TBS Unify Pro / SmartAudio

18.08.2016 – Revision 07

Description

SmartAudio uses single wire half duplex communication based on UART. In Idle mode both host and VTX define the SmartAudio pin as input. If the host want to talk to the VTX, he defines the SmartAudio pin as output and start sending a command. Once the command is sent the host defines the SmartAudio pin as input and the VTX will answer according to the received command. The VTX only sends data if requested by the host.

Table Of Content

SmartAudio Versions

TBS published V1 and V2 of SmartAudio. All the Unify Pro with 5V power supply run SmartAudio V1. SmartAudio V2 was introduced by Unify Pro HV together with PitMode, CleanSwitch.

Please see Unify Pro manual -> Specifications -> Extra features
http://www.team-blacksheep.com/tbs-unify-pro-5g8-manual.pdf

Hardware Interface

Software Serial Port: 4800bps 1 Start bit and 2 Stop bit
Voltage Level: Logic high 0.9-3.3V / Logic low 0V-0.5V

TBS Unify Pro MCUs uses internal clock. Due the high temperature changes during run-time and the software based uart the timing (baud rate) can change up to +/- 5%. As the Unify Pro will answer for any frame with a response this response can be used to verify if the Unify Pro successfully received the sent frame.
The SmartAudio line need to be low before a frame is sent. If the host MCU can't handle this it can be done by sending a 0x00 dummy byte in front of the actual frame.

Frame Structure

<Start code> <Commands> <Frame length> <Payload> <CRC>

Start Code: Two bytes sync and header (0xAA 0x55)
Commands: one byte
Data Length: one byte (total amount of bytes of Type, payload and CRC)
Payload: depending on Commands

For more details see Commands.

CRC

SmartAudio uses 8bit CRC. Used polynom is 0xD5. The CRC includes all bytes of the frame.

Code example:

```
/* CRC8 implementation with polynom = x^8+x^7+x^6+x^4+x^2+1 (0xD5) */
unsigned char crc8tab[256] = {
  0x00, 0xD5, 0x7F, 0xAA, 0xFE, 0x2B, 0x81, 0x54,
  0x29, 0xFC, 0x56, 0x83, 0xD7, 0x02, 0xA8, 0x7D,
  0x52, 0x87, 0x2D, 0xF8, 0xAC, 0x79, 0xD3, 0x06,
  0x7B, 0xAE, 0x04, 0xD1, 0x85, 0x50, 0xFA, 0x2F,
  0xA4, 0x71, 0xDB, 0x0E, 0x5A, 0x8F, 0x25, 0xF0,
  0x8D, 0x58, 0xF2, 0x27, 0x73, 0xA6, 0x0C, 0xD9,
  0xF6, 0x23, 0x89, 0x5C, 0x08, 0xDD, 0x77, 0xA2,
  0xDF, 0x0A, 0xA0, 0x75, 0x21, 0xF4, 0x5E, 0x8B,
  0x9D, 0x48, 0xE2, 0x37, 0x63, 0xB6, 0x1C, 0xC9,
  0xB4, 0x61, 0xCB, 0x1E, 0x4A, 0x9F, 0x35, 0xE0,
  0xCF, 0x1A, 0xB0, 0x65, 0x31, 0xE4, 0x4E, 0x9B,
  0xE6, 0x33, 0x99, 0x4C, 0x18, 0xCD, 0x67, 0xB2,
  0x39, 0xEC, 0x46, 0x93, 0xC7, 0x12, 0xB8, 0x6D,
  0x10, 0xC5, 0x6F, 0xBA, 0xEE, 0x3B, 0x91, 0x44,
  0x6B, 0xBE, 0x14, 0xC1, 0x95, 0x40, 0xEA, 0x3F,
  0x42, 0x97, 0x3D, 0xE8, 0xBC, 0x69, 0xC3, 0x16,
  0xEF, 0x3A, 0x90, 0x45, 0x11, 0xC4, 0x6E, 0xBB,
  0xC6, 0x13, 0xB9, 0x6C, 0x38, 0xED, 0x47, 0x92,
  0xBD, 0x68, 0xC2, 0x17, 0x43, 0x96, 0x3C, 0xE9,
  0x94, 0x41, 0xEB, 0x3E, 0x6A, 0xBF, 0x15, 0xC0,
  0x4B, 0x9E, 0x34, 0xE1, 0xB5, 0x60, 0xCA, 0x1F,
  0x62, 0xB7, 0x1D, 0xC8, 0x9C, 0x49, 0xE3, 0x36,
  0x19, 0xCC, 0x66, 0xB3, 0xE7, 0x32, 0x98, 0x4D,
  0x30, 0xE5, 0x4F, 0x9A, 0xCE, 0x1B, 0xB1, 0x64,
  0x72, 0xA7, 0x0D, 0xD8, 0x8C, 0x59, 0xF3, 0x26,
  0x5B, 0x8E, 0x24, 0xF1, 0xA5, 0x70, 0xDA, 0x0F,
  0x20, 0xF5, 0x5F, 0x8A, 0xDE, 0x0B, 0xA1, 0x74,
  0x09, 0xDC, 0x76, 0xA3, 0xF7, 0x22, 0x88, 0x5D,
  0xD6, 0x03, 0xA9, 0x7C, 0x28, 0xFD, 0x57, 0x82,
  0xFF, 0x2A, 0x80, 0x55, 0x01, 0xD4, 0x7E, 0xAB,
  0x84, 0x51, 0xFB, 0x2E, 0x7A, 0xAF, 0x05, 0xD0,
  0xAD, 0x78, 0xD2, 0x07, 0x53, 0x86, 0x2C, 0xF9
};

uint8_t crc8(const uint8_t * ptr, uint8_t len)
{
  uint8_t crc = 0;
  for (uint8_t i=0; i<len; i++) {
    crc = crc8tab[crc ^ *ptr++];
  }
  return crc;
}
```

