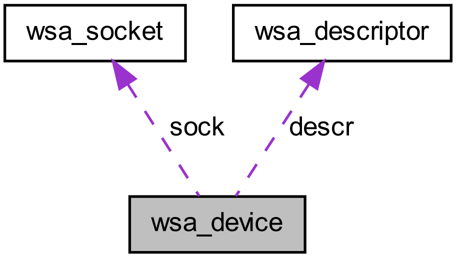
4.1.1.15 char rfe_version

WSA product version number.

4.2 wsa_device Struct Reference

A structure containing the components associate with each WSA device.

Collaboration diagram for wsa_device:



Data Fields

- struct wsa_descriptor descr
- struct wsa_socket sock

4.2.1 Field Documentation

4.2.1.1 struct wsa_descriptor descr

The information component of the WSA, stored in wsa_descriptor.

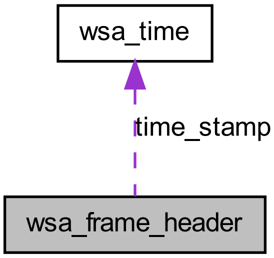
4.2.1.2 struct wsa_socket sock

The socket structure component of the WSA, used for TCPIP connection.

4.3 wsa_frame_header Struct Reference

This structure contains header information related to each frame read by wsa_read_frame().

Collaboration diagram for wsa_frame_header:



Data Fields

- uint32_t sample_size
- struct wsa_time time_stamp

4.3.1 Field Documentation

4.3.1.1 uint32_t sample_size

Number of {I, Q} samples pairs per WSA data frame.

4.3.1.2 struct wsa_time time_stamp

The time when a data frame capture begins, stored in wsa_time structure.

4.4 wsa_resp Struct Reference

This structure contains the response information for each query.

Data Fields

- int64_t status
- char output [MAX_STR_LEN]

4.4.1 Field Documentation

4.4.1.1 char output

The char pointer to an output string responded to a query.

4.4.1.2 int32_t status

The status of the query. Positive number when success, negative when failed.

4.5 wsa_socket Struct Reference

A structure containing the socket parameters used for creating TCP/IP connection for control and data acquisition.

Data Fields

- SOCKET cmd
- SOCKET data

4.5.1 Field Documentation

4.5.1.1 SOCKET cmd

The command socket for command controls and queries. The port used for this socket is 37001.

4.5.1.2 SOCKET data

The data socket used for streaming of data. The port used for this socket is 37000.

4.6 wsa_time Struct Reference

This structure contains the time information. It is used for the time stamp in a frame header.

Data Fields

- uint32_t sec
- uint64_t psec

4.6.1 Field Documentation

4.6.1.1 uint64_t psec

Nanoseconds after the second (0 - 999 999 999).

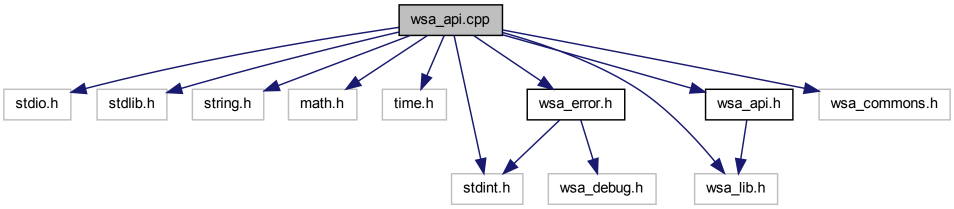
4.6.1.2 uint32_t sec

The number of seconds elapsed since 00:00 hours, Jan 1, 1970 UTC.

5 File Documentation

5.1 wsa_api.cpp File Reference

Include dependency graph for wsa_api.cpp:



Defines

- #define WSA_RFE0440 "RFE0440"
- #define MAX_ANT_PORT 2

Functions

- int16_t wsa_verify_freq (struct wsa_device ∗dev, uint64_t freq)
- int16_t wsa_open (struct wsa_device ∗dev, char ∗intf_method)
- void wsa_close (struct wsa_device ∗dev)
- int16_t wsa_check_addr (char ∗ip_addr)
- int16_t wsa_is_connected (struct wsa_device ∗dev)
- const char ∗ wsa_get_err_msg (int16_t err_code)
- int16_t wsa_set_command_file (struct wsa_device ∗dev, char ∗file_name)
- float wsa_get_abs_max_amp (struct wsa_device ∗dev, enum wsa_gain gain)
- int32_t wsa_read_frame_raw (struct wsa_device ∗dev, struct wsa_frame_header ∗header, char ∗data_buf, const int32_t sample_size)
- int32_t wsa_read_frame_int (struct wsa_device ∗dev, struct wsa_frame_header ∗header, int16_t ∗i_buf, int16_t ∗q_buf, const int32_t sample_size)
- int32_t wsa_frame_decode (struct wsa_device ∗dev, char ∗data_buf, int16_t ∗i_buf, int16_t ∗q_buf, const int32_t sample_size)
- int16_t wsa_set_sample_size (struct wsa_device ∗dev, int32_t sample_size)
- int32_t wsa_get_sample_size (struct wsa_device ∗dev)
- int64_t wsa_get_freq (struct wsa_device ∗dev)
- int16_t wsa_set_freq (struct wsa_device ∗dev, int64_t cfreq)
- int16_t wsa_get_gain_if (struct wsa_device ∗dev, int ∗gain)
- int16_t wsa_set_gain_if (struct wsa_device ∗dev, int gain)
- enum wsa_gain wsa_get_gain_rf (struct wsa_device ∗dev)
- int16_t wsa_set_gain_rf (struct wsa_device ∗dev, enum wsa_gain gain)
- int16_t wsa_get_antenna (struct wsa_device ∗dev)
- int16_t wsa_set_antenna (struct wsa_device ∗dev, int16_t port_num)
- int16_t wsa_get_bpf (struct wsa_device ∗dev)
- int16_t wsa_set_bpf (struct wsa_device ∗dev, int16_t mode)
- int16_t wsa_query_cal_mode (struct wsa_device ∗dev)
- int16_t wsa_run_cal_mode (struct wsa_device ∗dev, int16_t mode)

5.1.1 Define Documentation

5.1.1.1 #define MAX_ANT_PORT 2

5.1.1.2 #define WSA_RFE0440 "RFE0440"

5.1.2 Function Documentation

5.1.2.1 int16_t wsa_check_addr (char ∗ *ip_addr*)

Verify if the IP address or host name given is valid for the WSA.

