How to install Benewake TF SERIES on PixHawk

（Take TF01 for example）

Install TF SERIES module on your drone vertically to the ground so you can get the absolute altitude of your drone. Here is how to install our module on PixHawk. We provided two methods below.

1. How does TF SERIES work on PixHawk

Lidar's are used in flight modes which have height control, such as Altitude Hold, Loiter and PosHold Mode. The data from the sensor will be used until you exceed RNGFND_MAX_CM, after that it switches to the barometer. Currently Lidar is not supported in Auto Mode.

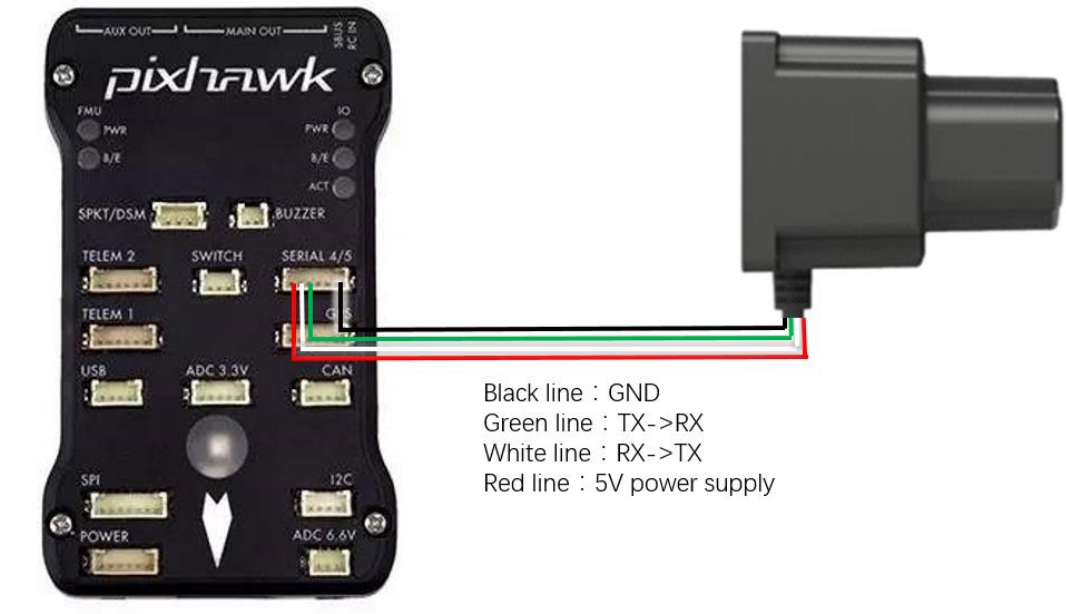
PixHawk interface for rangefinder are I2C , Analog, Serial. Details are on http://ardupilot.org/copter/docs/common-rangefinder-landingpage.html

2. Serial Mode

We recommend using **Serial** to send altitude signal to PixHawk.

Cautions: If you use serial, please update your firmware, make sure is newer than V 3.3.3.

