Network API

1.0

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Contents

Chapter 1

Introduction

A communication protocol for the Field-Oriented Control system is described.

1.1 Protocol

The protocol is based on Websockets. The server is listening on the same port as the web server. The sub-protocol is "field-oriented-control"; this must be specified when opening the connection, otherwise the server will not respond or might close the connection prematurely.

The commands and replies are plain text Websockets messages. Every command receives a corresponding reply. Error responses are distinguished by the prefix "ERROR" in the response.

Binary Websockets messages are used in one case only to transfer the results of data capture.

1.1.1 General form

Command:

```
COMMAND [ARG1 [ARG2 ...]]
```

where the arguments are optional.

Response is a copy of the command unless otherwise mentioned:

```
COMMAND [ARG1 [ARG2 ...]]
```

1.1.2 Configuration query

Command to query configuration:

```
Configuration?
```

Response:

```
Configuration { "field1":value1, ... }
```

The response contains a configuration object in the JSON format; see the Table 1.1.

Table 1.1 Configuration object fields

Name	Type	Description
design	string	One of "SDSoC" or "HLS"
focserver	string	Version string of the program "focserver"
samplerate	integer	Sample rate of the data capture IP core
testmode	boolean	Whether the server has test flag set with the *-t* command-line option
ppr	integer	Number of encoder pulses per revolution.
adc2A	float	Conversion factor from ADC samples to current in amperes.
pwm2V	float	Conversion factor from PWM duty cycle to voltage in volts.

Example configuration in the form of a JSON object:

```
{
    "adc2A":0.0003899999999999999,
    "design":"HLS",
    "focserver":"2017-07-31",
    "ppr":1000,
    "pwm2V":0.0003662000000000001,
    "samplerate":78125,
    "testmode":false
}
```

1.1.3 Registers

The parameter registers are listed in the table 1.2. The status registers, which are read-only, are listed in the table 1.3. The pseudo registers, which exist only in the Network API, are listed in the table 1.4.

Command to query a register:

```
REGISTER?
```

Response:

```
REGISTER VALUE
```

Syntax of the command to set a variable value:

```
REGISTER VALUE
```

Response:

```
REGISTER VALUE
```

Table 1.2 Parameter registers

Index	Macro name	Name	Type	Description
0	CONTROL_REG	Control	Integer	Control register
1	FLUX_SP_REG	FluxSp	Integer	Flux setpoint. Unit: Resolution of the current ADC-s.
2	FLUX_KP_REG	FluxKp	Integer	Flux PI loop proportional factor.
3	FLUX_KI_REG	FluxKi	Integer	Flux PI loop integral factor.
4	TORQUE_SP_REG	TorqueSp	Integer	Torque setpoint

Index	Macro name	Name	Type	Description
5	TORQUE_KP_REG	TorqueKp	Integer	Torque PI loop proportional factor.
6	TORQUE_KI_REG	TorqueKi	Integer	Torque PI loop integral factor
7	RPM_SP_REG	RPMSp	Integer	Speed setpoint, in RPM
8	RPM_KP_REG	RPMKp	Integer	Speed PI loop proportional factor
9	RPM_KI_REG	RPMKi	Integer	Speed PI loop integral factor
10	ANGLE_SH_REG	Shift	Integer	Angle between the encoder zero and the stator zero, in encoder units.
11	VD_REG	Vd	Integer	Manually set V_d
12	VQ_REG	Vq	Integer	Manually set V_q
13	FA_REG	Fa	Integer	Filter coefficient A; Vivado SDSoC FOC project only
13	DECIMATE_REG	Decimate	Integer	Decimation factor for the data capture IP core; Vivado HLS FOC project only
14	FB_REG	Fb	Integer	Filter coefficient B; Vivado SDSoC FOC project only
14	TRIGGER	Trigger	Integer	Trigger data capture in the data capture IP core; Vivado HLS FOC project only
15	CONTROL2_REG	Control2	Integer	Second control register; see the user manual for FOC SDSoC for the description of the register `CONTROL2`

Table 1.3 Status registers

Index	Macro name	Name	Type	Description
0	ANGLE_REG	Angle	Integer	Angle position, in terms of encoder steps
1	RPM_REG	Speed	Integer	Speed, in RPM
2	ID_REG	Id	Integer	Stator flux
3	IQ_REG	Iq	Integer	Stator torque
N/A	N/A	LEDs	Bitmask	State of the LED-s `LD0` ... `LD3` on the ARTY-Z7 board

Table 1.4 Pseudo registers

Name	Type	Description
Mode	Integer	FOC operating mode bits in the register `CONTROL`
FixedDelay	Integer	Delay in the fixed speed mode in the register `CONTROL`

1.1.4 Miscellaneous commands

1.1.4.1 Motor

Query or set the operating mode of the FOC. When changing the operating mode to speed control or to torque control, the corresponding parameter register initialization as specified in the configuration file of the server is performed. This is required, because there are different torque control settings in the speed control mode and the torque control mode.

Command:

```
Motor MODE
```

where `MODE` is a number between 0 ... 6. The mode corresponds to the FOC operating mode; see the user manual for the FOC SDSoC for the list of modes available.

Response:

```
Motor MODE
```

1.1.4.2 Capture

Capture data from the given source and send it as a Websockets binary message. The text response will be sent immediately. The actual data capture takes some time, during which further capture commands will not be accepted. After completion of the capture, the data will be sent in a binary message. See the Table 1.5 for the structure of the message.

Command:

```
Capture SOURCE NSAMPLES DECIMATE
```

where

- `SOURCE` : one of "ADC", "IDIQ" or "VDVQ".
- `NSAMPLES` : Number of samples to be captured.
- `DECIMATE` : Number of samples to skip for every sample captured (a decimation factor), optional.

Response:

```
Capture SOURCE NSAMPLES DECIMATE
```

Table 1.5 Binary format of the data captured

Offset, bytes	Type	Name	Description
0..1	UInt16	nchannels	Number of channels
2..3	UInt16	nsamples	Number of samples captured
4..7	UInt32	sample_rate	Sample rate
8..31	string	name	Name of data source
32..nsamples∗nchannels∗2-1	Array of Int16	samples	Samples captured, in interleaved layout.

1.1.4.3 ResetError

Reset the FOC speed check error flag.

Command:

```
ResetError
```

Response:

```
ResetError
```

1.2 Tools used

For the documentation Doxygen is used. See the table 1.6 .

Table 1.6 Tools

Tool	Version	Notes
Doxygen	1.8.11	Documentation extraction
MiKTeX	2.9	PDF generation