

TECH MODEL PRODUCTS

TH-2 VTOL

GENERAL PURPOSE HELICOPTER CONTROL SYSTEM

VERTICAL TAKE-OFF AND LAND

Words: Chuck Bassani

In the RC world, commanding twin rotor helicopters such as the tandem CH-47 and vertical take-off and landing (VTOL) aircraft like the V-22 Osprey require complex control mixing. The mixing needed is typically beyond the capability of most radio systems. Factor in the necessity to process real-time inputs from on-board sensors (i.e. gyros) and you'll quickly discover that it's something that just can't be done from the transmitter at all.

For this reason, we need to turn to on-board mixers. These purpose built devices are designed to integrate with on-board sensors and perform all the necessary control mixing. One such product is the Tech Model Products TH-2 GP Helicopter / VTOL Control System.

OVERVIEW

The TH-2 GP is designed for use in single rotor and tandem helis, as well as coaxial VTOL aircraft. It can control 2-, 3-, and 4-point CCPM swash plates and drive up to 8 individual micro servos directly.

The unit itself is well built and compact – utilizing state-of-the-art surface mount technology. The TH-2 GP is also enabled for future expansion, exposing electrical interfaces for digital I/O and 10-bit analog to digital input.

PROGRAMMING FEATURES

As already stated, the TH-2 contains programming for helis and VTOL aircraft. Each mode has its own unique set of features. Initially, all control mixing at the transmitter is disabled. For the most part, raw control positions are all the TH-2 GP needs to operate.

HELI MODE

PROGRAMMING FEATURES IN THIS

MODE INCLUDE:

Collective pitch direction control: Sets proper collective control direction

based on whether your blade grips have the links on the leading or trailing edge. Basically, this determines if an upward or downward moving swash plate increases pitch.

Servo reversing on all 8 outputs: Allows you to individually control servo travel direction on all 8 servo outputs

Servo centering on all 8 outputs: Individual fine tuning (+/- 12.5%) of center adjustment on all 8 servo outputs

Gain control on all inputs: Adjusts the authority each input has on the mixing algorithms

2, 3, and 4 point swashplate types: Selects mixing to support all the popular 90- and 120 degree CCPM swash plate geometries

Swash plate layout: Tells the TH-2 GP where the elevator attaches to the swash plate. It can be set for the front or rear of the swash plate.

Low pass yaw filter: Helps reduce vibrations that may be picked up by sensitive gyros.

SPECIFICALLY FOR TANDEM HELIS:

Differential Collective Pitch (DCP): Facilitates fore/aft pitch control by apply-

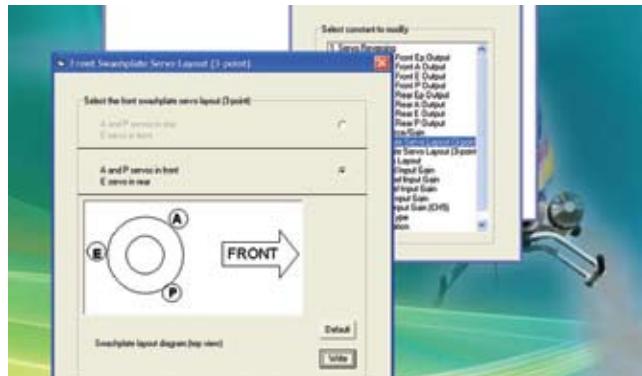
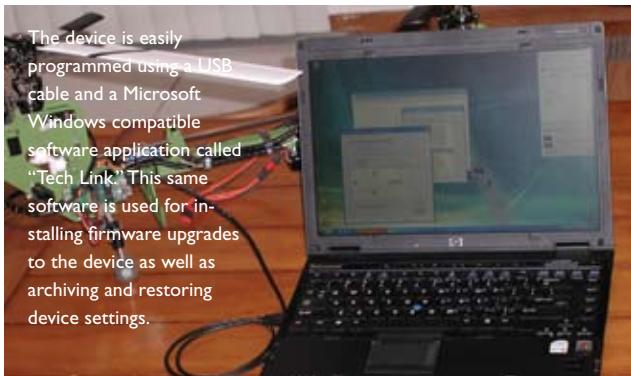
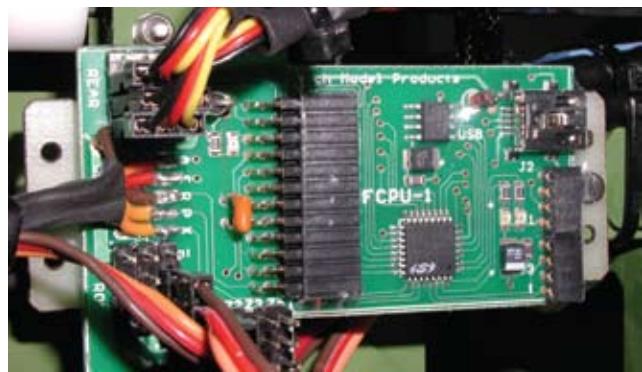
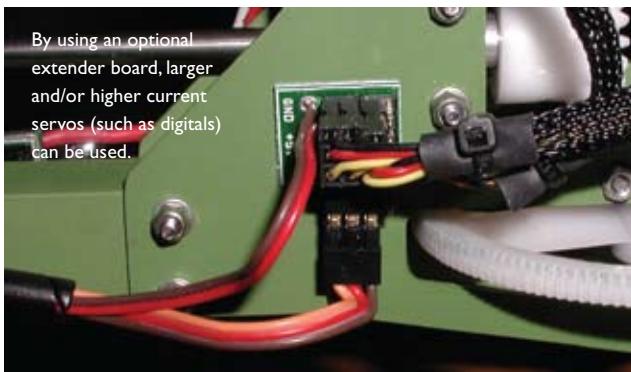
ing differential (opposite) movement to the front and rear swash plates.