2.1 Wire



Pic. 1(a) Connect TF SERIES to PixHawk via Serial

Pic. 1(b) Connect TF SERIES to PixHawk via Serial

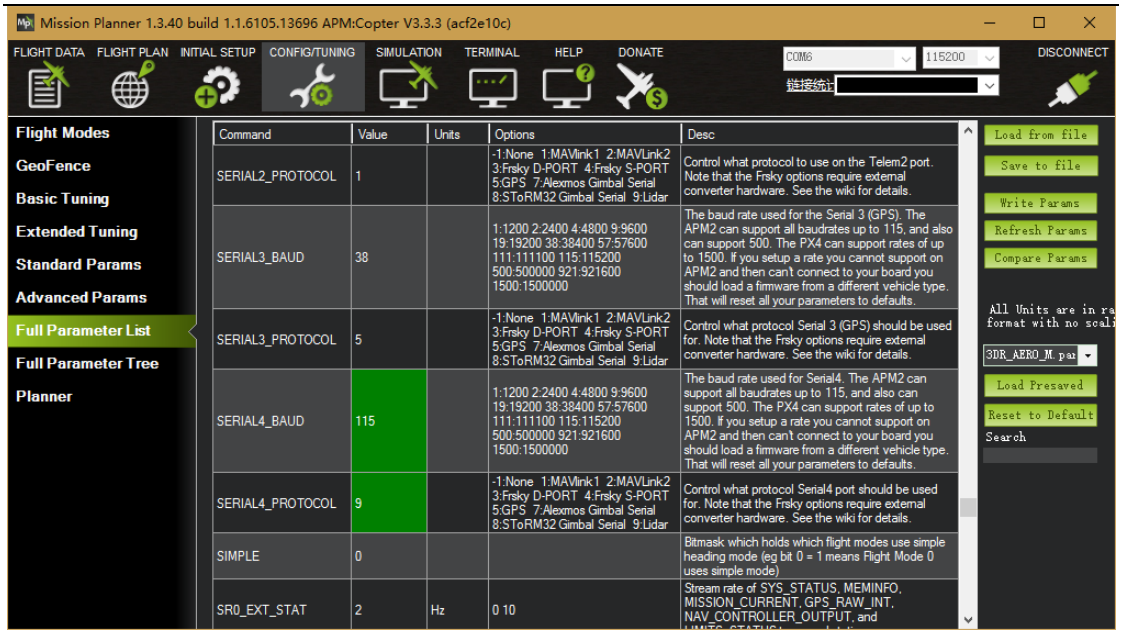
2.2 Mission Planner

Connect Flight Controller to MP, click `CONFIG/TUNING` then select `Full Parameter List` change parameters as below:

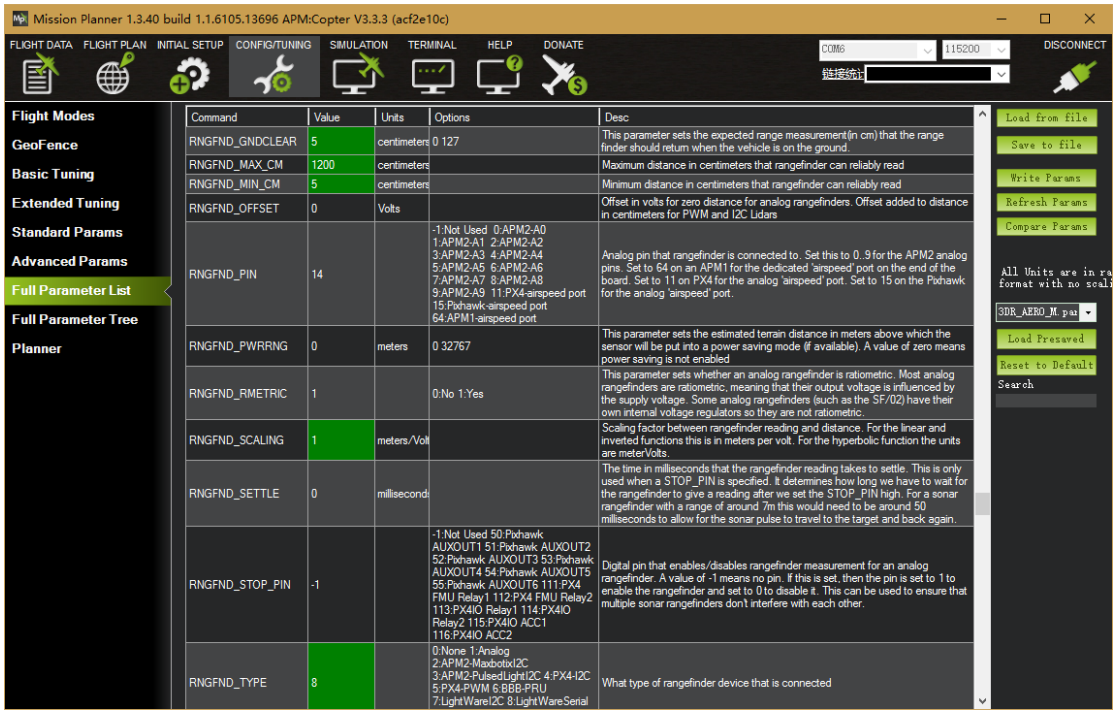
- SERIAL4_PROTOCOL = 9 (Lidar)
- SERIAL4_BAUD = 115
- RNGFND_TYPE = 8 (LightWareSerial)
- RNGFND_SCALING = 1
- RNGFND_MIN_CM = 5
- RNGFND_MAX_CM = 1200
- RNGFND_GNDCLEAR = 5 unit cm, or you can use more specific value, it depends on the height TF SERIES installed.