Parameters

ip_addr	- A char pointer to the IP address or host name to be verified.

Returns

1 if the IP is valid, or a negative number on error.

5.1.2.2 void wsa_close (struct wsa_device ∗ *dev*)

Closes the device handle if one is opened and stops any existing data capture.

Parameters

dev	- A pointer to a WSA device structure to be closed.

Returns

none

5.1.2.3 int32_t wsa_frame_decode (struct wsa_device ∗ *dev,* char ∗ *data_buf,* int16_t ∗ *i_buf,* int16_t ∗ *q_buf,* const int32_t *sample_size*)

Decodes the raw **data_buf** buffer containing frame(s) of I & Q data bytes and returned the I and Q buffers of data with the size determined by the **sample_size** parameter.

Note: the **data_buf** size is assumed as **sample_size** ∗ 4 bytes per sample

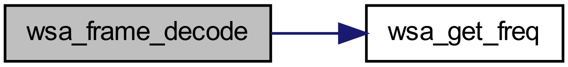
Parameters

dev	- A pointer to the WSA device structure.
data_buf	- A char pointer buffer containing the raw I and Q data in in bytes to be decoded into separate I and Q buffers. Its size is assumed to be the number of 32-bit sample_size words multiply by 4 (i.e. sizeof(data_buf) = sample_size ∗ 4 bytes per sample).
i_buf	- A 16-bit signed integer pointer for the unscaled, I data buffer with size specified by the **sample_size**.
q_buf	- A 16-bit signed integer pointer for the unscaled, Q data buffer with size specified by the **sample_size**.
sample_size	- A 32-bit unsigned integer number of {I, Q} sample pairs to be decoded from **data_buf**. The frame size is limited to a maximum number, **max_sample_size**, listed in the **wsa_descriptor** structure.

Returns

The number of samples decoded, or a 16-bit negative number on error.

Here is the call graph for this function:



5.1.2.4 float wsa_get_abs_max_amp (struct **wsa_device** ∗ *dev,* enum **wsa_gain** *gain*)

Gets the absolute maximum RF input level (dBm) for the WSA at the given gain setting.

Operating the WSA device at the absolute maximum may cause damage to the device.

Parameters

dev	- A pointer to the WSA device structure.
gain	- The gain setting of **wsa_gain** type at which the absolute maximum amplitude input level is to be retrieved.

Returns

The absolute maximum RF input level in dBm or negative error number.

5.1.2.5 int16_t wsa_get_antenna (struct **wsa_device** ∗ *dev*)

Gets which antenna port is currently in used with the RFE board.

Parameters

dev	- A pointer to the WSA device structure.

Returns

The antenna port number on success, or a negative number on error.

5.1.2.6 int16_t wsa_get_bpf (struct **wsa_device** ∗ *dev*)

Gets the current mode of the RFE's preselect BPF stage.

Parameters

dev	- A pointer to the WSA device structure.

Returns

1 (on), 0 (off), or a negative number on error.

5.1.2.7 const char∗ wsa_get_err_msg (int16_t *err_code*)

Returns a message string associated with the given error code **err_code**.

Parameters

err_code	- The negative WSA error code, returned from a WSA function.

Returns

A char pointer to the error message string.

5.1.2.8 int64_t wsa_get_freq (struct wsa_device ∗ *dev*)

Retrieves the center frequency that the WSA is running at.

Parameters

dev	- A pointer to the WSA device structure.

Returns

The frequency in Hz, or a negative number on error.

5.1.2.9 int16_t wsa_get_gain_if (struct wsa_device ∗ *dev,* int ∗ *gain*)

Gets the current IF gain value of the RFE in dB.

Parameters

dev	- A pointer to the WSA device structure.
gain	- An integer pointer to the IF gain value.

Returns

The gain value in dB, or a large negative number on error.

5.1.2.10 enum wsa_gain wsa_get_gain_rf (struct wsa_device ∗ *dev*)

Gets the current quantized RF front end gain setting of the RFE.

Parameters

dev	- A pointer to the WSA device structure.

Returns

The gain setting of wsa_gain type, or a negative number on error.

5.1.2.11 int32_t wsa_get_sample_size (struct wsa_device ∗ *dev*)

Gets the number of samples per frame.

Parameters

dev	- A pointer to the WSA device structure.

Returns

The sample size if success, or a negative number on error.

5.1.2.12 int16_t wsa_is_connected (struct wsa_device * *dev*)

Indicates if the WSA is still connected to the PC.

Parameters

dev	- A pointer to the WSA device structure to be verified for the connection.

Returns

1 if it is connected, 0 if not connected, or a negative number if errors.

5.1.2.13 int16_t wsa_open (struct wsa_device * *dev,* char * *intf_method*)

Establishes a connection of choice specified by the interface method to the WSA.

At success, the handle remains open for future access by other library methods until wsa_close() is called. When unsuccessful, the WSA will be closed automatically and an error is returned.

Parameters

dev	- A pointer to the WSA device structure to be opened.
intf_method	- A char pointer to store the interface method to the WSA. Possible methods: • With LAN, use: "TCPIP::<Ip address of the WSA>::37001" • With USB, use: "USB" (check if supported with the WSA version used).

Returns

0 on success, or a negative number on error.