Commands

Summary:

SmartAudio V1 & V2:

GET SETTINGS	0x01 (see Get Settings section)
SET POWER	0x02 (see Set Power section)
SET CHANNEL	0x03 (see Set Channel section)
SET FREQUENCY	0x04 (we use 5000 to 6000 AS 5GHz to 6GHz / see Set Frequency section)

SmartAudio V2 only:

SET OPERATION MODE	0x05 (see Set Mode)	
In Range PitMode	0x01	
Out Range PitMode		0x02
Disable PitMode		0x04 (Off only)
Lock / Unlock VTx		0x08 (1 is unlock, 0 is lock)

Host to VTX

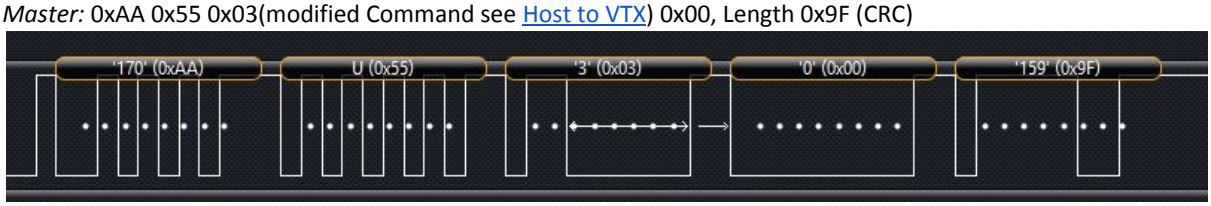
For all frames sent to the VTX the command byte needs to be shifted left by one bit and the LSB needs to be set. For example to set power the command send over the bus from the host to the VTX is 0x05 and the returned command is 0x02.