Yaw compensation: Provides an automatic pro-active control input designed to counteract any yaw tendencies introduced by DCP before they occur. This helps because of the rather slow response tandem helicopters exhibit during yaw inputs.

Example - How it controls a Tandem heli: A typical application for the TH-2 GP is to control a tandem rotor heli. Tandem helis have two main rotors: one in the front of the machine and one in the rear. Let's take a look at how the TH-2 GP translates transmitter inputs to swash plate movements.

Throttle/Collective: Control pulses from the receiver's 'Pitch' output are received by the 'Pitch' input of the controller. Both swash plates will move up/down together as the throttle stick is moved.

Aileron: Control Pulses from the receiver's 'Aileron' channel are received by the 'Aileron' input of the controller. When the aileron stick is moved, both swash plates will tilt in the appropriate left/right direction.



Elevator: Control pulses from the receiver's 'Elevator' channel are received by the 'Elevator' input of the controller. When the elevator stick is moved, both swash plates will tilt in the appropriate fore/aft direction. Additionally, we can enable a transmitter compensation mix to slave a 'Spare' channel off of the 'Elevator' channel. Control pulses from the slave channel are input to a gyro sensing the helicopter's pitch axis. Gyro output is received by the controller's 'Channel 5' input. When DCP is enabled, elevator tilting is augmented with Differential Collective Pitch. This moves the front and rear swash plates up/down in opposite directions, thus producing very effective gyro stabilized pitch control.

Rudder: The control pulse from the receiver's 'Rudder' channel are input to a gyro sensing the helicopter's yaw axis. Output from the gyro is received by the controller's 'Rudder' input. When the rudder stick is moved, both swash plates will tilt in opposite left/right directions.

VTOL MODE

PROGRAMMING FEATURES IN THIS MODE INCLUDE:
Servo reversing, Servo centering, and

Input gain, Swashplate type, Swashplate layout, Collective pitch layout, and DCP. These function just as they do in helicopter mode.

Remote switching between Airplane and Heli mode: Allows you to switch between the Airplane and Heli operating mode. The point at which the TH-2 switches modes on the 'Channel 5' input can be set.

Individual DCP Source selection for Airplane and Heli mode: Allows you to define the DCP input source (aileron, elevator, rudder, or pitch) for each mode of operation.

Heli mode flap settings: Allows you to select points on the 'Channel 5' input where the TH-2 engages flap movement. Two points can be set as well as defined flap positions for when each of those points is triggered.

Airplane mode flaps input source: In airplane mode, the ailerons work as flaperons. This setting allows you to specify which input controls the flap position.

Yaw axis selection: Allows you to specify which axis 'Yaw' applies to. It can be set to 'roll' or 'pitch'.

Three general purpose program mixes in each mode: Up to three compensation mixes can be set in each mode of operation. Input gains can be adjusted individually.

WIRING IT ALL UP

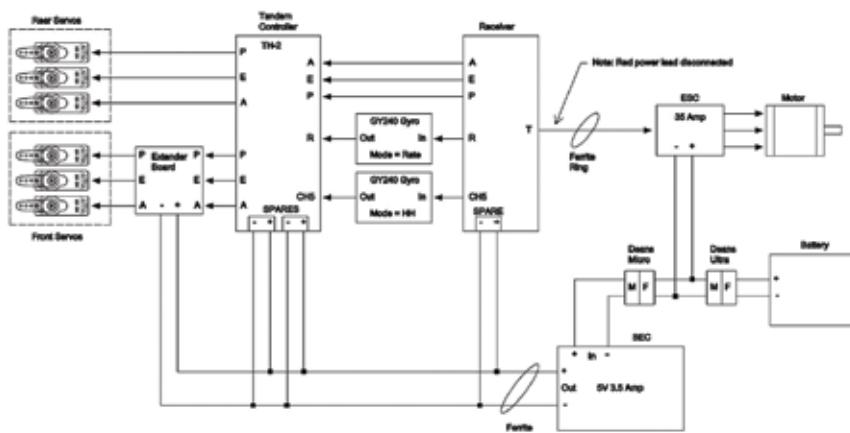
As you can imagine, the on-board circuits are somewhat involved. The support page on the Tech Model Products website has some very detailed diagrams that show exactly how all the components should be connected. Here's how it's wired in a tandem heli application:

