Throttle Jockey PRO

Instructions

Safety Warning

- When using the Throttle Jockey for the first time or making changes to the throttle servo throw, always perform the calibration operation.
- Always perform a range check after installing the Jockey.
- When starting the model, always keep the throttle below 25%.
- Set the failsafe of the throttle channel to the stop position of the engine.

Model Avionics "Throttle Jockey Pro" Instructions

Introduction

The Throttle Jockey is a digital rotor speed governor for Model Helicopters. It uses an adaptive feed-forward control algorithm to govern rotor speed. The Jockey monitors and governs engine speed. It continuously adapts to the response of the engine and the demands of the pilot. Aggressive throttle commands cause the Jockey to underdamp the control loop yielding a fast response to changing loads and slowly changing throttle command cause the Jockey to overdamp the control loop yielding a smooth response to changing loads.
The Jockey employs a pulse filtering system that cleans up any hits or glitches on the auxiliary and throttle channels.

The Jockey is designed to govern the engine speed between 9500 and 20500rpm. The actual head speed can be calculated by dividing the engine speed by the main gear ratio.

$$Rotor\ rpm = engine\ rpm\ /\ gear\ ratio$$

For example, a 9:1 gear ratio would yield a governed head speed range of 1055 to 2253 rpm.

The Model Avionics website (http://www.modelavionics.com) includes the latest information, setup tips for various radio systems and an on-line ATV calculator.

Key Features

- Advanced Digital Control Algorithm – employs an adaptive feed-forward rpm control loop.
- Selectable Super Servo Support – gives optimum update rate for Super and Digital Servos.
- Set the target RPM from your transmitter or by an on-board POT.
- High Resolution pulse and generation system.
- Low Power
- Small and lightweight.
- Outstanding customer support and service.
- Fail-out feature on low battery conditions – Governing ceases on a low battery condition passing control back to the receiver.

Radio System requirements

The wiring of this Governor is compatible with JR, Futaba, Hi-Tec, Graupner, Robbe and the current style blue plug Sanwa/Airtronics radio systems. A spare channel for setting the target RPM is not necessary.

Servo Choice

Super Servos

Optimum performance from the Throttle Jockey is obtained when it is used in conjunction with a high speed super servo or digital servo (0.1 seconds/60° or less).

The term super servo is used to describe servos capable of running at high data frames rates (250 frames/sec or more). Examples of this type of servo are Airtronics 94757, JR 8700G and Futaba S9253. The use of super servos with the Throttle Jockey is highly recommended as they yield the best overall performance. When used with this type of servo, the "super servo" support of the Throttle Jockey should be activated. This can be done with the calibration routine.
Warning: Use of the super servo facility with servos not designed to accept the high frame rate will result in damage to the servo and may cause malfunction is flight.
The calibration routine runs the servo in standard mode even when the governor has previously activated the super servo feature.

Standard Servos

With super servo support off the Throttle Jockey will work with any servo in the Futaba, JR and Sanwa ranges (and many other makes). The connectors should be oriented so that the Black (Futaba) / Brown (JR) wires are at the bottom.

Connections

From left to right, the connections are as follows:

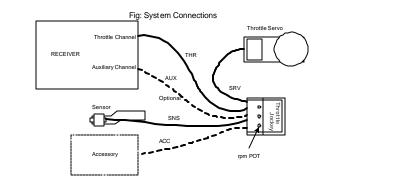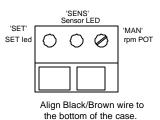|	
SRV	Throttle Servo Output
THR	Throttle Channel Input
AUX	Auxiliary Channel Input (Optional)
SNS	RPM Sensor input (magnetic OR optical)
ACC	Accessory Output (For future Model Avionics Accessories)

Fig: System Connections

RECEIVER
Throttle Channel
Auxiliary Channel

THR
AUX
Optional
SRV
SNS
ACC

Throttle Servo

Throttle Jockey

Sensor

Accessory

rpm POT

Fig: Indicators and Control – Front view

'SENS'
Sensor LED
'SET'
SET led
'MAN'
rpm POT

Align Black/Brown wire to
the bottom of the case.

Modes of Operation.

The Throttle Jockey Pro can be operated in one of two operational modes; Manual or Remote mode. In *remote* mode, the AUX channel is used to remotely set the target RPM from the transmitter. In *manual* mode, a small POT (beneath the hole marked 'REM') is used to set the target RPM. This mode is used when the radio system does not have a spare AUX channel.
The Throttle Jockey automatically detects the mode of operation.