After all your settings click `Write Params`

See in Pic.2 and Pic.3



Pic.2 Serial parameter configuration



Pic.3 Serial parameter configuration

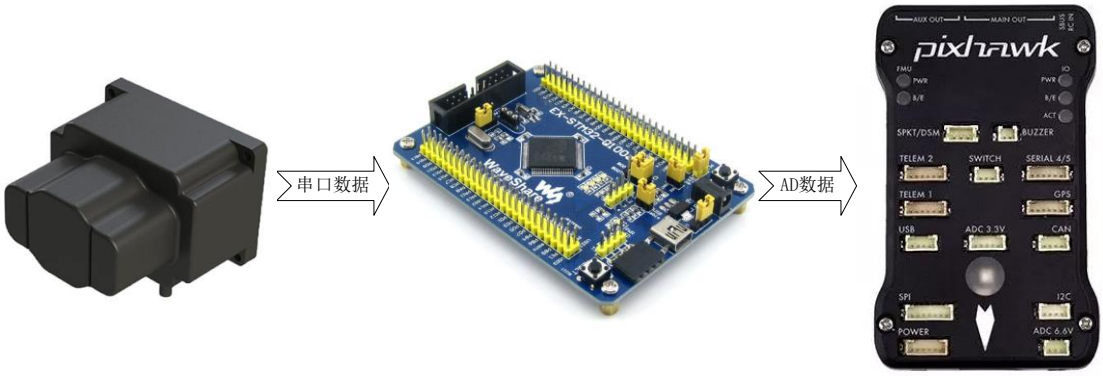
If Bad Lidar Health error occurs, please check if TF SERIES LiDAR window first, see whether TF SERIES emit red LED light. If there`s no red LED light, please check power supply. (Sometimes PixHawk have Serial 4/5 power supply issue) If there is LED light, please check if you wire the Serial correctly. If you still get this error message and got no reading in sonarrange/sonarvoltage, please connect TF01 to TELEM2 (like Pic.1(b))and change the Parameter for Serial 2 as below.

- SERIAL2_PROTOCOL = 9 (Lidar)
- SERIAL2_BAUD = 115

3. AD mode to simulate Sonar Sensor Maxbotix

TF SERIES data is first send to a STM32 board and data is translated into AD data then sent to PixHawk.

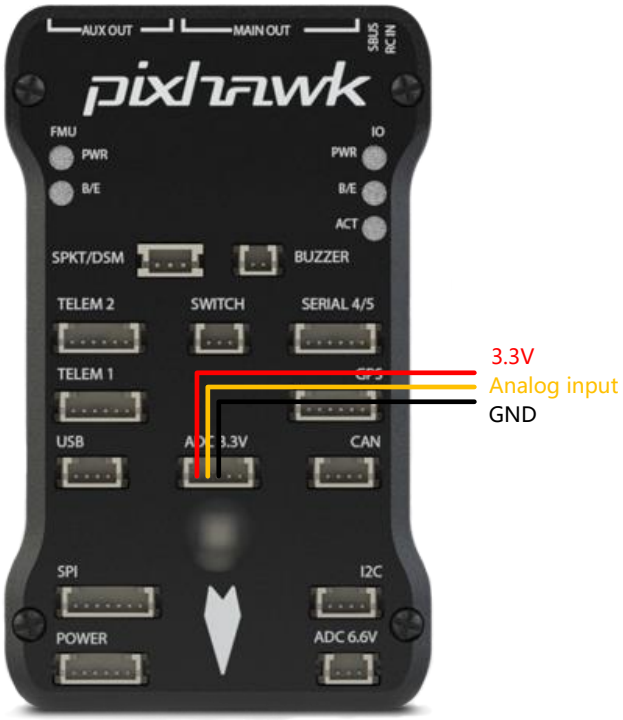
Caution: TF SERIES, STM32 board and PixHawk shall share a common-ground.