Errors:

Situations that will generate an error are:

- the interface method does not exist for the WSA product version.
- the WSA is not detected (has not been connected or powered up).
-

5.1.2.14 int16_t wsa_query_cal_mode (struct wsa_device * *dev*)

Gets the current mode of the RFE's internal anti-aliasing LPF.

Parameters

dev	- A pointer to the WSA device structure.

Returns

1 (on), 0 (off), or a negative number on error. Checks if the RFE's internal calibration has finished or not.

Parameters

dev	- A pointer to the WSA device structure.

Returns

1 if the calibration is still running or 0 if completed, or a negative number on error.

5.1.2.15 int32_t wsa_read_frame_int (struct **wsa_device** ∗ *dev,* struct **wsa_frame_header** ∗ *header,* int16_t ∗ *i_buf,* int16_t ∗ *q_buf,* const int32_t *sample_size*)

Reads a frame of raw data and return pointers to the decoded 16-bit integer I & Q buffers. *Each* frame consists of a header, and I and Q buffers of data of length determine by the **sample_size** parameter. This function also checks for the continuity of the frames coming from the WSA. Warning will be issued if the frame count (tracked local to the function) is not continuous from the previous read but will still return the frame.

Remarks

1. wsa_read_frame_int() simplily invokes wsa_read_frame_raw() follow by wsa_frame_decode() for each frame read. However, if timing between each data acquisition frames is important and needs to be minimized, it might be more advantageous to use wsa_read_frame_raw() to gather multiple of frames first and then invokes wsa_frame_decode() separately.
2. This function does not set the **sample_size** to WSA at each capture in order to minimize the delay between captures. The number of samples per frame (**sample_size**) must be set using wsa_set_sample_size() at least once during the WSA powered on.

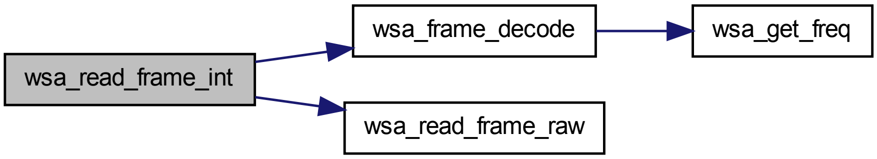
Parameters

dev	- A pointer to the WSA device structure.
header	- A pointer to **wsa_frame_header** structure to store information for the frame.
i_buf	- A 16-bit signed integer pointer for the unscaled, I data buffer with size specified by the sample_size.
q_buf	- A 16-bit signed integer pointer for the unscaled Q data buffer with size specified by the sample_size.
sample_size	- A 32-bit unsigned integer sample size (i.e. {I, Q} sample pairs) per data frame to be captured. The frame size is limited to a maximum number, **max_sample_size**, listed in the **wsa_descriptor** structure.

Returns

The number of data samples read upon success, or a negative number on error.

Here is the call graph for this function:



5.1.2.16 int32_t wsa_read_frame_raw (struct **wsa_device** ∗ *dev,* struct **wsa_frame_header** ∗ *header,* char ∗ *data_buf,* const int32_t *sample_size*)

Reads a frame of data. *Each* frame consists of a header, and a buffer of data of length determine by the **sample_size** parameter (i.e. sizeof(**data_buf**) = **sample_size** ∗ 4 bytes per sample).

Each I and Q samples is 16-bit (2-byte) wide, signed 2-complement. The raw data_buf contains alternatively 2-byte Q follows by 2-byte I, so on. In another words, the I & Q samples are distributed in the raw data_buf as follow:

```
                data_buf = QIQIQIQI... = <2 bytes Q><2bytes I><...>
```

The bytes can be decoded as follow:

```
        Let takes the first 4 bytes of the data_buf, then:

                int16_t I[0] = data_buf[3] << 8 + data_buf[2];
                int16_t Q[0] = data_buf[1] << 8 + data_buf[0];

  And so on for N number of samples:

                int16_t I[i] = data_buf[i+3] << 8 + data_buf[i+2];
                int16_t Q[i] = data_buf[i+1] << 8 + data_buf[i];
  for i = 0, 1, 2, ..., (N - 1).
```

Alternatively, the data_buf can be passed to wsa_frame_decode() to have I and Q splited up and stored into separate int16_t buffers. Or use wsa_get_frame_int() to do both tasks at once. Those 2 functions are useful when delaying in data acquisition time between frames is not a factor. In addition, the wsa_frame_decode() function is useful for later needs of decoding the data bytes when a large amount of raw data (multiple frames) has been captured for instance.

Remarks

This function does not set the **sample_size** to WSA at each capture in order to minimize the delay between captures. The number of samples per frame (**sample_size**) must be set using wsa_set_sample_size() at least once during the WSA powered on.

Parameters

dev	- A pointer to the WSA device structure.
header	- A pointer to **wsa_frame_header** structure to store information for the frame.
data_buf	- A char pointer buffer to store the raw I and Q data in in bytes. Its size is determined by the number of 32-bit **sample_size** words multiply by 4 (i.e. sizeof(**data_buf**) = **sample_size** $*$ 4 bytes per sample, which is automatically done by the function).
sample_size	- A 32-bit unsigned integer sample size (i.e. number of {I, Q} sample pairs) per data frame to be captured. The size is limited to a maximum number, **max_sample_size**, listed in the **wsa_descriptor** structure.

Returns

The number of data samples read upon success, or a 16-bit negative number on error.

5.1.2.17 int16_t wsa_run_cal_mode (struct **wsa_device** $*$ *dev*, int16_t *mode*)

Runs the RFE'S internal calibration mode or cancel it.

While the calibration mode is running, no other commands should be running until the calibration is finished by using wsa_query_cal_mode(), or could be cancelled

Parameters

dev	- A pointer to the WSA device structure.
mode	- An integer mode of selection: 1 - Run, 0 - Cancel.

Returns

0 on success, or a negative number on error.

5.1.2.18 int16_t wsa_set_antenna (struct wsa_device ∗ *dev,* int16_t *port_num*)

Sets the antenna port to be used for the RFE board.

