Trilby Sample Firmware - API

Version 1.02

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Licensing Information

Introduction

This document describes the Application Programming Interface used in the Trilby HAT Sample Firmware. It assumes that the reader is familiar with the principles and terminology of computer communications and programming.

Control Interfaces

There are 3 interfaces for sending API commands to configure the I/O and the tuner, all using pins on the Raspberry Pi connector. For an example (using the **SPI interface) written in C see the source code for the ttune utility.**

SPI interface

Send a sequence of SPI bytes with CS0 = 0 to read or write a block of one or more consecutive registers.
Byte 0 = command (0x00 for register write, 0x01 for register read)
Byte 1 = high byte of register address to write or read (currently always 0x00)

Byte 2 = low byte of first register address to write or read
Byte 3 onwards = register data to write (data = don't care if reading)

I2C slave interface

The firmware will respond to an I2C slave address of 44 hex, i.e. the command/address byte is 0x88 for write and 0x89 for read.
To write one or more consecutive firmware registers, send the I2C address byte, then the first 2-byte register address (high byte then low byte), then one or more bytes of data. To read register(s), send the register address without any data, and then read one or more bytes.

Serial interface (UART)

This can be used for example with a PC and a USB serial cable (FTDI manufacture a suitable 3.3 volt cable). Configured for115.2 k Baud 8 bits no parity. The packet format is:
Byte 0 = DLE character (0x10)
Byte 1 = STX character (0x02)
Byte 2 = Packet type (Command) byte (0x90 for register write, 0x91 for register read)
Byte 3 = Sequence number or packet tag. This byte is included in the reply packet for identification.
Byte 4 = Low byte of first register address to be written or read
Byte 5 = High byte of first register address to be written or read (currently always 0x00)
Byte 6 = Low byte of number of bytes to be written or read
Byte 7 = High byte of number of bytes to be written or read (currently always 0x00)
Byte 8 = First data byte.
:
Byte 8+(n-1) = Last data byte
Byte n+8 = DLE character (0x10)
Byte n+9 = ETX character (0x03)
Byte n+10 = High byte of CRC
Byte n+11= Low byte of CRC
Notes:
N is the number of bytes of consecutive register data (1 to 255)
DLE stuffing is employed. Any DLE characters (0x10) present in bytes 2 to 8+(n-1) or in the CRC are sent doubled up, in other words the sequence DLE DLE is sent.
The CRC is based on the CCITT-16 polynomial and incudes bytes 2 through 8+(n-1). The CRC is calculated on the data prior to DLE stuffing.
A register read command (0x91) will elicit a reply packet of type 0x92 containing the register data in the data bytes.
A protocol error detected by the firmware will elicit a reply packet of type 0x20.

Firmware Internal Registers

The above control interfaces allow you to read and write control registers within the firmware. Here is a list of these registers:

Port Control Registers

Registers 0x00 to 0x05
Output pin level (1 for logic high, 0 for logic low). Bit 0 of register 0x00 corresponds to I/O pin 0, Bit 7 of register 0x05 is I/O bit 47. The register bits corresponding to input pins or pins configured for special function are ignored. These registers default to 0x00.

Registers 0x10 to 0x15
Data direction control bits for the 48 I/O pins (0 = output, 1 = input). This bit is ignored for pins configured for special function. These registers default to 0x00.

Registers 0x20 to 0x25
Function control bits for the 48 I/O pins (0 = special function of pin enabled, 1 = treat as general purpose I/O). If a bit is set to 0 the corresponding I/O bit becomes an input if it does not have an actual special function such as LED's, SPI, I2C or UART. These registers default to 0x00.

Registers 0x30 to 0x35
Read-only registers for reading back the input value of the I/O pins.

Tuning registers

Register 0x40
Control register.
Bit 0 is 1 for AM demodulation, 0 for FM and also by default controls the Yellow LED
Bit 1 is 1 for WFM, 0 for narrow band and also controls the Green LED,
Bit 2 is the antenna switch (0 for VHF/UHF antenna, 1 for HF antenna) and also controls the Orange LED.

Register 0xF0 to 0xF3
Tuner frequency in kHz (low byte first)

Register 0xF4
Tuner command. Having set the tuner frequency using the registers above, write 0xa0 to this register to initiate retuning.

Register 0xF4
Squelch value in dB – this is the RSSI value below which the audio is muted. Set to 0 for no squelch.

Register 0xF5
Mute – set bit 7 to 1 to mute the audio output.

Register 0xF8
Read only register – relative signal strength (RSSI) value in dB.
Register 0xF9

Read only register – total tuner AGC value in dB (higher number = less RF+IF gain).
Register 0xFA
Read only register – tuner RF AGC gain byte – see tuner data sheet.
Register 0xFB
Read only register – tuner IF AGC gain byte – see tuner data sheet.

Audio output registers

Allowing digital audio data to be read by the Raspberry Pi (audio is mono for the moment)

Register 0x50, 0x51- read only - n 16-bit PCM samples can be read using these addresses. The low byte is read from address 0x50 and then the high byte from address 0x51 (read 2*n bytes i.e. 24000 bytes for 0.25 seconds of audio at 48ksps)
As a special case, after reading from address 0x51 using SPI the address pointer is reset to 0x50 instead of auto-incrementing the address, so that many samples can be read in a single SPI operation.

Register 0x54 - read only reg - num samples available in buffer (low byte)
Register 0x55 - read only reg - num samples available in buffer (high byte)
Register 0x56 - sample speed - set this to 0x01 for 48ksps, 0x02 for 24ksps, 0x03 for 16 ksps
Register 0x57 - set to 0x80 to enable audio out

Version number registers

Register 0x60 and 0x61 - read only registers returning the major and minor version numbers of the firmware, for example 0x01, 0x02 for v1.02

List of Input/Output Pins

Bit	Description	Rpi header	Expansion Pin	FPGA Pin	Default Dir
0	Red LED			E18	Output
1	Yellow LED			F18	Output
2	Green LED			G16	Output
3	Orange LED			H16	Output
4	Tuner SDA			C7	Input
5	Tuner SCL			C6	Input
6	HF switch			D8	Output
7	(Spare)				Output
8	RTC I2C SDA	3		A3	Input
9	RTC I2C SCL	5		B3	Input

10	RTC INT	7		E2	Input
11	Serial RX	8		G3	Input
12	Serial TX	10		H3	Output
13		11		D5	Input
14		12		G5	Input
15	SPI MOSI	19		C3	Input
16	SPI MISO	21		D3	Output
17		22		E4	Input
18	SPI SCLK	23		F4	Input
19	SPI CS0	24		E1	Input
20	SPI CS1	26		D2	Input
21		29		E3	Input
22		31		E5	Input
23		32		D1	Input
24		33		F5	Input
25		35		A2	Input
26		36		C1	Input
27		37		B1	Input
28		38		C2	Input
29		40		B2	Input
30			3	E12	Input
31			4	H18	Input
32			5	A12	Input
33			6	H17	Input
34			7	A13	Input
35			8	J17	Input
36			9	B13	Input
37			10	J16	Input
38			11	C13	Input
39			12	E19	Input
40			13	D13	Input
41			14	E20	Input
42			15	E13	Input
43			16	F19	Input
44			17	A14	Input
45			18	F20	Input
46			19	C14	Input
47			21	D14	Input