Pic. 4 connect TF SERIES to PixHawk

3.1 Wire

Connect TF SERIES to input distance data using analog into PixHawk



Pic. 5 Analog input wire,

Red: 3.3V

Orange: AD analog signal

Black: GND

3.2 Mission Planner Configuration

Connect Flight controller to MP, select **Full Parameter List** in **Config/Tuning**, find and change the parameters below:

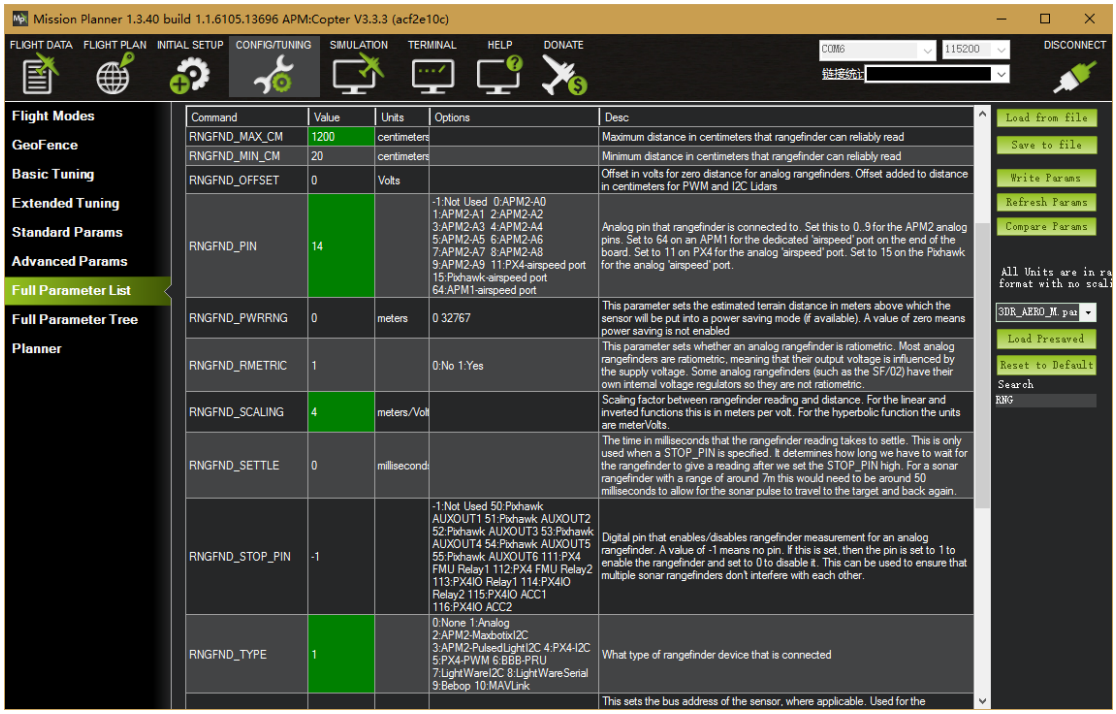
- RNGFND_PIN = “14” for PixHawk’s ADC 3.3v pin #2 **OR** “0” for APM2.x
- RNGFND_MAX_CM = “1200” (i.e. 12m max range)
- RNGFND_SCALING = “4” (i.e. 4m / 1v)
- RNGFND_TYPE = “1” (Analog)

STM32 DA module can output voltage between 0-3.3V. When the distance reaches 12m, the voltage sent to PixHawk is 3V. Therefore set RNGFND_SCALING to 4。

When all parameters are set, click **Write Param**.

After all parameters are set and written, the TF SERIES data works on Altitude Hold, Loiter and PosHold Mode. The data from the sensor will be used until you exceed RNGFND_MAX_CM,(which as our set is 12m) after that it switches to the barometer. Currently Lidar is not supported in Auto Mode。