Calibration

During calibration, the Jockey measures the limits of the auxiliary and throttle channels. Once calibrated, the Jockey stores the measurements in non-volatile memory.

Calibration only needs to be performed when first installing the Jockey, changing throttle servo throws or after transferring the Jockey to a new machine.

REMOTE mode Calibration Procedure

- Setup the throttle servo operation so the travel (ATV) is a close to +/-100% as possible.
- Set the Aux travel (ATV) to +/-100%, make sure that any mixing to the Aux channel is turned off.
- Set the throttle and trim to the low (stopped) position <- **Important!**
- Turn on the transmitter and then turn on the receiver.
- During the first 3 seconds, toggle the AUX switch twice
- The SET led will flash green indicating that the Jockey has entered its calibration phase.
- With the throttle trim all the way down raise and lower the throttle stick over its full range.
- The super servo option can be enabled by re-raising the throttle stick at this time, for regular servos, leave the throttle stick in the low position. The SET LED will turn yellow to confirm the Super Servo mode.
- Exit calibration by toggling the AUX switch twice.
- The SET led will stop flashing indicating that it has stored the radio parameters.

MANUAL mode Calibration Procedure

- Setup the throttle servo operation so the travel (ATV) is a close to +/-100% as possible.
- Rotate the rpm POT fully anti-clockwise.
- Set the throttle and trim to the low (stopped) position <- **Important!**
- Turn on the transmitter and then turn on the receiver.
- During the first 6 seconds rotate the rpm POT fully clockwise.
- The SET led will flash green indicating that the Jockey has entered its calibration phase.
- With the throttle trim all the way down raise and lower the throttle stick over its full range.
- The super servo option can be enabled by re-raising the throttle stick at this time, for regular servos, leave the throttle stick in the low position. The SET LED will turn yellow to confirm the Super Servo mode.
- Exit calibration by rotating the rpm POT fully anti-clockwise.
- The SET led will stop flashing indicating that it has stored the radio parameters.

To verify correct calibration, verify that the SET led is OFF when the throttle stick is below 25% and ON when the throttle stick is above 25%.

Setting the Target RPM

If the AUX channel was connected during calibration, the target RPM can be set remotely (REMOTE MODE). If calibration was performed without the AUX channel, the target RPM is set using the rpm POT (MANUAL MODE). Switching between Manual and Remote modes will require re-calibration.
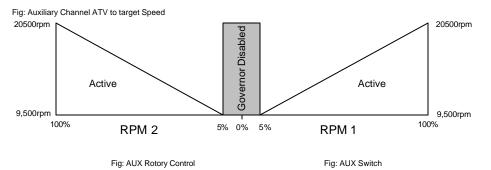
Setting the Target RPM in Manual mode

The position of the rpm POT determines the target RPM. If the POT is turned fully anti-clockwise, the target RPM is set to 9500rpm. If the POT is set fully clockwise, the target RPM is set to 20500rpm. The POT can be set anywhere in this range. The position of the POT proportionally corresponds to a RPM setting between 9500rpm and 20500rpm. After calibration, start with a low initial setting and slowly progress to higher values until the desired RPM is achieved.
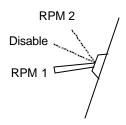
Setting the Target RPM in Remote mode

The AUX channel input is usually assigned to a slider, pot or two or three position switch. The ATV of this channel controls the active state of the Jockey as well as the target engine rpm. If the ATV in either direction is set to less than 5%, regulation is disabled. An ATV setting between 5% and 100% sets the target speed. The relationship between ATV and rpm above 5% depends on the radio system type. ATVs above 100% are possible, but to use them, the TJ must be calibrated using these higher settings. Settings above the calibrated ATVs are ignored. Always use symmetrical ATVs on the AUX channel, this allows the Jockey to correctly calculate the midpoint.

The highest target rpm is 20500rpm and the lowest rpm setting is 9500rpm. To verify operation, raise the throttle above the 25% threshold and lower the active ATV of the auxiliary channel below 5% and verify the Green LED is off. Alternatively, the ATV at each state of the aux switch can be used to set a different speed target. ATVs greater than 5% set the target rpm. 6% corresponds to 9500 rpm and 100% corresponds to 20500 rpm. On some radio systems, the auxiliary channel can be mixed with the flight mode switch. Different ATVs (or speeds) can be assigned to each flight mode setting using this method. Set the PCM failsafe to 0% for this channel.