Parameters

dev	- A pointer to the WSA device structure.
port_num	- An integer port number to used. Available ports: 1, 2. Or see product datasheet for ports availability. **Note:** When calibration mode is enabled through wsa_run_cal_mode(), these antenna ports will not be available. The seletected port will resume when the calibration mode is set to off.

Returns

0 on success, or a negative number on error.

5.1.2.19 int16_t wsa_set_bpf (struct wsa_device ∗ *dev,* int16_t *mode*)

Sets the RFE's preselect band pass filter (BPF) stage on or off (bypassing).

Parameters

dev	- A pointer to the WSA device structure.
mode	- An integer mode of selection: 0 - Off, 1 - On.

Returns

0 on success, or a negative number on error.

5.1.2.20 int16_t wsa_set_command_file (struct wsa_device ∗ *dev,* char ∗ *file_name*)

Read command line(s) stored in the given **file_name** and send each line to the WSA.

Remarks

- Assuming each command line is for a single function followed by a new line.
- Currently read only SCPI commands. Other types of commands, TBD.

Parameters

dev	- A pointer to the WSA device structure.
file_name	- A pointer to the file name

Returns

Number of command lines at success, or a negative error number.

5.1.2.21 int16_t wsa_set_freq (struct wsa_device ∗ *dev,* int64_t *cfreq*)

Sets the WSA to the desired center frequency, **cfreq**.

Remarks

wsa_set_freq() will return error if trigger mode is already running. See the **descr** component of **wsa_dev** structure for maximum/minimum frequency values.

Parameters

dev	- A pointer to the WSA device structure.
cfreq	- The center frequency to set, in Hz

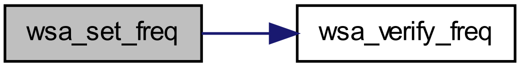
Returns

0 on success, or a negative number on error.

Errors:

- Frequency out of range.
- Set frequency when WSA is in trigger mode.
- Incorrect frequency resolution (check with data sheet).

Here is the call graph for this function:



5.1.2.22 int16_t wsa_set_gain_if (struct **wsa_device** ∗ *dev,* int *gain*)

Sets the gain value in dB for the variable IF gain stages of the RFE, which is additive to the primary RF quantized gain stages (wsa_set_gain_rf()).

Parameters

dev	- A pointer to the WSA device structure.
gain	- The gain level in dB.

Remarks

See the **descr** component of **wsa_dev** structure for maximum/minimum IF gain values. ???

Returns

0 on success, or a negative number on error.

Errors:

- Gain level out of range.

5.1.2.23 int16_t wsa_set_gain_rf (struct **wsa_device** ∗ *dev,* enum **wsa_gain** *gain*)

Sets the quantized **gain** (sensitivity) level for the RFE of the WSA.

Parameters

dev	- A pointer to the WSA device structure.

gain	- The gain setting of type wsa_gain to set for WSA. Valid gain settings are: • WSA_GAIN_HIGH • WSA_GAIN_MED • WSA_GAIN_LOW • WSA_GAIN_VLOW

Returns

0 on success, or a negative number on error.

Errors:

- Gain setting not allow.

5.1.2.24 int16_t wsa_set_sample_size (struct wsa_device * *dev,* int32_t *sample_size*)

Sets the number of samples per frame to be received

Parameters

dev	- A pointer to the WSA device structure.
sample_size	- The sample size to set.

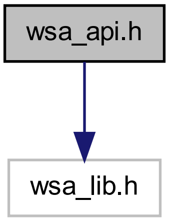
Returns

0 if success, or a negative number on error.

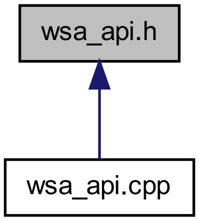
5.1.2.25 int16_t wsa_verify_freq (struct wsa_device * *dev,* uint64_t *freq*)

5.2 wsa_api.h File Reference

Include dependency graph for wsa_api.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct wsa_descriptor

  This structure stores WSA information.
- struct wsa_time

  This structure contains the time information. It is used for the time stamp in a frame header.
- struct wsa_frame_header

  This structure contains header information related to each frame read by wsa_read_frame().
- struct wsa_socket

  A structure containing the socket parameters used for creating TCP/IP connection for control and data acquisition.
- struct wsa_device

  A structure containing the components associate with each WSA device.
- struct wsa_resp

  This structure contains the response information for each query.

Enumerations

- enum wsa_gain { WSA_GAIN_HIGH = 1, WSA_GAIN_MED, WSA_GAIN_LOW, WSA_GAIN_VLOW }

Functions

- int16_t wsa_open (struct wsa_device ∗dev, char ∗intf_method)
- void wsa_close (struct wsa_device ∗dev)
- int16_t wsa_check_addr (char ∗intf_method)
- int16_t wsa_is_connected (struct wsa_device ∗dev)
- const char ∗ wsa_get_err_msg (int16_t err_code)
- int16_t wsa_set_command_file (struct wsa_device ∗dev, char ∗file_name)
- float wsa_get_abs_max_amp (struct wsa_device ∗dev, enum wsa_gain gain)
- int32_t wsa_read_frame_raw (struct wsa_device ∗dev, struct wsa_frame_header ∗header, char ∗data_buf, const int32_t sample_size)
- int32_t wsa_frame_decode (struct wsa_device ∗dev, char ∗data_buf, int16_t ∗i_buf, int16_t ∗q_buf, const int32_t sample_size)

