Software documentation - WFYD API

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Chapter 1

qbAPI Libraries

Those functions allows to use WFYD haptic feedback device through a serial port

Author

Centro "E.Piaggio"

Copyright

Date

October 01, 2017

This is a set of functions that allows to use the boards via a serial port.

Those APIs can be compiled for Unix systems like Linux and Mac OS X and even for Windows. Refer to `https://github.com/NMMI/qbAPI/tree/centropiaggio` for detailed instructions.

Chapter 2

Data Structure Index

2.1 Data Structures

Here are the data structures with brief descriptions:

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Here is a list of all documented files with brief descriptions:

Chapter 4

Data Structure Documentation

4.1 comm_settings Struct Reference

Data Fields

- HANDLE **file_handle**

The documentation for this struct was generated from the following file:

- **qbmove_communications.h**

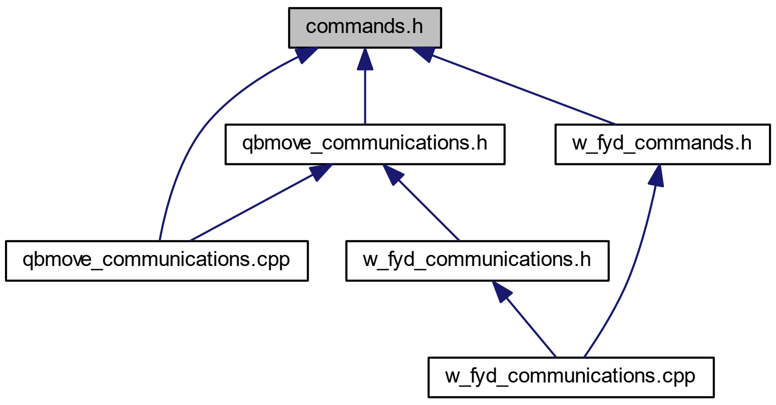
Chapter 5

File Documentation

5.1 commands.h File Reference

Definitions for board commands, parameters and packages.

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



Macros

- #define **API_VERSION** "v6.1.0"

QB Move Information Strings

- #define **INFO_ALL** 0
  All system information.

Enumerations

qbMove and qbHand Commands

- enum **qbmove_command** {
  CMD_PING = 0, **CMD_SET_ZEROS** = 1, **CMD_STORE_PARAMS** = 3, **CMD_STORE_DEFAULT_P**←
  ARAMS = 4,
  CMD_RESTORE_PARAMS = 5, **CMD_GET_INFO** = 6, **CMD_SET_VALUE** = 7, **CMD_GET_VALUE** =
  8,
  CMD_BOOTLOADER = 9, **CMD_INIT_MEM** = 10, **CMD_CALIBRATE** = 11, **CMD_GET_PARAM_LIST**
  = 12,
  CMD_HAND_CALIBRATE = 13, **CMD_ACTIVATE** = 128, **CMD_GET_ACTIVATE** = 129, **CMD_SET**←
  _INPUTS = 130,
  CMD_GET_INPUTS = 131, **CMD_GET_MEASUREMENTS** = 132, **CMD_GET_CURRENTS** = 133, **C**←
  MD_GET_CURR_AND_MEAS = 134,
  CMD_SET_POS_STIFF = 135, **CMD_GET_EMG** = 136, **CMD_GET_VELOCITIES** = 137, **CMD_GET**←
  _COUNTERS = 138,
  CMD_GET_ACCEL = 139, **CMD_GET_CURR_DIFF** = 140, **CMD_SET_CURR_DIFF** = 141, **CMD_S**←
  ET_CUFF_INPUTS = 142,
  CMD_SET_WATCHDOG = 143, **CMD_SET_BAUDRATE** = 144, **CMD_EXT_DRIVE** = 145, **CMD_G**←
  ET_JOYSTICK = 146 }

qbMove and qbHand Parameters

- #define **PARAM_BYTE_SLOT** 50
- #define **PARAM_MENU_SLOT** 150
- enum **qbmove_parameter** {
  PARAM_ID = 0, **PARAM_PID_CONTROL** = 1, **PARAM_STARTUP_ACTIVATION** = 2, **PARAM_INPU**←
  T_MODE = 3,
  PARAM_CONTROL_MODE = 4, **PARAM_MEASUREMENT_OFFSET** = 5, **PARAM_MEASUREMENT**←
  _MULTIPLIER = 6, **PARAM_POS_LIMIT_FLAG** = 7,
  PARAM_POS_LIMIT = 8, **PARAM_MAX_STEP_POS** = 9, **PARAM_MAX_STEP_NEG** = 10, **PARAM_**←
  POS_RESOLUTION = 11,
  PARAM_CURRENT_LIMIT = 12, **PARAM_EMG_CALIB_FLAG** = 13, **PARAM_EMG_THRESHOLD** = 14,
  PARAM_EMG_MAX_VALUE = 15,
  PARAM_EMG_SPEED = 16, **PARAM_PID_CURR_CONTROL** = 18, **PARAM_DOUBLE_ENC_ON_OFF**
  = 19, **PARAM_MOT_HANDLE_RATIO** = 20,
  PARAM_MOTOR_SUPPLY = 21, **PARAM_CURRENT_LOOKUP** = 23, **PARAM_DL_POS_PID** = 24, **P**←
  ARAM_DL_CURR_PID = 25 }
- enum **qbmove_resolution** {
  RESOLUTION_360 = 0, **RESOLUTION_720** = 1, **RESOLUTION_1440** = 2, **RESOLUTION_2880** = 3,
  RESOLUTION_5760 = 4, **RESOLUTION_11520** = 5, **RESOLUTION_23040** = 6, **RESOLUTION_46080** = 7,
  RESOLUTION_92160 = 8 }
- enum **qbmove_input_mode** {
  INPUT_MODE_EXTERNAL = 0, **INPUT_MODE_ENCODER3** = 1, **INPUT_MODE_EMG_PROPORTION**←
  AL = 2, **INPUT_MODE_EMG_INTEGRAL** = 3,
  INPUT_MODE_EMG_FCFS = 4, **INPUT_MODE_EMG_FCFS_ADV** = 5 }
- enum **qbmove_control_mode** {
  CONTROL_ANGLE = 0, **CONTROL_PWM** = 1, **CONTROL_CURRENT** = 2, **CURR_AND_POS_CONT**←
  ROL = 3,
  DEFLECTION_CONTROL = 4, **DEFL_CURRENT_CONTROL** = 5 }
- enum **motor_supply_tipe** { **MAXON_24V** = 0, **MAXON_12V** = 1 }
- enum **acknowledgment_values** { **ACK_ERROR** = 0, **ACK_OK** = 1 }
- enum **data_types** {
  TYPE_FLAG = 0, **TYPE_INT8** = 1, **TYPE_UINT8** = 2, **TYPE_INT16** = 3,
  TYPE_UINT16 = 4, **TYPE_INT32** = 5, **TYPE_UINT32** = 6, **TYPE_FLOAT** = 7,
  TYPE_DOUBLE = 8 }

5.1.1 Detailed Description

Definitions for board commands, parameters and packages.

