

Configuring TFS20-L with UART Interface on Ardupilot Flight Stack using PixHawk 6C and 6X Flight Controllers



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www.benewake.com Benewake (Beijing) Co., Ltd. TFS20-L can directly be connected with one of the serial ports of Pixhawk 6C or 6X from Holybro. There are four serial ports which can be used to interface LiDAR. The following port mapping shows hardware (left) and software (right) serial port mapping:

- TELEM1 > SERIAL1
- TELEM2 > SERIAL2 (used in this tutorial)
- TELEM3 (USART2) > SERIAL5
- GPS2 Port (UART8) > SERIAL4

TFS20-L can be interfaced with flight controller for the purpose of Altitude Holding or Obstacle Avoidance or Terrain Following. At the time of writing this document the flight controller used was PixHawk 6C from Holybro flashed with ArduCopter V4.3.3. However, this document can also be used with PixHawk 6X and other flight controllers running with different ArduCopter firmware versions with slight modification in parameter names and choosing the right port on flight controller. For choosing right port, refer to the hardware and software serial port mapping of flight controller. **Please note that supported firmware of Ardupilot for PixHawk 6C and 6X is 4.2.3 stable release and later.**



Figure-1: Pinout sequence of available ports on PixHawk 6C

NOTE: Pin 1 starts from the flight controllers "right side" like in the diagram shown above



Telem 1 Port

Pin	Signal	Voltage
1(red)	VCC	+5V
2(black)	UART7_TX(out)	+3.3V
3(black)	UART7_RX(in)	+3.3V
4(black)	UART7_CTS(in)	+3.3V
5(black)	UART7_RTS(out)	+3.3V
6(black)	GND	GND

Telem 2 Port

Pin	Signal	Voltage
1(red)	VCC	+5V
2(black)	UART5_TX(out)	+3.3V
3(black)	UART5_RX(in)	+3.3V
4(black)	UART5_CTS(in)	+3.3V
5(black)	UART5_RTS(out)	+3.3V
6(black)	GND	GND

Telem 3 Port

Pin	Signal	Voltage
1(red)	VCC	+5V
2(black)	USART2_TX(out)	+3.3V
3(black)	USART2_RX(in)	+3.3V
4(black)	NOT CONNECTED*	-
5(black)	NOT CONNECTED*	-
6(black)	GND	GND

GPS2 Port

Pin	Signal	Voltage
1(red)	VCC	+5V
2 black)	UART8_TX(out)	+3.3V
3(black)	UART8_RX(in)	+3.3V
4(black)	I2C2_SCL	+3.3V
5(black)	I2C2_SDA	+3.3V
6(black)	GND	GND

Figure-2: Pinout description of available serial ports on PixHawk 6C

Example for connecting TFS20-L to PixHawk 6C:



Figure 3: Schematic Diagram of Connecting TFS20-L with TELEM 2 Interface (Serial Port 2) of PixHawk 6C

The same procedure can be followed for other serial ports like TELEM1/TELEM3/GPS2 by looking at the pin out details given in *Figure-2*.

Notes:

- 1. Please pay attention to connect right wires to the right pins of flight controller. For pin sequence refer to *Figure-2*.
- Related connectors need to be purchased by the user, LiDAR connector is SMD HC-0.8-6PWT (PCB connector) and JST SUR 0.8mm Pitch (mating connector), while flight controller needs JST-GH with 1.25mm pitch.
- 3. If LiDAR faces down, please take care of the distance between lens and ground, it should be larger than LiDAR's blind zone (20cm).
- 4. Power source should meet the product manual current and voltage requirements: peak current is 115mA @ 3.3V.

a) Mission Planner configuration description for TFS20-L used for Altitude Hold

Connect the flight control board to mission planar, Select [Full Parameter List] in the left from the below bar-[CONFIG/TUNING]. Find and modify the following parameters:

PRX1_TYPE = 0 [on equal to 4 also gives the value if RNGFND1_ORIENT = 25]

SERIAL2_PROTOCOL = 9 [Rangefinder option]

SERIAL2_BAUD = 115 [Choose the current LiDAR baud rate, if haven't been changed, the default baud rate 115200 should be selected, that is 115]

RNGFND1_TYPE = 20 [TFS20-L/TFmini-Plus/TFmini-S UART option]

RNGFND1_MIN_CM = 30 [It could be changed according to real application requirement and should be greater LiDAR than non-detection zone, unit is cm]

RNGFND1_MAX_CM = 300 [It could be changed according to real application requirement and should be smaller than effective measure range of LiDAR, unit is cm]

RNGFND1_GNDCLEAR = 25 [expressed in cm, depending upon mounting height of the module and should be greater LiDAR than non-detection zone]



RNGFND1_ORIENT = 25 [facing down]

Upon setting of these parameters, click [Write Params] on the right of mission planner to finish. After writing the parameters, you need to power off the controller and then turn it on to apply the setting changes.