Response from VTX

The Unify Pro response frame is usually send <100ms after a frame is successfully received from the host MCU. As the Unify Pro always will answer for any frame with a response, this response can be used to verify if the Unify Pro successfully received the sent frame.
The default response it the same frame as sent by the host including the updated data and an additional reserved byte at the very end of the payload. This reserved byte can be ignored.
For the GET SETTINGS command the VTX will answer with a full set of settings and the SmartAudio version number. This frame also doesn't include a reserved byte.
For more details please see below.

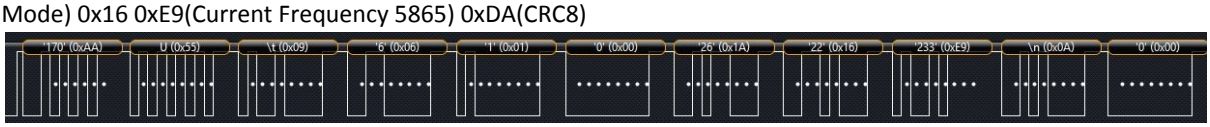
Get Settings:

Example frame:
Master: 0xAA 0x55 0x03(modified Command see Host to VTX) 0x00, Length 0x9F (CRC)



SmartAudio V1 response:
VTX: 0xAA 0x55 0x01 (Version/Command) 0x06 (Length) 0x00 (Channel) 0x00 (Power Level) 0x01(Operation Mode) 0x16 0xE9(Current Frequency 5865) 0x4D(CRC8)

SmartAudio V2 response:
VTX: 0xAA 0x55 0x09 (Version/Command) 0x06 (Length) 0x01 (Channel) 0x00 (Power Level) 0x1A(Operation Mode) 0x16 0xE9(Current Frequency 5865) 0xDA(CRC8)



Version/Command

The command byte of the **GET SETTINGS** response is split up in SmartAudio version and **GET SETTINGS** value. Bit 7-3 is holding the Smartio audio version where 0 is V1 and 1 is V2 and bit 2-0 is holding the **GET SETTINGS** value which is 1. In result of this you will receive following values on the Command position inside the **GET SETTINGS** response frame

SmartAudio Version	Response Command
SmartAudio V1	0x01
SmartAudio V2	0x09

Channel Response

See Set Channel.

Power Level Response

See Set Power.

Operation Mode Response

Response	Description
Bit 0	1 = VTX uses set frequency / 0 = VTX uses set channel
Bit 1	PitMode Running (1 = active / 0 = inactive)
Bit 2	In-Range Pitmode Flag (1 = active / 0 = inactive)
Bit 3	Out-Range Pitmode Flag (1 = active / 0 = inactive)
Bit 4	Unlocked Mode (1 = VTX unlocked / 0 = VTX is lockecd)

Frequency Response

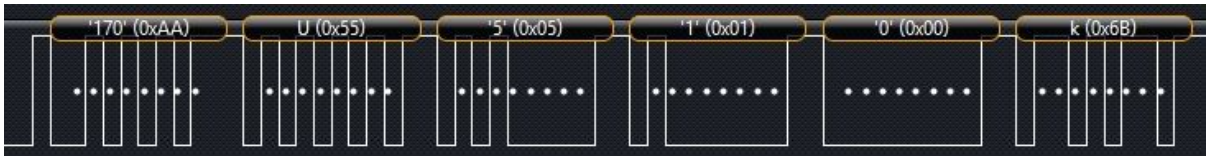
See Set Frequency.

Set Power:

SmartAudio V1 has direct access to the DAC converter for the PA gain as the VTX with SmartAudio V2 has an build in PA gain regulator. Because of this SmartAudio V2 uses a lookup table (see below) and any DAC value can be selected for SmartAudio V1.