- int32_t wsa_read_frame_int (struct wsa_device ∗dev, struct wsa_frame_header ∗header, int16_t ∗i_buf, int16_t ∗q_buf, const int32_t sample_size)
- int16_t wsa_set_sample_size (struct wsa_device ∗dev, int32_t sample_size)
- int32_t wsa_get_sample_size (struct wsa_device ∗dev)
- int64_t wsa_get_freq (struct wsa_device ∗dev)
- int16_t wsa_set_freq (struct wsa_device ∗dev, int64_t cfreq)
- int16_t wsa_get_gain_if (struct wsa_device ∗dev, int ∗gain)
- int16_t wsa_set_gain_if (struct wsa_device ∗dev, int gain)
- enum wsa_gain wsa_get_gain_rf (struct wsa_device ∗dev)
- int16_t wsa_set_gain_rf (struct wsa_device ∗dev, enum wsa_gain gain)
- int16_t wsa_get_antenna (struct wsa_device ∗dev)
- int16_t wsa_set_antenna (struct wsa_device ∗dev, int16_t port_num)
- int16_t wsa_get_bpf (struct wsa_device ∗dev)
- int16_t wsa_set_bpf (struct wsa_device ∗dev, int16_t mode)
- int16_t wsa_query_cal_mode (struct wsa_device ∗dev)
- int16_t wsa_run_cal_mode (struct wsa_device ∗dev, int16_t mode)

5.2.1 Enumeration Type Documentation

5.2.1.1 enum wsa_gain

Defines the RF quantized gain settings available for the radio front end (RFE) of the WSA.

Enumerator:

WSA_GAIN_HIGH High RF amplification. Value 1.

WSA_GAIN_MED Medium RF amplification.

WSA_GAIN_LOW Low RF amplification.

WSA_GAIN_VLOW Very low RF amplification.

5.2.2 Function Documentation

5.2.2.1 int16_t wsa_check_addr (char ∗ *ip_addr*)

Verify if the IP address or host name given is valid for the WSA.

Parameters

ip_addr	- A char pointer to the IP address or host name to be verified.

Returns

1 if the IP is valid, or a negative number on error.

5.2.2.2 void wsa_close (struct wsa_device ∗ *dev*)

Closes the device handle if one is opened and stops any existing data capture.

Parameters

dev	- A pointer to a WSA device structure to be closed.

Returns

none

5.2.2.3 int32_t wsa_frame_decode (struct **wsa_device** ∗ *dev,* char ∗ *data_buf,* int16_t ∗ *i_buf,* int16_t ∗ *q_buf,* const int32_t *sample_size*)

Decodes the raw **data_buf** buffer containing frame(s) of I & Q data bytes and returned the I and Q buffers of data with the size determined by the **sample_size** parameter.

Note: the **data_buf** size is assumed as **sample_size** ∗ 4 bytes per sample

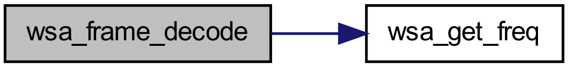
Parameters

dev	- A pointer to the WSA device structure.
data_buf	- A char pointer buffer containing the raw I and Q data in in bytes to be decoded into separate I and Q buffers. Its size is assumed to be the number of 32-bit sample_size words multiply by 4 (i.e. sizeof(data_-buf) = sample_size ∗ 4 bytes per sample).
i_buf	- A 16-bit signed integer pointer for the unscaled, I data buffer with size specified by the **sample_size**.
q_buf	- A 16-bit signed integer pointer for the unscaled, Q data buffer with size specified by the **sample_size**.
sample_size	- A 32-bit unsigned integer number of {I, Q} sample pairs to be decoded from **data_buf**. The frame size is limited to a maximum number, **max_sample_size**, listed in the **wsa_descriptor** structure.

Returns

The number of samples decoded, or a 16-bit negative number on error.

Here is the call graph for this function:



5.2.2.4 float wsa_get_abs_max_amp (struct **wsa_device** ∗ *dev,* enum **wsa_gain** *gain*)

Gets the absolute maximum RF input level (dBm) for the WSA at the given gain setting.

Operating the WSA device at the absolute maximum may cause damage to the device.

Parameters

dev	- A pointer to the WSA device structure.
gain	- The gain setting of **wsa_gain** type at which the absolute maximum amplitude input level is to be retrieved.

Returns

The absolute maximum RF input level in dBm or negative error number.

5.2.2.5 int16_t wsa_get_antenna (struct wsa_device * *dev*)

Gets which antenna port is currently in used with the RFE board.

Parameters

dev	- A pointer to the WSA device structure.

Returns

The antenna port number on success, or a negative number on error.

5.2.2.6 int16_t wsa_get_bpf (struct wsa_device * *dev*)

Gets the current mode of the RFE's preselect BPF stage.

Parameters

dev	- A pointer to the WSA device structure.

Returns

1 (on), 0 (off), or a negative number on error.

5.2.2.7 const char* wsa_get_err_msg (int16_t *err_code*)

Returns a message string associated with the given error code **err_code**.

Parameters

err_code	- The negative WSA error code, returned from a WSA function.

Returns

A char pointer to the error message string.

5.2.2.8 int64_t wsa_get_freq (struct wsa_device * *dev*)

Retrieves the center frequency that the WSA is running at.

Parameters

dev	- A pointer to the WSA device structure.

Returns

The frequency in Hz, or a negative number on error.

5.2.2.9 int16_t wsa_get_gain_if (struct wsa_device * *dev,* int * *gain*)

Gets the current IF gain value of the RFE in dB.

Parameters

dev	- A pointer to the WSA device structure.
gain	- An integer pointer to the IF gain value.

Returns

The gain value in dB, or a large negative number on error.

5.2.2.10 enum **wsa_gain** wsa_get_gain_rf (struct **wsa_device** ∗ *dev*)

Gets the current quantized RF front end gain setting of the RFE.

Parameters

dev	- A pointer to the WSA device structure.

Returns

The gain setting of wsa_gain type, or a negative number on error.

5.2.2.11 int32_t wsa_get_sample_size (struct **wsa_device** ∗ *dev*)

Gets the number of samples per frame.

Parameters

dev	- A pointer to the WSA device structure.

Returns

The sample size if success, or a negative number on error.