If the error message "**Bad LiDAR Health**" appears, please check if the connection is correct, the power supply is normal and have you restarted the controller?

How to see the altitude value from LiDAR sensor: double click the area of Mission Planner, looking at the following picture:



Select option *sonarrange*, see following picture:

🛃 Display This								×
accel_cal_x	🗸 az3	ch11out	ch7out	gimballng	gz	my	remnoise	ter_space
accel_cal_y	AZTOMAV	ch12in	ch8in	gpsh_acc	gz2	my2	remotesnrdb	timeInAir
accel_cal_z	battery_cell1	ch12out	ch8out	gpshdg_acc	gz3	my3	remrssi	timeInAirMinSec
accelsq	battery_cell2	ch13in	ch9in	gpshdop	HomeAlt	mz	roll	📃 timesincelastshot
accelsq2	battery_cell3	ch13out	ch9out	gpshdop2	horizondist	mz2	rpm1	toh
accelsq3	battery_cell4	ch14in	climbrate	gpsstatus	hwvoltage	mz3	rpm2	tot
airspeed	battery_cell5	ch14out	crit_AOA	gpsstatus2	i2cerrors	nav_bearing	rssi	turnrate
alt	battery_cell6	ch15in	current	gpsv_acc	KIndex 🛛	nav_pitch	rxerrors	vertical speed
alt_error	battery_kmleft	ch15out	current2	gpsvel_acc	lat	nav_roll	rxrssi	vibex
altasl	🔄 battery_mahperkm	ch16in	DistFromMovingBas	🔤 groundcourse	lat2	noise	satcount	vibey
altasl2	battery_remaining	ch16out	DistRSSIRemain	📃 groundcourse2	🗌 linkqualitygos	opt_m_x	satcount2	vibez
altd100	battery_temp	chlin	DistToHome	groundspeed	lng	opt_m_y	satcountB	vlen vlen
altd1000	🔄 battery_usedmah	ch1 out	distTraveled	🔤 groundspeed2	lng2	🔤 packetdropremote	servovoltage	wx
altoffsethome	🗌 battery_usedmah2	ch2in	ekfcompv	gx	load	🔤 pidachi eved	sonarrange	∎ уу
AOA	battery_voltage	ch2out	ekfflags	gx2	localsnrdb	🔤 pidD	sonarvoltage	٧z
aspd_error	battery_voltage2	ch3in	ekfposhor	g x3	mag_declination	piddesired	speedup	watts
asratio	ber_error	ch3out	ekfposvert	ຍ	mag_ofs_x	pidff	SSA	wind_dir
ax	🗖 boardvoltage	ch3percent	ekfstatus	g y2	mag_ofs_y	🗖 pi dI	target_bearing	wind_vel
ax2	brklevel	ch4in	ekfteralt	🔤 gy3	mag_ofs_z	🗖 pidP	targetairspeed	wp_dist
ax3	- campointa	ch4out	ekfvelv	gyro_cal_x	magfield	🔤 pitch	targetalt	wpno
ay ay	campointb	ch5in	ELT oMAV	gyro_cal_y	magfield2	press_abs	🔤 targetaltd100	<pre>xtrack_error</pre>
ay2	campointe	ch5out	🔤 fixedp	gyro_cal_z	magfield3	press_temp	ter_alt	yaw
ay3	ch10in	ch6in	freemem	gyrosq	mx	radius	ter_curalt	
az	ch10out	ch6out	GeoFenceDist	gyrosq2	mx2	raw_press	ter_load	
az2	ch11in	ch7in	🔲 gimballat	gyrosq3	mx3	raw_temp	ter_pend	



The altitude distance from the LiDAR will be displayed in Sonar Range (meters), see the following picture:



b) Mission Planner configuration description for TFS20-L used for Obstacle Avoidance

Connect the flight control board to MP. Select [Full Parameter List] in the left from the below bar-[CONFIG/TUNING]. Find and modify the following parameters:

AVOID_ENABLE = 0 [If 0 = UseFence and UseProximitySensor doesn't work in IIC then **choose 1 =** UseProximitySensor]

AVOID_MARGIN = 4 [Unit: m, set obstacle avoidance distance as required.]