Output Power	SmartAudio V1 recommended value	SmartAudio V1 lookup table
25mW	7	0
200mW	16	1
500mW	25	2
800mW	40	3

Example:
Master SmartAudioV2: Master: 0xAA 0x55 0x05(Command 2) 0x01(Length) 0x00(Power Level) 0x6B(CRC8)

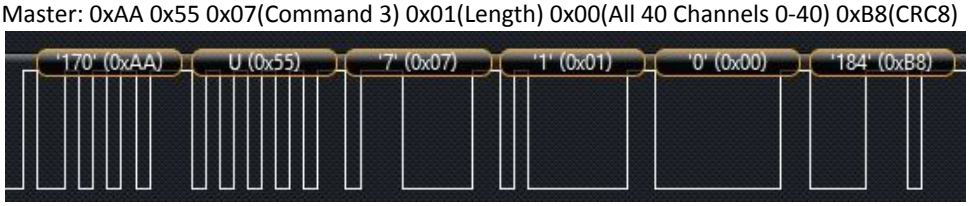


Response:
VTX SmartAudioV2: 0xAA 0x55 0x02 (Command) 0x03 (Length) 0x01 (Channel) 0x00 (Power Level) 0x01(reserved) 0x0F(CRC8)

Set Channel:

The Unify Pro used one frequency table for all channels and bands starting with Band A channel 1 (table entry 0) and ends with raceband channel 8 (table entry 39)

Example:
Master: 0xAA 0x55 0x07(Command 3) 0x01(Length) 0x00(All 40 Channels 0-40) 0xB8(CRC8)



Response:

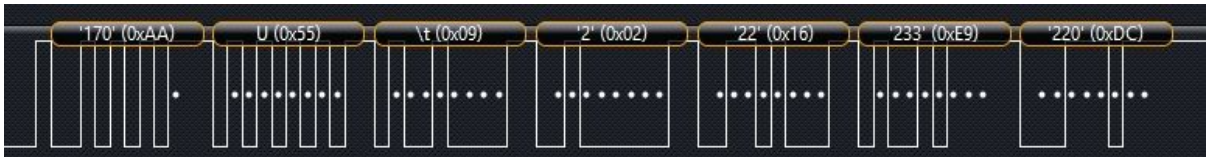
Please see our Unify Pro manual -> Frequency table.
http://www.team-blacksheep.com/tbs-unify-pro-5g8-manual.pdf

Set Frequency:

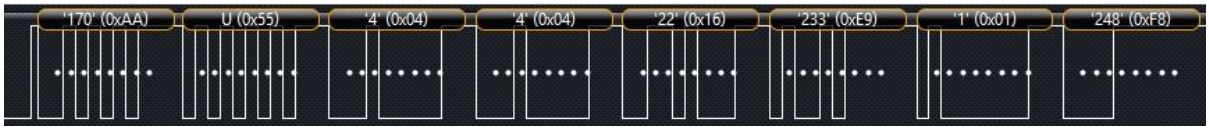
The highest two bits of **SET FREQUENCY** have a special functionality as described below
0x16 0xE9 → 0001 0110 1110 1001

Response	Description
Bit 15	If 1, the frequency along with this 16 bit will set the PIT mode frequency
Bit 14	If 1, it will return the PIT mode frequency. Rest of the bits are irrelevant

Example:
Master: 0xAA 0x55 0x09(Command 4) 0x02(Length) 0x16 0xE9(Frequency 5865) 0xDC(CRC8)



Response:



Set Mode:

Set mode is supported by SmartAudio V2 only!

Pit Mode: Operation mode that allows you to power on your VTx while preventing interfering with regular race operations, and messing with other mode parameters of the video transmitter. Fully supported only with UNIFY PRO 5G8 HV and later models.

Out Range Pit Mode: Reduces output power to bare minimum and sets frequency to 5584 MHz (not any of the 40 popular FPV frequencies!).
In Range Pit Mode: Reduces output power to bare minimum, at whatever channel/frequency that is currently active.