5.2.2.12 int16_t wsa_is_connected (struct **wsa_device** ∗ *dev*)

Indicates if the WSA is still connected to the PC.

Parameters

dev	- A pointer to the WSA device structure to be verified for the connection.

Returns

1 if it is connected, 0 if not connected, or a negative number if errors.

5.2.2.13 int16_t wsa_open (struct **wsa_device** ∗ *dev,* char ∗ *intf_method*)

Establishes a connection of choice specified by the interface method to the WSA.

At success, the handle remains open for future access by other library methods until wsa_close() is called. When unsuccessful, the WSA will be closed automatically and an error is returned.

Parameters

dev	- A pointer to the WSA device structure to be opened.
intf_method	- A char pointer to store the interface method to the WSA. Possible methods: • With LAN, use: "TCPIP::<Ip address of the WSA>::37001" • With USB, use: "USB" (check if supported with the WSA version used).

Returns

0 on success, or a negative number on error.

Errors:

Situations that will generate an error are:

- the interface method does not exist for the WSA product version.
- the WSA is not detected (has not been connected or powered up).
-

5.2.2.14 int16_t wsa_query_cal_mode (struct wsa_device ∗ *dev*)

Gets the current mode of the RFE's internal anti-aliasing LPF.

Parameters

dev	- A pointer to the WSA device structure.

Returns

1 (on), 0 (off), or a negative number on error. Checks if the RFE's internal calibration has finished or not.

Parameters

dev	- A pointer to the WSA device structure.

Returns

1 if the calibration is still running or 0 if completed, or a negative number on error.

5.2.2.15 int32_t wsa_read_frame_int (struct wsa_device ∗ *dev,* struct wsa_frame_header ∗ *header,* int16_t ∗ *i_buf,* int16_t ∗ *q_buf,* const int32_t *sample_size*)

Reads a frame of raw data and return pointers to the decoded 16-bit integer I & Q buffers. *Each* frame consists of a header, and I and Q buffers of data of length determine by the **sample_size** parameter. This function also checks for the continuity of the frames coming from the WSA. Warning will be issued if the frame count (tracked local to the function) is not continuous from the previous read but will still return the frame.

Remarks

1. wsa_read_frame_int() simplily invokes wsa_read_frame_raw() follow by wsa_frame_decode() for each frame read. However, if timing between each data acquisition frames is important and needs to be minimized, it might be more advantageous to use wsa_read_frame_raw() to gather multiple of frames first and then invokes wsa_frame_decode() separately.
2. This function does not set the **sample_size** to WSA at each capture in order to minimize the delay between captures. The number of samples per frame (**sample_size**) must be set using wsa_set_sample_size() at least once during the WSA powered on.

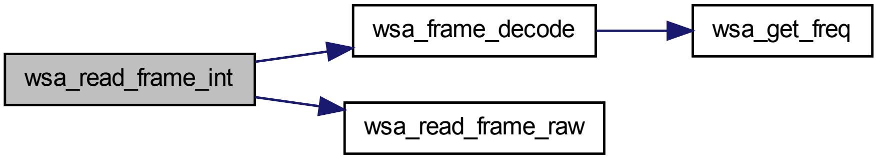
Parameters

dev	- A pointer to the WSA device structure.
header	- A pointer to **wsa_frame_header** structure to store information for the frame.
i_buf	- A 16-bit signed integer pointer for the unscaled, I data buffer with size specified by the sample_size.
q_buf	- A 16-bit signed integer pointer for the unscaled Q data buffer with size specified by the sample_size.
sample_size	- A 32-bit unsigned integer sample size (i.e. {I, Q} sample pairs) per data frame to be captured. The frame size is limited to a maximum number, **max_sample_size**, listed in the **wsa_descriptor** structure.

Returns

The number of data samples read upon success, or a negative number on error.

Here is the call graph for this function:



5.2.2.16 int32_t wsa_read_frame_raw (struct **wsa_device** ∗ *dev,* struct **wsa_frame_header** ∗ *header,* char ∗ *data_buf,* const int32_t *sample_size*)

Reads a frame of data. *Each* frame consists of a header, and a buffer of data of length determine by the **sample_size** parameter (i.e. sizeof(**data_buf**) = **sample_size** ∗ 4 bytes per sample).

Each I and Q samples is 16-bit (2-byte) wide, signed 2-complement. The raw data_buf contains alternatively 2-byte Q follows by 2-byte I, so on. In another words, the I & Q samples are distributed in the raw data_buf as follow:

```
                data_buf = QIQIQIQI... = <2 bytes Q><2bytes I><...>
```

The bytes can be decoded as follow:

```
        Let takes the first 4 bytes of the data_buf, then:

                int16_t I[0] = data_buf[3] << 8 + data_buf[2];
                int16_t Q[0] = data_buf[1] << 8 + data_buf[0];

  And so on for N number of samples:

                int16_t I[i] = data_buf[i+3] << 8 + data_buf[i+2];
                int16_t Q[i] = data_buf[i+1] << 8 + data_buf[i];
  for i = 0, 1, 2, ..., (N - 1).
```

Alternatively, the data_buf can be passed to wsa_frame_decode() to have I and Q splited up and stored into separate int16_t buffers. Or use wsa_get_frame_int() to do both tasks at once. Those 2 functions are useful when delaying in data acquisition time between frames is not a factor. In addition, the wsa_frame_decode() function is useful for later needs of decoding the data bytes when a large amount of raw data (multiple frames) has been captured for instance.

Remarks

This function does not set the **sample_size** to WSA at each capture in order to minimize the delay between captures. The number of samples per frame (**sample_size**) must be set using wsa_set_sample_size() at least once during the WSA powered on.