Author

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This file is included in the board firmware, in its libraries and applications. It contains all definitions that are necessary for the contruction of communication packages.

It includes definitions for all of the device commands, parameters and also the size of answer packages.

5.1.2 Enumeration Type Documentation

5.1.2.1 qbmove_command

```
enum qbmove_command
```

Enumerator

CMD_PING	Asks for a ping message.
CMD_SET_ZEROS	Command for setting the encoders zero position.
CMD_STORE_PARAMS	Stores all parameters in memory and loads them
CMD_STORE_DEFAULT_PARAMS	Store current parameters as factory parameters.
CMD_RESTORE_PARAMS	Restore default factory parameters.
CMD_GET_INFO	Asks for a string of information about.
CMD_SET_VALUE	Not Used.
CMD_GET_VALUE	Not Used.
CMD_BOOTLOADER	Sets the bootloader modality to update the firmware
CMD_INIT_MEM	Initialize the memory with the defalut values.
CMD_CALIBRATE	Starts the stiffness calibration of the qbMove.
CMD_GET_PARAM_LIST	Command to get the parameters list or to set a defined value chosen by the use
CMD_HAND_CALIBRATE	Starts a series of opening and closures of the hand.
CMD_ACTIVATE	Command for activating/deactivating the device
CMD_GET_ACTIVATE	Command for getting device activation state
CMD_SET_INPUTS	Command for setting reference inputs.
CMD_GET_INPUTS	Command for getting reference inputs.
CMD_GET_MEASUREMENTS	Command for asking device's position measurements
CMD_GET_CURRENTS	Command for asking device's current measurements
CMD_GET_CURR_AND_MEAS	Command for asking device's measurements and currents

Enumerator

CMD_SET_POS_STIFF	Not used in the softhand firmware.
CMD_GET_EMG	Command for asking device's emg sensors measurements
CMD_GET_VELOCITIES	Command for asking device's velocity measurements
CMD_GET_COUNTERS	Command for asking device's counters (mostly used for debugging sent commands)
CMD_GET_ACCEL	Command for asking device's acceleration measurements
CMD_GET_CURR_DIFF	Command for asking device's current difference between a measured one and an estimated one (Only for SoftHand)
CMD_SET_CURR_DIFF	Command used to set current difference modality (Only for Cuff device)
CMD_SET_CUFF_INPUTS	Command used to set Cuff device inputs (Only for Cuff device)
CMD_SET_WATCHDOG	Command for setting watchdog timer or disable it
CMD_SET_BAUDRATE	Command for setting baudrate of communication
CMD_EXT_DRIVE	Command to set the actual measurements as inputs to another device (Only for Armslider device)
CMD_GET_JOYSTICK	Command to get the joystick measurements (Only for devices driven by a joystick)

5.1.2.2 qbmove_control_mode

```
enum qbmove_control_mode
```

Enumerator

CONTROL_ANGLE	Classic position control.
CONTROL_PWM	Direct PWM value.
CONTROL_CURRENT	Current control.
CURR_AND_POS_CONTROL	Position and current control.
DEFLECTION_CONTROL	Deflection control.
DEFL_CURRENT_CONTROL	Deflection and current control.

5.1.2.3 qbmove_input_mode

```
enum qbmove_input_mode
```

Enumerator

INPUT_MODE_EXTERNAL	References through external commands (default)
INPUT_MODE_ENCODER3	Encoder 3 drives all inputs.
INPUT_MODE_EMG_PROPORTIONAL	Use EMG measure to proportionally drive the position of the motor 1
INPUT_MODE_EMG_INTEGRAL	Use 2 EMG signals to drive motor position
INPUT_MODE_EMG_FCFS	Use 2 EMG. First reaching threshold wins and its value defines hand closure
INPUT_MODE_EMG_FCFS_ADV	Use 2 EMG. First reaching threshold wins and its value defines hand closure Wait for both EMG to lower under threshold

5.1.2.4 qbmove_parameter

`enum qbmove_parameter`

Enumerator

PARAM_ID	Device's ID number.
PARAM_PID_CONTROL	PID parameters.
PARAM_STARTUP_ACTIVATION	Start up activation byte.
PARAM_INPUT_MODE	Input mode.
PARAM_CONTROL_MODE	Choose the kind of control between position control, current control, direct PWM value or current+position control
PARAM_MEASUREMENT_OFFSET	Adds a constant offset to the measurements
PARAM_MEASUREMENT_MULTIPLIER	Adds a multiplier to the measurements
PARAM_POS_LIMIT_FLAG	Enable/disable position limiting.
PARAM_POS_LIMIT	Position limit values | int32 | int32 | int32 | int32 | | INF_LIM_1 | SUP_LIM_1 | INF_LIM_2 | SUP_LIM_2 |
PARAM_MAX_STEP_POS	Used to slow down movements for positive values.
PARAM_MAX_STEP_NEG	Used to slow down movements for negative values.
PARAM_POS_RESOLUTION	Angle resolution for inputs and measurements. Used during communication.
PARAM_CURRENT_LIMIT	Limit for absorbed current.
PARAM_EMG_CALIB_FLAG	Enable calibration on startup.
PARAM_EMG_THRESHOLD	Minimum value to have effect.
PARAM_EMG_MAX_VALUE	Maximum value of EMG.
PARAM_EMG_SPEED	Closure speed when using EMG.
PARAM_PID_CURR_CONTROL	PID current control.
PARAM_DOUBLE_ENC_ON_OFF	Double Encoder Y/N.
PARAM_MOT_HANDLE_RATIO	Multiplier between handle and motor.
PARAM_MOTOR_SUPPLY	Motor supply voltage of the hand.
PARAM_CURRENT_LOOKUP	Table of values used to calculate an estimated current of the SoftHand
PARAM_DL_POS_PID	Double loop position PID.
PARAM_DL_CURR_PID	Double loop current PID.

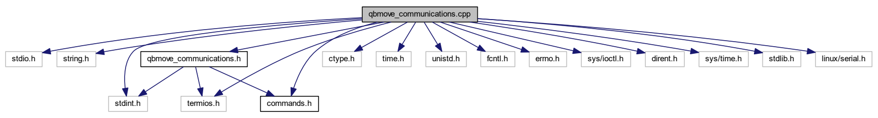
5.2 qbmove_communications.cpp File Reference

Library of functions for serial port communication with a board.

```
#include <stdio.h>
#include <string.h>
#include <stdint.h>
#include <ctype.h>
#include <time.h>
#include <unistd.h>
#include <fcntl.h>
```

```
#include <errno.h>
#include <termios.h>
#include <sys/ioctl.h>
#include <dirent.h>
#include <sys/time.h>
#include <stdlib.h>
#include <linux/serial.h>
#include "qbmove_communications.h"
#include "commands.h"
```

Include dependency graph for qbmove_communications.cpp:



Macros

- #define **BUFFER_SIZE** 500

  Size of buffers that store communication packets.