Fig: Auxiliary Channel ATV to target Speed

20500rpm
9,500rpm
100%
RPM 2
Active

Governor Disabled

5% 0% 5%

20500rpm
9,500rpm
100%
RPM 1
Active

Fig: AUX Rotary Control

Fig: AUX Switch

ATV ranges differ slightly between radio manufacturers. The tables below show examples of ATV settings for popular radio systems.

Example 1: Raptor 30: 9.56-1 gear ratio Rotor/ATV

RPM	JR	FUT	HITEC	SANWA
1500	76	56	81	78
1550	80	59	85	82
1600	84	63	89	86
1650	88	66	94	90
1700	92	69	97	94
1750	96	72	101	98
1800	99	75	105	101

Example 2: Engine RPM / ATV

ATV	JR	FUTABA	HITEC	SANWA
10	9480	9600	9420	9420
20	10140	10380	9840	10020
30	10620	11200	10380	10500
40	11280	12240	10920	11100
50	11900	13700	11640	11820
60	12720	15000	12420	12600
70	13500	16500	13200	13500
80	14700	18060	14100	14520
90	16080	18500	15240	15720
100	17340	18500	16620	17160

Throttle channel operation

Make the servo operating range as close to +/-100% ATV as possible.
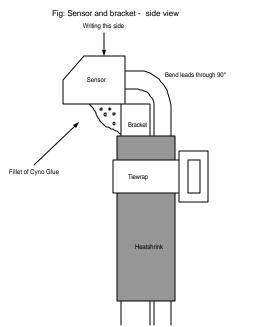Use backup throttle curves.
Set the flight mode/stunt/idle up minimum throttle settings greater the 25% so that the Jockey is enabled (SET led on) at all stunt throttle stick positions. (Note that it can still be disabled using the aux channel).
Make sure that the engine can idle reliably when the throttle stick is below 25%.
Set the throttle hold below the enabled threshold so that the Jockey is automatically disabled during autorotations.
Set the PCM failsafe to the stop position of the engine.

Sensor and magnet installation

The Jockey uses a magnetic hall-effect sensor. The magnet is installed on the cooling fan of the engine and the sensor is attached to a bracket which attaches to one side of the engine mount.
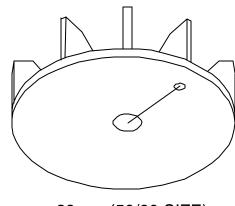
Fig: Sensor and bracket - side view

Fig: Engine Fan Magnet – bottom view

28mm (50/60 SIZE)
23mm (30 SIZE)

Use the supplied Heat Shrink tubing and tie wraps to mount the sensor to the bracket. A dab of Cyno can be used to secure the sensor and tie wraps once the position has been set. The sensor is carefully bent over the top of the bracket with the writing on the sensor facing the fan (Note: The most sensitive side of the sensor is the side with the writing, however, if you have a magnet installed from a previous Futaba GV1 setup, the Jockey sensor needs to be oriented with the side without the writing facing the magnet).

The magnet should be mounted on the underside of the fan at a radius of 28mm (60 size) or 23mm (30 size) from the center of the fan. Drill a 4mm hole 1.5mm deep and epoxy the magnet to the fan. Do **not** use metallic epoxy such as JB-Weld, it will lower the performance of the magnet. Use a good epoxy with a 20min or greater curing time.

If both magnets are installed to balance the fan in a 2-stroke setup, make sure that the sensor only responds to **one** of the magnets.

The sensor must be mounted a close to the magnet as possible. The sensor must be less than 2mm away from the surface of the magnet.

The sensor is only sensitive to one pole of the magnet. To check the correct orientation of the magnet, connect the Jockey to the receiver and turn on the transmitter then connect the sensor and pass it in front of the magnet. The Red LED will light as the sensor detects the magnet. After installation, this method can be used to periodically check that the sensor and magnet are in range.

Operation

After power-up, the Jockey waits for a calibration event from the AUX channel or the rpm POT. Normally the Jockey will enter an idle state monitoring the sensor, throttle and auxiliary channels waiting to be enabled. Once enabled the jockey waits for the engine to reach the target speed set by the auxiliary channel state ATV. After 1 second, the Jockey will slowly and smoothly take over the throttle channel, regulating the engine directly. If the target speed is changed during flight (by changing the aux state setting), the Jockey will acquire the new speed target setting.