Higher than average power requirements result in a separate BEC or voltage regulator being specified. This will feed power to the receiver, servos, gyros, and the TH-2 GP controller. In electric applications, the ESC gets its power directly from the motor battery and only receives a signal pulse from the receiver.

THE 'TECH LINK' SOFTWARE

Installing the 'Tech Link' software is as easy as most Windows application installs. You basically run an install program. Once that's done, you'll need to

TH2 GP TANDEM HELI WIRING DIAGRAM



If you haven't guessed we favor Mac's in this office.

install the USB device drivers. Again, this is as easy as plugging in the TH-2 to your computer through the USB cable and following the 'New Hardware Found' dialog.

The TH-2 gets its power from the USB port when connected to the PC, so no other power source is necessary. In fact, if you do have another source providing power to the TH-2, the USB port doesn't work. Once the TH-2 is connected to your PC through the USB cable, run the 'Tech Link' application.

USING THE 'TECH LINK' SOFTWARE, YOU CAN:

- Install the TH-2 firmware (.hex file)
- Load / Modify / Save feature settings (called 'Constants', .cst file)

The 'Tech Link' software, USB drivers, and firmware and constants files are all available as free downloads from the Tech Model Products website.

Once the firmware and constants are loaded into the TH-2, you can begin modifying the feature settings. Every feature has its own dialog. Once you make a change, you must write the setting back to the TH-2's flash memory.

Testing your changes means you have to disconnect the USB cable and power up the model. Initially, there is a lot of back and forth between making changes and testing them, especially when adjusting servo centering.

SOME TECHNICAL STUFF ...

The TH-2 operates on 5.0 volts. When choosing a regulator or BEC, verify that

it can hold the supply voltage to within +/- 0.1 volts. This is very important as no fail-safe capability is provided. By using the optional extender board, you can feed power directly to the servos – essentially bypassing the TH-2 GP. I highly recommend this approach. I cannot stress enough how imperative it is to calculate the total power required by the entire on-board system and to use a regulator or BEC capable of handling the load.

With every frame received, the TH-2 GP sequentially stores channel control pulses output by the receiver. Once it receives the control pulse from its 'Pitch' input, it executes its internal mixing algorithms. The documentation refers to this as 'synching' on the 'Pitch' input. Obviously, this means that all other inputs to the TH-2 GP must come earlier than the 'Pitch' input in the transmission frame. After processing, the TH-2 GP outputs control pulses to the servos in pairs. Depending on mode of operation, that's three or four sequences of two simultaneous outputs.

CONCLUSION

The TH-2 GP faces the task of performing complex mixing head-on and does it quite well. I found it easy to learn, easy to install, and easy to program. The fact that it provides a robust power distribution solution is a plus.

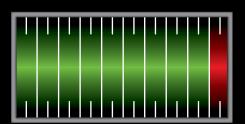
Next month we're going to see how this puppy performs, in nothing else than a Tech Model Products Twinn Rexx.

Stay tuned ...

» SCORECARD

SCALE RATING: 1=POOR 10=EXCELLENT

9.0



THE GOOD

- Excellent performance
- State of the art design
- Flexible programming via Tech Link PC software
- Upgradeable firmware

THE BAD

- A lot of cumbersome switching between programming and testing during setup.

CONNECT

MANUFACTURER: Tech Model Products

WEBSITE: www.tech-mp.com

PART NUMBER/STREET PRICE:

- TMP TH-2 GP Controller: \$149.99
- TMP TH-2 Extender Board: \$8.99
- TMP TH-2 Mounting Plate: \$5.99
- TMP USB Cable: \$4.99
- TMP Tech Link Software: Free download
- TMP TH-2 USB Windows Drivers: Free download
- TMP TH-2 Helicopter Firmware: Free download
- TMP TH-2 VTOL Firmware: Free download
- TMP TH-2 Constants: Free download

Note for PCM receiver users: PCM receivers typically have a lower output pulse voltage than non-PCM receivers. Not all PCM receivers will work with the TH-2 GP. Please check with Tech Model Products for compatibility with your specific receiver.