PRX1_TYPE = 4 [Rangefinder should be selected for proximity sensor in obstacle avoidance mode]

SERIAL2_PROTOCOL = 9 [Rangefinder option]

SERIAL2_BAUD = 115 [Choose the current LiDAR baud rate, if haven't been changed, the default baud rate 115200 should be selected, that is 115]

RNGFND1_TYPE = 20 [TFS20-L/TFmini-Plus/TFmini-S UART option]

RNGFND1_MIN_CM = 30 [It could be changed according to real application requirement and should be greater LiDAR than non-detection zone, unit is cm]

RNGFND1_MAX_CM = 300 [It could be changed according to real application requirement and should be smaller than effective measure range of LiDAR, unit is cm]

RNGFND1_ORIENT = 0 [It depends on the LiDAR's real installation direction, 0~7, 24 = Up and 25 =

Down (total ten) are supported up till now, see details in MP]

AVOID_BEHAVE = 0 [This parameter will define what drone will do upon the encounter of obstacle (stop or slide to avoid the object) **0: Slide**; **1: Stop**]

Upon setting of these parameters, click [Write Params] on the right of the software to finish. After writing the parameters you need to power off the controller and then turn it on to apply the settings.

If the error message "**PreArm: check the proximity sensor**" appears, please check if the connection is correct, the power supply is normal and have you restarted the controller.



How to see the target distance measured by the LiDAR: (distance from LiDAR in obstacle avoidance can't be displayed in *sonarrange* option) press Ctrl+F button in keyboard, the following window will pop out:

🖳 temp							×
Geo ref imeges	Geo Refrence photos			S3D GYRO	Ea	Preserver	05
Warning Manager	Create custom audio warnings		sitl				
Follow Me	use a nmea gps to follow me		streamcombi				
NMEA	outputs the may location in nmea		Inject GPS				
MicroDrone	outputs the may location in microdrone format		FFT				
Mavlink	mirrors the mavlink stream received by mp		TD				
Param gen	regenerage the param info used inside mp		Toboot				
Lang Edit	translation language editor		pixhawk		01.0		
OSDVideo	overlay the hud into your recorded videos		QNH	VISION POSITION	Dis		
Moving Base	show an extra icon on the map of your current		Sequence				
Shp to Poly	convert shp file ot a polygon file		Swarm				
	output the may location into xplanes	nk In	vlc				
Swarm	multi mav swarm interface		estream				
Follow the leader	follow the leader swarm		Aze Man				
MAVSerial pass	create a exclusive passthrough to the gps		Data				
	remove all apm drivers		faram gen				
Sort TLogs	sort tlogs into there type and sysid		riming	NOTOR OCTPETS	Dis		
rip all fw	download all current fw's		Sighing	DC RECEIVER			
Inject GE	add custom imagery to mp		calib				
Clear Custom Maps	wipe custom imagery		sphere	30 67902	B1s		
structtest	struct conversion speed test		mag calls	3D ACCEL2	Dis		
DashWare			log				
arm and takeoff	quad: arm and takeoff		extract				
gimbal test	run the gimbal pointing algo		The state of the s	ARTES			
map logs	create map jpg's for all tlogs in a dir		Troximity	TERRAIN			
logindex	tlog browser		Swarm				
GST test	DEM logdownload KeSort All Cust	om GDAL	Custom DTED				

Click button Proximity, the following window will appear:



The number in green color means the distance from LiDAR in obstacle avoidance mode (it doesn't mean the real time distance from LiDAR and will not be influenced in Mission Planner. The mission planner version at the time of writing this tutorial was v1.3.79.

♦ c) If TELEM 2 port has been used, TELEM1/TELEM3/GPS2-Port interfaces can also be used, the other settings are same

Configuration Descriptions on Mission Planner:

Connect flight control board to MP, Select [Full Parameter List] in the left from the below bar [CONFIG/TUNING]. Find and modify following parameters:

For TELEM1:

SERIAL1_PROTOCOL = 9 (LiDAR)

SERIAL1_BAUD = 115

For TELEM3:

SERIAL5_PROTOCOL = 9 (LiDAR)

SERIAL5_BAUD = 115



For GPS2:

SERIAL4_PROTOCOL = 9 (LiDAR)

SERIAL4_BAUD = 115

Upon setting of these parameters, the other parameters are same as Mission Planner configuration description of TFS20-L for the purpose of Obstacle Avoidance or Altitude Holding, then click [Write Params] on the right of the software to finish.

Important Note: If you have configured protocol type (SERIALX_PROTCOL: X can be 1, 2, 3, 4 etc.) for more than one UART ports as **9**: **Rangefinder** but you have connected LiDAR to only single UART port then it will give **Bad LiDAR Health error**. So, you need to configure only those UART ports as **9**: **Rangefinder** to which you will connect LiDAR. In other words, we can say that if the number of serial ports configured as **9**: **Rangefinder** is greater than the number of connected LiDARs then Bad LiDAR Health error will occur.