

Generalities

This gyro system serves to stabilize and dampen, respectively, the motion of R/C model aircraft about a single axis, depending on the method of installation of the sensor of the unit in a model. Novel feature of the system is the utilization of the piezo-electrical effect of special ceramic elements which replace the revolving gyros used up to now. As a result all mechanical parts which are susceptible to wear have been eliminated.

Be sure to read these instructions carefully, so you'll be familiar with this new gyro and can use it in optimum manner. A gyroscope can not steer a model; it can only stabilize it about a single axis and dampen rotational motion about that axis, respectively. This means that when a model is being displaced from its normal attitude - by wind or fluctuation of torque, for example - about the axis concerned, this deviation will be detected by the sensor element. Electronics connected to the sensor immediately generate a servo signal which counteracts the rotary motion, with the result that the model in fact does not alter its attitude. Control signal and gyro signal are mixed electronically.

Prominent features

- Completely wear-free detection of rotary motion by die piezo-electrical elements, no revolving parts, no bearings as used in previous gyro systems, hence reliability and no need for maintenance.
- High signal/noise ratio. Disturbances, such as the airframe vibrations of a model heli, for example, are substantially suppressed.
- High dynamics with extremely high resolution ensure precision control even at very small angular velocities.
- Extremely high linearity and temperature stability ensured by complex electronics.
- Absence of hysteresis effects.
- Sensitivity improved over conventional gyro systems.
- Compact design: Sensor module sporting ultra-modern SMD-electronics.
- Low current consumption.
- Simple, comfortable handling for many possibilities:
- Infinitely variable adjustment of sensor sensitivity from 0% to 100% (depending on transmitter equipment).
- Reversing switch for reversing the positive direction which facilitates adaption of the gyro to a specific model.

Technical data (nom.)

Operation voltage	4,8-6 V
Current consumption	85 mA
Temperature range	-10° C à + 60° C
Sensitivity	± 22,5 mV ± 0,65 mV/degree/sec.
Weight, a.u.	85 g
Dimensions:	
Sensor unit	34×33×33 mm 41 g
Electronic unit	53×38×16 mm 32 g
Regulating unit	35×24×10 mm 12 g

Applications

- Main field of application is the stabilization of a model helicopter about its vertical axis, which is to say that tailrotor control is affected (damping in yaw), with the effects of fluctuations of wind and torque of the drive system in relation to the vertical axis being effectively reduced.
- In the case of fixed wing model aircraft the Piezo 2000 system can be used to stabilize it about the longitudinal axis (ailerons), or the transverse axis (elevator) or the vertical one (rudder), as practical.
- Model copters as well as fixed wing model aircraft can be stabilized about more than one axis by using an appropriate number of gyros. This will make sense in special cases only, however. The axis, about which the model is to be stabilized, is an imaginary line passing through the center of the bottom part and the center of the surface of the lid of the sensor unit.

Zu stabilisierende Achse = axis to be stabilized
Gyro = gyro

How the gyro has to be installed for the various application options is shown by the diagrams (below).

2. Principle of operation

Heart of the piezo-electrical gyro system is the piezo-electrical sensor element of Messrs. Murata. It consists of a special flexible metal rod of prismatic cross-section, with piezo-ceramic elements attached to its three faces. One of these elements (FB = feedback) excites the prism, causing it to oscillate. These vibrations are detected by the other two elements (R + L = right and left) and converted into electric impulses. As long as the prism is not revolved about its axis of rotation - which may possibly be located outside the rod - the signals at the ceramics "R" and "L" will have the same amplitude "A" and the output difference signal when then be zero. It is only when a rotary motion occurs about the rotational axis of the prism that a further force comes into play which deforms (bends) the prism and stretches one of the ceramic elements L + R, and compresses the other one. Result is a positive or negative difference signal, depending on the direction of rotation. The value of the signal, depending on the direction of rotation. The value of the signal is proportional to the angular velocity of the rotary motion. Further electronic processing of the difference signal in the end results in appropriate servo motion in the required direction.