Details are in Pic.6：



Pic. 6 Details for parameter setting

3.3 STM32 Trans Board Code

Receive and analyze the distance data from TF SERIES

```
// Global Variables
u16 distance = 0;
// Variables used by serial
static u8 Usart1buf[USART1_BUF_SIZE];
```

```
static u8 pointer = 0;

// Serial Port 1 Function Initialize
void USART1_Init(void)
{
	USART_InitTypeDef USART1_InitStructure;
	GPIO_InitTypeDef GPIO_InitStructure;
	NVIC_InitTypeDef NVIC_InitStructure;

	// GPIOA Clock
	RCC_AHB1PeriphClockCmd(RCC_AHB1Periph_GPIOA, ENABLE);
	// A9 -> TX   ,   A10 -> RX
	GPIO_InitStructure.GPIO_Pin = GPIO_Pin_9 | GPIO_Pin_10;
	GPIO_InitStructure.GPIO_Speed = GPIO_High_Speed;
	GPIO_InitStructure.GPIO_Mode = GPIO_Mode_AF;
	GPIO_InitStructure.GPIO_OType = GPIO_OType_PP;
	GPIO_InitStructure.GPIO_PuPd = GPIO_PuPd_NOPULL;
	GPIO_Init(GPIOA,&GPIO_InitStructure);

	// Alternative Function Configuration
	GPIO_PinAFConfig(GPIOA,GPIO_PinSource9,GPIO_AF_USART1);
	GPIO_PinAFConfig(GPIOA,GPIO_PinSource10,GPIO_AF_USART1);
	// USART1 clock
	RCC_APB2PeriphClockCmd(RCC_APB2Periph_USART1, ENABLE);
	// USART1 Interrupt Priority
	NVIC_InitStructure.NVIC_IRQChannel = USART1_IRQn;
	NVIC_InitStructure.NVIC_IRQChannelPreemptionPriority = 0;
	NVIC_InitStructure.NVIC_IRQChannelSubPriority = 0;
	NVIC_InitStructure.NVIC_IRQChannelCmd = ENABLE;
	NVIC_Init(&NVIC_InitStructure);
	// USART1 Initialize
	USART_DeInit(USART1);
	USART1_InitStructure.USART_BaudRate = 115200;
	USART1_InitStructure.USART_WordLength = USART_WordLength_8b;
	USART1_InitStructure.USART_StopBits = USART_StopBits_1;
	USART1_InitStructure.USART_Parity = USART_Parity_No;
	USART1_InitStructure.USART_Mode = USART_Mode_Rx|USART_Mode_Tx;
	USART1_InitStructure.USART_HardwareFlowControl = USART_HardwareFlowControl_None;
	USART_Init(USART1,&USART1_InitStructure);
	USART_Cmd(USART1,ENABLE);
	USART_ITConfig(USART1,USART_IT_RXNE,ENABLE);
}

// Serial Interrupt Function
void USART1_IRQHandler(void)
{

	if(USART_GetITStatus(USART1, USART_IT_RXNE) != RESET
	   || (USART_GetITStatus(USART1, USART_IT_ORE_RX) != RESET))
	{
		USART_ClearITPendingBit(USART1, USART_IT_RXNE);
		Usart1buf[pointer++%USART1_BUF_SIZE] = USART_ReceiveData(USART1);

		// Receive data program
		if((pointer%USART1_BUF_SIZE >= 9))
		{
```

```
                // Check the head and the tail of the packet
                // Better do a checksum, not written here
                if(     (Usart1buf[pointer%USART1_BUF_SIZE-3]==0x59)
                        &&(Usart1buf[pointer%USART1_BUF_SIZE-4]==0x59))
                {
                        //Distance
                        distance=((u16)((Usart1buf[pointer%USART1_BUF_SIZE-1])<<8)
                                        |(u16)(Usart1buf[pointer%USART1_BUF_SIZE-2]));
                }
            }

        }
}
```

DAC Configuration

```
void DAC_Config(void)
{
        GPIO_InitTypeDef GPIO_InitStructure;

        RCC_AHB1PeriphClockCmd(RCC_AHB1Periph_GPIOA, ENABLE);
        RCC_APB1PeriphClockCmd(RCC_APB1Periph_DAC, ENABLE);

        GPIO_InitStructure.GPIO_Pin = GPIO_Pin_4;
        GPIO_InitStructure.GPIO_Mode = GPIO_Mode_AN;
        GPIO_InitStructure.GPIO_PuPd = GPIO_PuPd_NOPULL;
        GPIO_InitStructure.GPIO_Speed = GPIO_Speed_50MHz;
        GPIO_InitStructure.GPIO_OType = GPIO_OType_OD;
        GPIO_Init(GPIOA, &GPIO_InitStructure);

        DAC_InitTypeDef    DAC_InitStructure;
        DAC_DeInit();
        DAC_InitStructure.DAC_Trigger = DAC_Trigger_Software;
        DAC_InitStructure.DAC_WaveGeneration = DAC_WaveGeneration_None;
        DAC_InitStructure.DAC_OutputBuffer = DAC_OutputBuffer_Enable;
        DAC_Init(DAC_Channel_1, &DAC_InitStructure);
        DAC_Cmd(DAC_Channel_1,ENABLE);

        DAC_SetChannel1Data(DAC_Align_12b_R,0x1fff);

        DAC_SoftwareTriggerCmd(DAC_Channel_1,ENABLE);
}
```