Bit table of Mode

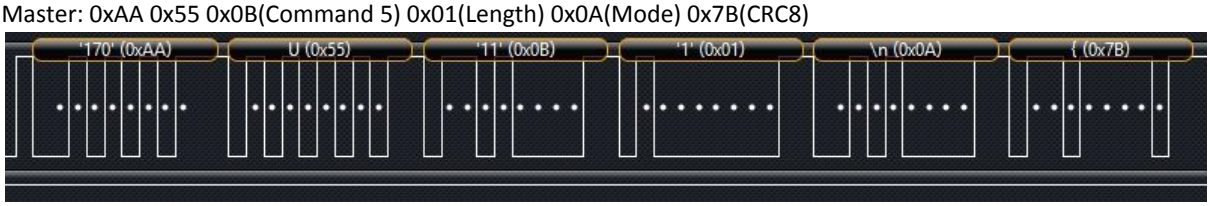
Response	Description
Bit 0	In Range PitMode value (0 = Inactive / 1 = Active)
Bit 1	Out Range PitMode value (0 = Inactive / 1 = Active)
Bit 2	Pit Mode running value (0 = Inactive / 1 = Active)
Bit 3	Locked / Unlocked value (1 = Unlocked, 0 = Locked)

Activating Pit Mode
Master: 0xAA 0x55 0x0B(Command 5) 0x01(Length) 0x01(IN RANGE PIT FLAG) 0xXX(CRC8)
Master: 0xAA 0x55 0x0B(Command 5) 0x01(Length) 0x02(OUT RANGE PIT FLAG) 0xXX(CRC8)

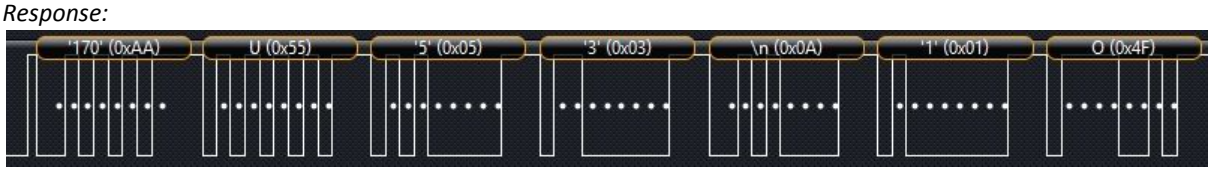
Deactivating Pit Mode
Master: 0xAA 0x55 0x0B(Command 5) 0x01(Length) 0x04(Quit PIT MODE) 0xXX(CRC8)

Quit Pit Mode without unsetting the pit mode flag
Master: 0xAA 0x55 0x0B(Command 5) 0x01(Length) 0x05(IN RANGE PIT FLAG) 0xXX(CRC8)
Master: 0xAA 0x55 0x0B(Command 5) 0x01(Length) 0x06(OUT RANGE PIT FLAG) 0xXX(CRC8)

Example:
Master: 0xAA 0x55 0x0B(Command 5) 0x01(Length) 0x0A(Mode) 0x7B(CRC8)



Response:



Quad LED Strip Color:

Within the TBS CORE PRO, we use SmartAudio and LED strip functionality of Cleanflight to change your LED colors according to the frequency that you have set. Video transmitters broadcasting on close frequencies will have a similar color, and therefore allow you to visually check if you're going to interfere in flight.

The underlying formula is simple yet effective. LED's in Cleanflight use HSV color format:

```
H = (current freq - 5645) * 1.2
S = 1
V = 255
```

HSV Ref: https://en.wikipedia.org/wiki/HSL_and_HSV

TBS UNIFY PRO 5G8 II PCB Module

The new version of UNIFY PRO 5G8 II will be available for system integrators to be placed as VTx module onto existing projects. You can leverage best-in-industry performance, small form factor, the power of the TBS brand and CE/FCC conformity as well as fast time-to-market for your electronics projects. Please contact TBS customer service if you are interested in receiving sample(s) of this new transmitter revision. Below are the (provisional) dimension and pad descriptions that you can import into your CAD / PCB software. Availability is expected for late Q3, 2016.