Parameters

dev	- A pointer to the WSA device structure.

header	- A pointer to **wsa_frame_header** structure to store information for the frame.
data_buf	- A char pointer buffer to store the raw I and Q data in in bytes. Its size is determined by the number of 32-bit **sample_size** words multiply by 4 (i.e. sizeof(**data_buf**) = **sample_size** * 4 bytes per sample, which is automatically done by the function).
sample_size	- A 32-bit unsigned integer sample size (i.e. number of {I, Q} sample pairs) per data frame to be captured. The size is limited to a maximum number, **max_sample_size**, listed in the **wsa_descriptor** structure.

Returns

The number of data samples read upon success, or a 16-bit negative number on error.

5.2.2.17 int16_t wsa_run_cal_mode (struct wsa_device * *dev,* int16_t *mode*)

Runs the RFE'S internal calibration mode or cancel it.

While the calibration mode is running, no other commands should be running until the calibration is finished by using wsa_query_cal_mode(), or could be cancelled

Parameters

dev	- A pointer to the WSA device structure.
mode	- An integer mode of selection: 1 - Run, 0 - Cancel.

Returns

0 on success, or a negative number on error.

5.2.2.18 int16_t wsa_set_antenna (struct wsa_device * *dev,* int16_t *port_num*)

Sets the antenna port to be used for the RFE board.

Parameters

dev	- A pointer to the WSA device structure.
port_num	- An integer port number to used. Available ports: 1, 2. Or see product datasheet for ports availability. **Note:** When calibration mode is enabled through wsa_run_cal_mode(), these antenna ports will not be available. The seletected port will resume when the calibration mode is set to off.

Returns

0 on success, or a negative number on error.

5.2.2.19 int16_t wsa_set_bpf (struct wsa_device * *dev,* int16_t *mode*)

Sets the RFE's preselect band pass filter (BPF) stage on or off (bypassing).

Parameters

dev	- A pointer to the WSA device structure.
mode	- An integer mode of selection: 0 - Off, 1 - On.

Returns

0 on success, or a negative number on error.

5.2.2.20 int16_t wsa_set_command_file (struct wsa_device * *dev*, char * *file_name*)

Read command line(s) stored in the given **file_name** and send each line to the WSA.

Remarks

- Assuming each command line is for a single function followed by a new line.
- Currently read only SCPI commands. Other types of commands, TBD.

Parameters

dev	- A pointer to the WSA device structure.
file_name	- A pointer to the file name

Returns

Number of command lines at success, or a negative error number.

5.2.2.21 int16_t wsa_set_freq (struct wsa_device * *dev*, int64_t *cfreq*)

Sets the WSA to the desired center frequency, **cfreq**.

Remarks

wsa_set_freq() will return error if trigger mode is already running. See the **descr** component of **wsa_dev** structure for maximum/minimum frequency values.

Parameters

dev	- A pointer to the WSA device structure.
cfreq	- The center frequency to set, in Hz

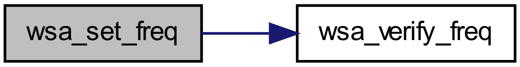
Returns

0 on success, or a negative number on error.

Errors:

- Frequency out of range.
- Set frequency when WSA is in trigger mode.
- Incorrect frequency resolution (check with data sheet).

Here is the call graph for this function:



5.2.2.22 int16_t wsa_set_gain_if (struct wsa_device * *dev*, int *gain*)

Sets the gain value in dB for the variable IF gain stages of the RFE, which is additive to the primary RF quantized gain stages (wsa_set_gain_rf()).

Parameters

dev	- A pointer to the WSA device structure.
gain	- The gain level in dB.

Remarks

See the **descr** component of **wsa_dev** structure for maximum/minimum IF gain values. ???

Returns

0 on success, or a negative number on error.

Errors:

- Gain level out of range.

5.2.2.23 int16_t wsa_set_gain_rf (struct wsa_device * *dev*, enum wsa_gain *gain*)

Sets the quantized **gain** (sensitivity) level for the RFE of the WSA.

Parameters

dev	- A pointer to the WSA device structure.
gain	- The gain setting of type wsa_gain to set for WSA. Valid gain settings are: • WSA_GAIN_HIGH • WSA_GAIN_MED • WSA_GAIN_LOW • WSA_GAIN_VLOW

Returns

0 on success, or a negative number on error.

Errors:

- Gain setting not allow.

5.2.2.24 int16_t wsa_set_sample_size (struct wsa_device * *dev*, int32_t *sample_size*)

Sets the number of samples per frame to be received

Parameters

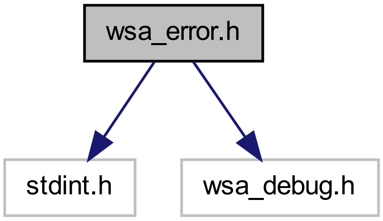
dev	- A pointer to the WSA device structure.
sample_size	- The sample size to set.

Returns

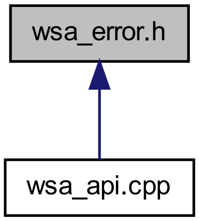
0 if success, or a negative number on error.

5.3 wsa_error.h File Reference

Include dependency graph for wsa_error.h:



This graph shows which files directly or indirectly include this file:



Defines

- #define LNEG_NUM (-10000)
- #define WSA_ERR_NOWSA (LNEG_NUM - 1)
- #define WSA_ERR_INVIPADDRESS (LNEG_NUM - 2)
- #define WSA_ERR_NOCTRLPIPE (LNEG_NUM - 3)
- #define WSA_ERR_UNKNOWNPRODSER (LNEG_NUM - 4)
- #define WSA_ERR_UNKNOWNPRODVSN (LNEG_NUM - 5)
- #define WSA_ERR_UNKNOWNFWRVSN (LNEG_NUM - 6)
- #define WSA_ERR_UNKNOWNRFEVSN (LNEG_NUM - 7)
- #define WSA_ERR_PRODOBSOLETE (LNEG_NUM - 8)
- #define WSA_ERR_QUERYNORESP (LNEG_NUM - 9)
- #define WSA_ERR_WSANOTRDY (LNEG_NUM - 101)
- #define WSA_ERR_WSAINUSE (LNEG_NUM - 102)
- #define WSA_ERR_SETFAILED (LNEG_NUM - 103)