Rules of governor engagement
The Jockey will only govern the throttle after ALL of the following conditions have been met:
1. The Sensor, Throttle and Aux channel are operating correctly AND
2. The Jockey has been calibrated AND
3. The Throttle stick is above 25% AND
4. The AUX ATV is greater than 5% (if connected) AND
5. The target speed has been reached.

After governing has been enabled, the Jockey will pass control back to the throttle channel if ANY of the following conditions occur:
1. The Throttle stick is below 25 % (Throttle stick priority) OR
2. The sensor fails OR
3. The AUX ATV is less than (Auxiliary disable) 5%

If the battery voltage dips below 3.56V, the Jockey will enter a 'fail-out' mode where control is passed back to the receiver. The only way to exit the 'fail-out' mode is to cycle the power.

Four-stroke engine setup

Four-stroke engines run at about half the speed of a two-stroke engine. Two magnets can be installed 180 degrees apart on the fan. This will cause the Jockey to govern at half the target rpm (4750 to 10250 rpm).

Specifications:

Regulation range:	9500 to 20500 rpm engine shaft speed. 4-stroke: 4750 to 10250 rpm
Control System:	Adaptive, digital Feed-Forward
Resolution:	0.04Hz (2.26rpm engine speed)
Response:	20ms (Standard Servo mode) 4ms (Super Servo mode)
Operating Voltage range:	3.56 – 8V
Operating Temp range:	-40 to +85 degrees C
Weight:	10g
Current Drain:	13mA @ 4.8V
Command oversampling:	8X
Nominal command:	1510us
Absolute range:	900us to 2200us

Disclaimer and Limitation of Liability

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Radio Systems setup examples

FUTABA T9CHP Setup

The throttle connects to channel (3)
The auxiliary connects to the GOVERNOR channel (7)
End Point Adjust [END POINT]

Setup the throttle with the E.POINT range as close to 100/100 as possible.

Select channel 7 (AUX) and set the [E.POINT] to 95/95

Make sure that the [GOVERNOR] function is inhibited [INH] before calibration. (See page <2/2> in the GOVERNOR menu). The system is now ready for calibration.
The target rotor speed can be calculated using the table above.
Note: The 9C has a Governor function. The EPA values for rotor speed must be converted to Governor rates by dividing by 2 and adding 50. A rate of 50 disables the Throttle Jockey, An EPA of 53 (1500 rpm @ 9.3) corresponds to a rate of 53/2 + 50 = 76.5.
Enable the Governor function:

    In the [ADVANCE(HELI)] menu select GOVERNOR
    Page <1/2>
    RATE-UP   > 76.5%   (53/2 + 50)
        CNTR > 64.5%   (29/2 + 50)
        DOWN > 50.0%
    Select SW>C
    Page <2/2>
    Change MIX>INH to MIX>ACT
    CUT-CH>CH7
    DIR>+Limit

This will yield the following results:

SW(C)	Rotor RPM @ 9.3:1
Up	1500rpm
Center	1200rpm
Down	Disabled

JR 8301/8103 Setup

The throttle connects to THRO channel (1)
The auxiliary connects to GEAR channel (5)
ATV setup [TRVL ADJ]
Setup the throttle servo and linkage as close to +/- 100% ATV as possible.
Select the GEAR channel to +100% and -100%
Hint: You can observe the GEAR range on the [MONIT] screen.
The system is now ready for calibration.
The target rotor speed can be calculated using the table above.

Example 1): 2 speed setup:
    Gear ratio = 9.3:1
    ATV- = 39%, ATV+ = 72%

GEAR Sw Posn	Rotor RPM
down (MIX)	1200
up (GEAR/INVERT)	1500

Example 2): 1 speed setup and disable:
    Gear ratio = 9.3:1
    ATV- = 0%, ATV+ = 72%