5.2.1 Detailed Description

Library of functions for serial port communication with a board.

Date

October 01, 2017

Author

Centro "E.Piaggio"

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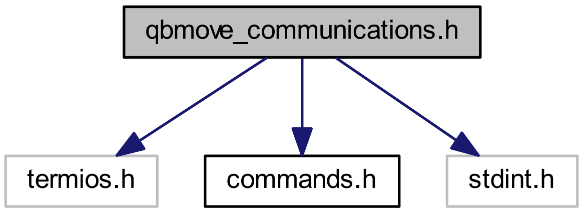
Check the **qbmove_communications.h** (p. 15) file for a complete description of the public functions implemented in **qbmove_communications.cpp** (p. 13).

5.3 qbmove_communications.h File Reference

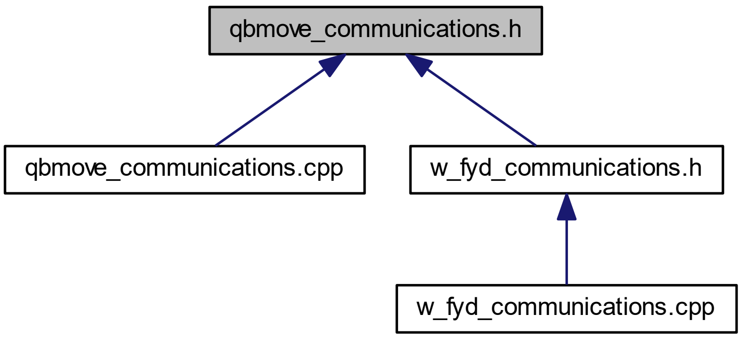
Library of functions for SERIAL PORT communication with a board. Function Prototypes.

```
#include <termios.h>
#include "commands.h"
#include <stdint.h>
```

Include dependency graph for qbmove_communications.h:



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



Data Structures

- struct **comm_settings**

Macros

- #define **HANDLE** int
- #define **INVALID_HANDLE_VALUE** -1
- #define **BAUD_RATE_T_2000000** 0
- #define **BAUD_RATE_T_460800** 1
- #define **MAX_WATCHDOG_TIME** 500
- #define **READ_TIMEOUT** 4000

Typedefs

- typedef struct **comm_settings comm_settings**

Functions

Virtual COM (RS485) functions

- int **RS485listPorts** (char list_of_ports[10][255])
- void **openRS485** (**comm_settings** ∗comm_settings_t, const char ∗port_s, int BAUD_RATE=B2000000)
- void **closeRS485** (**comm_settings** ∗comm_settings_t)
- int **RS485read** (**comm_settings** ∗comm_settings_t, int id, char ∗package)
- int **RS485ListDevices** (**comm_settings** ∗comm_settings_t, char list_of_ids[255])
- void **RS485GetInfo** (**comm_settings** ∗comm_settings_t, char ∗buffer)

qbAPI Commands

- int **commPing** (**comm_settings** ∗comm_settings_t, int id)
- void **commActivate** (**comm_settings** ∗comm_settings_t, int id, char activate)
- void **commSetBaudRate** (**comm_settings** ∗comm_settings_t, int id, short int baudrate)
- void **commSetWatchDog** (**comm_settings** ∗comm_settings_t, int id, short int wdt)
- void **commSetInputs** (**comm_settings** ∗comm_settings_t, int id, short int inputs[ ])
- void **commSetPosStiff** (**comm_settings** ∗comm_settings_t, int id, short int inputs[ ])
- int **commGetInputs** (**comm_settings** ∗comm_settings_t, int id, short int inputs[2])
- int **commGetMeasurements** (**comm_settings** ∗comm_settings_t, int id, short int measurements[3])
- int **commGetCounters** (**comm_settings** ∗comm_settings_t, int id, short unsigned int counters[20])
- int **commGetCurrents** (**comm_settings** ∗comm_settings_t, int id, short int currents[2])
- int **commGetCurrAndMeas** (**comm_settings** ∗comm_settings_t, int id, short int ∗values)
- int **commGetEmg** (**comm_settings** ∗comm_settings_t, int id, short int emg[2])
- int **commGetVelocities** (**comm_settings** ∗comm_settings_t, int id, short int measurements[ ])
- int **commGetAccelerations** (**comm_settings** ∗comm_settings_t, int id, short int measurements[ ])
- int **commGetActivate** (**comm_settings** ∗comm_settings_t, int id, char ∗activate)
- int **commGetInfo** (**comm_settings** ∗comm_settings_t, int id, short int info_type, char ∗info)
- int **commBootloader** (**comm_settings** ∗comm_settings_t, int id)
- int **commCalibrate** (**comm_settings** ∗comm_settings_t, int id)
- int **commHandCalibrate** (**comm_settings** ∗comm_settings_t, int id, short int speed, short int repetitions)

qbAPI Parameters

- int **commSetZeros** (**comm_settings** ∗comm_settings_t, int id, void ∗values, unsigned short num_of_↩ values)
- int **commGetParamList** (**comm_settings** ∗comm_settings_t, int id, unsigned short index, void ∗values, unsigned short value_size, unsigned short num_of_values, uint8_t ∗buffer)
- int **commStoreParams** (**comm_settings** ∗comm_settings_t, int id)
- int **commStoreDefaultParams** (**comm_settings** ∗comm_settings_t, int id)
- int **commRestoreParams** (**comm_settings** ∗comm_settings_t, int id)
- int **commInitMem** (**comm_settings** ∗comm_settings_t, int id)

General Functions

- long **timevaldiff** (struct timeval ∗starttime, struct timeval ∗finishtime)
- char **checksum** (char ∗data_buffer, int data_length)

Functions for other devices

- int **commExtDrive** (**comm_settings** ∗comm_settings_t, int id, char ext_input)
- void **commSetCuffInputs** (**comm_settings** ∗comm_settings_t, int id, int flag)
- int **commGetJoystick** (**comm_settings** ∗comm_settings_t, int id, short int joystick[2])

5.3.1 Detailed Description

Library of functions for SERIAL PORT communication with a board. Function Prototypes.

Date

October 01, 2017

Author

Centro "E.Piaggio"

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This library contains all necessary functions for communicating with a board when using a USB to RS485 connector that provides a Virtual COM interface.