- #define WSA_ERR_OPENFAILED (LNEG_NUM - 104)
- #define WSA_ERR_INITFAILED (LNEG_NUM - 105)
- #define WSA_ERR_INVADCCORRVALUE (LNEG_NUM - 106)
- #define WSA_ERR_INVINTFMETHOD (LNEG_NUM - 201)
- #define WSA_ERR_INVIPHOSTADDRESS (LNEG_NUM - 202)
- #define WSA_ERR_USBNOTAVBL (LNEG_NUM - 203)
- #define WSA_ERR_USBOPENFAILED (LNEG_NUM - 204)
- #define WSA_ERR_USBINITFAILED (LNEG_NUM - 205)
- #define WSA_ERR_ETHERNETNOTAVBL (LNEG_NUM - 206)
- #define WSA_ERR_ETHERNETCONNECTFAILED (LNEG_NUM - 207)
- #define WSA_ERR_ETHERNETINITFAILED (LNEG_NUM - 209)
- #define WSA_ERR_WINSOCKSTARTUPFAILED (LNEG_NUM - 210)
- #define WSA_ERR_SOCKETSETFUPFAILED (LNEG_NUM - 211)
- #define WSA_ERR_INVAMP (LNEG_NUM - 301)
- #define WSA_ERR_NODATABUS (LNEG_NUM - 401)
- #define WSA_ERR_READFRAMEFAILED (LNEG_NUM - 402)
- #define WSA_ERR_INVSAMPLESIZE (LNEG_NUM - 403)
- #define WSA_ERR_SIZESETFAILED (LNEG_NUM - 404)
- #define WSA_ERR_NOTIQFRAME (LNEG_NUM - 405)
- #define WSA_ERR_FREQOUTOFBOUND (LNEG_NUM - 601)
- #define WSA_ERR_INVFREQRES (LNEG_NUM - 602)
- #define WSA_ERR_FREQSETFAILED (LNEG_NUM - 603)
- #define WSA_ERR_PLLLOCKFAILED (LNEG_NUM - 604)
- #define WSA_ERR_INVRFGAIN (LNEG_NUM - 801)
- #define WSA_ERR_INVIFGAIN (LNEG_NUM - 802)
- #define WSA_ERR_IFGAINSETFAILED (LNEG_NUM - 803)
- #define WSA_ERR_RFGAINSETFAILED (LNEG_NUM - 804)
- #define WSA_ERR_INVRUNMODE (LNEG_NUM - 1001)
- #define WSA_ERR_INVTRIGID (LNEG_NUM - 1201)
- #define WSA_ERR_INVSTOPFREQ (LNEG_NUM - 1202)
- #define WSA_ERR_STARTOOB (LNEG_NUM - 1203)
- #define WSA_ERR_STOPOOB (LNEG_NUM - 1204)
- #define WSA_ERR_INVSTARTRES (LNEG_NUM - 1205)
- #define WSA_ERR_INVSTOPRES (LNEG_NUM - 1206)
- #define WSA_ERR_INVTRIGRANGE (LNEG_NUM - 1207)
- #define WSA_ERR_INVDWELL (LNEG_NUM - 1208)
- #define WSA_ERR_INVNUMFRAMES (LNEG_NUM - 1209)
- #define WSA_ERR_CMDSENDFAILED (LNEG_NUM - 1501)
- #define WSA_ERR_CMDINVALID (LNEG_NUM - 1502)
- #define WSA_ERR_RESPUNKNOWN (LNEG_NUM - 1503)
- #define WSA_ERR_INVANTENNAPORT (LNEG_NUM - 1601)
- #define WSA_ERR_ANTENNASETFAILED (LNEG_NUM - 1602)
- #define WSA_ERR_INVFILTERMODE (LNEG_NUM - 1603)
- #define WSA_ERR_FILTERSETFAILED (LNEG_NUM - 1604)
- #define WSA_ERR_INVCALIBRATEMODE (LNEG_NUM - 1605)
- #define WSA_ERR_CALIBRATESETFAILED (LNEG_NUM - 1606)
- #define WSA_ERR_INVRFESETTING (LNEG_NUM - 1607)
- #define WSA_ERR_FILECREATEFAILED (LNEG_NUM - 1900)
- #define WSA_ERR_FILEOPENFAILED (LNEG_NUM - 1901)
- #define WSA_ERR_FILEREADFAILED (LNEG_NUM - 1902)
- #define WSA_ERR_FILEWRITEFAILED (LNEG_NUM - 1903)

- #define WSA_ERR_INVNUMBER (LNEG_NUM - 2000)
- #define WSA_ERR_INVREGADDR (LNEG_NUM - 2001)
- #define WSA_ERR_MALLOCFAILED (LNEG_NUM - 2002)
- #define WSA_ERR_UNKNOWN_ERROR (LNEG_NUM - 2003)

Functions

- const char ∗ _wsa_get_err_msg (int16_t err_id)

5.3.1 Define Documentation

5.3.1.1 #define LNEG_NUM (-10000)

5.3.1.2 #define WSA_ERR_ANTENNASETFAILED (LNEG_NUM - 1602)

5.3.1.3 #define WSA_ERR_CALIBRATESETFAILED (LNEG_NUM - 1606)

5.3.1.4 #define WSA_ERR_CMDINVALID (LNEG_NUM - 1502)

5.3.1.5 #define WSA_ERR_CMDSENDFAILED (LNEG_NUM - 1501)

5.3.1.6 #define WSA_ERR_ETHERNETCONNECTFAILED (LNEG_NUM - 207)

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5.3.2 Function Documentation

5.3.2.1 const char∗ _wsa_get_err_msg (int16_t *err_id*)

5.4 wsa_lib.txt File Reference

Contain some code documents for wsa_lib.h.

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