See diagrams 5 and 6 (below)

3. Wiring the components of the Piezo 2000 system

Electronic unit

The connecting leads RX are plugged into that receiver output the function of which is to be stabilized; in the case of model copters this will be the tailrotor servo function output. The electronics unit sports a reversing switch (Rev SW) and a control lamp.

Servo (not included in Piezo 2000)

Connect the servo, the function of which is to be stabilized, - in case of model copters the tailrotor control servo - to socket SV of the electronics unit.

Sensor unit

(The leads of the latter are now connected to the socket marked Gyro of the electronics unit (direction of plug insertion optional). The sensor detects rotary motion and provides the appropriate electric impulses.

Regulation unit (gain controller)

Insert the larger 6-pin connector into the socket marked CTL (controller) of the electronic unit. The smaller 3-pin light grey connector is plugged into that socket of the receiver, with the channel of which the sensitivity of the gyro is to be adjusted (f.e. Gear, Aux2, Aux3, or outputs 7-9).

a) If a switch providing two end positions is used for this purpose at the transmitter, the end positions being determined by servo throw adjustment, two sensitivity stages for the gyro will be adjustable and switchable.

Throw adjustments between -100% and 0% result in adjustments of lower sensitivity, those between 0% and 100% in higher sensitivity.

b) If a proportional rotary - or slider-type regulator is used and the servo throw is adjusted between -100% and +100%, Gyro sensitivity can then be adjusted infinitely variable between 0% and 100% at the transmitter.

c) With some of the non-computer-controlled R/C equipment, such as the FM 6014, the gyro control module, too, can be used for regulating sensitivity. The regulation unit of the Gyro NEJ 120 BB can also be used with the Piezo 2000 system. The 6-pin connector of the regulating unit has, in this case, to be equipped with the leads of the furnished short-circuit connector, as per diagram. Two sensitivity stages are then adjustable and switchable at the transmitter.

6-Pol-Stecker = 6-pin connector
Kurzschlußbrücke = short-circuit bridge

Verkabelung	= Wiring diagram
zu stabilisierendes Servo	= servo to be stabilized
Empfänger	= Receiver
Elektronik-Einheit	= Electronics unit
Kontroll-Lampe	= control lamp
Umpolwechsler	= reversing switch
Sensor-Stecker	= sensor connector
Regler-Stecker 6-polig	= 6-pin regulator connector
Servo-Stecker	= Servo-connector
Gyro Sensor-Einheit	= gyro sensor unit
Regler-Einheit	= regulator unit (gain-controller)
zum Servo-Ausgang	= to servo output
Regler-Stecker, 3-polig	= 3-pin regulator connector

4. Installation of the sensor-unit

The sensor should be installed as close as possible to the center of gravity of the model. And, what's more: at a station where it will be exposed to the least and weakest possible vibrations. Its fixing base must be mounted at proper right angles to the axis to be stabilized. The fixing base must be made as robust as possible, using at least 3 mm aircraft quality plywood or 2 mm aluminum sheet. In the case of model copters equipped with a fuselage fairing the fixing base may be glued on the floor of the fuselage. In the case of Trainer-type copters a suitable place must be found at or between the side parts. A special gyro panel, aft of the mainrotor shaft, is provided in the case of the Graupner/Heim Mechanics "Vollmechanik", order No. 1290 and 1291, as well as the UNI-Expert Mechanics, order No. 4449 and 4450. An alternative solution: the sensor may be installed, together with the remaining R/C components, at a suitable station, which, too, should be as free as possible of vibrations. Fixing is performed by attaching the sensor with a piece of the furnished double-stick foam plastic.

Installation of the electronics unit

Electronics unit and receiver are to be installed together, wrapped in soft foamrubber for protection. If space does not permit such an installation they may be connected by (servo) connecting leads.

Installation of the regulator unit (gain controller)

This unit should be installed together with the electronics unit or in the vicinity of same, wrapped in foam rubber.