5.3.2 Function Documentation

5.3.2.1 checksum()

```
char checksum (
             char * data_buffer,
             int data_length )
```

This functions returns an 8 bit LCR checksum over the lenght of a buffer.

Parameters

data_buffer	Buffer.
data_length	Buffer length.

Example

```
char    aux;
char    buffer[5];

buffer  = "abcde";
aux     = checksum(buffer,5);
printf("Checksum: %d", (int) aux)
```

5.3.2.2 closeRS485()

```
void closeRS485 (
              comm_settings * comm_settings_t )
```

This function is used to close a serial port being used with the qbMove or an qbHand.

Parameters

comm_↩ settings_t	A ***comm_settings*** *(p. 7)* structure containing info about the communication settings.

Example

```
comm_settings   comm_settings_t;

openRS485(&comm_settings_t,"/dev/tty.usbserial-128");
closeRS485(&comm_settings_t);
```

5.3.2.3 commActivate()

```
void commActivate (
              comm_settings * comm_settings_t,
             int id,
             char activate )
```

This function activates or deactivates a qbMove or a qbHand connected to the serial port.

Parameters

comm_↩ settings_t	A ***comm_settings*** *(p. 7)* structure containing info about the communication settings.
id	The device's id number.
activate	TRUE to turn motors on. FALSE to turn motors off.

Example

```
comm_settings   comm_settings_t;
int             device_id = 65;

openRS485(&comm_settings_t,"/dev/tty.usbserial-128");
commActivate(&comm_settings_t, device_id, TRUE);
closeRS485(&comm_settings_t);
```

5.3.2.4 commBootloader()

```
int commBootloader (
              comm_settings * comm_settings_t,
             int id )
```

This function sends the board in bootloader modality in order to update the firmware on the board

Parameters

comm_↩ settings_t	A ***comm_settings*** *(p. 7)* structure containing info about the communication settings.
id	The device's id number.

Returns

Return 0 on success, -1 otherwise

Example

```
comm_settings comm_settings_t;
int     device_id = 65;

openRS485(&comm_settings_t,"/dev/tty.usbserial-128");
commBootloader(&comm_settings_t, device_id);
closeRS485(&comm_settings_t);
```

5.3.2.5 commCalibrate()

```
int commCalibrate (
              comm_settings * comm_settings_t,
             int id )
```

This function is used to calibrate the maximum stiffness value of the qbMove

Parameters

comm_↩ settings_t	A ***comm_settings*** *(p. 7)* structure containing info about the communication settings.
id	The device's id number.

Returns

Returns 0 on success, -1 otherwise

Example

```
comm_settings comm_settings_t;
int     device_id = 65;

openRS485(&comm_settings_t,"/dev/tty.usbserial-128");
commCalibrate(&comm_settings_t, device_id);
closeRS485(&comm_settings_t);
```

5.3.2.6 commExtDrive()

```
int commExtDrive (
              comm_settings * comm_settings_t,
             int id,
             char ext_input )
```

This function is used with the armslider device. Is used to drive another board with the inputs of the first one

Parameters

comm_↩ settings_t	A ***comm_settings*** *(p. 7)* structure containing info about the comunication settings.
id	The id of the board drive.
ext_input	A flag used to activate the external drive functionality of the board.

Returns

A negative value if something went wrong, a zero if everything went fine.

5.3.2.7 commGetAccelerations()

```
int commGetAccelerations (
              comm_settings * comm_settings_t,
             int id,
             short int measurements[] )
```

This function gets the acceleration of the qbHand motor

Parameters

comm_↩ settings_t	A ***comm_settings*** *(p. 7)* structure containing info about the communication settings.
id	The device's id number.
measurements	Velocity measurements.

Returns

Returns 0 if communication was ok, -1 otherwise.

Example

```
comm_settings    comm_settings_t;
int              device_id = 65;
short int        acc_measurements[3];

openRS485(&comm_settings_t,"/dev/tty.usbserial-128");

if(!commGetAccelerations(&comm_settings_t, device_id, acc_measurements))
    printf("Measurements: %d\t%d\t%d\n", acc_measurements[0], acc_measurements[1], acc_measurements[2]);
else
    puts("Couldn't retrieve accelerations.");

closeRS485(&comm_settings_t);
```

5.3.2.8 commGetActivate()

```
int commGetActivate (
              comm_settings * comm_settings_t,
             int id,
             char * activate )
```

This function gets the activation status of a qbMove or a qbHand connected to the serial port.

Parameters

comm_↩ settings_t	A ***comm_settings*** *(p. 7)* structure containing info about the communication settings.
id	The device's id number.
activation	Activation status.

Returns

Returns 0 if communication was ok, -1 otherwise.

Example

```
comm_settings comm_settings_t;
int      device_id = 65;
char     activation_status;

openRS485(&comm_settings_t,"/dev/tty.usbserial-128");

if(!commGetActivate(&comm_settings_t, DEVICE_ID, activation_status))
    printf("Activation status: %d\n", &activation_status);
else
    puts("Couldn't retrieve activation status.");

closeRS485(&comm_settings_t);
```

5.3.2.9 commGetCounters()

```
int commGetCounters (
               comm_settings * comm_settings_t,
              int id,
              short unsigned int counters[20] )
```

This function gets counters values from a qbMove connected to the serial port.

Parameters

comm_↩ settings_t	A ***comm_settings*** *(p. 7)* structure containing info about the communication settings.
id	The device's id number.
counters	Counters

Returns

Returns 0 if communication was ok, -1 otherwise.

Example

```
comm_settings        comm_settings_t;
int                  device_id = 65;
short unsigned int   counters[20];

openRS485(&comm_settings_t,"/dev/tty.usbserial-128");

if(!commGetCounters(&comm_settings_t, DEVICE_ID, counters))
    printf("Counters: %d\t%d\t {...} %d\n", counters[0], counters[1], {...}, counters[20]);
else
    puts("Couldn't retrieve counters.");

closeRS485(&comm_settings_t);
```

5.3.2.10 commGetCurrAndMeas()

```
int commGetCurrAndMeas (
              comm_settings * comm_settings_t,
              int id,
              short int * values )
```

This function gets currents and position measurements from a qbMove or a qbHand connected to the serial port

Parameters

comm_↩ settings_t	A ***comm_settings*** *(p. 7)* structure containing info about the communication settings.
id	The device's id number.
values	Current and position measurements. Currents are in first two positions

Returns

Returns 0 if communication was ok, -1 otherwise.