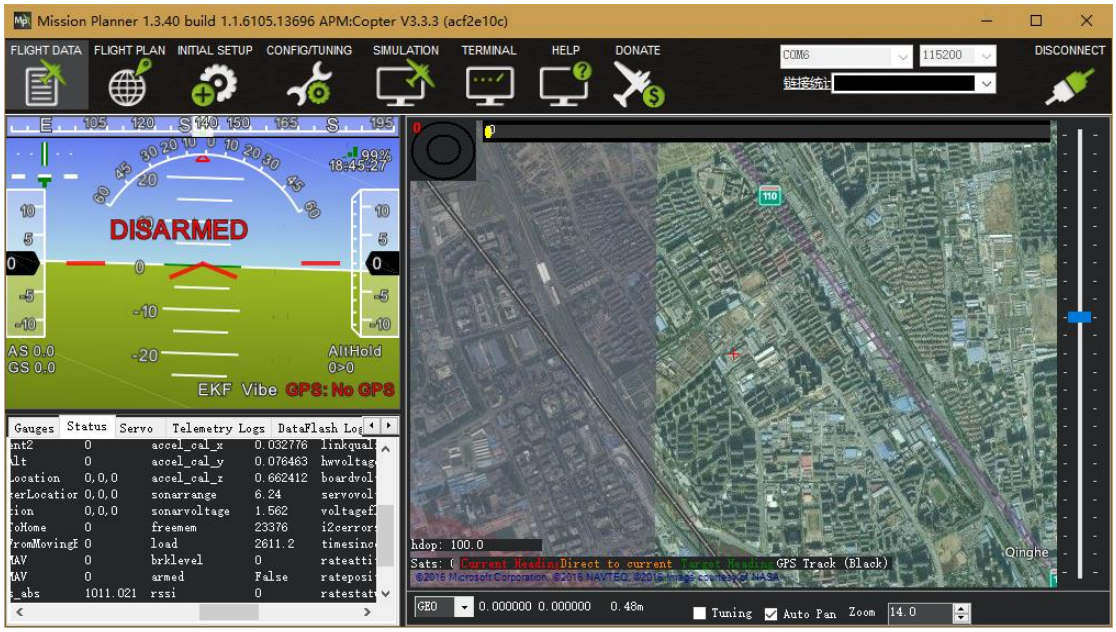
Main function:

```
// The test height of TE-01 ,Unit mm
float test_height;
// Height bias, Unit mm
float bias = 180;
// Analog value output
s16 analog=0;

// Main
void main(void)
{
        // Interrupt Group Configuration
        NVIC_Config();
        // Serial Initialize
        USART1_Init();
```

```
        // DAC Config
        DAC_Config();

        // Main Loop
        while(1)
        {
                // Remove Bias
                test_height = distance - bias;
                // Data Conversion, 3V corresponding to the height of 12m, therefore
                // test_height * 3.3 * 4096/ (3 * 1200) = test_height * 4096 / 1320
                analog = (s16)(test_height*4096/1320);
                // Range Limit
                analog = analog < 4095 ? analog : 4095;
                analog = analog > 0 ? analog : 0;
                // Voltage Output
                DAC_SetChannel1Data(DAC_Align_12b_R,analog);
                DAC_SoftwareTriggerCmd(DAC_Channel_1,ENABLE);
        }
}
```

4. Data Test

In **Flight Data** of Mission Planner, Click **Status** below, find **sonarrange(actual distance)** and **sonarvoltage(analog input voltage).**



Pic 7 Distance Sensor Test (Test if the sensor gets readings correctly)

5. PID configuration

All PID configuration for PixHawk can be done on Mission Planner. See in http://ardupilot.org/copter/docs/common-tuning.html.