GEAR Sw Posn	Rotor RPM
down (MIX)	Disabled
up (GEAR/INVERT)	1500

Example 3): Flight Mode Mixing:
    Set the throttle curves in Flight modes 1 and 2 above the throttle priority level.
    Set the GEAR switch to the (MIX) position
    Set the GEAR ATV [TRVL ADJ] to -0%
    Set the GEAR switch to the up (GEAR/INVERT) position
    Set the GEAR ATV [TRVL ADJ] to +100%
    [PROG.Mix3] - This mix disables the Governor in flight mode 'N'
    GEAR ->GEAR
    RATE:->-100%
        0%
    SW: ON, Offset 0
    [PROG.Mix2] - This mix sets the target rpm to 1200rpm (39%) in flight mode '1'
    GEAR ->GEAR
    [Select Point-H]
    Set the rate to 39
    [Select Point-L]
    Set the rate to 0
    [Ignore Point-1, Point-2 and Point-3]
    SW: F-S12
    [PROG.Mix1] - This mix sets the target rpm to 1500 (72% - 39% see note below) in flight mode '2'
    GEAR ->GEAR
    [Select Point-H]
    Set the rate to 33 (see note below)
    [Select Point-L]
    Set the rate to 0
    [Ignore Point-1, Point-2 and Point-3]
    SW: F-2
Note: The Mix1 rate is 72 (1500rpm) - 39 (1200rpm) = 33%

GEAR Sw Posn	Flight Mode	Rotor RPM
down (MIX)	N	Disabled
	1	Disabled
	2	Disabled
up (GEAR/INVERT)	N	Disabled
	1	1200 rpm
	2	1500rpm

AIRTRONICS RD8000 Setup

The throttle connects to channel (3)
The auxiliary connects to AUX1 channel (7)
Endpoint setup [EPA]
Setup the throttle servo and linkage as close to +/- 100% EPA as possible..
Select channel 7 (AUX1) and set the [EPA] to +100% and -100%
The system is now ready for calibration.
The target rotor speed can be calculated using the table above

Example 1): 2 position switch, single speed.
    Select Channel 7
    Select the Endpoint Adjust Menu [EPA]
    With the switch in the up position, set the EPA to 74% (1500rpm @ 9.3:1).
    With the switch in the down position, set the EPA to 0%

AUX1 Switch	Rotor RPM
Down	Disabled
Up	1500rpm

    Example 2): 2 position switch, two speeds.
    Select Channel 7
    Select the Endpoint Adjust Menu [EPA]
    With the switch in the up position, set the EPA to 74%
    With the switch in the down position, set the EPA to 42%

AUX1 Switch	Rotor RPM @ 9.3:1
Down	1200rpm
Up	1500rpm

Example 2): Flight Mode Mixing:
    After calibration, move the Auxiliary input to the GYRO channel (Channel 5)
    Select the [GYR] menu
    Set F-Mode N to 0%
    Set F-Mode 1 to 42% (1200rpm @ 9.3:1)
    Set F-Mode 2 to 74% (1500rpm @ 9.3:1)
    Set F-Mode 3 (Throttle Hold) to 0%

    Yeilds the following setup:

Flight Mode	Rotor RPM
N	Disabled
1	1200rpm
2	1500rpm
3 (throttle hold)	Disabled

HITEC Eclipse7 Setup

The throttle connects to CH3
The auxiliary connects to CH7
EPA (End Point Adjustment) setup [EPA]:
Setup the throttle with the EPA range as close to 100% as possible.
Select CH7 and set to R/D 110% and L/U 110%
The system is now ready for calibration.
The target rotor speed can be calculated using the table above.

Example 1): 2 speed setup:
    Gear ratio = 9.3:1
    EPA L/U = 44%, EPA R/D = 77%

CH7 Sw Posn	Rotor RPM
R/D	1500
L/U	1200

Example 2): 1 speed setup and disable:
    Gear ratio = 9.3:1
    EPA L/U = 0%, EPA R/D = 77%

CH7 Sw Posn	Rotor RPM
R/D	1500
L/U	Disabled

Example 3): Flight Mode Mixing:
    The Gyro channel can be used for flight mode mixing. Calibration must been done using CH7. The Gyro rates correspond to half the EPA or calculated rates. A Gyro rate of 50% disables the governor. The Gyro rate for the Flight mode channels must be subtracted from 50%. For example, an EPA of 77% for 1500 rpm corresponds to a gyro rate of 50 - 77/2 = 12 rounded up.
    After calibration, move the auxliary channel to CH5 - GYRO. Connect the gyro to CH7 and use the EPA for CH7 to set the gyro gain. Below 50% EPA, the gyro gain is disabled.
    Set the throttle curves in Flight modes ST1 and ST2 above the throttle priority level.
    Set the NOR rate to 50% (Disables the Governor)
    Set the ST1 rate to 28%   (50 - (EPA$_{1200}$/2))
    Set the ST2 rate to 12%   (50 - (EPA$_{1500}$/2))

Flight Mode	Rotor RPM
NOR	Disabled
ST1	1200rpm
ST2	1500rpm