Example

```
    comm_settings    comm_settings_t;
    int              device_id = 65;
    short int        values[5];

    openRS485(&comm_settings_t,"/dev/tty.usbserial-128");

     if(!commGetCurrAndMeas(&comm_settings_t, device_id, currents)){
         printf("Currents: %d\t%d\t%d\n",values[0], values[1]);
         printf("Measurements: %d\t%d\t%d\n", values[2], values[3], values[4]);
     }
     else
         puts("Couldn't retrieve currents.");

    closeRS485(&comm_settings_t);
```

5.3.2.11 commGetCurrents()

```
int commGetCurrents (
              comm_settings * comm_settings_t,
              int id,
              short int currents[2] )
```

This function gets currents from a qbMove or a qbHand connected to the serial port.

Parameters

comm_↩ settings_t	A ***comm_settings*** *(p. 7)* structure containing info about the communication settings.
id	The device's id number.
currents	Currents.

Returns

Returns 0 if communication was ok, -1 otherwise.

Example

```
comm_settings    comm_settings_t;
int              device_id = 65;
short int        currents[2];

openRS485(&comm_settings_t,"/dev/tty.usbserial-128");

if(!commGetCurrents(&comm_settings_t, device_id, currents))
    printf("Measurements: %d\t%d\t%d\n",currents[0], currents[1]);
else
    puts("Couldn't retrieve currents.");

closeRS485(&comm_settings_t);
```

5.3.2.12 commGetEmg()

```
int commGetEmg (
               comm_settings * comm_settings_t,
              int id,
              short int emg[2] )
```

This function gets measurements from electomyographics sensors connected to the qbHand. IS USED ONLY W↩ HEN THE BOARD IS USED FOR A QBHAND

Parameters

comm_↩ settings_t	A ***comm_settings*** *(p. 7)* structure containing info about the communication settings.
id	The device's id number.
values	Emg sensors measurements.

Returns

Returns 0 if communication was ok, -1 otherwise.

Example

```
comm_settings    comm_settings_t;
int              device_id = 65;
short int        values[2];

openRS485(&comm_settings_t,"/dev/tty.usbserial-128");
```

```
    if(!commGetEmg(&comm_settings_t, device_id, values));
        printf("Measurements: %d\t%d\t%d\n", values[0], values[1]);
    else
        puts("Couldn't retrieve emg values.");

    closeRS485(&comm_settings_t);
```

5.3.2.13 commGetInfo()

```
int commGetInfo (
                comm_settings * comm_settings_t,
                int id,
                short int info_type,
                char * info )
```

This function is used to ping the qbMove or the qbHand and get information about the device.

Parameters

comm_↩ settings_t	A ***comm_settings*** *(p. 7)* structure containing info about the communication settings.
id	The device's id number.
buffer	Buffer that stores a string with information about the device. BUFFER SIZE MUST BE AT LEAST 500.
info_type	Information to be retrieved.

Example

```
    comm_settings comm_settings_t;
    char    auxstring[500];
    int     device_id = 65;

    openRS485(&comm_settings_t,"/dev/tty.usbserial-128");
    commGetInfo(&comm_settings_t, device_id, INFO_ALL, auxstring);
    puts(auxstring);
    closeRS485(&comm_settings_t);
```

5.3.2.14 commGetInputs()

```
int commGetInputs (
                comm_settings * comm_settings_t,
                int id,
                short int inputs[2] )
```

This function gets input references from a qbMove or a qbHand connected to the serial port.

Parameters

comm_↩ settings_t	A ***comm_settings*** *(p. 7)* structure containing info about the communication settings.
id	The device's id number.
inputs	Input references.

Returns

Returns 0 if communication was ok, -1 otherwise.

Example

```
comm_settings   comm_settings_t;
int             device_id = 65;
short int       inputs[2];

openRS485(&comm_settings_t,"/dev/tty.usbserial-128");

if(!commGetInputs(&comm_settings_t, DEVICE_ID, inputs))
    printf("Inputs: %d\t%d\n",inputs[0], inputs[1]);
else
    puts("Couldn't retrieve device inputs.");

closeRS485(&comm_settings_t);
```

5.3.2.15 commGetJoystick()

```
int commGetJoystick (
                comm_settings * comm_settings_t,
               int id,
               short int joystick[2] )
```

This function gets joystick measurementes from a softhand connected to the serial port.

Parameters

comm_↩ settings_t	A ***comm_settings*** *(p. 7)* structure containing info about the communication settings.
id	The device's id number.
joystick	Joystick analog measurements.

Returns

Returns 0 if communication was ok, -1 otherwise.

Example

```
comm_settings    comm_settings_t;
int              device_id = 65;
short int        joystick[2];

openRS485(&comm_settings_t,"/dev/tty.usbserial-128");

if(!commGetJoystick(&comm_settings_t, device_id, joystick))
    printf("Measurements: %d\t%d\t%d\n",joystick[0], joystick[1]);
else
    puts("Couldn't retrieve joystick measurements.");

closeRS485(&comm_settings_t);
```

5.3.2.16 commGetMeasurements()

```
int commGetMeasurements (
              comm_settings * comm_settings_t,
             int id,
             short int measurements[3] )
```

This function gets position measurements from a qbMove or a qbHand connected to the serial port.

Parameters

comm_↩ settings_t	A ***comm_settings*** *(*p. *7)* structure containing info about the communication settings.
id	The device's id number.
measurements	Measurements.

Returns

Returns 0 if communication was ok, -1 otherwise.

Example

```
    comm_settings   comm_settings_t;
    int             device_id = 65;
    short int       measurements[3];

    openRS485(&comm_settings_t,"/dev/tty.usbserial-128");

    if(!commGetMeasurements(&comm_settings_t, DEVICE_ID, measurements))
        printf("Measurements: %d\t%d\t%d\n",measurements[0], measurements[1], measurements[2]);
    else
        puts("Couldn't retrieve measurements.");

    closeRS485(&comm_settings_t);
```

5.3.2.17 commGetParamList()

```
int commGetParamList (
              comm_settings * comm_settings_t,
             int id,
             unsigned short index,
             void * values,
             unsigned short value_size,
             unsigned short num_of_values,
             uint8_t * buffer )
```

This function gets all the parameters that are stored in the qbMove or qbHand memory and sets one of them if requested

Parameters

comm_↩ settings_t	A ***comm_settings*** *(*p. *7)* structure containing info about the communication settings.
id	The device's id number.
index	The index relative to the parameter to be get.
values	An array with the parameter values.
value_size	The byte size of the parameter to be get
num_of_values	The size of the array of the parameter to be get
buffer	The array where the parameters' values and descriptions are saved

Example

```
comm_settings   comm_settings_t;
int             device_id = 65;
unsigned char   aux_string[2000];
int             index = 0;
int             value_size = 0;
int             num_of_values = 0;

// Get parameters
commGetParamList(&comm_settings_t, device_id, index, NULL, value_size, num_of_values, aux_string);
string_unpacking_and_printing(aux_string);

// Set parameters

float           pid[3];
pid[0] = 0.1;
pid[1] = 0.2;
pid[2] = 0.3;
index = 2;
value_size = 4;
num_of_values = 3;
commGetParamList(&comm_settings_t, device_id, index, pid, value_size, num_of_values, NULL);
```

5.3.2.18 commGetVelocities()

```
int commGetVelocities (
              comm_settings * comm_settings_t,
              int id,
              short int measurements[ ] )
```

This function gets velocities of the two motors and the shaft from a qbMove connected to a serial port or from the only shaft of the qbHand

Parameters

comm_↩ settings_t	A ***comm_settings*** *(p. 7)* structure containing info about the communication settings.
id	The device's id number.
measurements	Velocity measurements.