Operation (In conjunction with model helicopters)

1. After the wiring has been completed, run up rudder throw for the tailfunction to max. 150% right and left at the transmitter (possible only with some of the computer equipment).
2. Set the sub-trim function to zero.
3. Set trim levers to zero.
4. Set throttle stick to center position, so static torque compensation will be neutral. Dynamic torque compensation won't interfere here.
5. Turn the transmitter on first, then the receiver.

Attention: The gyro system requires approx. 3 seconds to level. The control lamp of the electronics unit will then light up.

During these three seconds the model must not be moved!

6. Now move the tailfunction control stick and check for correct coordination. Keep in mind that an intended righthand rotation of the bow of the copter corresponds to a lefthand rotation of its tail end. Change polarity at the transmitter, if necessary.
7. As shown by the diagram (below) the tail control linkage must be installed at right angles (90°) to the servo output when the latter is in centre position. Mount servo output arm on servo accordingly. If possible do not use the sub-trim function for this operation.

Heckanlenkung	= arrangement of the tail control linkage
Heckservo	= tail function servo

Check gyro action for correct coordination by turning the copter slightly about its vertical axis and observing the gyro-induced reaction of the tail servo when doing so. Tailrotor deflection must cause a rotation which counteracts the rotation of the model!

If this is not the case, shift the reversing switch (REV-SW) at the electronics unit to the opposite end station. This check must be conducted with utmost care!

9. Check sensitively control which must permit adjusting the sensitivity in steps or infinitely variable, depending on the use of a switch or a regulator.

10. Example of adjustment for the "static" torque compensation function:

Normal setting: "up" approx. +30% "down" approx. -10%

5. Effect in flight

1. As a first step the model copter has to be set up neutrally by performing appropriate adjustments of the various linkages. Only in an emergency or for fine-tuning may the trim means of the transmitter be used for this step.

2. Adjusting gyro sensitivity. Piezo 2000 is an extremely fast reacting system. As a result no major differences will be observable when flying in the hover mode. A better chance for adjusting sensitivity is provided by flying the model in circles or transversally to the wind direction. If still higher sensitivity is to be attained this has to be tried via servo throw: attach the linkage at the next bore (outward) of the servo output.

3. Adjusting static torque compensation. Preferably have the model transition to the hovering mode at safe height in calm air, then perform the adjustments for climbing and descending flight.

4. Make the model fly on pirouette each to the left and to the right. Compare the rotative speeds and reduce the higher one by altering servo throw. Rotative speed should be the same either side.

5. Optimum effect of the tailrotor – whether with or without gyro – will be obtained when the entire tail control linkage is as robust and stiff as possible. For that reason a linkage routed inside a tube will always prove advantageous.

6. Attention! – Caution!

- If, after the transmitter has been turned on, the receiver, too, has been turned on, the model must not be moved for approx. three seconds, until the control lamp in the electronics unit lights up.
- After that moment it does not matter later on whether the control lamp is on or off. This depends on the attitude of the model.
- You may notice excessive tail rotor servo drift if the gyro encounters an abrupt change in temperature; e. g. in cool weather, if you take your model out of a warm car into the colder outside air, or, in warm conditions, if you take the model out of your air-conditioned car into the heat of a Summer day. If this should occur, simply switch the unit OFF, then ON again. This action resets the level of the Piezo 2000 (as described in point 5. in the section "Using the gyro"). As far as possible, it is best to avoid ... rapid changes in temperature!
- The gyro must not be brought into the vicinity of strong magnetic fields.
- Piezo 2000 is highly sensitive. Be sure to vibration-dampen your model copter as well as possible!
- The tailrotor of a model helicopter is a delicate mechanism and requires thorough maintenance and care. Only then will reliable function be guaranteed – no matter whether a gyro is used or not.
- When the Piezo 2000 system is used your tail servo will be subjected to higher loads than in the case of conventional gyro systems. For that reason make sure the power supplies are fully charged before each flight, even more so than you do normally anyway. Battery capacity should be at least 1000 mAh

GRAUPNER GmbH & Co. KG D-73230 KIRCHHEIM/TECK GERMANY

Subject to changes!

10/93 1/95