Returns

Returns 0 if communication was ok, -1 otherwise.

Example

```
comm_settings    comm_settings_t;
int              device_id = 65;
short int        vel_measurements[3];

openRS485(&comm_settings_t,"/dev/tty.usbserial-128");

if(!commGetVelocities(&comm_settings_t, device_id, vel_measurements))
    printf("Measurements: %d\t%d\t%d\n", vel_measurements[0], vel_measurements[1], vel_measurements[2]);
else
    puts("Couldn't retrieve velocities.");

closeRS485(&comm_settings_t);
```

5.3.2.19 commHandCalibrate()

```
int commHandCalibrate (
            comm_settings * comm_settings_t,
            int id,
            short int speed,
            short int repetitions )
```

This function is used to make a series of opening and closures of the qbHand

Parameters

comm_↩ settings_t	A ***comm_settings*** *(*p. *7)* structure containing info about the communication settings.
id	The device's id number.
speed	The speed of hand closure and opening [0 - 200]
repetitions	The nnumber of closures needed to be done [0 - 32767]

Example

```
comm_settings comm_settings_t;
int     speed = 200
int     repetitions = 400;
int     device_id = 65;

openRS485(&comm_settings_t,"/dev/tty.usbserial-128");
commHandCalibrate(&comm_settings_t, device_id, speed, repetitions);
closeRS485(&comm_settings_t);
```

5.3.2.20 commInitMem()

```
int commInitMem (
            comm_settings * comm_settings_t,
            int id )
```

This function initialize the EEPROM memory of the board by loading the default factory parameters. After the initialization a flag is set.

Parameters

comm_↩ settings_t	A ***comm_settings*** *(*p. *7)* structure containing info about the communication settings.
id	The device's id number.

Example

```
comm_settings comm_settings_t;
int     device_id = 65;

openRS485(&comm_settings_t,"/dev/tty.usbserial-128");

commInitMem(&comm_settings_t, device_id)

closeRS485(&comm_settings_t);
```

5.3.2.21 commPing()

```
int commPing (
              comm_settings * comm_settings_t,
             int id )
```

This function is used to ping the qbMove or the qbHand.

Parameters

comm_↩ settings_t	A ***comm_settings*** *(p. 7)* structure containing info about the communication settings.
id	The device's id number.
buffer	Buffer that stores a string with information about the device. BUFFER SIZE MUST BE AT LEAST 500.

Returns

Returns 0 if ping was ok, -1 otherwise.

Example

```
comm_settings   comm_settings_t;
int             device_id = 65;

openRS485(&comm_settings_t,"/dev/tty.usbserial-128");
if ( commPing(&comm_settings_t, device_id) )
    puts("Device exists.");
else
    puts("Device does not exist.");

closeRS485(&comm_settings_t);
```

5.3.2.22 commRestoreParams()

```
int commRestoreParams (
              comm_settings * comm_settings_t,
             int id )
```

This function restores the factory default parameters.

Parameters

comm_↩ settings_t	A ***comm_settings*** *(p. 7)* structure containing info about the communication settings.
id	The device's id number.

Example

```
comm_settings comm_settings_t;
```

```
int     device_id = 65;

openRS485(&comm_settings_t,"/dev/tty.usbserial-128");

commRestoreParams(&comm_settings_t, device_id)

closeRS485(&comm_settings_t);
```

5.3.2.23 commSetBaudRate()

```
void commSetBaudRate (
               comm_settings * comm_settings_t,
              int id,
              short int baudrate )
```

This function sets the baudrate of communication.

Parameters

comm_↩ settings_t	A ***comm_settings*** *(p. 7)* structure containing info about the communication settings.
id	The device's id number.
baudrate	BaudRate requested 0 = 2M baudrate, 1 = 460.8k baudrate

Example

```
comm_settings   comm_settings_t;
int             device_id = 65;
short int       baudrate = 0;

openRS485(&comm_settings_t,"/dev/tty.usbserial-128");
commSetBaudRate(&comm_settings_t, global_args.device_id, baudrate);
closeRS485(&comm_settings_t);
```

5.3.2.24 commSetCuffInputs()

```
void commSetCuffInputs (
               comm_settings * comm_settings_t,
              int id,
              int flag )
```

This function send reference inputs to a qbMove board connected to the serial port. Is used only when the device is a Cuff.

Parameters

comm_↩ settings_t	A ***comm_settings*** *(p. 7)* structure containing info about the communication settings.
id	The device's id number.
flag	A flag that indicates used to activate the cuff driving functionality of the board.

Example

```
comm_settings   comm_settings_t;
int             device_id = 65;
short int       cuff_inputs[2];

openRS485(&comm_settings_t,"/dev/tty.usbserial-128");

int flag = 1;
commSetCuffInputs(&comm_settings_t, device_id, flag);
closeRS485(&comm_settings_t);
```

5.3.2.25 commSetInputs()

```
void commSetInputs (
              comm_settings * comm_settings_t,
             int id,
             short int inputs[] )
```

This function send reference inputs to a qbMove or a qbHand connected to the serial port.

Parameters

comm_↩ settings_t	A ***comm_settings*** *(*p. *7)* structure containing info about the communication settings.
id	The device's id number.
inputs	Input references.

Example

```
comm_settings   comm_settings_t;
int             device_id = 65;
short int       inputs[2];

openRS485(&comm_settings_t,"/dev/tty.usbserial-128");

inputs[0]   = 1000;
inputs[1]   = -1000;
commSetInputs(&comm_settings_t, device_id, inputs);
closeRS485(&comm_settings_t);
```

5.3.2.26 commSetPosStiff()

```
void commSetPosStiff (
              comm_settings * comm_settings_t,
             int id,
             short int inputs[] )
```

This function send reference inputs to a qbMove connected to the serial port. The reference is in shaft position and stiffness preset. IS VALID ONLY WHEN USED FOR THE qbMove, NOT FOR THE qbHand

Parameters

comm_↩ settings_t	A ***comm_settings*** *(p. 7)* structure containing info about the communication settings.
id	The device's id number.
inputs	Input references.

Example

```
comm_settings   comm_settings_t;
int             device_id = 65;
short int       inputs[2];

openRS485(&comm_settings_t,"/dev/tty.usbserial-128");

inputs[0]   = 100;          //Degrees
inputs[1]   = 30;           //stiffness preset
commSetPosStiff(&comm_settings_t, device_id, inputs);
closeRS485(&comm_settings_t);
```

5.3.2.27 commSetWatchDog()

```
void commSetWatchDog (
               comm_settings * comm_settings_t,
              int id,
              short int wdt )
```

This function sets watchdog timer of a qbMove or a qbHand.

Parameters

comm_↩ settings_t	A ***comm_settings*** *(p. 7)* structure containing info about the communication settings.
id	The device's id number.
wdt	Watchdog timer in [csec], max value: 500 [cs] / min value: 0 (disable) [cs]

Example

```
comm_settings   comm_settings_t;
int             device_id = 65;
short int       wdt = 60;

openRS485(&comm_settings_t,"/dev/tty.usbserial-128);
commSetWatchDog(&comm_settings_t, global_args.device_id, wdt);
closeRS485(&comm_settings_t);
```

5.3.2.28 commSetZeros()

```
int commSetZeros (
               comm_settings * comm_settings_t,
int id,
void * values,
unsigned short num_of_values )
```

This function sets the encoders's zero positon value that remains stored in the qbMove or qbHand memory.

Parameters

comm_↩ settings_t	A ***comm_settings*** *(p. 7)* structure containing info about the communication settings.
id	The device's id number.
value	An array with the encoder readings values.
num_of_values	The size of the values array, equal to the sensor number.

Example

```
comm_settings   comm_settings_t;
int             device_id = 65;
short int       measurements[3];


openRS485(&comm_settings_t,"/dev/tty.usbserial-128");
commGetMeasurements(comm_settings_t, device_id, measurements)
for(i = 0; i<3; i++)
    measurements[i] = -measurements[i];
commSetZeros(&comm_settings_t, global_args.device_id, measurements, 3);
closeRS485(&comm_settings_t);
```

5.3.2.29 commStoreDefaultParams()

```
int commStoreDefaultParams (
             comm_settings * comm_settings_t,
             int id )
```

This function stores the factory default parameters.

Parameters

comm_↩ settings_t	A ***comm_settings*** *(p. 7)* structure containing info about the communication settings.
id	The device's id number.

Example

```
comm_settings comm_settings_t;
int      device_id = 65;

openRS485(&comm_settings_t,"/dev/tty.usbserial-128");
commStoreDefaultParams(&comm_settings_t, device_id)
closeRS485(&comm_settings_t);
```

5.3.2.30 commStoreParams()

```
int commStoreParams (
              comm_settings * comm_settings_t,
              int id )
```

This function stores all parameters that were set in the qbMove or the qbHand memory.

Parameters

comm_↩ settings_t	A ***comm_settings*** *(p. 7)* structure containing info about the communication settings.
id	The device's id number.

Example

```
comm_settings comm_settings_t;
int     device_id = 65;

openRS485(&comm_settings_t,"/dev/tty.usbserial-128");

commStoreParams(&comm_settings_t, device_id)

closeRS485(&comm_settings_t);
```

5.3.2.31 openRS485()

```
void openRS485 (
              comm_settings * comm_settings_t,
              const char * port_s,
              int BAUD_RATE = B2000000 )
```

This function is used to open a serial port for using with the qbMove or the qbHand.

Parameters

comm_settings *(p. 7)*	A ***comm_settings*** *(p. 7)* structure containing info about the communication settings.
port_s	The string to the serial port path.
BAUD_RATE	The default baud rate value of the serial port

Returns

Returns the file descriptor associated to the serial port.

Example

```
comm_settings   comm_settings_t;

openRS485(&comm_settings_t,"/dev/tty.usbserial-128");
if(comm_settings_t.file_handle == INVALID_HANDLE_VALUE)
{
// ERROR
}
```

5.3.2.32 RS485GetInfo()

```
void RS485GetInfo (
              comm_settings * comm_settings_t,
             char * buffer )
```

This function is used to ping the serial port for a qbMove or a qbHand and to get information about the device. ONLY USE WHEN ONE DEVICE IS CONNECTED ONLY.

Parameters

comm_↩ settings_t	A ***comm_settings*** *(*p. *7)* structure containing info about the communication settings.
buffer	Buffer that stores a string with information about the device. BUFFER SIZE MUST BE AT LEAST 500.

Example

```
comm_settings    comm_settings_t;
char             auxstring[500];

openRS485(&comm_settings_t,"/dev/tty.usbserial-128");
RS485GetInfo(&comm_settings_t, auxstring);
puts(auxstring);
closeRS485(&comm_settings_t);
```

5.3.2.33 RS485ListDevices()

```
int RS485ListDevices (
              comm_settings * comm_settings_t,
             char list_of_ids[255] )
```

This function is used to list the number of devices connected to the serial port and get their relative IDs

Parameters

comm_↩ settings_t	A ***comm_settings*** *(*p. *7)* structure containing info about the communication settings.
list_of_ids[255]	Buffer that stores a list of IDs to ping, in order to see which of those IDs is connected. Is then filled with the IDs connected to the serial port.

Returns

Returns the number of devices connected

Example

```
comm_settings   comm_settings_t;
int             device_id = 65;
int             device_num;
char            list_of_ids[255];

openRS485(&comm_settings_t, device_id);
device_num = RS485ListDevices(&comm_settings_t, &list_of_ids);
closeRS485(&comm_settings_t);
printf("Number of devices connected: %d", i);
```

5.3.2.34 RS485listPorts()

```
int RS485listPorts (
            char list_of_ports[10][255] )
```

This function is used to return a list of available serial ports. A maximum of 10 ports are found.

Parameters

list_of_ports	An array of strings with the serial ports paths.

Returns

Returns the number of serial ports found.

Example

```
int     i, num_ports;
char    list_of_ports[10][255];

num_ports = RS485listPorts(ports);

for(i = 0; i < num_ports; ++i)
{
    puts(ports[i]);
}
```

5.3.2.35 RS485read()

```
int RS485read (
            comm_settings * comm_settings_t,
            int id,
            char * package )
```

This function is used to read a package from the device.

Parameters

comm_↩ settings_t	A ***comm_settings*** *(*p. *7)* structure containing info about the communication settings.
id	The device's id number.
package	Package will be stored here.

Returns

Returns package length if communication was ok, -1 otherwise.

Example

```
comm_settings   comm_settings_t;
```

```
    int             device_id = 65;
    char            data_read[1000];

    openRS485(&comm_settings_t, "/dev/tty.usbserial-128");
    commPing(&comm_settings_t, device_id);
    RS485read(&comm_settings_t, device_id, data_read);
    closeRS485(&comm_settings_t);

    printf(data_read);
```

5.3.2.36 timevaldiff()

```
long timevaldiff (
            struct timeval * starttime,
            struct timeval * finishtime )
```

This functions returns a difference between two timeval structures in order to obtain time elapsed between the two timeval;

Parameters

starttime	The timeval structure containing the start time
finishtime	The timeval structure containing the finish time

Returns

Returns the elapsed time between the two timeval structures.

Example

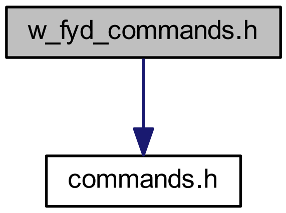
```
    struct timeval start, finish;
    gettimeofday(&start, NULL);
    // other instructions
    gettimeofday(&now, NULL);
    long diff = timevaldiff(&start, &now);

    printf(Time elapsed: %ld, diff);
```

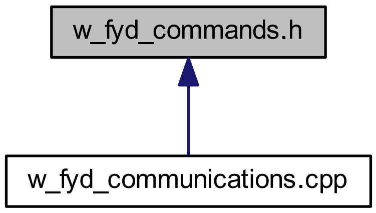
5.4 w_fyd_commands.h File Reference

Definitions for W-FYD commands, parameters and packages.

`#include "commands.h"`
Include dependency graph for w_fyd_commands.h:



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



Macros

- #define **API_VERSION** "v6.1.0 mod. W-FYD"

Enumerations

W-FYD Commands

- enum **w_fyd_command** {
  CMD_GET_IR = 147, **CMD_SET_SERVO** = 148, **CMD_GET_SERVO** = 149, **CMD_GET_FORCE** = 150,
  CMD_GET_DUTY_CY_MAX = 151 }

W-FYD Parameters

- enum **w_fyd_parameter** {
  PARAM_POWER_TENSION = 27, **PARAM_PULSE_MODALITY** = 28, **PARAM_SUP_PRESSURE_↩
  BOUND** = 29, **PARAM_INF_PRESSURE_BOUND** = 30,
  PARAM_PULSE_FREQ = 31 }

5.4.1 Detailed Description

Definitions for W-FYD commands, parameters and packages.

This file is included in the W-FYD firmware, in its libraries and applications. It contains all definitions that are necessary for the contruction of communication packages.

It includes definitions for all of the device commands, parameters and also the size of answer packages.

5.4.2 Enumeration Type Documentation

5.4.2.1 w_fyd_command

```
enum w_fyd_command
```

Enumerator

CMD_GET_IR	Command for asking ir readings (W-FYD)
CMD_SET_SERVO	Command for setting servo position (W-FYD)
CMD_GET_SERVO	Command for asking servo position (W-FYD)
CMD_GET_FORCE	Command for asking force measures (W-FYD)
CMD_GET_DUTY_CY_MAX	Command for setting the max dc (W-FYD)

5.4.2.2 w_fyd_parameter

```
enum w_fyd_parameter
```

Enumerator

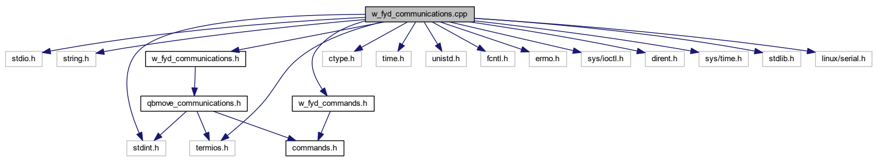
PARAM_POWER_TENSION	Device power tension.
PARAM_PULSE_MODALITY	Pulse modality byte (W-FYD)
PARAM_SUP_PRESSURE_BOUND	Systolic pressure value setting (W-FYD)
PARAM_INF_PRESSURE_BOUND	Diastolic pressure value setting (W-FYD)
PARAM_PULSE_FREQ	Pulse frequency setting (W-FYD)

5.5 w_fyd_communications.cpp File Reference

Library of functions for serial port communication with W-FYD.

```
#include <stdio.h>
#include <string.h>
```

```
#include <stdint.h>
#include <ctype.h>
#include <time.h>
#include <unistd.h>
#include <fcntl.h>
#include <errno.h>
#include <termios.h>
#include <sys/ioctl.h>
#include <dirent.h>
#include <sys/time.h>
#include <stdlib.h>
#include <linux/serial.h>
#include "w_fyd_communications.h"
#include "w_fyd_commands.h"
```
Include dependency graph for w_fyd_communications.cpp:



Macros

- #define **BUFFER_SIZE** 500

  Size of buffers that store communication packets.

5.5.1 Detailed Description

Library of functions for serial port communication with W-FYD.

Date

October 01, 2017

Author

Centro "E.Piaggio"

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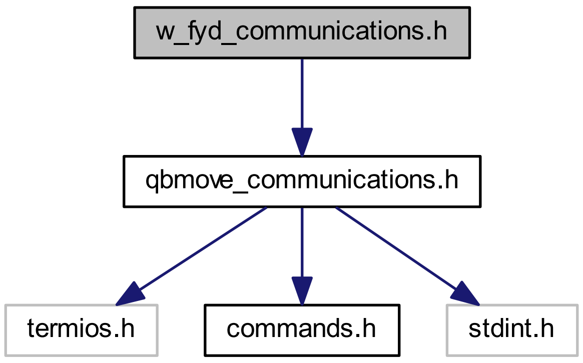
Check the **w_fyd_communications.h** (p. 43) file for a complete description of the public functions implemented in **w_fyd_communications.cpp** (p. 41).

5.6 w_fyd_communications.h File Reference

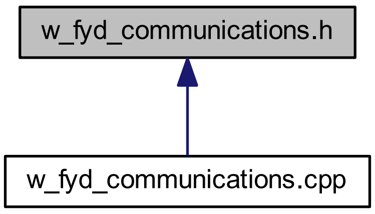
Library of functions for SERIAL PORT communication with WFYD. Function Prototypes.

```
#include "qbmove_communications.h"
```

Include dependency graph for w_fyd_communications.h:



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



Functions

- int **commGetIR** (**comm_settings** ∗comm_settings_t, int id, short int measurements[1])
- void **commSetServo** (**comm_settings** ∗comm_settings_t, int id, short int inputs[1])
- int **commGetServo** (**comm_settings** ∗comm_settings_t, int id, short int measurements[1])
- int **commGetForce** (**comm_settings** ∗comm_settings_t, int id, short int measurements[1])
- int **commGetDCyM** (**comm_settings** ∗comm_settings_t, int id, short int measurements[1])

5.6.1 Detailed Description

Library of functions for SERIAL PORT communication with WFYD. Function Prototypes.

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Author

Centro "E.Piaggio"

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This library contains all necessary functions for communicating with WFYD when using a USB to RS485 connector that provides a Virtual COM interface.

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